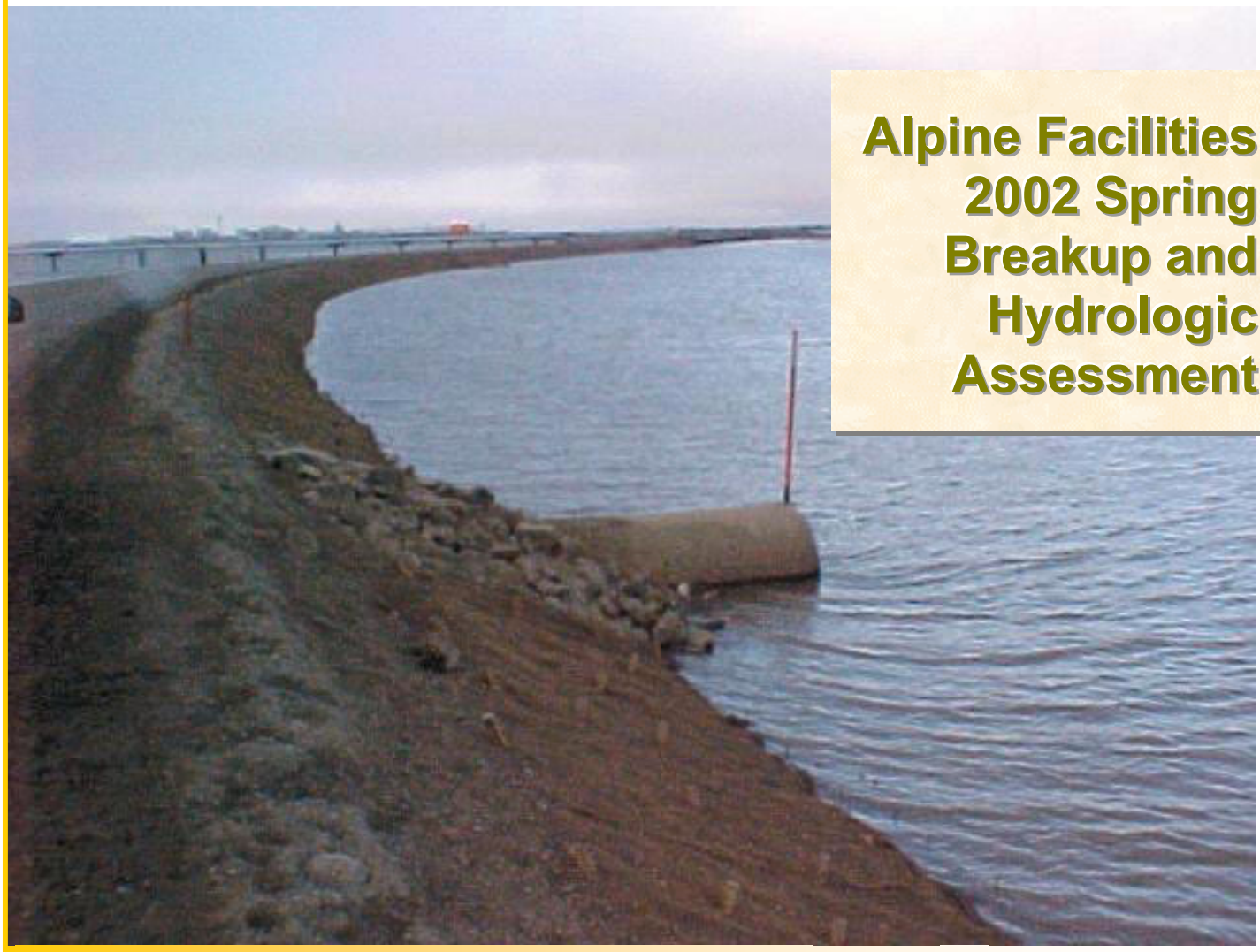
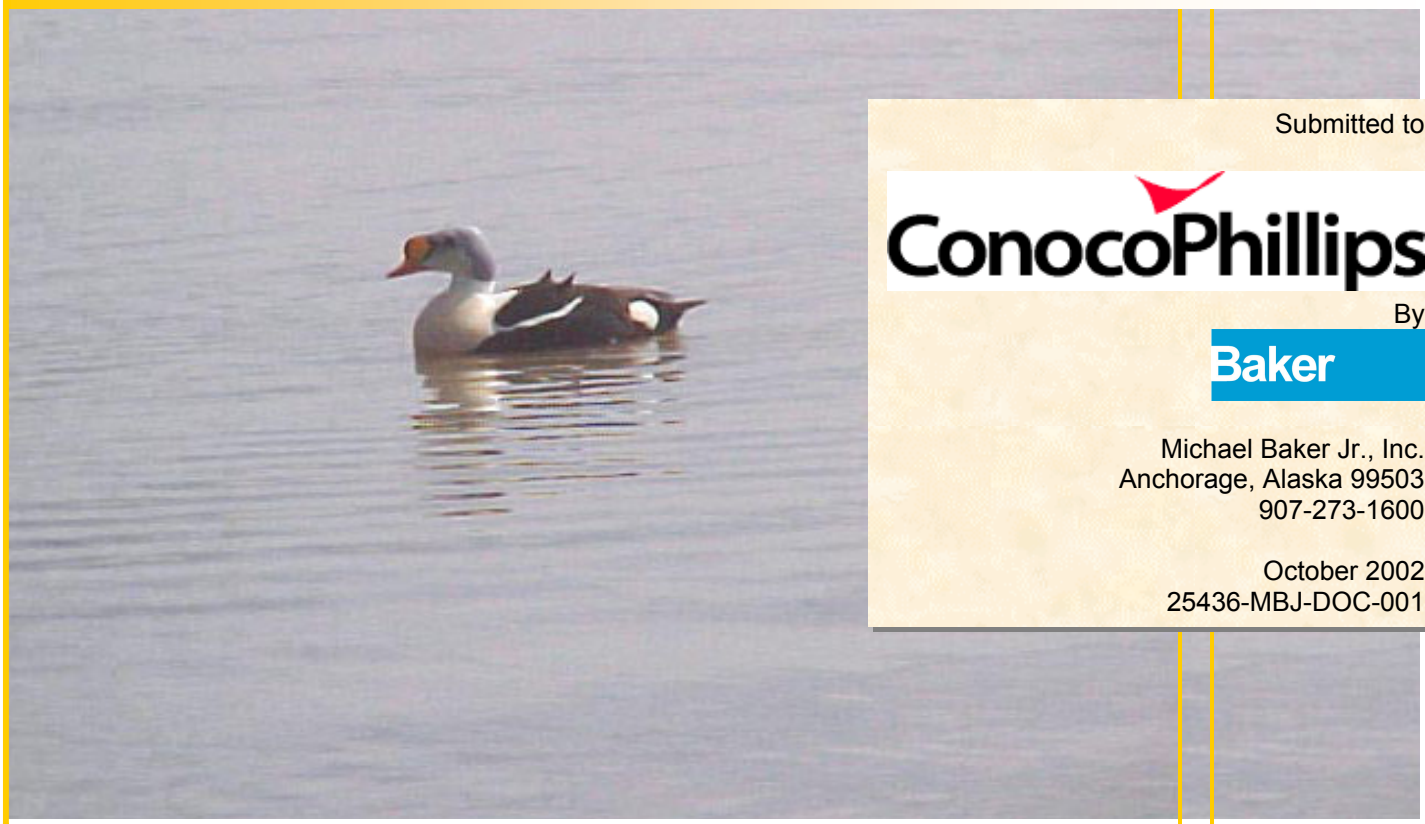


Alpine Facilities 2002 Spring Breakup and Hydrologic Assessment



Submitted to

ConocoPhillips

By

Baker

Michael Baker Jr., Inc.
Anchorage, Alaska 99503
907-273-1600

October 2002
25436-MBJ-DOC-001

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Contents

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1.0 Introduction

This report summarizes the hydrologic observations and measurements made during the 2002 spring breakup of the Colville River Delta in and around the Alpine Development (Alpine). This hydrologic breakup assessment was done in part to satisfy permit stipulations associated with the construction and operation of the Alpine facilities. Following are summaries of the relevant permit stipulations and, in parenthesis, the applicable report section that addresses each.

U.S Army Corps of Engineers, Department of the Army Permit 2-960874, Colville River 18 (USACE 2-960874)

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*Page 2-A Item 6. Aerial and ground photography shall be taken within 24 hours of peak flood discharge during spring breakup and any high water event that results in water passing through the infield facilities (subject to weather conditions and safety requirements) (*Section 2.1*). Monitoring shall continue weekly after the high water event until water is no longer ponded upstream of the road. The monitoring shall be done for the first five years after completion of construction and for high water events greater than the 10-year predicted floodwater surface elevation event. A monitoring plan shall be submitted to the District Engineer prior to completion of gravel placement for the infield facilities. The annual report shall contain: data and analysis related to the peak flow during the event (*Section 2.2*); the relationship of the observed peak flow with the predictive model (*Section 3.0*); water velocity along road and pad side slope corners (*Section 2.1*); velocity and discharge rates through culvert and bridge openings (*Section 2.3*); drawings showing the locations and extent of any erosion, scour, or gravel deposition greater than 20 cubic yards per 100 linear feet, a cross section of each erosion area superimposed on the as-built cross section of the area of concern, and an estimate of material eroded from each affected area (*Section 4.0*).*

*Page 2-B, Item 7. Remedial action plans (to include additional or modification of drainage structures) shall be developed, submitted for approval, and implemented when water surface elevation is equal to or greater than 0.5-foot higher than the downstream side water surface elevation one week after the peak discharge has occurred (*Section 2.3*). Remedial action measures (recovery, placement of additional erosion protection*

*material, tundra restoration resulting from scour holes, revegetation, etc) shall also be developed when erosion of more than 20 cubic yards of gravel material occurs in any 100 linear feet of infield gravel fill placement. Any road washout area that occurs when water surface elevations are below the predicted 50-year flood event shall be further armored to withstand the predicted 100-year flood event water surface elevation (*Section 4.0*).*

State of Alaska, Office of Management and Budget Final Consistency Determination, State I.D. No. AK9703-03OG (AK9703-03OG)

Page 7, Item 6. A photographic records shall be established of the flow around and through the gravel fill on the Colville River Delta during the first occurrence of a spring breakup that results in a flow between Q2 and Q10, and the first occurrence of a spring breakup that results in a flow greater than Q10. A report of the photographic records is due to DEC before December 31 of the year the documented flow event occurs (Section 2.1).

Page 9, Item 24. Each culvert and the culvert battery shall be monitored following installation. A report summarizing observations made (e.g., scour, erosion, water surface elevation differences and identifying remedial work (if needed) proposed shall be submitted to the DFG annually by July 1 following spring breakup. Note: If the monitoring indicates little or no change, the reporting requirements may be changed by permit amendment (Section 2.3).

State of Alaska, Department of Fish & Game Fish Habitat Permit FG99-III-0051 (FG99-III-0051)

Page 2, Item 3. ARCO Alaska Inc. shall monitor the water surface elevation of Lake L93-12 (U6.1) Water surface elevations shall be taken immediately after ice breakup and at least once a week for three weeks following breakup (Section 5.0). *Water surface elevations also shall be taken once each month until freeze-up.*

State of Alaska, Department of Fish & Game Fish Habitat Permit FG97-III-0190-Amendment #1 (FG97-III-0190-Amendment #1)

Page 2, Item 1. ARCO Alaska Inc. shall monitor the water surface elevation of Lake L93-13 (T6.1). Water surface elevations shall be taken immediately after ice breakup and at least once a week for three weeks following breakup (Section 5.0). *Water surface elevations also shall be taken once each month until freeze-up.*

2.0 Breakup Summary

2.1. Water Surface Elevations and Observations

All elevations presented in this report are in feet and are based on the British Petroleum Mean Sea Level (BPMSL) datum unless otherwise noted.

Observation of the permanent staff gages in the Alpine vicinity began on 23 May 2002 after flowing water was first observed at the head of the Colville Delta. Water surface elevation measurements began when rising water levels were noted at the permanent gages on 24 May. Measurements continued through 31 May at which point breakup flows had receded substantially. Alpine Environmental personnel continued weekly readings. Staff gage locations are shown on Figure 2-1 and 2-2, and water surface elevation and observations are presented in Tables 2-1 through 2-8.

Peak water surface elevations occurred in the Alpine area late on 25 May and early morning of 26 May. A peak water surface elevation of 8.90 feet was recorded at permanent staff gage no. 10 (Lake L93-13). Peak water surface elevations of the remaining permanent staff gages ranged from 6.90 to 8.21 feet. Floodwater did not rise high enough to register on permanent staff gage 7 and no floodwater reached permanent staff gage 8.

Measurements indicate that during the Spring 2002 breakup, the difference between water surface elevations on either side of the road was 0.69 feet at permanent staff gages 3 & 4 and 0.82 feet at permanent staff gages 6 & 7. No floodwaters were recorded on permanent staff gage 7 (downstream side of road); however, the depth of water at permanent staff gage 6 is 0.82 feet with respect permanent staff gage 7. The maximum differences are the recorded high water marks and thus likely coincided with the occurrence of the peak water surface elevation. Differences in water surface elevations between the south and north sides of the road rapidly decreased as breakup floodwaters receded.

Breakup flooding conditions at Alpine on the morning of 25 May (within 24 hours before the peak water surface elevation), on the morning of 26 May (within 24 hours after the peak water

surface elevation), and on 31 May can be seen in Photographs 2-1a-e, 2-2a-h, and 2-3a-g, respectively.

To monitor water surface elevations at the head of the Colville River delta and in the Nigliq Channel, temporary staff gages were established at selected locations (Figure 2-1). Measurements began on 23 May when flowing water was first observed near Monument 01. Measurements continued until 30 May at which time temporary gages were removed from the field. Water surface elevation and observation records for temporary staff gages are presented in Tables 2-9 through 2-16.

The 2002 peak water surface elevation at Monument 01 occurred on the afternoon of 24 May at an elevation of 16.87 feet BPMSL. Following the peak, the water level receded rapidly and after thirty-six hours the water surface elevation had decreased to an elevation of 13.96 feet. In the Nigliq Channel near Monument 12 and temporary benchmark 20N (TBM 20N) the peak water surface elevations likely occurred sometime during the afternoon of 25 May or early morning of 26 May at elevations of 10.72 and 9.60 feet, respectively. The peak water surface elevations near Monument 22 and 23 occurred the afternoon of 26 May at elevations of 7.94 and 7.45 feet, respectively. At Monument 28, the temporary staff gages were destroyed, presumable by ice, on the afternoon of 26 May. The highest recorded water surface elevation at Monument 28, 3.66 feet, was taken on the afternoon of 26 May.

2.2. Peak Discharge in the Colville River Delta

Discharge in the Colville River was estimated using the Slope-Area Method as defined by the United States Geological Survey (Dalrymple & Benson 1984). All discharge estimates are for the section of river at Monument 01 (also know as river mile E27.09 or “the head of the delta”) where the entire Colville flow is confined to a single channel. Water surface elevation and slope data were obtained from the measurements made at Monument 01 and temporary benchmarks 01U (TBM 01U) and 01D (TBM 01D). Cross section geometry was based on three cross sections surveyed by Kuukpik/LCMF (Kuukpik/LCMF, 2002). Hydraulic roughness values were estimated based on a 1993-discharge measurement (Alaska Biological Research and Shannon & Wilson, 1994) and on-site investigations of the channel bottom using methods outlined by the United States Geological Survey (Arcement, and Schinder, 1989).

The peak water surface elevation at Monument 01 occurred in the early afternoon of 24 May and the discharge at the time of the peak water surface elevation is estimated to have been 231,000 cubic feet per second (cfs). The channel at Monument 01 was free of intact low water channel ice at the time of the peak water surface elevation. Low water channel ice in the East and Nigliq channels was mostly intact (although floating) downstream from the divergence of these channels. Snow blockages were present in many of the smaller channels; however, much of the channel snow had melted and the exposed ice was rotten.

The peak discharge at the head of the Colville River Delta is estimated to have been 300,000 cfs, and to have occurred the afternoon of 27 May. It is estimated that this discharge will be equaled or exceeded, on average, approximately once every 4 years (Michael Baker Jr., Inc. et al., 2002). It should be noted that this estimate was based on limited data. Weather prevented data collection on 28 and 29 May. The estimated discharge on 30 May is considerably lower than the estimate for 27 May, but the data are not sufficient to determine either the time when the peak discharge began to recede, or if a peak discharge of higher magnitude occurred during that period.

The estimated peak discharge in 2002 is the same as that estimated for 2001 and observations at Monument 1 and other areas of the Delta suggest that the discharges were very similar. Thus, the estimated peak discharge is considered a reasonable approximation based on the available data. A hydrograph of water surface elevation and discharge vs. time is presented on Figure 2-3.

2.3. Alpine Facility Bridge and Culvert Observations

2.3.1. Bridges

Discharge was measured at both bridges on the CD-2 access road on 25 May 2002. As previously discussed, the peak water surface elevation occurred at the head of the delta on 24 May and occurred in the Alpine area sometime during the late evening of 25 May and morning of 26 May. Discharge at the 62-foot Bridge was measured to be approximately 430 cubic feet per second (cfs) with an average adjusted velocity of 1.5 feet per second (fps). Discharge at the 452-foot Bridge was measured at approximately 3,200 cfs with an average adjusted velocity of 3.5 fps. The average adjusted velocity represents the average velocity normal to the bridge section. The maximum recorded water velocity at the bridge sections (not adjusted for flow direction) was 1.9 fps at the 62-foot bridge and 5.0 fps at the 452-foot bridge.

Peak discharge through the 62-foot bridge was estimated at 500 cfs and peak discharge through the 452-foot bridge was estimated at 4,000 cfs (Table 2-17). Peak flow through the bridges likely occurred in the early morning of 26 May. At the time the discharge measurements were made (25 May), the ice in the vicinity of the bridges had cleared. Large chunks of ice floated through the area while the measurements were being taken, but did not affect the measurements. Based on the water surface elevations and the timing of the discharge measurements, the conditions observed at the time of the measured discharge can be considered to be reasonably representative of flow conditions at the bridges at the time of the peak discharge.

2.3.2. Culverts

On the evening of 25 May, velocity measurements were taken at each culvert where flow was observed. Water velocity and water depth were determined using a Price AA velocity meter and wading rod.

> ***Note:*** *The culvert numbering system in this report differs from those used in previous breakup reports. The revised culvert numbering system is based on an as-built survey and layout completed by Kuukpik/LCMF on July 18, 2001. See Appendix B for drawings depicting the culvert layout and numbering system.*

Water was observed throughout the length of 9 of the 26 culverts surveyed. Of these 9 culverts flow was measurable in only 4 out of the 9. Snow blockages in the culverts likely prevented the culverts flowing to a greater extent. Floodwaters did not rise high enough or the floodwater duration was too short to erode snow and cause flow in the remaining culverts. Depths of flow measured at the downstream end of the culverts ranged from 0.50 to 2.0 feet and velocities in those culverts containing water ranged from undetectable to 5.96 fps. Culvert water depths and velocities are provided in Table 2-17.

Culverts were visually inspected on the afternoon of 31 May, six days after the peak water surface elevation. All flow through the culverts had ceased by the time of the inspection and flowing water was not observed on either side of the road; however, discontinuous, shallow standing water was observed on both sides of the road. No evidence of scour was observed at any of the culverts.

Water surface elevation differences on the upstream and downstream side of the road were not more than 0.5 feet seven days after the peak water surface elevation, thus meeting the requirements of USACE 2-960874, Page 2-A, Item 7 and AK9703-030G, Page 9, Item 24. No remedial planning measures to alter drainage structure design are required at this time.

Table 2-1 Permanent Staff Gage #1, Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Water Depth (feet)	Observations
5/24/2002	11:35	3.89	2.99	
5/25/2002	10:55	6.67	5.77	Reading prior to discharge measurement at bridges. Taken by Alpine personnel.
High Water Mark		7.68	6.78	High water occurred on May 25 between 10:55 and 21:00.
5/25/2002	21:00	7.36	6.46	Reading after discharge measurement at bridges.
5/26/2002	9:40	7.01	6.11	
5/26/2002	15:25	6.86	5.96	
5/27/2002	9:45	6.42	5.52	Readings taken in approximately 20-knot wind.
5/28/2002	16:00	6.02	5.12	Reading taken by Alpine personnel. Reading time is approximate.
5/31/2002	14:00	3.42	2.52	
6/12/2002	15:00	--	--	No water on gage. Taken by Alpine personnel.

Notes:

1. Coordinates for Staff Gage #1 are N5975948.0, E386920.3, Alaska State Plane, Zone 4, NAD 27.
2. Elevations are based on an elevation of 2.28 feet (BPMSL) located at the top of the 1-inch angle iron welded on the 5-inch drill stem staff gage support. Elevations were re-established by Kuukpik/LCMF Incorporated in 2002.
3. Water depths are based on ground elevations that were surveyed by Kuukpik/LCMF Incorporated.

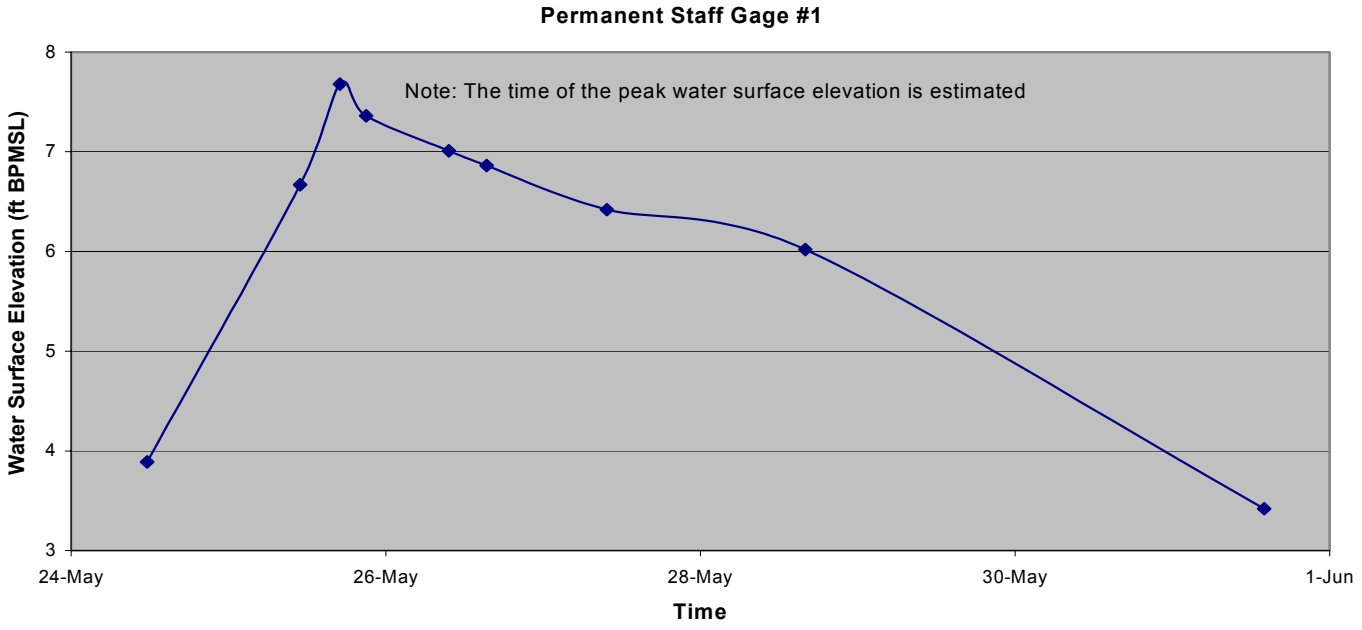


Table 2-2 Permanent Staff Gage #3, Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Water Depth (feet)	Observations
5/24/2002	11:55	6.49	1.59	Infield generally clear of snow. Water observed flowing under bridges, however, large snow drifts under bridges are present.
5/25/2002	11:10	6.41	1.51	Reading prior to discharge measurement at bridges. Taken by Alpine personnel.
5/25/2002	21:15	7.06	2.16	Reading after discharge measurement at bridges.
High Water Mark		7.59	2.69	High water occurred early morning May 26.
5/26/2002	8:45	7.15	2.25	
5/26/2002	14:55	6.87	1.97	
5/27/2002	10:15	6.13	1.23	Readings taken in approximately 20-knot wind.
5/28/2002	16:00	5.97	1.07	Reading taken by Alpine personnel. Time is approximate.
5/31/2002	14:30	--	--	No floodwater on gage. Localized ponding only.
6/5/2002	9:25	5.33	0.43	Taken by Alpine personnel. Assumed to be local ponding only.
6/12/2002	15:15	--	--	No water on gage. Localized ponding. Reading taken by Alpine personnel.

Notes:
1. Coordinates for Staff Gage #3 are N5975040.8, E379259.2, Alaska State Plane, Zone 4, NAD 27.
2. Elevations are based on an elevation of 5.95 feet (BPMSL) located at the top of the 1-inch angle iron welded on the 5-inch drill stem staff gage support. Elevations were re- established by Kuukpik/LCMF Incorporated in 2002.
3. Water depths are based on ground elevations that were surveyed by Kuukpik/LCMF Incorporated.

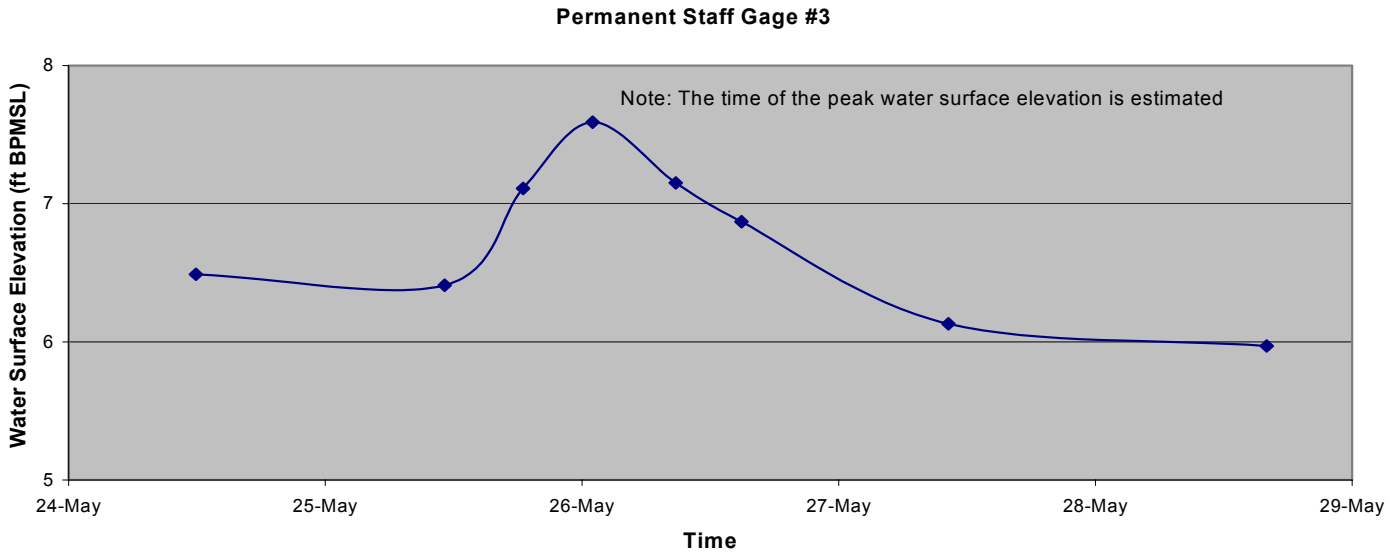


Table 2-3 Permanent Staff Gage #4, Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Water Depth (feet)	Observations
5/24/2002	11:55	6.20	1.20	Infield generally clear of snow. Water observed flowing under bridges, however, large snow drifts under bridges are present.
5/25/2002	11:10	6.19	1.19	Reading prior to discharge measurement at bridges; taken by Alpine personnel.
5/25/2002	21:15	6.54	1.54	Reading after discharge measurement at bridges.
High Water Mark		6.90	1.90	High water occurred eary morning May 26.
5/26/2002	8:45	6.76	1.76	
5/26/2002	14:55	6.56	1.56	
5/27/2002	10:15	6.03	1.03	Readings taken in approximately 20-knot wind.
5/28/2002	16:00	5.96	0.96	Reading taken by Alpine personnel. Time is approximate.
5/31/2002	14:30	--	--	No floodwater on gage. Localized ponding only.
6/5/2002	9:25	--	--	No water on gage. Localized ponding only.Reading taken by Alpine personnel.
6/12/2002	15:15	--	--	No water on gage.Localized ponding only.Reading taken by Alpine personnel.

Notes:

1. Coordinates for Staff Gage #4 are N5975173.9, E379222.5, Alaska State Plane, Zone 4, NAD 27.
2. Elevations are based on an elevation of 6.45 feet (BPMSL) located at the top of the 1-inch angle iron welded on the 5-inch drill stem staff gage support. Elevations were re-established by Kuukpik/LCMF Incorporated in 2002.
3. Water depths are based on ground elevations that were surveyed by Kuukpik/LCMF Incorporated.

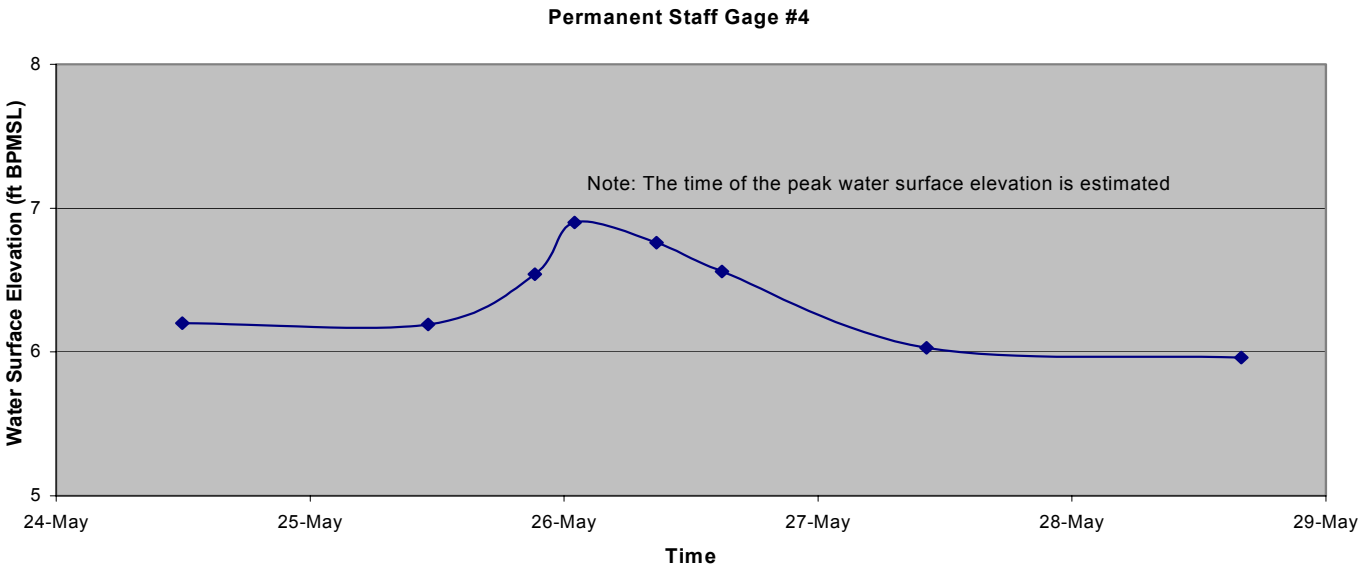


Table 2-4 Permanent Staff Gage #6, Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Water Depth (feet)	Observations
5/24/2002	--	--	--	No floodwater on gage.
5/25/2002	11:15	7.29	0.59	Reading prior to discharge measurement at bridges. Taken by Alpine personnel. Assume local ponding only.
5/25/2002	21:25	--	--	Reading after discharge measurement at bridges. Localized ponding only.
5/26/2002	8:55	7.62	0.92	Floodwater observed flowing overland from Lake L9921.
High Water Mark		7.62	0.92	High water occurred eary morning May 26.
5/26/2002	15:05	7.53	0.83	
5/27/2002	10:05	7.39	0.69	Readings taken in approximately 20-knot wind.
5/28/2002	14:25	--	--	No floodwater on gage.
6/5/2002	9:30	7.20	--	Reading taken by Alpine personnel. Assumed local ponding only
6/12/2002	15:25	7.16	--	Reading taken by Alpine personnel. Assumed local ponding only.

Notes:

1. Coordinates for Staff Gage #6 are N5974982.6, E373555.5, Alaska State Plane, Zone 4, NAD 27.
2. Elevations are based on an elevation of 7.35 feet (BPMSL) located at the top of the 1-inch angle iron welded on the 5-inch drillstem staff gage support. Elevations were re-established by Kuukpik/LCMF Incorporated, in 2002.
3. Water depths are based on ground elevations that were surveyed by Kuukpik/LCMF Incorporated.

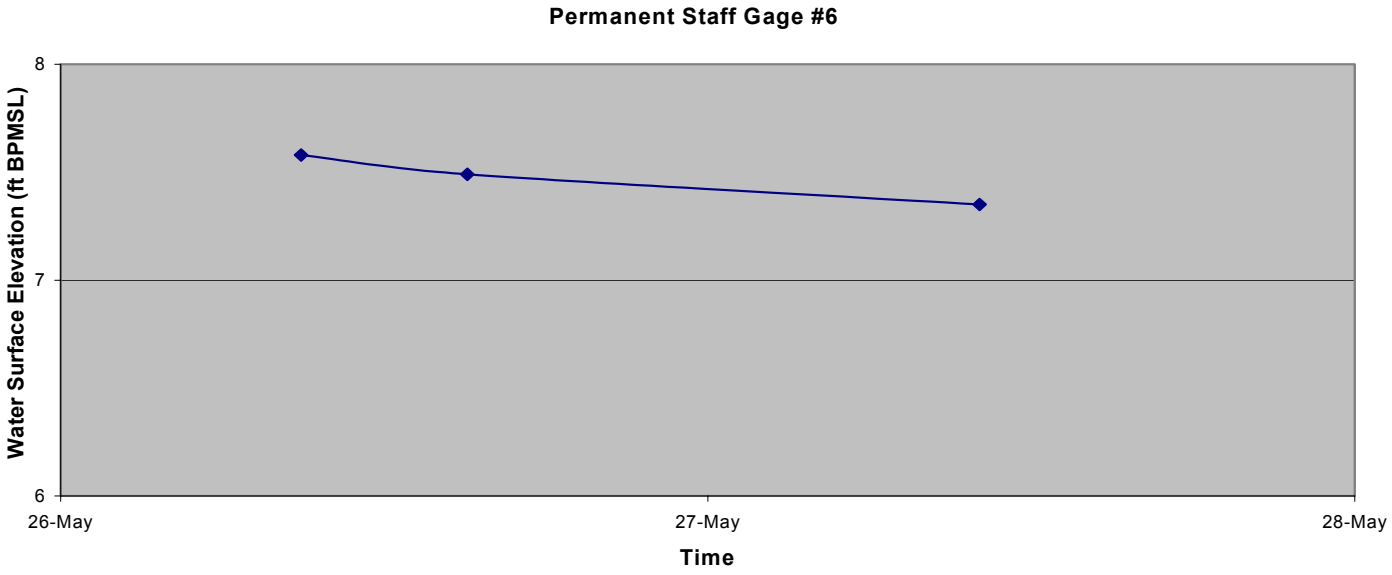


Table 2-5 Permanent Staff Gage #7, Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Water Depth (feet)	Observations
5/24/2002	--	--	--	No floodwater on gage.
5/25/2002	11:15	--	--	No floodwater on gage. Reading taken by Alpine personnel.
5/25/2002	21:25	--	--	No floodwater on gage.
5/26/2002	8:55	--	--	No floodwater on gage.
5/26/2002	15:05	--	--	No floodwater on gage.
5/27/2002	10:15	--	--	No floodwater on gage.
5/28/2002	14:45	--	--	No floodwater on gage.
6/5/2002	9:30	--	--	No floodwater on gage. Taken by Alpine personnel.
6/12/2002	15:25	--	--	No floodwater on gage. Taken by Alpine personnel.

Notes:

1. Coordinates for Staff Gage #7 are N5975132.9, E373586.4, Alaska State Plane, Zone 4, NAD 27.
2. Elevations are based on an elevation of 7.85 feet (BPMSL) located at the top of the 1-inch angle iron welded on the 5-inch drill stem staff gage support. Elevations were re-established by Kuukpik/LCMF Incorporated in 2002.
3. Water depths are based on ground elevations that were surveyed by Kuukpik/LCMF Incorporated.

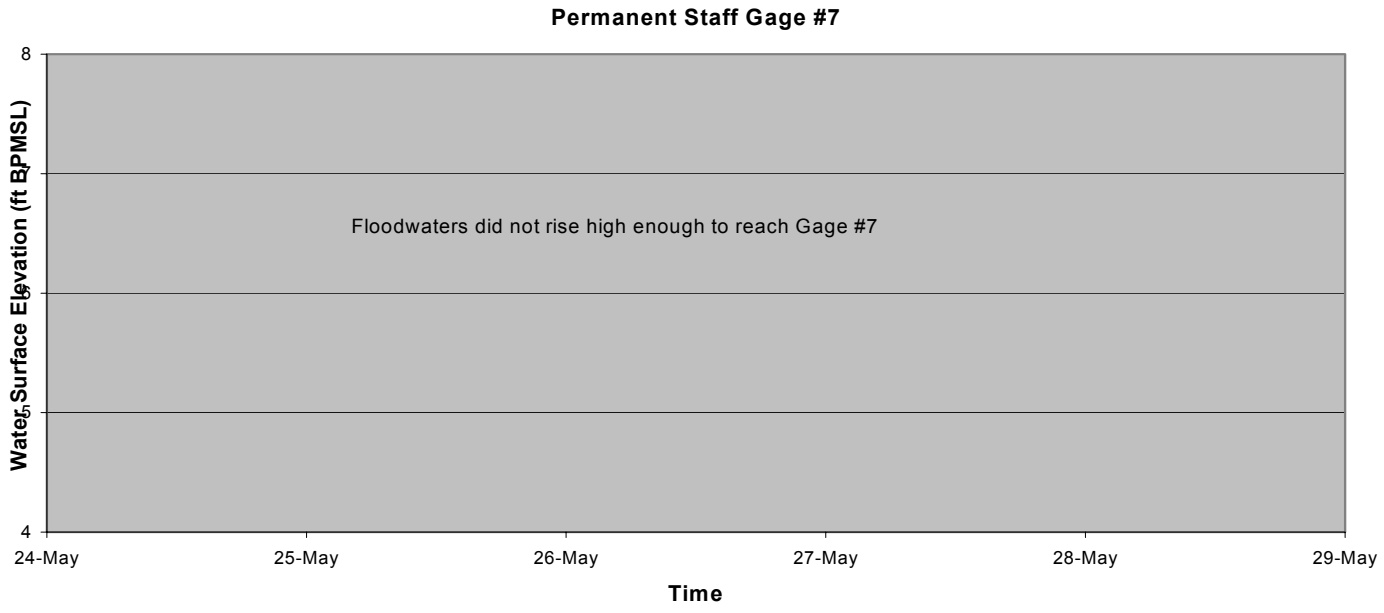


Table 2-6 Permanent Staff Gage #8, Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Water Depth (feet)	Observations
5/24/2002	--	--	--	No floodwater on gage.
5/25/2002	11:30	8.1	--	Reading taken by Alpine personnel, assume local ponding only.
5/25/2002	--	--	--	No floodwater on gage.
5/26/2002	--	--	--	No floodwater on gage.
5/26/2002	--	--	--	No floodwater on gage.
5/27/2002	--	--	--	No floodwater on gage.
5/28/2002	--	--	--	No floodwater on gage.
6/5/2002	9:50	8.02	--	Reading taken by Alpine personnel. Assume localized ponding only.

Notes:
1. Coordinates for Staff Gage #8 are N5974854.9, E371261.2, Alaska State Plane, Zone 4, NAD 27.
2. Elevations are based on an elevation of 8.73 feet (BPMSL) located at the top of the 1-inch angle iron welded on the 5-inch drill stem staff gage support. Elevations were re-established by Kuukpik/LCMF Incorporated in 2002.

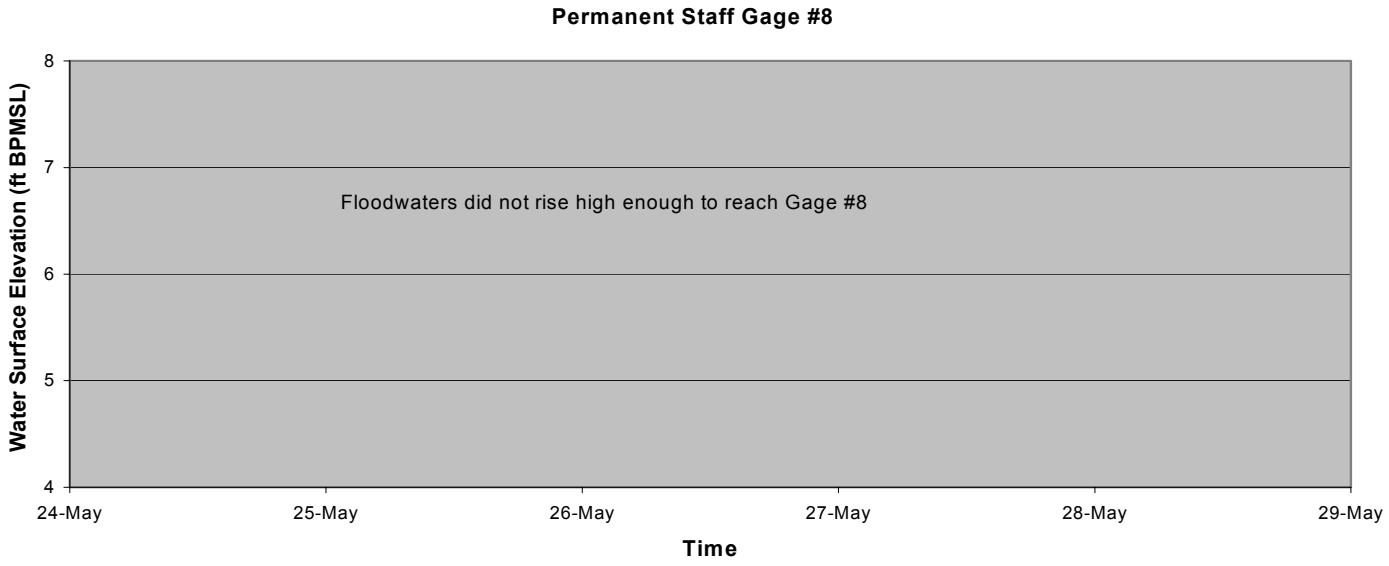


Table 2-7 Permanent Staff Gage #9 (Lake L93-12), Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Observations
04/06/02	17:20	7.31	Water surface elevation survey conducted by Kuukpik/LCMF.
High Water Mark 05/26/02	16:00	8.21	Thick ice immediately around gage, reading is at top of ice. Open water approximately 3-4 feet away looks to be at or near the same elevation.
05/27/02	13:00	8.18	Thick ice immediately around gage, reading is at top of ice. Open water approximately 3-4 feet away looks to be at or near the same elevation. Does not appear that recharge is continuing to flow into lake river source.
05/31/02	18:35	8.06	Open water around shoreline appears cloudy.
06/07/02	11:25	7.99	Majority of lake is covered in ice. Open water around shoreline only.
06/13/02	10:00	7.97	Reading by Alpine personnel.
06/19/02	17:00	7.95	Reading by Alpine personnel.
06/21/02	12:00	7.94	Reading by Alpine personnel.
06/23/02	17:30	7.98	Reading by Alpine personnel. Rain the previous night.
06/29/02	11:25	7.99	Lake is free of ice.

Notes:

1. Coordinates for Staff Gage #9 are N5975797.3; E385464.0, Alaska State Plane, Zone 4, NAD 27.
2. Water surface elevation measured by drilling a hole in the lake ice and surveying from a reference elevation of 14.57 feet BPMSL located on TBM L99-32-59 at the fresh water pump house. The elevation of L99-32-59 was confirmed by Kuukpik/LCMF 2002.
3. A difference of 0.01 feet was measured between the face plate readings on Permanent Staff gage #9 and the BPMSL datum as determined by TBM L99-32-59. All water surface elevation readings have been converted to BPMSL with respect to TBM L99-32-59.

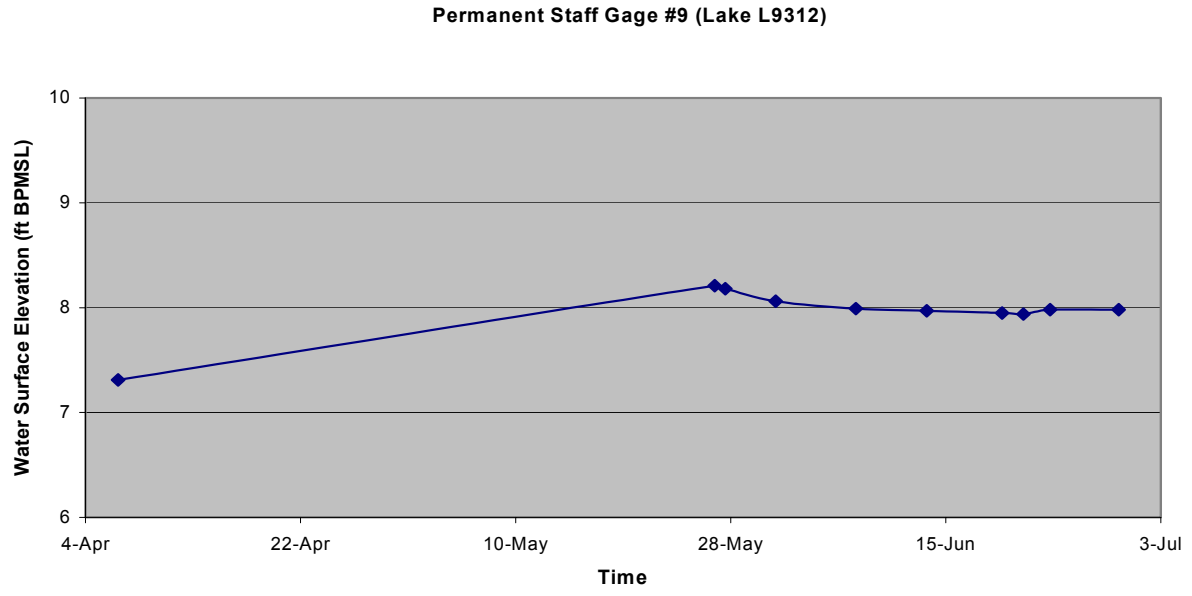


Table 2-8 Permanent Staff Gage #10 (Lake L93-13), Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Water Depth (ft)	Observations
5/11/2002	14:50	5.96	2.06	Water surface elevation survey conducted by Kuukpik/LCMF.
5/24/2002	--	--	--	Localized ponding only.
5/25/2002	10:45	8.85	4.95	Reading prior to discharge measurement at bridges. Taken by Alpine personnel.
High Water Mark		8.90	5.00	High water occurred on May 25 between 10:45 and 20:50.
5/25/2002	20:50	8.54	4.64	Reading after discharge measurement at bridges.
5/26/2002	09:40	8.18	4.28	Confirmed previous high water mark.
5/26/2002	15:20	8.05	4.15	
5/27/2002	09:40	7.77	3.87	Reading taken in approximately 20-knot wind.
5/28/2002	16:00	7.65	3.75	Reading taken by Alpine personnel. Reading time is approximate.
5/31/2002	13:50	6.55	2.65	
6/5/2002	09:15	6.34	2.44	Reading taken by Alpine personnel.
6/9/2002	10:10	6.30	2.40	Reading taken by Alpine personnel.
6/12/2002	15:05	6.25	2.35	Reading taken by Alpine personnel.
6/19/2002	09:00	6.22	2.32	Reading taken by Alpine personnel.
6/21/2002	14:00	6.22	2.32	Reading taken by Alpine personnel.
6/23/2002	16:30	6.22	2.32	Reading taken by Alpine personnel.
6/29/2002	11:30	6.24	2.34	

Notes:
1. Coordinates for Staff Gage #10 are N5975797.3; E385464.0, Alaska State Plane, Zone 4, NAD 27.
2. Water surface elevation measured by drilling a hole in the lake ice and surveying from a reference elevation of 16.00 feet located on TBM L99-32-60 at the fresh water pump house. The elevation of L99-32-60 was confirmed by Kuukpik/LCMF 2002.
3. Water surface elevation readings were taken from Permanent Staff Gage #10 unless noted otherwise. A difference of 0.50 feet was measured between the face plate readings on Permanent Staff gage #10 and the BPMSL datum as determined by TBM L99-32-60. All water surface elevation readings have been converted to BPMSL with respect to TBM L99-32-60.

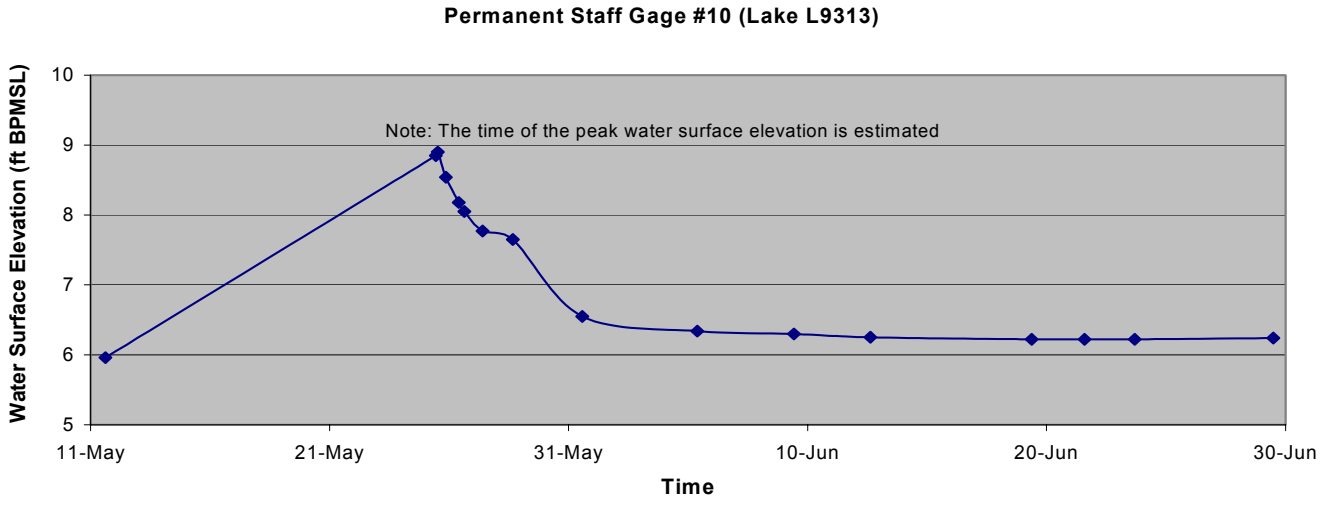


Table 2-9 Monument 01, Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Observations
5/23/2002	8:15	11.00	Channel is 70% clear. Channel ice intact along the right bank.
5/24/2002	8:00	16.21	Channel ice has cleared. Open channel conditions with floating ice chunks.
High Water Mark		16.87	High water occurred on May 24 between 08:00 and 13:50.
5/24/2002	13:50	16.82	Ice chunks observed floating along right bank.
5/24/2002	14:20	16.63	Majority of floating ice is along right bank.
5/24/2002	14:50	16.21	
5/25/2002	12:19	13.96	Channel is free of ice.
5/26/2002	11:15	13.83	Channel is ice free with occasional small ice chunks flowing through. Reading taken in very windy conditions.
5/27/2002	15:15	13.94	Channel is free of ice.
5/30/2002	16:25	7.77	

Notes:
1. Elevations are based on an elevation of 27.74 feet BPMSL for Monument 01, established by Lounsbury & Associates in 1996.
2. The distance from Monument 01 to TBM 01U is 3,040 feet. The distance from Monument 01 to TBM 01D is 2,960 feet.
3. GPS coordinates for Mounument 01 are N70° 09' 58.3" W150° 56' 12.6" (NAD 27), surveyed by Loundsbury and Associates.

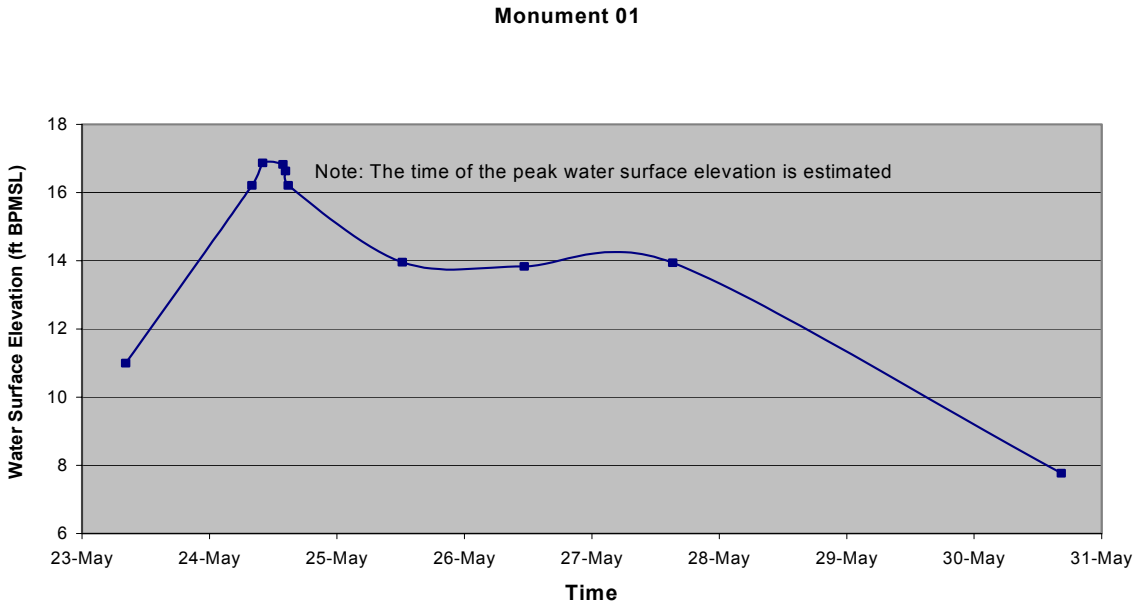


Table 2-10 Temporary Benchmark 01U, Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Observations
5/23/2002	8:10	11.29	Channel is 70% free of ice. Channel ice intact along the right bank.
5/23/2002	15:25	12.77	Channel is 90% free of ice. Channel ice intact on right bank. Ice chunks floating in open water.
5/24/2002	7:55	16.32	Channel ice has cleared. Open channel conditions with numerous floating ice chunks.
High Water Mark		17.00	High water occurred on May 24 between 07:55 and 14:40.
5/24/2002	14:40	16.47	
5/25/2002	12:38	14.25	Ice chunks floating near left bank.
5/26/2002	10:30	14.16	Reading taken in very windy conditions.
5/27/2002	15:00	14.28	Channel is free of ice.
5/30/2002	15:10	8.13	

Notes:

1. Elevations are based on an elevation of 27.74 feet BPMSL for Monument 01, established by Lounsbury & Associates in 1996.
2. The distance from TBM 01U to Monument 01 is 3,040 feet.
3. GPS coordinates for TBM 01U are N70° 09' 31/4" W150° 56' 36.7" (NAD 27) which were obtained by a Garmin GPS III Plus hand-held global positioning system.

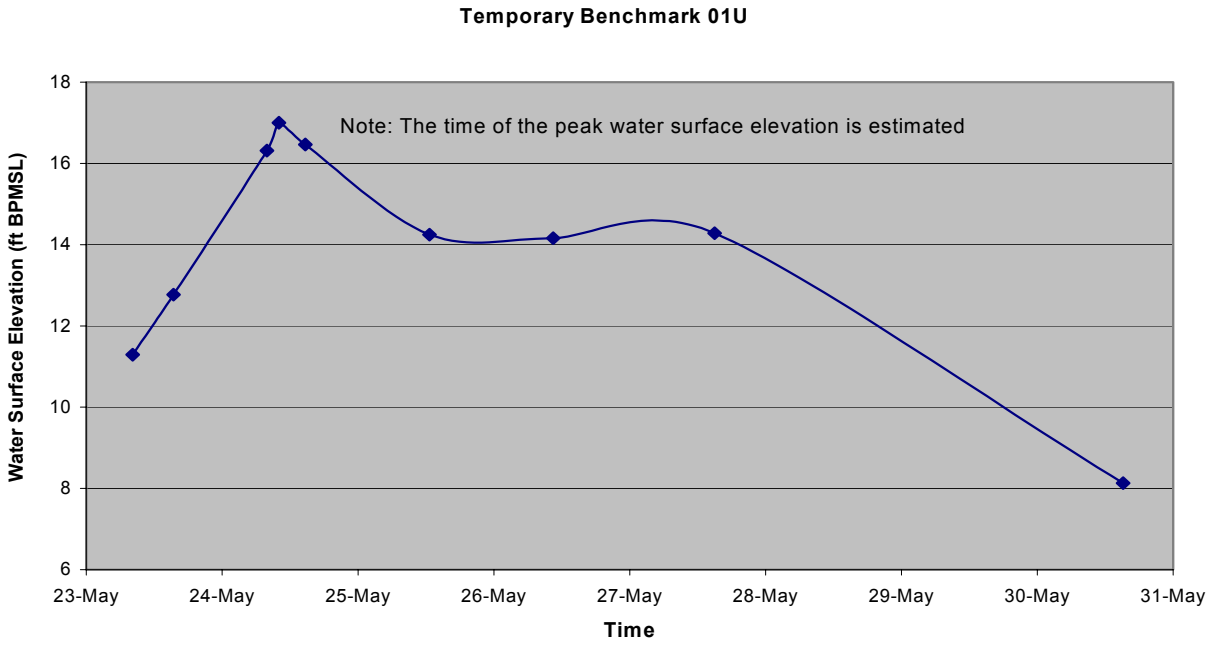


Table 2-11 Temporary Benchmark 01D, Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Observations
5/23/2002	8:20	10.78	Intact channel ice along right bank. Ice breaking into rafts downstream.
5/23/2002	15:55	11.98	Ice chunks passing through channel.
5/24/2002	8:15	16.14	Channel ice has cleared. Open channel conditions with floating ice chunks.
High Water Mark		16.65	High water occurred on May 24 between 08:15 and 14:55.
5/24/2002	14:55	15.74	Stranded ice chunks visible on banks.
5/25/2002	12:52	13.59	Ice less than 5 feet in diamater floating in channel.
5/26/2002	11:20	13.41	Channel is open with occasional small floating ice chunks. Reading taken in very windy conditions.
5/27/2002	15:25	13.39	Channel is free of ice.
5/30/2002	17:57	7.59	

Notes:

1. Elevations are based on an elevation of 27.74 feet BPMSL for Monument 01, established by Lounsbury & Associates in 1996.
2. The distance from Monument 01 to TBM 01D is 2,960 feet.
3. GPS coordinates for TBM 01D are N70° 10' 26.6" W150° 56' 01.6", (NAD 27) which were obtained by a Garmin GPS III Plus hand-held positioning system.

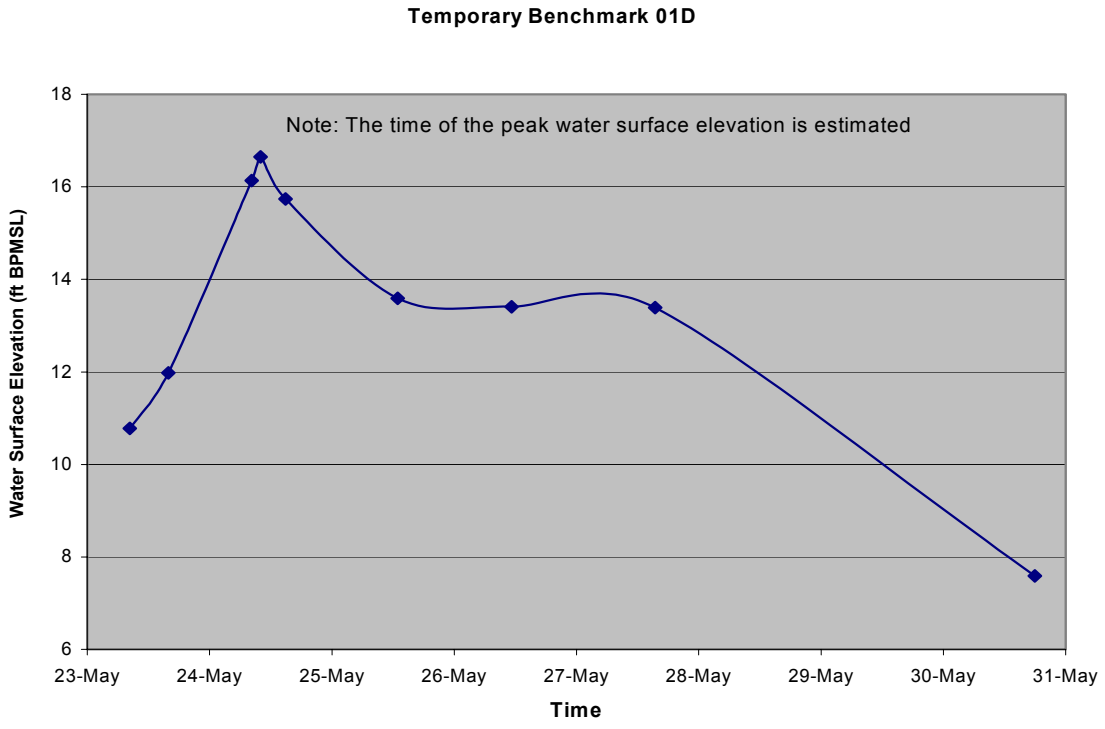


Table 2-12 Monument 12, Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Observations
5/23/2002	8:45	7.02	
5/23/2002	16:05	7.61	
5/24/2002	8:30	9.58	Channel is about 50% free of ice. Ice, although intact, is rotten and cracked.
High Water Mark		10.47	High water mark occurred on May 24 between 08:30 and 15:15.
5/24/2002	15:15	9.75	Grounded rotten ice around gages. Large flow extends halfway across channel.
High Water Mark		10.72	Peak water surface elevation occurred between May 24 at 15:15 and May 25 at 13:10.
5/25/2002	13:10	10.64	Large ice floes floating in reach. Large ice jam noted upstream near Nuiqsut.
5/26/2002	11:35	9.15	Stranded ice chunks up to 30 feet in diameter on banks.
5/31/2002	10:45	3.49	

Notes:
1. Elevations are based on an elevation of 14.60 feet BPMSL for Monument 12, established by Lounsbury & Associates in 1996.
2. Staff gages were set on opposite bank from Monument 12.
3. GPS coordinates for Monument 12 are N70° 14' 58.3" W151° 01' 23.5" (NAD 27), surveyed by Lounsbury and Associates.

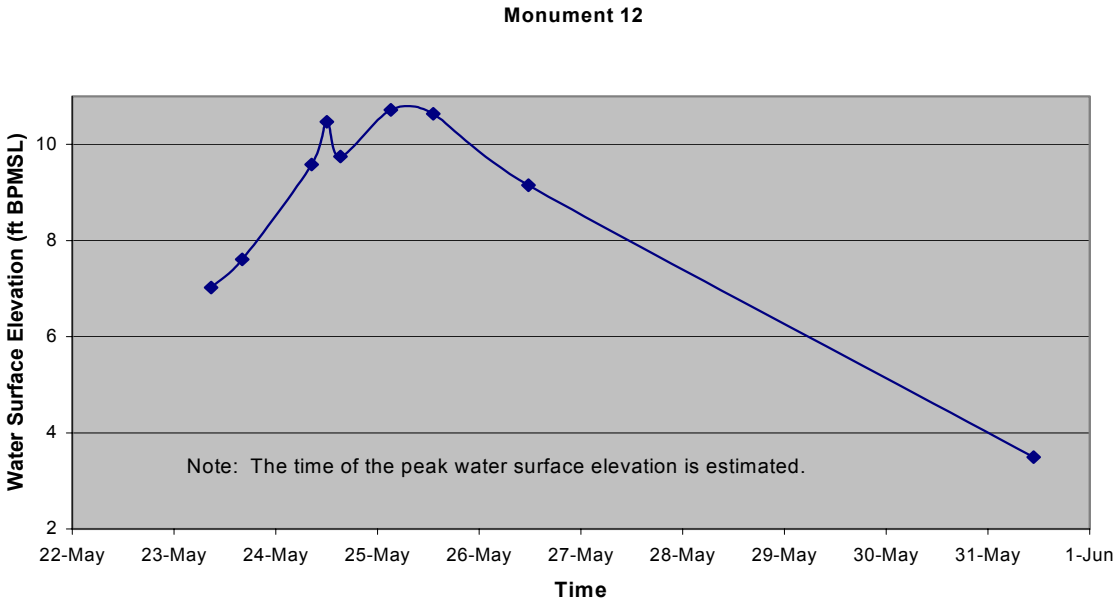


Table 2-13 TBM 20N Water Surface Elevations and Observations

Date	Time	Surface Elevation (feet BPMSL)	Observations
5/23/2002	08:50	5.39	Channel approximately 80% free of ice. Ice still intact along right bank.
5/23/2002	16:10	6.23	Majority of ice along right bank has broken apart since last reading.
5/24/2002	08:40	7.79	Large ice floes noted in front of gages.
High Water Mark		8.91	High water mark occurred on May 24 between 08:40 and 15:40.
5/24/2002	15:40	8.29	Rotten ice chunks floating in channel.
5/25/2002	13:35	8.75	Significant ice jam across channel with numerous ice chunks driven onto shore.
High Water Mark		9.60	Peak water surface elevation occurred between May 25 at 13:35 and May 26 at 11:45.
5/26/2002	11:45	8.29	Ice jam has cleared channel free of ice. 50-foot diameter ice chunks on banks.
5/27/2002	14:25	7.55	Channel is free of ice. Ice chunks along right bank.

Notes:

1. Elevations are based on an elevation of 19.17 feet BPMSL for Monument 20, established by Lounsbury & Associates in 1996.
2. Gages were set on opposite bank and approximately 1 mile downstream (north) of Monument 20.
3. GPS coordinates for TBM 20N are N70° 17' 29.0" W150° 59' 57.8" (NAD 27), obtained with a Garmin GPS III Plus hand-held global positioning system.

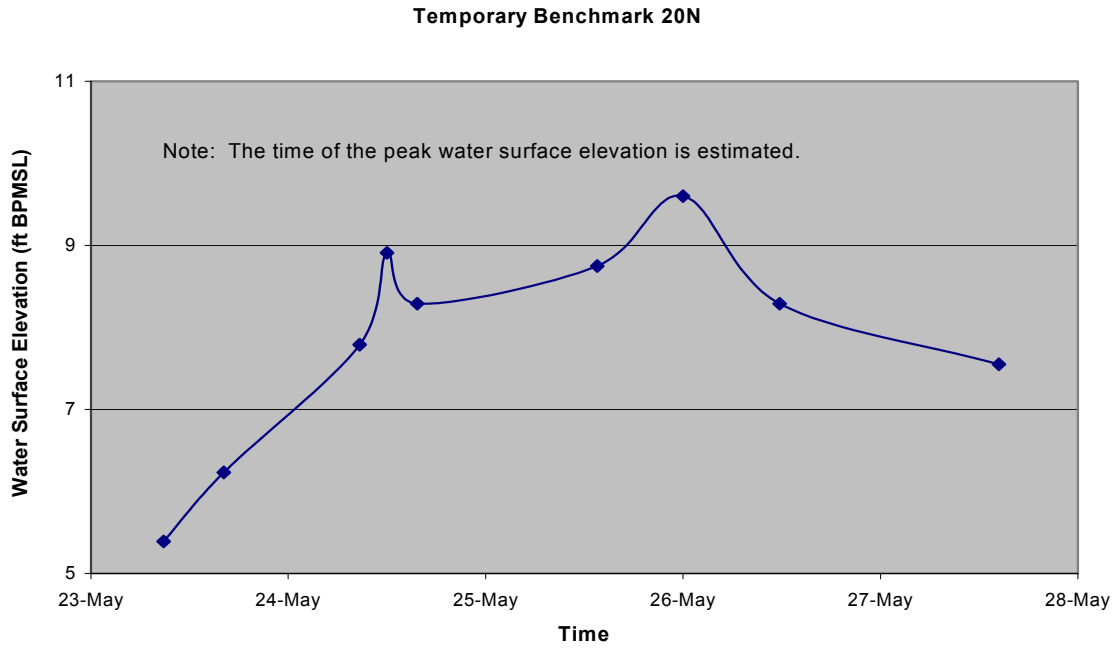


Table 2-14 Monument 22, Water Surface Elevations and Observations

Date	Time	Surface Elevation (feet BPMSL)	Observations
5/23/2002	08:45	4.11	Channel approximately 70% free of ice. Ice channel intact along right bank.
5/23/2002	16:15	5.19	Channel ice intact along right bank.
5/24/2002	9:00	6.47	Channel is 95% ice free. Large ice floe stranded in channel.
High Water Mark		7.06	High water mark occurred on May 24 between 09:00 and 15:50.
5/24/2002	15:50	6.92	
High Water Mark		7.27	High water mark occurred between May 24 at 15:50 and May 25 at 13:57.
5/25/2002	13:57	7.07	
High Water Mark		7.94	Peak water surface elevation occurred between May 25 at 13:57 and May 27 at 14:05.
5/27/2002	14:05	6.41	Left bank is choked with grounded and floating ice chunks.
5/31/2002	12:27	3.06	

Notes:

1. Elevations are based on an elevation of 10.13 feet BPMSL for Monument 22, established by Lounsbury & Associates in 1996.

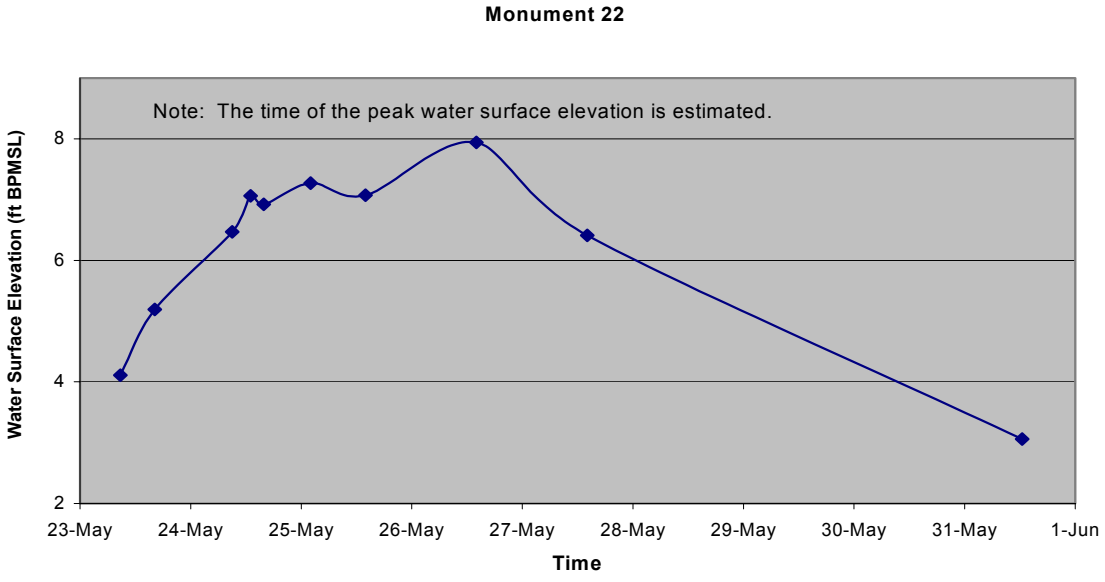


Table 2-15 Monument 23, Water Surface Elevations and Observations

Date	Time	Surface Elevation (feet BPMSL)	Observations
5/23/2002	9:10	3.65	
5/23/2002	16:25	4.49	
5/24/2002	9:10	5.64	Channel is 90% free of ice with small floes passing through reach.
High Water Mark		6.23	High water mark occurred on May 24 between 09:10 and 16:00.
5/24/2002	16:00	6.04	No visible ice floating in channel.
5/25/2002	14:15	6.15	Ice chunks moving through channel. Channel ice intact on left bank.
High Water Mark		7.42	High water mark occurred between May 25 at 14:15 and May 26 at 12:15.
5/26/2002	12:15	6.65	Large ice chunks stranded on both banks.
High Water Mark		7.45	Peak water surface elevation occurred between May 26 at 12:15 and May 27 at 12:45.
5/27/2002	12:45	5.62	Channel is free of ice. Grounded ice floes downstream on right bank.

Notes:

1. Elevations are based on an elevation of 8.76 feet (BPMSL) located at the top of the 1-inch angle iron welded on the 5-inch drill stem support at Permanent Staff Gage #8. Elevations were established by Kuukpik/LCMF Incorporated.
2. GPS coordinates for Monument 23 are N70° 20' 30.6" W151° 03' 30.3" (NAD 27), surveyed by Lounsbury and Associates.

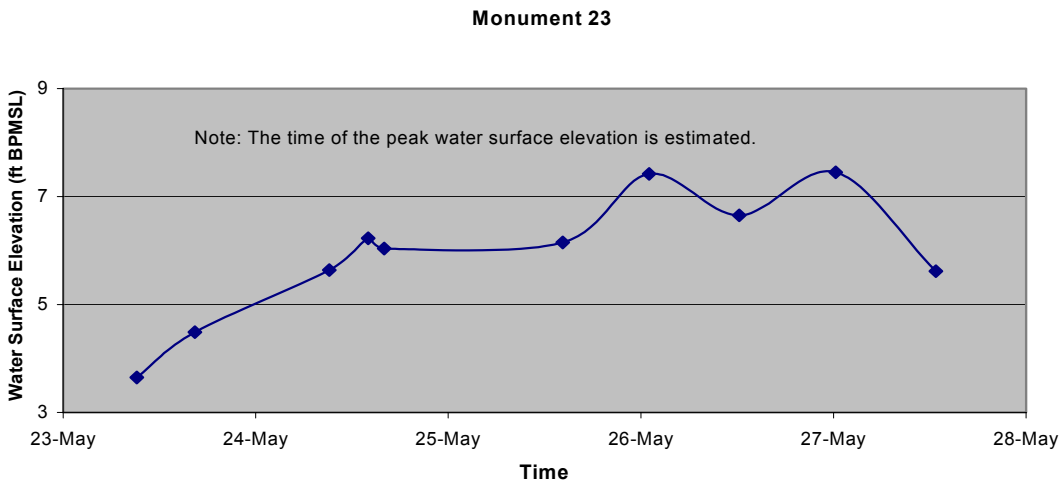


Table 2-16 Monument 28, Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Observations
5/23/2002	9:20	1.91	No intact channel ice present in distributary where gages are located. Main Nigliq Channel has low water channel ice intact.
5/23/2002	16:35	2.14	
5/24/2002	9:30	2.67	
High Water Mark		3.00	High water mark occurred on May 24 between 09:30 and 16:10.
5/24/2002	16:10	2.90	No visible ice floating in channel.
5/25/2002	14:36	3.23	
5/26/2002	12:25	3.66	Staff gages destroyed. Nigliq channel ice still intact adjacent to gage location.

Notes:

1. Elevations are based on an elevation of 3.66 feet BPMSL for Monument 28, established by Lounsbury & Associates in 1998.
2. GPS coordinates for Monument 28 are N70° 25' 33.2" W151° 03' 49.6" (NAD 27), surveyed by Lounsbury and Associates.
3. Staff gages destroyed on May 26. No high water mark available. Reading on May 26 from Monument 28.

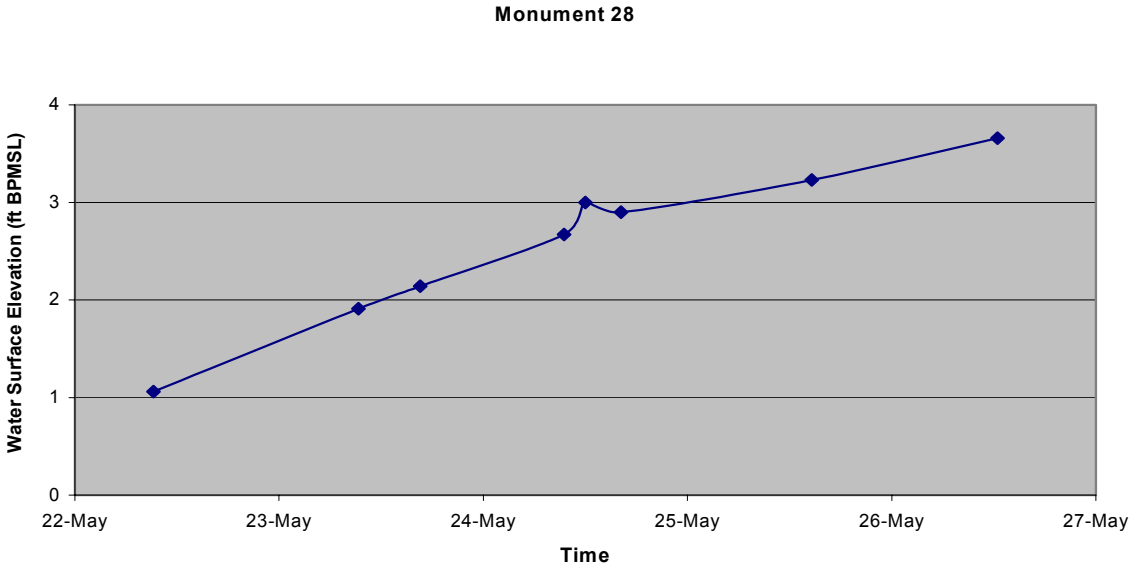


Table 2-17 Measured and Likely Maximum Depth, Velocity, and Discharge in Alpine Drainage Structures

Structure	Field Measurement				Maximum Likely Peak			
	Date	Water Depth (ft)	Average Velocity (ft/s)	Discharge (cfs)	Date	Water Depth (ft)	Average Velocity (ft/s)	Discharge (cfs)
62-ft Swale Bridge	5/25/02	6.4 (ave.)	1.2	430	5/26/02	7.1	1.2	500
452-ft Swale Bridge	5/25/02	2.2 (ave.)	3.4	3200	5/26/02	2.9	3.4	4000
Culvert 1	5/25/02	No flow			5/26/02	No flow		
Culvert 2	5/25/02	No flow			5/26/02	No flow		
Culvert 3	5/25/02	No flow			5/26/02	No flow		
Culvert 4	5/25/02	No flow			5/26/02	No flow		
Culvert 5	5/25/02	No flow			5/26/02	No flow		
Culvert 6	5/25/02	No flow			5/26/02	No flow		
Culvert 7	5/25/02	No flow			5/26/02	No flow		
Culvert 8	5/25/02	No flow			5/26/02	No flow		
Culvert 9	5/25/02	No flow			5/26/02	No flow		
Culvert 10	5/25/02	No flow			5/26/02	No flow		
Culvert 11	5/25/02	0.9	Undetectable	<1	5/26/02	0.7	4.0	6.7
Culvert 12	5/25/02	1.3	Undetectable	<1	5/26/02	1.2	4.2	16.5
Culvert 13	5/25/02	1.1	Undetectable	<1	5/26/02	0.9	3.9	9.0
Culvert 14	5/25/02	1.4	Undetectable	<1	5/26/02	1.2	4.3	14.9
Culvert 15	5/25/02	No flow			5/26/02	No flow		
Culvert 16	5/25/02	No flow			5/26/02	No flow		
Culvert 17	5/25/02	No flow			5/26/02	No flow		
Culvert 18	5/25/02	No flow			5/26/02	No flow		
Culvert 19	5/25/02	No flow			5/26/02	No flow		
Culvert 20	5/25/02	0.5	Undetectable	<1	5/26/02	0.9	4.6	10.3
Culvert 21	5/25/02	1.6	4.1	19.2	5/26/02	1.7	4.4	22.1
Culvert 22	5/25/02	1.9	5.6	32.8	5/26/02	2.2	4.8	34.4
Culvert 23	5/25/02	1.9	6.0	35.0	5/26/02	2.4	4.9	38.9
Culvert 24	5/25/02	2.0	5.5	34.2	5/26/02	2.7	4.7	41.7
Culvert 25	5/25/02	No flow			5/26/02	No flow		
Culvert 26	5/25/02	No flow			5/26/02	No flow		

Notes:
1. Culvert numbering system is based on an Alpine Facilities as-built survey, prepared by Kuukpik/LCMF, 7/18/2001. See Appendix B for culvert and bridge site plan.
3. Peak discharge and peak velocity occurred between the evening of May 25and the morning of May 26.
4. The maximum likely peak discharge and velocity estimate for the culverts are based on a clean culvert barrel.

Table 2-18 Summary of Breakup Data Obtained at the Head of the Colville River Delta, 1962 – 2002

Year	Approximate Date Water Began to Flow	Peak Water Surface Elevation (ft)	Date of Peak Water Surface Elevation	Peak Breakup Discharge (cfs)	Notes
2002	23 May	16.87	24 May	300,000	1
2001	5 June	17.37	10 June	300,000	1, 2
2000	8 June	19.33	11 June	580,000	1, 3
1999	22 May	13.97	30 May	203,000	1, 4, 5
1998	21 May	18.11	29 May	213,000	1, 6
1997	20 May	15.05	29 May	177,000	1
1996	15 May	17.19	26 May	160,000	1, 7
1995	8 May	15.7	16 May	233,000	8
1994	16 May	13.0	25 May	159,000	8
1993	–	20.0	31 May	379,000	8
1992	–	14.7	2 June	188,000	8
1977	–	19.9	7 June	407,000	8
1973	25 May	–	8 June	–	8
1971	23 May	–	2 June	–	8
1964	28 May	–	3 June	–	8
1962	19 May	13.2	14 June	215,000	8

Notes:

1. Water surface elevations are based on monuments set by Lounsbury & Associates in 1996 and are based on British Petroleum mean sea level (BPMSL).
2. Data from Michael Baker, Jr., Inc., 2001, Alpine Facilities Spring 2001 Breakup and Hydrologic Assessment. Prepared for Phillips Alaska, Inc., Anchorage.
3. The peak breakup discharge was estimated to range between 570,000 to 590,000 cfs. Data from Michael Baker, Jr., Inc., 2000, Alpine Facilities Spring 2000 Breakup Monitoring and Hydrologic Assessment. Prepared for Phillips Alaska, Inc., Anchorage.
4. Data from Michael Baker Jr., Inc., 1999, 1999 Spring Breakup and Hydrologic Assessment, Colville River Delta, North Slope, Alaska. Prepared for ARCO Alaska, Inc., Anchorage, Alaska.
5. Water was flowing in the Colville River at Umiat on this day. It is not known if this was the first day of flow. Therefore, it is not known if water was flowing on the delta prior to this date.
6. Data from Michael Baker Jr., Inc., 1998, 1998 Spring Breakup and Hydrologic Assessment, Colville River Delta, North Slope, Alaska. Prepared for ARCO Alaska, Inc., Anchorage, Alaska.
7. Data from Shannon & Wilson, Inc., 1996, 1996 Spring Breakup and Hydrologic Assessment, Colville River Delta, North Slope, Alaska. Prepared for Michael Baker Jr., Inc., Anchorage, Alaska.
8. Data from Jorgenson et al., 1996, Geomorphology and Hydrology of the Colville River Delta, Alaska, 1995. Prepared for ARCO Alaska, Inc., and Kuukpik Unit Owners, Anchorage, Alaska. The water surface elevations presented in this report were based on an elevation of 41.99 feet for the USCGS monument “River.” In 1996 Lounsbury & Associates surveyed USCGS monument “River” and tied it to BPMSL. The elevation of “River,” based on BPMSL, is 41.83 feet. The values presented in this table are based on the elevation for “River” that is based on BPMSL.

Figure 2-1 Temporary Staff Gage Locations

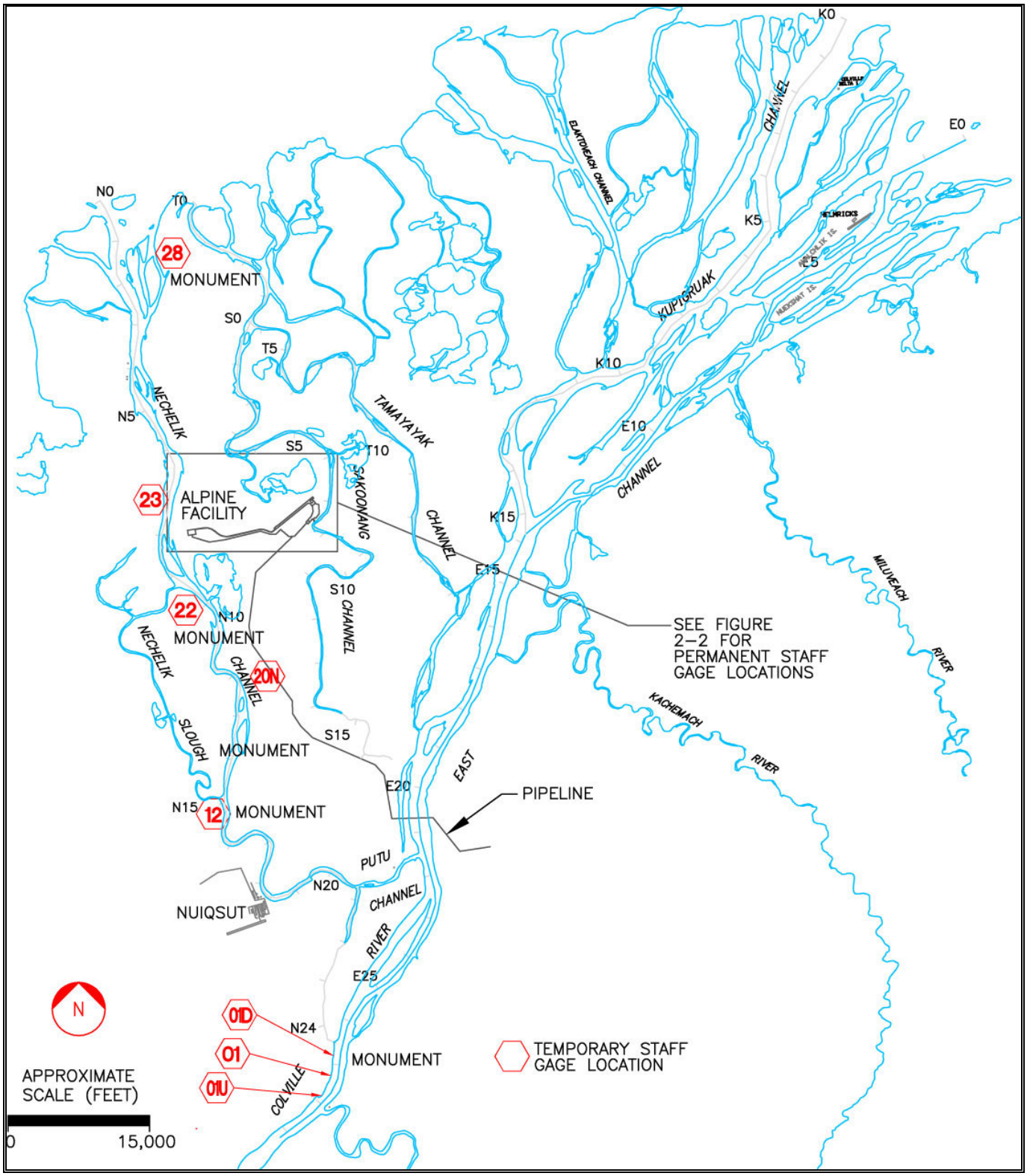


Figure 2-2 Permanent Staff Gage Locations

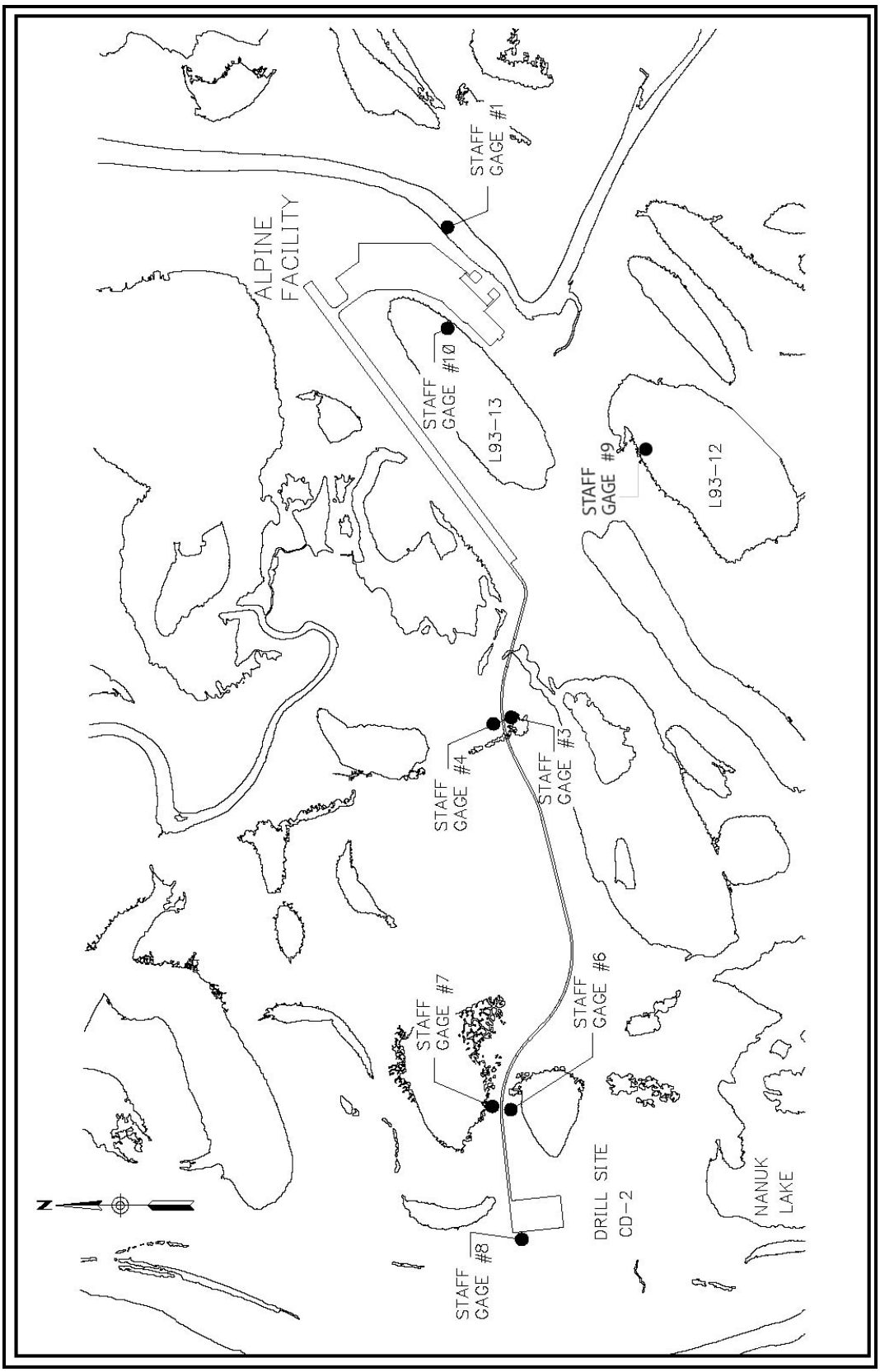
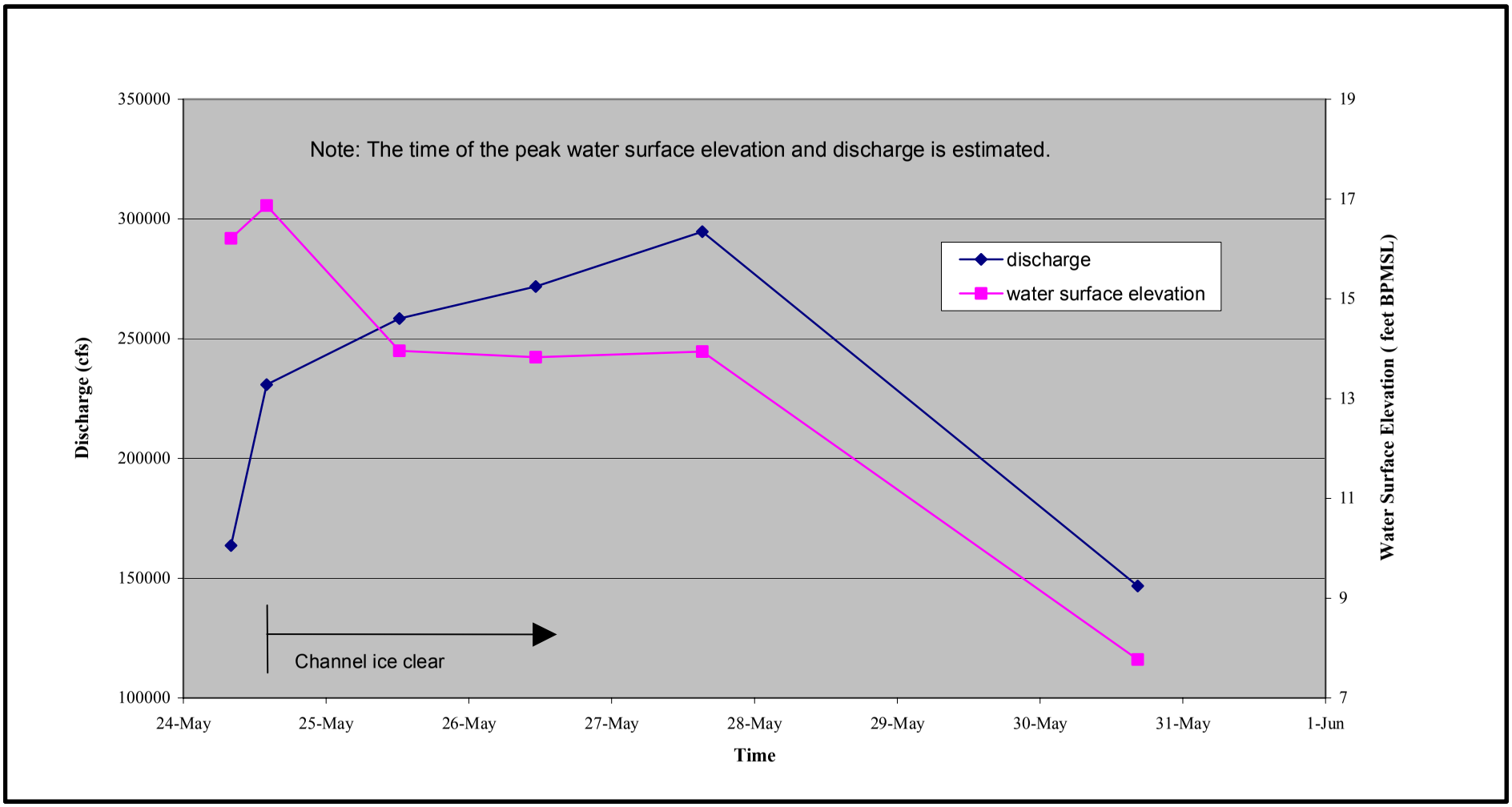


Figure 2-3 Discharge and Water Surface Elevation vs. Time at Monument 01



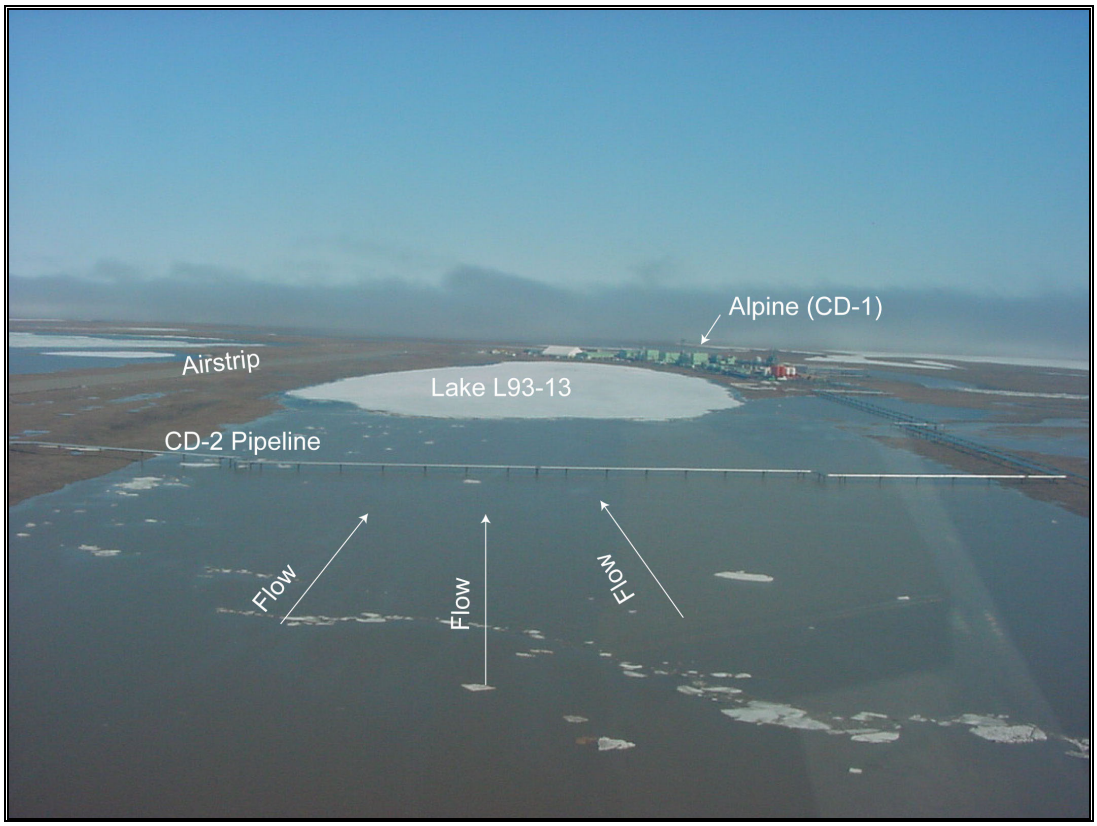


Photo taken May 25, 2002.

Photo 2-1 a Flooding conditions at Alpine looking northeast at CD-1 pad.

Photo taken May 25, 2002.

Photo 2-1 b Flooding conditions at Alpine looking northeast at swale bridges.

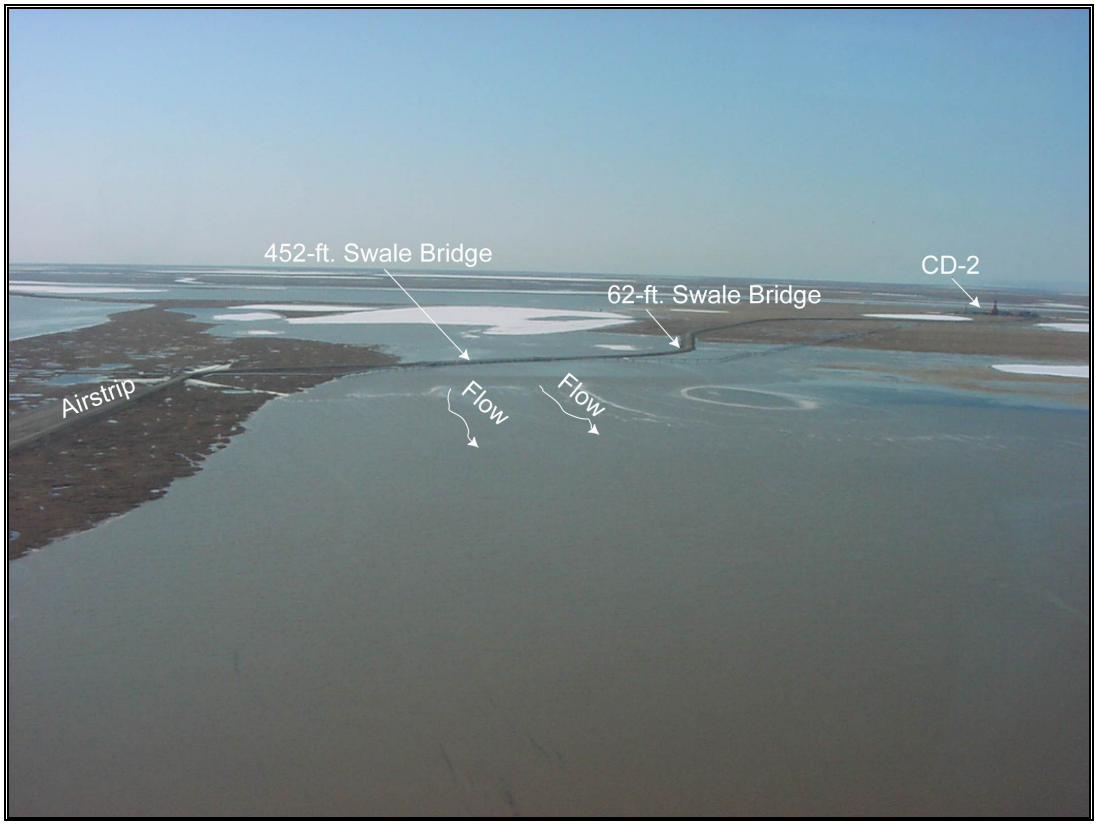


Photo taken May 25, 2002.

Photo 2-1 c Flooding conditions at Alpine looking southwest towards swale bridges.

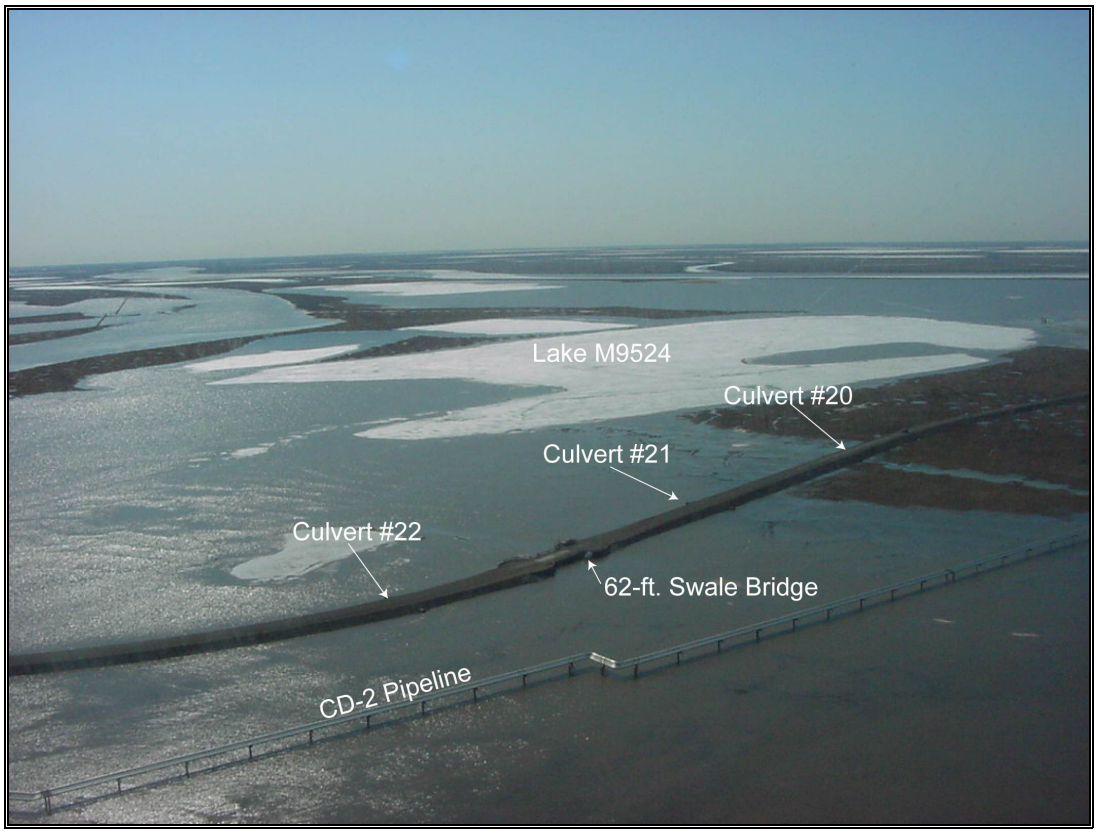


Photo taken May 25, 2002.

Photo 2-1 d Flooding conditions at Alpine looking southwest at the 62-ft. swale bridge.

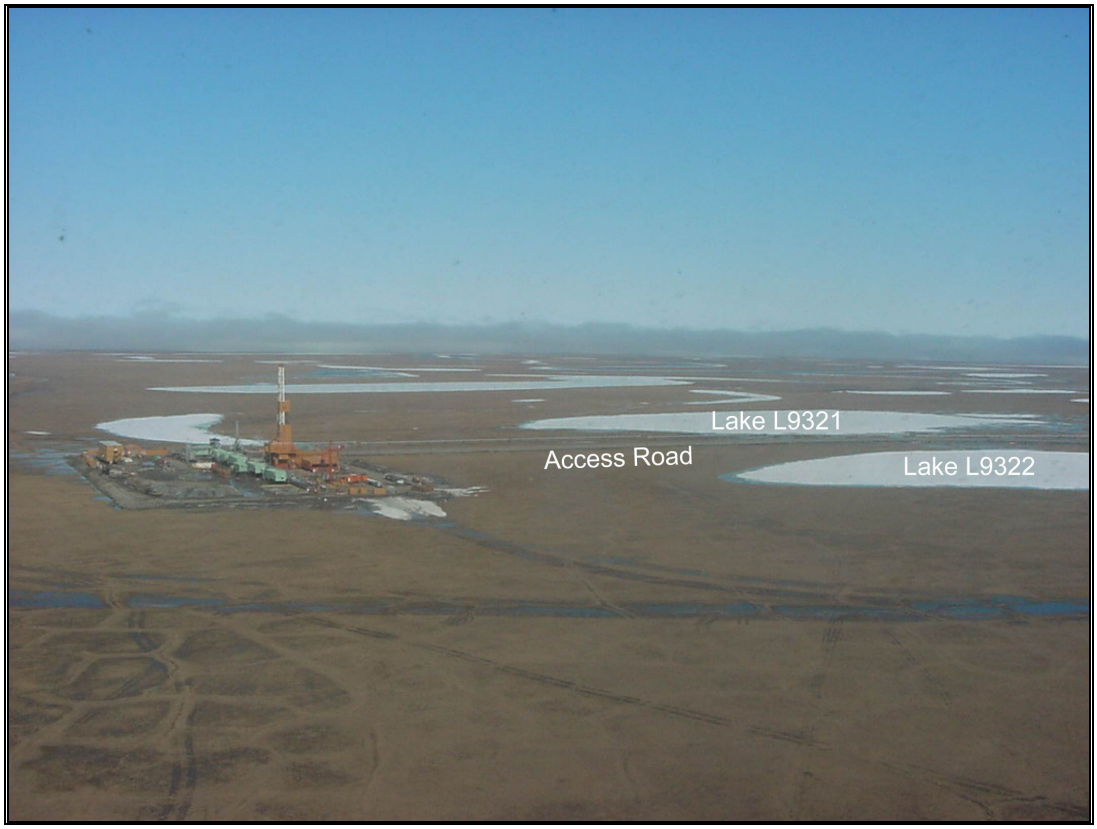


Photo taken May 25, 2002.

Photo 2-1 e Flooding conditions at Alpine looking north towards CD-2.

Photo taken May 26, 2002.

Photo 2-2 a Flooding conditions at Alpine looking northeast at CD-1.

Photo taken May 26, 2002.

Photo 2-2 b Flooding conditions at Alpine looking north at CD-1.

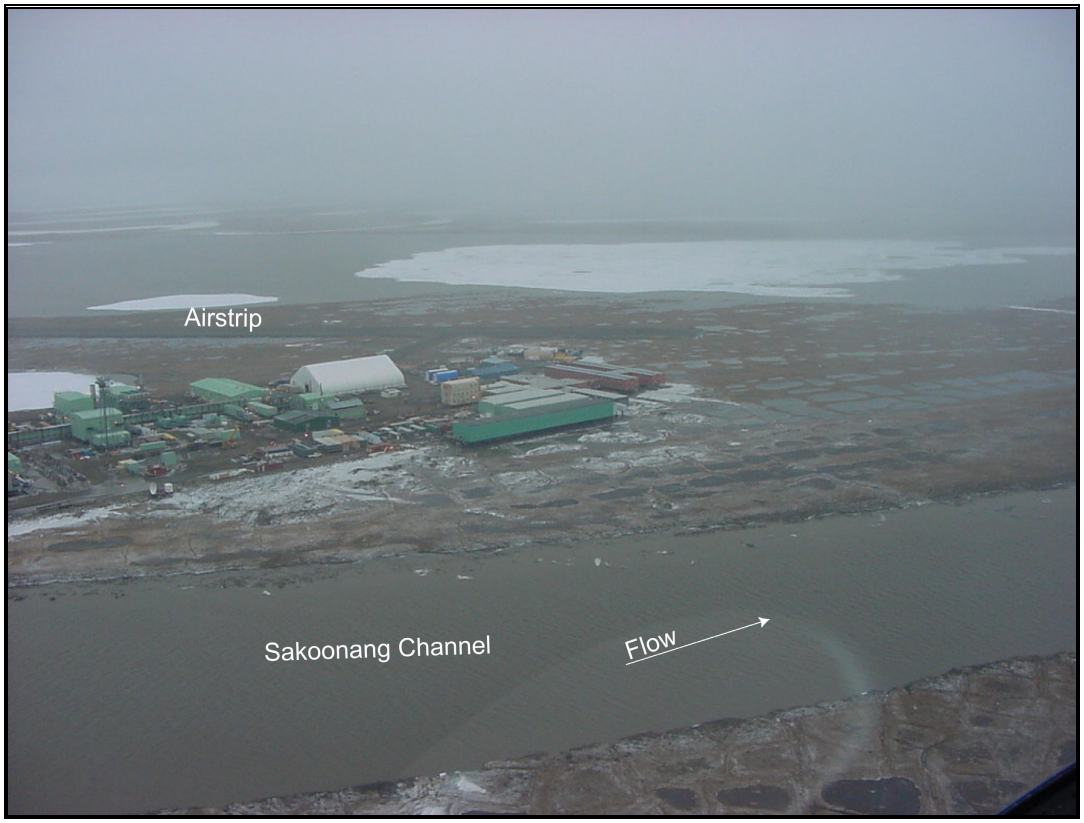


Photo taken May 26, 2002.

Photo 2-2 c Flooding conditions at Alpine looking northwest.

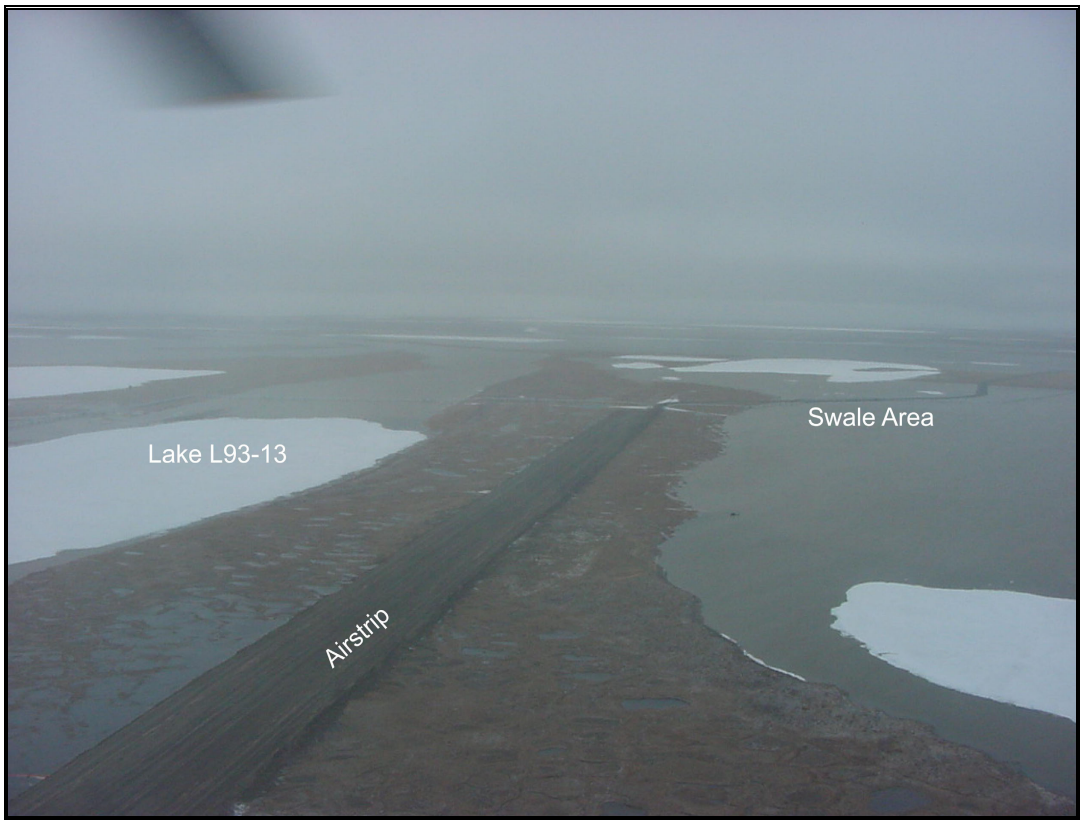


Photo taken May 26, 2002.

Photo 2-2 d Flooding conditions at Alpine looking southwest along airstrip.

Photo taken May 26, 2002.

Photo 2-2 e Flooding conditions at Alpine looking southwest at swale bridges.

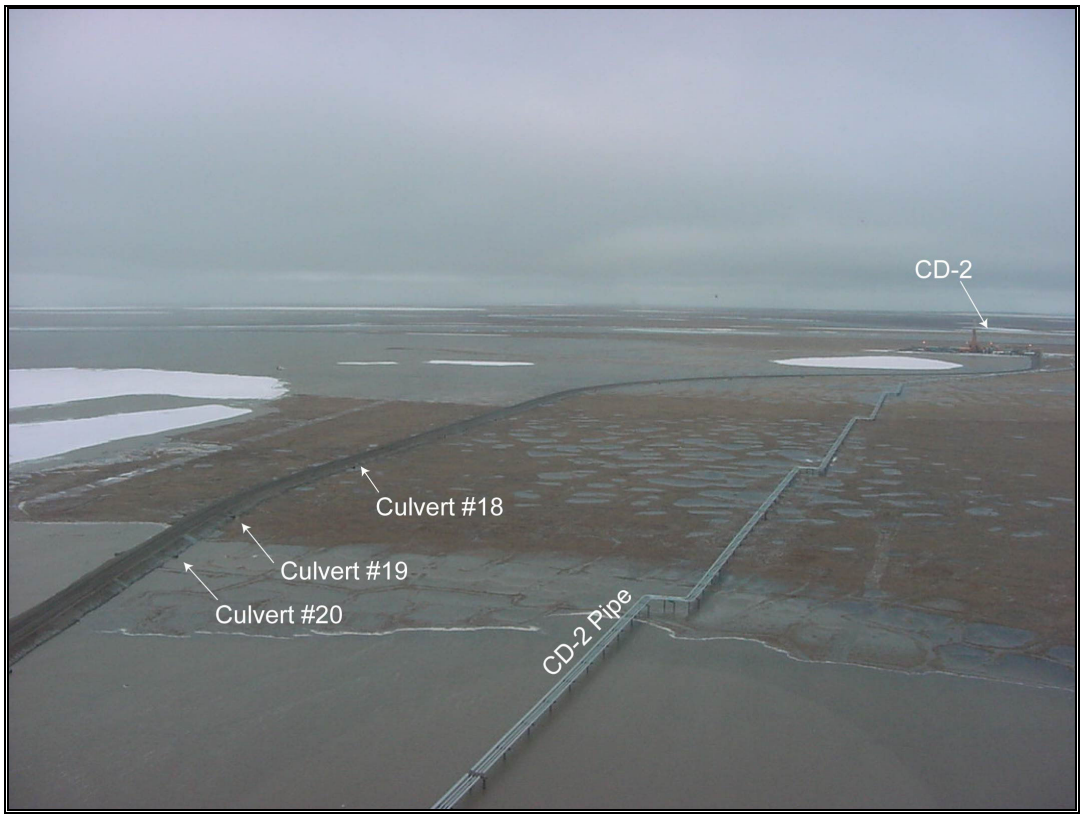


Photo taken May 26, 2002.

Photo 2-2 f Flooding conditions at Alpine looking west at CD-2.

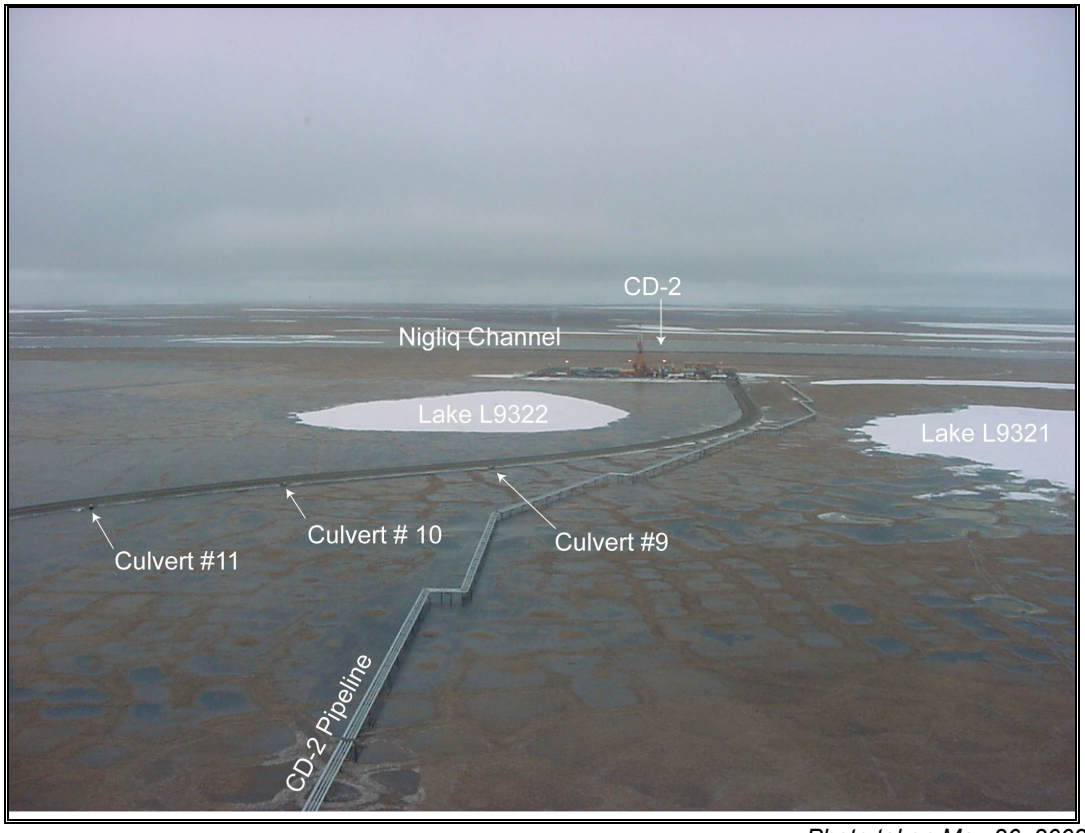


Photo taken May 26, 2002.

Photo 2-2 g Flooding conditions at Alpine looking west at CD-2.

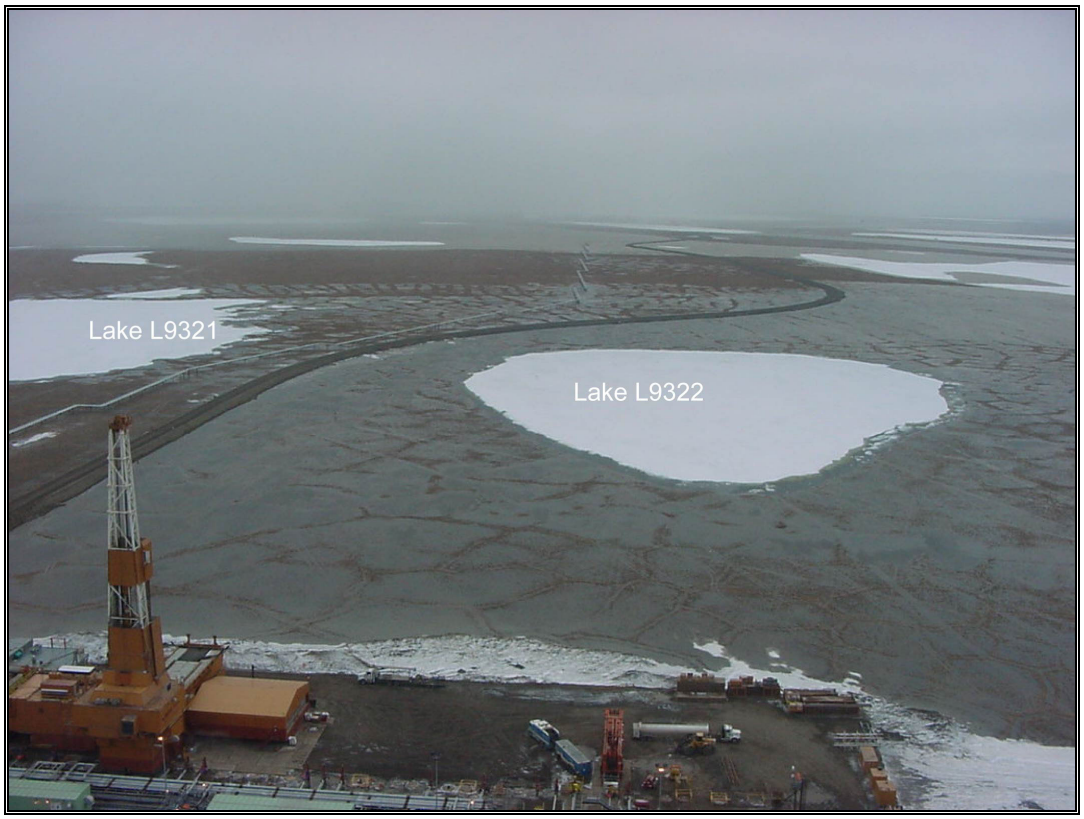


Photo taken May 26, 2002.

Photo 2-2 h Flooding conditions at Alpine looking east from CD-2.

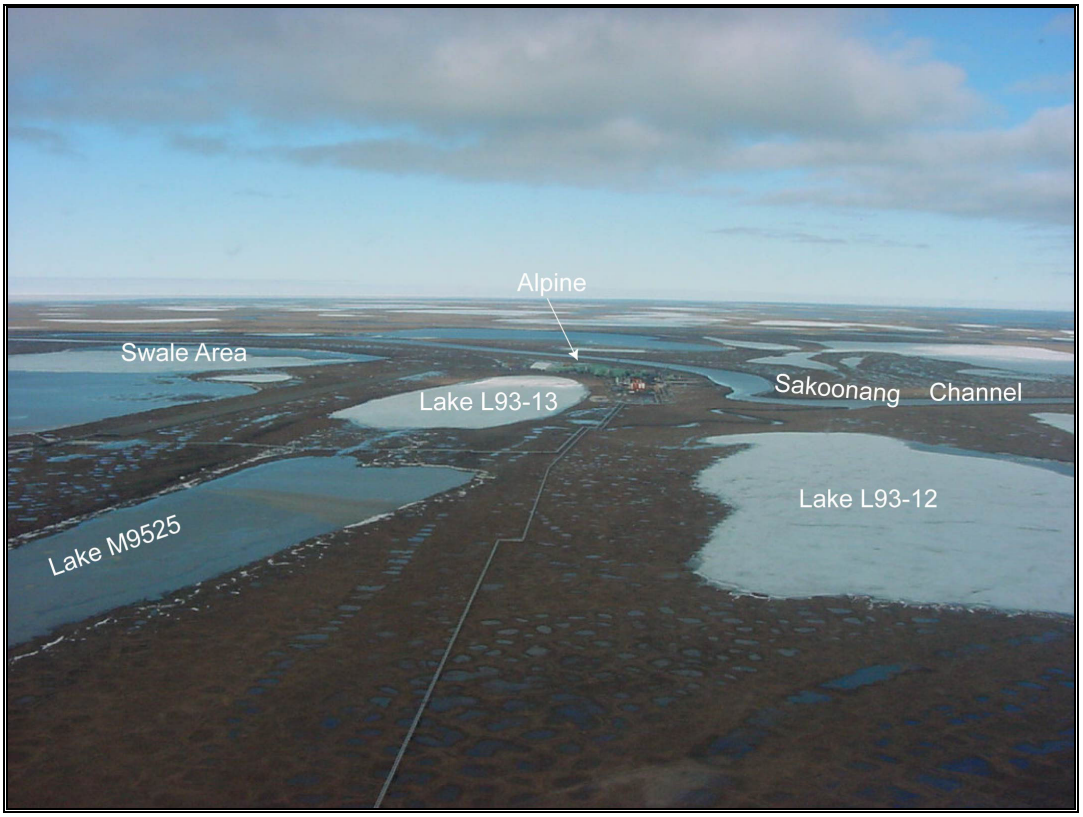


Photo taken May 31, 2002.

Photo 2-3 a Flooding conditions at Alpine looking north at Alpine.

Photo taken May 31, 2002.

Photo 2-3 b Flooding conditions at Alpine looking north at Alpine.

Photo taken May 31, 2002.

Photo 2-3 c Flooding conditions at Alpine looking south at Alpine.

Photo taken May 31, 2002.

Photo 2-3 d Flooding conditions at Alpine looking south at swale area.

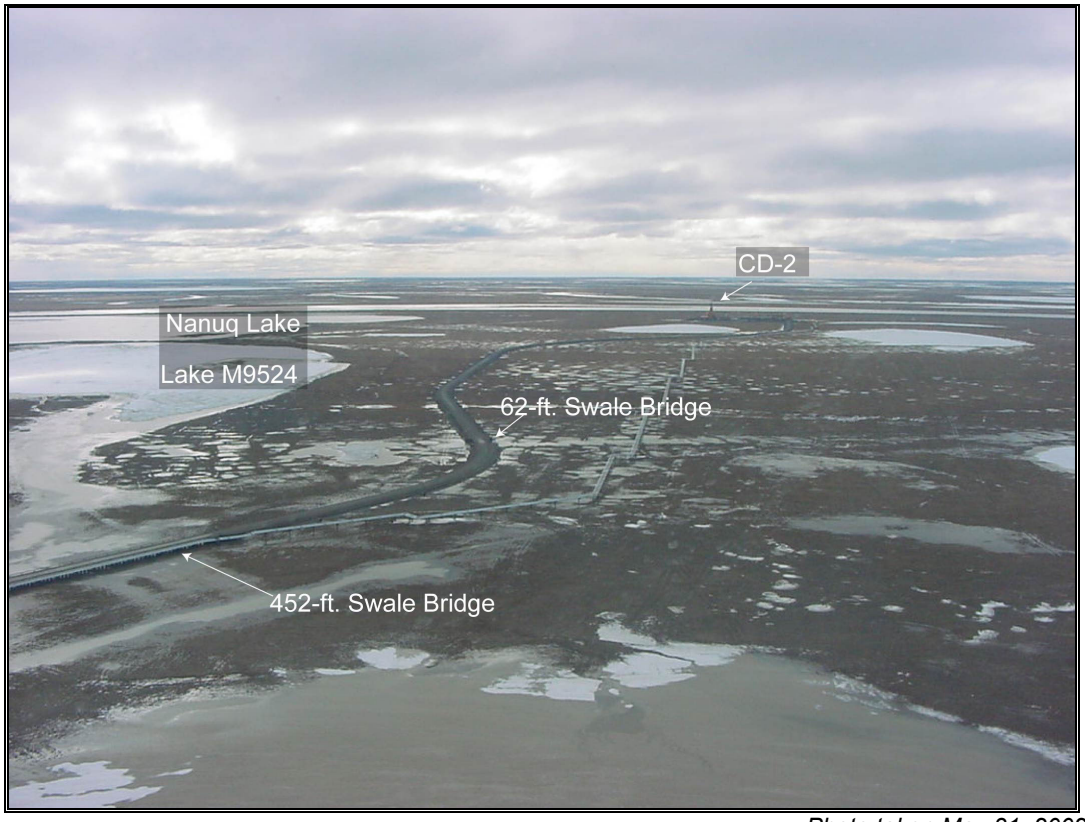


Photo taken May 31, 2002.

Photo 2-3 e Flooding conditions at Alpine looking west at CD-2.

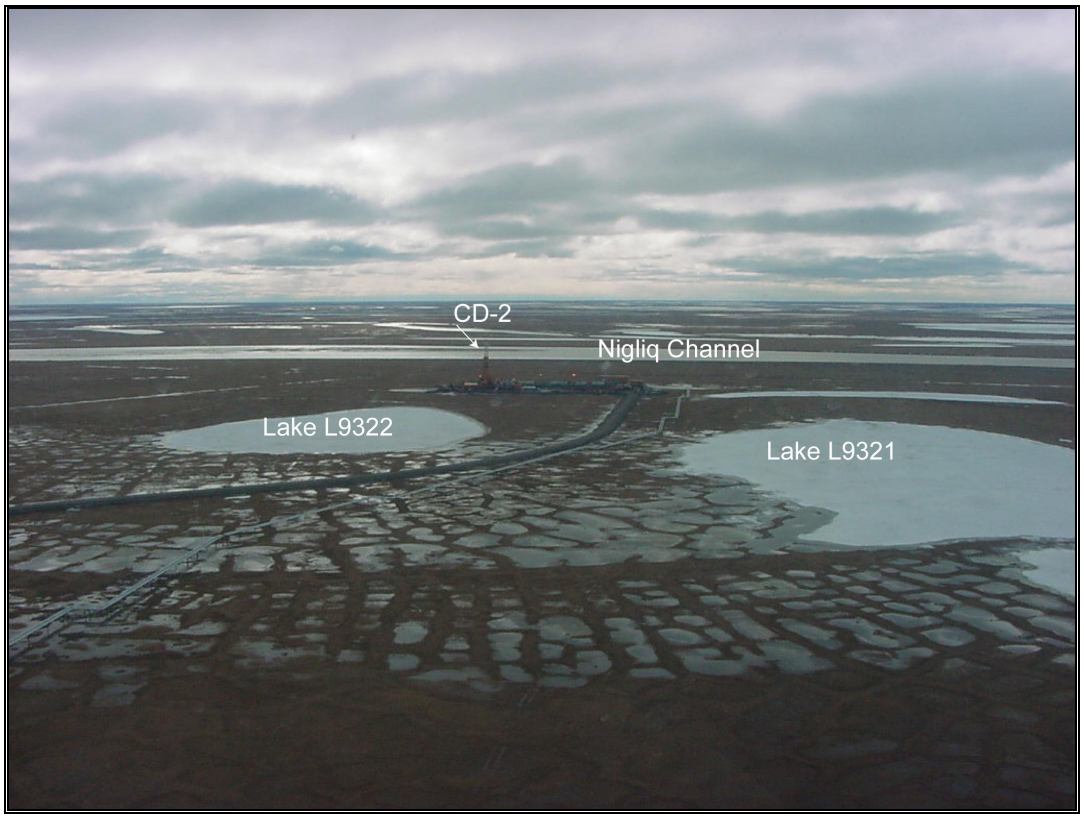


Photo taken May 31, 2002.

Photo 2-3 f Flooding conditions at Alpine looking west at CD-2.

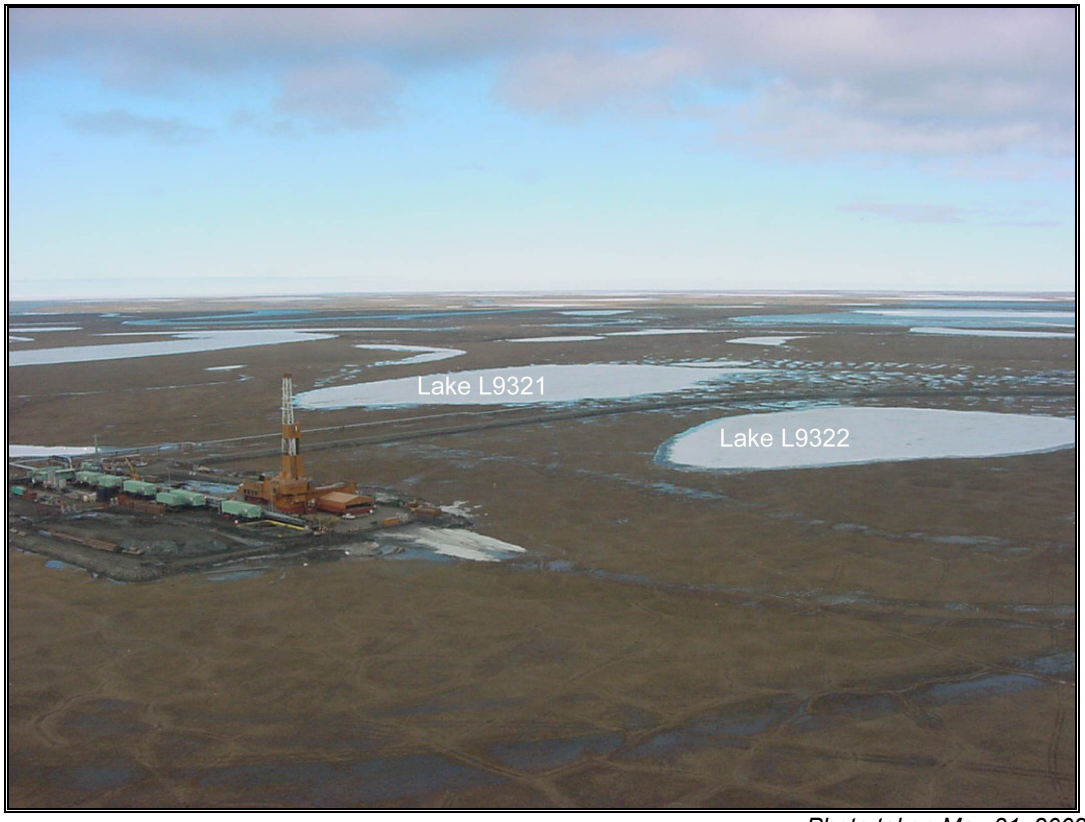


Photo taken May 31, 2002.

Photo 2-3 g Flooding conditions at Alpine looking northeast at CD-2.

3.0 Comparison of Predicted and Observed Water Surface Elevations

The peak water surface elevations in the immediate vicinity of Alpine were compared to water surface elevations predicted by the two-dimensional surface water model developed for the Colville River Delta (Michael Baker Jr., Inc., 2002, 1998; and Shannon & Wilson, Inc., 1997) to comply with USACE 2-960874, Page 2-A, Item 6. Based on a linear interpolation between the water surface elevations predicted for the 2- and 10-year open water floods, it is estimated that the peak water surface elevations experienced in spring 2002 will likely be equaled or exceeded on average about once every 7 years. Estimated recurrence intervals ranged from 5 to 8 years at the individual staff gages located around Alpine (Permanent Staff Gages 1, 3, 4, 6, 7, 9 and 10).

At Monument 01 (the head of the delta), the peak water surface elevation approximates a 7-year recurrence interval when compared to the predictions of the two-dimensional surface water model. However, using the measured water surface slopes and Slope-Area Method, the magnitude of the peak discharge is estimated to have a recurrence interval of about 4 years (Section 2.2).

Water surface elevation and flow pattern observations in 2002 were very similar to those observed in 2001, even though breakup occurred with uniquely different characteristics. For example, in 2002 breakup was preceded by warm sunny weather that caused a relatively rapid flood peak. At the head of the delta, the peak water surface elevation has occurred on average (since 1994) seven days after water was first observed on the delta. In 2002, the peak water surface elevation occurred only one day after water was first observed flowing, the fastest recorded time between observed flowing water and peak water surface elevation. In contrast, the 2001 breakup was preceded with cool cloudy weather that caused breakup to occur approximately two weeks later than average. Historically, the average date water has first been observed flowing at the head of the delta is 23 May. In 2001, flowing water was not observed until 5 June, with a peak water surface elevation occurring on 8 June.

Even though breakup occurred differently in 2002 and 2001, the magnitude of the flood peak discharge was estimated to be the same. Observed flow patterns were similar and comparisons to the two-dimensional model were similar. The differences in flood peak recurrence intervals

when comparing estimations based on discharge versus estimations based on water surface elevations (interpolated from the two-dimensional model) are the same, 4 verses 7, (rounded to the nearest whole year). Also, the estimated recurrence intervals in the Alpine area (based on measured water surface elevations compared to predicted) are similar, 5 to 8 years for 2002 and 5 to 9 years for 2001.

The two-dimensional surface water model was constructed to predict conditions during large flood events, i.e. 50-, 100-, and 200-year. It assumes open water, steady state conditions and does not take into account channel ice or ice jams. It was assumed that during a large flood event the presence of snow, ice, and ice jams would have little effect on the overall water surface elevations (this assumption is still valid). However, channel ice and ice jams are likely to always occur to some extent during breakup in the Colville River Delta. Channel ice and ice jams will restrict flow and cause increases in water surface elevations during smaller flood events when flow is mainly confined to the channels. Thus, the water surface elevation predictions of the model will generally under-predict water surface elevations during small flood events when channel ice and snow are present in the delta. For this reason the water surface elevation return period is higher than the discharge return period during small flood events.

During larger flood events (when there is considerable overbank flow) the two-dimensional model may over-predict versus under-predict water surface elevations in the lower areas (downstream or northern portions) of the delta. The reason for this may be that while the model assumes steady state flow conditions, breakup flows in the delta are seldom steady state, especially as the flood peak moves through. An attenuation of the flood peak occurs as it moves through the delta, caused by floodwater storage as the channels and depressions are filled. This results in an over-prediction of water surface elevations by the model. This situation may have occurred in 2000 when the peak discharge was estimated as a 25-year event based on discharge calculations and a 19-year event when compared to the model predictions (Baker, 2000).

To date, the two-dimensional surface water model has provided reasonable predictions when compared to the field observations and measurements. Explanations for the small variations between the field data and predicted data are reasonable based on the variation between the model's constraints and the physical characteristic of the delta. While the model cannot predict

localized variations due to ice jamming it has shown to provide a good overall prediction of the flooding conditions in the Colville River delta.

Table 3-1 Comparison of Observed and Predicted Water Surface Elevations

Observation Site	Observed Peak Water Surface Elevation (feet BPMSL)	Predicted 2-yr Water Surface Elevation (feet BPMSL)	Predicted 10-yr Water Surface Elevation (feet BPMSL)	Predicted 50-yr Water Surface Elevation (feet BPMSL)	Approximate Recurrence Interval of Observed Peak Water Surface Elevation (1) (years)
Staff Gage #1	7.68	5.5	8.4	11.2	7
Staff Gage #3	7.59	5.7 (2)	8.6	11.8	7
Staff Gage #4	6.90	5.1 (2)	7.6	9.9	8
Staff Gage #6	7.62	Dry (3)	8.8	11.9	<10
Staff Gage #7	n/a	Dry (3)	8.6	9.8	n/a
Staff Gage #8	n/a	Dry (3)	8.8	10.7	n/a
Staff Gage #9	8.21	6.7 (2)	10.0	12.1	5
Staff Gage #10	8.90	6.7 (2)	9.7	12.1	8
Monument 01	16.87	13.8	19.0	23.0	7 (4)
Monument 12	10.72	8.6	12.0	15.3	7
TBM 20N	9.60	7.3	10.9	14.2	7
Monument 22	7.94	5.9	8.7	11.9	8
Monument 23	7.45	5.2	7.3	10.5	12

Notes:

1. The recurrence interval was interpolated between water surface elevations predicted with the two-dimensional surface-water model of the Colville River Delta (Michael Baker Jr., Inc., 2002 and Shannon & Wilson, Inc., 1997). The model considers open water conditions therefore, the impact of an ice cover and/or ice jams has not been considered in the model's predictions.
2. The finite element at the staff gage is turned off in the two-dimensional surface water model. The presented water surface elevation is the water surface elevation in the immediate vicinity of the staff gage.
3. The finite element at the staff gage is turned off in the two-dimensional surface water model. All elements in the immediate vicinity are turned off and the area is considered dry.
4. The presented value is based on interpolation of the predicted water surface elevation (see Note 1). The recurrence interval estimated from the computed peak discharge and the flood frequency relationship developed for the head of the delta by Michael Baker Jr., Inc. 2002 is 4 years.
5. Locations of monuments and gages are shown in Figures 2-1 and 2-2, respectively.

4.0 Erosion and Scour

4.1. Gravel Pad and Road Erosion

Alpine's gravel pads and roads were inspected for erosion on 31 May - approximately six days after the peak water surface elevation had occurred. The inspection was performed in order to determine if any erosion of the road and pad had occurred as a result of contact with spring breakup floodwaters. No significant erosion due to breakup flows was observed anywhere along the gravel structures. At no location was the erosion of more than 20 cubic yards of gravel per hundred linear feet of infield gravel placement noted, thus the requirements of USACE 2-96087 are met and additional reporting or remedial action plans are not required at this time.

In areas where inundation did occur, some minor settlement of fine-grained material was noted, however, no slumping or side slope deterioration was noted. High water marks were noted on the gravel structures. Such marks were identified by grasses and other debris stranded on the gravel side slopes, or where fine-grained materials had been washed from the gravel. High water marks along the CD-2 access road are presented on Photos 4-1 through 4-7.

4.2. Scour at the Alpine Swale Bridges

A site visit was performed on 6 and 7 June to document scour that may have occurred at the two Alpine swale bridges. The intent of the inspection was to visually observe the vegetation and bridge piers for obvious problems.

Vegetation throughout the swale area was intact and has evidently been able to withstand the flows experienced to date. The only noteworthy scour observed was adjacent to the bridge piers. Scour measured at random piers was generally two to three feet deep (measured from the ground surface) (see Photo 4-8a). Depths were relatively consistent at both the large and small bridges and at both the upstream, downstream, and sides of the piers.

Scour observed around the bridge piers appeared to be a result of construction techniques used to install the piers rather than erosion of the natural ground materials. Scour holes did not have the characteristic shape of typical scour holes caused by the erosion of loose material around piers by high velocity flows. Instead, the scour appeared to be the result of degradation of the top two

to three feet of the slurry that was used to backfill the pre-drilled pier holes. This can be seen in Photos 4-9 and 4-10. In Photo 4-9, the rod was on natural ground approximately 6 inches from the pier and the depth of water was 1.2 feet. In Photo 4-10, the rod was moved against the pier and the depth was 3.2 feet. The natural ground and vegetation was intact right up to the edge of scour, where it dropped vertically for a depth of approximately two feet. This suggests that although the natural ground is holding up well, the top few feet of backfill slurry has degraded and been scoured during flood events.

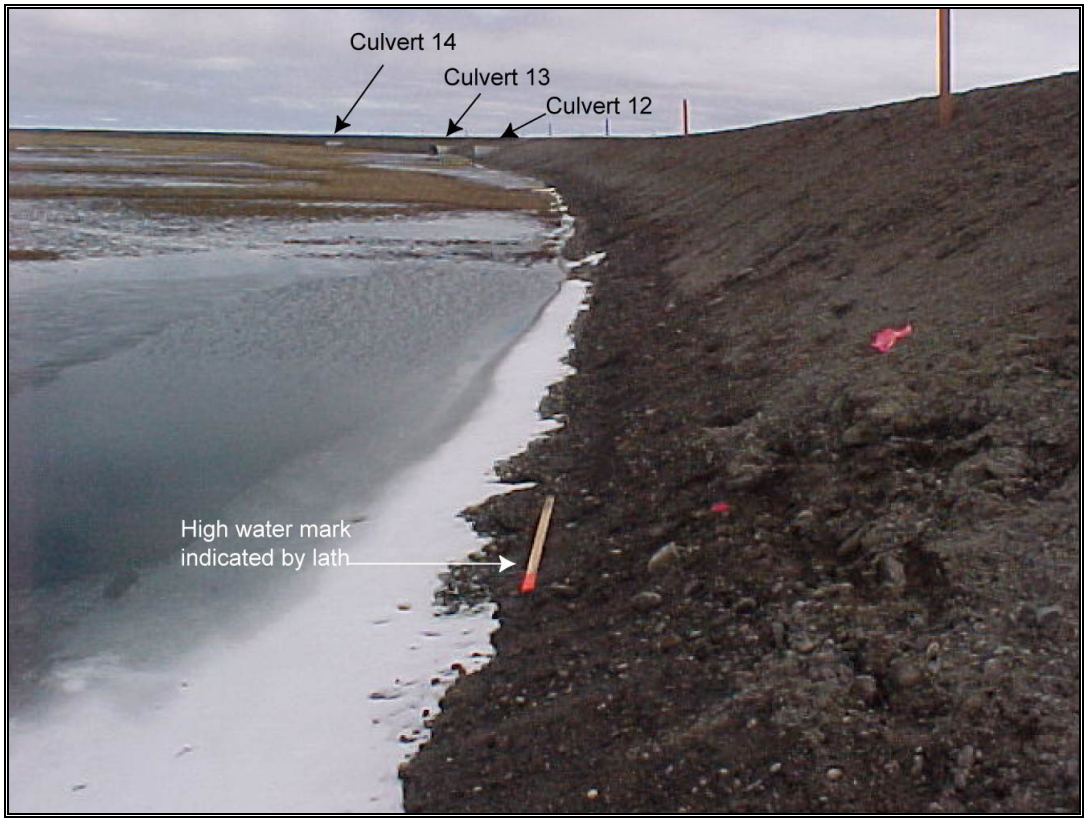


Photo taken May 31, 2002.

Photo 4-1 **Facing east from Culvert 11 along the north side of the CD-2 access road.**

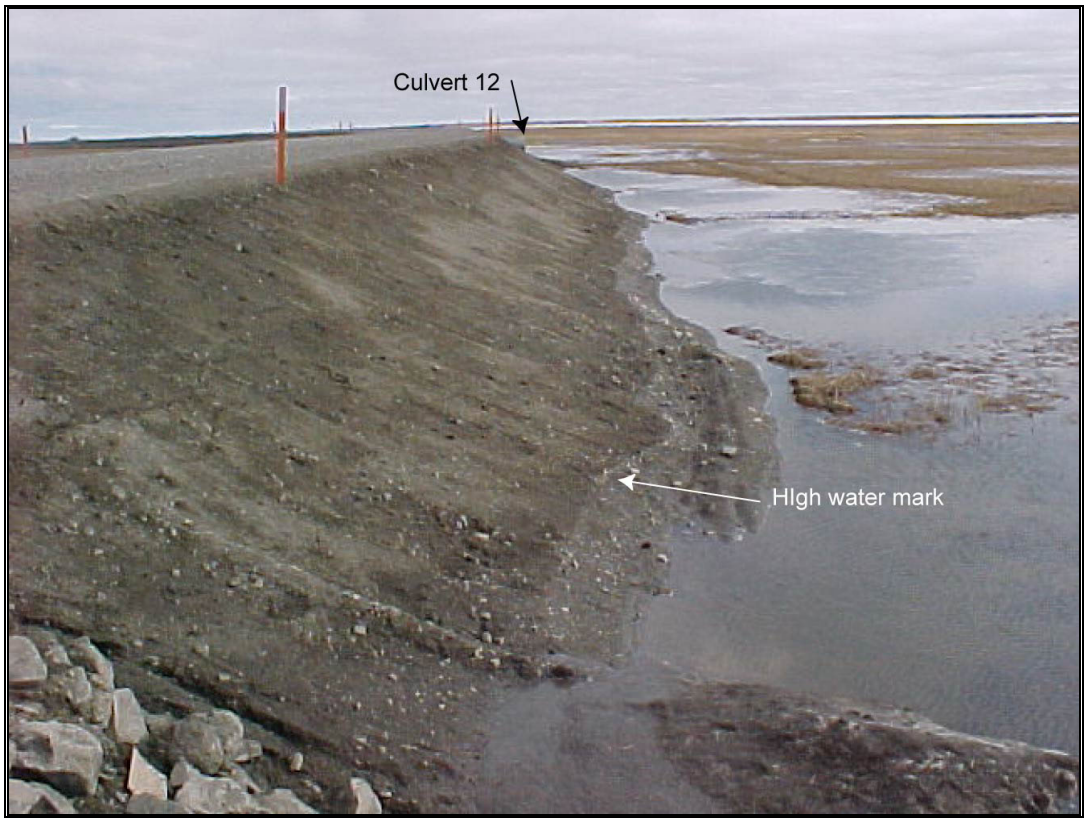


Photo taken May 31, 2002.

Photo 4-2 **Facing east from Culvert 11 along the south side of the CD-2 access road.**

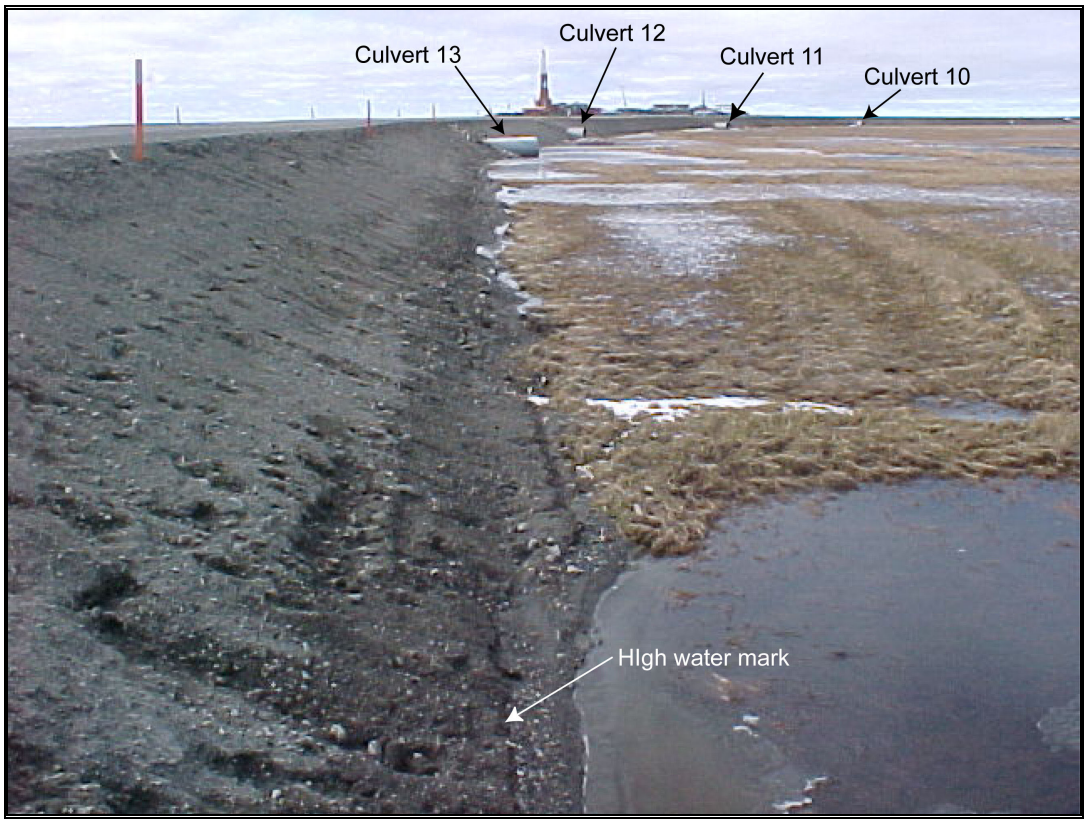


Photo taken May 31, 2002.

Photo 4-3 **Facing west from Culvert 14 along the north side of the CD-2 access road.**

Photo taken May 31, 2002.

Photo 4-4 **Facing west from Culvert 14 along the south side of the CD-2 access road.**

Photo taken May 31, 2002.

Photo 4-5 Facing east from Culvert 20 along the north side of the CD-2 access road.

Photo taken May 31, 2002.

Photo 4-6 Facing east from Culvert 20 along the south side of the CD-2 access road.

Photo taken May 31, 2002.

Photo 4-7 Facing east along the south side of the CD-2 access road from the 62-ft. bridge.

Photo taken June 7, 2002.

Photo 4-8 Typical depth of scour at bridge pier.

Reading on rod is 3.2 feet and scour depth is approximately 2 feet (depth of water adjacent to pier is 1.2 feet).

Photo taken June 7, 2002.

Photo 4-9 Depth of water approximately 6 inches from pier.

Reading on rod is 1.2 feet.

Photo taken June 7, 2002.

Photo 4-10 Depth of scour adjacent to pier.

Note reading on rod of 3.2 feet. Scour depth is approximately 2 feet.

5.0 Lake Recharge

Lakes L9312, L9313, L9282, and L9342 were monitored during breakup to assess recharge and the mechanisms causing recharge. Water surface elevations at Lakes L9312 and L9313 were measured with permanent staff gages. Water surface elevations were surveyed at Lakes L9342 and L9282 based on temporary benchmarks installed by Kuukpik/LCMF. Summaries of field observations are provided below and in the accompanying tables and photographs. Monitoring of Lakes L93-12 and L93-13 was completed to comply with the following permits:

- AK 9703-030G, Page 8, Item 16
- FG99-111-0051, Page 2, Item 3
- FG97-111-0190-Amendment 1, Page 2, Item 1

5.1. Lake L9312

Prior to breakup, the water surface elevation in Lake L9312 was 7.31 feet, measured on April 6. Recharge flow into Lake L9312 was first noted on May 25 when water was observed flowing from the Sakoonang Channel into Lake M9525, and eventually into Lake L9312. A peak water surface elevation of 8.21 feet was recorded on May 26 at Lake L9312. As the water surface elevation of the Sakoonang Channel began to drop, the water surface elevation in Lake 9312 began to recede. Water surface elevations and recharge of Lake 9312 are shown on Table 5-1 and on Photographs 5-1 and 5-2.

It is apparent from observations and readings made in the field that Lake L9312 was recharged by overflow from the Sakoonang Channel. The water surface elevation of Lake L9312 increased by 0.9 feet during breakup, and then receded approximately 0.2 feet indicating that the lake had overtopped and reached its bankfull elevation.

5.2. Lake L9313

Prior to breakup, the water surface elevation in Lake L9313 was 5.96 feet, measured on May 11. On May 25, water was observed flowing from the Sakoonang Channel into Lake M9525 and then into Lake L9313 through the low divide separating these lakes. The water surface elevation at Lake L9313 reached a peak of 8.90 feet sometime between 10:45 a.m. and 8:50 p.m. on May

25. The water surface elevation then began to recede as water levels in the river dropped. Water surface elevations and recharge of Lake L9313 are shown in Table 5-2 and Photographs 5-1 and 5-2.

It is apparent from field observations and readings that Lake L9313 was recharged by overflow from the Sakoonang Channel. The water surface elevation of Lake L9313 increased by 2.94 feet during breakup, and then receded approximately 2.68 feet indicating that the lake had overtopped and reached its bankfull elevation.

5.3. Lake L9282

Prior to breakup, the water surface elevation in Lake L9282 was 8.74 feet, measured on May 11. Water surface elevations of 8.85 and 8.83 feet that were recorded on June 1 and on June 29, respectively suggest that recharge to Lake L9282 from the Sakoonang channel did not occur. Furthermore, aerial observations of the channel between Lake L9282 and the Sakoonang Channel indicate that river water did not reach Lake L9282. Evidence of this can be seen on Photograph 5-3 taken on May 26 within 24 hours of the peak water surface elevation in the area. In the photo, note that although turbid river water has entered the channel, it has not reached Lake L9282 proper. If river water did at some point reach Lake L9282, its extent was likely minimal and did not have a significant impact with respect to lake recharge. Recharge to Lake L9282 was likely caused by local snowmelt and runoff only. Water surface elevations of Lake L9282 are shown in Table 5-3.

5.4. Lake L9342

Prior to breakup, the water surface elevation in Lake L9342 was 8.79 feet, measured on May 11. A water surface elevation of 8.88 feet was recorded on June 1 and 8.86 feet on June 29. No evidence of recharge from the Sakoonang channel was observed, however a hydraulic connection to Lake L9282 was observed on the east end of Lake L9342. This connection is shown on Photograph 5-4. Recharge to Lake L9342 was likely caused by local snowmelt and runoff only. Water surface elevations of Lake L9342 are shown in Table 5-4.

Table 5-1 Lake L9312 Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Observations
04/06/02	17:20	7.31	Water surface elevation survey conducted by Kuukpik/LCMF.
High Water Mark 05/26/02	16:00	8.21	Thick ice immediately around gage, reading is at top of ice. Open water approximately 3-4 feet away looks to be at or near the same elevation.
05/27/02	13:00	8.18	Thick ice immediately around gage, reading is at top of ice. Open water approximately 3-4 feet away looks to be at or near the same elevation. Does not appear that recharge is continuing to flow into lake river source.
05/31/02	18:35	8.06	Open water around shoreline appears cloudy.
06/07/02	11:25	7.99	Majority of lake is covered in ice. Open water around shoreline only.
06/13/02	10:00	7.97	Reading by Alpine personnel.
06/19/02	17:00	7.95	Reading by Alpine personnel.
06/21/02	12:00	7.94	Reading by Alpine personnel.
06/23/02	17:30	7.98	Reading by Alpine personnel. Rain the previous night.
06/29/02	11:25	7.99	Lake is free of ice.

Notes:

1. Coordinates for Staff Gage #9 are N5975797.3; E385464.0, Alaska State Plane, Zone 4, NAD 27.
2. Water surface elevation measured by drilling a hole in the lake ice and surveying from a reference elevation of 14.57 feet BPMSL located on TBM L99-32-59 at the fresh water pump house. The elevation of L99-32-59 was confirmed by Kuukpik/LCMF 2002.
3. A difference of 0.01 feet was measured between the face plate readings on Permanent Staff gage #9 and the BPMSL datum as determined by TBM L99-32-59. All water surface elevation readings have been converted to BPMSL with respect to TBM L99-32-59.

Table 5-2 Lake L9313 Water Surface Elevations and Observations

Date	Time	Water Surface Elevation (feet BPMSL)	Water Depth (ft)	Observations
5/11/2002	14:50	5.96	2.06	Water surface elevation survey conducted by Kuukpik/LCMF.
5/24/2002	--	--	--	Localized ponding only.
5/25/2002	10:45	8.85	4.95	Reading prior to discharge measurement at bridges. Taken by Alpine personnel.
High Water Mark		8.90	5.00	High water occurred on May 25 between 10:45 and 20:50.
5/25/2002	20:50	8.54	4.64	Reading after discharge measurement at bridges.
5/26/2002	09:40	8.18	4.28	Confirmed previous high water mark.
5/26/2002	15:20	8.05	4.15	
5/27/2002	09:40	7.77	3.87	Reading taken in approximately 20-knot wind.
5/28/2002	16:00	7.65	3.75	Reading taken by Alpine personnel. Reading time is approximate.
5/31/2002	13:50	6.55	2.65	
6/5/2002	09:15	6.34	2.44	Reading taken by Alpine personnel.
6/9/2002	10:10	6.30	2.40	Reading taken by Alpine personnel.
6/12/2002	15:05	6.25	2.35	Reading taken by Alpine personnel.
6/19/2002	09:00	6.22	2.32	Reading taken by Alpine personnel.
6/21/2002	14:00	6.22	2.32	Reading taken by Alpine personnel.
6/23/2002	16:30	6.22	2.32	Reading taken by Alpine personnel.
6/29/2002	11:30	6.24	2.34	

Notes:
1. Coordinates for Staff Gage #10 are N5975797.3; E385464.0, Alaska State Plane, Zone 4, NAD 27.
2. Water surface elevation measured by drilling a hole in the lake ice and surveying from a reference elevation of 16.00 feet located on TBM L99-32-60 at the fresh water pump house. The elevation of L99-32-60 was confirmed by Kuukpik/LCMF 2002.
3. Water surface elevation readings were taken from Permanent Staff Gage #10 unless noted otherwise. A difference of 0.50 feet was measured between the face plate readings on Permanent Staff gage #10 and the BPMSL datum as determined by TBM L99-32-60. All water surface elevation readings have been converted to BPMSL with respect to TBM L99-32-60.

Table 5-3 Lake L9282 Water Surface Elevations and Observations

Date	Time	Water Surface Elevation	Observations
11-May-02	9:40	8.74	Lake is frozen. Water surface elevation surveyed by Kuukpik/LCMF through a hole augered into the ice.
1-Jun-02	10:20	8.85	Lake is generally ice covered with open water around shoreline only. Hydraulic connection to Lake L9342 is visible at west the end of lake.
29-Jun-02	9:40	8.83	Lake is approximaetly 25% ice covered.

Notes:
1. Water surface elevation measured by surveying from reference elevations of 13.52, 13.73, 13.37, and 11.76 feet located on TBM 02-01-36 G, 02-01-36 H, 02-01-36-I, and 02-01-26 B, respectively. The TBMs and elevations were established by Kuukpik/LCMF in 2002.

Table 5-4 Lake L9342 Water Surface Elevations and Observations

Date	Time	Water Surface Elevation	Observations
11-May-02	8:20	8.79	Water surface elevation surveyed by Kuukpik/LCMF through a hole augered into the ice.
1-Jun-02	9:40	8.88	Lake is generally ice covered with open water around shorline only. Hydraulic connection to Lake L9282 is visible at east the end of lake.
29-Jun-02	9:00	8.86	Lake is free of ice.

Notes:
1. Water surface elevation measured by surveying from reference elevations of 13.61, 12.66, and 13.08 feet located on TBM 02-01-36 A, 02-01-37 J, and 02-01-37-K, respectively. The TBM's and elevations were established by Kuukpik/LCMF in 2002.

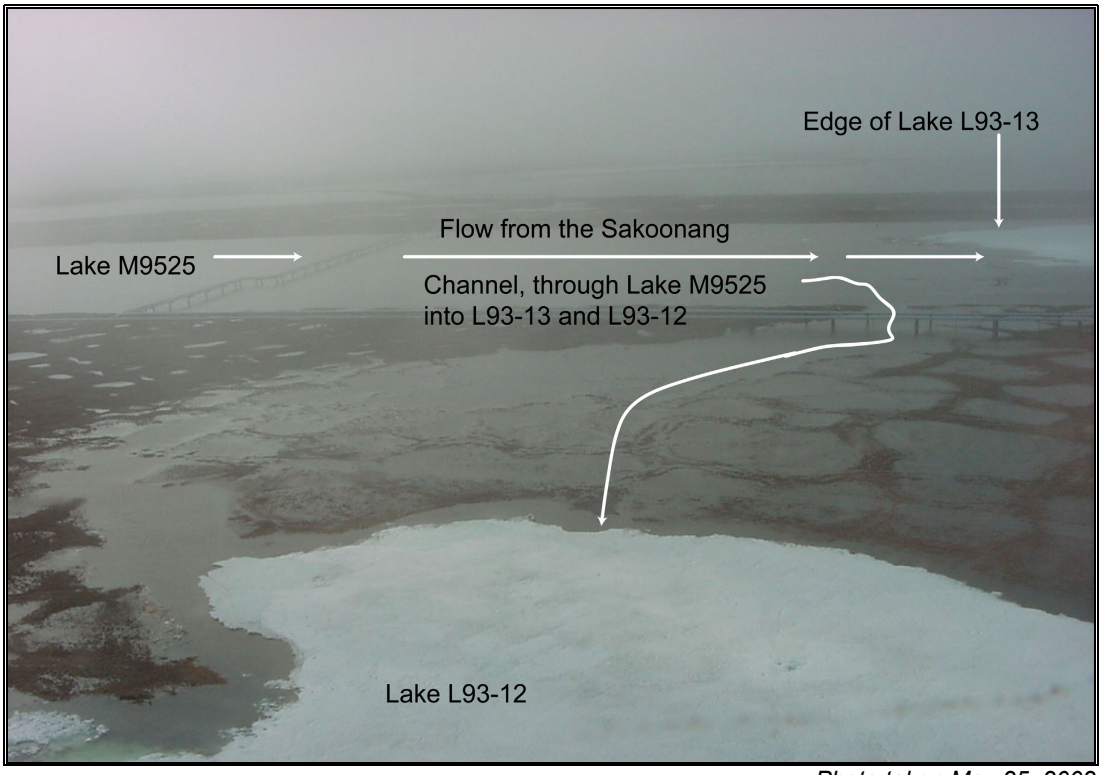


Photo taken May 25, 2002.

Photo 5-1 Looking west from Lake L93-12.

Photo taken May 26, 2002.

Photo 5-2 Looking northeast at Lake L93-13 and L93-12.

Photo taken May 26, 2002.

Photo 5-3 Looking northeast towards Lake L92-82.

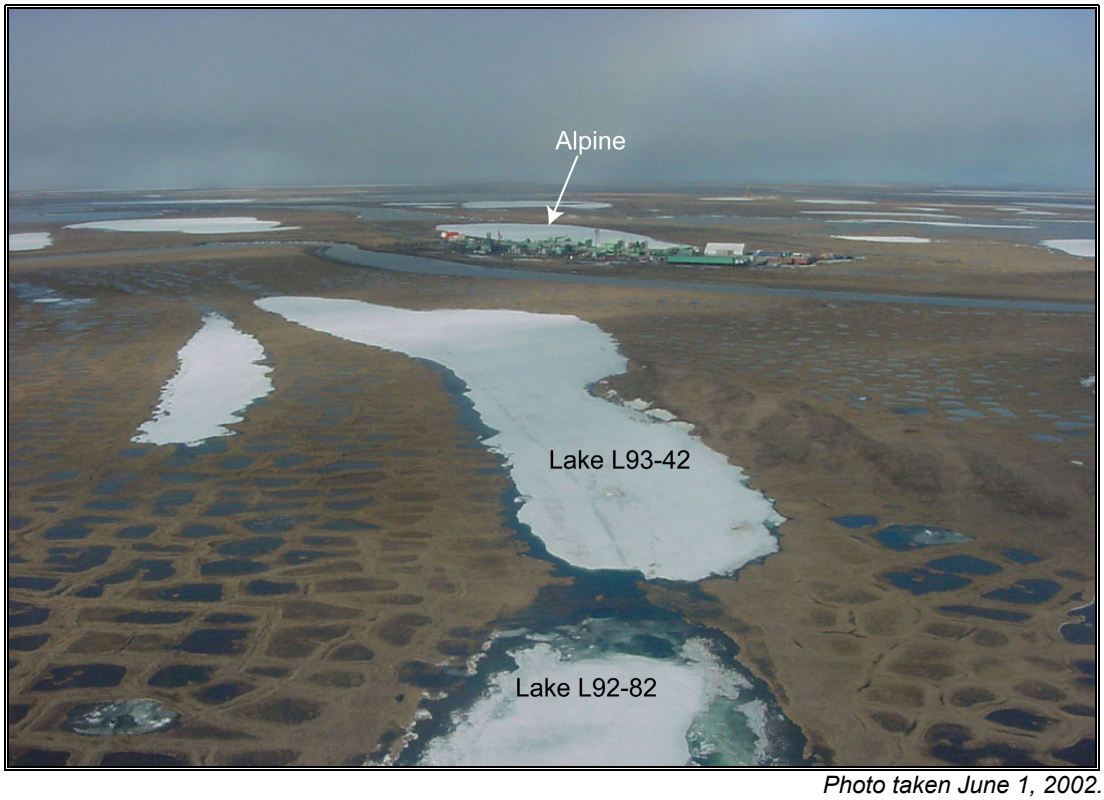


Photo taken June 1, 2002.

Photo 5-4 Looking west at Lake L93-42.
Note hydraulic connection to Lake L92-82.

6.0 Channel Ice Observations

Channel ice surveys began on 23 May when water was first observed flowing at the head of the delta. Channel ice surveys were performed daily until 26 May when all the major channels of the delta were clear of channel ice and ice jams. The progression of the channel ice clearing and ice jamming is shown on Figures 6-1 through 6-4.

6.1. Channel Ice

Unseasonably periods of warm and sunny weather and rapidly deteriorating channel ice characterized the early stages of breakup in the delta. Most of the snow cover in the delta had melted and many of the channels contained standing water. Channel ice in the main channels, East and Nigliq, showed signs of deterioration. Snow drifting that usually filled many of the smaller channels had melted, exposing areas of the channel bottom.

On the morning of 23 May, the first day of flowing water, the channel ice in the upper East and upper Nigliq channels was floating and beginning to break apart. Low water intact channel ice in all main channels was observed floating and becoming saturated by rising floodwaters. On the morning of 24 May, the East and Nigliq channels in the vicinity of Monument 01 were clear of all but broken and floating chunk ice. Channel ice in the East and Nigliq channels continued to clear on 25 May, and by 26 May all but the areas near the coast were clear of intact channel ice.

Near Alpine, the Sakoonang Channel was between 50 and 80 percent ice-free on the morning of 23 May. Channel ice deteriorated rapidly from the smaller channels in the lower portions of the delta as floodwaters began to rise and saturate these channels. By the morning of 24 May, ice that remained in these channels was, for the most part, floating and rotten; however, the floating channel ice in the lower Nigliq was mostly intact. On 25 May, small sections of channel ice remained on the West Ulamnigiaq and Sakoonang, but the majority of the lower channels were clear or contained only floating broken chunk ice. The channel ice on the lower Nigliq was still intact and extended into Harrison Bay. With the exception of the East and Nigliq channels, all channels in the lower delta (downstream near the coast) were either clear or contained only discontinuous sections of broken ice by 26 May.

6.2. Ice Jams

Ice jams were observed at various locations in the delta. A surface ice jam that formed above the village of Nuiqsut at the confluence of the Putu and Nigliq channels on 23 May grew in size on 24 May, but cleared by 25 May. Small ice jams were noted at the mouth of the Itkillik River, on the Sakoonang channel northeast of Alpine, and on portions of the Nigliq channel. All observed ice jams appeared to be surface ice jams rather that grounded jams. In no case did the observed ice jams appear to cause significant backwater, blockage, or diversions of flow.

The only significant ice jam observed in the vicinity of Alpine was in the Nigliq Channel at the sharp channel bend near Monument 20N on 25 May. The ice jam spanned the entire width of the channel and appeared to be a surface ice jam only. Large ice floes (some measured over 6 feet thick) were driven onto both banks of the channel; however, backwater effects from this ice jam did not appear significant and no observable effects on water surface elevations up or downstream were noted.

An ice jam along the coast near Monument 35 at Colville Village was observed. Here floodwater inundated parts of the local runway and surrounding floodplain. Based on staff gages installed and referenced to Monument 35, the water surface elevation reached peak 5.51 feet on the evening of 26 May. The water levels receded rapidly once the ice jam cleared (Helmricks, 2002).

Figure 6-1 Low Water Channel Ice Survey, May 23, 2002.

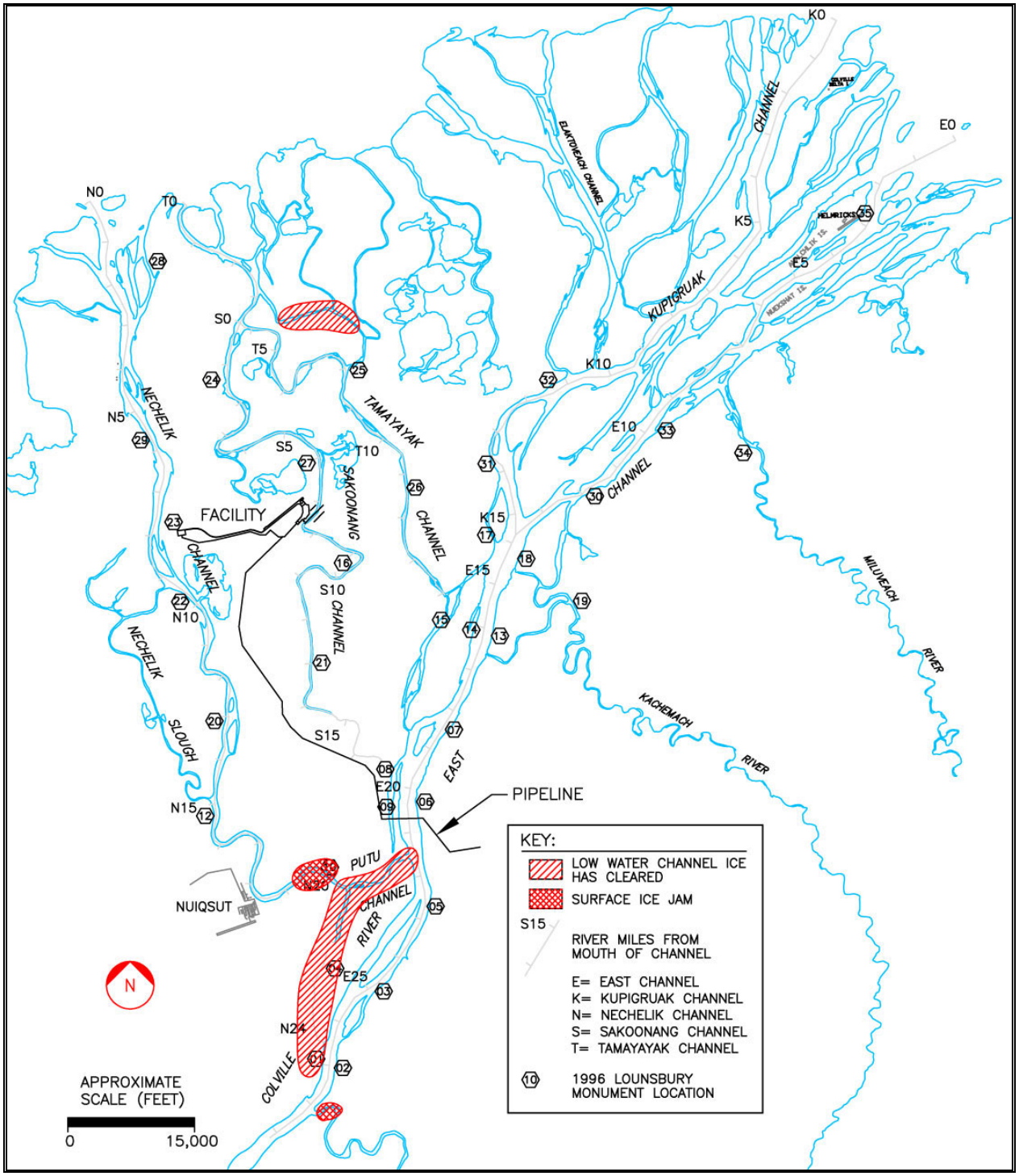


Figure 6-2 Low Water Channel Ice Survey, May 24, 2002.

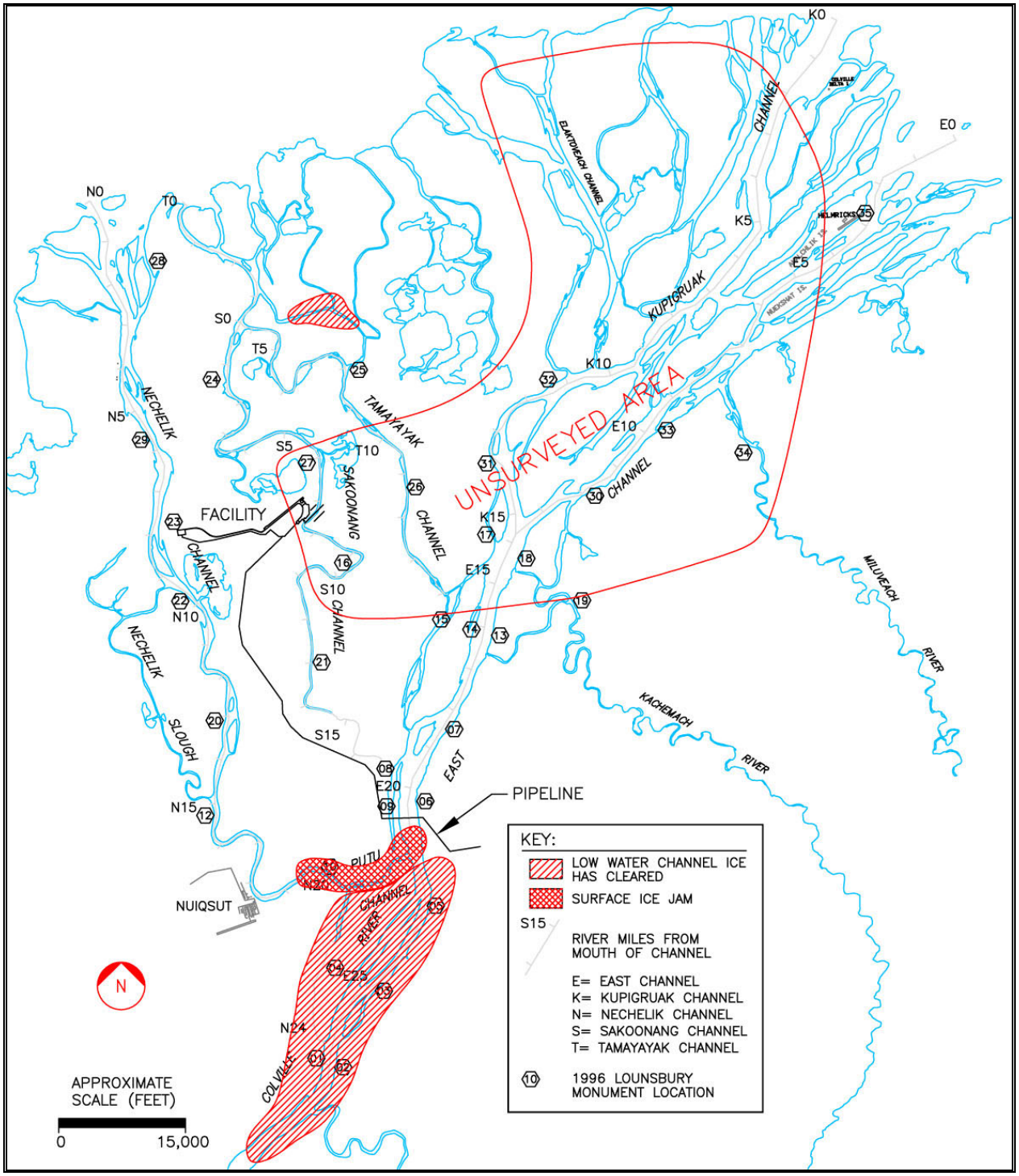


Figure 6-3 Low Water Channel Ice Survey, May 25, 2002.

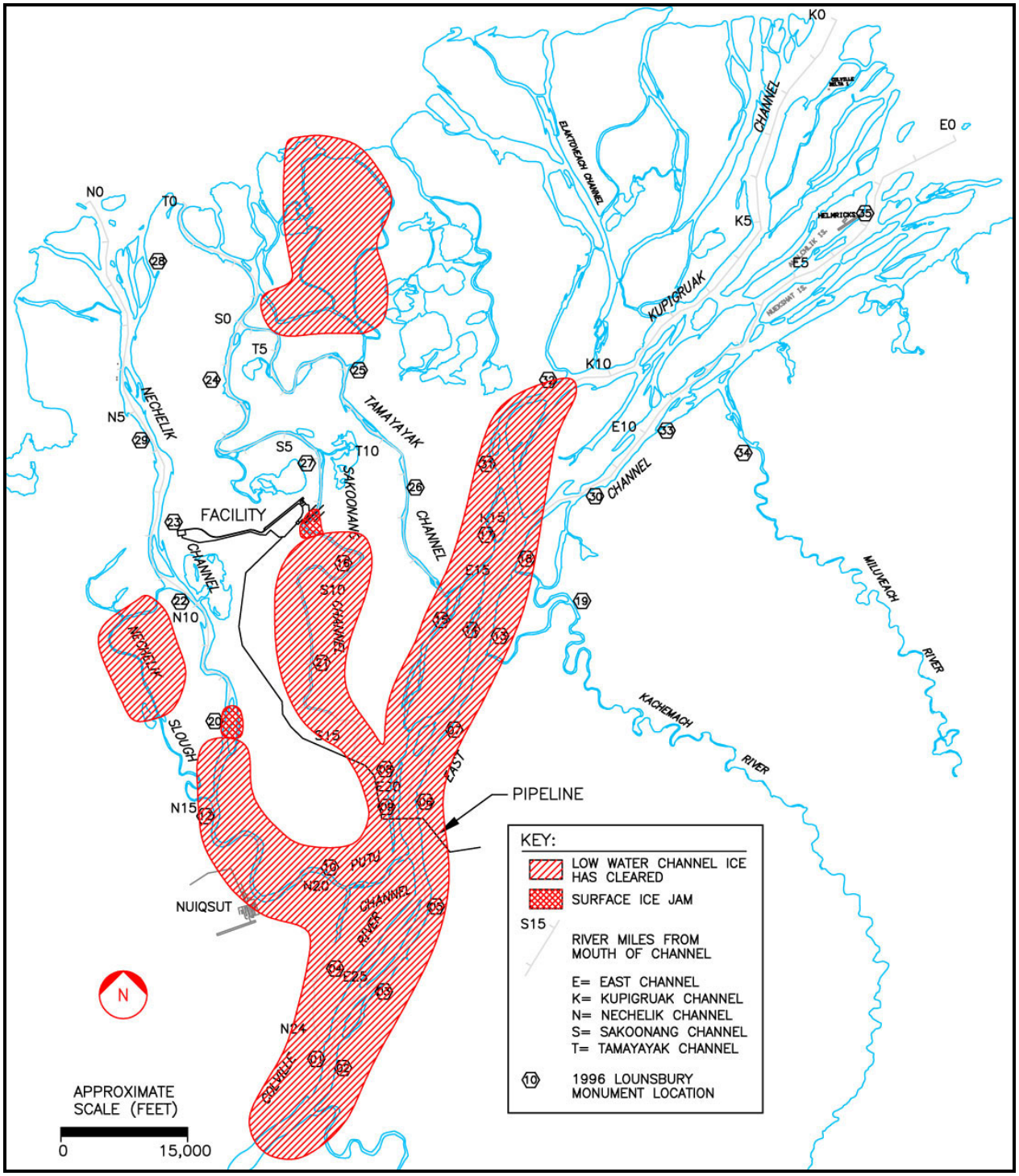
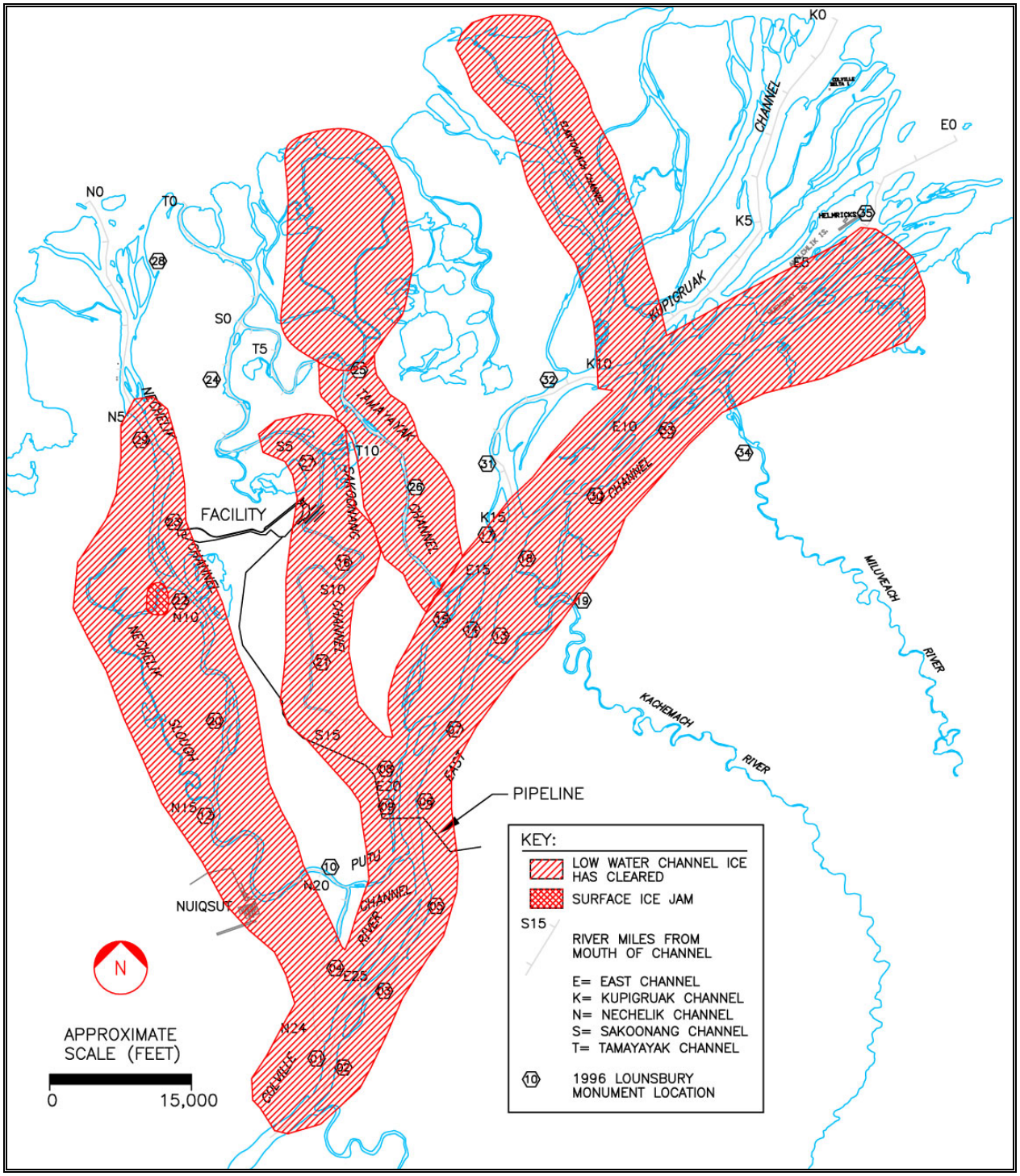


Figure 6-4 Low Water Channel Ice Survey, May 26, 2002.



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Appendix A Discharge Measurement Notes

DISCHARGE MEASUREMENT NOTES

LOCATION: Alpine 452 Swale Bridge

Date: May 25, 2002 **Party:** Jon Wolf, Hans Arnett

Width: 445 **ft** **Area:** 929.7 **ft²** **Vel:** 3.47 **fps** **G.H.:** **Discharge:** 3226 **cfs**

No Secs. **G.H. change:** **in.:** **hrs.:** **Susp.:**

Method coef.: **Hor. Angle coef.** **Sus. Coef.:** **Meter No.**

Gage Readings

Time	Recorder	Inside	Outside
Weighted M.G.H.			
G.H. corrections			
Correct M.G.H.			

See Tables 2-1 though 2-7

Type of meter: Price AA

Date rated:

Meter: 0.5 **ft. above bottom of weight.**

Spin before meas. 2 min 55 sec **after** 2 min 50 sec

Method:

30lb lead weight with bridge boom & reel

Levels obtained: Yes, before and after

Measurement rated: Good **Rating based on following conditions:**

Cross section: Fairly uniform channel

Flow: Uniform & steady **Weather:** **Air Temp.** ~40 degrees F

Gage: **Water Temp.** ~33 degrees F

Other:

Record Removed: **Intake flushed:** N/A

Observer

Control Open channel flow. No ice/snow under bridge. Many chucks of ice floating through beneath the bridge during measurement.

Remarks All measurements conducted at 0.6 depth due to long grass on channel bottom that prevented accurate 0.8 depth measurements.

Velocity was adjusted with method coefficient based on a velocity profile completed at Sta 255.

G.H. of zero flow: **ft.**

Page 1 of 2

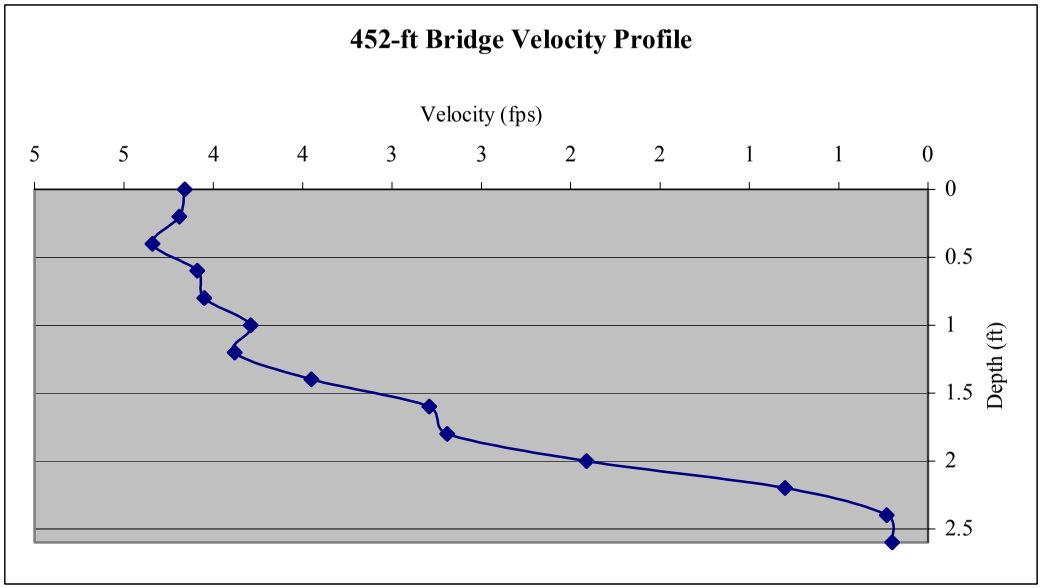
Alpine 452 Swale Bridge (cont'd)

Angle Coef. (deg)	Dist. From Initial Point (ft)	Width (ft)	Depth (ft)	Observ. depth (ft)	Revo-lutions	Time (sec)	VELOCITY		Adjust for Angle Coef.	Adjust for Method Coef.	Adjusted Velocity (fps)	Area (s.f.)	Discharge (cfs)	Description
							At Point (fps)	Mean in-vertical (fps)						
15	2	6.5	2.1	0.6	92	40	5.0	5.0	0.97	1.04	5.0	13.7	69	LEW @ bridge abutment
20	15	21.5	2.0	0.6	70	40	3.8	3.8	0.94	1.04	3.7	43.0	161	Tall grass
15	45	30.0	2.1	0.6	66	40	3.6	3.6	0.97	1.04	3.6	63.0	228	Tall grass
15	75	30.0	1.9	0.6	63	40	3.4	3.4	0.97	1.04	3.5	57.0	197	Tall grass
10	105	30.0	2.0	0.6	61	40	3.3	3.3	0.98	1.04	3.4	60.0	205	Tall grass
10	135	30.0	2.2	0.6	57	40	3.1	3.1	0.98	1.04	3.2	66.0	211	Tall grass
15	165	30.0	2.1	0.6	53	40	2.9	2.9	0.97	1.04	2.9	63.0	184	Tall grass
15	195	30.0	2.1	0.6	56	40	3.1	3.1	0.97	1.04	3.1	63.0	194	Tall grass
10	225	30.0	2.1	0.6	63	40	3.4	3.4	0.98	1.04	3.5	63.0	222	Tall grass
5	255	30.0	2.9	0.6	55	40	3.0	3.0	1.00	1.04	3.1	87.0	272	Tall grass
5	285	30.0	2.6	0.6	52	40	2.9	2.9	1.00	1.04	3.0	78.0	230	Tall grass
5	315	30.0	2.3	0.6	55	40	3.0	3.0	1.00	1.04	3.1	69.0	215	Tall grass
15	345	30.0	2.2	0.6	50	40	2.7	2.7	0.97	1.04	2.8	66.0	182	Tall grass
20	375	30.0	2.3	0.6	57	40	3.1	3.1	0.94	1.04	3.1	69.0	211	Tall grass
10	405	30.0	2.3	0.6	57	40	3.1	3.1	0.98	1.04	3.2	69.0	221	Tall grass
5	435	21.0	2.2	0.6	63	40	3.4	3.4	1.00	1.04	3.6	46.2	165	Tall grass
15	447	6.0	2.6	0.6	68	40	3.7	3.7	0.97	1.04	3.7	15.6	58	REW @ bridge abutment
TOTAL		**445.0**										**930**	**3226**	**Page 2 of 2**

Alpine 452 Swale Bridge (cont'd)

452-foot Bridge Velocity Profile

Depth (ft)	Velocity (FPS)
0.0	4.16
0.2	4.19
0.4	4.34
0.6	4.09
0.8	4.05
1.0	3.79
1.2	3.88
1.4	3.45
1.6	2.79
1.8	2.69
2.0	1.91
2.2	0.80
2.4	0.23
2.6	0.20
	40.57



Average Velocity = 2.90 fps
Six-tenths total depth = 2.6 x 0.6 = 1.56 ft
Six-tenths depth velocity = 2.79 fps
Method Coefficient to adjust six-tenths depth velocity to average velocity = 2.90 / 2.79 = 1.04

Alpine 62 Swale Bridge

DISCHARGE MEASUREMENT NOTES

LOCATION: Alpine 62 Swale Bridge

Date: May 25, 2002 **Party:** Jon Wolf, Hans Arnett

Width: 55.5 **ft** **Area:** 282.6 **ft²** **Vel:** 1.52 **fps** **G.H.:** **Discharge:** 429 **cfs**

No Secs. **G.H. change:** **in.:** **hrs.:** **Susp.:**

Method coef.: 1.23 **Hor. Angle coef.** **Sus. Coef.:** **Meter No.**

Type of meter: Price AA

Date rated:

Meter: 0.5 **ft. above bottom of weight.**

Spin before meas. 2 min 55 sec **after** 2 min 50 sec

Method:

30lb lead weight with bridge boom & reel

Gage Readings			
Time	**Recorder**	**Inside**	**Outside**
See Tables 2-1 though 2-7			
Weighted M.G.H.			
G.H. corrections			
Correct M.G.H.			

Levels obtained: Yes, before and after

Measurement rated: Good **Rating based on following conditions:**

Cross section: Fairly uniform channel

Flow: Uniform & steady **Weather:** **Air Temp.** ~40 degrees F

Gage: **Water Temp.** ~33 degrees F

Other:

Record Removed: **Intake flushed:** N/A

Observer

Control Open channel flow. No ice/snow under bridge. Occasional chunks of ice floating through beneath the bridge during measurement.

Remarks All measurements conducted at 0.6 depth due to long grass on channel bottom that prevented accurate 0.8 depth measurements.
Velocity was adjusted with method coefficient based on a velocity profile completed at Sta 20.5.

G.H. of zero flow: **ft.**

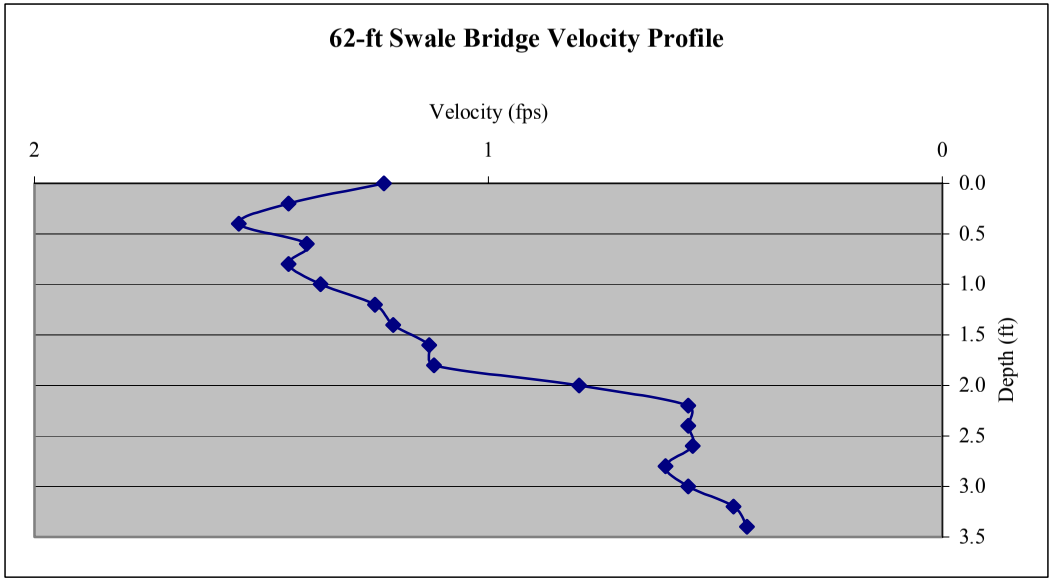
Alpine 62 Swale Bridge (cont'd)

Angle Coef. (deg)	Dist. From Initial Point (ft)	Width (ft)	Depth (ft)	Observ. depth (ft)	Revo-lutions	Time (sec)	VELOCITY		Adjust for Angle Coef.	Adjust for Method Coef.	Adjusted Velocity (fps)	Area (s.f.)	Discharge (cfs)	Description
							At Point (fps)	Mean in-vertical (fps)						
0	3.0	1.8	1.9	0.6	0	40	0.0	0.0	1.00	1.23	0.0	3.3	0	LEW @ bridge abutment
25	6.5	3.5	2.4	0.6	0	40	0.0	0.0	0.91	1.23	0.0	8.4	0	Tall grass
25	10.0	3.5	3.2	0.6	12	40	0.7	0.7	0.91	1.23	0.8	11.2	8	Tall grass
30	13.5	3.5	3.5	0.6	20	40	1.1	1.1	0.87	1.23	1.2	12.3	14	Tall grass
30	17.0	3.5	3.9	0.6	16	40	0.9	0.9	0.87	1.23	1.0	13.7	13	Tall grass
40	20.5	3.5	5.8	0.6	12	40	0.7	0.7	0.77	1.23	0.6	20.3	13	Tall grass
40	24.0	3.5	7.1	0.6	19	40	1.1	1.1	0.77	1.23	1.0	24.9	25	Tall grass
15	27.5	3.5	7.3	0.6	34	40	1.9	1.9	0.97	1.23	2.2	25.6	57	Tall grass
10	31.0	3.5	6.1	0.6	30	40	1.7	1.7	0.98	1.23	2.0	21.4	43	Tall grass
0	34.5	3.5	5.2	0.6	31	40	1.7	1.7	1.00	1.23	2.1	18.2	38	Tall grass
0	38.0	3.5	6.3	0.6	27	40	1.5	1.5	1.00	1.23	1.8	22.1	40	Tall grass
15	41.5	3.5	6.8	0.6	31	40	1.7	1.7	0.97	1.23	2.0	23.8	48	Tall grass
30	45.0	3.5	7.2	0.6	22	40	1.2	1.2	0.87	1.23	1.3	25.2	33	Tall grass
35	48.5	3.5	7.4	0.6	31	40	1.7	1.7	0.82	1.23	1.7	25.9	45	Tall grass
45	52.0	3.5	7.6	0.6	30	40	1.7	1.7	0.71	1.23	1.4	26.6	38	Tall grass
0	55.5	3.3	5.1	0.6	10	40	0.6	0.6	1.00	1.23	0.7	16.6	12	Tall grass
0	58.5	1.5	4.1	0.6	2	40	0.1	0.1	1.00	1.23	0.2	6.2	1	REW @ bridge abutment
TOTAL		**55.5**										**283**	**429**	**Page 2 of 2**

Alpine 62 Swale Bridge (cont'd)

62-foot Bridge Velocity Profile

Depth (ft)	Velocity (FPS)
0.0	1.23
0.2	1.44
0.4	1.55
0.6	1.40
0.8	1.44
1.0	1.37
1.2	1.25
1.4	1.21
1.6	1.13
1.8	1.12
2.0	0.80
2.2	0.56
2.4	0.56
2.6	0.55
2.8	0.61
3.0	0.56
3.2	0.46
3.4	0.43
	17.67



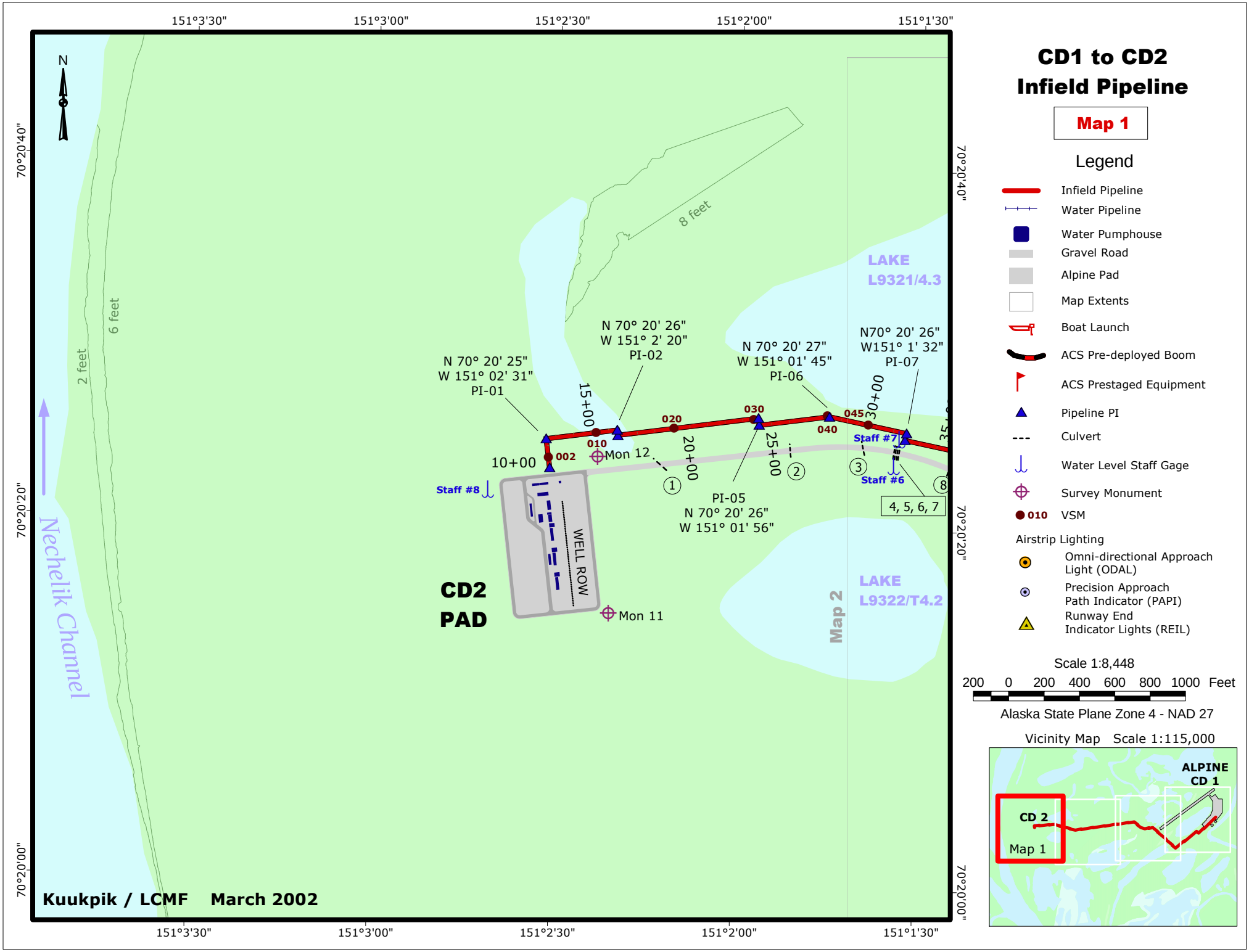
Average Velocity = 0.98 fps
Six-tenths total depth = 3.4 x 0.6 = 2.04 ft
Six-tenths depth velocity = 0.80 fps
Method Coefficient to adjust six-tenths depth velocity to average velocity = 0.98 / 0.80 = 1.23

CD-2 Access Road, Culvert Discharge Measurements on May 25, 2002

Culvert Number	Time	Culvert Diameter (ft)	Water Depth (ft)	Observ. depth (ft)	Revo-lutions[1]	Time (sec)	VELOCITY		Area (s.f.)	Discharge (cfs)	Description
							At Point (fps)	Mean in-vertical (fps)			
1	22:50	4	2.0	0.6	--	40	5.45	5.45	6.28	34.2	Water flowing from south to north.
2	22:45	4	1.9	0.6	--	40	5.96	5.96	5.88	35.0	Water flowing from south to north.
3	22:40	4	1.9	0.6	--	40	5.57	5.57	5.88	32.8	Water flowing from south to north.
4	22:35	4	1.6	0.6	--	40	4.09	4.09	4.70	19.2	Water flowing from south to north.
5	22:25	4	0.5	0.6	--	40	0.00	0.00	0.92	0.0	Water flowing from south to north.
6	22:15										Localized melt only. No flow.
7	22:10										Localized melt only. No flow.
8	22:05										Localized melt only. No flow.
9	22:05										Localized melt only. No flow.
10	22:00										Localized melt only. No flow.
11	21:55	4	1.4	0.6	--	40	0.00	0.00	3.92	0.0	Water above invert. No flow, partial snow blockage.
12	21:50	4	1.1	0.6	--	40	0.00	0.00	2.82	0.0	Water above invert. No flow, partial snow blockage.
13	21:50	4	1.3	0.6	--	40	0.00	0.00	3.54	0.0	Water above invert. No flow, partial snow blockage.
14	21:45	4	0.9	0.6	--	40	0.00	0.00	2.12	0.0	Water above invert. No flow, partial snow blockage.
15	21:45										Localized melt only. No flow.
16	21:45										Localized melt only. No flow.
17	21:40										Localized melt only. No flow.
18	21:40										Localized melt only. No flow.
19	21:40										Localized melt only. No flow.
20	21:40										Localized melt only. No flow.
21	21:35										Localized melt only. No flow.
22	21:35										Localized melt only. No flow.
23	21:35										Localized melt only. No flow.
24	21:35										Localized melt only. No flow.
25	22:50										Snow in culvert. Water level below invert. No flow.
26	22:50										Snow in culvert. Water level below invert. No flow.
Total									**36.1**	**121.2**	

Notes:
1 - A current meter digitizer was used, revolutions were not recorded.

Appendix B Alpine Facilities Layout



CD1 to CD2 Infield Pipeline

Map 1

Legend

- Infield Pipeline
- Water Pipeline
- Water Pumphouse
- Gravel Road
- Alpine Pad
- Map Extents
- Boat Launch
- ACS Pre-deployed Boom
- ACS Prestaged Equipment
- Pipeline PI
- Culvert
- Water Level Staff Gage
- Survey Monument
- 010 VSM

Airstrip Lighting

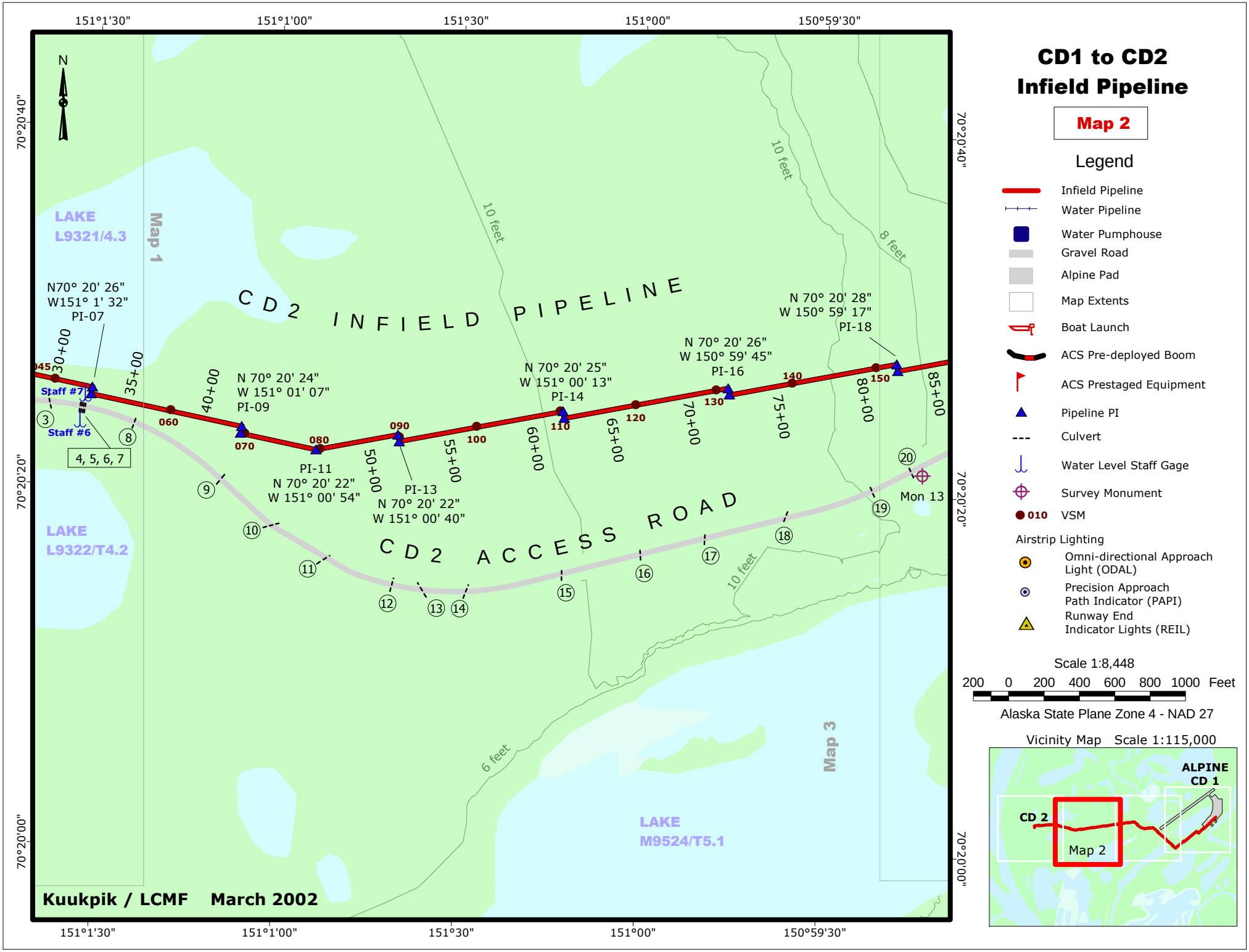
- Omni-directional Approach Light (ODAL)
- Precision Approach Path Indicator (PAPI)
- Runway End Indicator Lights (REIL)

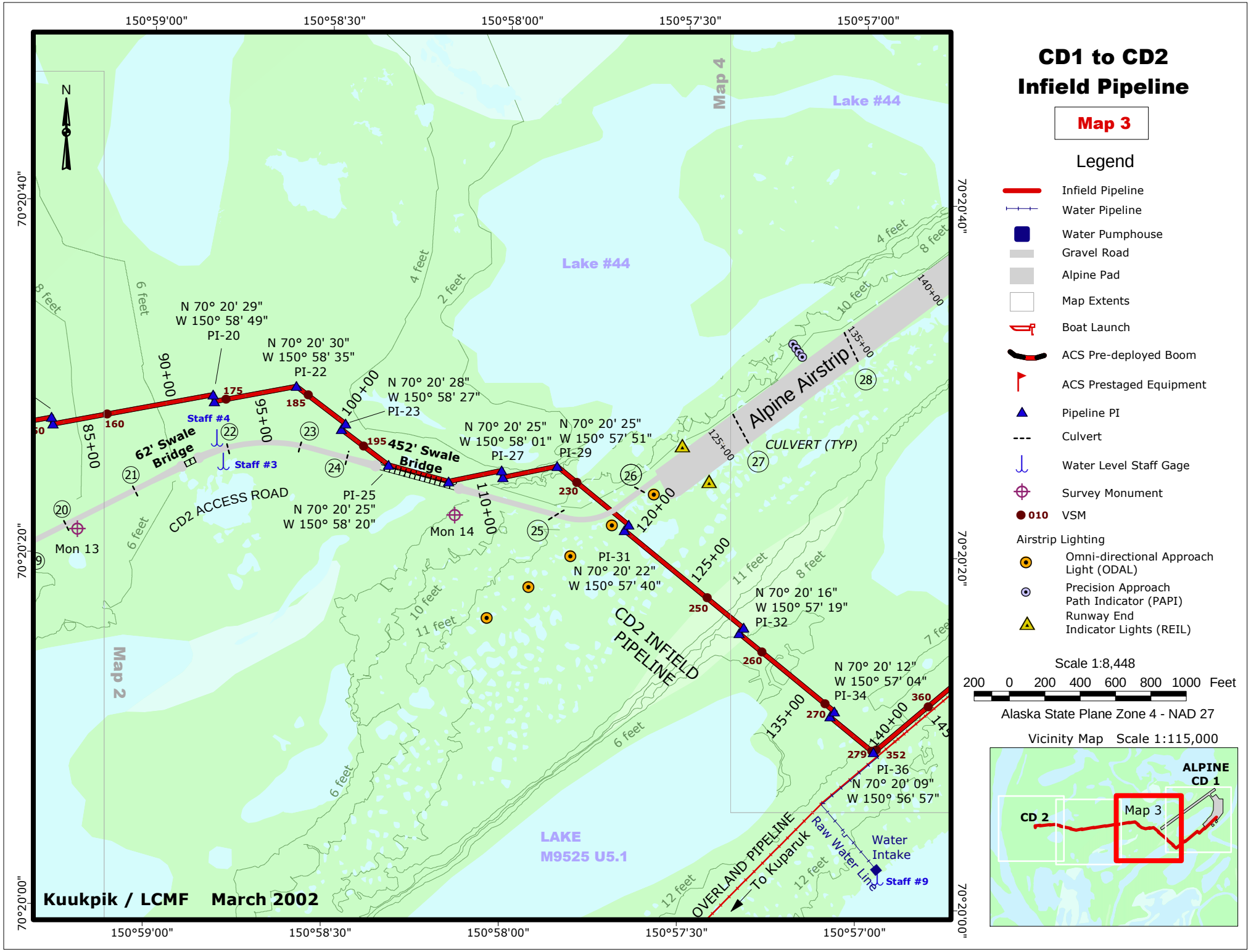
Scale 1:8,448

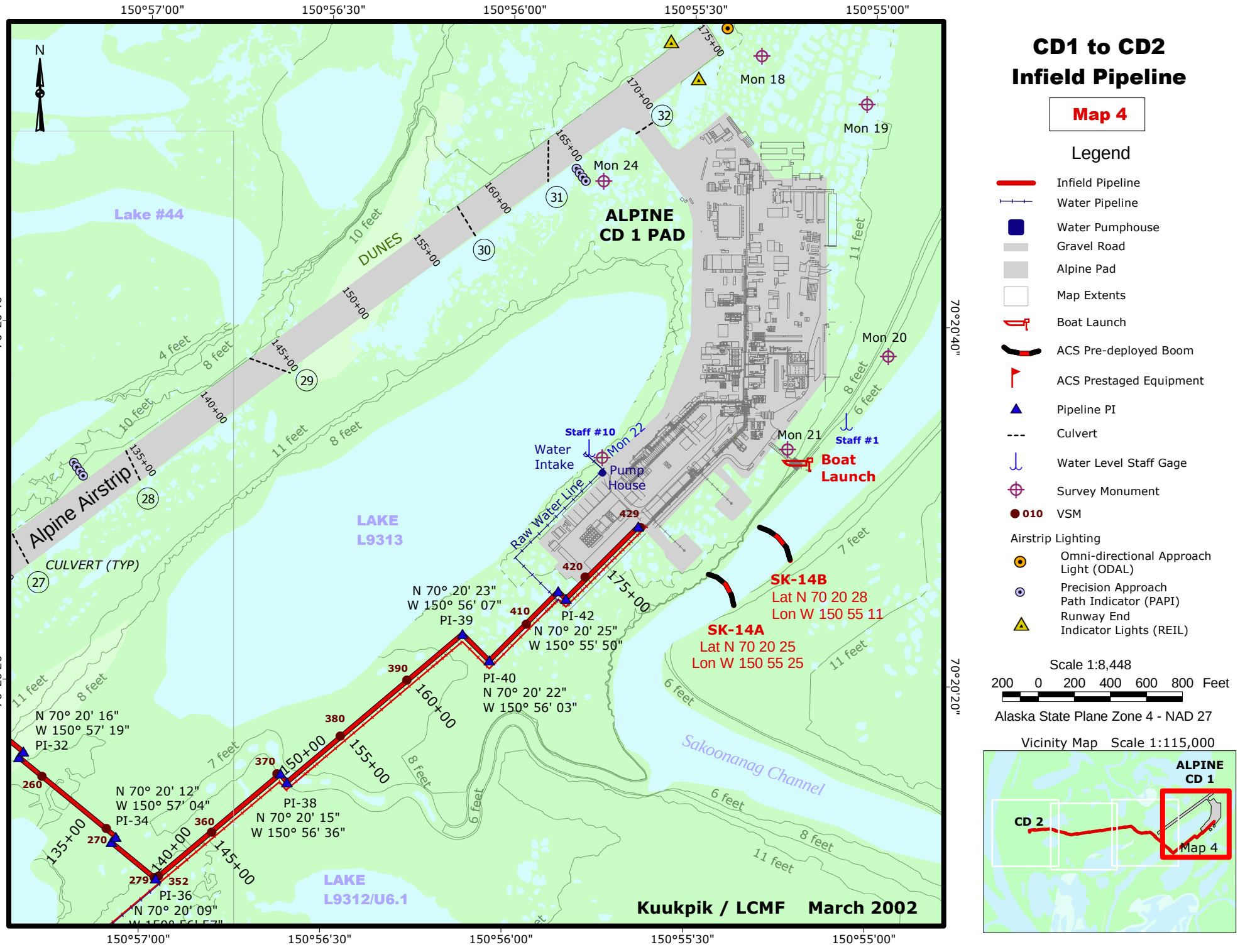
200 0 200 400 600 800 1000 Feet

Alaska State Plane Zone 4 - NAD 27

Vicinity Map Scale 1:115,000


151°1'30"
151°1'00"
151°30"
151°00"
150°59'30"
70°20'40"
70°20'20"
70°20'00"
N
CD1 to CD2
Infield Pipeline
Map 2
Legend
Infield Pipeline
Water Pipeline
Water Pumphouse
Gravel Road
Alpine Pad
Map Extents
Boat Launch
ACS Pre-deployed Boom
ACS Prestaged Equipment
Pipeline PI
Culvert
Water Level Staff Gage
Survey Monument
010 VSM
Airstrip Lighting
Omni-directional Approach Light (ODAL)
Precision Approach Path Indicator (PAPI)
Runway End Indicator Lights (REIL)
LAKE L9321/4.3
LAKE L9322/T4.2
LAKE M9524/T5.1
Map 1
Map 3
CD2 INFIELD PIPELINE
CD2 ACCESS ROAD
10 feet
8 feet
6 feet
N70° 20' 26"
W151° 1' 32"
PI-07
Staff #7
Staff #6
4, 5, 6, 7
30+00
35+00
40+00
45
060
070
N 70° 20' 24"
W 151° 01' 07"
PI-09
080
PI-11
N 70° 20' 22"
W 151° 00' 54"
50+00
090
PI-13
N 70° 20' 22"
W 151° 00' 40"
55+00
100
N 70° 20' 25"
W 151° 00' 13"
PI-14
60+00
110
65+00
120
70+00
130
N 70° 20' 26"
W 150° 59' 45"
PI-16
75+00
140
80+00
150
N 70° 20' 28"
W 150° 59' 17"
PI-18
85+00
Mon 13
Scale 1:8,448
200 0 200 400 600 800 1000 Feet
Alaska State Plane Zone 4 - NAD 27
Vicinity Map Scale 1:115,000
ALPINE CD 1
CD 2
Map 2
Kuukpik / LCMF March 2002


CD1 to CD2
Infield Pipeline
Map 3
Legend
Infield Pipeline
Water Pipeline
Water Pumphouse
Gravel Road
Alpine Pad
Map Extents
Boat Launch
ACS Pre-deployed Boom
ACS Prestaged Equipment
Pipeline PI
Culvert
Water Level Staff Gage
Survey Monument
010 VSM
Airstrip Lighting
Omni-directional Approach Light (ODAL)
Precision Approach Path Indicator (PAPI)
Runway End Indicator Lights (REIL)
Scale 1:8,448
200 0 200 400 600 800 1000 Feet
Alaska State Plane Zone 4 - NAD 27
Vicinity Map Scale 1:115,000
ALPINE CD 1
CD 2
Map 3
Kuukpik / LCMF March 2002
150°59'00"
150°58'30"
150°58'00"
150°57'30"
150°57'00"
70°20'40"
70°20'20"
70°20'00"
N
Map 2
Map 4
Lake #44
LAKE M9525 U5.1
Alpine Airstrip
CULVERT (TYP)
CD2 ACCESS ROAD
CD2 INFIELD PIPELINE
62' Swale Bridge
452' Swale Bridge
OVERLAND PIPELINE
To Kuparuk
Raw Water Line
Water Intake
Staff #3
Staff #4
Staff #9
Mon 13
Mon 14
PI-20 N 70° 20' 29" W 150° 58' 49"
PI-22 N 70° 20' 30" W 150° 58' 35"
PI-23 N 70° 20' 28" W 150° 58' 27"
PI-25 N 70° 20' 25" W 150° 58' 20"
PI-27 N 70° 20' 25" W 150° 58' 01"
PI-29 N 70° 20' 25" W 150° 57' 51"
PI-31 N 70° 20' 22" W 150° 57' 40"
PI-32 N 70° 20' 16" W 150° 57' 19"
PI-34 N 70° 20' 12" W 150° 57' 04"
PI-36 N 70° 20' 09" W 150° 56' 57"
85+00
90+00
95+00
100+00
110+00
120+00
125+00
135+00
140+00
160
175
185
195
230
250
260
270
279
352
360
4 feet
6 feet
8 feet
10 feet
11 feet
12 feet


CD1 to CD2
Infield Pipeline
Map 4
Legend
Infield Pipeline
Water Pipeline
Water Pumphouse
Gravel Road
Alpine Pad
Map Extents
Boat Launch
ACS Pre-deployed Boom
ACS Prestaged Equipment
Pipeline PI
Culvert
Water Level Staff Gage
Survey Monument
010 VSM
Airstrip Lighting
Omni-directional Approach Light (ODAL)
Precision Approach Path Indicator (PAPI)
Runway End Indicator Lights (REIL)
Scale 1:8,448
200 0 200 400 600 800 Feet
Alaska State Plane Zone 4 - NAD 27
Vicinity Map Scale 1:115,000
ALPINE CD 1
CD 2
Map 4
150°57'00"
150°56'30"
150°56'00"
150°55'30"
150°55'00"
70°20'40"
70°20'20"
N
Lake #44
ALPINE CD 1 PAD
DUNES
Alpine Airstrip
CULVERT (TYP)
LAKE L9313
LAKE L9312/U6.1
Sakoonanag Channel
Mon 18
Mon 19
Mon 20
Mon 21
Mon 22
Mon 24
Staff #10
Staff #1
Water Intake
Pump House
Raw Water Line
Boat Launch
SK-14B
Lat N 70 20 28
Lon W 150 55 11
SK-14A
Lat N 70 20 25
Lon W 150 55 25
PI-32
N 70° 20' 16"
W 150° 57' 19"
PI-34
N 70° 20' 12"
W 150° 57' 04"
PI-36
N 70° 20' 09"
PI-38
N 70° 20' 15"
W 150° 56' 36"
PI-39
N 70° 20' 23"
W 150° 56' 07"
PI-40
N 70° 20' 22"
W 150° 56' 03"
PI-42
N 70° 20' 25"
W 150° 55' 50"
Kuukpik / LCMF March 2002

Appendix C Cross Section Data — Head of the Delta

Project Note

To: Tony Hoffman, LCMF	Date: July 11, 2002
From: Jeff Baker	Project: Alpine and CD-Satellite Developments
Subject: Colville River Cross Sections	

We would like to have three cross sections of the Colville River near Monument 01 surveyed. The objective is to determine accurate channel geometry to assist with discharge estimates. The existing cross section data was taken in 1995 and I have attached it as a reference. We are requesting that three cross section measurements be made. One is at the same location as the 1995 cross section (x-sec Mon 01), one is upstream of this (x-sec Mon 01U), and one is downstream (x-sec Mon 01D), see attached figure.

Names and coordinates for the cross section end points are:

All coordinates in Alaska State Plane, Zone 4, NAD27

x-sec Mon 01D

x-sec Mon 01D-L	N5,912,928	E383,588
x-sec Mon 01D-R	N5,912,2104	E387,053

x-sec Mon 01

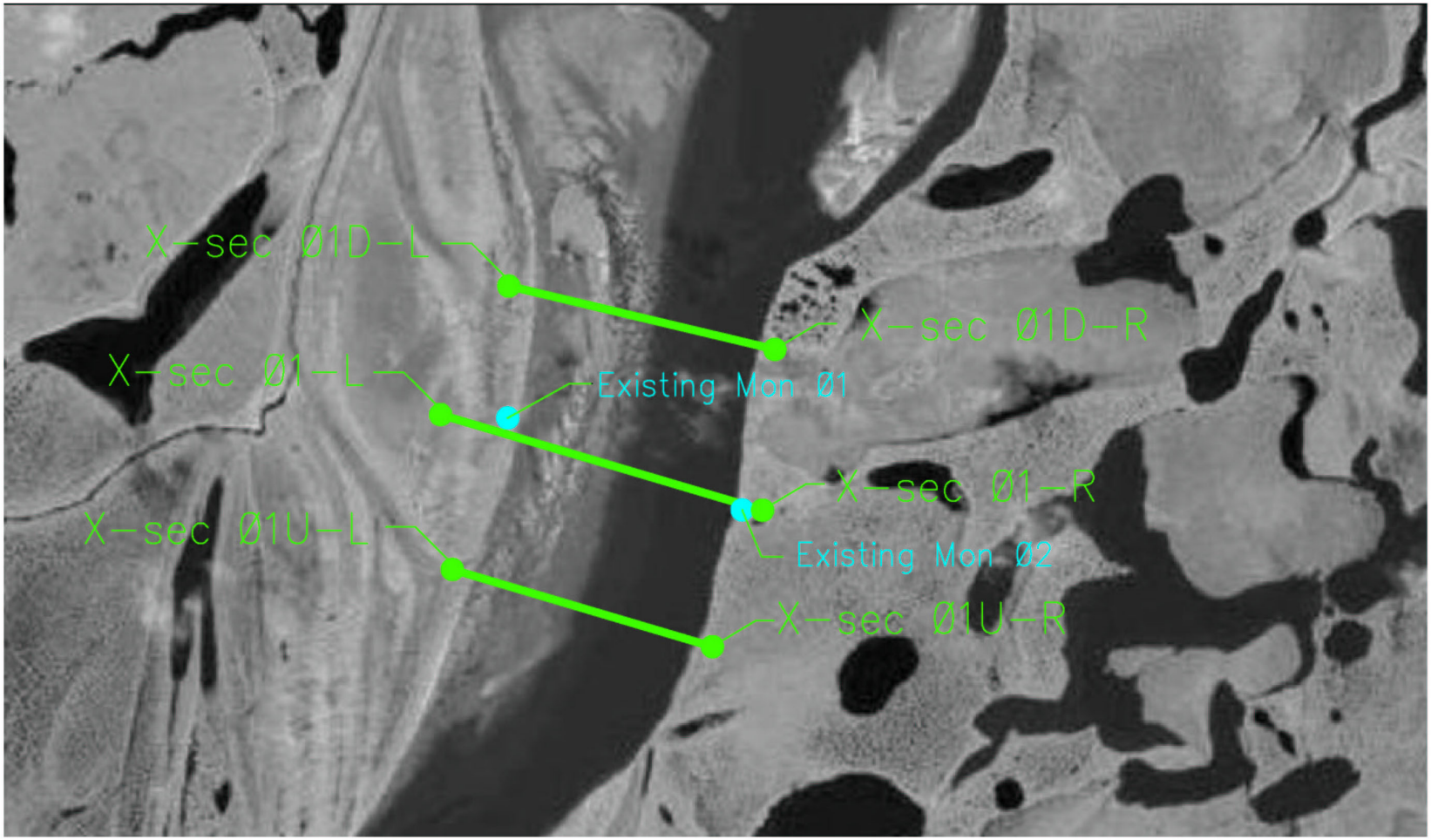
x-sec Mon 01-L	N5,911,257	E382,701
x-sec Mon 01-R	N5,910,016	E386,893

x-sec Mon 01U

x-sec Mon 01U-L	N5,909,245	E382,855
x-sec Mon 01U-R	N5,908,243	E386,240

Cross sections should be run from left bank to right bank (facing downstream). Points shall be taken at a maximum spacing of 50 feet (approximate) but in particular at all grade breaks or changes in soil/vegetation and at edges of water. Note the edge of water and the water surface elevation at the time of the survey. For each point please provide a station offset, ground/channel bottom elevation in BPMSL, northing/easting, and surface description (the same data as the 1995 example). In addition, install monumentation (monument cap with identification) at each cross section end point for future reference.

A spreadsheet file of the data and a description of the data collection procedure will be sufficient for a deliverable.



1000 0 1000 2000

SCALE IN FEET

Baker Michael Baker Jr., Inc.	TITLE: Colville River Monument Ø1 Cross Section Locations		
	FILE NAME: 25009C031	SCALE: As Shown	

Table B-1: Cross Section Data For Cross Section E27.09 (East Channel)

Station (ft)	Elevation (ft)	Northing (ft)	Easting (ft)	Soil Cover Complex
1000	18.4	5911257	382701	Grass covered
1022	18.1	5911251	382722	"
1092	18.6	5911231	382789	"
1133	19.4	5911219	382828	Sand dunes/ willow covered/ sparse grass
1385	23.3	5911148	383070	"
1511	25.2	5911112	383191	"
1708	26.6	5911056	383380	Sand dunes/ sparse willows
1751	30.7	5911044	383421	Top of dunes
1768	30.3	5911039	383438	Sand dunes/ sparse willows
1791	26.1	5911032	383460	"
1812	28.5	5911026	383479	"
1840	24.0	5911018	383507	"
1854	27.2	5911014	383520	"
1871	27.1	5911010	383536	"
1912	19.2	5910998	383576	"
1930	18.6	5910993	383593	"
1937	20.5	5910991	383600	"
1954	14.8	5910986	383616	Edge of dunes
2126	9.9	5910937	383781	Riverbed/sandbar
2429	9.2	5910851	384072	"
2771	7.9	5910754	384400	"
3098	6.3	5910661	384713	"
3321	4.3	5910598	384927	"
3463	2.5	5910558	385063	"
3624	-1.8	5910512	385218	"
3737	-4.2	5910480	385326	"
3842	-6.7	5910450	385427	"
3943	-8.2	5910421	385524	"
4007	-9.7	5910403	385585	"
4074	-10.7	5910384	385649	"
4145	-13.1	5910364	385717	"
4227	-16.0	5910341	385796	"
4318	-20.0	5910315	385883	"
4392	-23.7	5910294	385954	"
4472	-23.1	5910271	386031	"
4532	-22.7	5910254	386089	"
4591	-20.7	5910238	386145	"
4663	-19.2	5910217	386214	"
4719	-18.2	5910201	386268	"
4775	-15.7	5910185	386322	"
4839	-13.7	5910167	386383	"
4888	-13.2	5910153	386430	"
4929	-12.2	5910142	386469	"
4975	-1.9	5910129	386513	"
5001	6.3	5910121	386538	"
5006	9.2	5910120	386543	"

Table B-1: Cross Section Data For Cross Section E27.09 (East Channel)

Station (ft)	Elevation (ft)	Northing (ft)	Easting (ft)	Soil Cover Complex
5011	14.2	5910118	386548	
5016	17.9	5910117	386553	Low-centered polygons/ grass covered/ sparse willows
5022	19.4	5910115	386558	Top of bank
5030	20.1	5910113	386566	Low-centered polygons/ grass covered/ sparse willows
5061	19.4	5910104	386596	"
5080	17.9	5910099	386614	"
5121	18.1	5910087	386653	"
5140	20.3	5910082	386672	"
5200	18.6	5910065	386729	"
5213	18.8	5910061	386742	"
5238	20.1	5910054	386766	"
5370	19.7	5910017	386892	"
5371	19.6	5910016	386893	"

Notes:

1. Elevations are based on British Petroleum Mean Sea Level (BPMSL) datum, coordinate system AK State Plane Zone 4, NAD 27.
2. Ground profile was obtained using a level, theodolite, and sounding weight. The horizontal coordinates for the ends of the cross section were measured with DGPS.
3. In some previous reports, Cross Section E27.09 has been referred to as Cross Section 6.
4. The cross section was measured on 11 Jun 1995. The water-surface elevation on 30 May 1996 was 8.46 feet.

Colville River Channel Cross-Sections

Cross Section Mon 01 Upstream

Station	Offset	Northing	Easting	Elevation	Description
0+00	0	5909266.6	382894.5	27.2	MON-01-UL
0+49	0	5909252.1	382941.5	24.7	Scattered Grass and 3' Willows
0+66	0	5909247.1	382957.7	24.4	Top of Bank
1+12	0	5909233.6	383001.7	18.3	Tundra Ground Shot
1+64	0	5909218.4	383051.0	12.1	Tundra / Edge of Vegetation
2+17	0	5909202.7	383102.0	8.5	Toe of Bank
2+65	0	5909188.7	383147.4	7.4	Ground Shot / Sandy Beach
3+13	0	5909174.5	383193.4	7.1	Ground Shot / Sandy Beach
3+61	0	5909160.4	383239.2	6.8	Ground Shot / Sandy Beach
4+10	0	5909146.0	383286.1	6.6	Ground Shot / Sandy Beach
4+60	0	5909131.3	383333.7	5.6	Ground Shot / Sandy Beach
5+08	0	5909117.1	383380.0	5.4	Ground Shot / Sandy Beach
5+56	0	5909102.8	383426.2	5.4	Ground Shot / Sandy Beach
6+04	0	5909088.9	383471.4	5.1	Ground Shot / Sandy Beach
6+52	0	5909074.7	383517.5	4.6	Ground Shot / Sandy Beach
6+96	0	5909061.6	383560.1	4.9	Ground Shot / Sandy Beach
7+46	0	5909046.9	383607.8	4.7	Ground Shot / Sandy Beach
7+96	0	5909032.4	383655.0	4.6	Ground Shot / Sandy Beach
8+44	0	5909018.0	383701.5	4.0	Ground Shot / Sandy Beach
8+89	0	5909004.9	383744.2	4.1	Ground Shot / Sandy Beach
9+37	0	5908990.9	383789.7	4.7	Ground Shot / Sandy Beach
9+83	0	5908977.2	383834.3	4.8	Ground Shot / Sandy Beach
10+29	0	5908963.8	383877.6	5.3	Ground Shot / Sandy Beach
10+76	0	5908949.8	383923.1	5.1	Ground Shot / Sandy Beach
11+24	0	5908935.9	383968.3	4.9	Ground Shot / Sandy Beach
11+71	0	5908921.9	384013.8	5.1	Ground Shot / Sandy Beach
12+19	0	5908907.9	384059.2	5.1	Ground Shot / Sandy Beach
12+67	0	5908893.8	384105.1	5.2	Ground Shot / Sandy Beach
13+16	0	5908879.2	384152.3	4.9	Ground Shot / Sandy Beach
13+65	0	5908864.7	384199.3	4.2	Ground Shot / Sandy Beach
14+10	0	5908851.4	384242.4	4.1	Ground Shot / Sandy Beach
14+57	0	5908837.6	384287.3	3.5	Ground Shot / Sandy Beach
15+04	0	5908824.0	384331.4	3.1	Ground Shot / Sandy Beach
15+55	0	5908809.0	384380.4	2.4	Ground Shot / Sandy Beach
16+05	0	5908794.0	384428.8	1.4	Edge of Water
16+43	0	5908782.9	384464.9	0.6	River Bed
16+81	0	5908771.7	384501.3	-0.6	River Bed
16+90	4	5908765.2	384508.6	-0.5	River Bed
17+13	8	5908754.7	384529.2	-1.4	River Bed
17+14	0	5908762.0	384532.7	-1.6	River Bed
17+32	0	5908756.6	384549.5	-2.1	River Bed
17+42	0	5908754.0	384559.0	-2.1	River Bed
17+51	-2	5908752.8	384568.7	-2.9	River Bed
17+56	6	5908743.9	384570.5	-2.4	River Bed
17+73	1	5908744.2	384588.8	-3.7	River Bed
17+78	10	5908733.5	384591.0	-3.3	River Bed
17+89	-1	5908740.9	384604.7	-4.3	River Bed
18+01	3	5908733.1	384615.2	-4.4	River Bed
18+28	6	5908722.6	384639.2	-5.6	River Bed
18+47	11	5908712.1	384656.3	-6.5	River Bed

Colville River Channel Cross-Sections

Cross Section Mon 01 Upstream

Station	Offset	Northing	Easting	Elevation	Description
18+73	-3	5908717.8	384685.1	-7.4	River Bed
18+83	-11	5908722.8	384697.5	-7.2	River Bed
18+93	8	5908701.3	384701.1	-7.6	River Bed
19+19	-3	5908704.5	384729.9	-8.6	River Bed
19+45	14	5908680.2	384749.1	-9.5	River Bed
19+65	-9	5908696.5	384774.6	-10.8	River Bed
19+68	18	5908669.7	384769.7	-11.0	River Bed
19+91	12	5908669.4	384793.8	-10.8	River Bed
20+14	5	5908669.0	384818.0	-11.0	River Bed
20+28	-1	5908670.3	384833.3	-10.7	River Bed
20+40	8	5908658.5	384842.0	-10.6	River Bed
20+66	11	5908647.9	384866.0	-11.5	River Bed
20+81	1	5908653.1	384883.1	-12.2	River Bed
20+89	15	5908637.4	384886.6	-12.2	River Bed
21+12	8	5908637.1	384910.8	-13.6	River Bed
21+38	11	5908626.5	384934.8	-14.9	River Bed
21+58	5	5908626.2	384955.5	-15.1	River Bed
21+78	10	5908615.8	384972.6	-15.4	River Bed
22+04	13	5908605.3	384996.6	-16.5	River Bed
22+24	7	5908605.0	385017.4	-17.6	River Bed
22+43	12	5908594.5	385034.5	-18.3	River Bed
22+63	7	5908594.2	385055.2	-18.3	River Bed
22+89	10	5908583.7	385079.2	-18.4	River Bed
23+15	2	5908583.3	385106.8	-18.5	River Bed
23+48	14	5908562.5	385134.1	-18.4	River Bed
23+77	16	5908551.9	385161.6	-18.4	River Bed
24+03	19	5908541.4	385185.6	-18.3	River Bed
24+27	1	5908551.1	385213.4	-17.7	River Bed
24+59	2	5908540.5	385244.3	-16.5	River Bed
24+88	15	5908519.8	385268.2	-15.7	River Bed
25+14	18	5908509.3	385292.2	-15.2	River Bed
25+40	21	5908498.7	385316.2	-15.0	River Bed
25+70	12	5908498.3	385347.3	-14.9	River Bed
25+93	5	5908497.9	385371.5	-14.5	River Bed
26+20	8	5908487.4	385395.5	-14.3	River Bed
26+52	10	5908476.7	385426.4	-14.5	River Bed
26+82	12	5908466.2	385453.9	-15.1	River Bed
27+11	14	5908455.6	385481.4	-15.9	River Bed
27+37	17	5908445.0	385505.4	-17.0	River Bed
27+70	18	5908434.4	385536.3	-18.5	River Bed
27+93	11	5908434.0	385560.5	-19.3	River Bed
28+22	13	5908423.5	385587.9	-20.4	River Bed
28+52	15	5908412.9	385615.4	-22.4	River Bed
28+78	18	5908402.3	385639.4	-23.2	River Bed
29+04	21	5908391.8	385663.5	-23.2	River Bed
29+34	12	5908391.3	385694.5	-23.4	River Bed
29+66	13	5908380.7	385725.5	-23.0	River Bed
29+99	14	5908370.1	385756.4	-22.8	River Bed
30+35	14	5908359.4	385790.8	-19.2	River Bed
30+68	16	5908348.8	385821.7	-18.1	River Bed

Colville River Channel Cross-Sections

Cross Section Mon 01 Upstream

Station	Offset	Northing	Easting	Elevation	Description
30+88	10	5908348.4	385842.4	-17.2	River Bed
31+14	13	5908337.9	385866.4	-16.7	River Bed
31+37	6	5908337.5	385890.6	-15.9	River Bed
31+63	9	5908327.0	385914.6	-13.8	River Bed
31+84	21	5908309.3	385931.7	-7.2	River Bed
31+89	12	5908316.5	385938.6	-5.9	River Bed
32+05	18	5908306.1	385952.3	-2.0	River Bed
32+42	0	5908312.3	385993.0	1.4	Edge of Water
32+50	0	5908310.0	386000.1	1.6	Toe of Bank
32+54	0	5908308.7	386004.6	3.7	Gread Break
32+57	0	5908308.0	386006.8	9.0	Gread Break
32+64	0	5908305.8	386014.0	11.2	Gread Break
32+70	0	5908304.0	386019.7	15.4	Gread Break
32+75	0	5908302.4	386024.8	18.1	Top of Bank
33+25	0	5908287.7	386072.6	18.2	Tundra / Ground Shot
33+75	0	5908273.2	386119.6	19.7	Tundra / Ground Shot
34+24	0	5908258.7	386166.8	19.6	Tundra / Ground Shot
34+75	0	5908243.7	386215.4	19.8	Tundra / Ground Shot
35+08	0	5908234.0	386247.1	20.3	MON-01-UR
Notes:					

1. Elevations are British Petroleum Mean Sea Level Datum, based on the elevation of BM 1at 26.82'.
2. Horizontal Coordinates are Alaska State Plane Zone 4, NAD 27 Datum.
3. Ground profile was surveyed with a conventional total station. River bed depths were obtained with a Garmin GPS Depth Sounder, and spot checked with the total station and rod.
4. Rebar with Aluminum Caps were set at Cross-Section endpoints. Horizontal coordinates of the endpoints are based on found Benchmarks 1 and 2, per GPS survey performed in June 2002.
5. This cross section was surveyed on July 14, 2002. Water surface elevation at time of survey was 1.50' at 5:00 pm.

Colville River Channel Cross-Sections

Cross Section at Mon 01

Station	Offset	Northing	Easting	Elevation	Description
0+00	0	5911257.3	382698.4	18.5	MON-01-L
0+55	0	5911242.1	382751.6	17.6	Sandy Tundra w/ Grass
1+18	-1	5911224.9	382812.3	18.7	Sandy Tundra w/ Grass
1+73	-1	5911209.9	382864.8	18.4	Sandy Tundra w/ Grass
2+29	-1	5911193.7	382918.3	19.6	Sandy Tundra w/ Grass
2+86	-1	5911177.5	382972.6	19.4	Sandy Tundra w/ Grass
3+43	-2	5911162.5	383027.9	20.6	Sandy Tundra w/ Grass
4+00	-1	5911145.4	383082.7	22.7	Sandy Tundra w/ Grass
4+56	-1	5911129.6	383136.0	24.5	Sandy Tundra w/ Grass
5+14	-1	5911112.8	383191.3	24.1	Sandy Tundra w/ Grass
5+69	0	5911096.7	383244.6	23.4	Sandy Tundra w/ Grass
6+27	-1	5911081.3	383299.9	24.1	Sandy Tundra w/ Grass
6+85	0	5911064.0	383355.2	24.4	Sandy Tundra w/ Grass
7+40	0	5911048.3	383408.3	27.1	Sand Dunes w/ Scattered 2' Willows
7+53	0	5911044.6	383420.3	29.1	Sand Dunes w/ Scattered 2' Willows
7+70	0	5911040.1	383437.5	28.2	Sand Dunes w/ Scattered 2' Willows
7+82	0	5911036.7	383448.6	24.7	Sand Dunes w/ Scattered 2' Willows
7+97	0	5911032.0	383463.0	27.5	Sand Dunes w/ Scattered 2' Willows
8+16	1	5911026.2	383481.3	27.3	Sand Dunes w/ Scattered 2' Willows
8+30	0	5911022.6	383494.7	24.4	Sand Dunes w/ Scattered 2' Willows
8+47	0	5911017.7	383511.2	26.5	Sand Dunes w/ Scattered 2' Willows
8+53	-207	5911214.8	383574.5	26.8	BM-01
8+71	0	5911011.3	383534.1	26.2	Sand Dunes w/ Scattered 2' Willows
8+80	0	5911008.9	383542.6	24.4	Sand Dunes w/ Scattered 2' Willows
8+88	0	5911006.8	383549.8	26.1	Top of Bank
8+88	0	5911006.7	383549.9	25.3	Grade Break w/ Scattered Brush
9+08	0	5911000.8	383569.9	20.4	Grade Break w/ Scattered Brush
9+38	0	5910992.4	383598.6	19.2	Grade Break w/ Scattered Brush
9+54	0	5910988.0	383613.4	14.3	Edge of Vegetation
10+34	0	5910965.4	383690.4	9.0	Toe of Bank
10+82	0	5910951.9	383736.3	7.9	Ground Shot / Sandy Beach
11+32	0	5910937.9	383783.9	7.5	Ground Shot / Sandy Beach
11+79	0	5910924.4	383829.7	7.2	Ground Shot / Sandy Beach
12+26	0	5910911.1	383874.9	7.2	Ground Shot / Sandy Beach
12+76	0	5910897.1	383922.3	7.2	Ground Shot / Sandy Beach
13+25	0	5910883.1	383969.9	7.2	Ground Shot / Sandy Beach
13+74	0	5910869.4	384016.4	7.6	Ground Shot / Sandy Beach
14+23	0	5910855.5	384063.9	7.5	Ground Shot / Sandy Beach
14+73	0	5910841.4	384111.5	7.4	Ground Shot / Sandy Beach
15+22	0	5910827.8	384158.0	7.4	Ground Shot / Sandy Beach
15+71	0	5910813.9	384205.2	7.3	Ground Shot / Sandy Beach
16+21	0	5910799.8	384253.1	7.1	Ground Shot / Sandy Beach
16+70	0	5910785.9	384300.2	6.8	Ground Shot / Sandy Beach
17+18	0	5910772.3	384346.5	6.6	Ground Shot / Sandy Beach
17+68	0	5910758.1	384394.6	6.4	Ground Shot / Sandy Beach
18+18	0	5910744.1	384442.4	6.1	Ground Shot / Sandy Beach
18+67	0	5910730.2	384489.7	6.1	Ground Shot / Sandy Beach
19+17	0	5910716.1	384537.5	5.8	Ground Shot / Sandy Beach
19+66	0	5910702.2	384584.6	5.5	Ground Shot / Sandy Beach

Colville River Channel Cross-Sections

Cross Section at Mon 01

Station	Offset	Northing	Easting	Elevation	Description
20+16	0	5910688.3	384631.9	5.2	Ground Shot / Sandy Beach
20+66	0	5910673.9	384680.8	4.9	Ground Shot / Sandy Beach
21+17	0	5910659.8	384728.8	4.6	Ground Shot / Sandy Beach
21+64	0	5910646.3	384774.5	4.4	Ground Shot / Sandy Beach
22+11	0	5910633.0	384819.8	4.2	Ground Shot / Sandy Beach
22+59	0	5910619.7	384865.1	3.5	Ground Shot / Sandy Beach
23+06	0	5910606.4	384910.4	3.0	Ground Shot / Sandy Beach
23+52	0	5910593.2	384955.0	2.7	Ground Shot / Sandy Beach
23+92	0	5910582.1	384992.7	1.8	Edge of Water
24+28	0	5910571.8	385027.8	1.4	River Bed
24+69	0	5910560.2	385067.1	0.6	River Bed
25+02	0	5910551.0	385098.4	-0.1	River Bed
25+34	0	5910542.0	385129.2	0.5	River Bed
25+66	0	5910533.0	385159.8	-0.9	River Bed
25+73	-4	5910534.6	385167.5	-1.2	River Bed
25+76	-5	5910534.5	385171.0	-1.1	River Bed
25+83	-6	5910534.4	385177.9	-1.4	River Bed
25+92	0	5910525.6	385184.9	-2.0	River Bed
26+02	-1	5910524.0	385195.0	-1.8	River Bed
26+22	-7	5910523.7	385215.7	-1.7	River Bed
26+41	-2	5910513.3	385232.8	-2.0	River Bed
26+52	4	5910505.0	385241.0	-2.9	River Bed
26+61	-7	5910512.9	385253.5	-2.8	River Bed
26+81	-2	5910502.5	385270.6	-3.7	River Bed
27+01	-8	5910502.2	385291.3	-4.4	River Bed
27+23	-3	5910491.7	385311.9	-5.0	River Bed
27+34	4	5910481.6	385320.3	-5.3	River Bed
27+40	-8	5910491.5	385329.1	-6.2	River Bed
27+59	-3	5910481.0	385346.3	-6.4	River Bed
27+76	-7	5910480.8	385363.5	-6.8	River Bed
27+95	-2	5910470.4	385380.6	-6.2	River Bed
27+98	5	5910462.5	385381.1	-7.7	River Bed
28+12	-7	5910470.1	385397.9	-7.5	River Bed
28+25	9	5910451.1	385406.0	-8.2	River Bed
28+35	-3	5910459.6	385418.4	-8.3	River Bed
28+58	-9	5910459.2	385442.6	-8.3	River Bed
28+81	-5	5910448.8	385463.2	-8.1	River Bed
28+86	-10	5910452.5	385469.8	-8.4	River Bed
29+01	-10	5910448.5	385483.9	-9.1	River Bed
29+30	-8	5910437.9	385511.3	-9.3	River Bed
29+47	-13	5910437.6	385528.6	-8.7	River Bed
29+51	-17	5910440.3	385533.5	-8.5	River Bed
29+73	-9	5910427.1	385552.6	8.1	River Bed
29+95	-5	5910416.6	385573.2	-8.4	River Bed
30+05	-17	5910425.0	385585.6	-9.3	River Bed
30+19	-12	5910416.2	385597.3	-9.8	River Bed
30+35	-5	5910405.0	385610.7	-9.8	River Bed
30+61	-13	5910405.4	385638.6	-10.0	River Bed
30+87	-9	5910394.9	385662.6	-9.6	River Bed

Colville River Channel Cross-Sections

Cross Section at Mon 01

Station	Offset	Northing	Easting	Elevation	Description
31+04	-14	5910394.6	385679.9	-9.4	River Bed
31+23	-7	5910382.0	385696.1	-11.2	River Bed
31+43	-14	5910383.9	385717.7	-12.7	River Bed
31+63	-20	5910383.6	385738.4	-14.1	River Bed
31+82	-15	5910373.2	385755.5	-14.4	River Bed
32+05	-11	5910362.7	385776.1	-15.5	River Bed
32+22	-15	5910362.4	385793.3	-16.7	River Bed
32+41	-10	5910352.0	385810.5	-18.5	River Bed
32+61	-16	5910351.7	385831.2	-20.5	River Bed
32+80	-10	5910341.3	385848.3	-21.2	River Bed
33+00	-16	5910341.0	385869.0	-22.3	River Bed
33+26	-13	5910330.4	385893.0	-23.5	River Bed
33+43	-17	5910330.2	385910.3	-24.0	River Bed
33+56	-21	5910330.0	385924.1	-24.2	River Bed
33+86	-19	5910319.4	385951.5	-25.4	River Bed
34+25	-19	5910308.6	385989.4	-25.4	River Bed
34+61	-18	5910298.0	386023.7	-24.8	River Bed
34+87	-15	5910287.4	386047.7	-24.6	River Bed
35+04	-20	5910287.2	386065.0	-24.4	River Bed
35+24	-25	5910286.9	386085.7	-23.9	River Bed
35+44	-31	5910286.5	386106.4	-23.8	River Bed
35+60	-35	5910286.3	386123.7	-23.1	River Bed
35+83	-42	5910285.9	386147.9	-22.3	River Bed
36+03	-37	5910275.5	386165.0	-22.3	River Bed
36+29	-33	5910265.0	386189.0	-20.9	River Bed
36+42	-37	5910264.8	386202.8	-20.6	River Bed
36+61	-32	5910254.3	386219.9	-19.9	River Bed
36+75	-36	5910254.1	386233.7	-19.5	River Bed
36+94	-30	5910243.7	386250.8	-19.0	River Bed
37+11	-35	5910243.4	386268.1	-18.7	River Bed
37+33	-31	5910233.0	386288.6	-17.8	River Bed
37+56	-27	5910222.5	386309.2	-16.5	River Bed
37+79	-22	5910212.0	386329.8	-16.5	River Bed
37+95	-27	5910211.7	386347.0	-15.8	River Bed
38+13	-42	5910221.6	386367.9	-15.2	River Bed
38+49	-42	5910210.9	386402.3	-14.8	River Bed
38+65	-36	5910200.5	386415.9	-14.8	River Bed
38+87	-31	5910190.1	386436.5	-13.6	River Bed
39+07	-37	5910189.8	386457.2	-13.3	River Bed
39+30	-33	5910179.3	386477.7	-12.3	River Bed
39+49	-28	5910168.9	386494.9	-11.7	River Bed
39+69	-22	5910158.4	386512.0	-11.3	River Bed
39+78	-25	5910158.5	386521.8	-8.8	River Bed
39+85	-16	5910148.1	386525.6	-5.4	River Bed
39+99	-31	5910158.0	386543.0	-1.7	River Bed
40+02	0	5910127.6	386537.3	1.6	Edge of Water
40+10	0	5910125.3	386545.2	2.3	Toe of Bank
40+17	0	5910123.5	386551.7	4.8	Grade Break
40+24	0	5910121.4	386558.6	9.9	Grade Break

Colville River Channel Cross-Sections

Cross Section at Mon 01

Station	Offset	Northing	Easting	Elevation	Description
40+33	0	5910118.9	386567.1	9.7	Grade Break
40+35	0	5910118.1	386569.7	18.5	Top of Bank
40+84	0	5910104.4	386616.3	17.2	Tundra, Dense 3' Willow Brush
41+19	78	5910020.0	386627.7	20.5	BM-02
41+32	0	5910090.9	386662.0	19.1	Tundra, Dense 3' Willow Brush
41+80	0	5910077.3	386708.4	18.5	Tundra, Dense 3' Willow Brush
42+26	0	5910064.4	386752.0	19.7	Tundra, Dense 3' Willow Brush
42+73	0	5910050.8	386798.0	18.9	Tundra, Dense 3' Willow Brush
43+19	0	5910038.1	386841.3	18.7	Tundra, Dense 3' Willow Brush
43+69	0	5910023.9	386889.7	19.9	MON-01-R
Notes:					

1. Elevations are British Petroleum Mean Sea Level Datum, based on the elevation of BM 1at 26.82'.
2. Horizontal Coordinates are Alaska State Plane Zone 4, NAD 27 Datum.
3. Ground profile was surveyed with a conventional total station. River bed depths were obtained with a Garmin GPS Depth Sounder, and spot checked with the total station and rod.
4. Rebar with Aluminum Caps were set at Cross-Section endpoints. Horizontal coordinates of the endpoints are based on found Benchmarks 1 and 2, per GPS survey performed in June 2002.
5. This cross section was surveyed on July 15, 2002. Water surface elevation at time of survey was 1.60' at 4:40 pm.

Colville River Channel Cross-Sections

Cross Section Mon 01 Downstream

Station	Offset	Northing	Easting	Elevation	Description
0+00	0	5912947.6	383708.9	29.3	MON-01-DL
0+14	0	5912944.2	383722.7	26.3	Grade Break
0+26	0	5912941.3	383733.9	26.9	Grade Break
0+73	0	5912929.6	383779.2	25.7	Grade Break
0+92	0	5912924.7	383798.4	26.5	Grade Break
1+09	0	5912920.6	383814.1	23.4	Grade Break
1+55	0	5912908.9	383859.4	24.9	Grade Break
1+94	0	5912899.3	383896.8	24.4	Top of Bank
2+40	0	5912887.7	383941.2	17.9	Grade Break
2+89	0	5912875.4	383988.9	13.9	Grade Break
3+29	0	5912865.4	384027.7	12.5	Tundra / Edge of Vegetation
3+80	0	5912852.7	384077.3	10.7	Toe of Bank
4+32	0	5912839.9	384127.0	9.6	Ground Shot / Sandy Beach
4+85	0	5912826.6	384178.4	8.8	Ground Shot / Sandy Beach
5+36	0	5912813.9	384227.9	8.0	Ground Shot / Sandy Beach
5+87	0	5912801.2	384277.0	7.8	Ground Shot / Sandy Beach
6+38	0	5912788.5	384326.4	7.1	Ground Shot / Sandy Beach
6+87	0	5912776.2	384374.2	6.9	Ground Shot / Sandy Beach
7+38	0	5912763.6	384423.1	7.1	Ground Shot / Sandy Beach
7+87	0	5912751.1	384471.2	6.7	Ground Shot / Sandy Beach
8+35	0	5912739.2	384517.5	6.7	Ground Shot / Sandy Beach
8+84	0	5912727.0	384564.9	6.8	Ground Shot / Sandy Beach
9+33	0	5912714.8	384612.3	7.1	Ground Shot / Sandy Beach
9+84	0	5912701.9	384662.1	7.1	Ground Shot / Sandy Beach
10+36	0	5912689.1	384711.9	7.0	Ground Shot / Sandy Beach
10+86	0	5912676.6	384760.5	7.0	Ground Shot / Sandy Beach
11+36	0	5912664.0	384809.3	7.0	Ground Shot / Sandy Beach
11+88	0	5912651.1	384859.5	6.8	Ground Shot / Sandy Beach
12+39	0	5912638.3	384909.1	6.5	Ground Shot / Sandy Beach
12+90	0	5912625.6	384958.1	6.4	Ground Shot / Sandy Beach
13+41	0	5912612.8	385007.8	5.9	Ground Shot / Sandy Beach
13+90	0	5912600.6	385055.1	5.5	Ground Shot / Sandy Beach
14+38	0	5912588.7	385101.5	5.2	Ground Shot / Sandy Beach
14+87	0	5912576.6	385148.5	4.4	Ground Shot / Sandy Beach
15+37	0	5912564.0	385197.2	4.2	Ground Shot / Sandy Beach
15+86	0	5912551.7	385244.9	3.9	Ground Shot / Sandy Beach
16+32	0	5912540.3	385289.1	3.3	Ground Shot / Sandy Beach
16+81	0	5912528.2	385336.2	2.7	Ground Shot / Sandy Beach
17+24	0	5912517.3	385378.4	2.4	Ground Shot / Sandy Beach
17+56	0	5912509.3	385409.3	1.6	Edge of Water
17+94	0	5912499.8	385446.5	1.2	River Bed
18+32	0	5912490.3	385483.0	0.7	River Bed
18+69	0	5912481.1	385518.9	-0.2	River Bed
19+04	0	5912472.5	385552.3	-0.7	River Bed
19+35	0	5912464.8	385582.2	-1.1	River Bed
19+47	0	5912461.9	385593.9	-1.6	River Bed
19+62	0	5912457.8	385609.3	-2.1	River Bed
19+75	16	5912439.4	385617.6	-2.0	River Bed
19+95	11	5912439.0	385638.3	-2.3	River Bed
20+18	-1	5912445.2	385663.8	-3.7	River Bed
20+41	10	5912428.2	385683.0	-3.7	River Bed
20+67	15	5912417.7	385707.0	-5.3	River Bed

Colville River Channel Cross-Sections

Cross Section Mon 01 Downstream

Station	Offset	Northing	Easting	Elevation	Description
20+78	-2	5912430.8	385721.3	-5.8	River Bed
20+91	9	5912417.3	385731.1	-5.7	River Bed
21+11	4	5912417.0	385751.9	-6.6	River Bed
21+37	8	5912406.5	385775.9	-6.7	River Bed
21+41	-1	5912413.9	385782.4	-6.8	River Bed
21+59	13	5912396.0	385796.4	-8.0	River Bed
21+82	18	5912385.5	385817.0	-8.7	River Bed
22+05	13	5912385.1	385841.1	-7.8	River Bed
22+29	7	5912384.8	385865.3	-9.0	River Bed
22+53	-1	5912386.7	385890.7	-10.5	River Bed
22+58	10	5912374.2	385892.7	-10.2	River Bed
22+78	5	5912373.9	385913.4	-10.3	River Bed
22+96	-3	5912377.8	385932.8	-11.1	River Bed
23+04	10	5912363.3	385937.5	-11.4	River Bed
23+26	15	5912352.9	385958.0	-12.1	River Bed
23+47	10	5912352.6	385978.7	-11.4	River Bed
23+54	1	5912359.1	385988.0	-11.7	River Bed
23+72	14	5912342.0	386002.7	-12.7	River Bed
23+93	9	5912341.7	386023.4	-12.0	River Bed
24+18	13	5912331.2	386047.4	-12.3	River Bed
24+28	-3	5912345.0	386060.9	-12.9	River Bed
24+42	8	5912330.8	386071.6	-13.3	River Bed
24+64	13	5912320.3	386092.2	-13.7	River Bed
24+87	18	5912309.9	386112.7	-14.2	River Bed
25+10	12	5912309.5	386136.9	-15.0	River Bed
25+31	7	5912309.2	386157.6	-15.1	River Bed
25+54	1	5912308.8	386181.7	-15.8	River Bed
25+80	6	5912298.3	386205.7	-16.5	River Bed
25+97	2	5912298.0	386223.0	-16.9	River Bed
26+23	6	5912287.5	386247.0	-17.9	River Bed
26+45	11	5912277.0	386267.6	-18.3	River Bed
26+65	6	5912276.7	386288.3	-18.4	River Bed
26+91	10	5912266.2	386312.3	-19.5	River Bed
27+15	5	5912265.8	386336.4	-19.8	River Bed
27+35	0	5912265.5	386357.1	-20.0	River Bed
27+58	-6	5912265.2	386381.3	-20.0	River Bed
27+78	-11	5912264.8	386402.0	-20.8	River Bed
28+04	-7	5912254.3	386426.0	-21.5	River Bed
28+33	-3	5912243.7	386453.5	-22.2	River Bed
28+54	-8	5912243.4	386474.2	-22.8	River Bed
28+76	-3	5912233.0	386494.7	-22.9	River Bed
28+99	2	5912222.5	386515.3	-22.9	River Bed
29+25	-5	5912222.1	386542.9	-23.1	River Bed
29+60	8	5912201.3	386573.7	-23.5	River Bed
29+90	11	5912190.7	386601.1	-22.7	River Bed
30+32	11	5912179.9	386642.4	-22.3	River Bed
30+59	5	5912179.5	386670.0	-22.3	River Bed
30+82	10	5912169.0	386690.5	-21.4	River Bed
30+98	6	5912168.8	386707.8	-21.0	River Bed
31+31	8	5912158.1	386738.7	-19.0	River Bed
31+54	3	5912157.8	386762.9	-18.1	River Bed
31+77	8	5912147.3	386783.4	-17.1	River Bed

Colville River Channel Cross-Sections

Cross Section Mon 01 Downstream

Station	Offset	Northing	Easting	Elevation	Description
31+86	16	5912137.0	386790.2	-16.4	River Bed
31+99	23	5912126.7	386800.4	-15.6	River Bed
32+02	23	5912126.6	386803.8	-15.0	River Bed
32+23	-10	5912152.9	386832.3	-11.2	River Bed
32+33	5	5912136.3	386838.5	-9.0	River Bed
32+43	0	5912138.3	386848.9	1.7	Edge of Water
32+47	-1	5912138.5	386853.3	2.3	Toe of Bank
32+52	0	5912135.9	386858.1	6.2	Grade Break
32+57	0	5912134.7	386862.7	11.0	Grade Break
32+63	0	5912133.2	386868.9	13.8	Grade Break
32+65	0	5912132.8	386870.4	16.6	Top of Bank
33+10	0	5912121.6	386913.7	16.7	Tundra, Dense 3' Willow Brush
33+58	0	5912109.6	386960.3	17.1	Tundra, Dense 3' Willow Brush
34+06	0	5912097.4	387007.5	17.6	Tundra, Dense 3' Willow Brush
34+37	0	5912089.9	387037.1	17.8	MON-01-DR
Notes:					

1. Elevations are British Petroleum Mean Sea Level Datum, based on the elevation of BM 1at 26.82'.
2. Horizontal Coordinates are Alaska State Plane Zone 4, NAD 27 Datum.
3. Ground profile was surveyed with a conventional total station. River bed depths were obtained with a Garmin GPS Depth Sounder, and spot checked with the total station and rod.
4. Rebar with Aluminum Caps were set at Cross-Section endpoints. Horizontal coordinates of the endpoints are based on found Benchmarks 1 and 2, per GPS survey performed in June 2002.
5. This cross section was surveyed on July 15, 2002. Water surface elevation at time of survey was 1.60' at 4:40 pm.

Alpine Facilities 2002 Spring Breakup and Hydrologic Assessment
October 2002

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