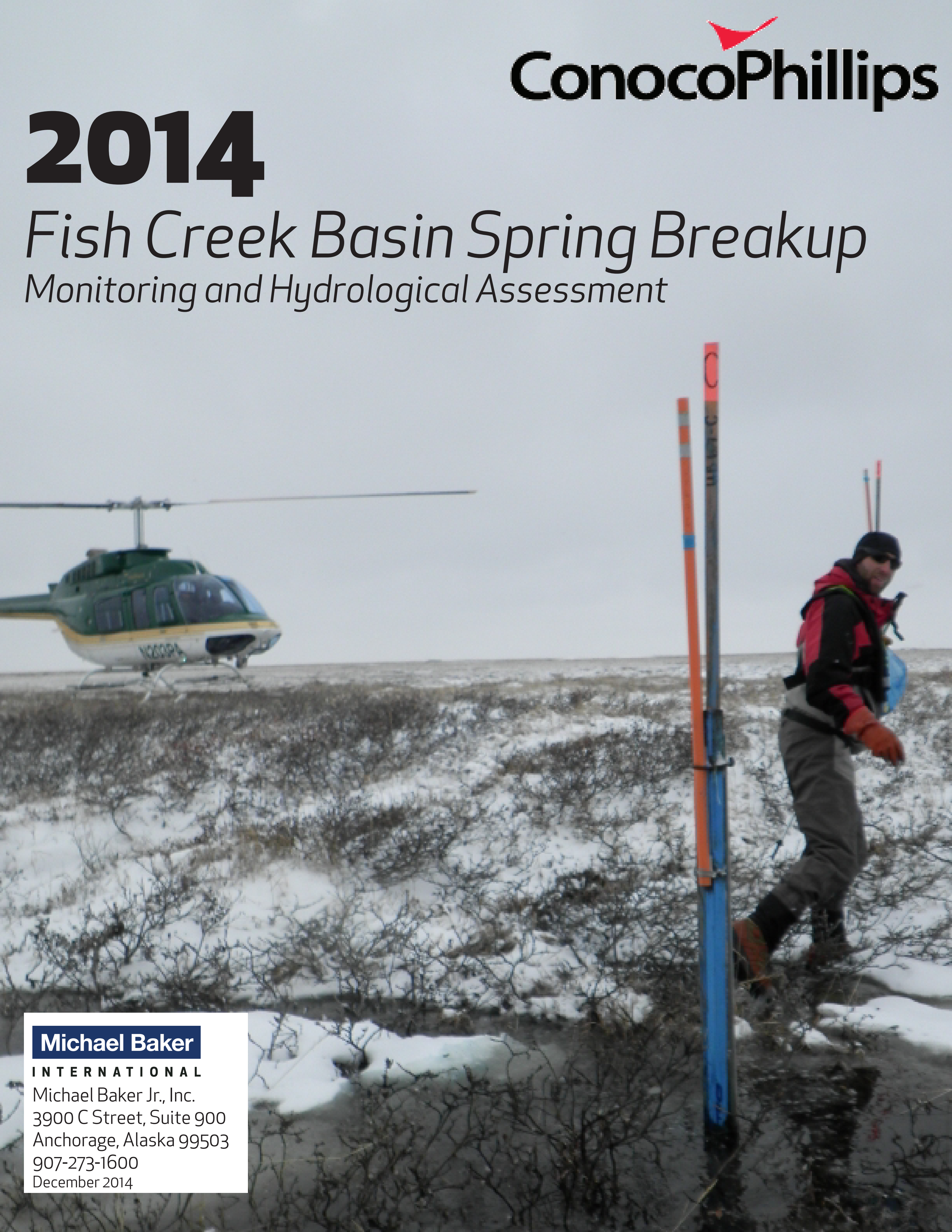
ConocoPhillips

2014
Fish Creek Basin Spring Breakup
Monitoring and Hydrological Assessment



Michael Baker
INTERNATIONAL
Michael Baker Jr., Inc.
3900 C Street, Suite 900
Anchorage, Alaska 99503
907-273-1600
December 2014

CONTENTS

FIGURES

TABLES

GRAPHS

PHOTOS

ACRONYMS AND ABBREVIATIONS

Baker	Michael Baker Jr., Inc.
BPMSL	British Petroleum Mean Sea Level
cfs	Cubic feet per second
CMS	Clover Material Source
CRD	Colville River Delta
FCB	Fish Creek Basin
GMT	Greater Mooses Tooth
GPS	Global positioning system
HWM	High water mark
LCMF	UMIAQ LLC (LCMF)
NAD 83	North American Datum of 1983
OSW	Office of Surface Water
PT	Pressure transducer
RM	River mile
USGS	U.S. Geological Survey
WSE	Water surface elevation

1.0 INTRODUCTION

The 2014 Fish Creek Basin (FCB) Spring Breakup Monitoring and Hydrologic Assessment supports the ConocoPhillips Alaska, Inc. Alpine Satellite Development Project. During 2014, Michael Baker Jr., Inc. (Baker) conducted hydrologic monitoring at 18 sites within the eastern portion of the FCB. Results of the 2014 monitoring and summaries of historical data are presented in this report.

Spring breakup timing and magnitude has been documented for 11 years beginning in 2001. Preliminary hydrologic and hydraulic assessments were completed in 2001 and 2003. Breakup monitoring was conducted annually from 2003 to 2006, and then again in 2009. The current field program has occurred annually since 2010 with the exception of 2012.

UMIAQ, LLC (LCMF), Alpine Field Environmental Coordinators, North Slope Environmental Field Studies Coordinators, Alpine Helicopter Coordinators, and Pathfinder Aviation provided support during the 2014 fieldwork and contributed to a safe and productive monitoring season.

1.1 MONITORING OBJECTIVES

The primary objective of the spring breakup monitoring and hydrologic assessment is to estimate the magnitude of flooding in the FCB. Field data documenting the timing and magnitude of flooding is being used to support planning and design of proposed infrastructure. The objective was accomplished by visually observing breakup events and floodwater distribution, measuring water surface elevations (WSE), measuring stream discharge, and calculating peak discharge estimates.

1.2 MONITORING LOCATIONS

The current gaging sites are located on streams near proposed development. The proposed Greater Mooses Tooth (GMT) Road would access potential development sites in NPRA. The proposed road begins at the west end of the CD5 access road, extends approximately 7.7 miles west to the proposed GMT1 pad, then continues southwest 8.3 miles to the proposed GMT2 pad. Between the CD5 access road and the proposed GMT1 pad, the road alignment crosses the Ublutuoch (Tinmiaqsiugvik) River and several small drainages. The Clover Material Source (CMS), a potential gravel source, is located to the south of the road corridor. It is bounded on the north by the Ublutuoch River and on the west, east, and south by small perennial and ephemeral drainage channels.

The 2014 FCB spring breakup program included monitoring the following 18 gage sites:

- Ublutuoch River at the proposed GMT road crossing (UB6.7, UB6.8, and UB6.9)
- Five small stream crossings along the proposed GMT road (S3, S4, S5, S6, and S7)
- One small drainage near the proposed GMT2 pad (GMT2)
- Ublutuoch River near the potential CMS (UB11.45, and UB11.6)
- Four sites on Clover B drainage (Clover B1, Clover B2, Clover B3, and Clover B4)
- Three sites on Clover C drainage (Clover C1, Clover C2, and Clover C3)

Two other monitoring locations (gages S1 and S2), near the CD5 Road and Pad, were also monitored and those results are reported in the 2014 Colville River Delta (CRD) Breakup Monitoring Report (Baker 2014).

Gaging sites are listed in Table 1.1. Figure 1.1 shows the FCB drainage basin. Figure 1.2 shows the 2014 monitoring locations in relation to the proposed infrastructure and material source. Gage location coordinates and their vertical control references are provided in Appendix A, A.1 and A.2.

Table 1.1: 2014 Monitoring Locations

Site Name	Type	Stream Name and General Location
UB6.7 (downstream)	Staff Gage/PT	Ublutuoch River downstream of GMT road alignment
UB6.8 (center)	Staff Gage/PT/Baro	Ublutuoch River centerline of GMT road alignment
UB6.9 (upstream)	Staff Gage/PT	Ublutuoch River upstream of GMT road alignment
UB11.45	Staff Gage/PT	Ublutuoch River near CMS
UB11.6	Staff Gage/PT	Ublutuoch River near CMS
S3	Staff Gage	Unnamed stream along GMT road alignment
S4-A (downstream)	Staff Gage/PT	Barely Creek downstream of GMT road alignment
S4-B (center)	Staff Gage	Barely Creek centerline of GMT road alignment
S4-C (upstream)	Staff Gage/PT	Barely Creek upstream of GMT road alignment
S5-A (downstream)	Staff Gage/PT	Crea Creek downstream of GMT road alignment
S5-B (center)	Staff Gage	Crea Creek centerline of GMT road alignment
S5-C (upstream)	Staff Gage/PT	Crea Creek upstream of GMT road alignment
S6-A (downstream)	Staff Gage	Unnamed stream downstream of GMT road alignment
S6-B (center)	Staff Gage	Unnamed stream centerline of GMT road alignment
S6-C (upstream)	Staff Gage	Unnamed stream upstream of GMT road alignment
S7	Staff Gage	Unnamed stream along GMT road alignment
GMT2	Staff Gage/PT	Unnamed stream along GMT road alignment
Clover B1	Staff Gage/PT	Unnamed stream downstream of CMS
Clover B2	Staff Gage/PT	Unnamed stream within CMS
Clover B3	Staff Gage	Unnamed stream within CMS
Clover B4	Staff Gage	Unnamed stream upstream of CMS
Clover C1	Staff Gage/PT	Unnamed stream downstream of CMS
Clover C2	Staff Gage/PT	Unnamed stream within CMS
Clover C3	Staff Gage	Unnamed stream within CMS

Note:
Baro - In-Situ BaroTROLL® barometric sensor
CMS – Clover Material Source
GMT – Greater Mooses Tooth
PT- Pressure Transducer

Note:

Drainage basins were delineated using 2014 USGS Hydrologic Units

ConocoPhillips Alaska

0 7.25 14.5 29 Miles

Date:	11/07/2014	Project:	141364
Drawn:	MEA	File:	Figure 1.1
Checked:	SAC	Scale:	1 in = 14.5 miles

Legend

- Place Name
- Existing Road
- Proposed Road
- Stream
- Fish Creek Basin
- Colville River Basin
- Existing Facility
- Proposed Facility

Michael Baker INTERNATIONAL

Michael Baker Jr., Inc.
3900 C Street, Suite 900
Anchorage, AK 99503
Phone: (907) 273-1600
Fax: (907) 273-1699

Fish Creek & Colville River

Drainage Basins

FIGURE: 1.1

(SHEET 1 of 1)

ConocoPhillips Alaska

0 1.25 2.5 Miles

Date:	11/07/2014	Project:	141364
Drawn:	MEA	File:	Figure 1.2
Checked:	SAC	Scale:	1 in = 1.25 miles

Legend

- Gage Location
- Existing Road
- Proposed Road
- Material Source
- Existing Facility
- Proposed Facility

Michael Baker INTERNATIONAL

Michael Baker Jr., Inc.
3900 C Street, Suite 900
Anchorage, AK 99503
Phone: (907) 273-1600
Fax: (907) 273-1699

2014 FCB Breakup

Monitoring Locations

FIGURE: 1.2

(SHEET 1 of 1)

2.0 METHODS

2.1 VISUAL OBSERVATIONS

Field data collection and observations of breakup progression, flow distribution, and ice events were recorded in field notebooks (Photo 2.1). Photographic documentation was collected using digital cameras with integrated global positioning systems (GPS). The latitude and longitude, date and time are imprinted onto each photo. The photo location is based on the World Geodetic System of 1984 datum.

2.2 WATER SURFACE ELEVATION

Stage or WSE data was collected using staff gages and pressure transducers (PT). Site visits were performed periodically as conditions allowed. The word stage and the acronym WSE are used interchangeably in this report.

2.2.1 STAFF GAGES

Staff gages are designed to measure floodwater elevations relative to a known or assumed datum. Their locations are shown on Figure 1.2. Bed degradation, erosion, and ice impacts can require re-installation, rehabilitation, and re-survey of the gages and is performed as needed in the fall and the early spring before breakup. At each site, chalk is applied to the angle iron gage supports down to the water surface (Photo 2.2). Subsequent high water marks (HWM) are recorded when floodwaters wash away the chalk. On gage without PTs, the peak WSE can be captured as a HWM because field staff are not always present to read the gage during the peak event.

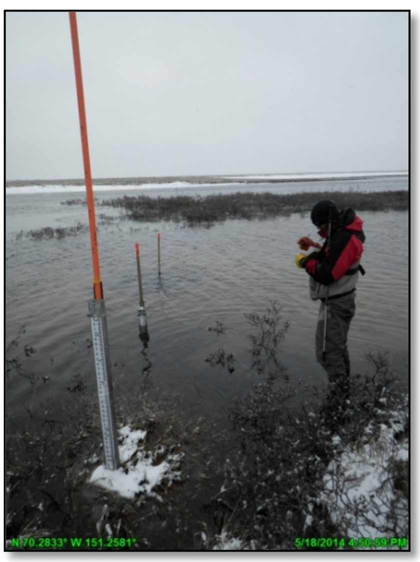


Photo 2.1: Recording breakup observations at UB6.9; May 18, 2014

Photo 2.2: Chalking gage to collect HWM; May 22, 2014

Gages that correlate to British Petroleum Mean Sea Level (BPMSL) elevation were surveyed prior to breakup by Baker using temporary bench marks established and assigned an elevation by LCMF. Gages that do not correlate to BPMSL are surveyed relative to a local control assigned an arbitrary elevation based on GPS data.

Gage sets consist of one or more gage assemblies positioned along stream channels as shown in Photo 2.1. Each gage in a set includes a standard U.S. Geological Survey (USGS) metal faceplate mounted on a wooden two-by-four. The two-by-four is attached with U-bolts to a 1.5-inch-wide angle iron post driven into the ground. The faceplate is graduated and indicates water levels every 100th of a foot between 0.00 to 3.33 feet.

Photo 2.3: PT installed during rehabilitation of gage UB6.7-A; May 2, 2014

The quantity of gage assemblies per set depends on site specific conditions, primarily the slope of the channel bank and overbank. In locations where terrain elevation varied by more than three feet or where the loss of gages from ice impacts was considered to be likely, multiple gages were installed linearly from the edge of the low water channel up to the overbank. Gage plates are positioned so they overlap bankward and streamward gages by approximately one foot. Individual gage assemblies were identified with alphabetical designations beginning with an “A” representing the location nearest to the stream centerline.

2.2.2 PRESSURE TRANSDUCERS

At many gage locations, PTs are installed to supplement and validate observations. They provide a WSE measurement by sensing the absolute pressure imposed by both the atmosphere and water. A BaroTroll barometric pressure sensor was used to adjust the absolute pressure reading for subsequent calculations of water depth above the sensor. The PTs are either surveyed to vertical control or are calibrated to staff gage readings, allowing water depth to be converted to WSE.

Each PT consists of an unvented pressure sensor designed to collect and store pressure and temperature data at discrete pre-set intervals. They were programmed to collect absolute pressure and water temperature at 15 minute intervals from May 10 to July 15, 2014. Both In-Situ® Level TROLL® 500 PTs and Solinst® Levelogger® Model 3001 PTs were used during the 2014 monitoring program. Each PT was housed in a small perforated galvanized steel pipe and clamped to the angle iron or the base of the gage assembly nearest to the bed of the active channel (Photo 2.3). Table 1.1 identifies the gage locations with PT installations. Appendix A , A.3 contains additional details regarding PT setup and testing.

2.3 Peak Discharge

Peak discharge is determined either by direct measurement, or it is indirectly calculated based on WSE data, channel geometry and bed roughness. Standard USGS midsection techniques (USGS 1982) were used to measure velocities and estimate discharge of the Ublutuoch River. Normal depth computations were used to calculate peak discharge estimates for the Ublutuoch River (UB6.9), Barely Creek (S4), and Crea Creek (S5).

2.3.1 Direct Measurements

A Price-type AA velocity meter was used to measure velocities near gage UB6.9 on the Ublutuoch River. Measurements were taken using a sounding reel connected to a boat-mounted boom with a 30-pound Columbus-type lead sounding weight (Photo 2.4). A tag line was used to define the cross section and to delineate measurement subsections within the channel. The standard rating table No.2 for Price-type AA velocity meters, developed by the USGS Office of Surface Water (OSW) Hydraulic Laboratory as announced in the OSW Technical Memorandum No. 99.05 (USGS 1999a) was used to convert revolutions to stream velocity. The meter was rated by Rickly Hydrological to comply with ISO standard 3455 (Hydrometry - Calibration of current-meters in straight open tanks) before being used in 2014. A spin test of the meter was successfully completed prior to the discharge measurement. To ensure accurate performance of meters, procedures outlined in OSW Technical Memorandum No. 99.06 (USGS 1999b) were followed.

Photo 2.4: Discharge measurement at UB6.9; May 20, 2014

2.3.2 Indirect Calculation Method

Estimated peak discharge for the Ublutuoch River and small streams S4 and S5 was calculated using physical characteristics obtained during field observations. These physical characteristics, including measured stage, velocity data and channel cross section geometry, are used as hydraulic equation input variables to calculate discharge and estimate the peak discharge at each location. Discharge was estimated using normal depth computations. The slope of the WSE was determined from PT data and gage readings during various stages of breakup. Cross-section geometry for UB6.9 was based on channel profile measurements completed by Baker in 2006 and 2014 as as shown in Appendix B ,B.1. Cross-section geometry for S4 and S5 were based on channel profile measurements completed by Baker in 2010 as shown in Appendix B, B.2 and B.3.

3.0 BREAKUP OBSERVATIONS

The 2014 field program WSEs and general observations of breakup are presented in this section. Gage setup and monitoring occurred concurrently with CRD spring breakup monitoring program between May 2 through June 9, 2014. A summary of the general observations of the conditions throughout the FCB is presented in Section 3.1. Figure 3.1 provides a timeline showing the progression of breakup events.

3.1 CONDITIONS SUMMARY

Following setup of gages and PTs, periodic helicopter overflights were conducted to monitor the progression of melt. Initial breakup occurred rapidly; on May 16, local melting was observed (Photo 3.1). The PT data shows stage increased rapidly at both the downstream (UB6.7, UB6.8, and UB6.9) and upstream (UB11.45 and UB11.6) Ublutuoch River gage sites on May 17. On May 18, the Ublutuoch River stage was near bankfull (Photo 3.2). Floodwaters peaked on May 19 at the downstream gages and on May 20 at the upstream gages.

Photo 3.1: Small stream gage S6, local melt; May 16, 2014

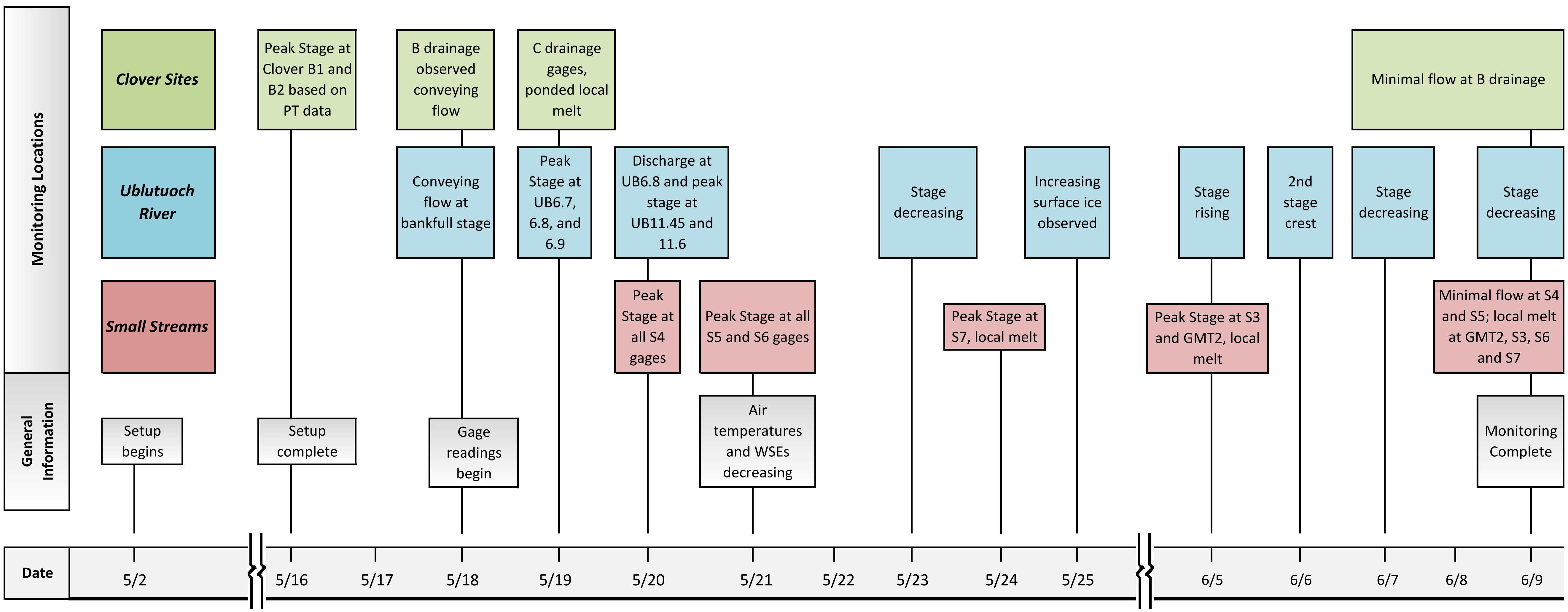
Photo 3.2: Ublutuoch River at gage UB6.8 looking downstream; May 18, 2014

Two of the five small stream crossings monitored along the proposed GMT Road corridor had a rapid rise in stage and distinct stage peak. At gage S5 on Crea Creek, WSE peaked on May 21 and quickly receded. At gage S4 on Barely Creek, peak stage occurred on May 20. Minor fluctuations with no distinct WSE peaks were observed at the other small streams monitored by gages S3, S6, and S7 indicating flooding did not occur.

Photo 3.3: Clover drainage at gage B1 conveying flow; May 18, 2014

Following peak stage at gages Clover B1 and B2 on May 16, WSE declined steadily. On May 18, the Clover B drainage was conveying flow (Photo 3.3). No additional rise in stage was observed. At the Clover C drainage, local melt and ponded water was observed.

Figure 3.1: 2014 Fish Creek Basin Spring Breakup Hydrologic Timeline



3.2 Ublutuoch (Tinmiaqsiugvik) River

3.2.1 Downstream Gages (UB6.7, UB6.8, & UB6.9)

The PTs were installed at UB6.7, UB 6.8, and UB6.9 gages on May 2 (Photo 3.4). The drainage had deep drifted snow accumulation, and snow covered the surrounding tundra.

Gage readings began on May 18, and the Ublutuoch was flowing at near bankfull stage (Photo 3.5). Peak stage occurred on May 19. At the peak stage, adjacent oxbow lakes and paleochannels were connected to the Ublutuoch River (Photo 3.6). Stage decreased steadily until May 29. Stage began to increase on May 31, and a second smaller crest occurred on June 6. When gage observations ended on June 9, stage was falling, and surrounding tundra polygon depressions were filled with local melt and snow. Table 3.1 shows the observations at the time of gage readings, and Graph 3.1 shows the WSE data for the Ublutuoch River at the proposed GMT Road crossing.

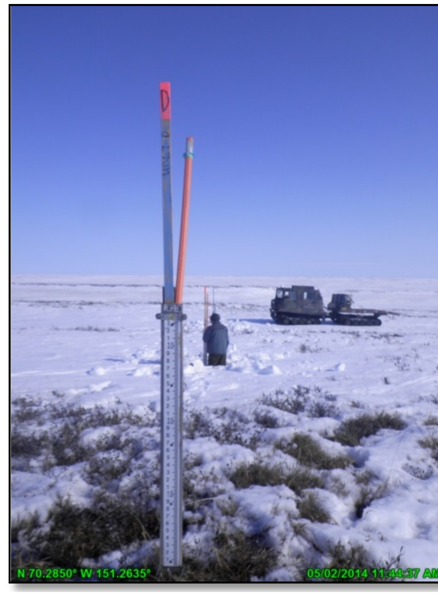


Photo 3.4 Ublutuoch River at UB6.7 prior to breakup; May 2, 2014

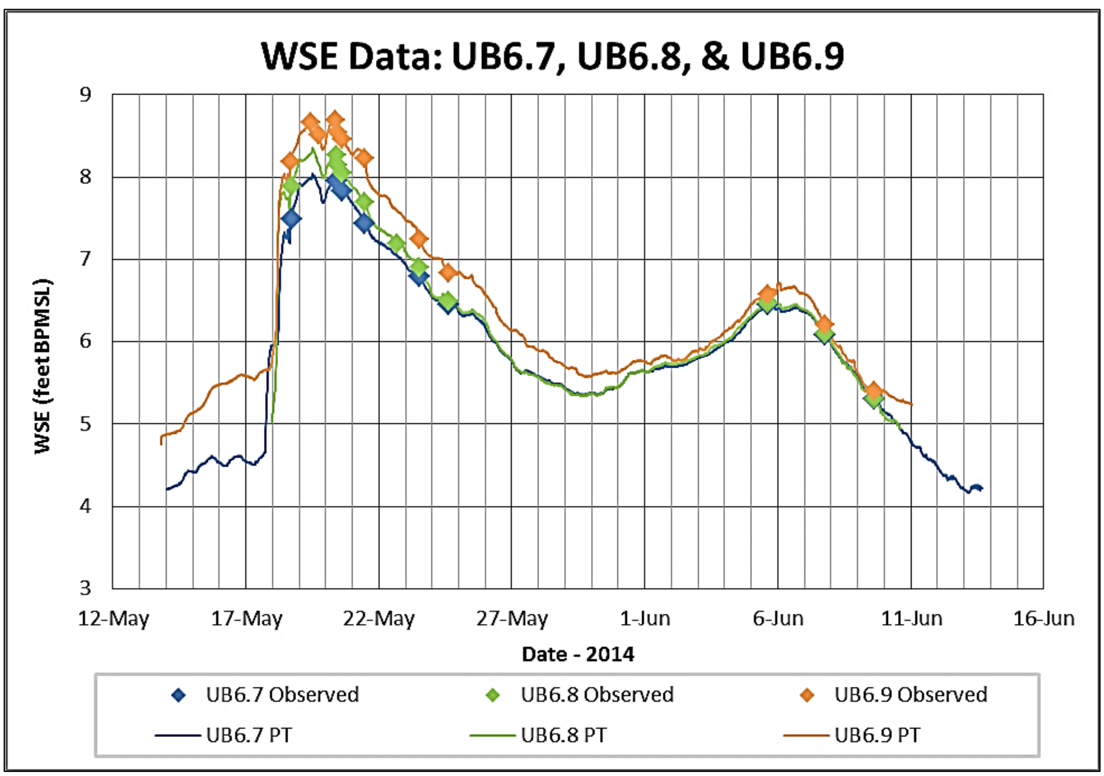
Photo 3.5: Ublutuoch River at UB6.9 near peak stage; May 18, 2014

Photo 3.6: Ublutuoch River near UB6.8 at peak stage; May 19, 2014

Table 3.1: Ublutuoch River Gages UB6.7, UB6.8, and UB6.9 2014 Stage Data

Date	WSE (feet BPMSL)			Observations
	UB6.7	UB6.8	UB6.9	
18-May	7.49	7.89	8.18	Near bankfull conditions observed, channel mostly clear of snow and surface ice
19-May	*8.04*	*8.34*	*8.69*	Peak stage
20-May	7.96	8.27	8.69	Direct discharge measured, stage decreasing
21-May	7.45	7.70	8.22	Stage decreasing throughout FCB, below freezing air temperature and snowing
22-May	-	7.19	-	Stage decreasing and surface ice forming
23-May	6.79	6.90	7.25	
24-May	6.45	6.50	6.84	
29-May	*5.35*	*5.34*	*5.57*	
5-Jun	6.45	6.47	6.60	Stage increasing, some snow and ice remains along the edge of the channel and a few ice floes remain in the channel
6-Jun	*6.48*	*6.52*	*6.72*	Stage crest
7-Jun	6.08	6.10	6.21	Stage decreasing
9-Jun	5.31	5.31	5.41	Ice jam affecting all gages, ponded water at UB6.9 no longer connected to channel

Note:
1. Italicized values are PT data
2. Dash (-) indicates no gage reading collected
3. Yellow highlight denotes peak stage



Graph 3.1: Ublutuoch River Gages UB6.7, UB6.8, and UB6.9 2014 Stage Data

3.2.2 Upstream Gages (UB11.45 & UB11.6)

On May 13, PTs were installed at UB11.45 and UB11.6 gages. Gage readings began on May 18, and stage was rising (Photo 3.7). Breakup of the upstream Ublutuoch River followed the same trend as the downstream sites. WSEs increased rapidly and peaked on May 20. Following peak stage, WSEs decreased steadily until June 2 (Photo 3.8). WSE began to increase on June 2 and a second, smaller crest occurred on June 6. When gage readings ended on June 9, stage was falling. Table 3.2 shows the observations at the time of gage readings, and Graph 3.2 shows the WSE data for the upstream Ublutuoch River gages.

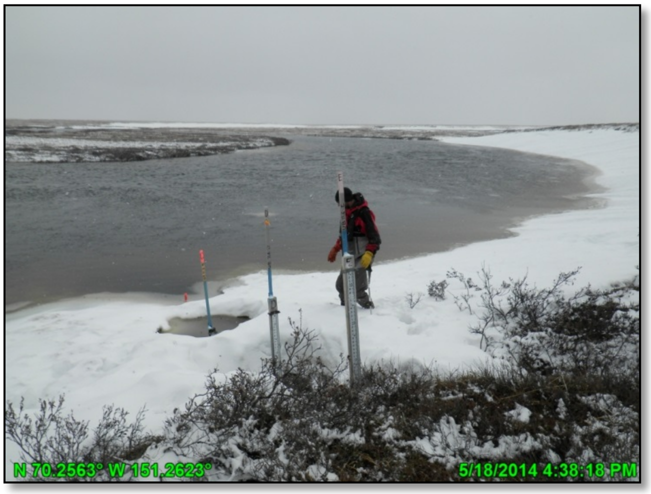


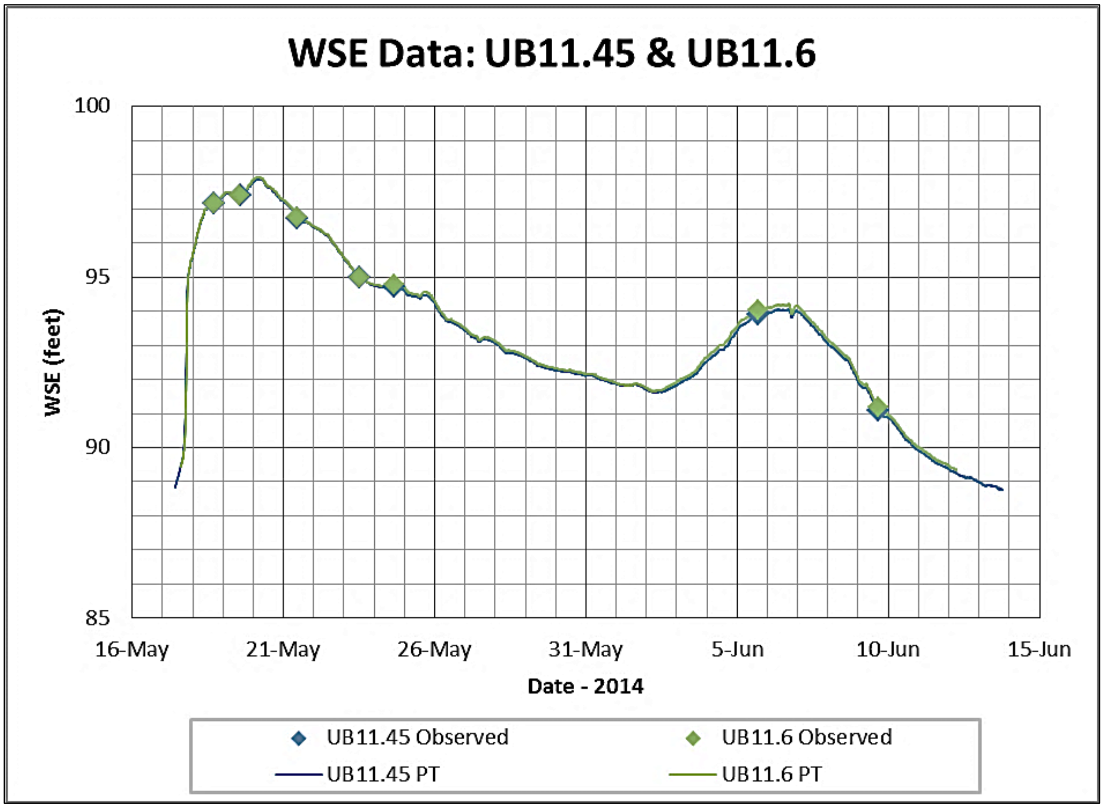
Photo 3.7: Ublutuoch River at gage UB11.6, stage increasing; May 18, 2014

Photo 3.8: Ublutuoch River at gage UB11.45, stage receded from peak; May 23, 2014

Table 3.2: Ublutuoch River Gages UB11.45 and UB11.6 2014 Stage Data

Date	WSE (feet)		Observations
	UB11.45	UB11.6	
18-May	97.15	97.16	Stage increasing
19-May	97.38	97.40	
20-May	*97.86*	*97.92*	Peak stage
21-May	96.71	96.74	Stage decreasing
23-May	94.98	94.98	
24-May	94.72	94.78	
2-Jun	*91.62*	*91.65*	
5-Jun	93.90	94.04	Stage increasing, some snow and ice remain in channel
6-Jun	*94.07*	*94.21*	Stage crest
9-Jun	91.10	91.18	Stage decreasing

Note:
1. Italicized values are PT data
2. Yellow highlight denotes peak stage



Graph 3.2: Ublutuoch River Gages UB11.45 and UB11.6 Stage Data

3.3 Small Stream Crossings

Five small streams along the proposed GMT Road corridor were monitored. Monitoring locations were chosen based on the proposed drainage structures and observations made during 2009 and 2010 breakup. Gage S4 is located on Barely Creek. Gage S5 is located on Crea Creek, the largest stream along the proposed road corridor. The other three streams (S3, S6, S7) are much smaller and are unnamed. Gage GMT2 is located on a small drainage near the proposed GMT2 pad.

Photo 3.9: Barely Creek gage S4 prior to peak stage; May 19, 2014

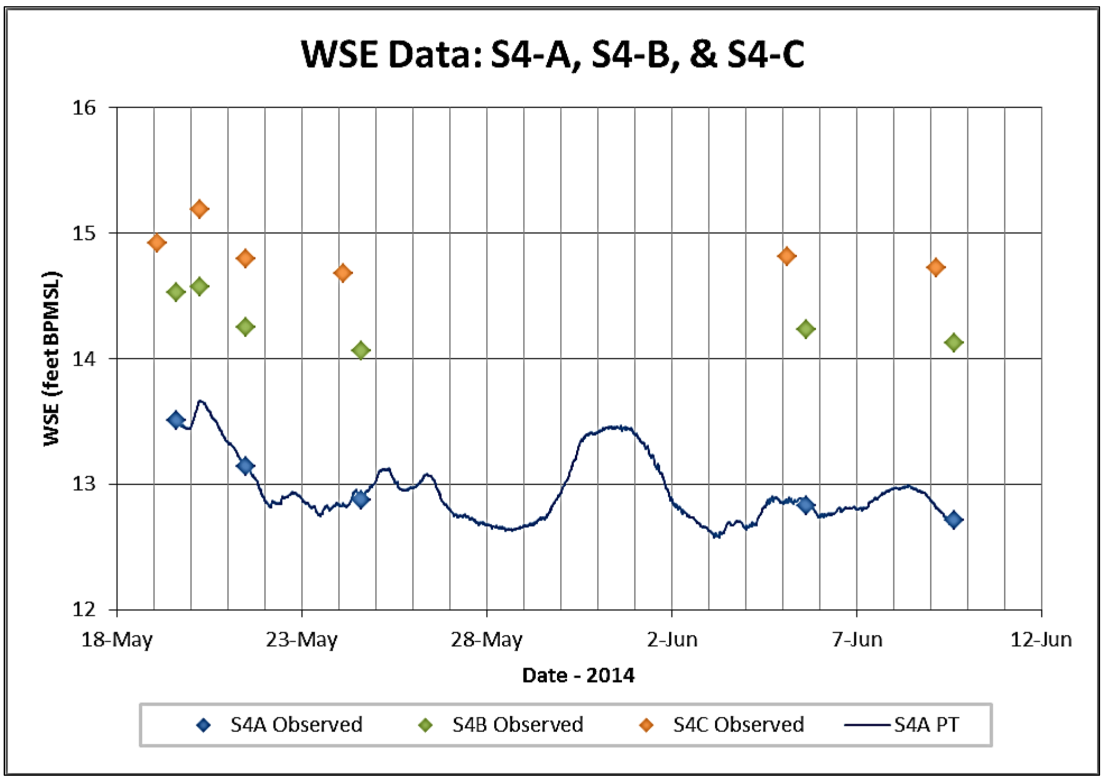
3.3.1 Barely Creek- Gage S4

At Barely Creek, minimal flooding was observed on May 19, and a thin layer of ice covered the water surface (Photo 3.9). Peak stage occurred on May 20 at gages S4-A , S4-B and S4-C. A second crest in stage occurred on May 31 at gage S4-A and on June 5 at gages S4-B and S4-C. Stage was falling on June 9 when observations ended. Table 3.3 summarizes observations at the time of gage readings, and Graph 3.3 shows the WSE data for at gage S4.

Table 3.3: Barely Creek Gage S4 2014 Stage Data

Date	WSE (feet BPMSL)			Observations
	S4-A Upstream	S4-B Centerline	S4-C Downstream	
19-May	13.51	14.53	14.92	Ice on water surface
20-May	*13.67*	14.57	15.19	Peak stage at S4-A (from PT), and S4-B and S4-C (from high water mark)
21-May	13.14	14.25	14.79	Stage decreasing, below freezing air temperature
24-May	12.87	14.06	14.68	
31-May	*13.47*			Second crest in stage at S4-A
5-Jun	12.83	14.23	14.81	Second crest in stage at S4-B and S4-C
9-Jun	12.71	14.12	14.72	Decrease in stage at all gages

Note:
1. Italicized values are PT data
2. Dash (-) indicates no gage reading collected
3. Yellow highlight denotes peak stage



Graph 3.3: Barely Creek Gage S4 2014 Stage Data

3.3.2 CREA CREEK- GAGE S5

Gage setup was completed at Crea Creek on May 15. On May 19, water was present on the gages, and the water surface was covered in ice (Photo 3.10). Peak stage was observed on May 21. Flooding was minimal. Stage decreased until June 1, and a slight crest in stage occurred at gage S5-A on June 3. When observations ended on June 9 the channel and banks were mostly clear of snow and ice. Table 3.4 summarizes the observations at the time of gage readings, and Graph 3.4 shows the WSE data for Crea Creek at gage S5.

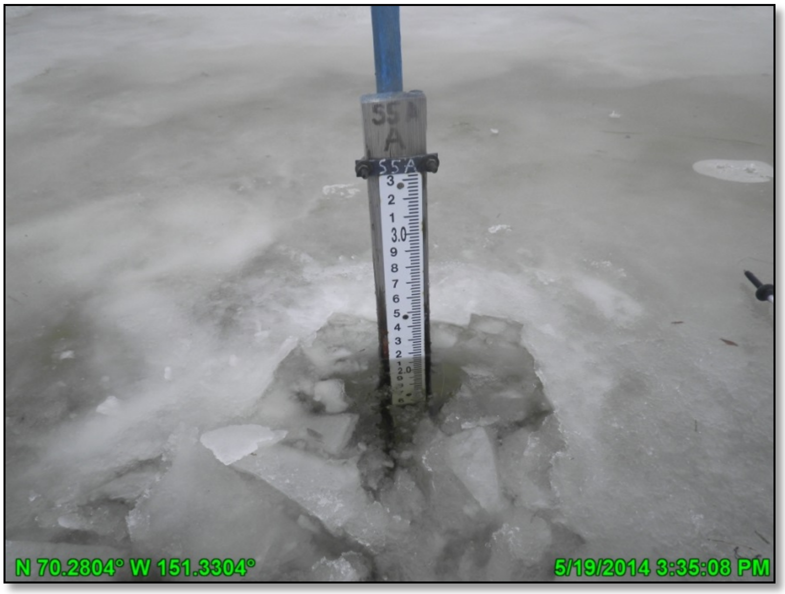
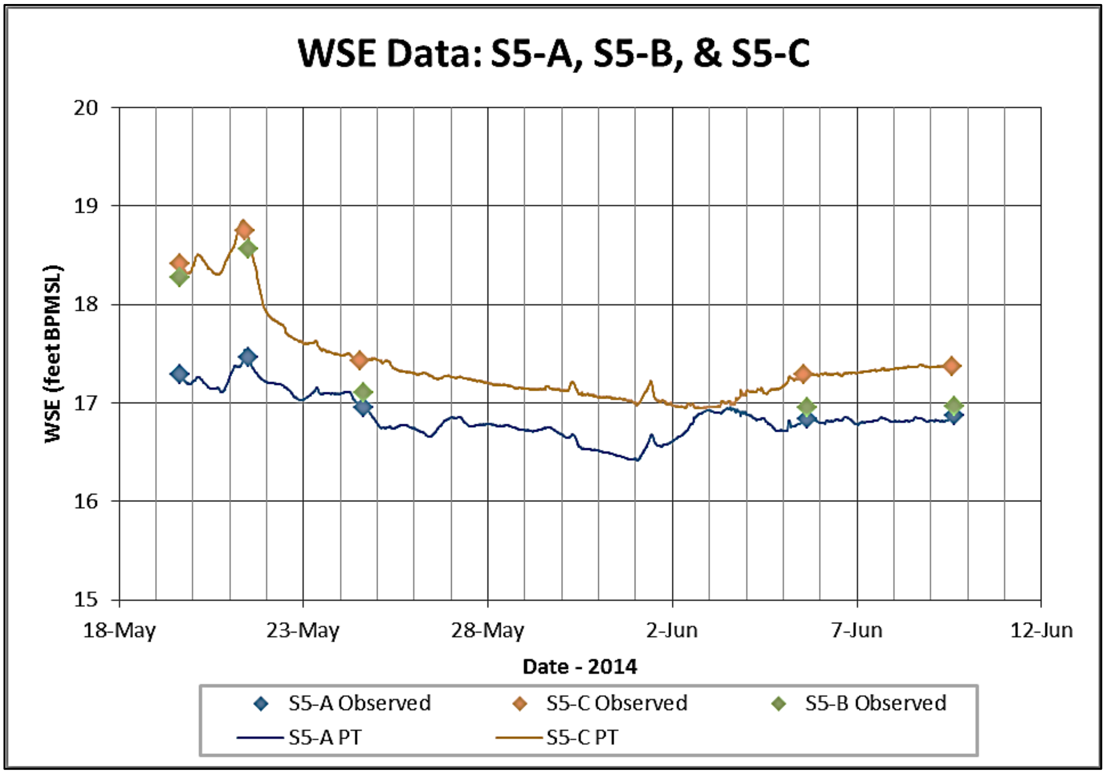


Photo 3.10: Crea Creek at S5 gage prior to peak stage; May 19, 2014

Table 3.4: Crea Creek Gage S5 2014 Stage Data

Date	WSE (feet BPMSL)			Observations
	S5-A Upstream	S5-B Centerline	S5-C Downstream	
19-May	17.29	18.27	18.41	
21-May	*17.54*	18.57	*18.86*	Peak stage observed at all gages
24-May	16.96	17.10	17.43	Stage decreasing, below freezing air temperature
1-Jun	*16.42*	-	*16.98*	
3-Jun	*16.96*	-	*17.14*	Second crest in stage at S5-A
5-Jun	16.84	16.96	17.29	
9-Jun	16.87	16.97	17.37	Slight increase in stage, channel and banks mostly clear of snow and ice

Note:
1. Italicized values are PT data
2. Dash (-) indicates no gage reading collected
3. Yellow highlight denotes peak stage



Graph 3.4: Crea Creek at Gage S5 2014 Stage Data

3.3.3 Gages S3, S6 & S7

The three small drainages monitored by gages S3, S6, and S7 received minimal water; flooding was not observed at these sites. Photo 3.11 through Photo 3.13 show the gages at the time of observed peak WSE. Ponded, local melt was present. Table 3.5 summarizes the observations at time of gage readings, and Graph 3.5 shows the WSEs remained relatively constant throughout the breakup period.

Photo 3.11: S3 gage on June 5, 2014 during peak stage; June 5, 2014

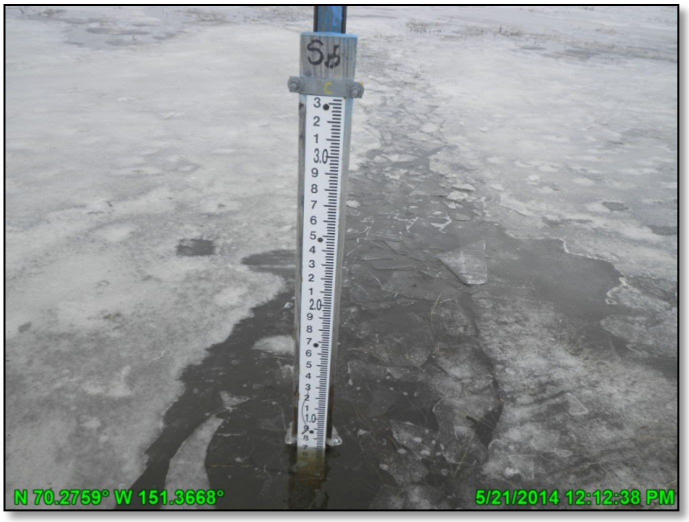


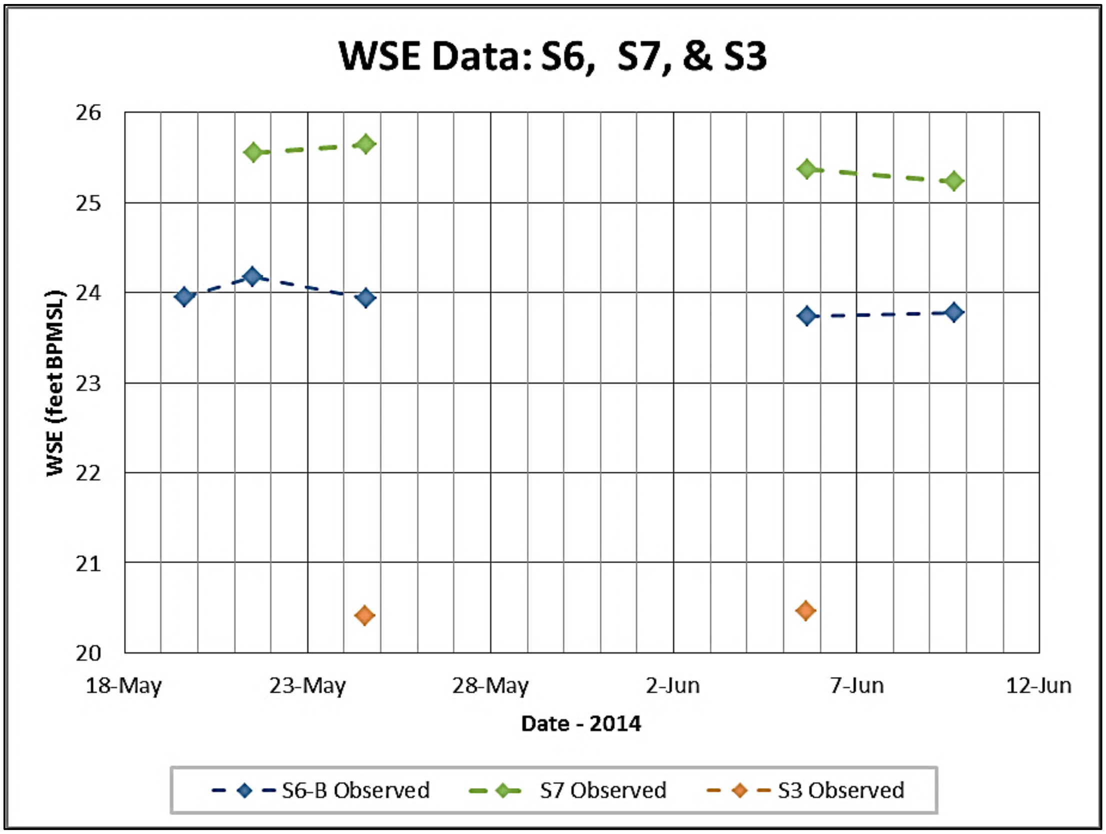
Photo 3.12: S6 gage during peak stage; May 21, 2014

Photo 3.13: S7 gage during peak stage; May 24, 2014

Table 3.5: Small Stream Gages S3, S6, and S7 2014 Stage Data

Date	WSE (feet BPMSL)					Observations
	S3	S6-A	S6-B	S6-C	S7	
19-May	-	23.93	23.95	23.99	-	
21-May	-	24.13	24.17	24.19	25.55	Peak stage observed at S6, ice on surface of ponded water
24-May	20.41	23.89	23.93	23.99	25.64	Peak stage observed at S7, ice on surface of ponded water
5-Jun	20.46	23.70	23.73	23.79	25.37	Peak stage observed at S3, ponded water
9-Jun	-	23.73	23.77	23.83	25.23	Ponded water at gage S7

Note:
1. Dash (-) indicates no gage reading collected
2. Yellow highlight denotes peak stage



Graph 3.5: Small Streams Gages S3, S6, and S7 2014 Stage Data

3.4 GMT2

The small drainage monitored by gage GMT2 received local melt. Peak WSE was observed on June 5. Water was ponded throughout the breakup monitoring period. Photo 3.14 shows the GMT2 gage at peak observed stage, and Table 3.6 shows the WSE data and observations at the time of gage readings.

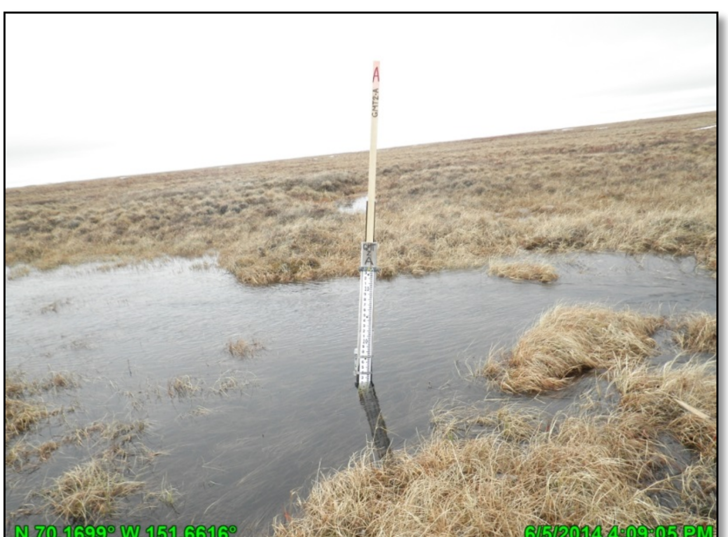


Photo 3.14: GMT2 gage during peak observed stage; June 5, 2014

Table 3.6: GMT2 2014 Stage Data

Date	WSE (feet[1]) GMT2	Observations
21-May	88.07	Snow and local melt
23-May	Dry	
24-May	87.92	Snow and local melt
5-Jun	88.21	Peak stage observed, ponded water, local melt
9-Jun	87.99	Ponded water, stage decreasing

Note:
1. Elevation not referenced to BPMSL
2. Yellow highlight denotes peak stage

3.5 Clover Material Source

Seven CMS sites (B1, B2, B3, B4, and C1, C2, C3) were monitored during breakup. The CMS sites were selected as representative of the two small drainages, Clover B and Clover C, in the area.

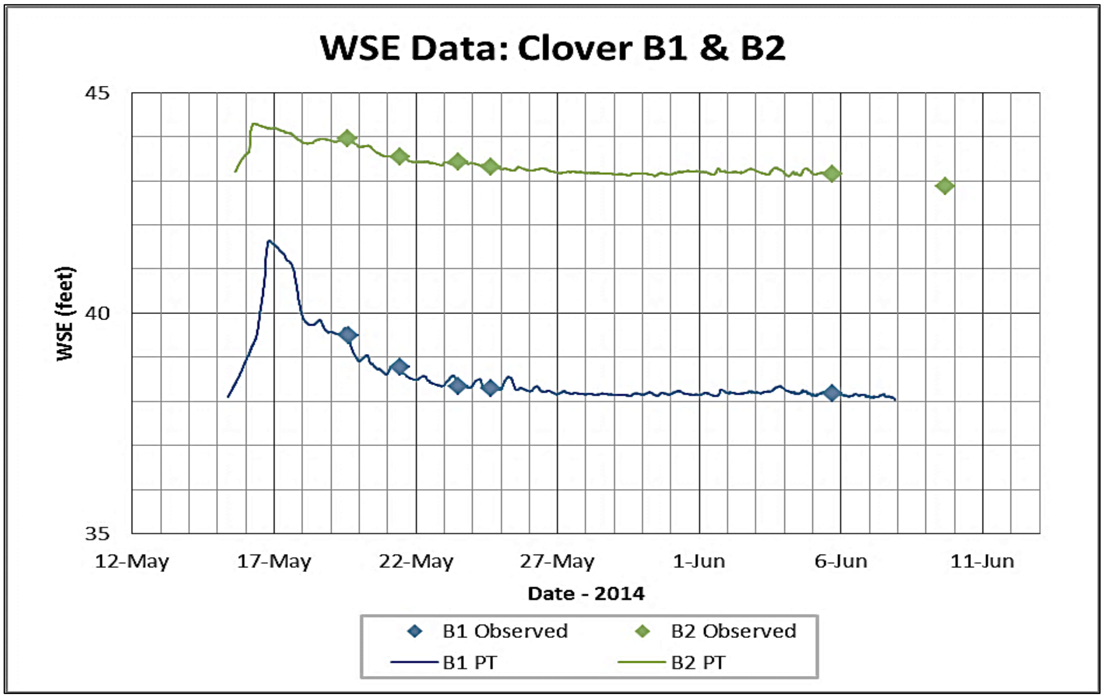
3.5.1 Clover B Drainage (Gages B1-B4)

The PTs began recording water on May 15, and WSE peaked on May 16. Flooding was not observed. Following the peak, stage decreased steadily, and gages were either dry or had minimal ponded water when observations ended on June 9. Table 3.7 shows the observations at the time of gage readings, and Graph 3.6 shows the WSE data for the Clover B gages.

Table 3.7: Clover B Gages 2014 Stage Data

Date	WSE (feet) [1]				Observations
	Clover B1	Clover B2	Clover B3	Clover B4	
16-May	*41.65*	*44.29*	-	-	Peak stage at B1 and B2
19-May	39.50	43.95	Dry	Dry	
21-May	38.77	43.53	46.62	-	Peak stage at B3
23-May	38.33	43.42	Dry	-	Extensive snow and ice remains, thin layer of ice on water surface
24-May	38.29	43.32	Dry	-	
5-Jun	38.19	43.14	Dry	-	
9-Jun	Dry	42.88	Dry	-	Ponded water at B2

Note:
1. Elevation not referenced to BPMSL
2. Italicized values are PT data
3. Dash (-) indicates no gage reading collected
4. Yellow highlight denotes peak stage



Graph 3.6: Clover B Gages 2014 Stage Data

3.5.2 CLOVER C DRAINAGE (GAGES C1-C3)

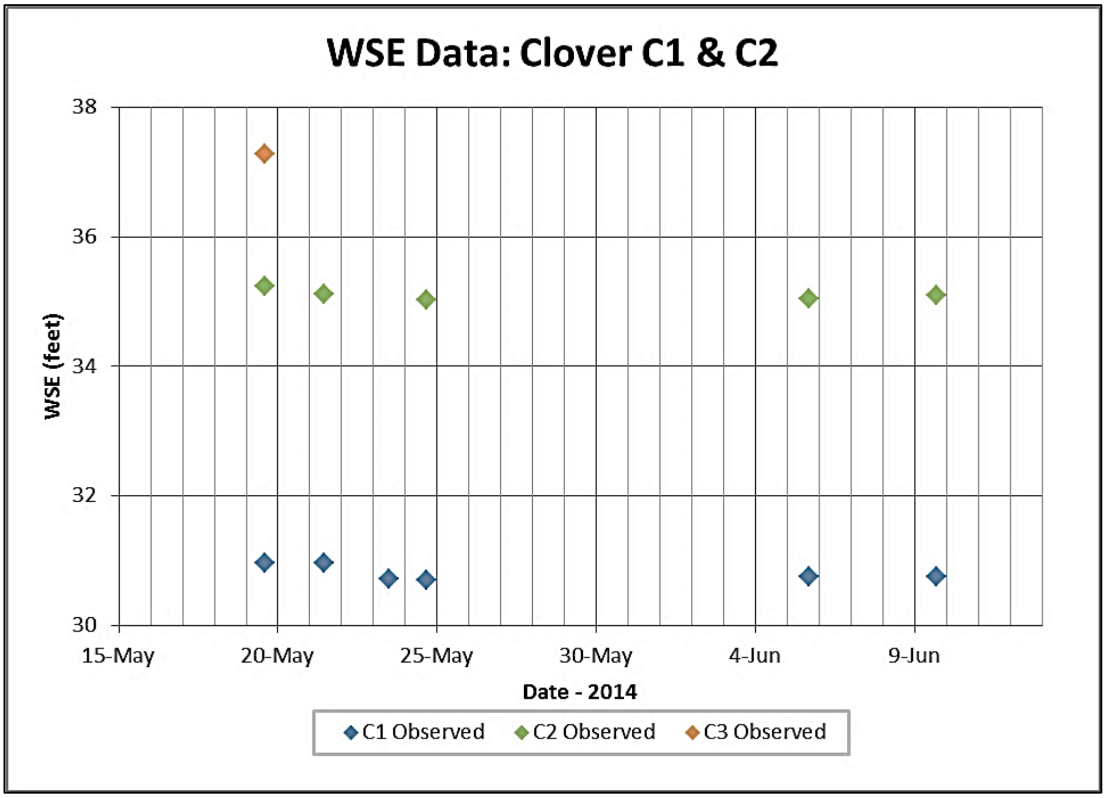
The PTs established within Clover C drainage did not receive sufficient water to record data. Gage readings occurred periodically from May 19 through June 9. Ponded water from local melt was observed; flow was not observed in the Clover C drainage. Photo 3.15 shows the Clover C2-A gage at the peak WSE on May 19. Table 3.8 summarizes the observations at the time of gage readings, and Graph 3.7 shows the WSE data for the Clover C gages.

Photo 3.15: Clover gage C2 at peak stage; May 19, 2014

Table 3.8: Clover C Gages 2014 Stage Data

Date	WSE (feet) [1]			Observations
	Clover C1	Clover C2	Clover C3	
19-May	30.96	35.24	37.27	Peak stage observed, ponded water, local melt
21-May	30.96	35.12	Dry	
23-May	30.72	Dry	Dry	
24-May	30.70	35.03	Dry	Ponded water, local melt at C2
5-Jun	30.75	35.04	Dry	
9-Jun	30.74	35.09	-	

Note:
1. Elevation not referenced to BPMSL
2. Dash (-) indicates no gage reading collected
3. Yellow highlight denotes peak stage



Graph 3.7: Clover C Gages 2014 Stage Data

4.0 DISCHARGE

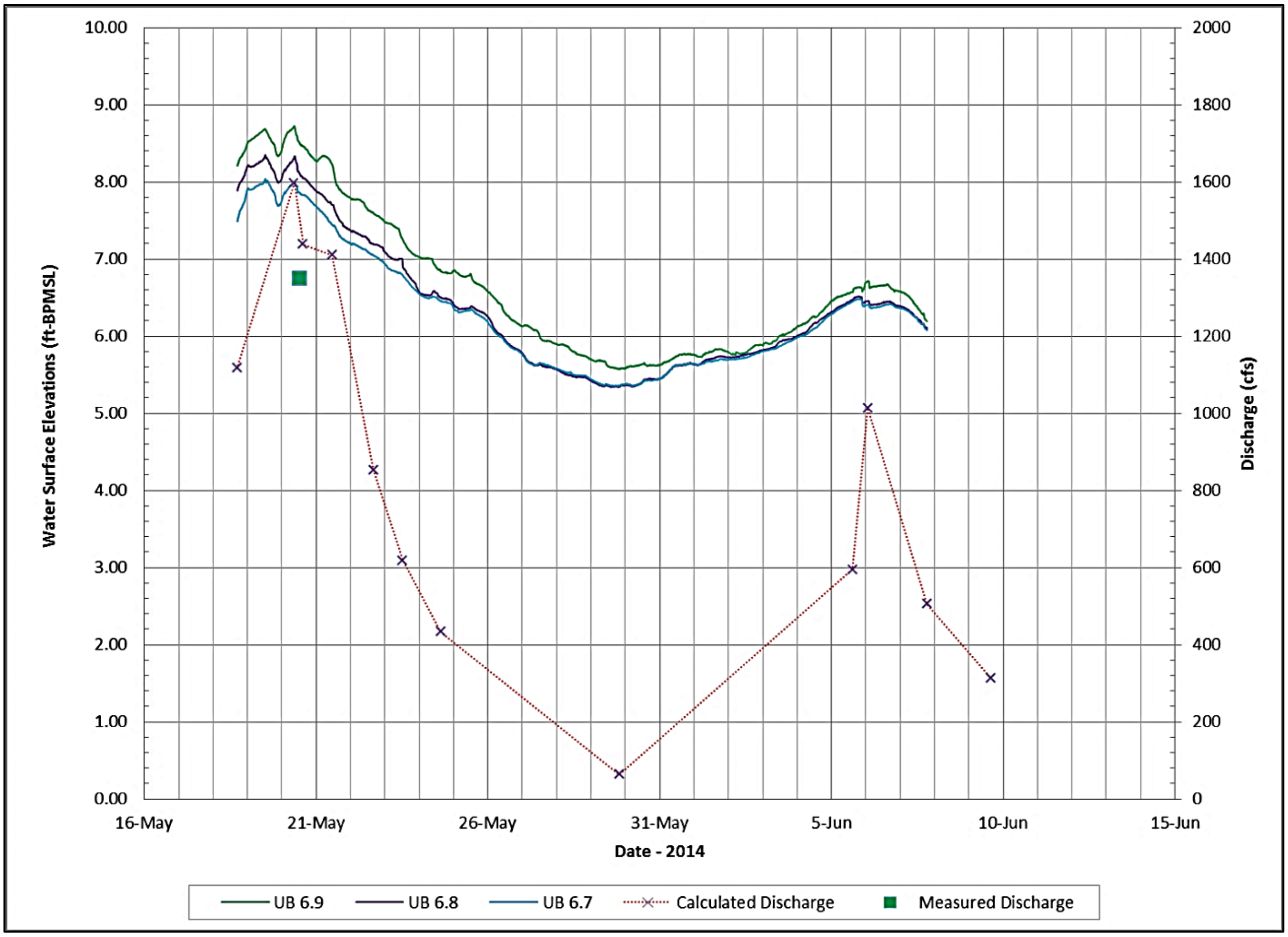
4.1 UBLUTUOCH (TINMIAQSIUGVIK) RIVER

Discharge was measured upstream of the proposed GMT Road Ublutuoch (Tinmiaqsiugvik) Bridge crossing near gage UB6.9 on May 20. The measured discharge was 1,350 cubic feet per second (cfs) with a corresponding stage of 8.10 feet BPMSL at UB6.8. Stage was falling at the time of measurement. Bottomfast ice was present in the main channel, and saturated snow extended approximately 30 feet into the channel from the right bank during the discharge measurement. The discharge measurement data is located in Appendix C.

Discharge was estimated using normal depth calculations. The accuracy of the method depends on conditions at the time of calculation, particularly the presence of snow, bottomfast ice and ice jam backwater effects. The presence of snow and bottomfast ice in the main channel impact river hydraulics by elevating the riverbed and raising WSEs above snow- and ice-free channel conditions. The snow and ice also affects the size and shape of the channel and roughness of the channel bottom. Bottomfast ice can persist long into the breakup flood. Because the ice and snow are melting during breakup, factors such as channel geometry, slope, and roughness continuously change until the channel is snow- and ice-free. These dynamic characteristics of the channel were documented in 2006 when channel profiles were measured daily during breakup.

Bottomfast ice loss or ablation was estimated by computing the heat flux from the water to the ice using water surface and water temperature data collected with PTs and measured velocities. The estimated ice ablation was used to select a representative cross section from the 2014 or 2006 measured cross sections for discharge computations. Peak discharge was estimated with normal depth computations using the energy grade-line slope as approximated by the water surface between UB6.7 and UB6.9, and the 2014 cross-sectional data collected during the discharge measurement at UB6.9. Hydraulic roughness values were back-calculated from the 2014 discharge measurement.

Estimated peak discharge for the Ublutuoch River is 1,600 cfs and occurred on May 20 with a corresponding WSE of 8.31 feet BPMSL at UB6.8. A summary of the calculated discharge results and corresponding WSE elevations is presented in Graph 4.1. The 2014 cross sectional geometry collected during direct discharge is located in Appendix B, B.1.



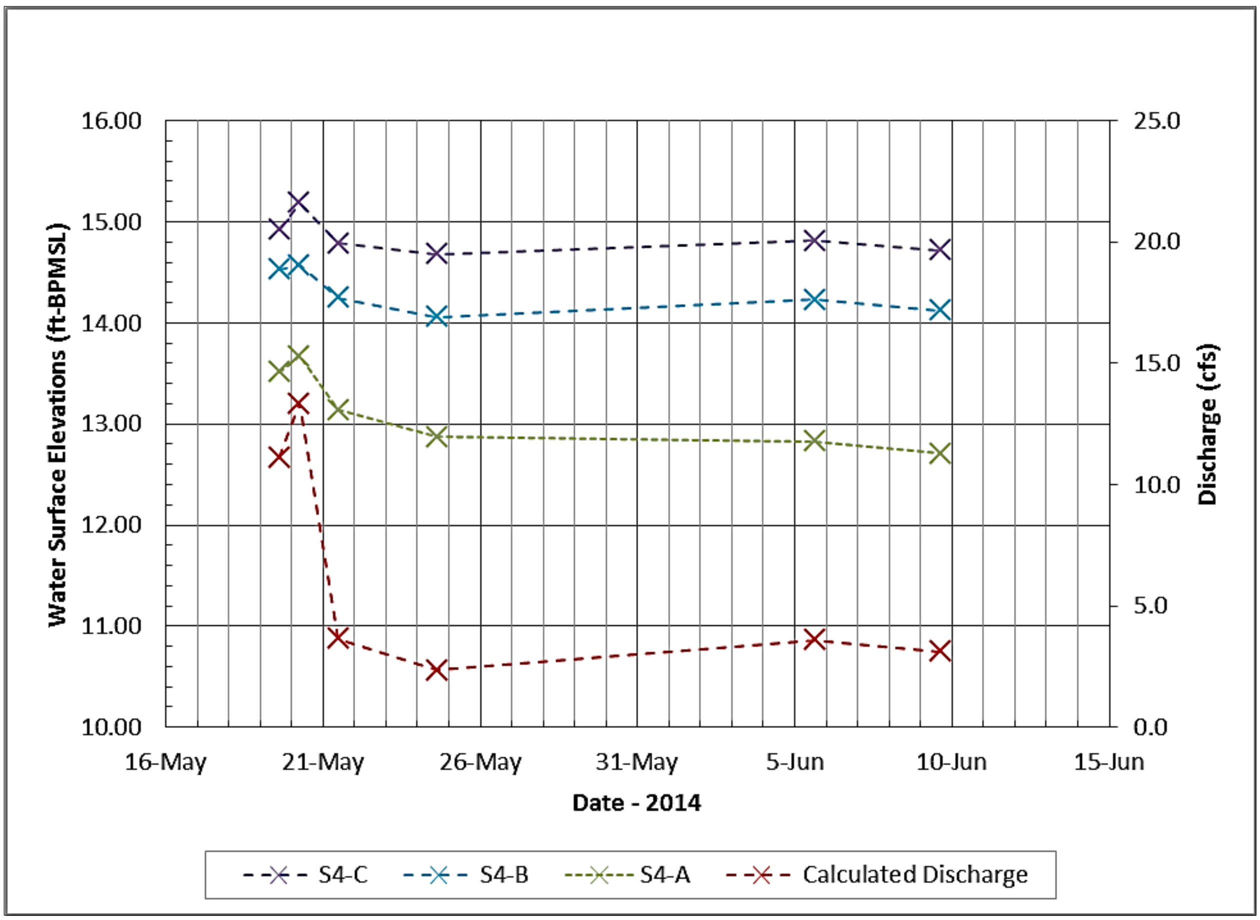
Graph 4.1: Ublutuoch River Discharge and Corresponding WSE

4.2 SMALL STREAMS

4.2.1 BARELY CREEK AT GAGE S4

Estimated peak discharge for Barely Creek at gage S4 is 13 cfs and occurred on May 20 with a corresponding WSE of 14.57 feet BPSML at S4-B. Discharge was estimated with normal depth computations using the energy grade-line slope as approximated by the water surface slope between S4-A and S4-C, the corresponding WSE at S4-B, and the 2010 cross-sectional data. The results are considered a high estimate because the calculations assume a snow- and ice-free channel. Saturated snow was present at the time, increasing stage above snow-free conditions.

A summary of calculated discharge results and corresponding WSE data is presented in Graph 4.2. The cross sectional geometry used in the calculation is located in Appendix B, B.2.

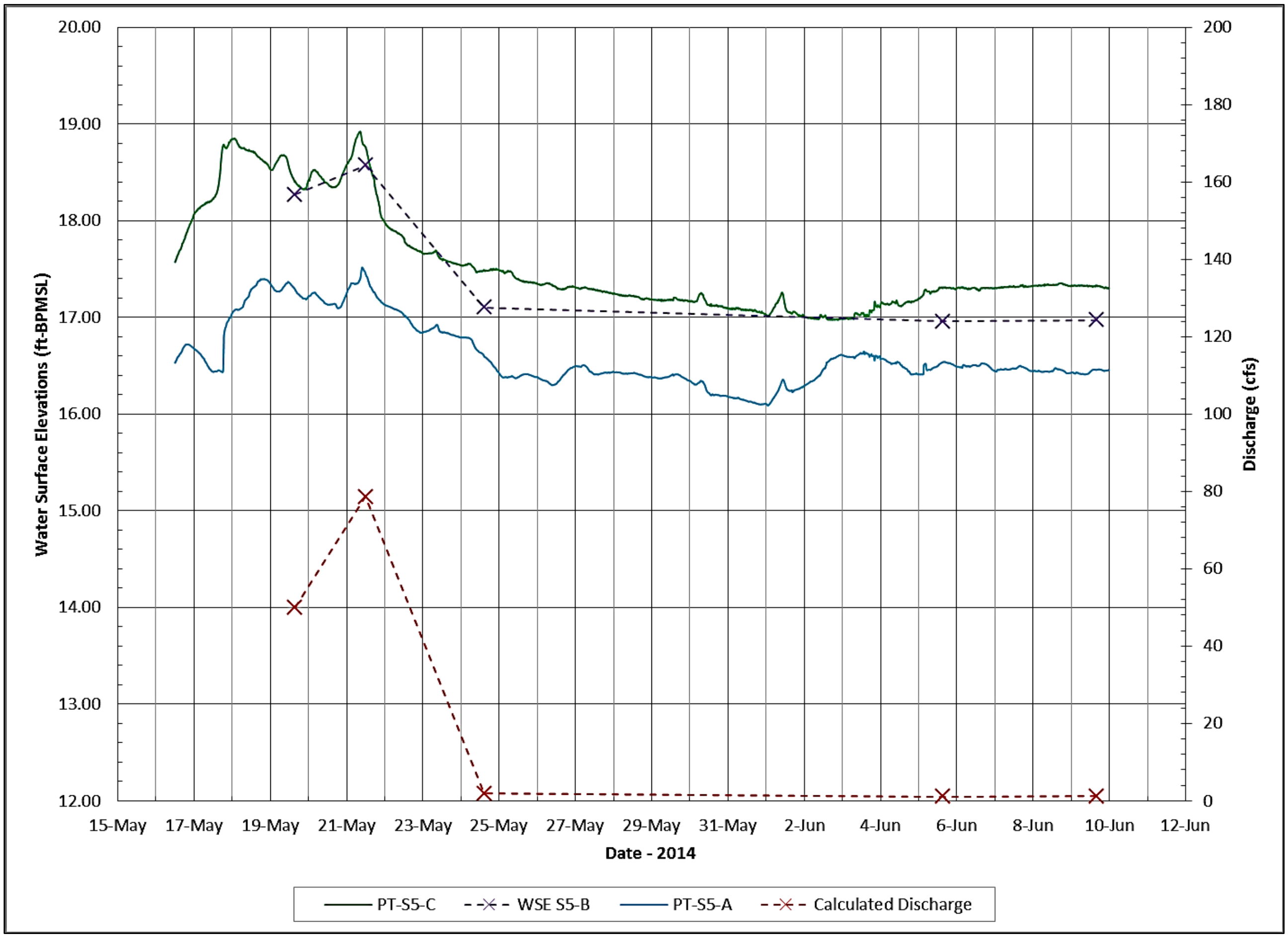


Graph 4.2: Barely Creek Calculated Discharge and Corresponding WSE

4.2.2 CREA CREEK AT GAGE S5

Estimated peak discharge for Crea Creek at gage S5 is 79 cfs and occurred on May 21 with a corresponding WSE of 18.57 feet BPMSL at S5-B. Discharge was estimated with normal depth computations using the energy grade-line slope as approximated by the water surface slope between S5-A and S5-C, the peak WSE at S5-B, and the 2010 cross-sectional data. The results are considered a high estimate because the calculations assume a snow- and ice-free channel. Saturated snow was present at the time, increasing stage above snow-free conditions.

A summary of indirect discharge results and peak WSE elevation data is presented in Graph 4.3. The cross sectional geometry used in the calculation is located in Appendix B, B.3.



Graph 4.3: Crea Creek Calculated Discharge and Corresponding WSE

5.0 BREAKUP TIMING AND MAGNITUDE

The timing and magnitude of breakup has been determined intermittently since 2001 by measuring WSE and discharge at locations throughout FCB. With 9-years of data since 2003, the Ublutuoch River gage at mile 6.8 provides the most consistent record of peak stage and discharge within the FCB.

In 2014, peak stage occurred on May 19, and peak discharge occurred on May 20. This was the earliest ocurrance of peak stage, and the fourth lowest peak discharge on record at UB6.8. The historic average date of peak stage is June 2, and June 3 is the average for peak discharge. The historic averages for peak stage and discharge at the downstream Ublutuoch River monitoring site are 9.25 feet BPSML and 2,250 cfs. Table 5.1 summarizes the peak stage and peak discharge data at gage UB6.8 from 2003 to 2014 and includes two years of additional data collected upstream at river mile (RM) 13.7.

Table 5.1: Ublutuoch River Historical Peak Discharge and WSE

Year	Location (RM)	WSE		Discharge		Reference
		Peak WSE (feet BPMSL)	Date	Peak Discharge (cfs)	Date	
2014	**6.8**	**8.34**	**19-May**	**1,600**	**20-May**	**This Report**
2013	6.8	9.83	5-Jun	2,110	5-Jun	Baker 2013
2011	6.8	9.39	2-Jun	2,350	2-Jun	Baker 2011
2010	6.8	10.38	8-Jun	5,360	8-Jun	Baker 2010
2009	6.8	8.45	29-May	1,990	30-May	Baker 2009
2006	6.8	6.19	7-Jun	1,290	6-Jun	Baker 2007
2005	6.8	10.01	7-Jun	1,680	9-Jun	Baker 2005b
2004	6.8	10.50	6-Jun	2,800	5-Jun	Baker 2005a
2003	6.8	10.14	6-Jun	1,300	9-Jun	Baker 2003
2002	13.7	18.22 [1]	22-May	1,900	22-May	URS 2003
2001	13.7	18.09 [1]	10-Jun	1,440	10-Jun	URS 2001

Note:
1. WSE measured at RM 13.7 are not comparable to WSE measured at RM 6.8
2. Yellow highlight denotes 2014 data

6.0 STAGE AND DISCHARGE FREQUENCY ANALYSIS

A flood and stage frequency analysis was performed to estimate the recurrence interval and magnitude of peak flood conditions on the Ublutuoch River at gage UB6.8. Flood frequency for Barely Creek at gage S4 and Crea Creek at gage S5 was also computed.

6.1 FLOOD FREQUENCY

This analysis applies USGS Region 7 regression equations using stream drainage area and empirical regional data. The results tend to be conservative when compared to site-specific data. Comparison to the historical record shows the Region 7 regression over-predicts flood recurrence intervals, particularly for the lower recurrence flood years when ice and snow have more effect on stage and discharge. A weighted flood frequency analysis was computed for the Ublutuoch River by weighting the regional regression results with the the historical data (Curran et al 2003).The Weibull statistical analysis of the historical record is also presented.

6.1.1 UBLUTUOCH RIVER

The estimated peak discharge of 1,600 cfs in the Ublutuoch River at UB6.8 corresponds to a less than 2-year recurrence interval based on the USGS regional regression analysis (Table 6.1), weighted flood frequency analysis (Table 6.2), and a 2-year recurrence interval based on the Weibull analysis (Table 6.3). The flood frequency analyses are plotted with the 2014 peak discharge in Graph 6.1.

Table 6.1: Ublutuoch River Regional Regression Flood Frequency Analysis Results

Recurrence Interval (Years)	Discharge (cfs)
	USGS Region 7 Regression Equations RM 6.8[1]
2	3,600
5	5,300
10	6,500
25	7,900
50	8,800
100	9,800

Note:
[1]Baker 2009
Drainage basin area is 228.3 square miles

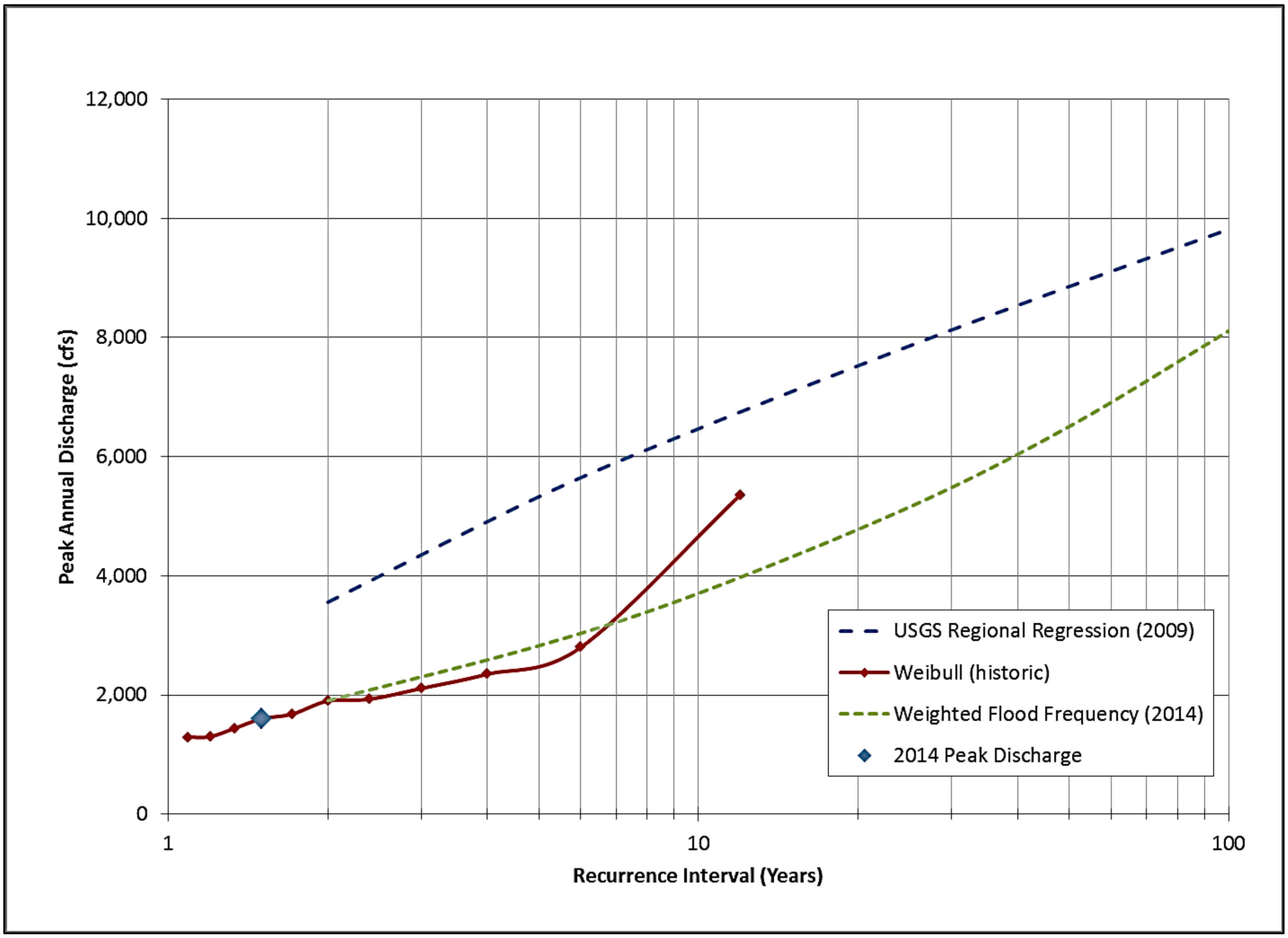
Table 6.2: Ublutuoch River Weighted Flood Frequency Analysis Results

Recurrence Interval (Years)	Discharge (cfs)
	Weighted Flood Frequency RM 6.8
2	1,900
5	2,800
10	3,700
25	5,100
50	6,500
100	8,100

Table 6.3: Ublutuoch River Weibull Analysis Recurrence Intervals of Historical Peak Discharge

Year	Discharge (cfs)	Probability	Recurrence Interval (Years)	Reference
2014	**1,600**	**0.67**	**2**	**This Report**
2013	2,110	0.33	3	Baker 2013
2011	2,350	0.25	4	Baker 2011
2010	5,360	0.08	12	Baker 2010
2009	1,930	0.42	2	Baker 2009
2006	1,290	0.92	1	Baker 2006
2005	1,680	0.58	2	Baker 2005
2004	2,800	0.17	6	Baker 2004
2003	1,300	0.83	1	Baker 2003
2002	1,900	0.50	2	URS 2003
2001	1,440	0.75	1	URS 2001

1. Yellow highlight denotes 2014 data



Graph 6.1: Ublutuoch River Peak Discharge and Discharge Frequency Estimates

6.1.2 Small Streams S4 and S5

The estimated peak discharge of 13 cfs calculated for Barely Creek at gage S4 corresponds to a less than 2-year recurrence interval (Table 6.4). The estimated peak of 79 cfs for Crea Creek at gage S5 also corresponds to a less than 2-year recurrence interval based on the USGS regression equations (Table 6.5).

Table 6.4: Barely Creek Flood Frequency Analysis Results at Gage S4

Recurrence Interval (Years)	Discharge (cfs)
	USGS Region 7 Regression Equations at S4
2	50
5	84
10	107
25	136
50	158
100	179
Note: Drainage basin area is 1.91 mi²	

Table 6.5: Crea Creek Flood Frequency Analysis Results at Gage S5

Recurrence Interval (Years)	Discharge (cfs)
	USGS Region 7 Regression Equations at S5
2	100
5	164
10	208
25	263
50	304
100	344
Note: Drainage basin area is 4.16 mi²	

6.2 Stage Frequency

Stage frequency for the Ublutuoch River at gage UB6.8 is estimated with three methods. A Log-Pearson type III stage frequency analysis was performed for the Ublutuoch River using 8-years of data from gage UB6.8. This analysis assumes open channel conditions; however, the Ublutuoch River is typically impacted by snow and ice. Stage data for rivers impacted by snow and ice is generally not extrapolated beyond the observed record (USACE 2002 and FEMA 2003). Annually, recurrence intervals are assigned to each of the current and historical peak stage values using the Weibull plotting equation (USACE 1982). In addition to the statistical analysis, a HEC-RAS model was developed in 2003, using the 2003 flood frequency analysis, to estimate the 100-year flood stage (Baker 2003).

Peak stage for a 100-year event at UB6.8 is estimated to be 12.5 feet BPMSL based on the 2003 HEC-RAS estimate. The 2014 peak WSE of 8.34 feet BPSML corresponds to a recurrence interval of less than 2-years based on Log-Pearson type III analysis and 1-year based on the historical data. The Log-Pearson type III stage frequency design values are presented in Table 6.6. Peak annual stage and Weibull recurrence interval is shown in Table 6.7. Both the historical Weibull and the Log-Pearson type III values are plotted for comparison with 2014 peak WSE and the HEC-RAS 100-year flood stage estimate in Graph 6.2.

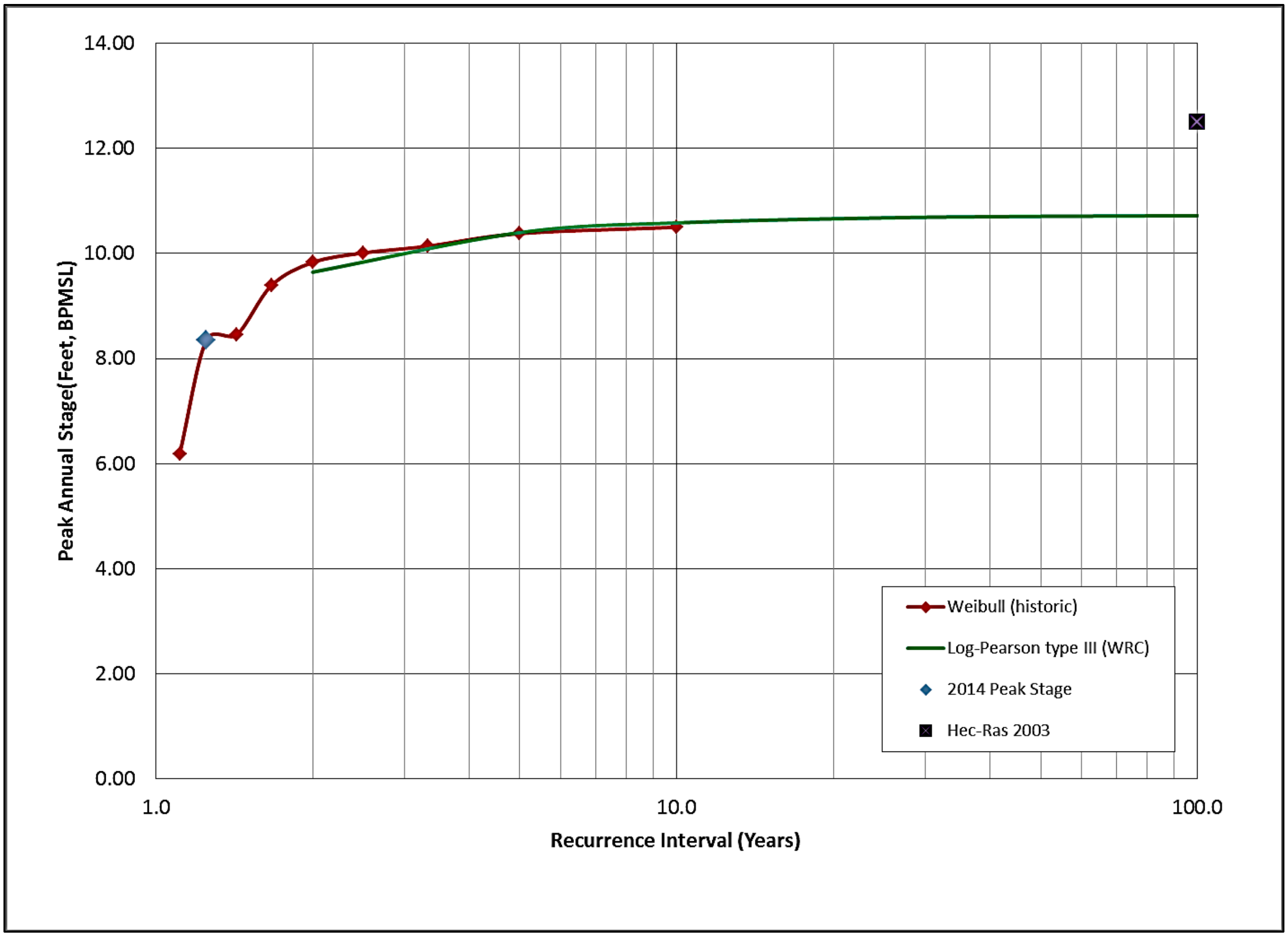
Table 6.6: Ublutuoch River UB6.8 Peak Annual Stage Estimates

Recurrence Interval (Years)	Peak Annual Stage (feet BPMSL)
	Log-Pearson Type III[1]
2	9.6
5	10.5
10	10.7
25	10.9
50	10.9
100	11.0

Table 6.7: Ublutuoch River Weibull Analysis Recurrence Intervals of Historical Peak Stage

Year	Peak Annual Stage (feet BPMSL)	Probability	Recurrence Interval (Years)	Reference
2014	**8.34**	**0.89**	**1**	**This Report**
2013	9.83	0.56	2	Baker 2013
2011	9.39	0.67	2	Baker 2011
2010	10.38	0.22	5	Baker 2010
2009	8.45	0.78	1	Baker 2009
2006	6.19	1.00	1	Baker 2006
2005	10.01	0.44	2	Baker 2005
2004	10.50	0.11	9	Baker 2004
2003	10.14	0.33	3	Baker 2003

1. Yellow highlight denotes 2014 data



Graph 6.2: Ublutuoch River Peak Stage and Stage Frequency Estimates

7.0 REFERENCES

Curran, et al. 2003. Curren J.H., Meyer, D.F., and Tasker, G.D. Estimating the magnitude and frequency of peak streamflows for ungaged sites on streams in Alaska and conterminous basins in Canada: U.S. Geological Survey Water-Resources Investigations Report 03-4188.

Federal Emergency Management Agency (FEMA). 2003. Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix F: Guidance for Ice-Jam Analysis and Mapping. April 2003.

Michael Baker Jr., Inc. (Baker). 2003. Alpine Satellites Development Plan 2003 Spring Breakup and Hydrologic Assessment. September 2003. Prepared for ConocoPhillips Alaska, Inc.

-------- 2004. Alpine Satellites Development Plan 2004 Spring Breakup and Hydrologic Assessment. Prepared for ConocoPhillips Alaska, Inc.

-------- 2005. Colville River Delta and Fish Creek Basin 2005 Spring Breakup and Hydrological Assessment. Prepared for ConocoPhillips Alaska, Inc.

-------- 2006. Colville River Delta Two-Dimensional Surface Water Model CD5 Update. February 2006. Prepared for ConocoPhillips Alaska, Inc.

-------- 2009. Greater Mooses Tooth 1 (GMT1) Alpine Satellite Project 2009 Spring Breakup Hydrologic Assessment. September 2009. Prepared for ConocoPhillips Alaska, Inc.

-------- 2010. 2010 Colville River Delta Spring Breakup 2010 Hydrologic Assessment. November 2010. Prepared for ConocoPhillips Alaska, Inc.

-------- 2011. 2011 Colville River Delta Spring Breakup 2011 Hydrologic Assessment. Prepared for ConocoPhillips Alaska, Inc.

-------- 2013. 2013 Fish Creek Basin Spring Breakup Monitoring and Hydrologic Assessment. Prepared for ConocoPhillips Alaska, Inc.

-------- 2014. 2014 Colville River Delta Spring Breakup Monitoring and Hydrologic Assessment. November 2014. Prepared for ConocoPhillips Alaska, Inc.

U.S. Army Corps of Engineers (USACE). 1982. Mixed Population Frequency Analysis Training Document-17, April 1982.

-------- 2002. Ice-Affected Stage Frequency. Engineering and Design Technical Letter No. 1110-2-576.

URS. 2001. 2001 Hydrologic and Hydraulic Assessment. Fish Creek, Judy Creek, and the Ublutuoch River, North Slope, Alaska. Prepared for ConocoPhillips Alaska, Inc.

-------- 2003. 2002 Hydrologic and Hydraulic Assessment. Fish Creek, Judy Creek, and the Ublutuoch River, North Slope, Alaska. Prepared for ConocoPhillips Alaska. USACE 2002.

U.S. Geolocical Survey (USGS). 1982. Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge. Water-Supply Paper 2175.

-------- 1999a. Office of Surface Water Hydraulic Laboratory Technical Memorandum No. 99.05.

-------- 1999b. Office of Surface Water Hydraulic Laboratory Technical Memorandum No. 99.06.

Appendix A Gage Locations, Vertical Control , and Pressure Transducer Methods

A.1 2014 Gage Locations

Gage Site	Gage	Latitude (NAD 83)	Longitude (NAD 83)	Basis of Elevation (Vertical Control Name)
UB6.7	UB6.7-A[1]	N 70.2853°	W 151.263°	JACK
	UB6.7-B	N 70.2853°	W 151.2631°	
	UB6.7-C	N 70.2852°	W 151.2632°	
	UB6.7-D	N 70.2851°	W 151.2633°	
UB6.8	UB6.8-A[1]	N 70.2845°	W 151.2604°	JACK
	UB6.8-B	N 70.2845°	W 151.2605°	
	UB6.8-C	N 70.2844°	W 151.2606°	
	UB6.8-D[2]	N 70.2843°	W 151.2614°	
UB6.9	UB6.9-A[1]	N 70.2834°	W 151.2578°	JACK
	UB6.9-B	N 70.2834°	W 151.2579°	
	UB6.9-C	N 70.2834°	W 151.258°	
UB11.45	UB11.45-A[1]	N 70.2566°	W 151.2544°	GUTZWILLER
	UB11.45-B	N 70.2566°	W 151.2544°	
	UB11.45-C	N 70.2566°	W 151.2544°	
	UB11.45-D	N 70.2566°	W 151.2545°	
	UB11.45-E	N 70.2567°	W 151.2545°	
UB11.6	UB11.6-A[1]	N 70.2562°	W 151.2621°	GUTZWILLER
	UB11.6-B	N 70.2562°	W 151.2621°	
	UB11.6-C	N 70.2562°	W 151.2621°	
	UB11.6-D	N 70.2562°	W 151.2621°	
	UB11.6-E	N 70.2562°	W 151.2623°	
S3	S3-A	N 70.2961°	W 151.2367°	MON31
S4	S4-A[1]	N 70.2818°	W 151.2927°	CHAR
	S4-B	N 70.2811°	W 151.2938°	
	S4-C[1]	N 70.2804°	W 151.2955°	
S5	S5-A[1]	N 70.2804°	W 151.3306°	CLARA
	S5-B	N 70.2797°	W 151.3301°	
	S5-C[1]	N 70.2792°	W 151.3302°	
S6	S6-A	N 70.2772°	W 151.3685°	CAID BRAD
	S6-B	N 70.2766°	W 151.36861°	
	S6-C	N 70.2762°	W 151.3671°	

Notes:
[1] Pressure Transducer
[2] Barometric Pressure Sensor
NAD 83 – North American Datum of 1983

A.1 2014 Gage Locations (continued)

Gage Site	Gage	Latitude (NAD 83)	Longitude (NAD 83)	Basis of Elevation (Vertical Control Name)
S7	S7-A	N 70.2722°	W 151.3928°	S6-B
GMT2	GMT2-A[1]	N 70.17°	W 151.6614°	BRYNN LOGAN MADISON
Clover B1	Clover B1-A[1] Clover B1-B Clover B1-C	N 70.2545° N 70.2545° N 70.2545°	W 151.2386° W 151.2384° W 151.2387	MEG CLARK
Clover B2	Clover B2-A[1]	N 70.2516°	W 151.2364°	MEG CLARK
Clover B3	Clover B3-A	N 70.2496°	W 151.2308°	MEG CLARK
Clover B4	Clover B4-A	N 70.2482°	W 151.2326°	MEG CLARK
Clover C1	Clover C1-A[1]	N 70.2509°	W 151.2533°	SHOCKER EICKELMAN
Clover C2	Clover C2-A[1]	N 70.2492°	W 151.2447°	SHOCKER EICKELMAN
Clover C3	Clover C3-A	N 70.2481°	W 151.2399°	SHOCKER EICKELMAN

Note:
[1] Pressure Transducer
NAD 83 – North American Datum of 1983

A.2 2014 Vertical Control

Control	Elevation (feet BPMSL)	Latitude (NAD 83)	Longitude (NAD 83)	Control Type	Reference
BRAD	25.780	N 70.2771°	W 151.3696°	Alcap	LCMF 2005
BRYNN	**89.272**	**N 70.1698°**	**W 151.6615°**	**Alcap**	**BAKER 2010**
CAID	25.420	N 70.2759°	W 151.3679°	Alcap	BAKER 2005
CHAR	25.248	N 70.2819°	W 151.2949°	Alcap	LCMF 2009
CLARA	23.228	N 70.2804°	W 151.3331°	Alcap	LCMF 2009
CLARK	**47.293**	**N 70.2546°**	**W 151.2394°**	**Alcap**	**BAKER 2010**
EICKELMAN	**36.542**	**N 70.2506°**	**W 151.2532°**	**Alcap**	**BAKER 2010**
GUTZWILLER	**100.000**	**N 70.2568°**	**W 151.2592°**	**Alcap**	**BAKER 2010**
JACK	23.450	N 70.2821°	W 151.2646°	Alcap	LCMF 2005
LOGAN	**90.000**	**N 70.1698°**	**W 151.6624°**	**Alcap**	**BAKER 2010**
MADISON	**90.137**	**N 70.1695°**	**W 151.6621°**	**Alcap**	**BAKER 2010**
MEG	**46.984**	**N 70.2546°**	**W 151.2392°**	**Alcap**	**BAKER 2010**
MON31	26.891	N 70.3051°	W 151.1992°	Capped Drillstem	BAKER 2014
SHOCKER	**36.216**	**N 70.2505°**	**W 151.2526°**	**Alcap**	**BAKER 2010**

Notes:
1. Elevations for control in bold were set by handheld GPS and are not referenced to BPMSL
2. NAD 83 – North American Datum of 1983

A.3 Pressure Transducer Setup and Testing Methods

The PTs measure the absolute pressure of the atmosphere and water, allowing the depth of water above the sensor to be calculated. Resulting data yield a comprehensive record of the fluctuations in stage. The reported pressure datum is the sum of the forces imparted by the water column and atmospheric conditions. A correction of barometric pressure was obtained from the In-Situ BaroTROLL® sensor installed at UB6.8.

The PTs were tested before field mobilization. The PTs were configured using Win-Situ® LT 5.6.21.0 (for the Level TROLL 500s) or Solinst Levelogger® v4.0.3 (for the Solinst Leveloggers) software prior to placement in the field. Absolute pressure was set to zero. The PT sensor was surveyed during setup to establish a vertical datum using local control.

The PT-based stage values were determined by adding the calculated water depth and the surveyed sensor elevation. Gage WSE readings were used to validate and adjust the data collected by the PTs. PTs have the potential to drift and can be affected by ice floe impacts. A standard conversion using the density of water at 0°C was used to calculate all water depths from adjusted gage pressures. Fluctuations in water temperature during the monitoring period did not affect WSE calculations because of the limited range in temperature and observed water depths.

Appendix B Cross-Sectional Geometry

B.1 Ublutuoch River Gage UB6.9 Plan and Profile

ConocoPhillips Alaska

Feet 0 250 500

Date:	11/11/2014	Project:	141364
Drawn:	MEA	File:	UB_6.9_Plan
Checked:	GCY	Scale:	1 in = 500 feet

Legend

Gage Location — Proposed Road

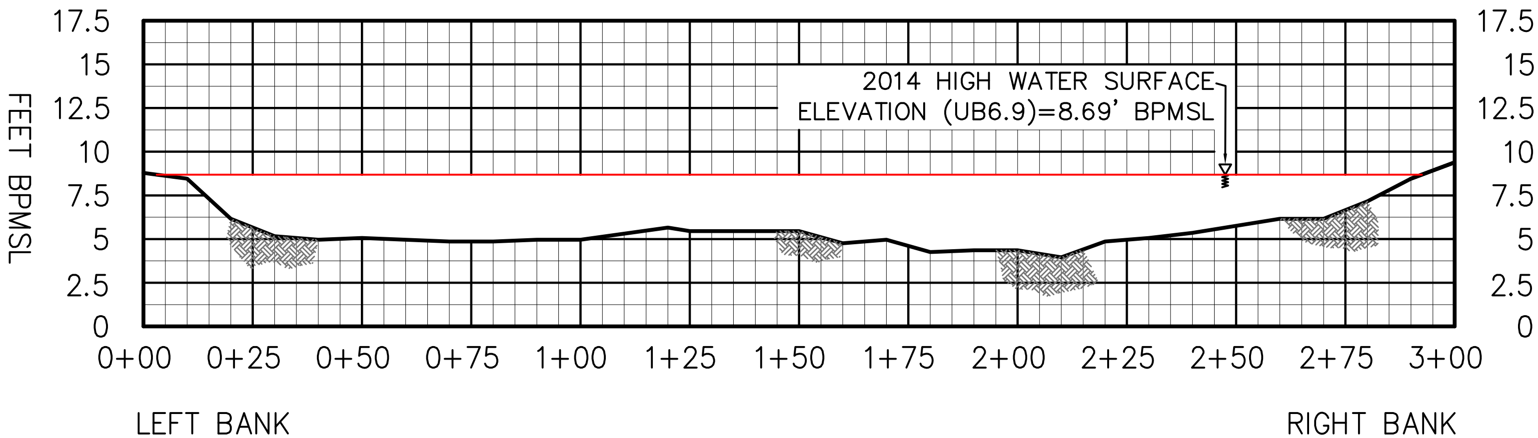
Michael Baker INTERNATIONAL

Michael Baker Jr., Inc.
3900 C Street, Suite 900
Anchorage, AK 99503
Phone: (907) 273-1600
Fax: (907) 273-1699

2014 FCB Breakup
Ublutuoch River Gages
Plan View

(SHEET 1 of 2)

NOTES
1. BASIS OF ELEVATION, CP09-11-09B.
2. CHANNEL PROFILE MEASUREMENTS COMPLETED MAY 2014 BY GCY, MNU AND KMB



1 FISH CREEK BASIN – UBLUTUOCH RIVER UPSTREAM CROSS SECTION

0 50 100

HORIZONTAL SCALE IN FEET

ConocoPhillips Alaska, Inc.

DATE:	11/12/2014	PROJECT:	141364
DRAWN:	MNU	FILE:	UB 6.9 X-SECT.DWG
CHECKED:	GCY	SCALE:	AS SHOWN

Michael Baker INTERNATIONAL
Michael Baker Jr., Inc.
A Unit of Michael Baker International
3900 C Street, Suite 900
Anchorage, Alaska 99503
Phone: (907) 273-1600
Fax: (907) 273-1699

2014 FCB BREAKUP
UBLUTUOCH RIVER
UPSTREAM CROSSING SECTION

(SHEET 2 OF 2)

B.2 Barely Creek Gage S4 Plan and Profile

ConocoPhillips Alaska

Feet
0 250 500

Date:	11/11/2014	Project:	141364
Drawn:	MEA	File:	S4-B_Gage_Plan
Checked:	GCY	Scale:	1 in = 500 feet

Legend

Gage Location — Proposed Road

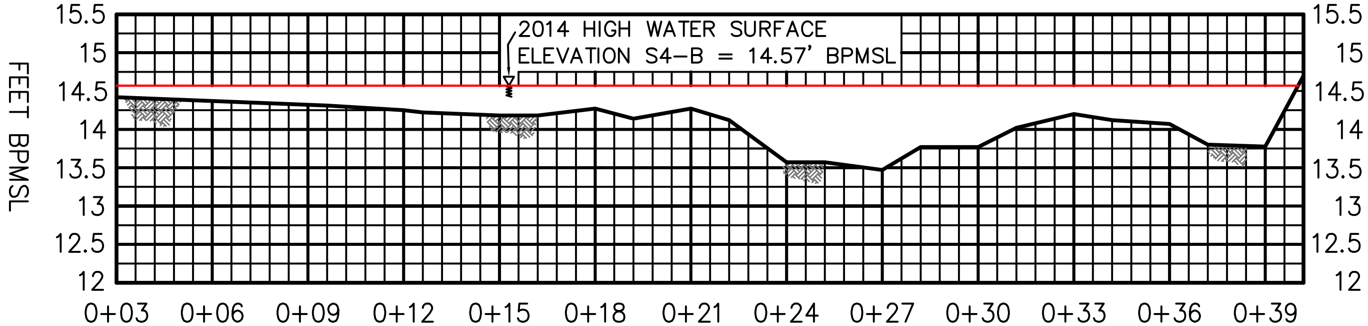
Michael Baker INTERNATIONAL

Michael Baker Jr., Inc.
3900 C Street, Suite 900
Anchorage, AK 99503
Phone: (907) 273-1600
Fax: (907) 273-1699

2014 FCB Breakup
Barely Creek Gages
Plan View

(SHEET 1 of 2)

NOTES
1. BASIS OF ELEVATION, CP09-11-09B.
2. CHANNEL PROFILE MEASUREMENTS COMPLETED JUNE 2010 BY JPM, HLR, AND EJK



(1) FISH CREEK BASIN – BARELY CREEK CENTERLINE CROSS SECTION

0 9 18

HORIZONTAL SCALE IN FEET

ConocoPhillips Alaska, Inc.

DATE: 11/12/2014	PROJECT: 141364
DRAWN: SAC	FILE: S4 X-SECT.DWG
CHECKED: MNU	SCALE: AS SHOWN

Michael Baker INTERNATIONAL
Michael Baker Jr., Inc.
3900 C Street, Suite 900
Anchorage, Alaska 99503
Phone: (907) 273-1600
Fax: (907) 273-1699

2014 FCB BREAKUP

BARELY CREEK CENTERLINE CROSS SECTION

(SHEET 2 OF 2)

B.3 Crea Creek Gage S5 Plan and Profile

ConocoPhillips Alaska

Feet
0 250 500

Date:	11/11/2014	Project:	141364
Drawn:	MEA	File:	S5-B_Gage_Plan
Checked:	GCY	Scale:	1 in = 500 feet

Legend

Gage Location
Proposed Road

Michael Baker INTERNATIONAL

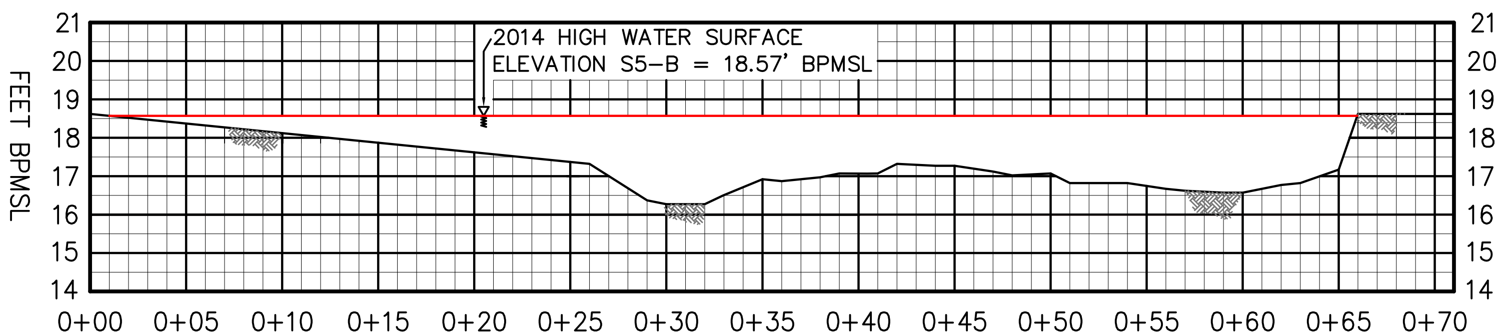
Michael Baker Jr., Inc.
3900 C Street, Suite 900
Anchorage, AK 99503
Phone: (907) 273-1600
Fax: (907) 273-1699

2014 FCB Breakup
Crea Creek Gages
Plan View

(SHEET 1 of 2)

NOTES

1. BASIS OF ELEVATION, CP09-11-09B.
2. CHANNEL PROFILE MEASUREMENTS COMPLETED JUNE 2010 BY JPM, HLR, AND EJK



1 FISH CREEK BASIN – CREA CREEK CENTERLINE CROSS SECTION

0 10 20

HORIZONTAL SCALE IN FEET

ConocoPhillips Alaska, Inc.

DATE:	11/12/2014	PROJECT:	141364
DRAWN:	SAC	FILE:	S5 X-SECT.DWG
CHECKED:	MNU	SCALE:	AS SHOWN

Michael Baker INTERNATIONAL
Michael Baker Jr., Inc.
3900 C Street, Suite 900
Anchorage, Alaska 99503
Phone: (907) 273-1600
Fax: (907) 273-1699

2014 FCB BREAKUP

CREA CREEK CENTERLINE CROSS SECTION

Appendix C Discharge Measurement Notes

C.1 Ublutuoch River at Gage UB6.9

Michael Baker INTERNATIONAL

Discharge Measurement Notes

Date: May 20, 2014
Computed By: KMB
Checked By: SMC

Location Name: Ublutuoch 6.9

Party: GCY, MNU, KMB
Start: 11:00
Finish: 14:40

Temp: 34 °F
Weather: Sunny, 7 knot wind

Channel Characteristics:

Width: 260 ft
Area: 872 sq ft
Velocity: 1.54 fps
Discharge: 1346 cfs

Method: USGS Midsection
Number of Sections: 25
Count: N/A

Spin Test: Passed after 180 seconds
Meter: MJBA01

GAGE READINGS			
Gage	Start	Finish	Change
UB6.9	8.54	8.46	0.08
UB6.8	8.14	8.05	0.09

Meter: 0.5 ft above bottom of weight

Weight: 30 lbs

Wading **Cable** Ice **Boat**

Upstream Downstream side of bridge

GPS Data:

Left Edge of Water: N 70.2836 °, W 150.2582 °
Right Edge of Water: N 70.2840 °, W 150.2564 °

LE Floodplain: ° ' . "
RE Floodplain: ° ' . "

Measurement Rated: Excellent Good Fair **Poor** based on "Descriptions"

Descriptions:

Cross Section: Saturated snow extends 30 feet out on right bank

Flow:

Remarks: Water level dropping throughout day.

Water depths at stations 115 through 140 were impacted by thick willow and were not obtained in the field. Velocities were measured at the surface for these stations, and depths were acquired from the 2006 cross section. The mean velocity for these stations was estimated using a vertical logarithmic velocity profile established from adjacent measurements with similar bottom type and depths.

Angle Coeff	Distance from initial point (ft)	Section Width (ft)	Water Depth (ft)	Observed Depth (ft)	Revolution Count	Time Increment (sec)	VELOCITY At Point (fps)	Mean in Vertical (fps)	Adjusted for Angle Coeff (fps)	Area (s.f.)	Discharge (cfs)
Start at LEW @ 11:00											
1.00	10	5.0	2.3	1.4	20	50	0.90	0.90	0.90	11.5	10.35
0.98	20	10.0	3.3	2.6 0.7	25 25	49 45	1.14 1.24	1.19	1.17	33.0	38.57
1.00	30	10.0	3.5	2.8 0.7	20 25	49 49	0.92 1.14	1.03	1.03	35.0	36.06
1.00	40	15.0	3.4	2.7 0.7	25 20	55 46	1.02 0.98	1.00	1.00	51.0	50.91
0.99	60	15.0	3.6	2.9 0.7	25 20	48 43	1.17 1.04	1.10	1.09	54.0	59.06
0.99	70	10.0	3.6	2.9 0.7	25 25	47 44	1.19 1.27	1.23	1.22	36.0	43.86
0.99	80	10.0	3.5	2.8 0.7	20 20	47 45	0.96 1.00	0.98	0.97	35.0	33.85
0.98	90	15.0	3.5	2.8 0.7	3 25	68 55	0.12 1.02	0.57	0.56	52.5	29.20
0.92	110	12.5	2.8	2.2 0.6	25 25	57 47	0.98 1.19	1.09	1.00	35.0	35.02
0.94	115	10.0	3.0	0.0	30	44	1.52	1.35	1.27	30.0	38.18
0.94	130	12.5	3.4	0.0	30	45	1.49	1.32	1.24	42.5	52.89
0.99	140	10.0	3.5	0.0	30	45	1.49	1.32	1.31	35.0	45.88
0.99	150	10.0	3.7	3.0 0.7	30 50	46 45	1.46 2.47	1.96	1.94	37.0	71.86
1.00	160	10.0	3.5	2.8 0.7	40 50	50 46	1.78 2.41	2.10	2.10	35.0	73.43
1.00	170	10.0	4.2	3.4 0.8	50 50	50 45	2.22 2.47	2.35	2.35	42.0	98.49
1.00	180	10.0	4.1	3.3 0.8	50 50	51 43	2.18 2.58	2.38	2.38	41.0	97.60
1.00	190	10.0	4.1	3.3 0.8	50 60	54 51	2.06 2.61	2.34	2.34	41.0	95.75
1.00	200	10.0	4.5	3.6 0.9	40 50	48 43	1.86 2.58	2.22	2.22	45.0	99.82
1.00	210	10.0	3.6	2.9 0.7	40 50	50 44	1.78 2.52	2.15	2.15	36.0	77.49
1.00	220	10.0	3.4	2.7 0.7	40 50	50 46	1.78 2.41	2.10	2.10	34.0	71.33
1.00	230	10.0	3.1	2.5 0.6	40 50	57 49	1.57 2.27	1.92	1.92	31.0	59.41
1.00	240	10.0	2.7	2.2 0.5	30 50	46 53	1.46 2.10	1.78	1.78	27.0	47.97
1.00	250	10.0	2.3	1.4	40	55	1.62	1.62	1.62	23.0	37.29
1.00	260	10.0	2.3	1.4	40	58	1.54	1.54	1.54	23.0	35.38
1.00	270	5.0	1.3	0.8	30	66	1.02	1.02	1.02	6.5	6.63
	280-300		Saturated Snow								
End at REW @ 14:40											

Total Discharge: **1346.27** cfs

2014 Fish Creek Basin Spring Breakup Monitoring and Hydrological Assessment