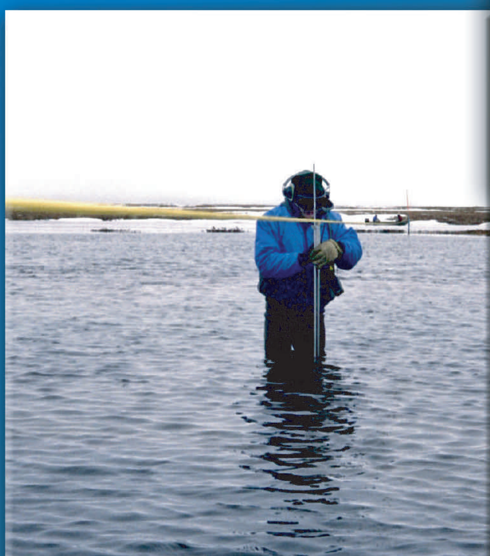

2004

Alpine Satellites Development Plan

2004 Spring Breakup and Hydrologic Assessment

Submitted to

ConocoPhillips

By

Baker

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March 2005
103478-MBJ-RPT-001

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Executive Summary

The 2004 spring breakup in the National Petroleum Reserve-Alaska (NPRA) for the Alpine Satellites Development Plan (ASDP) was a relatively normal breakup with respect to timing of floodwater arrival, maximum water surface elevations, and stream discharges. Backwater flooding in the vicinity of the confluence of Fish Creek and the Ublutuoch River affected water surface elevations in both drainages. As in 2003, ice rafting and jamming was a factor in 2004 with respect to localized water surface elevations.

The 2004 spring breakup flood in the Colville Delta was unique in that it produced some of the highest water levels ever recorded, but not necessarily high with respect to design events. This appears to be directly related to the higher than normal (based on past observations) amount of flow diverted into the Nigliq Channel. The peak water surface elevation at Alpine occurred in the early afternoon on May 27.

On May 29, Judy Creek and the lower portion of Fish Creek were the first NPRA drainages to see floodwaters. Flow at river mile 6.8 on the Ublutuoch River was observed on June 4. The timing of the arrival of floodwaters in the NPRA was similar to patterns observed in 2002 and 2003. All initial flows were over intact channel ice and snow.

The peak water surface elevation at monitoring station Fish Creek river mile 0.7 was recorded on the morning of May 30. At this time however, water at the Fish Creek river mile 0.7 site was documented to be from the Colville River. Water from the Nigliq Channel was flowing across the sea ice and entering the mouth of Fish Creek causing water to backup into the river, and observed flow from Fish Creek was not documented at Fish Creek river mile 0.7 until June 2.

Flooding on the Ublutuoch River in 2004 was similar to observations made in 2003. Backwater effects from Fish Creek resulted in water on the furthest downstream gages located at river mile 1.9 six days prior to the arrival of floodwaters at the proposed bridge crossing located at mile 6.8. Peak water surface elevations on the Ublutuoch River at river mile 6.8 and 1.9 occurred over intact channel ice and snow on June 6 and June 7, respectively. Direct discharge measurements were conducted on the Ublutuoch River at the proposed bridge site on June 5 and June 6.

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1.0 Introduction

1.1 Purpose of the 2004 Monitoring Program

Spring breakup studies have been conducted on the Colville River Delta since 1992 and in the National Petroleum Reserve-Alaska (NPRA) beginning in 2001. These studies have been performed to further the understanding of hydrology associated with spring breakup flooding, typically the largest annual flooding event in the region.

Hydrologic data for the Colville River region and the NPRA are limited and continued monitoring efforts are required to provide information needed to ensure the continued safety of oilfield personnel, facilities and the environment during flood events. As oil exploration and facility construction moves west into the NPRA, including the ASDP, hydrologic monitoring, analysis, and evaluation will be an important component in the design and construction of future roads, pads, and other facilities. The approximate location of the proposed ASDP route and 2004 monitoring sites are shown on Figure 1-1.

The purpose of the 2004 ASDP spring breakup monitoring program was to monitor hydrologic conditions during spring breakup on major streams within the limits of the proposed ASDP. The major streams and channels crossed by the proposed project include the Nigliq Channel and Paleochannels located within the Colville River Delta, and the Ublutuoch River within the Fish Creek drainage in the NPRA. Other sites within the ASDP project vicinity that were monitored during spring 2004 include the main channel of the Colville River and Fish Creek.

The spring breakup field program for the ASDP was completed in conjunction with a similar program for the existing Alpine Facilities (Alpine). A report that details 2004 breakup conditions specifically at Alpine was submitted in March 2005 (Michael Baker Jr., 2005). The Alpine and ASDP breakup programs overlap in several important areas with respect to conditions in the Colville River Delta. For completeness, information presented in the 2004 Alpine spring breakup report that applies to the ASDP program is also presented in this report.

1.2 2004 ASDP Spring Breakup Monitoring Program

1.2.1 Water Surface Elevation Monitoring

Water surface elevations were monitored at the various sites using temporary staff gages installed in sets. Each gage set included between two and five staff gages. Each gage assembly consisted of metal gage faceplates mounted on two-by-four timbers attached with U-bolts to 1.5-inch angle iron posts driven into the ground. The elevations of individual gages were tied to established benchmark elevations using level loop surveys and were referenced to the British Petroleum Mean Sea Level datum (BPMSL). All elevations presented in this report are in feet BPMSL unless otherwise noted. The location of each monitoring site was recorded using a handheld Global Positioning System (GPS) in the North American Datum 83 (NAD 83).

Installation of the temporary staff gages was completed either during Fall 2003 or Spring 2004. All level loop surveys were completed during Spring 2004 just prior to breakup.

1.2.2 Colville River and Nigliq Channel

A number of temporary staff gage sets were established to monitor water surface elevations on the Colville River and within the river's delta along the Nigliq Channel. Gage sets were also installed at the Paleochannels, located to the west of Alpine facility CD-2 and the Nigliq Channel. Temporary staff gage placement was concentrated in two general areas. The first area was near permanent survey Monument 01 at the head of the delta representing the downstream-most point where the Colville River flows in a single channel. The second general area of gage placement was along the northern portion of the Nigliq Channel near permanent survey Monuments 22, 23, and 28. The Colville River monitoring sites are shown on Figure 1-1. Monitoring sites along the northern Nigliq Channel near the proposed bridge crossing are shown on Figure 1-2. The 2004 spring breakup on the Colville River and Nigliq Channel is summarized in Section 3.0.

1.2.3 Fish Creek Basin

The 2004 breakup program in the Fish Creek drainage focused on the lower reaches of Fish Creek, specifically Fish Creek's confluence with the Ublutuoch River and the area downstream between the confluence and Fish Creek's outfall at Harrison Bay. Accordingly, one temporary staff gage set at river mile 0.7 was re-established for use within the 2004-monitoring program. River mile designations refer to the distance in miles along the stream channel above the stream's mouth. In the case of tributary streams, river mile designations refer to the distance above their confluence with the main stream. Two new monitoring locations were established on Fish Creek at river miles 4.0 and 10.9. The Fish Creek basin monitoring site locations are shown on Figure 1-1.

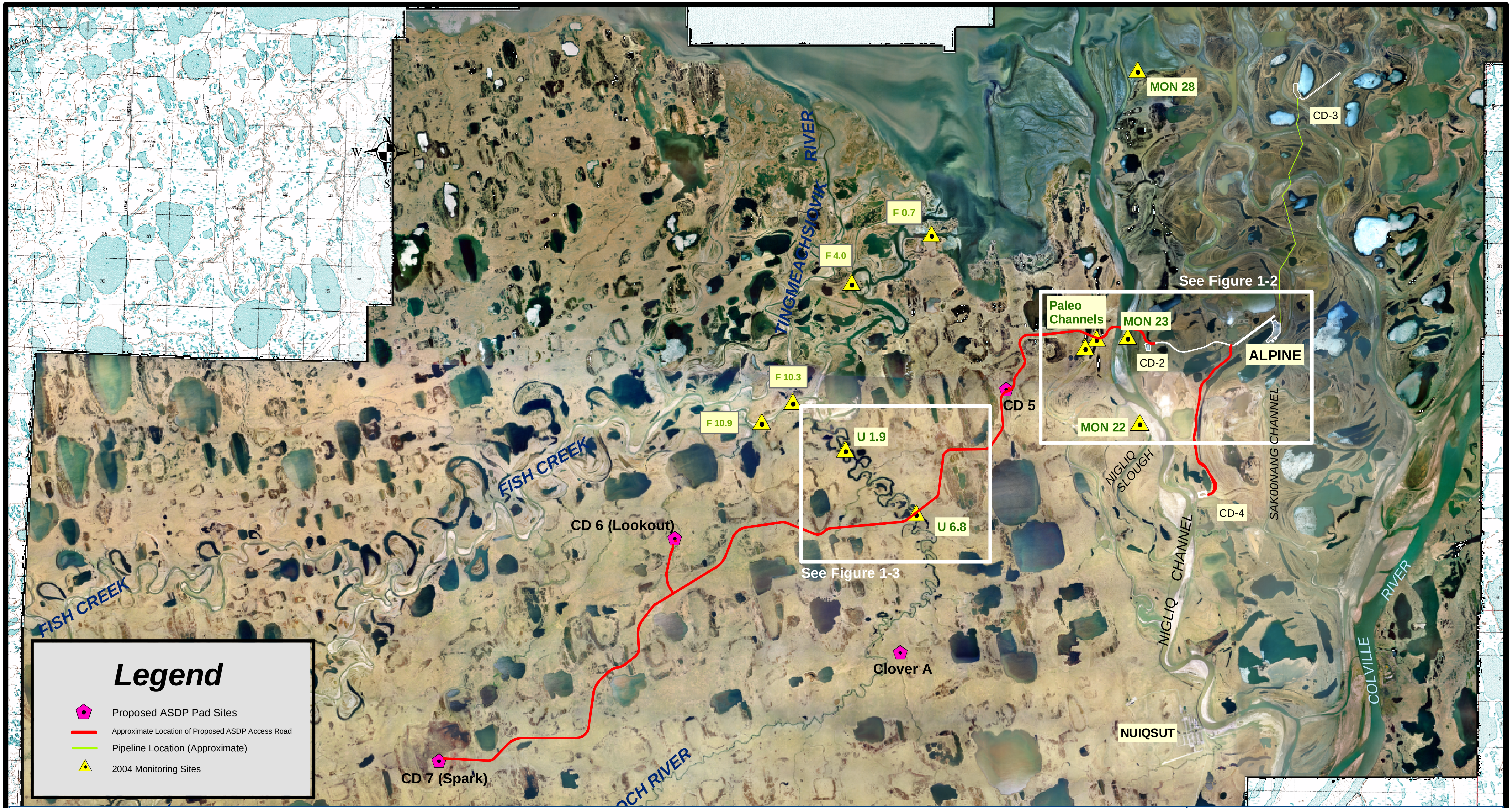
The Ublutuoch River monitoring sites were re-established at river miles 1.9 and 6.8. The sites were first established in 2003 to evaluate hydrologic conditions at two proposed bridge sites and it is understood that RM 6.8 is the current preferred crossing location. Each monitoring site on the Ublutuoch River consisted of an upstream and downstream set of gages. The Ublutuoch River monitoring site locations are shown on Figure 1-3. The 2004 spring breakup in the Fish Creek Basin is summarized in Section 4.0.

1.2.4 Discharge Measurements

Two direct discharge measurements were made in the Ublutuoch River – by boat in the eastern section and by wading the western section. The measurement cross-section was located near the proposed bridge site at river mile 6.8 adjacent to the upstream monitoring site Ublutuoch River 6.8U. Discharge measurements were completed using standard United States Geological Survey (USGS) midsection techniques. A 1,000-foot-long Kevlar tag line was used to define the cross-section and delineate the measurement subsections within the channel. For the eastern portion of the measurements, a Price AA current meter and sounding reel mounted on a boat boom were used to measure water velocity. A 30-pound Columbus-type lead sounding weight was used to stabilize the meter. For the western portion of the measurements, a Price AA current meter and USGS wading rod were used to measure water velocity.

1.3 Acknowledgements

Unusually high water levels combined with the impending Alpine Facility Expansion Phase I and Phase II shutdown resulted in an especially challenging 2004 spring breakup at Alpine. Baker would like to recognize the following people without whose professionalism and cooperation we could not have completed our job. Justin Harth and Beth Sharpe provided superior logistics and helicopter support. Maritime Helicopter delivered us to our monitoring sites promptly and safely. The support of Rob Murray, Tad Smith, Squeak, and Bob Lebune at Alaska Clean Seas proved to be invaluable as always. Reliable survey assistance and ground transportation was again provided by LCMF. We would also like to recognize Mike Rodriguez, John Murray, and Zane Henning whose support enabled us to do our job better. Special thanks are extended to the people of the village of Nuiqsut and to our local guide, Dora Nukapigak. Finally, thanks to Caryn Rea, the CPAI Project Manager.



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Vicinity Map

Figure 1-1

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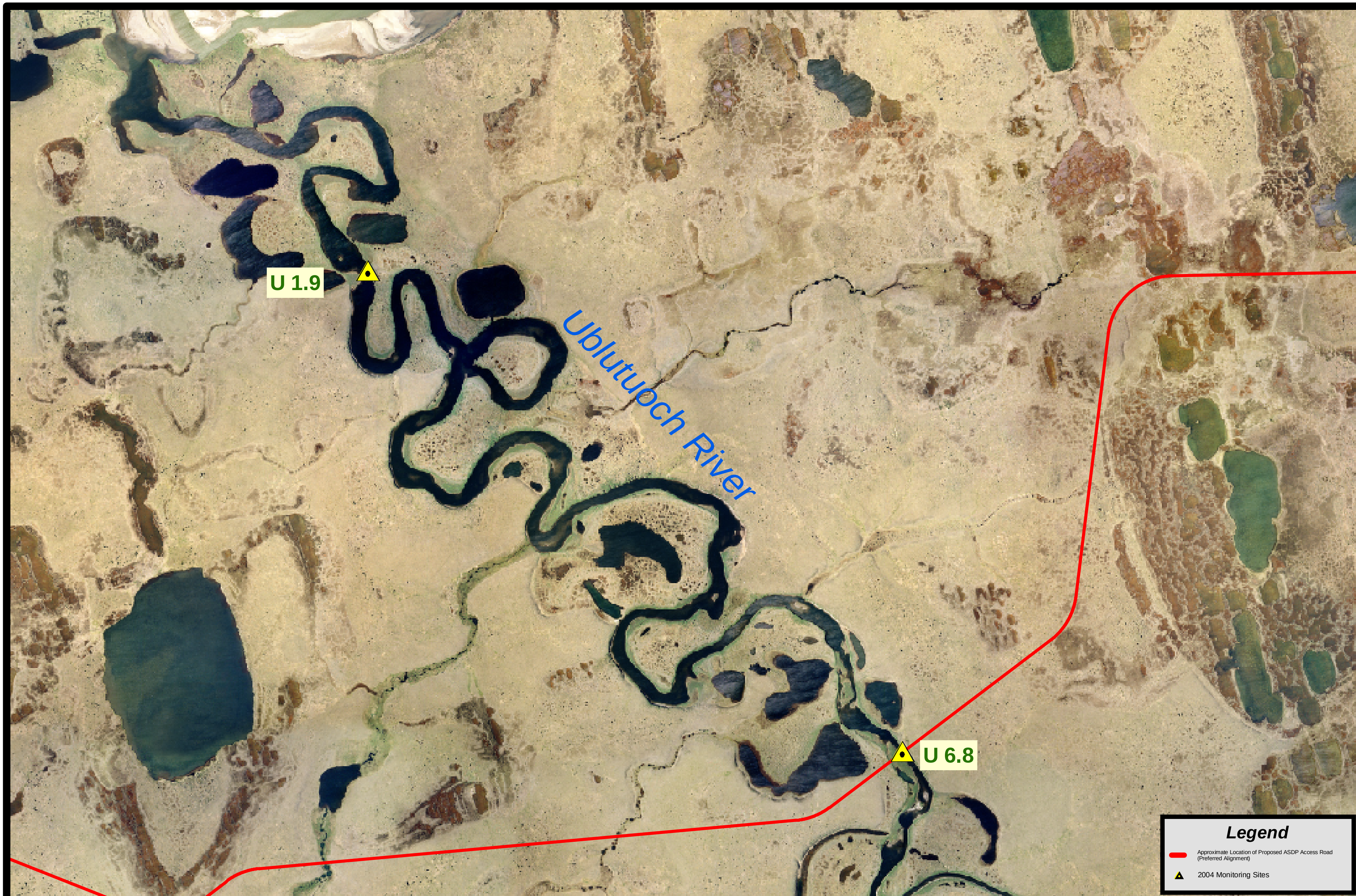
Nigliq Channel Monitoring Site Locations

Figure 1-2



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Ublutuoch River Monitoring Site Locations

Figure 1-3

2.0 Stream Basin and Monitoring Site Descriptions

The project area for the ASDP is located within the drainage basins of two major North Slope streams, the Colville River and Fish Creek. A portion of the proposed access road and pipeline facilities for the ASDP will cross the Nigliq Channel and Paleochannels within the northwestern portion of the Colville River Delta, and the Ublutuoch River tributary within the eastern portion of the basin of Fish Creek.

2.1 Basin Physiography

2.1.1 Colville River Basin Physiography

The Colville River drains almost 30% of Alaska's North Slope (Walker, 1983) having a drainage basin encompassing approximately 21,000 square miles (mi^2). Most of the river's major tributaries drain northward from the Brooks Range into the main stem of the Colville River, which flows into the Beaufort Sea at Harrison Bay. Major Colville River tributaries include the Etivluk, Killik, Chandler, Anaktuvuk, Kikiakrorak, Kogosukruk, and Itkillik Rivers. The drainage basin of the Colville River is shown on Figure 2-1.

The Colville River drainage basin is situated within three physiographic provinces including the Arctic Coastal Plain, Arctic Foothills, and Brooks Range. The Arctic Foothills province accounts for the 64% of the river's basin (Walker, 1976). The ASDP project area lies entirely within the Arctic Coastal Plain province. Low relief, poor drainage, tundra vegetation, numerous lakes, low-gradient sinuous stream channels, and abundant permafrost-related landforms characterize this physiographic province.

Where the Colville River reaches the Beaufort Sea, it forms a delta more than 25 miles long and extends over an area of approximately 250 mi^2. The entire delta lies within the Arctic Coastal Plain physiographic province. At the head of the delta a few miles north of the river's confluence with the Itkillik River, its channel pattern changes from a single meandering channel to a complex system of deltaic distributary channels. The East and Nigliq Channels carry the bulk of the flow in the delta, and during spring breakup account for approximately 90% of the flow in the delta. During the delta's low water periods the East and Nigliq Channels account for approximately 99% of the flow (Walker, 1983). It has been estimated that the Nigliq Channel carries approximately 20% of the river's flow during spring breakup flooding (Arnborg et al,

1967) but proportions of as much as 38% of peak breakup flows have been reported (Jorgenson et al, 1996). Other major distributary channels of the delta include the Sakoonang, Tamayagiaq, Ulamnigiaq, East and West Ulamnigiaq, Kupigruak, and Elaktoveach Channels.

The scars of two formerly active delta distributary channels are situated between the Nigliq Channel and the far western margin of the Colville River Delta and are termed the Paleochannels. These channels will be crossed by the proposed ASDP access road connecting facility CD-2 and facility CD-5 and are occupied by marshes and shallow lakes. The Paleochannels typically carry flowing water only during low frequency, high magnitude flood events.

The Nigliq Slough is a major side channel of the Nigliq Channel and begins along the west bank of the Nigliq Channel approximately three river miles north of the village of Nuiqsut. The slough flows generally northward for approximately six miles before rejoining the Nigliq Channel south of facility CD-2. Overflow within the Nigliq Slough is the expected source for floodwaters entering the Paleochannels. The Nigliq Slough and Paleochannels are shown on Figure 1-1.

2.1.2 Fish Creek Basin Physiography

Fish Creek and its tributaries flow generally northeastward and enter Harrison Bay of the Beaufort Sea west of the Colville River Delta. Two significant tributary sub-basins are situated within the approximately 1,830-mi^2-drainage basin of Fish Creek. The sub-basins are the 665-mi^2 Judy Creek basin, and the 245 mi^2 Ublutuoch River basin. Judy Creek and the Ublutuoch River join the main stem of Fish Creek at approximately 26 and 10 miles, respectively, above the mouth of Fish Creek (URS, 2003). Approximately 12 miles upstream of where Fish Creek enters Harrison Bay, the channel splits into the main Fish Creek channel and the Tingmeachsiovik River distributary channel. The mouth of the Tingmeachsiovik River enters Harrison Bay to the northwest of the main branch of Fish Creek. The drainage basin of Fish Creek is shown on Figure 2-1.

Almost the entire Fish Creek basin is situated within the Arctic Coastal Plain physiographic province with the exception of the upper portion of the Judy Creek basin, which extends southward into the Arctic Foothills physiographic province.

2.2 Climate

The ASDP area is situated within the Arctic Coastal climate zone. This zone is characterized by long cold winters and short cool summers. The mean annual temperature is approximately 10 degrees Fahrenheit, and average daily temperatures can fall below freezing on 200 or more days of the year. The annual precipitation total for the area is 7.8 inches, with 3.4 inches falling as rain and the remainder as snow. Seasonal snow cover typically begins in late September and lasts until late May to mid-June.

Windy conditions are common along the Arctic Coast. These winds are strongest in the winter and result in significant drifting and redistribution of the snow pack. Significant evaporation is associated with summer winds. The mean annual wind speed in the area is approximately 13 miles per hour (USDOI, 2003). Wind gusts typically range from 30 to 45 miles per hour, although wind speeds as high 60 miles per hour have been recorded at the Alpine Facility (Alpine Security, 2005).

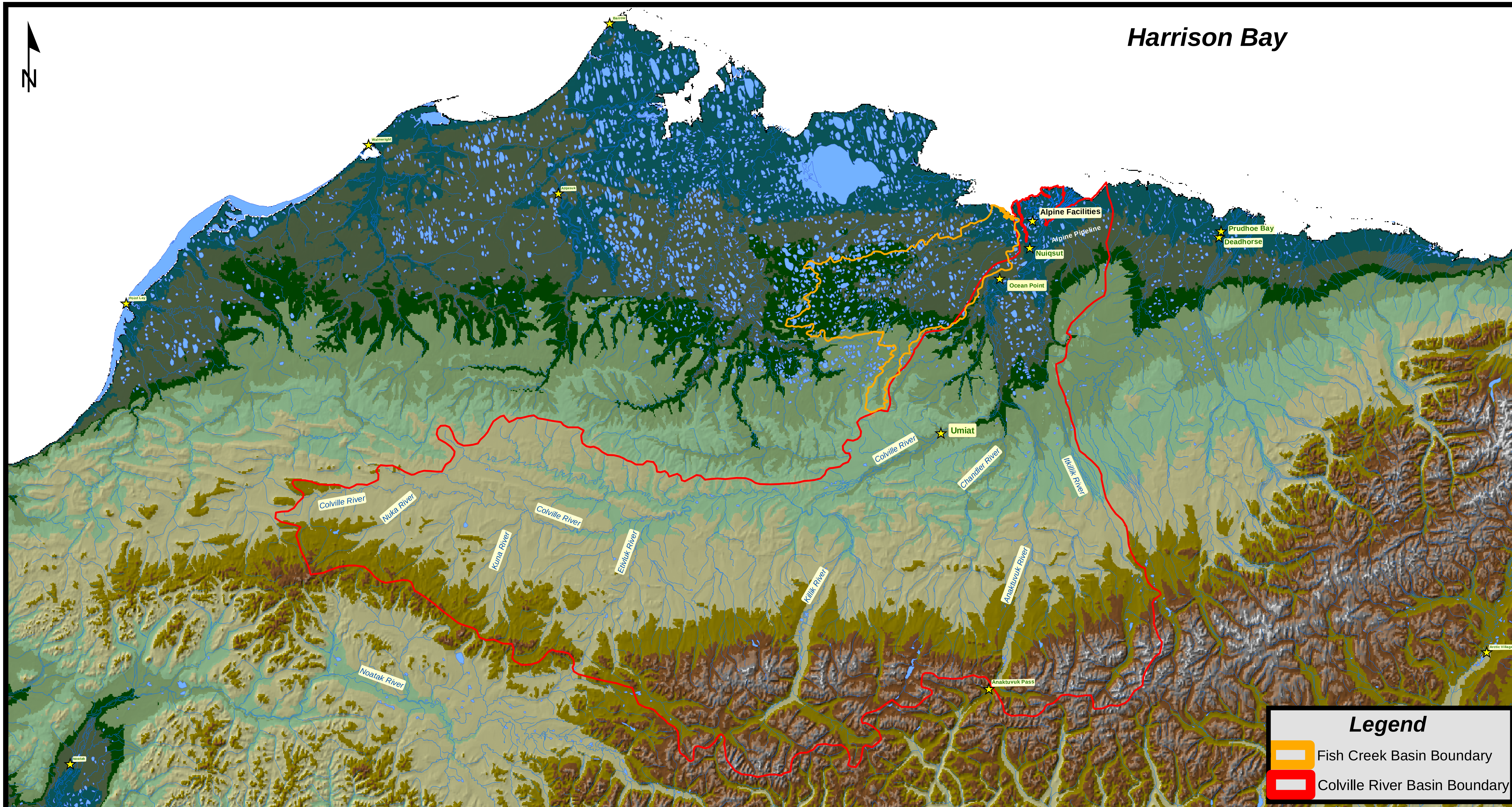
2.3 North Slope Basin Hydrology

North Slope streams share common hydrologic characteristics due to the Arctic climate and the continuous nature of regional permafrost. For most of the year, many North Slope streams are frozen to their beds and cease flowing. Groundwater influx to streams is essentially nonexistent with shallow groundwater being restricted to isolated zones beneath deep lakes and river channels. Spring snowmelt produces most of the annual flow that occurs in these streams.

Annual peak floods commonly occur in the spring during breakup but can occasionally take place in the summer or fall from rain events in some mountainous basins. The Sagavanirktok River located to the east of the ASDP project area is such an example. Summers are marked by generally declining low flow conditions with occasional temporary increases due to rainfall events. Freeze-up occurs in the fall and generally results in the cessation of flow until the following spring. Freeze-up usually begins at the coast and proceeds southward into the foothills and mountains. However, spring breakup usually begins in the higher terrain to the south and proceeds northward.

2.3.1 Colville River Hydrology

Spring breakup in the Colville River Delta normally occurs in either late May or early June but has been known to occur as early as mid-May and as late as mid-June. As waters from snowmelt within the Brooks Range tributaries enter the delta, low water channel ice formed over the winter lifts, breaks apart, and either flows out to the sea, or is trapped along channel margins and bars as river stage drops. This process of breakup of the winter ice cover frequently results in ice jams within the delta. Ice jams can cause significant overbank flooding, particularly during lower magnitude flood events. Historically, annual peak floods occur during the spring in the Colville River Delta. Overbank flooding from summer or fall rain events has not been documented. A summary of breakup data obtained at the head of the Colville River Delta between 1962 and 2004 is presented in Table 2-1.



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Fish Creek Drainage Basin

Figure 2-1

Table 2-1 Summary of Breakup Data Obtained on the Colville River at Monument 01, 1962 - 2004

Year	Approximate Date of First Flowing Water	Peak Water Surface Elevation (ft)	Date of Peak Water Surface Elevation	Peak Breakup Discharge (cfs)	Notes
2004	20 May	19.54	27 May	360,000	1,2,12,13
2003	27 May	13.76	5 June	350,000	1,3,12,13
2002	23 May	16.87	24 May	300,000	1,4,12,13
2001	5 June	17.37	10 June	300,000	1,5,12,13
2000	8 June	19.33	11 June	580,000	1,6,12,13
1999	22 May	13.97	30 May	203,000	1,7,8,12,13
1998	21 May	18.11	29 May	213,000	1,912,13
1997	20 May	15.05	29 May	177,000	1,11,13
1996	15 May	17.19	26 May	160,000	1,10,12,13
1995	8 May	15.7	16 May	233,000	11,12,13
1994	16 May	13.0	25 May	159,000	11,12,13
1993	–	20.0	31 May	379,000	11,12,13
1992	–	14.7	2 June	188,000	11,12,13
1977	–	19.9	7 June	407,000	11,12,13
1973	25 May	–	8 June	–	11,12,13
1971	23 May	–	2 June	–	11,12,13
1964	28 May	–	3 June	–	11,12,13
1962	19 May	13.2	14 June	215,000	11,12,13

Notes:

1. Water surface elevations are based on monuments set by Lounsbury & Associates in 1996 and are based on the British Petroleum mean sea level (BPMSL) datum.
2. Data from Michael Baker, Jr. Inc., 2005
3. Data from Michael Baker, Jr., Inc., 2003.
4. Data from Michael Baker, Jr., Inc., 2002b.
5. Data from Michael Baker, Jr., Inc., 2001.
6. The peak discharge was estimated to range between 570,000 to 590,000 cfs. Data from Michael Baker, Jr., Inc., 2000.
7. Data from Michael Baker Jr., Inc., 1999.
8. 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.
9. Data from Michael Baker Jr., Inc., 1998.
10. Data from Shannon & Wilson, Inc., 1996.
11. Data from Jorgenson et al., 1996. 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.
12. The timing of the peak breakup discharge is not necessarily coincident with that of the peak breakup water surface elevation. It is not uncommon for the peak discharge to occur sometime after the peak water surface elevation, at a time when channel ice has lifted, cleared from the channel, increasing the channel’s cross-section and flow-carrying capacity.
13. For this year, the date of first flowing water represents the first date on which water was noted to be flowing in the channel at the head of the delta (near Monument 01). In other years, the date of first water may indicate the first day that water reached temporary staff gages installed at the head of the delta. The timing of the two events – the day that water was first noted flowing in the channel vs. the day that water was first noted reaching temporary staff gages – will not necessarily be coincident in all years.

The results of a flood frequency analysis for the Colville River Delta are presented in Table 2-2. Baker and Hydroconsult EN3 Services, Ltd. performed an updated flood frequency analysis in 2002 in order to provide recommended flood frequency values for the design of facilities within the delta (Michael Baker Jr. and Hydroconsult, 2002).

Table 2-2 Colville River Delta Flood Frequency Analysis Results

Recurrence Interval	Flood Peak Discharge [cfs]
2-year	240,000
5-year	370,000
10-year	470,000
25-year	610,000
50-year	730,000
100-year	860,000
200-year	1,000,000

2.3.2 Fish Creek Basin Hydrology

Based on observations made during the past four years, the general hydrologic characteristics of North Slope streams discussed above also apply to Fish Creek and its tributaries. Like other North Slope streams, Fish Creek and its tributaries in areas are frozen to their beds during the winter. In addition, Fish Creek and its tributaries produce most of their annual flow and their annual peak floods in the spring during breakup, display generally declining low flow conditions in the summer, have little or no influx from groundwater, and cease flowing in the fall during freeze-up.

Based on observations between 2001 and 2004, the timing of spring breakup in the Fish Creek basin occurs at roughly the same time as breakup in the Colville River Delta. Because the southern portion of Judy Creek's drainage basin is in the Arctic Foothills physiographic province, it is generally the first tributary to breakup within the Fish Creek basin. The timing of breakup on the Ublutuoch River has been more variable and either lags behind or precedes breakup on Judy Creek and upper Fish Creek. Regardless of when breakup begins on the Ublutuoch River, the peak water surface elevation has consistently occurred within a few days after the arrival of first water.

For the ASDP, the Fish Creek basin tributary of the most interest is the Ublutuoch River. The proposed ASDP access road crosses the Ublutuoch at approximately river mile 6.8. Hydrologic issues specific to the Ublutuoch River and the proposed bridge site are described below in the following sections.

2.3.2.1. Ublutuoch River Bridge Crossings Flood Frequency Analysis

The results of a flood frequency analysis for the proposed ASDP bridge crossing of the Ublutuoch River at river mile 6.8 is presented below in Table 2-3. The analysis, performed by URS Corporation (URS, 2003), provides recommended flood frequency values for the design of facilities within the Fish Creek basin. The results shown below are based on drainage area estimates of the Ublutuoch River at the proposed bridge site.

Table 2-3 Ublutuoch River Mile 6.8 Bridge Site Flood Frequency Analysis Results

Recurrence Interval	Flood Peak Discharge [ft^3/sec]
2-year	2,290
5-year	3,670
10-year	4,680
25-year	6,140
50-year	7,380
100-year	8,670
200-year	10,130
Note: Drainage area at the Ublutuoch River RM 6.8 bridge site is estimated to be 227 square miles.	

2.3.2.2. Ublutuoch River 100-Year Floodplain Delineation

One–dimensional modeling using Hydrologic Engineering Center River Analysis System (HEC-RAS) software was not conducted on the Ublutuoch River following the 2004 spring breakup (Baker, 2003). The parameters of the HEC-RAS model have not changed appreciably since modeling was conducted in 2003. Channel roughness estimates calculated in 2004 were consistent with 2003 roughness estimates. The assumptions used in the HEC-RAS model made in 2003 proved valid as breakup floodwaters occurred over bottomfast channel ice, which was consistent with annual observations made since 2001. Bottomfast channel ice elevations used in the calculation of the 100-year flood in 2003 were confirmed in 2004.

Table 2-3 Summary of Breakup Data Obtained on the Ublutuoch River, 2001 - 2004

Year	Gage Location	Peak Water Surface Elevation (ft)	Date of Peak Water Surface Elevation	Peak Breakup Discharge (cfs)	Notes
2004	RM 6.8 Upstream	10.50	6 June	5,600	1
2003	RM 6.8 Upstream	10.14	6 June	5,300	1, 2
2002	RM 13.7	18.22	22 May	2,000	1, 3
2001	RM 13.7	18.09	10 June	2,200	1, 4

Notes:
1. Water surface elevations are based on British Petroleum mean sea level (BPMSL) datum.
2. Data from Michael Baker, Jr. Inc., 2003
3. Data from URS Corporation, 2002
4. Data from URS Corporation, 2001

It should be noted that backwater effects of Fish Creek during spring breakup influence the river hydraulics and water surface elevations of the lower portions of the Ublutuoch River including Ublutuoch River at river mile 6.8. The observed peak water surface elevation on the lower section of Fish Creek has been relatively consistent based on 2001, 2002, and 2004 observed water surface elevations at Fish Creek 0.7 and 10.3. This condition has been documented and taken into consideration with the Ublutuoch HEC-RAS model. A complete water surface elevation, water velocity data, and a HEC-RAS output report for the 100-year flood are presented in the ASDP 2003 Spring Breakup and Hydrologic Assessment Report (Baker, 2003). However, Table 2-4 presents Ublutuoch River 100-year floodwater elevations and Velocities based on the 2003 HEC-RAS model.

Table 2-4 Ublutuoch River 100-year Flood Water Surface Elevations and Velocities

Location	Water Surface Elevation (BPMSL)	Velocity (ft/s)
UB 6.8	12.55	4.2

3.0 2004 Colville River Delta Spring Breakup Summary

3.1 2004 Spring Breakup at Monument 01

3.1.1 Monument 01 – Water Surface Elevations and Observations

A number of temporary staff gage sets were established in 2004 in order to monitor water surface elevations in the Colville River Delta. Water was first noted flowing in the Colville River at the Monument 01 reach on May 20. Staff Gage readings at Monument 01 continued until May 29. Staff gage measurements in the Nigliq Channel began on May 21 when floodwaters first reached the gages at Monument 22, 23, and 28 and continued until May 30. Water surface elevation and observation records for temporary staff gages in the Colville River Delta are presented in Tables 3-1 through 3-8. Floodwater data and observations of the Paleochannel gages were recorded between May 26 and May 30.

The 2004 spring breakup at Alpine was unique in that it produced some of the highest water levels recorded at the facility, although not necessarily high with respect to design events. High runoff volumes within the Colville basin did not cause the high water levels. Rather, intact channel ice at the entrance to the East Channel caused a substantial increase in backwater that based on visual observations diverted an unusually high percentage of flow into the Nigliq Channel. The intact channel ice was composed of a continuous section of ice locked in place throughout the low water channel.

Ice jams approximately 30 river miles upstream of Alpine affected flow patterns at the head of the delta. Additionally, significant overbank flooding was observed in the Ocean Point area. Multiple peak stages were recorded on the rising limb of the hydrograph of the Colville River at Monument 01. The peak stage of 19.54 feet occurred at Monument 01 between the evening of May 26 and the afternoon of May 27.

The above peak stage at Monument 01 was ice-affected to some extent. The presence of the ice sheet at Monument 01 resulted in a higher stage than would have occurred for the same magnitude of flow during ice-free conditions. Channel ice did not clear completely from the Monument 01 section until about May 30, well after the peak flood stage had passed.

3.1.2 Monument 01 – Discharge

Discharge in the Colville River during the 2004 spring breakup was estimated using Slope Area computations. The discharge estimate on the Colville River is for the reach of river near Monument 01. Water surface elevation and slope data were obtained from the measurements made at Monument 01, and temporary benchmarks Monument 01 Upstream (TBM 01U) and Monument 01 Downstream (TBM 01D). Cross-section geometry was based on three cross-sections surveyed by Kuukpik/LCMF, Inc. in August 2004 (Kuukpik/LCMF, Inc., 2004). The cross-sections, presented in Appendix A, were surveyed at Monument 01, TBM 01U and TBM 01D.

As discussed earlier, intact, floating channel ice was present both upstream and downstream of the Monument 01 reach. An ice sheet that covered a portion of the channel along the right (east) bank was present during breakup. At the time of peak discharge, the ice sheet covered approximately 38% of the active channel. Shore cracks were present along the east bank of the ice sheet, however traverse cracks were not observed in the ice until after the peak stage and discharge had passed through the reach.

A stationary river ice cover, such as the one observed at Monument 01, introduces an additional boundary and therefore increases energy losses with respect to flow and results in an increase in stage compared to open-water conditions for the same discharge. The ice sheet makes a portion of the channels cross-sectional area unavailable for flow. The net result is to reduce the channel conveyance largely by increasing the wetted perimeter and reducing the hydraulic radius of the channel, but also by modifying the effective channel roughness. 2004 is the first year on record where peak discharge has been estimated with a significant ice sheet in place during peak discharge at Monument 01. An in-channel ice sheet that occupied nearly 40% of the channel surface substantially increases the complexity of discharge calculations because the roughness of the ice sheet and its dimensions continuously changed. 2004 discharge calculations were made using procedures outlined in the U.S. Army Corps of Engineers Ice Engineering Manual EM 1110-2-1612 (USACE, 2002).

Hydraulic roughness values for the channel were estimated to be between 0.021 and 0.023 based on a 1993-discharge measurement (Alaska Biological Research and Shannon & Wilson, 1994) and annual on-site investigations of the channel bottom using methods outlined by the United

States Geological Survey (Arcement and Schneider, 1989). An ice roughness value of 0.01 was determined using the USACE Ice Engineering Manual.

The 2004 spring breakup peak discharge at the head of the Colville River Delta is estimated to have been approximately 360,000 cubic feet per second (cfs). Peak discharge is estimated to have occurred on the morning of May 26 at a water surface elevation of 19.48 feet. The peak stage at Monument 01 (19.54 feet) occurred approximately 20 hours later. The 2004 peak discharge is estimated to have a recurrence interval of about five years based on the most recent flood frequency analysis (Michael Baker Jr., Inc. and Hydroconsult EN3 Services, Ltd., 2002). In other words, the 2004 spring breakup peak discharge has about a 20% chance of being equaled or exceeded in any given year.

A summary of breakup data obtained at the head of the Colville River Delta between 1962 and 2004 is presented on Table 2-1.

3.2 2004 Spring Breakup on the Nigliq Channel

3.2.1 Nigliq Channel – Water Surface Elevations and Observations

The Nigliq Channel monitoring sites are located along the northern portion of the channel near permanent survey monuments 22, 23, and 28. The Monument 23 monitoring site is located along the east bank adjacent to the CD-2 facility and near the proposed Nigliq bridge crossing (Figure 1-2). The peak stage at the Monument 22 and 23 monitoring sites most likely occurred on the afternoon of May 27 at elevations of 10.17 and 9.14 feet, respectively. At the Monument 28 monitoring site, the peak stage occurred between the afternoon of May 27 and the morning of May 28 at an elevation of 4.47 feet. Water surface elevation and observation records for temporary staff gages at Monuments 22, 23, and 28 are presented in Tables 3-4, 3-5, and 3-8, respectively.

Photo 3-3 and 3-4 show breakup conditions on May 23 and May 26 near the proposed Nigliq bridge site.

3.2.2 Nigliq Channel – Discharge

Spring breakup peak discharge in the Nigliq Channel of the Colville River Delta near CD-2 was estimated using Slope-Conveyance computations. Water surface elevation and slope data were obtained from field measurements made at Monuments 22 and 23 monitoring sites. Cross-section geometry was based on survey data by LCMF in 2003 (Kuukpik/LCMF, 2003a). Hydraulic roughness values were estimated to be between 0.022 and 0.095 based on on-site investigations of the channel using methods outlined by the United States Geological Survey (Arcement and Schneider, 1989), and engineering judgment based on prior experience.

A floating ice sheet covering a portion of the channel along the left (west) bank was present during breakup. At the time of peak discharge, the ice sheet covered approximately 10% of the active channel. Discharge calculations in the Nigliq Channel in 2004 were made using procedures outlined in the USACE Ice Engineering Manual and by procedures previously described in Section 3.1.2. An ice roughness value of 0.01 was determined using the USACE Ice Engineering Manual. Discharge was calculated at the proposed Nigliq bridge site based on topography provided by Kuukpik/LCMF and is presented in Appendix B.

The 2004 spring breakup peak discharge near Monument 23 on the Nigliq Channel of the Colville River Delta occurred on the afternoon of May 27 and is estimated to have been approximately 64,000 cfs. This flow and the measured flow in the CD2 road drainage structures represent approximately 20% of the Colville River flow. The peak discharge in the Nigliq channel is considered ice-affected, as the channel near Monument 23 was not clear of ice at the time of peak discharge.

3.3 2004 Spring Breakup at the Nigliq Channel Paleochannels

3.3.1 Water Surface Elevations and Observations in the Paleochannels

The Paleochannels monitoring sites are located within the Colville River Delta a short distance west of the proposed bridge crossing of the Nigliq Channel. The monitoring sites are comprised of two sets of staff gages located within roughly parallel relict channel scars. These channel scars are termed Paleochannel East and Paleochannel West and most likely mark former positions of the Nigliq Slough or possibly the Nigliq Channel (Figure 1-2). The Paleochannels do not have a hydraulic connection with the Nigliq Channel or Nigliq Slough during low water or lower magnitude flooding events. In 2004, floodwater overtopped the banks along the north end of the Nigliq Slough resulting in surface water observed in both Paleochannels. Although velocities in the Paleochannels were not measured, qualitative observations made during staff gage readings suggest that flow velocity at the two monitoring sites was minor, and likely never exceeded 0.5 feet per second.

The peak stage at the Paleochannels East and West monitoring sites occurred on the evening of May 27 at elevations of 9.81 and 9.76 feet, respectively. Water surface elevation and observation records for temporary staff gages at the Paleochannels are presented in Tables 3-6 and 3-7. Photos 3-5 and 3-6 show flooding conditions in the vicinity of the East and West Paleochannels approximately 12 hours after the occurrence of the peak water surface elevation in that area.

3.4 Comparison of Observed and Predicted Water Surface Elevations

The peak water surface elevations observed at locations throughout the Colville Delta were compared to the elevations predicted by the two-dimensional surface water model developed for the Colville River Delta (Michael Baker Jr., Inc., 2002a). All recurrence interval estimates are based on a linear interpolation between the water surface elevations predicted for the 2-, 10-, 30-, and 50-year open water floods. Because recurrence interval relationships are not linear, recurrence interval estimates should be considered as approximate.

Based on the two-dimensional surface water model, at Monument 01 near the head of the Colville Delta, the spring 2004 peak discharge had an average expected recurrence interval of about 5 years. However, based on observed water surface elevations at Monument 01, the recurrence interval would have been predicted to be a 14-year event. This difference in the stage discharge relationship is due to the presence of an ice sheet that partially covered the active channel at Monument 01 and the backwater effects of the ice bridge observed at the confluence of the East Channel and Nigliq Channel.

At Monuments 22 and 23, the estimate of recurrence intervals for the 2004 flood based on linear interpolation between the water surface elevations predicted for the 10-, 30-, and 50-year open water floods were 26 and 35 respectively. The disparity between Monuments 22 and 23 estimated recurrence intervals represents approximately a 0.5-foot difference. The cause for the difference in the estimated recurrence intervals is likely due to errors associated with the field measurements of water surface elevation due to high winds, waves, and ice at these locations during peak stage and the flat rating curve for this water level.

At Monument 28, the peak water surface elevation measured during the 2004 breakup exceeded the water surface elevation predicted for a flood event with a recurrence interval of 200 years. The probable causes include offshore ice effects and the diversion of flow to the Nigliq Channel. Water elevation increases at the mouth of the Colville during this period were likely also exaggerated by a particularly high tide cycle. The National Oceanic and Atmospheric Administration (NOAA) tide station No. 9497645 is located near the Seawater Treatment Plant (STP) on West Dock in Prudhoe Bay. Hourly tidal measurements at that station indicate that the 5AM high tide on May 26 was 0.55 feet Mean Low Low Water (MLLW). By the morning of May 28, the elevation of the high tide had reached 1.60 MLLW. This high tide cycle roughly coincided with peak water surface elevation at Monument 28 that occurred sometime during the early morning hours of May 28. Finally, Monument 28 is located near the downstream boundary of the two-dimensional surface water model and therefore the predicted water surface elevation estimates at this location are subject to considerably more error than those at the Alpine Facility. This is the case because the downstream boundary conditions at the interface point of the Colville River and Harrison Bay are less certain and are affected more by the presence of sea ice.

Table 3-1 Monument 01, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
5/20/04 6:14 PM	11.28	Channel is 50% clear of snow and ice. Ice intact along right bank.
5/21/04 9:52 AM	12.97	Channel is 60% clear of snow and ice. Ice intact along right bank.
5/21/04 4:05 PM	13.22	
5/22/04 10:03 AM	13.42	Channel is 60% clear of snow and ice. Ice intact along right bank.
5/22/04 5:50 PM	13.54	
5/22/04 7:53 PM	13.14	Channel is 60% clear of snow and ice. Ice intact along right bank.
5/23/04 9:45 AM	13.51	
5/23/04 7:00 PM	14.04	
5/24/04 4:30 AM	15.89	Windy conditions, gage protected from the wind. Time estimated.
5/24/04 10:56 AM	14.82	
5/25/04 10:30 AM	17.66	Ice intact along right bank. Water flowing overland to the west of the gages.
5/25/04 8:21 PM	18.39	Windy conditions, gage protected from the wind.
5/26/04 9:39 AM	19.48	Ice intact along right bank. Ice measured at approximately 1,250-feet wide.
5/26/04 8:10 PM	19.08	Ice intact along right bank. Water flowing overland to the west of the gages.
High Water Mark	19.54	Peak water surface elevation occurred on May 27 at approximately 2 a.m.
5/27/04 1:26 PM	19.20	Channel is 65% clear of snow and ice. Ice intact along right bank.
5/28/04 9:11 AM	17.98	
5/28/04 8:06 PM	16.50	Channel is 70% clear of snow and ice. Ice intact along right bank.
5/29/04 9:16 AM	15.43	Floating and grounded chunks of ice located along the west bank.
5/29/04 10:20 AM	14.70	Ice intact along right bank.

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. Coordinates for Monument 01 are N70° 09' 57.1" W150° 56' 24.1" (NAD 83), surveyed by Lounsbury and Associates.

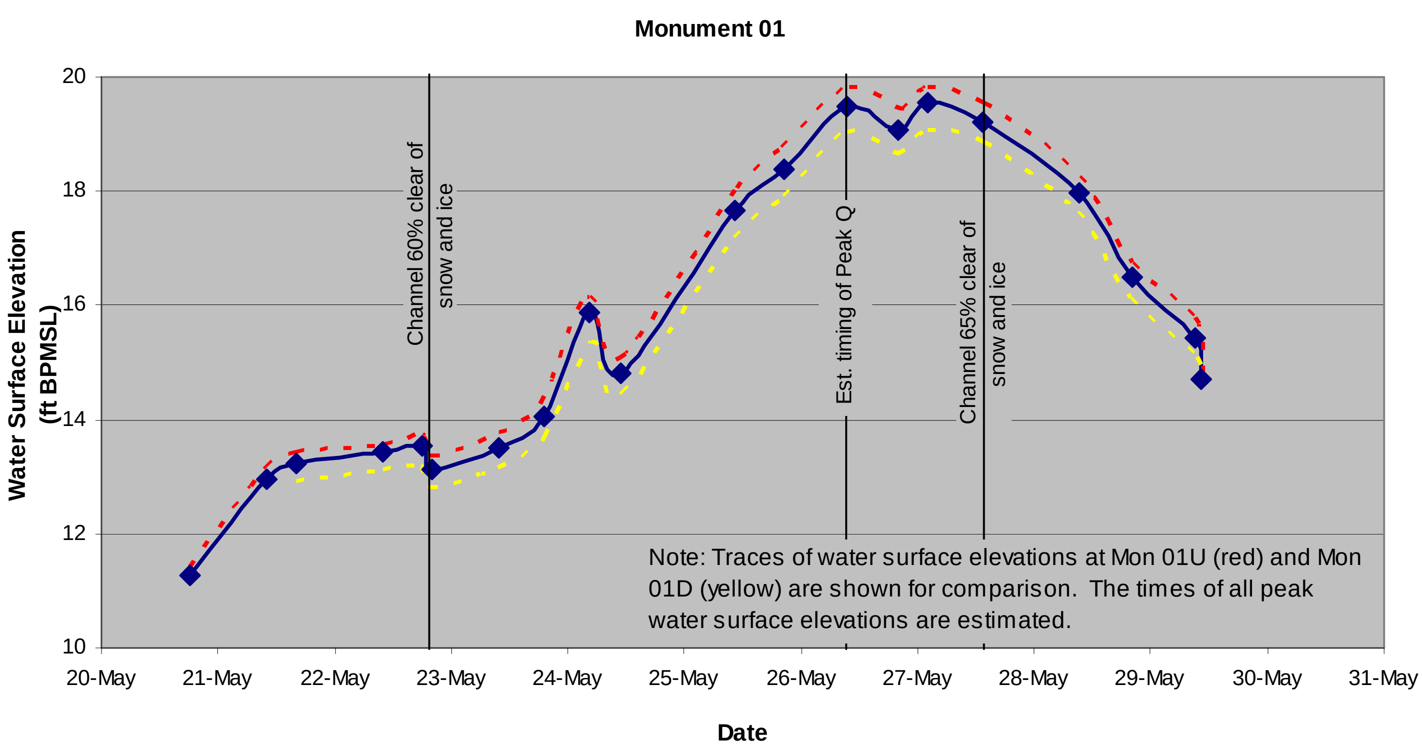


Table 3-2 Temporary Benchmark 01U, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
5/20/04 6:08 PM	11.41	Channel is 50% clear of snow and ice. Ice intact along right bank.
5/21/04 9:50 AM	13.15	Channel is 60% clear of snow and ice. Ice intact along right bank.
5/21/04 4:14 PM	13.43	Entire channel upstream from Monument 1U is covered by intact ice.
5/22/04 10:11 AM	13.59	
5/22/04 6:10 PM	13.75	Channel is 60% clear of snow and ice. Ice intact along right bank.
5/22/04 8:03 PM	13.36	Entire channel upstream from Monument 1U is covered by intact ice.
5/23/04 9:54 AM	13.78	
5/23/04 6:25 PM	14.25	
5/24/04 4:00 AM	16.16	Windy conditions, gage protected from the wind. Time estimated.
5/24/04 11:03 AM	15.09	
5/25/04 10:37 AM	18.03	Ice intact along right bank. Water flowing overland to the west of the gages.
5/25/04 8:13 PM	18.76	Water flowing into the Colville Channel from the area west of the gages upstream of Mon 1U.
5/26/04 9:45 AM	19.82	95% of channel upstream from Monument 1U is covered by intact ice.
5/26/04 8:20 PM	19.44	Ice intact along right bank. Water flowing overland to the west of the gages.
High Water Mark	19.83	Peak water surface elevation occurred on May 27 at approximately 2 a.m.
5/27/04 1:31 PM	19.54	Channel is 65% clear of snow and ice. Ice intact along right bank.
5/28/04 9:20 AM	18.25	
5/28/04 8:11 PM	16.75	Channel is 70% clear of snow and ice. Ice intact along right bank.
5/29/04 9:06 AM	15.78	Floating and grounded chunks of ice located along the west bank.
5/29/04 10:52 AM	14.86	Ice intact along right bank.

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. Coordinates for TBM 01U are N70° 09' 30.2" W150° 56' 48.1" (NAD 83), by Garmin III Plus GPS.

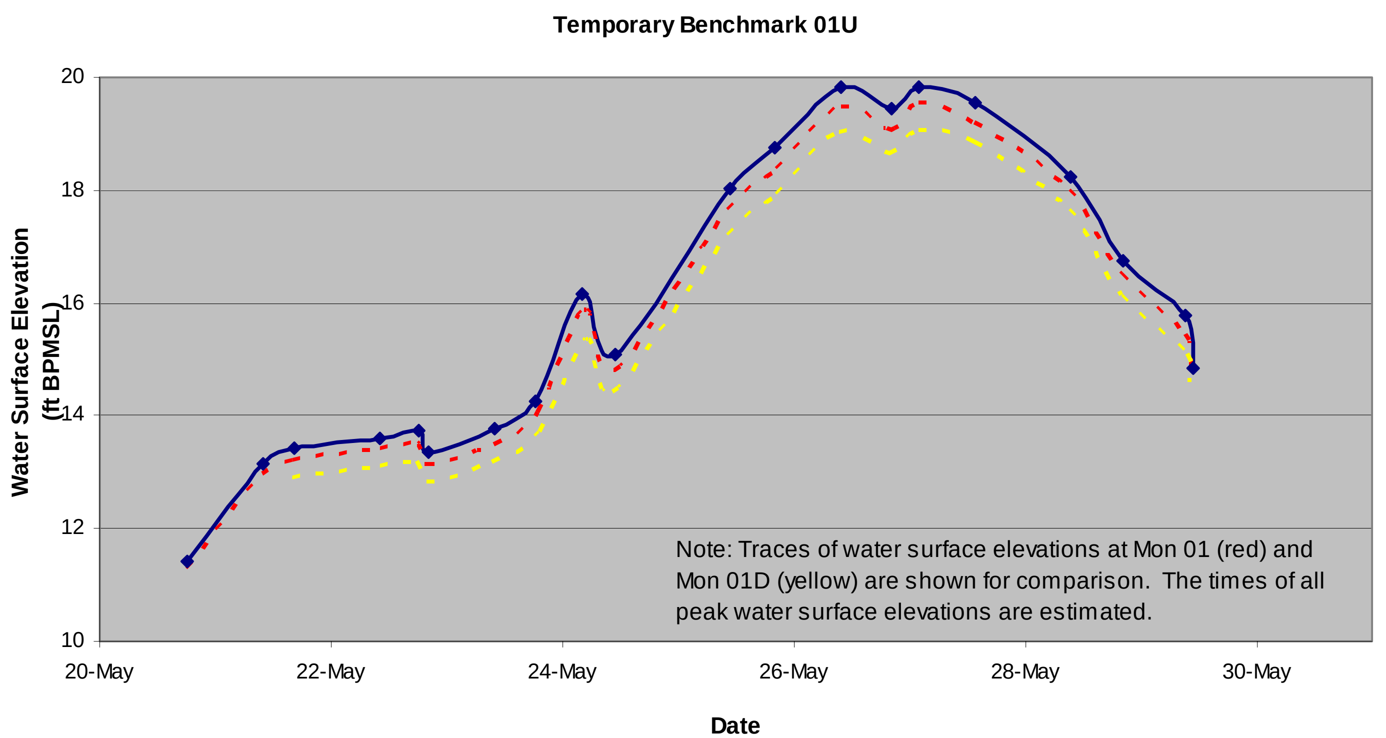


Table 3-3 Temporary Benchmark 01D, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
5/21/04 10:00 AM	12.49	Channel is 50% clear of snow and ice. Ice intact along right bank.
5/21/04 4:00 PM	12.91	Channel is 60% clear of snow and ice. Ice intact along right bank.
5/22/04 10:00 AM	13.11	Entrance to East Channel downstream from Monument 1D is covered by intact ice.
5/22/04 5:45 PM	13.19	Channel is 60% clear of snow and ice. Ice intact along right bank. Nigliq Channel free of ice.
5/22/04 7:42 PM	12.83	Entrance to East Channel downstream from Monument 1D is covered by intact ice.
5/23/04 9:38 AM	13.17	
5/23/04 7:11 PM	13.69	
5/24/04 5:00 AM	15.36	Windy conditions, gage protected from the wind. Time estimated.
5/24/04 10:43 AM	14.42	
5/25/04 10:21 AM	17.19	Ice intact along right bank. Water flowing overland to the west of the gages.
5/25/04 8:31 PM	17.92	Windy conditions, gage protected from the wind.
5/26/04 9:32 AM	19.04	Good water surface elevation, gage protected from the wind.
5/26/04 8:00 PM	18.65	Ice intact along right bank. Water flowing overland to the west of the gages.
High Water Mark	19.08	Peak water surface elevation occurred on May 27 at approximately 2 a.m.
5/27/04 1:15 PM	18.85	Channel is 65% clear of snow and ice. Ice intact along right bank.
5/28/04 9:00 AM	17.63	Good water surface elevation, gage protected from the wind.
5/28/04 7:56 PM	16.11	Entrance to East Channel, downstream from Monument 1D, is 80% covered by intact ice.
5/29/04 9:37 AM	15.10	Floating and grounded chunks of ice located along the west bank.
5/29/04 9:53 AM	14.61	Ice intact along right bank.

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. Coordinates for TBM 01D are N70° 10' 25.4" W150° 56' 13.0", (NAD 83), by Garmin III Plus GPS.

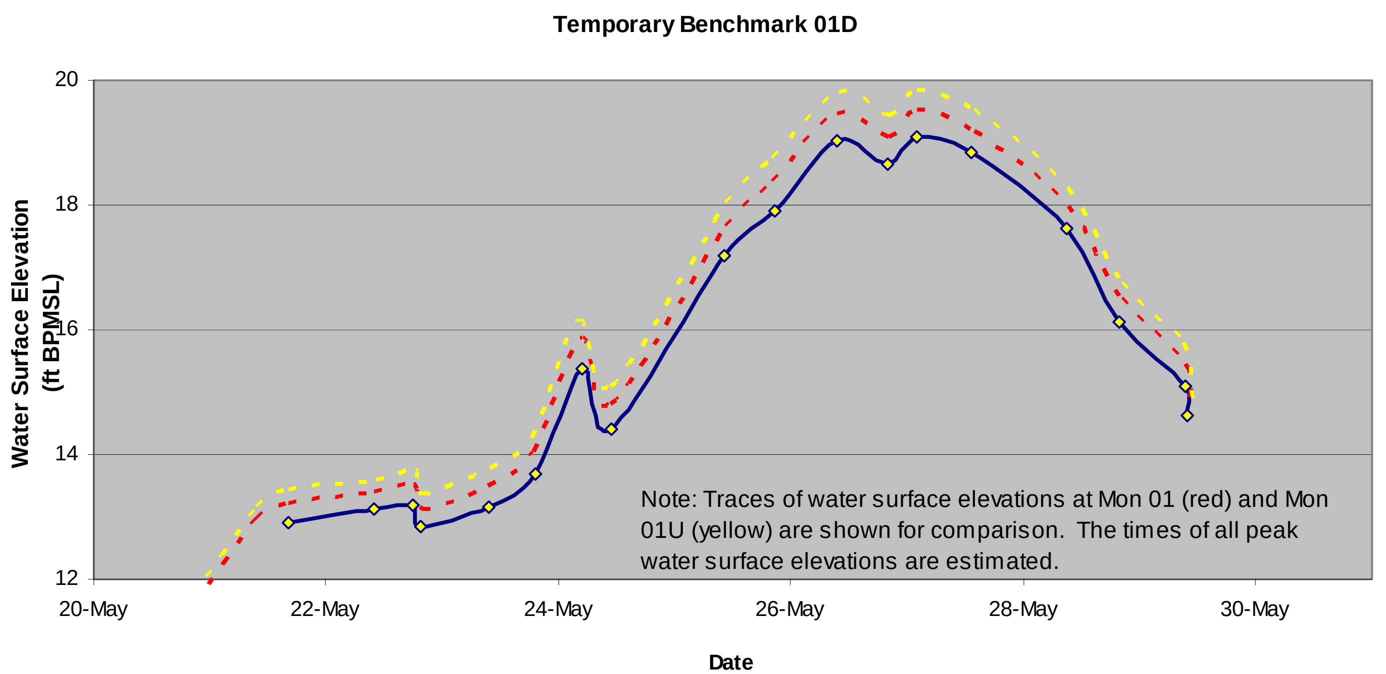


Table 3-4 Monument 22, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
5/21/04 11:12 AM	5.94	Flow over intact channel ice.
5/21/04 3:40 PM	6.09	Entire Nigliq channel downstream of Monument 22 is covered by intact ice.
5/22/04 10:50 AM	6.64	
5/22/04 5:30 PM	6.66	Ice intact along right bank.
5/22/04 7:27 PM	6.58	Measurement made using binoculars, water surface elevation +/- 0.06'.
5/23/04 10:33 AM	6.74	Ice intact along right bank.
5/24/04 10:27 AM	7.56	High winds, water surface elevation +/- 0.05'. Measurement made with stilling tube.
5/25/04 10:02 AM	8.74	Windy conditions, gage protected from the wind.
5/25/04 5:28 PM	8.99	Windy conditions, gage protected from the wind.
5/26/04 9:15 AM	9.83	Windy conditions, gage protected from the wind.
5/26/04 11:45 AM	10.01	
5/26/04 7:40 PM	9.83	Windy conditions, gage protected from the wind.
High Water Mark	10.17	Peak water surface elevation occurred on May 27 at approximately 3 p.m.
5/28/04 9:46 AM	9.78	
5/28/04 7:42 PM	9.17	Ice intact along right bank.
5/29/04 9:52 AM	8.35	
5/30/04 5:22 PM	6.87	

Notes:
1. Elevations are based on an elevation of 10.13 feet BPMSL for Monument 22, verified by Kuukpik/LCMF, Inc. in 2003.
2. Coordinates for Monument 22 are N70° 19' 05.2" W151° 03' 21.9" (NAD 83), by Garmin III Plus GPS.

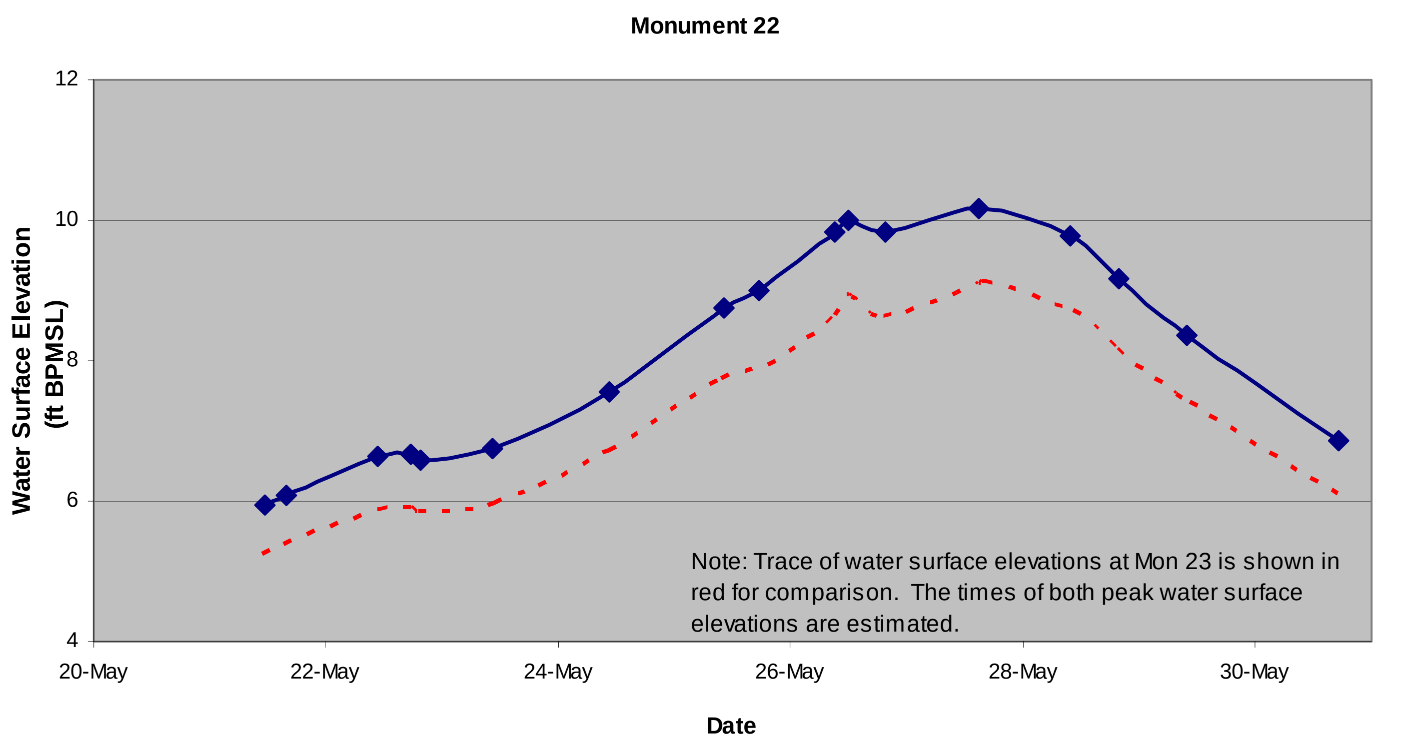


Table 3-5 Monument 23, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
5/21/04 11:03 AM	5.26	Flow over intact channel ice.
5/21/04 3:30 PM	5.39	Ice intact along the left bank. Channel is approximately 30% free of snow and ice.
5/22/04 11:10 AM	5.90	
5/22/04 5:00 PM	5.93	
5/22/04 7:13 PM	5.86	Ice intact along the left bank. Channel is approximately 30% to 40% free of snow and ice.
5/23/04 10:45 AM	5.97	
5/24/04 10:21 AM	6.73	Windy conditions, gage protected from the wind.
5/25/04 9:50 AM	7.74	Ice intact along the left bank. Channel is approximately 50% free of snow and ice.
5/25/04 7:19 PM	7.95	Windy conditions, gage protected from the wind.
5/26/04 9:00 AM	8.64	Ice intact along left bank. Water flowing overland to the east of the gages.
5/26/04 12:00 PM	8.95	Windy conditions, water surface elevation +/- 0.02'. Measurement made with stilling tube.
5/26/04 7:17 PM	8.65	Water in the Nigliq, downstream of the gages, is connected to floodwater west of CD-2.
5/27/04 2:25 PM	9.08	Windy conditions, gage protected from the wind.
High Water Mark	9.14	Peak water surface elevation occurred on May 27 at approximately 4 p.m.
5/28/04 10:11 AM	8.73	Water in the Nigliq, downstream of the gages, is connected to floodwater west of CD-2.
5/28/04 7:18 PM	8.16	Water flowing overland to the east of the gages.
5/29/04 10:03 AM	7.42	Ice intact along left bank.
5/30/04 5:05 PM	6.09	

Notes:
1. Elevations are based on an elevation of 9.53 feet BPMSL for Monument 23, verified by Kuukpik/LCMF, Inc. in 2003.
2. Coordinates for Monument 23 are N70° 20' 40.1" W151° 03' 40.7" (NAD 83), by Garmin III Plus GPS.

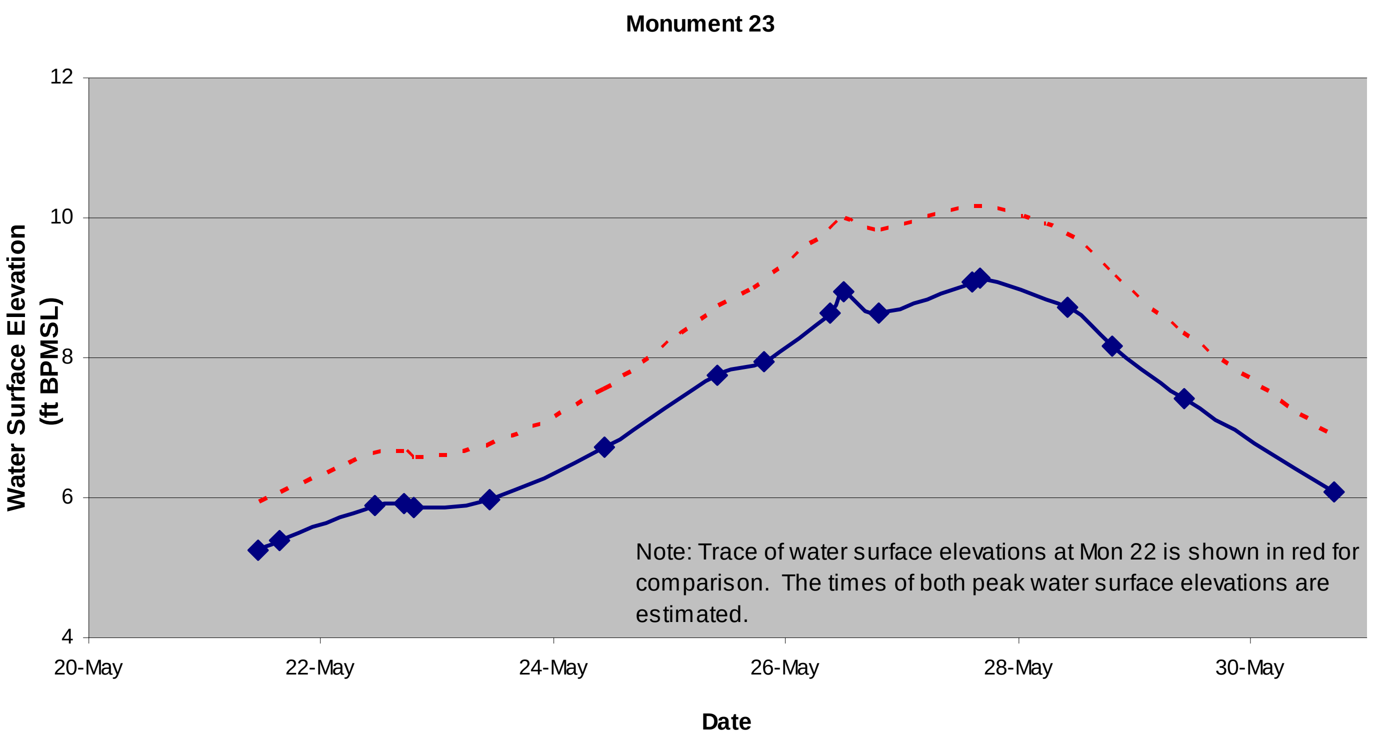


Table 3-6 Paleochannel East, Water Surface Elevations and Observation

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
5/26/04 9:09 AM	9.10	Water on top of ground fast ice.
5/26/04 7:30 PM	9.50	Water on top of ground fast ice.
5/26/04 7:30 PM	9.46	Windy conditions, water surface elevation +/- 0.02'. Measurement made with stilling tube.
5/27/04 2:32 PM	9.77	Water on top of ground fast ice.
High Water Mark	9.81	Peak water surface elevation observed on May 27 at approximately 7 p.m.
5/28/04 10:00 AM	9.51	Water on top of ground fast ice.
5/28/04 7:25 PM	9.17	Water on top of ground fast ice.
5/29/04 10:30 AM	8.45	Water on top of ground fast ice.
5/30/04 5:11 PM	8.17	Water on top of ground fast ice.

Notes:
1. Elevations are based on an elevation of 25.50 feet BPMSL for US Coast & Geodetic Survey Monument "Clear 1951", verified by Kuukpik/LCMF, Inc. in 2003.
2. Coordinates for Paleochannel East are N 70° 20' 26.5" W 151° 05' 33.8" (NAD 83), by Garmin III Plus GPS.

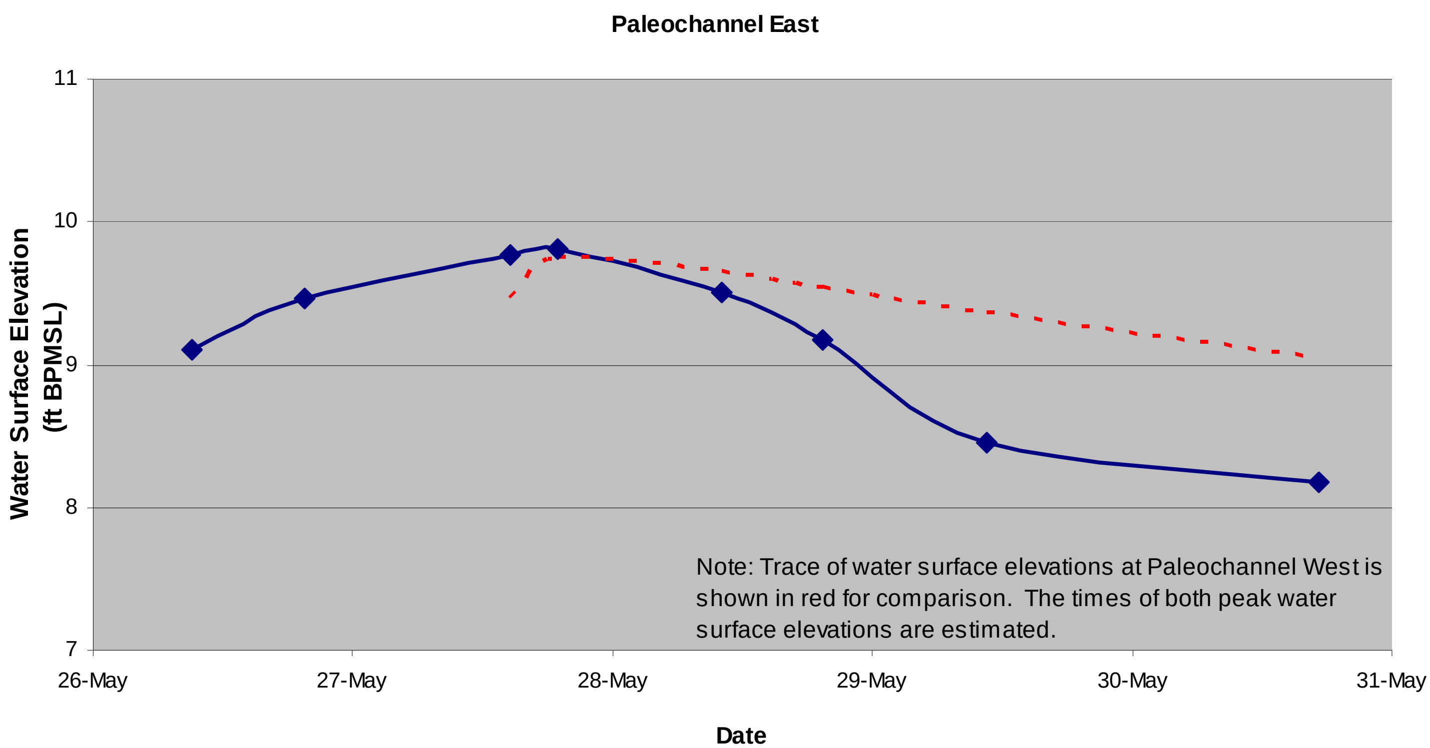


Table 3-7 Paleochannel West, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
5/27/04 2:43 PM	9.46	Water on top of ground fast ice.
High Water Mark	9.76	Peak water surface elevation observed on May 27 at approximately 7 p.m.
5/28/04 9:53 AM	9.66	Water on top of ground fast ice.
5/28/04 7:36 PM	9.55	Water on top of ground fast ice.
5/29/04 10:35 AM	9.36	Water on top of ground fast ice.
5/30/04 5:16 PM	9.05	Water on top of ground fast ice.

Notes:
1. Elevations are based on an elevation of 25.50 feet BPMSL for US Coast & Geodetic Survey Monument "Clear 1951", verified by Kuukpik/LCMF, Inc. in 2003.
2. Coordinates for Paleochannel West are N 70° 20' 16.7" W 151° 06' 20.4" (NAD 83), by Garmin III Plus GPS.

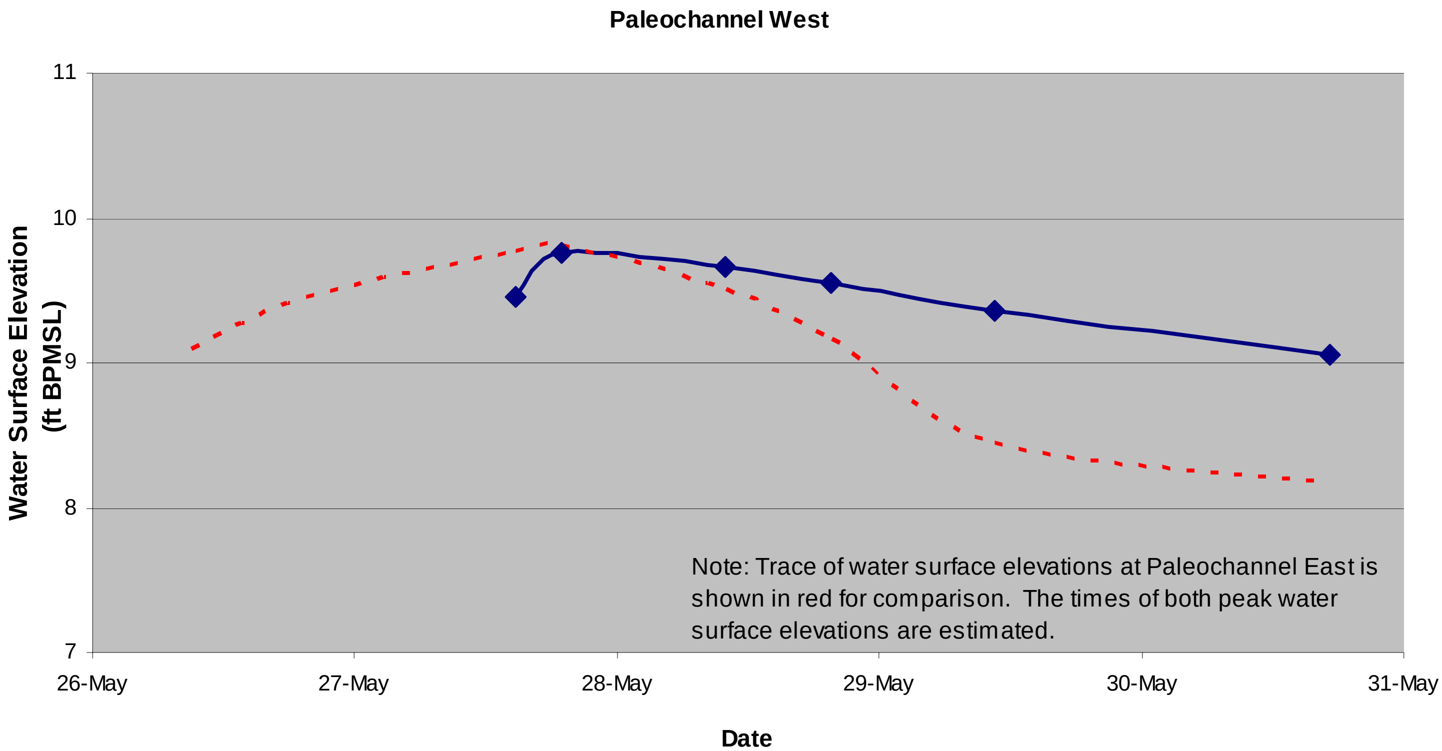
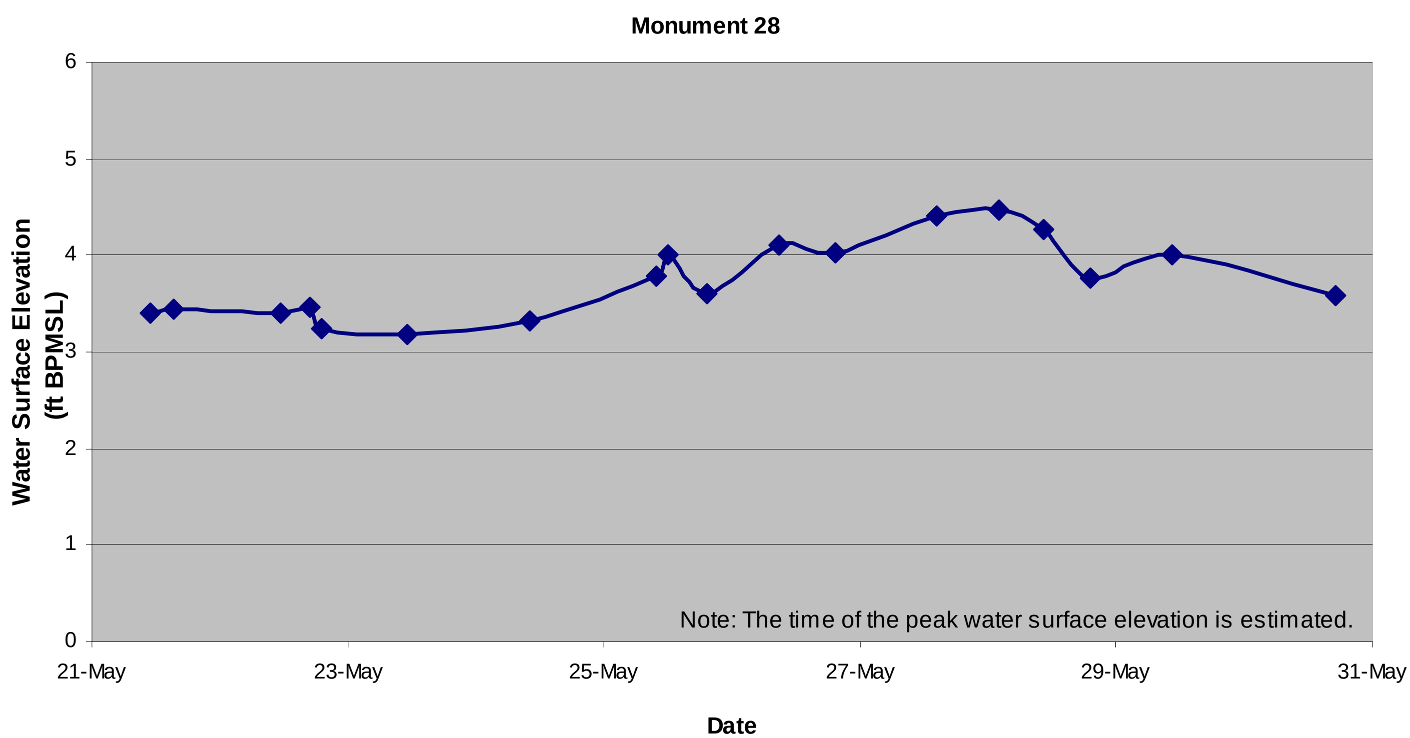


Table 3-8 Monument 28, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
5/21/04 10:50 AM	3.41	Flow over intact channel ice.
5/21/04 3:20 PM	3.45	
5/22/04 11:18 AM	3.41	
5/22/04 5:00 PM	3.47	Main channel covered by ice.
5/22/04 7:04 PM	3.25	
5/23/04 11:00 AM	3.18	
5/24/04 10:05 AM	3.33	High winds, water surface elevation +/- 0.05'. Measurement made using a stilling tube.
5/25/04 9:42 AM	3.78	Windy, water surface elevation +/- 0.05'. Measurement made using a stilling tube.
5/25/04 12:00 PM	4.01	
5/25/04 7:10 PM	3.60	
5/26/04 8:50 AM	4.11	High winds, water surface elevation +/- 0.05'. Measurement made using a stilling tube.
5/26/04 7:09 PM	4.02	High winds, water surface elevation +/- 0.05'. Measurement made using a stilling tube.
5/27/04 2:10 PM	4.41	Windy, water surface elevation +/- 0.05'. Measurement made using a stilling tube.
High Water Mark	4.47	Peak water surface elevation occurred on May 28 at approximately 2 a.m.
5/28/04 10:24 AM	4.27	
5/28/04 7:03 PM	3.77	
5/29/04 10:20 AM	4.00	
5/30/04 4:55 PM	3.59	

Notes:
1. Elevations are based on an elevation of 3.66 feet BPMSL for Monument 28, verified by Kuukpik/LCMF, Inc. in 2003.
2. Coordinates for Monument 28 are N70° 25' 32.0" W151° 04' 01.2" (NAD 83), by Garmin III Plus GPS.



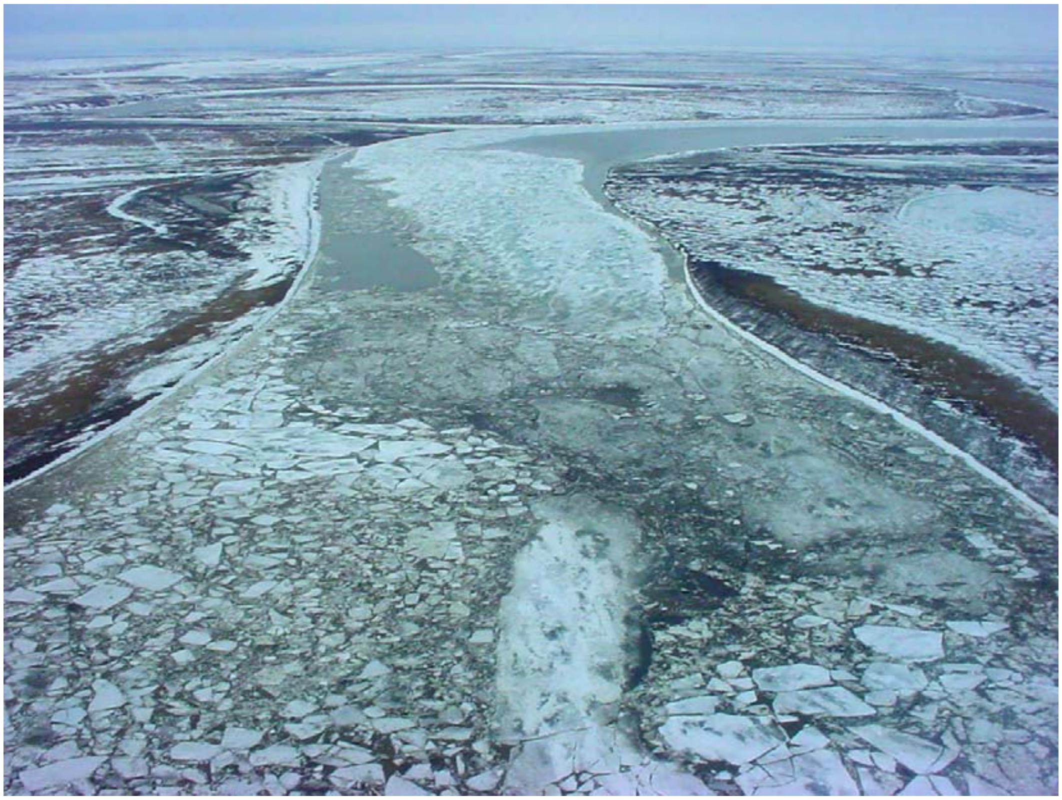


Photo 3-1 The leading edge of the Ocean Point ice jam looking downstream. May 22, 2004.

Photo 3-2 Floating ice bridged at the entrance to the East Channel. May 21, 2004.

Photo 3-3 Looking south along the Nigliq Channel in the vicinity of the proposed bridge location near Monument 23. May 21, 2004.

Photo 3-4 Looking south along the Nigliq Channel near Monument 23 approximately five days after the arrival of floodwaters. May 26, 2004.

Photo 3-5 Looking north across the East and West Paleochannels area. The Nigliq Channel is on the extreme right. May 28, 2004.

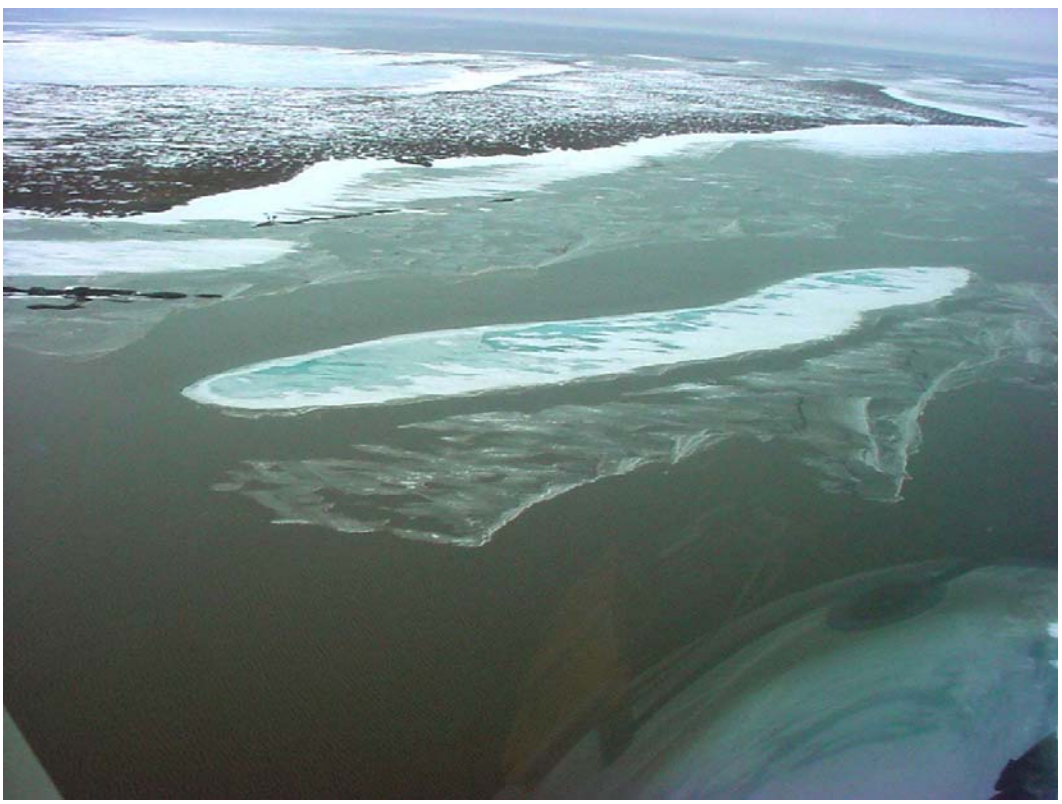


Photo 3-6 Detail of the East and West Paleochannel monitoring sites. May 28, 2004.

4.0 2004 Fish Creek Basin Spring Breakup Summary

The timing of the 2004 spring snowmelt in the Fish Creek basin was similar to that observed during 2003 in that the first observation of water on the temporary staff gages occurred across a span of approximately six days. Flowing water was first noted on Judy Creek and on Fish Creek below the Fish-Judy confluence on May 29. Flow on Fish Creek above the Fish-Judy confluence began on June 2. Flow down the Ublutuoch River began two days later on June 4.

Backwater effects of flow from both Judy Creek and the Nigliq Channel of the Colville River were noted in the early stages of breakup at several monitoring sites. Gages at Mile 1.9 on the lower Ublutuoch River were inundated as early as May 29 by backwater from Judy Creek. Gages at Fish Creek Mile 0.7 near Fish Creek's outfall at Harrison Bay were inundated as early as May 26 by flow from the Nigliq Channel.

Discussions of breakup of the streams in the Fish Creek basin are provided below in chronological order according to when water was first observed. At the completion of the monitoring program, the gages were marked with snow poles and left in place. Water surface elevation and observation records for temporary staff gages in the Fish Creek basin are shown on Tables 4-1 through 4-8.

4.1 2004 Spring Breakup on Fish Creek

4.1.1 Fish Creek – Water Surface Elevations and Observations

Judy Creek was the first stream to begin flowing in the Fish Creek basin. Water surface elevation measurements on Fish Creek began on May 29 when flows originating in the Judy Creek tributary were noted on the gages at monitoring locations Fish 10.9, 10.3, 4.0, and 0.7. Flow in Fish Creek proper was not observed until noon on June 2. Measurements on Fish Creek continued until June 10.

The peak stage at Fish 0.7 occurred on the morning of May 30 at an elevation of 4.53 feet. The relatively early occurrence of the peak stage at Fish 0.7 compared to monitoring stations further upstream on Fish Creek was a result of backwater effect from peaking floodwaters at the mouth of the Colville River. Additionally, northeast to southwest winds likely had an effect at the mouth of Fish Creek.

The peak stage occurred at Fish Creek 10.9 and 10.3 in the early morning of June 7 at elevations of 9.65 and 9.15 feet, respectively. Numerous preliminary peaks on the rising limb of the hydrographs at those locations were the result of the formation and subsequent release of several localized ice jams. An ice jam on June 3 located at the Fish 10.3 monitoring site caused significant backwater and an accompanying preliminary peak at the Fish 10.9 site that was not reflected in the hydrograph at Fish 10.3. Peak stage occurred at Fish 4.0 on the morning of June 7 at an elevation of 5.34 feet.

The peak water surface elevation in Fish Creek typically occurs after the channelfast bottom ice has lifted and the 2004 breakup was no exception. By June 7, the majority of the channelfast ice in the vicinity of the Fish Creek monitoring stations had become buoyant and was floating in the channel. Intact floating channel ice, both moving and stationary, likely had some affect on the observed water surface elevations. As was previously discussed, formation and release of ice jams also likely affected localized water surface elevations.

Photographs 4-1 through 4-5 show the progression of breakup on Fish Creek.

4.2 2004 Spring Breakup on the Ublutuoch River

4.2.1 Ublutuoch River – Water Surface Elevations and Observations

Water surface elevation monitoring on the Ublutuoch River began on May 29 at gages located at Ublutuoch 1.9. The water on the gages at Ublutuoch 1.9 was not the result of flow from the Ublutuoch River, but rather from flows over intact channel ice on Fish and Judy Creeks that had backed up into the lower Ublutuoch channel. On June 1, the leading edge of breakup flow on the Ublutuoch River proper was observed approximately 10 air miles upstream from the southernmost Ublutuoch staff gages located at the Ublutuoch mile 6.8 monitoring site. Water surface elevation measurements at Ublutuoch 6.8 began three days later.

Photographs 4-6 through 4-10 show the progression of breakup on the Ublutuoch River, primarily at the mile 6.8 bridge site.

Peak stage at the Ublutuoch RM 6.8 upstream and downstream sites occurred in the early morning of June 6 at elevations of 10.50 feet and 10.31 feet, respectively. At the Ublutuoch RM 1.9 upstream and downstream sites, peak stage occurred on the afternoon of June 7 at elevations of 7.43 feet and 7.55 feet, respectively. Bottomfast channel ice was intact at both monitoring locations at the time the peak stage occurred and the peak water surface elevations were therefore considered ice-affected. Numerous preliminary peaks on the rising limb of the hydrographs at Ublutuoch 6.8 Upstream and Ublutuoch 6.8 Downstream were the result of the formation and subsequent release of several localized ice jams that affected both monitoring sites.

The peak stage at Ublutuoch RM 1.9 occurred less than twelve hours after the peak water surface elevation at the Fish Creek 10.9 and 10.3 monitoring sites were recorded. It is likely that the flooding conditions on lower Fish Creek produced backwater effects on the lower Ublutuoch River that to some degree affected the timing and elevation of the peak water surface at Ublutuoch RM 1.9.

A comparison of the water surface elevations at the Ublutuoch 1.9 Upstream and Downstream monitoring sites suggests that the water elevations at the downstream gages were consistently higher than water elevations at the upstream gages. This inconsistency is believed to be a result of inaccurate reference datum elevations of the two benchmarks used to establish the Ublutuoch 1.9 Upstream and Downstream staff gage elevations. Water surface elevation data at the Ublutuoch 1.9 Upstream and Downstream monitoring sites are presented on a provisional basis and their elevation accuracy should be considered as approximate. The probable reason for the benchmark datum inaccuracies is as follows.

4.2.1.1. Survey Uncertainty

Monitoring site elevations in the NPRA region in 2004 were established using numerous existing benchmarks each having been set by Lounsbury and LCMF using the bpmsl datum. Each of the benchmarks at the 2004 Fish Creek gaging locations were originally installed and surveyed by Lounsbury in 2001 and 2002. The elevations of the benchmarks used at these Fish Creek sites were not resurveyed in 2004 and it is probable that these benchmarks have been subjected to some degree of frost jacking. Benchmarks used to establish monitoring site elevations at the Ublutuoch River were originally installed and surveyed by LCMF in the spring of 2003. LCMF resurveyed these markers using either level loop survey or static GPS survey in July and August 2003.

The water surface elevation data presented in this report is as accurate as the basis of elevation on which each benchmark elevation is based. At Ublutuoch RM 1.9, by using different benchmarks, water surface elevations were measured with insufficient precision to determine the slope of the water surface along the 1,400-foot segment of the river. Each gage set has been found to have acceptable accuracy for use in the basin, however the accuracy between benchmarks has been found to deviate by +/- 0.25 foot. The elevations of Ublutuoch 1.9 Downstream gaging site and the Ublutuoch 1.9 Upstream gaging site are therefore presented with limited accuracy (See Tables 4-7 and 4-8). Benchmarks UBN-1 and UBN-3 were used as the basis of elevations to establish elevation of staff gages at 1.9 Upstream and 1.9 Downstream, respectively. These benchmarks were surveyed by LCMF in August 2003 using static GPS survey techniques with an accuracy of +/- 0.25 foot. The average difference in water surface elevation readings at the two gaging sites was 0.11 foot, well within the error range associated with the static GPS method of survey.

It is understood that in 2005 additional survey control will be established in NPRA to provide a more accurate basis of elevation for future hydrology studies.

4.2.2 Ublutuoch River – Discharge Measurements

Direct discharge measurements were made on the afternoon of June 5 and the morning of June 6 at the Ublutuoch 6.8 monitoring site. Field discharge calculation forms are provided in Appendix C.

The purpose of measuring discharge directly at Ublutuoch 6.8 was to add to the overall understanding of the channel at the proposed bridge crossing. The collection of direct-measurement discharge data as close as possible to the peak stage was completed to assist in determination of peak discharge, which has typically been measured by indirect methods. The direct discharge measurements enabled a back-calculation of channel Manning’s roughness coefficient, n, using the Manning Equation, resulting in a more accurate indirect measurement of peak discharge. This is particularly important in a river like the Ublutuoch where peak discharge has always occurred over intact channel ice. Because the nature and extent of the ice changes constantly, its roughness and the roughness of the channel is also constantly changing. Discharge measurements on consecutive days enabled tracking of these changes.

The intent was to perform the discharge measurements as near as possible to the peak water surface elevation. The peak water surface elevation occurred at the Ublutuoch 6.8 in the early morning of June 6. Two discharge measurements essentially bracketed the peak and both discharge measurements were completed during periods in which the river stage at the measurement cross section was falling.

4.2.2.1. Measured Discharge

On June 5, discharge in the Ublutuoch River at mile 6.8 was measured to be 2,800 cubic feet per second (cfs) over a frozen channel with intact low-water bottomfast snow and ice. The active channel was 675 feet wide and the average water velocity across the measurement section was 1.34 feet per second (fps). Field observations made after the discharge measurement suggested that bottomfast channel ice upstream from the measurement section were beginning to become buoyant. Observations identified several large ice chunks rising from the bottom, breaking the water surface and floating downstream.

On June 6, measured discharge at mile 6.8 had decreased to about 2,550 cfs. Despite observations the previous day that suggested the channel ice might have cleared overnight, soundings on June 6 indicated that flow in the channel at the measurement section was still occurring over intact bottomfast snow and ice. The active channel had widened to 688 feet due to snowmelt on the right bank, and average velocity had decreased to 1.21 fps. No further indications of rising chunks of bottomfast ice were observed. However, floating ice was consistently moved through the section during the course of the measurement.

4.3 Ublutuoch River – Peak Discharge

Peak discharge on the Ublutuoch River at river mile 6.8 was estimated using Normal Depth computations. Water surface elevation and slope data were obtained from the measurements made at temporary gages at Ublutuoch RM 6.8U and Ublutuoch RM 6.8D. Cross-section geometry was based on cross-sections surveyed by LCMF in 2003 (Kuukpik/LCMF, 2003b), see Appendix D.

During spring breakup at mile 6.8 on the Ublutuoch River, flow was initially conveyed over drifted snow within the floodplain and bottomfast, low water channel ice and windblown snow that, prior to the arrival of floodwaters, was up to nine feet thick at the channel’s deepest point.

The formation of this in-channel ice and snow began during low water conditions at freeze-up the previous fall. It was continuously deepened and compacted as snow was blown in during the course of the winter. Soundings made on June 5 and June 6 indicated that the drifted snow within the main channel was degraded at a rate that averaged about 1.2 feet per day after inundation by flowing water. Therefore the ice and snow remained in place to some degree through the end of breakup observations.

Observations of breakup flows occurring over drifted snow and low water channel ice on the Ublutuoch River in 2004 are consistent with observations made during spring breakup in 2001 and 2002 at locations further upstream (URS 2001, 2003), and at mile 6.8 in 2003. The presence of snow and bottomfast ice in the channel of the Ublutuoch River has had a significant impact on river hydraulics during breakup each year. The ice and snow elevated the riverbed and thus raised the peak water surface elevation to a level greater than would be expected during snow-free and ice-free conditions. The snow and ice also affected the size and shape of the channel, the slope of the channel bottom, the water surface, and the roughness of the channel. Because the ice and snow were constantly degraded during breakup, factors such as channel geometry, slope, and roughness changed continuously throughout breakup. These dynamic characteristics of the channel were considered in the computations of discharge for the 2004 spring breakup on the Ublutuoch River, however, in some cases the magnitude and extent of the change was not directly measured.

In order to account for the effects of bottomfast low water channel ice and snow during breakup, conditions of the channel were estimated at various times during breakup. The conditions included roughness, ice surface elevation, extrapolated rates of ice and snow loss, and also included summer channel survey geometry review. Direct discharge measurements on June 5 and June 6 at the Ublutuoch RM 6.8U monitoring site were used to determine channel bottom ice surface elevations and an ice loss rate. The channel bottom ice surface elevations were compared to the ice-free cross-section data for the Ublutuoch RM 6.8U site. A snow/ice loss rate was calculated using soundings made on June 5 and 6 and the rate was applied to the channel bottom ice and snow surface elevations in order to extrapolate channel geometry prior to the June 5 measurement and after the June 6 discharge measurement.

Channel hydraulic roughness values were estimated based on the two discharge measurements made on June 5 and 6. Roughness values were back-calculated from the discharge measurement data using Normal Depth computations. Back-calculated channel roughness values from the June 5 measurement were applied to discharge estimates for water surface elevation data collected up to and including June 5. Channel roughness values back-calculated from the June 6 discharge measurement were applied to estimates from water surface elevation data collected on or after June 6.

The 2004 spring breakup peak discharge at RM 6.8 on the Ublutuoch River is estimated to have been approximately 5,600 cfs, and to have occurred early on the morning of June 8, approximately 48 hours after the peak stage. Based on a linear interpolation between discharge values predicted for the 10- and 25-year recurrence interval flood events in the most recent flood frequency analysis (URS, 2003), it is estimated that the 2004 spring breakup peak discharge had a recurrence interval of approximately twenty years. In other words, based on the 2003 URS regression equations, the peak discharge has only a five percent chance of being equaled or exceeded in any given year.

Recurrence intervals and associated floods calculated for the Ublutuoch River at river mile 6.8 were provided in Section 2.0. Table 2-3 shows a Summary of Breakup Data Obtained on the Ublutuoch River at river miles 6.8 and 13.7. Based on the 2003 flood frequency analysis, the peak 2003 spring discharge was estimated to be a fifteen-year event. Based on limited historical water elevation data and published peak discharge values, the 2003 and 2004 Ublutuoch River breakup events appear to be of greater magnitude than 2001 and 2002 events. While it is possible for the 2003 and 2004 flood events to have been fifteen and twenty year flood events, it is also possible that the 2003 flood frequency analysis under predicts the annual peak discharge of the Ublutuoch River, because of the limited data these were developed from.

Table 4-1 Fish Creek Mile 10.9, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
5/29/04 5:16 PM	8.77	Flow over intact ice/snow. Flow originating in Judy Creek.
5/30/04 7:00 AM	8.89	Flow over intact ice/snow. Flow originating in Judy Creek.
5/30/04 3:08 PM	8.21	Flow over intact ice/snow. Flow originating in Judy Creek.
5/30/04 11:45 PM	8.29	
5/31/04 9:25 AM	8.04	Flow over intact ice/snow. Flow originating in Judy Creek.
5/31/04 11:00 PM	8.62	
6/1/04 10:15 AM	8.52	Ice/Snow degrading. Ice floating through section
6/1/04 5:25 PM	8.25	Ice/Snow degrading. Ice floating through section
6/2/04 11:23 AM	8.31	Fish Creek above Fish/Judy confluence flowing
6/3/04 10:18 AM	8.67	Significant floating ice,
6/3/04 11:00 PM	9.45	Preliminary peak caused by ice jam downstream near Fish Creek Mile 10.3 gages.
6/4/04 10:52 AM	9.26	Ice floating through section, some minor ice jamming
6/4/04 5:59 PM	9.22	
6/5/04 10:00 AM	9.43	No floating ice in section
6/6/04 1:47 PM	9.60	No floating ice in section, windy conditions
High Water Mark	9.65	The peak water surface elevation occurred on June 7 at approximately 2am.
6/7/04 2:38 PM	9.34	Noted HWM occurring previous night
6/8/04 10:23 AM	9.07	Stage dropping
6/9/04 10:33 AM	8.82	Stage dropping
6/10/04 8:39 AM	8.39	Significant stage drop

Notes:
1. Elevations are based on an elevation of 12.30 feet BPMSL for temporary monument C-2 established by Lounsbury in 2002.
2. Coordinates for Fish Creek 10.9 are N 70^{o} 18' 46.5" W 151^{o} 24' 07.8"(NAD 83), by Garmin III Plus GPS.

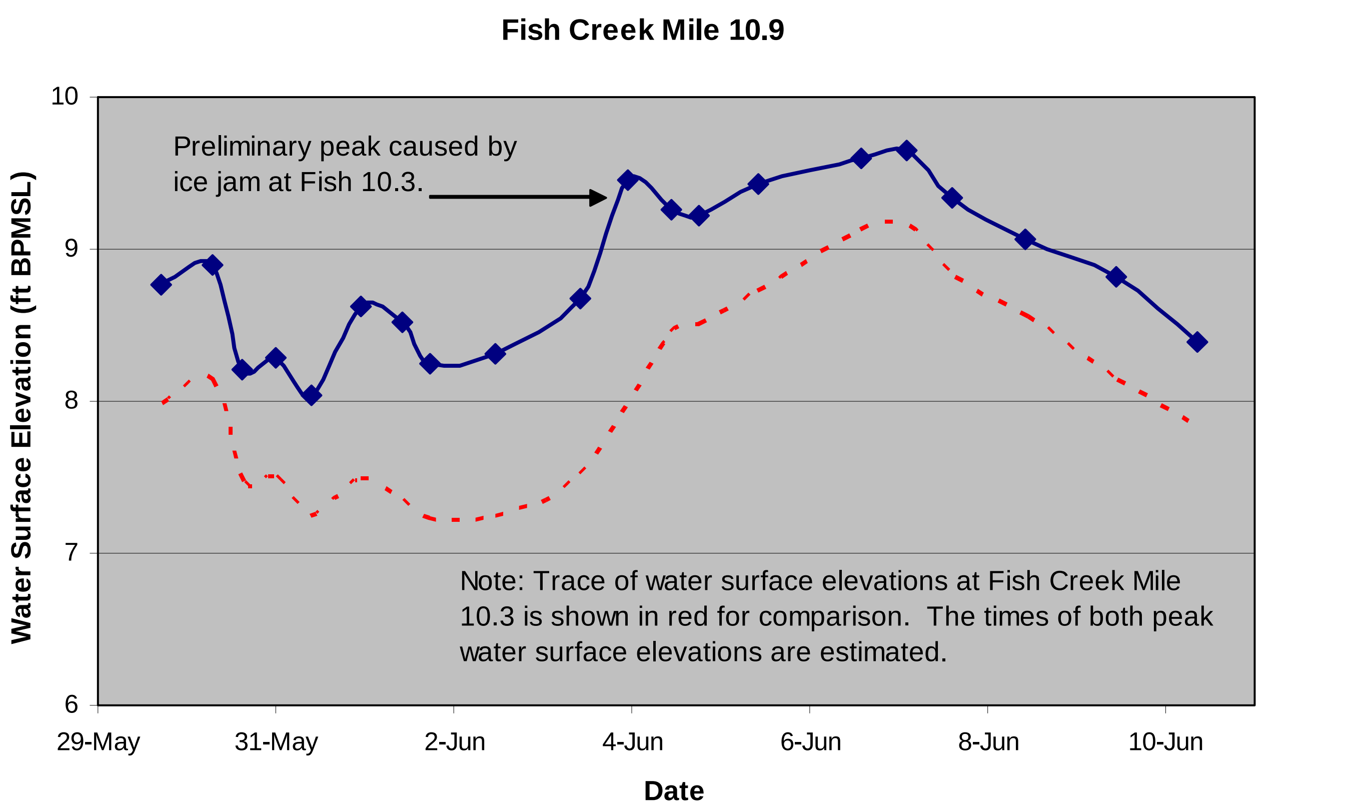


Table 4-2 Fish Creek Mile 10.3, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
5/29/04 5:23 PM	7.99	Flow over intact ice/snow. Flow originating in Judy Creek.
5/30/04 7:00 AM	8.14	Flow over intact ice/snow. Flow originating in Judy Creek.
5/30/04 3:16 PM	7.47	Flow over intact ice/snow. Flow originating in Judy Creek.
5/30/04 11:45 PM	7.51	
5/31/04 9:34 AM	7.25	Flow over intact ice/snow. Flow originating in Judy Creek.
5/31/04 11:00 PM	7.49	
6/1/04 10:23 AM	7.35	Ice/Snow degrading. Ice floating through section
6/1/04 5:08 PM	7.24	Ice/Snow degrading. Ice floating through section
6/2/04 11:05 AM	7.25	Fish Creek above Fish/Judy confluence flowing
6/3/04 9:55 AM	7.52	Significant floating ice, large localized jam at 10.3
6/4/04 10:48 AM	8.46	Ice through section, some bottomfast ice
6/4/04 6:07 PM	8.51	
6/5/04 10:06 AM	8.73	Significant amounts of ice in section
6/6/04 1:51 PM	9.13	Little floating ice in section, windy conditions
High Water Mark	9.15	The peak water surface elevation occurred on June 7 at approximately 2am.
6/7/04 2:42 PM	8.82	Noted HWM occurring previous night
6/8/04 10:28 AM	8.56	Stage dropping
6/9/04 10:40 AM	8.14	Stage dropping
6/10/04 8:45 AM	7.84	Significant stage drop

Notes:
1. Elevations are based on an elevation of 12.30 feet BPMSL for temporary monument C-2 established by Lounsbury in 2002.
2. Coordinates for Fish Creek 10.3 are N 70° 19' 04.3" W 151° 22' 52.0" (NAD 83), by Garmin III Plus GPS.

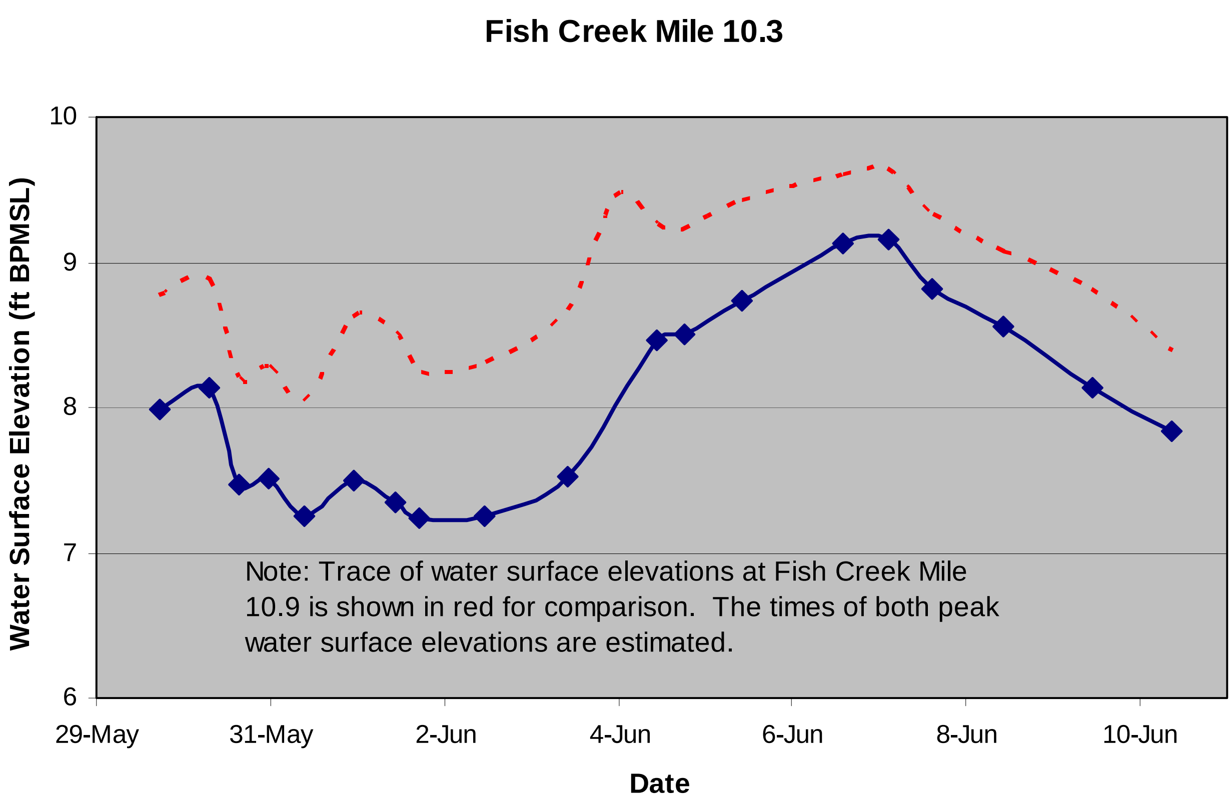


Table 4-3 Fish Creek Mile 4.0, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
5/29/04 5:29 PM	4.84	Flow over intact ice/snow. Flow originating in Judy Creek.
5/30/04 7:00 AM	4.92	Flow over intact ice/snow. Flow originating in Judy Creek.
5/30/04 3:44 PM	4.75	Flow over intact ice/snow. Flow originating in Judy Creek.
5/30/04 11:45 PM	4.80	
5/31/04 9:48 AM	4.45	Flow over intact ice/snow. Flow originating in Judy Creek.
6/1/04 10:09 AM	4.33	
6/1/04 5:35 PM	4.34	Ice/Snow degrading. Ice floating through section
6/2/04 10:51 AM	4.33	Fish Creek above Fish/Judy confluence flowing
6/3/04 9:30 AM	4.33	Significant floating ice
6/4/04 11:02 AM	4.43	
6/4/04 6:10 PM	4.63	
6/5/04 10:17 AM	5.05	
6/6/04 1:39 PM	5.21	Windy conditions
High Water Mark	5.34	The peak water surface elevation occurred on June 7 at approximately 6am.
6/7/04 2:27 PM	5.26	Read with binoculars, no check for HWM
6/8/04 10:15 AM	5.07	Read with binoculars, no check for HWM
6/8/04 10:15 AM	5.10	
6/9/04 10:25 AM	4.82	Stage dropping
6/10/04 8:34 AM	4.30	Significant stage drop

Notes:
1. Elevations are based on an elevation of 24.19 feet BPMSL for temporary monument L01-28-24, established by Lounsbury in 2002.
2. Coordinates for Fish Creek 4.0 are N 70° 21' 32.4" W 151° 19' 13.9" (NAD 83), by Garmin III Plus GPS.

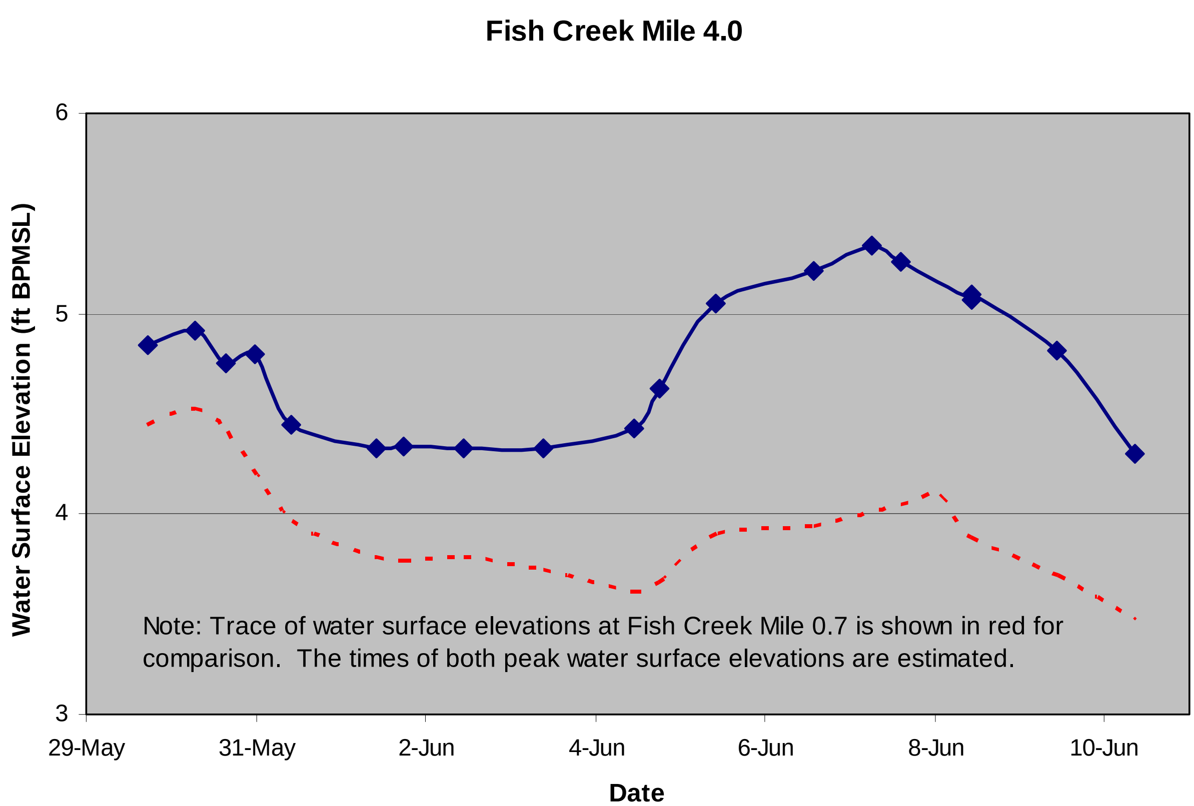


Table 4-4 Fish Creek Mile 0.7, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
5/29/04 5:34 PM	4.45	Flow over intact ice/snow. Possible backwater from Nigliq Channel
High Water Mark	4.53	The peak water surface elevation occurred on May 30 at approximately 7am. Nigliq backwater.
5/30/04 3:51 PM	4.41	Ice/snow degrading, floating. Flow originating in Judy Creek/Nigliq backwater.
5/31/04 9:57 AM	3.97	Ice/Snow degrading. Ice floating through section
6/1/04 10:01 AM	3.79	Ice/snow degrading, floating. Flow originating in Judy Creek/Nigliq backwater.
6/1/04 5:44 PM	3.77	Ice/Snow degrading. Ice floating through section
6/2/04 10:35 AM	3.79	Fish Creek above Fish/Judy confluence flowing
6/3/04 9:23 AM	3.72	Significant floating ice
6/4/04 11:08 AM	3.61	
6/4/04 6:18 PM	3.66	
6/5/04 10:26 AM	3.90	Stage rising somewhat
6/6/04 1:35 PM	3.94	Windy conditions, little or no floating ice
6/7/04 2:21 PM	4.05	Windy conditions, little or no floating ice
6/8/04 1:04 AM	4.09	
6/8/04 10:04 AM	3.89	Noted possible secondary peak stage occurring previous night
6/9/04 10:19 AM	3.70	Stage dropping
6/10/04 8:28 AM	3.47	Stage dropping steeply

Notes:
1. Elevations are based on an elevation of 3.90 feet BPMSL for temporary monument D1A South, established by Lounsbury in 2002.
2. Coordinates for Fish Creek 0.7 are N 70° 22' 17.2" W 151° 15' 20.9" (NAD 83), by Garmin III Plus GPS.

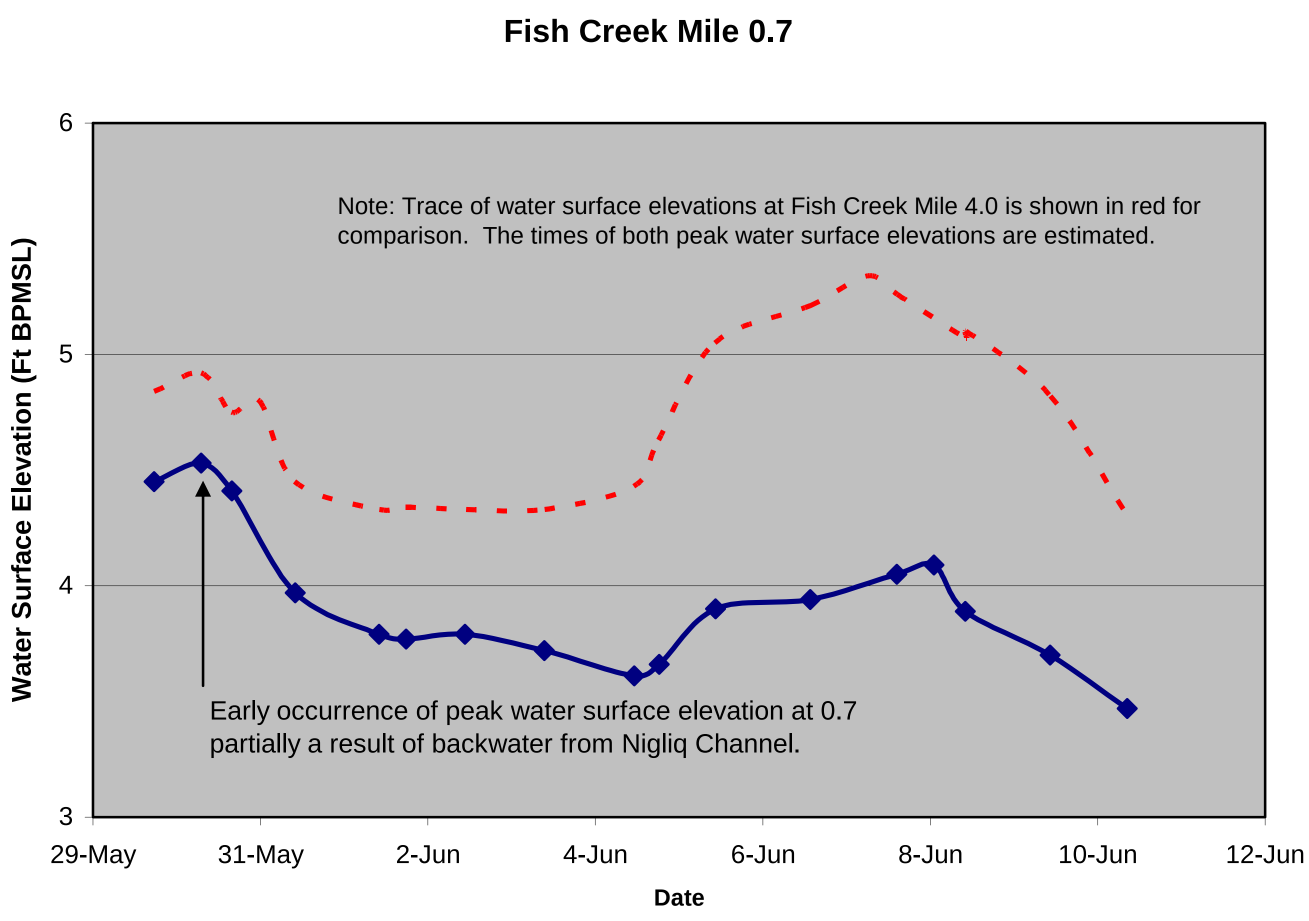


Table 4-5 Ublutuoch River Mile 6.8 Upstream, Water Surface Elevations and Observations

Date	Water Surface Elevation (feet BPMSL)	Observations
6/4/04 10:20 AM	10.33	All gages except TBM C destroyed by floating ice
6/4/04 4:40 PM	10.39	Heavy ice floating through section
6/5/04 11:03 AM	10.41	Reading prior to June 5 discharge measurement
6/5/04 12:13 PM	10.39	Reading prior to June 5 discharge measurement
6/5/04 1:35 PM	10.36	Reading prior to June 5 discharge measurement
6/5/04 2:50 PM	10.32	Reading after Q measurement
High Water Mark	10.50	The peak water surface elevation occurred on June 6 at approximately 1am.
6/6/04 10:40 AM	9.92	Reading prior to June 6 discharge measurement
6/6/04 12:37 PM	9.79	Reading after Q measurement
6/7/04 3:07 AM	10.15	Time is approximate
6/7/04 3:07 PM	9.73	Possible secondary HWM
6/8/04 10:49 AM	9.69	No new HWM, stage appears to be dropping
6/9/04 11:26 AM	8.45	Significant drop in stage
6/10/04 9:50 AM	7.36	Elevation by surveyed level loop, stage dropping

Notes:
1. Elevations are based on an elevation of 10.96 feet BPMSL for temporary monument UBS-2, established by Kuukpik/LCMF, Inc. in August 2003.
2. Coordinates for Ublutuoch River 6.8 Upstream are N70° 17' 00.1" W151° 15' 30.3" (NAD 83), by Garmin III Plus GPS.

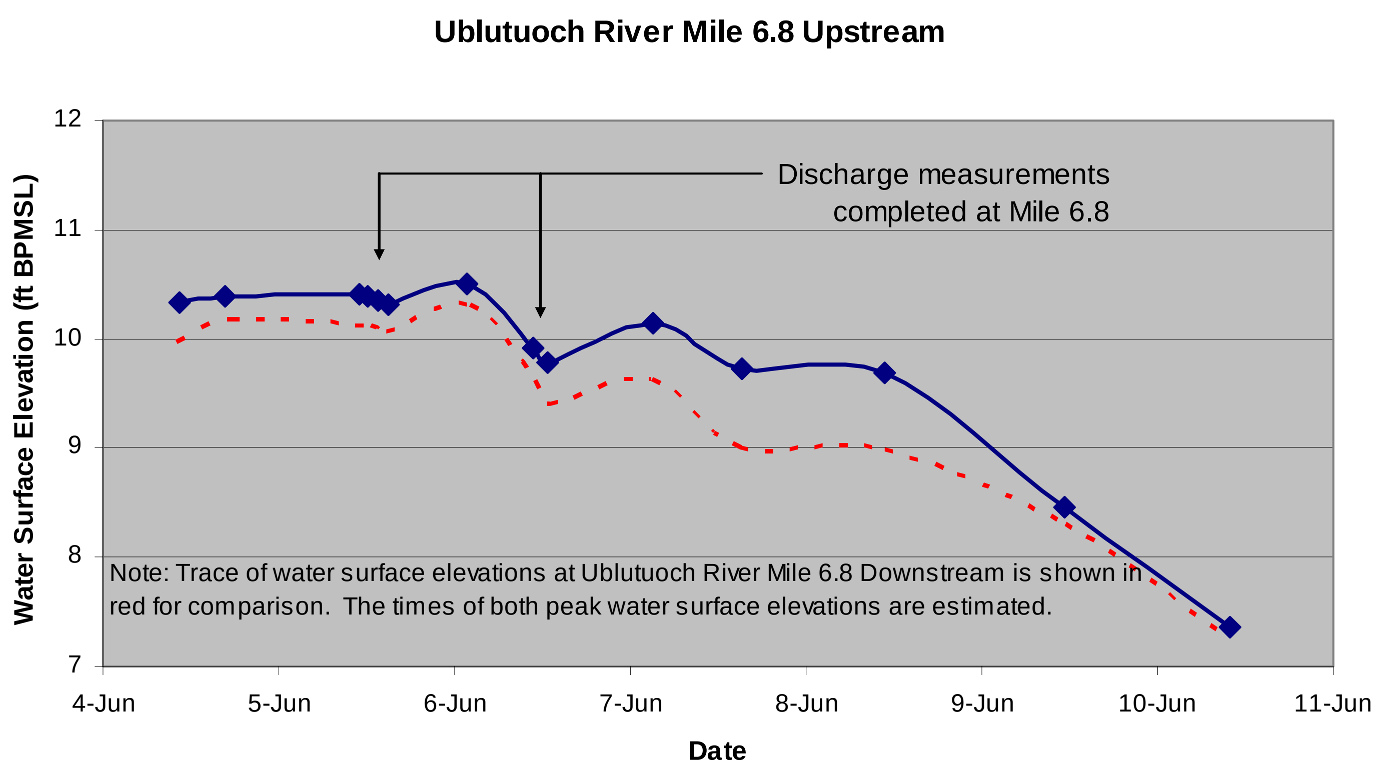


Table 4-6 Ublutuoch River Mile 6.8 Downstream, Water Surface Elevations and Observations

Date	Water Surface Elevation (feet BPMSL)	Observations
6/4/04 10:15 AM	9.97	Heavy ice floating through section
6/4/04 5:30 PM	10.18	Heavy ice floating through section
6/5/04 12:19 PM	10.12	Reading prior to June 5 discharge measurement at 6.8 bridge site
6/5/04 2:48 PM	10.07	Reading after Q measurement at 6.8 bridge site
High Water Mark	10.31	The peak water surface elevation occurred on June 6 at approximately 1am.
6/6/04 10:53 AM	9.62	Reading prior to June 6 discharge measurement at 6.8 bridge site
6/6/04 12:52 PM	9.41	Reading after Q measurement at 6.8 bridge site
6/7/04 2:52 AM	9.64	Time is approximate
6/7/04 2:52 PM	9.01	Possible secondary HWM
6/8/04 10:43 AM	8.98	No new HWM, stage appears to be dropping
6/9/04 11:20 AM	8.31	Elevation by surveyed level loop, stage dropping
6/10/04 9:20 AM	7.27	Elevation by surveyed level loop, stage dropping

Notes:
1. Elevations are based on an elevation of 9.28 feet BPMSL for temporary monument UBS-1, established by Kuukpik/LCMF, Inc. in August 2003.
2. Coordinates for Ublutuoch River 6.8 Downstream are N70° 17' 08.2" W151° 15' 45.5" (NAD 83), by Garmin III Plus GPS.

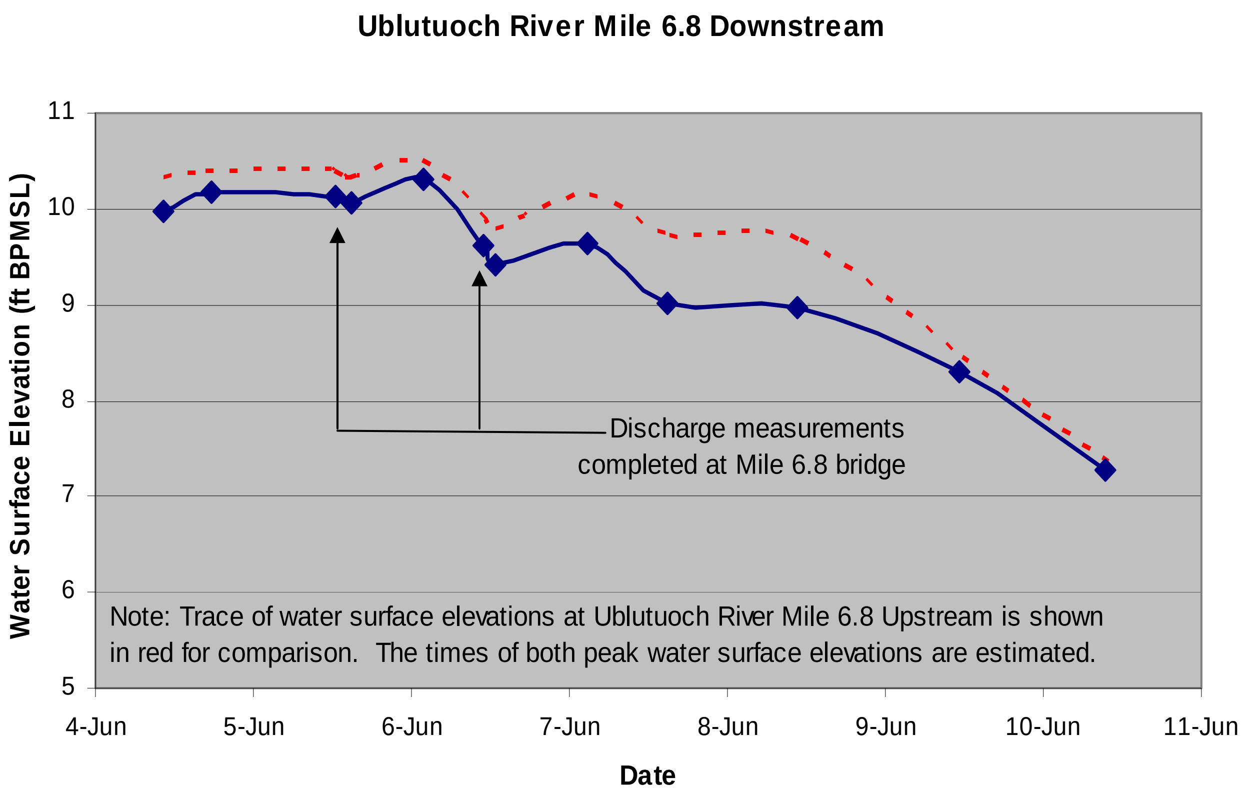


Table 4-7 Ublutuoch River Mile 1.9 Upstream, Water Surface Elevations and Observations

Date	Water Surface Elevation (feet BPMSL)	Observations
5/29/04 7:05 PM	5.76	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
5/30/04 2:53 PM	5.56	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
5/30/04 9:03 PM	5.92	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
5/31/04 9:03 AM	5.30	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
6/1/04 11:14 AM	5.23	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
6/1/04 5:55 PM	5.22	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
6/2/04 11:53 AM	5.23	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
6/3/04 10:33 AM	5.37	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
6/4/04 10:35 AM	6.00	Ublutuoch flowing well.
6/4/04 5:42 PM	6.58	Ice floating through section
6/5/04 9:52 AM	7.08	Ice floating through section
6/6/04 1:27 PM	7.23	Ice floating through section
High Water Mark	7.43	The peak water surface elevation occurred on June 7 at approximately 3 pm.
6/8/04 10:38 AM	7.14	Too deep to wade -read with binoculars
6/9/04 10:59 AM	6.64	Too deep to wade -read with binoculars
6/10/04 9:09 AM	6.24	Gages wind/wave washed, but stage obviously dropping

Notes:
1. Elevations are based on an elevation of 12.17 feet BPMSL for temporary monument UBN-1, established by Kuukpik/LCMF, Inc. in July 2003.
2. Coordinates for Ublutuoch River 1.9 Upstream are N70° 18' 15.8" W151° 19' 41.0" (NAD 83), by Garmin III Plus GPS.

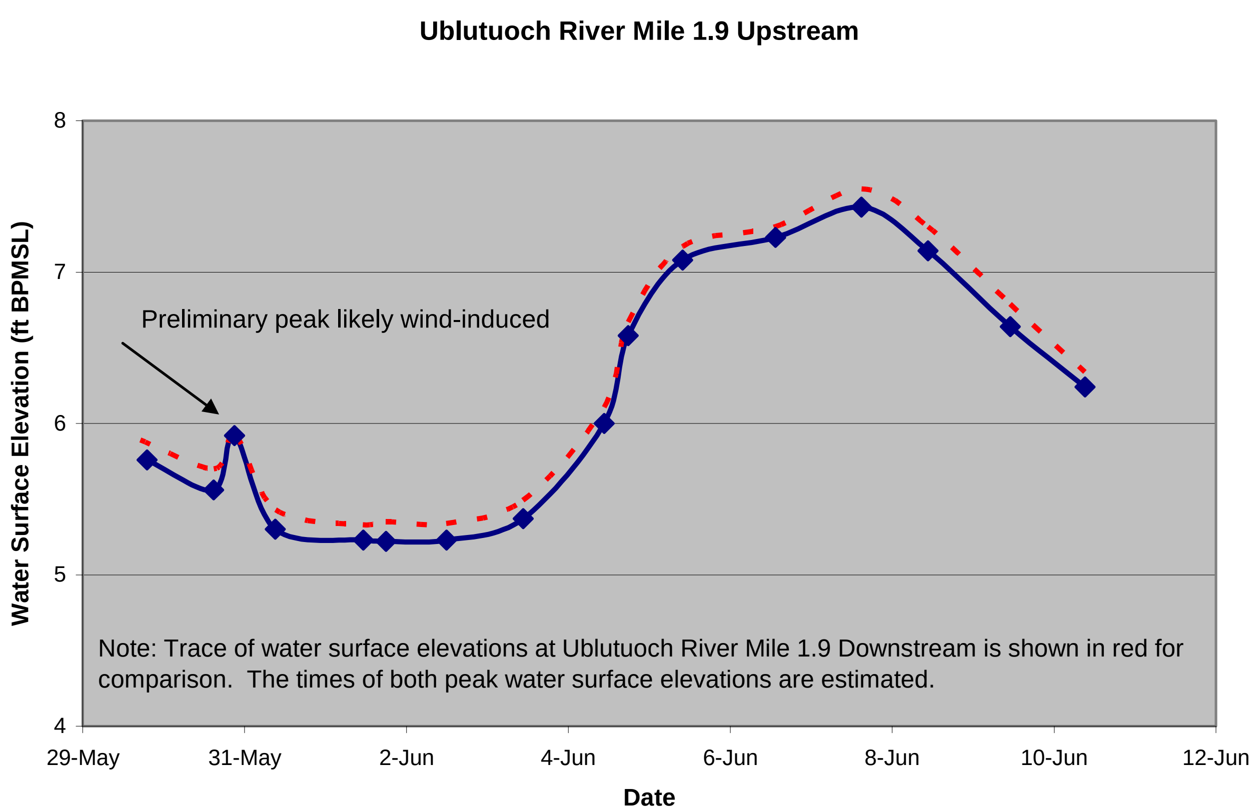


Table 4-8 Ublutuoch River Mile 1.9 Downstream, Water Surface Elevations and Observations

Date	Water Surface Elevation (feet BPMSL)	Observations
5/29/04 5:08 PM	5.89	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
5/30/04 2:58 PM	5.70	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
5/30/04 9:12 PM	5.92	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
5/31/04 9:12 AM	5.43	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
6/1/04 10:58 AM	5.33	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
6/1/04 5:50 PM	5.35	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
6/2/04 11:45 AM	5.34	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
6/3/04 10:27 AM	5.49	Water on gages due to backwater from Fish Creek. No flow on Ublutuoch.
6/4/04 10:40 AM	6.11	Ublutuoch flowing well.
6/4/04 5:45 PM	6.67	Ice floating through section
6/5/04 9:56 AM	7.17	Ice floating through section
6/6/04 1:30 PM	7.30	Ice floating through section
High Water Mark	7.55	The peak water surface elevation occurred on June 7 at approximately 3 pm.
6/8/04 10:35 AM	7.30	Too deep to wade -read with binoculars
6/9/04 10:57 AM	6.79	Too deep to wade -read with binoculars
6/10/04 9:01 AM	6.34	Gages wind/wave washed, but stage obviously dropping

Notes:
1. Elevations are based on an elevation of 5.65 feet BPMSL for temporary monument UBN-3, established by Kuukpik/LCMF, Inc. in July 2003.
2. Coordinates for Ublutuoch River 1.9 Downstream are N70° 18' 27.5" W151° 19' 57.5" (NAD 83), by Garmin III Plus GPS.

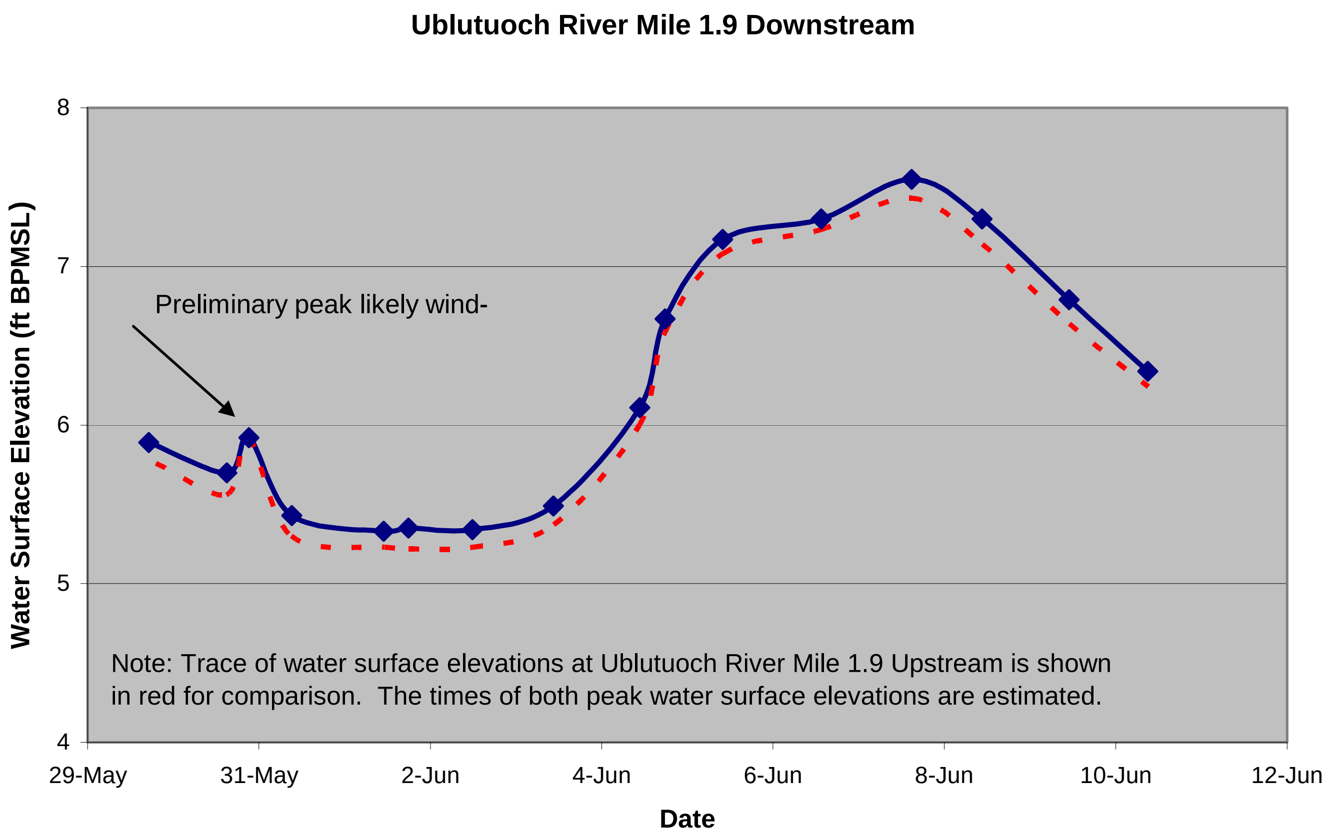


Photo 4-1 Water surface elevation measurements on Fish Creek began on May 29 when flows originating in the Judy Creek tributary were noted on the gages at monitoring locations downstream of the Fish/Judy confluence. Flow in Fish Creek proper was not observed until June 2. May 29, 2004.

Photo 4-2 Breakup flooding on Fish Creek was characterized by heavy floating ice and frequent ice jamming that affected localized water surface elevations at some monitoring stations. May 30, 2004.

Photo 4-3 The relatively early occurrence of the peak stage at Fish 0.7 was likely a result of backwater effect from peaking floodwaters at the mouth of the Colville River combined with high wind. Note wind-driven southerly swell. May 30, 2004.

Photo 4-4 Small ice jam at Fish 10.3 that affected localized water surface elevations at Fish 10.9 monitoring site. The Fish 10.3 gages were located downstream of the jam and water surface elevations there were not affected. June 3, 2004.

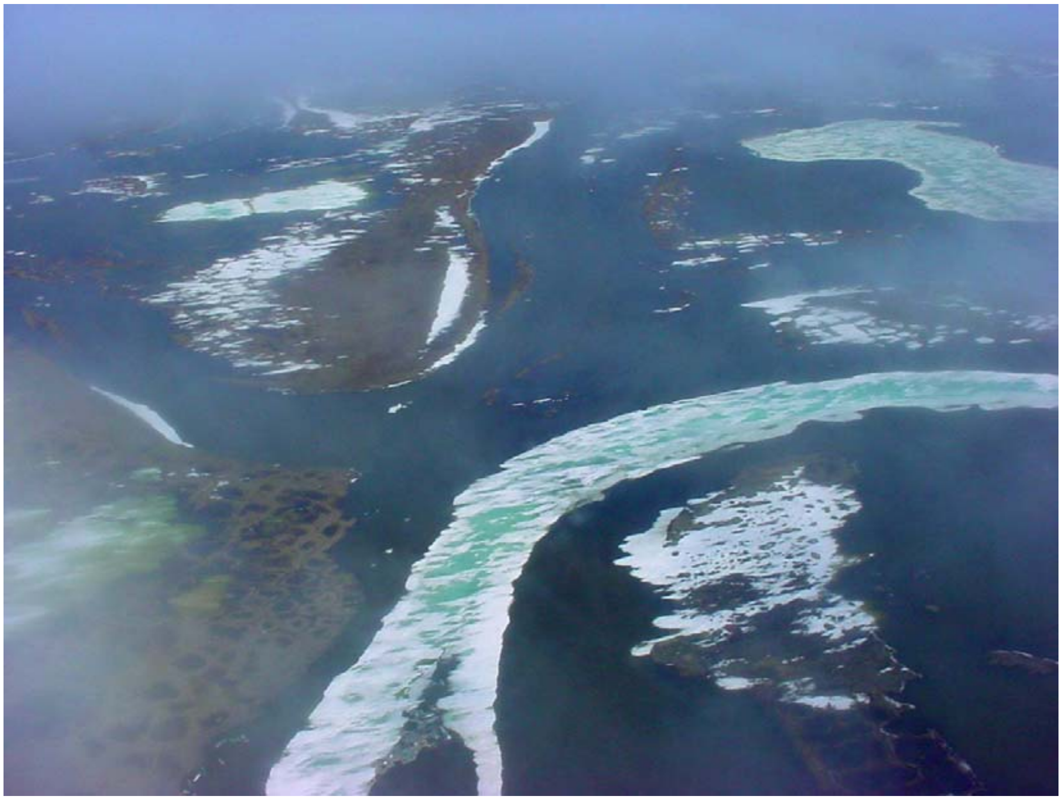


Photo 4-5 By June 7, the majority of the channelfast ice in the vicinity of the Fish Creek monitoring stations had become buoyant and was floating in the channel. June 8, 2004.

Photo 4-6 The water in the lower Ublutuoch River during the early stages of breakup was not flow from the Ublutuoch River itself, but rather backwater from flows over intact channel ice on Fish and Judy Creeks. Note that flooding from backwater extends to a point approximately one-quarter of a mile upstream of the gages (visible at lower left) at the Ublutuoch mile 1.9 monitoring site. May 30, 2004.

Photo 4-7 Leading edge of breakup floodwaters on the Ublutuoch River approximately 3.5 air miles upstream of the proposed bridge location at mile 6.8. June 3, 2004.

Photo 4-8 Less than 24 hours later, the leading edge had moved through the mile 6.8 bridge site (shown) and commingled with Fish Creek backwater in the lower portions of the Ublutuoch River. Flow at this point was over intact channel ice and snow at all monitoring sites. June 4, 2004.

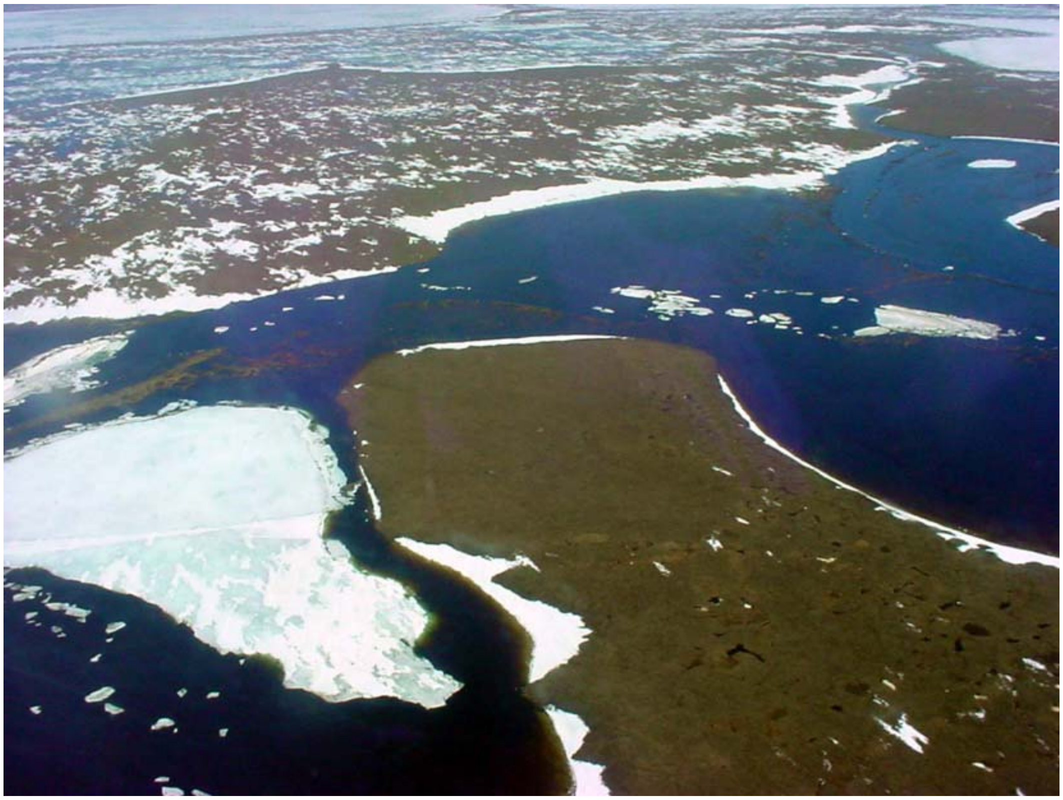


Photo 4-9 The discharge measurements conducted on June 5 and 6 on the Ublutuoch River were made on the day prior to and the day following the peak water surface elevation at the mile 6.8 bridge site (shown). June 6, 2004.

Photo 4-10 Water levels at the Ublutuoch bridge site (shown) dropped relatively quickly after the peak stage though small ice jams continued to cause localized, temporary water surface elevation increases that were reflected as secondary peaks on the hydrograph. June 9, 2004.

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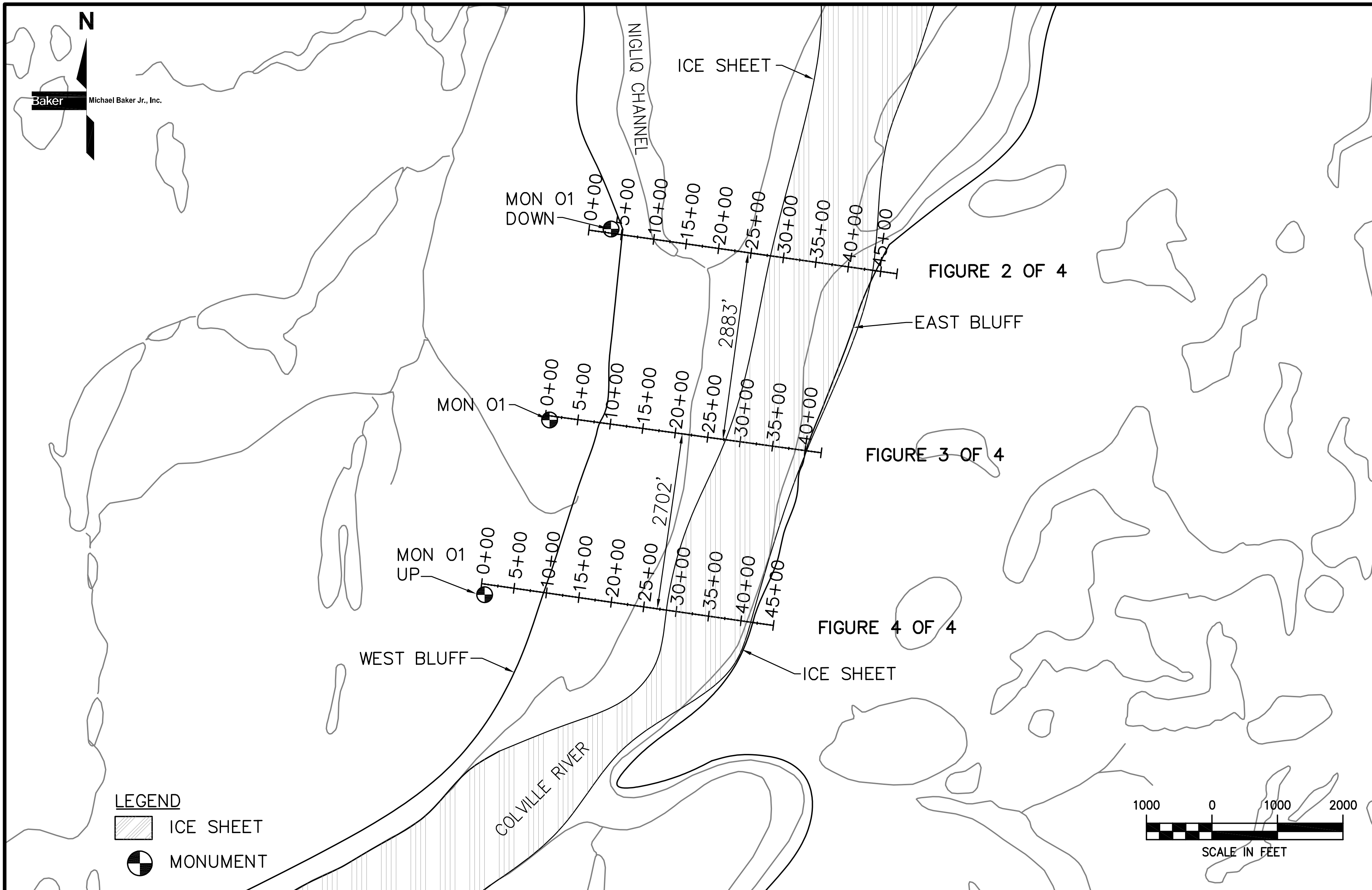
Appendix A Colville River Monument 01 Cross Sections Locations



ConocoPhillips

DATE:	12/07/04	PROJECT:	2004 BREAKUP STUDY
DRAWN:	WAP	FILE:	MON 01 CROSS SECTION
CHECKED:	MTA	SCALE:	SEE SCALE

Baker

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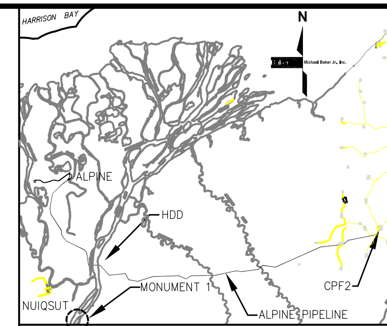
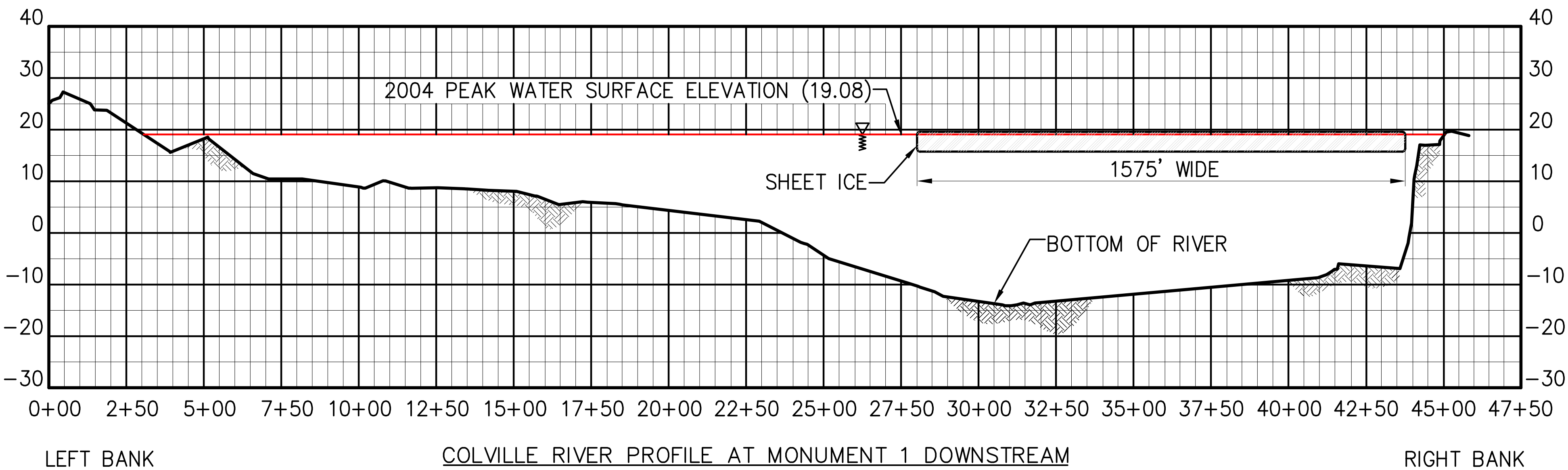
COLVILLE RIVER MONUMENT 01 CROSS SECTIONS LOCATIONS

FIGURE 1 OF 4

NOTES
1. CHANNEL PROFILE MEASUREMENTS COMPLETED AUGUST 2004 BY KUUKPIK/LCMF INC.
2. ELEVATIONS SHOWN ARE REFERENCED TO BRITISH PETROLEUM MEAN SEA LEVEL DATUM.
3. ICE WIDTH AND THICKNESS BASED ON ESTIMATES MADE DURING PEAK DISCHARGE ON MAY 26, 2004.



VICITINY MAP
NTS



COLVILLE RIVER PROFILE AT MONUMENT 1 DOWNSTREAM

15 0 15 30
VERTICAL SCALE IN FEET

250 0 250 500
HORIZONTAL SCALE IN FEET

ConocoPhillips

DATE:	12/07/04	PROJECT:	2004 BREAKUP STUDY
DRAWN:	WAP	FILE:	DOWNSTREAM PROFILE.DWG
CHECKED:	MTA	SCALE:	SEE SCALE

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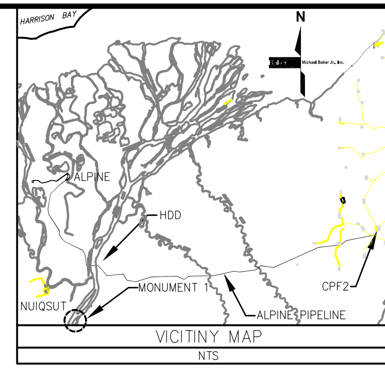
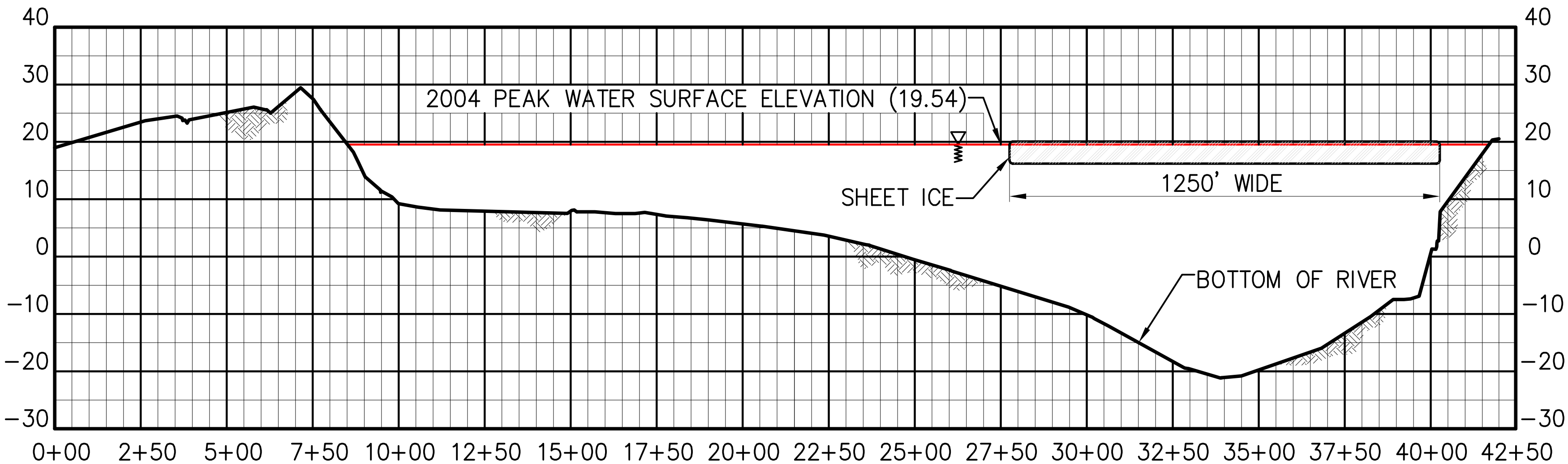
COLVILLE RIVER MONUMENT 01 DOWNSTREAM PROFILE

FIGURE 2 OF 4



NOTES
1. CHANNEL PROFILE MEASUREMENTS COMPLETED AUGUST 2004 BY KUUKPIK/LCMF INC.
2. ELEVATIONS SHOWN ARE REFERENCED TO BRITISH PETROLEUM MEAN SEA LEVEL DATUM.
3. ICE WIDTH AND THINKNESS BASED ON ESTIMATES MADE DURING PEAK DISCHARGE ON MAY 26, 2004.



LEFT BANK

COLVILLE RIVER PROFILE AT MONUMENT 1

RIGHT BANK

15 0 15 30
VERTICAL SCALE IN FEET

250 0 250 500
HORIZONTAL SCALE IN FEET

ConocoPhillips

DATE:	12/07/04	PROJECT:	2004 BREAKUP STUDY
DRAWN:	WAP	FILE:	MONUMENT 01 PROFILE.DWG
CHECKED:	MTA	SCALE:	SEE SCALE

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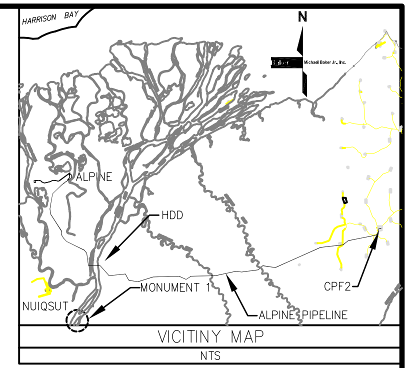
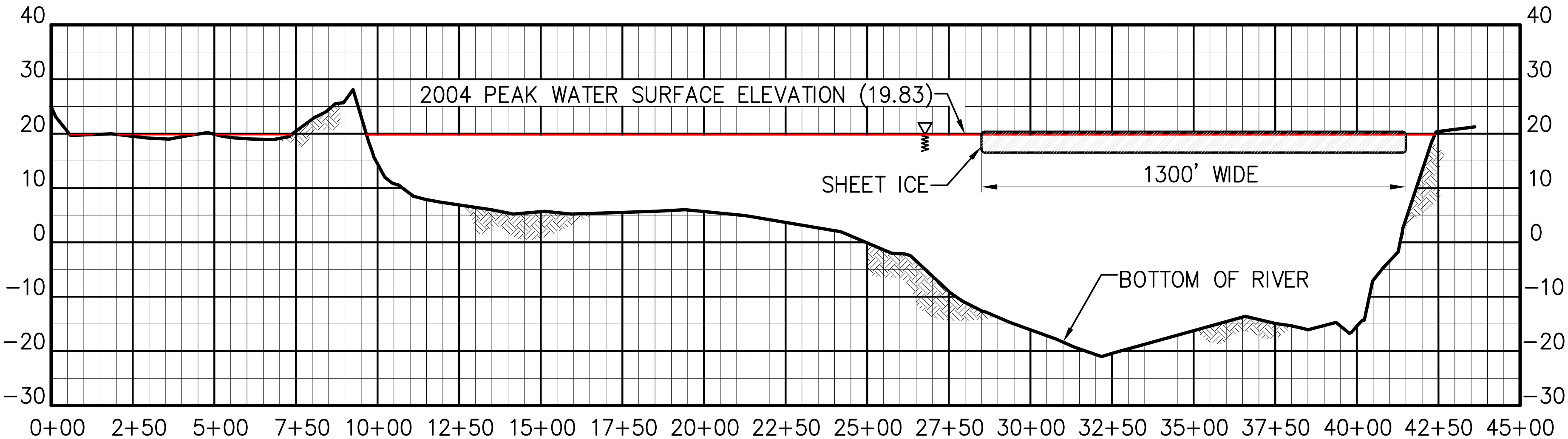
COLVILLE RIVER MONUMENT 01 PROFILE

FIGURE 3 OF 4



NOTES
1. CHANNEL PROFILE MEASUREMENTS COMPLETED AUGUST 2004 BY KUUKPIK/LCMF INC.
2. ELEVATIONS SHOWN ARE REFERENCED TO BRITISH PETROLEUM MEAN SEA LEVEL DATUM.
3. ICE WIDTH AND THICKNESS BASED ON ESTIMATES MADE DURING PEAK DISCHARGE ON MAY 26, 2004.



LEFT BANK

COLVILLE RIVER PROFILE AT MONUMENT 1 UPSTREAM

RIGHT BANK

15 0 15 30
VERTICAL SCALE IN FEET

250 0 250 500
HORIZONTAL SCALE IN FEET

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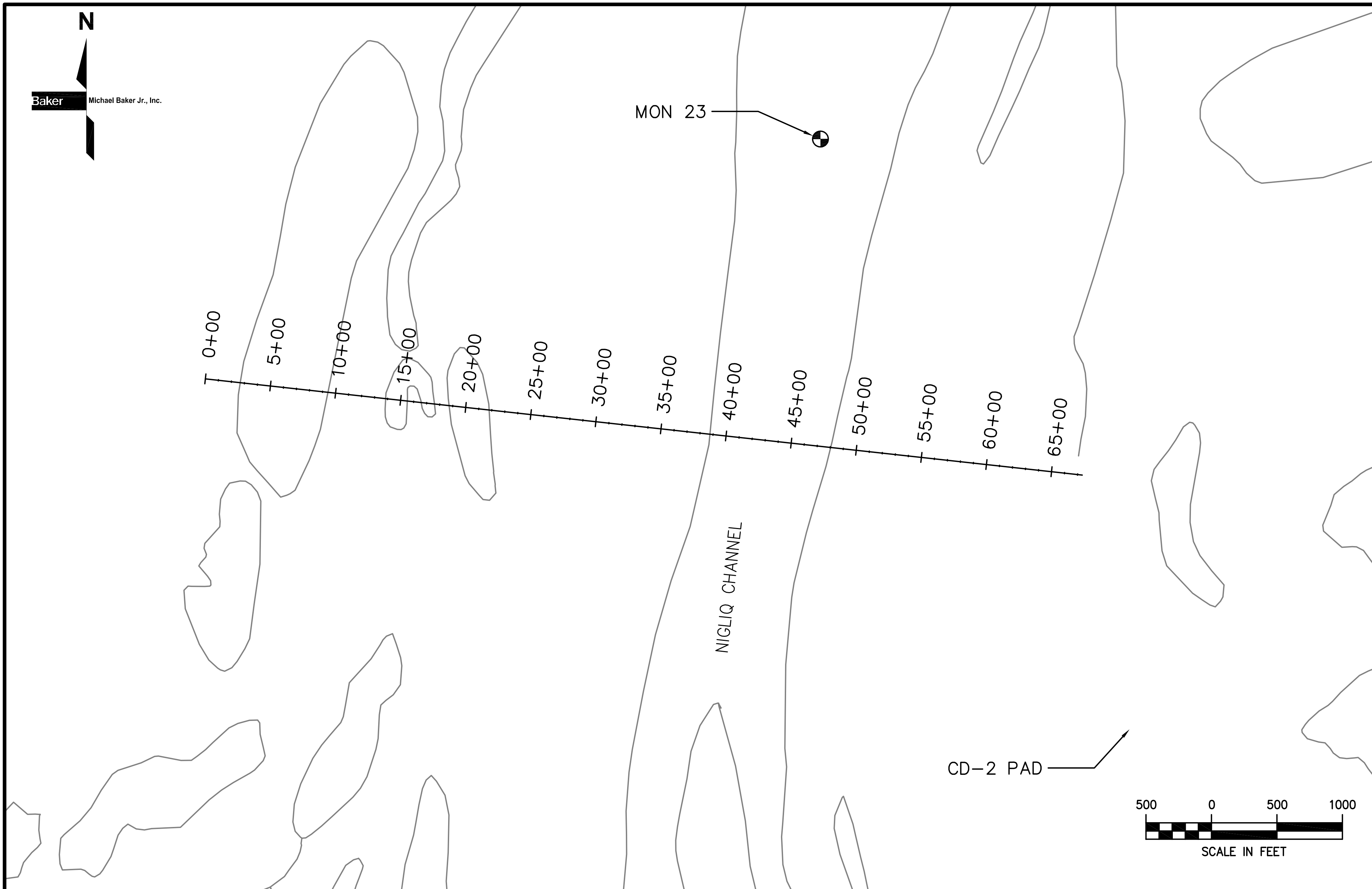
COLVILLE RIVER MONUMENT 01 UPSTREAM PROFILE

DATE:	12/07/04	PROJECT:	2004 BREAKUP STUDY
DRAWN:	WAP	FILE:	UPSTREAM PROFILE.DWG
CHECKED:	MTA	SCALE:	SEE SCALE

FIGURE 4 OF 4

Appendix B Nigliq Channel Monument 23 Cross Section Location



ConocoPhillips

DATE:	2/02/05	PROJECT:	2004 BREAKUP STUDY
DRAWN:	VLR	FILE:	NIGLIQ1250_PLANVIEW
CHECKED:	MTA	SCALE:	SEE SCALE

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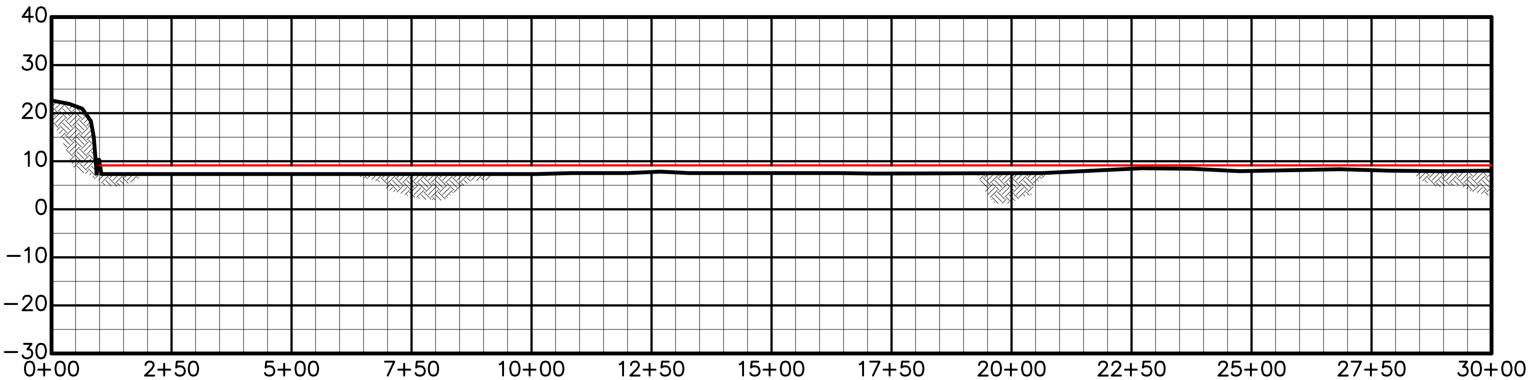
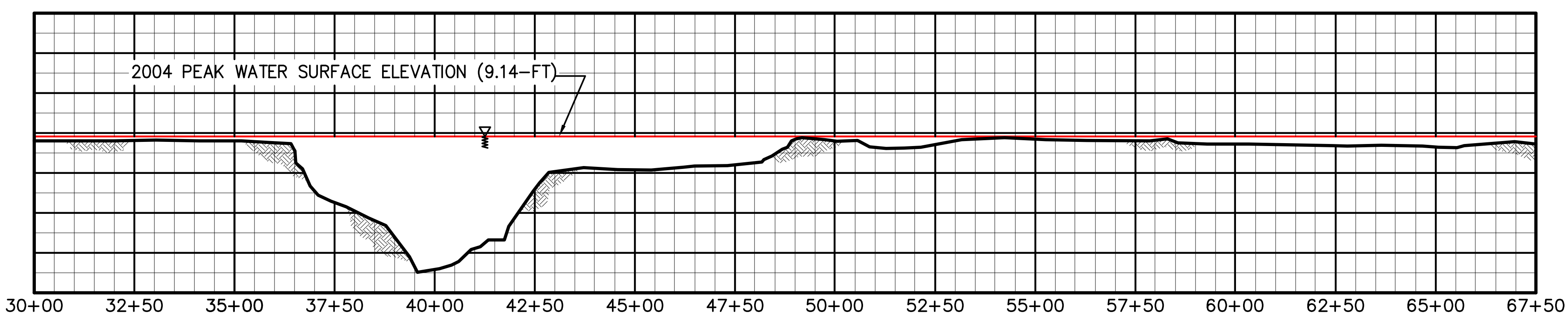
NIGLIQ CHANNEL PROPOSED 1250-FT BRIDGE CROSS SECTIONS LOCATIONS

FIGURE 1 OF 2

NOTES
1. CHANNEL PROFILE MEASUREMENTS COMPLETED AUGUST 2004 BY KUUKPIK/LCMF INC.
2. ELEVATIONS SHOWN ARE REFERENCED TO BRITISH PETROLEUM MEAN SEA LEVEL DATUM.
3. ICE WIDTH AND THICKNESS BASED ON ESTIMATES MADE DURING PEAK DISCHARGE ON MAY 26, 2004.



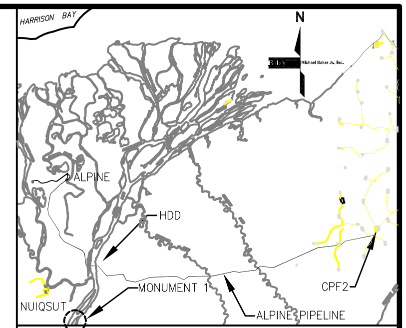
NIGLIQ CHANNEL (AT BRIDGE)
STA 0+00 TO 30+00



NIGLIQ CHANNEL (AT BRIDGE)
STA 30+00 TO 67+50

20 0 20 40
VERTICAL SCALE IN FEET

200 0 200 400
HORIZONTAL SCALE IN FEET



VICINITY MAP
NTS

ConocoPhillips

DATE:	2/01/05	PROJECT:	2004 BREAKUP STUDY
DRAWN:	VLR	FILE:	NIGLIQ1250_PROFILE
CHECKED:	MTA	SCALE:	SEE SCALE

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NIGLIQ CHANNEL PROPOSED 1250-FT BRIDGE PROFILE

FIGURE 2 OF 2

Appendix C Ublutuoch Bridge Discharge Measurement

DISCHARGE MEASUREMENT NOTES

LOCATION: Ublutuoch River Mile 6.8

Date: June 5, 2004 **Party:** MTA, JPM, MDC, JWW

Width: 675 **ft** **Area:** 2077 **ft^2** **Ave. Vel:** 1.34 **fps** **G.H.:** NA **Discharge:** **2782 cfs**

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

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

Gage Readings			
Time	**Recorder**	**Inside**	**Outside**
	See Tables 4-5 and 4-6		
Weighted M.G.H.			
G.H. corrections			
Correct M.G.H.			

Type of meter: Price AA

Date rated: Standard

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

Spin before measurement: 2+ minutes **After:** 2+ minutes

Method:

Combination Measurement -

-Sta 95 to Sta 370: Boat w/30-pound lead weight and bridge boom/reel

-Sta 370 to 770: Wading w/ wading rod

Levels obtained: Yes, before and after

Measurement rated: Fair to Poor **Rating based on the following conditions:** Snow/ice in channel

Cross section: Irregular, bottom grass and embedded ice, some willow

Flow: Uniform and steady **Weather:** Overcast **Air Temp.** 35^{o}F

Gage: **Water Temp.** 35^{o}F

Other:

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

Observer N/A

Control Channel downstream constricted by snowbanks on edges and stationary floating ice causing backwater

Remarks The velocity meter used for the boat section was equipped with a Scientific Instruments Model 9000 current meter digitizer that calculates velocity. Revolutions of the meter were not always recorded in the field notes when the digitizer was used, denoted NR.

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

Page 1 of 3

Angle Coef. (deg)	Distance From Initial Point (ft)	Width (ft)	Total Depth (ft)	Observed Depth (ft)		Revo-lutions	Time (sec)	Velocity At Point (fps)	Velocity Mean in-vertical (fps)	Velocity Adjust for Angle Coef.	Velocity Adjusted (fps)	Area (s.f.)	Discharge (cfs)	Description
30	95	2.5	0.7	0.6	0.42	11	40	0.65	0.65	0.87	0.6	1.8	1.0	Snow
5	100	4.5	1.5	0.6	0.9	20	40	1.07	1.07	1.00	1.1	6.8	7.2	Snow
0	104	4.0	1.9	0.6	1.14	27	40	1.49	1.49	1.00	1.5	7.6	11.3	Snow
0	108	8.0	2.0	0.6	1.14	NR	40	1.37	1.37	1.00	1.4	16.0	21.9	Snow
10	120	11.0	2.8	0.2	0.56	31	40	1.70	1.9	0.98	1.8	30.8	56.1	Ice
10				0.8	2.24	NR	40	2.00						
0	130	10.0	3.7	0.2	0.74	31	40	1.72	2.0	1.00	2.0	37.0	73.1	Ice
				0.8	2.96	41	40	2.23						
0	140	10.0	4.5	0.2	0.90	37	40	2.02	2.2	1.00	2.2	45.0	97.0	Ice
				0.8	3.60	42	40	2.29						
0	150	10.0	4.7	0.2	0.94	42	40	2.28	2.4	1.00	2.4	47.0	111.6	Ice
				0.8	3.76	45	40	2.47						
0	160	12.5	4.8	0.2	0.96	34	40	1.89	2.3	1.00	2.3	60.0	139.8	Ice
				0.8	3.84	51	40	2.77						
0	175	15.0	4.9	0.2	0.98	36	40	2.00	2.3	1.00	2.3	73.5	166.1	Ice
				0.8	3.92	46	40	2.52						
0	190	15.0	5.4	0.2	1.08	40	40	2.18	2.5	1.00	2.5	81.0	205.3	Ice
				0.8	4.32	53	40	2.89						
0	205	15.0	5.8	0.2	1.16	40	40	2.21	2.5	1.00	2.5	87.0	217.1	Ice
				0.8	4.64	NR	40	2.78						
0	220	15.0	6.1	0.2	1.22	43	40	2.38	2.5	1.00	2.5	91.5	224.2	Ice
				0.8	4.88	46	40	2.52						
0	235	15.0	6.1	0.2	1.22	NR	40	1.50	2.1	1.00	2.1	91.5	194.0	Ice
				0.8	4.88	50	40	2.74						
0	250	15.0	5.2	0.2	1.04	18	40	0.94	1.7	1.00	1.7	78.0	129.9	Ice/Grass
				0.8	4.16	NR	40	2.39						
0	265	15.0	5.1	0.2	1.02	NR	40	1.20	1.6	1.00	1.6	76.5	125.5	Firm
				0.8	4.08	NR	40	2.08						
0	280	15.0	4.9	0.2	0.98	NR	40	0.86	1.4	1.00	1.4	73.5	104.7	Firm
				0.8	3.92	NR	40	1.99						
0	295	15.0	5.6	0.2	1.12	NR	40	1.47	1.5	1.00	1.5	84.0	125.6	Firm
				0.8	4.48	NR	40	1.52						
0	310	15.0	5.6	0.2	1.12	NR	40	1.17	1.2	1.00	1.2	84.0	100.4	Firm
				0.8	4.48	NR	40	1.22						
0	325	15.0	5.4	0.2	1.08	NR	40	1.04	1.2	1.00	1.2	81.0	100.4	Firm
				0.8	4.32	NR	40	1.44						
SUBTOTAL		**237.5**										**1153**	**2212**	**Page 2 of 3**

Angle Coef. (deg)	Distance From Initial Point (ft)	Width (ft)	Total Depth (ft)	Observed Depth (ft)		Revo-lutions	Time (sec)	Velocity At Point (fps)	Velocity Mean in-vertical (fps)	Velocity Adjust for Angle Coef.	Velocity Adjusted Velocity (fps)	Area (s.f.)	Discharge (cfs)	Description
10	340	15.0	5.5	0.2	1.10	NR	40	1.44	1.61	0.98	1.6	82.5	130.8	Firm
				0.8	4.40	NR	40	1.78						
20	355	12.5	5.8	0.2	1.16	NR	40	1.29	1.41	0.94	1.3	72.5	95.7	Firm
				0.8	4.64	NR	40	1.52						
15	365	7.5	5.9	0.2	1.18	NR	40	1.02	1.14	0.97	1.1	44.3	48.7	Firm
				0.8	4.72	NR	40	1.26						
15	370	6.0	5.4	0.2	1.08	NR	40	0.33	0.40	0.97	0.4	32.4	12.4	Grass/Tundra
				0.8	4.32	NR	40	0.46						
0	377	5.0	3.0	0.2	0.60	NR	44	0.17	0.09	1.00	0.1	15.0	1.3	Smooth Ground/Grass to 0.5'
				0.8	2.40	NR	40	0.14						
0	380	6.5	2.0	0.6	1.80	NR	40	0.00	0.00	--	0.0	13.0	0.0	Smooth Ground/Grass to 0.5'
0	390	15.0	0.9	0.6	0.54	NR	40	0.00	0.00	--	0.0	13.5	0.0	Smooth Ground/Grass to 0.5'
0	410	20.0	1.7	0.6	0.54	NR	67	0.12	0.12	1.00	0.1	34.0	4.0	Rough Grnd/Shrt Willows/Grass to 1.0'
5	430	20.0	1.9	0.6	1.14	NR	41	0.18	0.18	1.00	0.2	38.0	6.8	Rough Grnd/Shrt Willows/Grass to 1.0'
10	450	20.0	1.7	0.6	1.14	NR	42	0.18	0.18	0.98	0.2	34.0	5.9	Rough Grnd/Shrt Willows/Grass to 1.0'
30	470	20.0	1.8	0.6	1.08	NR	48	0.34	0.34	0.87	0.3	36.0	10.5	Rough Grnd/Shrt Willows/Grass to 1.0'
25	490	20.0	1.2	0.6	1.08	NR	52	0.65	0.65	0.91	0.6	24.0	14.1	Rough Grnd/Shrt Willows/Grass to 1.0'
15	510	20.0	1.5	0.6	0.90	NR	55	0.62	0.62	0.97	0.6	30.0	17.8	Rough Grnd/Shrt Willows/Grass to 1.0'
15	530	20.0	1.2	0.6	0.90	NR	40	0.84	0.84	0.97	0.8	24.0	19.4	Rough Grnd/Grass to 1.0'
15	550	20.0	1.5	0.6	0.90	NR	50	0.67	0.67	0.97	0.7	30.0	19.5	Rough Grnd/Grass to 1.0'
25	570	20.0	1.8	0.6	0.90	NR	53	0.43	0.43	0.91	0.4	36.0	14.1	Rough Grnd/Grass to 1.0'
30	590	17.5	1.7	0.6	1.02	NR	52	0.31	0.31	0.87	0.3	29.8	8.1	Rough Grnd/Grass to 1.0'
35	605	15.0	1.0	0.6	1.02	NR	52	0.65	0.65	0.82	0.5	15.0	8.0	Rough Grnd/Grass to 1.0'
35	620	15.0	1.9	0.6	1.14	NR	52	0.31	0.31	0.82	0.3	28.5	7.3	Grass to 1.0'
35	635	15.0	2.9	0.6	1.14	NR	45	0.36	0.36	0.82	0.3	43.5	12.8	Grass to 1.0'
30	650	15.0	2.0	0.6	1.20	NR	46	0.35	0.35	0.87	0.3	30.0	9.1	Rough Grnd/Grass to 1.0'
35	665	12.5	2.2	0.6	1.20	NR	50	0.46	0.46	0.82	0.4	27.5	10.3	Grass to 1.0'
25	675	12.5	1.7	0.6	1.02	NR	50	0.67	0.67	0.91	0.6	21.3	13.0	Grass to 1.0'
20	690	15.0	2.0	0.6	1.02	NR	49	0.69	0.69	0.94	0.6	30.0	19.4	Grass to 1.0'
10	705	15.0	2.6	0.6	1.56	NR	55	0.42	0.42	0.98	0.4	39.0	16.0	0.6 Due to Grass to 1.0'
30	720	15.0	2.3	0.6	1.56	NR	55	0.62	0.62	0.87	0.5	34.5	18.4	Frozen Grass/Ice
30	735	15.0	2.1	0.6	1.26	NR	54	0.63	0.63	0.87	0.5	31.5	17.1	Ice
30	750	12.5	1.6	0.6	1.26	NR	46	1.20	1.20	0.87	1.0	20.0	20.8	Frozen Grass/Ice
20	760	7.5	1.4	0.6	0.84	NR	51	0.66	0.66	0.94	0.6	10.5	6.5	Frozen Grass/Ice
20	765	5.0	0.7	0.6	0.84	NR	56	0.60	0.60	0.94	0.6	3.5	2.0	Slush to 0.6' Deep
0	770	2.5	0.0	0.6	0.00	NR		0.00	0.00	--	0.0	0.0	0.0	Slush/Saturated Snow
TOTAL		**675**										**2077**	**2782**	**Page 3 of 3**

DISCHARGE MEASUREMENT NOTES

LOCATION: Ublutuoch River Mile 6.8

Date: June 6, 2004 **Party:** MTA, JPM, MDC, JWW

Width: 688 **ft** **Area:** 2045 **ft^2** **Ave. Vel:** 1.21 **fps** **G.H.:** NA **Discharge:** **2465 cfs**

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

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

Gage Readings			
Time	**Recorder**	**Inside**	**Outside**
		See Tables 4-5 and 4-6	
Weighted M.G.H.			
G.H. corrections			
Correct M.G.H.			

Type of meter: Price AA

Date rated: Standard

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

Spin before measurement: 2+ minutes **After:** 2+ minutes

Method:

Combination Measurement -

-Sta 80 to Sta 370: Boat w/30-pound lead weight and bridge boom/reel

-Sta 370 to 768: Wading w/ wading rod

Levels obtained: Yes, before and after

Measurement rated: Fair to Poor **Rating based on the following conditions:** Snow/ice in channel

Cross section: Irregular, grass and willows embedded in ice, floodplain overflow

Flow: Uniform and steady, falling stage **Weather:** Overcast **Air Temp.** 35°F

Gage: **Water Temp.** 35°F

Other:

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

Observer N/A

Control Channel downstream contains stationary ice on surface causing backwater

Remarks
1. The velocity meter used for the boat section was equipped with a Scientific Instruments Model 9000 current meter digitizer that calculates velocity. Revolutions of the meter were not always recorded in the field notes when the digitizer was used, denoted NR.
2. A method coefficient of 0.90 was used for velocity measurements made at the water's surface.

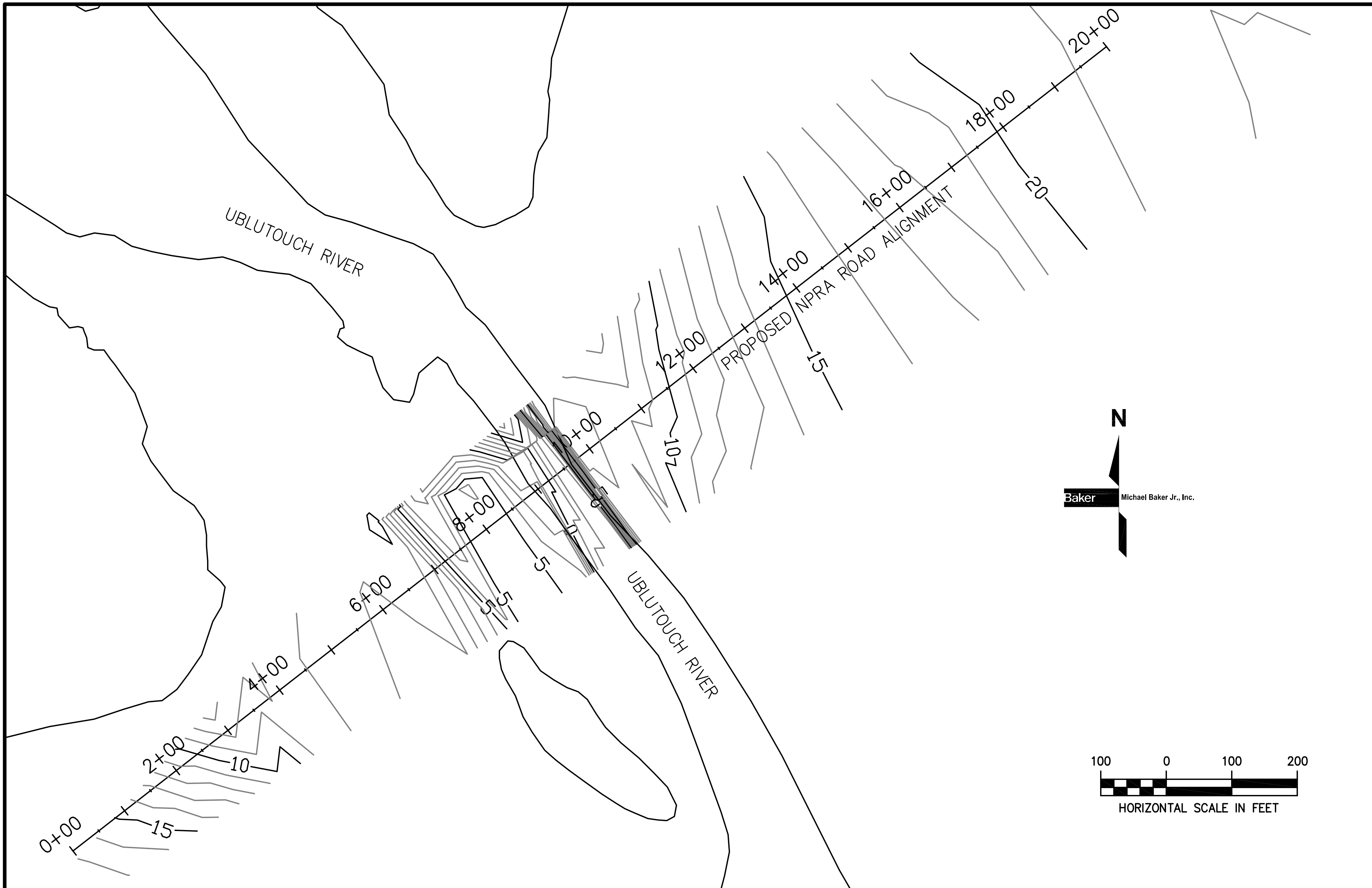
G.H. of zero flow: **ft.**

Page 1 of 3

Angle Coef. (deg)	Distance From Initial Point (ft)	Width (ft)	Total Depth (ft)	Observed Depth (ft)		Revo-lutions	Time (sec)	Velocity At Point (fps)	Velocity Mean in-vertical (fps)	Velocity Adjust for Angle Coef.	Velocity Adjusted (fps)	Area (s.f.)	Discharge (cfs)	Description
0	80	7.5				0						0.0	0.0	REW, Slush/Soft Snow
10	95	10.0	1.7	0.6	1.02	20	40	1.09	1.09	0.98	1.1	17.0	18.2	Snow/Slush/ Soft Bottom
10	100	5.0	2.2	0.6	1.32	18	40	0.99	0.99	0.98	1.0	11.0	10.7	Snow/Slush/ Soft Bottom
0	105	5.0	2.8	0.2	0.56	48	40	2.66	1.8	1.00	1.8	14.0	24.6	Snow/Slush/ Soft Bottom
				0.8	2.24	16	40	0.86						
0	110	5.0	3.6	0.2	0.72	38	40	2.02	1.6	1.00	1.6	18.0	28.4	Bottom Firmer, Little Slush
				0.8	2.88	21	40	1.13						
10	115	5.0	3.8	0.2	0.76	36	40	2.00	1.7	0.98	1.7	19.0	32.0	Bottom Firmer, Little Slush
				0.8	3.04	27	40	1.42						
5	120	7.5	4.1	0.2	0.82	53	40	2.90	2.1	1.00	2.1	30.8	64.0	Bottom Firm/Ice
				0.8	3.28	NR	40	1.28						
0	130	10.0	5.0	0.2	1.00	43	40	2.33	2.4	1.00	2.4	50.0	121.5	Ice
				0.8	4.00	44	40	2.53						
5	140	12.5	5.2	0.2	1.04	45	40	2.46	2.1	1.00	2.1	65.0	137.6	Ice
				0.8	4.16	33	40	1.79						
0	155	15.0	5.7	0.2	1.14	36	40	2.00	2.3	1.00	2.3	85.5	198.8	Ice
				0.8	4.56	48	40	2.65						
0	170	15.0	5.7	0.2	1.14	53	40	2.90	2.6	1.00	2.6	85.5	223.2	Ice
				0.8	4.56	42	40	2.32						
0	185	15.0	6.2	0.2	1.24	53	40	2.90	2.49	1.00	2.49	93.0	231.6	Ice
				0.8	4.96	38	40	2.08						
0	200	15.0	6.6	0.2	1.32	47	40	2.58	2.4	1.00	2.4	99.0	234.6	Ice
				0.8	5.28	39	40	2.16						
0	215	15.0	6.7	0.2	1.34	45	40	2.44	2.2	1.00	2.2	100.5	222.1	Ice
				0.8	5.36	36	40	1.98						
0	230	15.0	6.9	0.2	1.38	45	40	2.44	1.8	1.00	1.8	103.5	182.2	Ice
				0.8	5.52	20	40	1.08						
0	245	15.0	5.0	0.2	1.00	NR	40	2.08	1.5	1.00	1.5	75.0	110.6	Ice
				0.8	4.00	16	40	0.87						
0	260	15.0	4.7	0.2	0.94	23	40	1.29	1.3	1.00	1.3	70.5	88.5	Ice/Grass, Ice Flow Thru Section
				0.8	3.76	22	40	1.22						
20	275	15.0	4.6	0.2	0.92	14	40	0.73	0.5	0.94	0.5	69.0	32.4	Ice
				0.8	3.68	5	44	0.27						
20	290	15.0	5.2	0.2	1.04	20	40	1.11	0.9	0.94	0.8	78.0	63.8	Ice
				0.8	4.16	12	43	0.63						
30	305	15.0	5.1	0.2	1.02	16	42	0.85	0.7	0.87	0.6	76.5	44.4	Ice
				0.8	4.08	9	40	0.49						
30	320	15.0	5.0	0.2	1.00	15	40	0.79	0.7	0.87	0.6	75.0	43.8	Ice
				0.8	4.00	10	40	0.56						
10	335	12.5	5.0	0.2	1.00	22	40	1.23	1.1	0.98	1.1	62.5	67.4	Ice
				0.8	4.00	NR	40	0.96						
SUBTOTAL		**260**										**1298**	**2180**	**Page 2 of 3**

Angle Coef. (deg)	Distance From Initial Point (ft)	Width (ft)	Total Depth (ft)	Observed Depth (ft)		Revo- lutions	Time (sec)	Velocity At Point (fps)	Velocity Mean in- vertical (fps)	Velocity Adjust for Angle Coef.	Velocity Adjusted Velocity (fps)	Area (s.f.)	Discharge (cfs)	Description
10	345	10.0	5.8	0.2	1.16	NR	40	1.22	0.87	0.98	0.9	58.0	49.4	Ice
				0.8	4.64	NR	40	0.51						
10	355	10.0	5.7	0.2	1.14	45	40	1.10	1.03	0.98	1.0	57.0	57.5	Ice
				0.8	4.56	17	40	0.95						
30	365	7.5	5.9	0.2	1.18	NR	40	1.07	1.64	0.87	1.4	44.3	62.7	Ice
				0.8	4.72	42	42	2.20						
0	370	5.5	5.3	0.2	1.06	5	40	0.27	0.31	1.00	0.3	29.2	8.9	Frozen Willows
				0.8	4.24	6	40	0.34						
0	376	5.0	2.6	0.6	1.56	3	55	0.14	0.14	1.00	0.1	13.0	1.8	Short Grass/Tundra
0	380	7.0	1.4	0.6	1.56	0	55	0.00	0.00	--	0.0	9.8	0.0	Short Grass/Tundra
0	390	10.0	0.4	0.6	0.24	0	55	0.00	0.00	--	0.0	4.0	0.0	Short Willow
0	400	10.0	0.8	0.6	0.48	0	55	0.00	0.00	--	0.0	8.0	0.0	Short Willow
0	410	10.0	1.3	0.6	0.24	0	55	0.00	0.00	--	0.0	13.0	0.0	Short Willow/Tall Grass
0	420	15.0	1.5	0.6	0.90	0	55	0.00	0.00	--	0.0	22.5	0.0	Short Willow/Tall Grass
0	440	20.0	1.0	0.6	0.90	0	55	0.00	0.00	--	0.0	20.0	0.0	Tall Grass
30	460	20.0	1.4	0.6	0.84	3	63	0.12	0.12	0.87	0.1	28.0	3.0	Tall Grass
25	480	20.0	1.3	Surface		3	43	0.15	0.15	0.91	0.1	26.0	3.6	Tall Grass, Surface Measurement
15	500	20.0	0.8	Surface		5	48	0.22	0.22	0.97	0.2	16.0	3.4	Tall Grass, Surface Measurement
5	520	20.0	1.2	0.6	0.48	5	62	0.20	0.20	1.00	0.2	24.0	4.7	Tall Grass
5	540	20.0	0.9	0.6	0.54	3	39	0.18	0.18	1.00	0.2	18.0	3.2	Tall Grass
4	560	20.0	1.6	Surface		5	46	0.23	0.23	1.00	0.2	32.0	7.4	Short Willow, Surface Measurement
0	580	20.0	1.2	Surface		3	45	0.15	0.15	1.00	0.1	24.0	3.6	Short Grass, Surface Measurement
15	600	20.0	0.8	0.6	0.48	5	50	0.24	0.24	0.97	0.2	16.0	3.7	Short Grass
5	620	20.0	1.4	0.6	0.84	2	86	0.07	0.07	1.00	0.1	28.0	2.0	Short Grass
20	640	20.0	2.2	0.6	0.84	3	59	0.13	0.13	0.94	0.1	44.0	5.4	Grass/Mud
0	660	20.0	3.5	0.6	2.10	3	47	0.16	0.16	1.00	0.2	70.0	11.1	Tall Grass/Ice
15	680	20.0	1.0	0.6	2.10	5	44	0.27	0.27	0.97	0.3	20.0	5.2	Short Grass
15	700	20.0	2.0	Surface		10	54	0.38	0.38	0.97	0.4	40.0	14.7	Tall Grass, Surface Measurement
5	720	20.0	1.8	Surface		5	40	0.26	0.26	1.00	0.3	36.0	9.4	Tall Grass/Ice, Surface Measurement
0	740	15.0	1.6	Surface		15	55	0.55	0.55	1.00	0.6	24.0	13.3	Short Grass/Ice, Surface Measurement
0	750	11.0	1.2	Surface		15	46	0.66	0.66	1.00	0.7	13.2	8.7	Tall Grass, Surface Measurement
5	762	9.0	0.8	Surface		7	46	0.32	0.32	1.00	0.3	7.2	2.3	Tall Grass, Surface Measurement
0	768	3.0	0.7	Surface		0	40	0.00	0.00	--	0.0	2.1	0.0	Slush
TOTAL		**688**										**2045**	**2465**	**Page 3 of 3**

Appendix D Ublutuoch 6.8 Cross Section Location



ConocoPhillips

DATE:	3/18/05	PROJECT:	2004 BREAKUP STUDY
DRAWN:	MTA	FILE:	UB 6.8 2003
CHECKED:	MTA	SCALE:	SEE SCALE

Baker

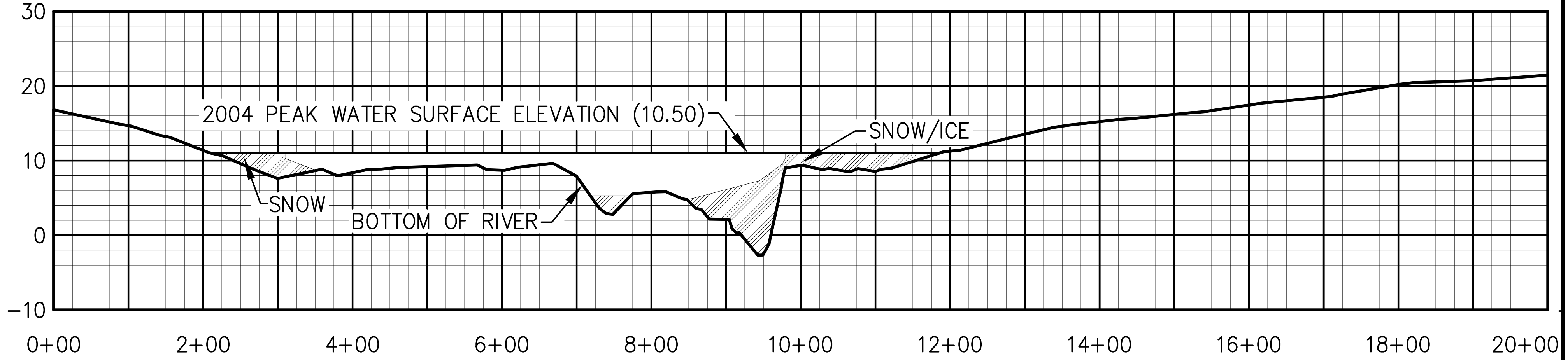
Michael Baker Jr., Inc.
A Unit of Michael Baker Corporation
4601 Business Park Blvd., Suite 42
Anchorage, Alaska 99503
Phone: (907) 273-1600
Fax: (907) 273-1699

UBLUTUOCH RIVER MILE 6.8 CROSS SECTION LOCATION

FIGURE 1 OF 2

NOTES

1. TOPOGRAPHIC CHANNEL PROFILE MEASUREMENTS COMPLETED 2003 BY KUUKPIK/LCMF INC.
2. ELEVATIONS SHOWN ARE REFERENCED TO BRITISH PETROLEUM MEAN SEA LEVEL DATUM.
3. ICE AND SNOW ELEVATIONS BASED ON JUNE 2004 DISCHARGE MEASURMENT.



LEFT BANK

UBLUTUOCH RIVER PROFILE AT MONUMENT 6.8 UPSTREAM

RIGHT BANK

10 0 10 20

VERTICAL SCALE IN FEET

100 0 100 200

HORIZONTAL SCALE IN FEET

ConocoPhillips

DATE:	3/18/05	PROJECT:	2004 BREAKUP STUDY
DRAWN:	MTA	FILE:	UB 6.8 2003
CHECKED:	MTA	SCALE:	SEE SCALE

Baker

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UBLUTUOCH RIVER MILE 6.8 PROFILE

FIGURE 2 OF 2