Willow Master Development Plan

Appendix D.3C
Ice Bridge Plan

January 2023

2022 Summary Report – Ocean Point Discharge and Water Quality

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2022

Summary Report

Ocean Point
Discharge and Water Quality

PREPARED BY:

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ConocoPhillips Alaska

MSA Contract No. 296937

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ACRONYMS & ABBREVIATIONS

% sat ..... percent saturation

°C ..... degrees Celsius

cfs ..... cubic feet per second

CPAI ..... ConocoPhillips Alaska, Inc.

DO ..... dissolved oxygen

ft ..... feet

ft/s ..... feet per second

ICE ..... ICE Design & Consult

µS/cm ..... microsiemens per centimeter

mg/L ..... milligrams per liter

Michael Baker ..... Michael Baker International

NAVD88 ..... North American Vertical Datum of 1988

Ocean Point Upstream ..... the South transect, Transect #1, the Rolligon crossing, the west crossing, the upstream crossing, Ocean Point South

NES ..... Northern Energy Services

ppt ..... parts per thousand

Q ..... discharge

UMIAQ ..... UMIAQ, LLC

USGS ..... United States Geological Survey

Willow ..... Willow Project

WSE ..... water surface elevation

1.0 INTRODUCTION

Michael Baker International (Michael Baker) collected water resources data for Conoco Phillips Alaska, Inc. (CPAI) in support of the Willow Project (Willow). The proposed ice road crossing of the Colville River was investigated at Ocean Point. During winter of 2022, data was collected in six field events. This report summarizes the methods and results of that effort.

ICE Design & Consult (ICE), Northern Energy Services (NES), and UMIAQ, LLC (UMIAQ) provided support during the field program and contributed to a safe and productive field season.

2.0 CROSSING LOCATION

The Ocean Point Upstream transect near Ocean Point was investigated this year and is shown in Figure 1. This transect was selected based on shallow water depths relative to the other transects investigated in previous years. Ocean Point Upstream (also historically referred to as “Transect #1”, the “Rolligon crossing”, the “west crossing”, the “upstream crossing”, “Ocean Point South”) is an historic ice and snow road crossing location. It was the location of a snow road during the 2018-2019 season, an ice road crossing for Cruz Construction during the 2020-21 season and a snow road crossing for Cruz Construction during 2021-22. This is the preferred proposed crossing location.

Table 1 provides a summary of dates and data collected at the transect. Table 2 provides a summary of measurements collected.

Table 1: Field Events

Data Collection	9/5/2019	12/31/2019	2/25/2020	4/14/2020	2/17/2021	3/10/2021	4/8/2021	4/21/2021	2/16/2022	3/3/2022	3/15/2022	3/30/2022	4/12/20212	4/27/2022
discharge	Yes	Yes	Yes	ND[b]	Yes	Yes	ND[a]	ND[a]	Yes	Yes	Yes	ND[a]	ND[a]	ND[a]
water quality	Yes	Yes	Yes	ND[b]	No	Yes	ND[a]	ND[a]	Yes	Yes	Yes	ND[a]	ND[a]	ND[a]
water surface elevation survey	Yes	No	Yes	ND[b]	No	Yes	ND[a]	ND[a]	Yes	Yes	No	ND[a]	ND[a]	ND[a]

Notes: ND (no data).

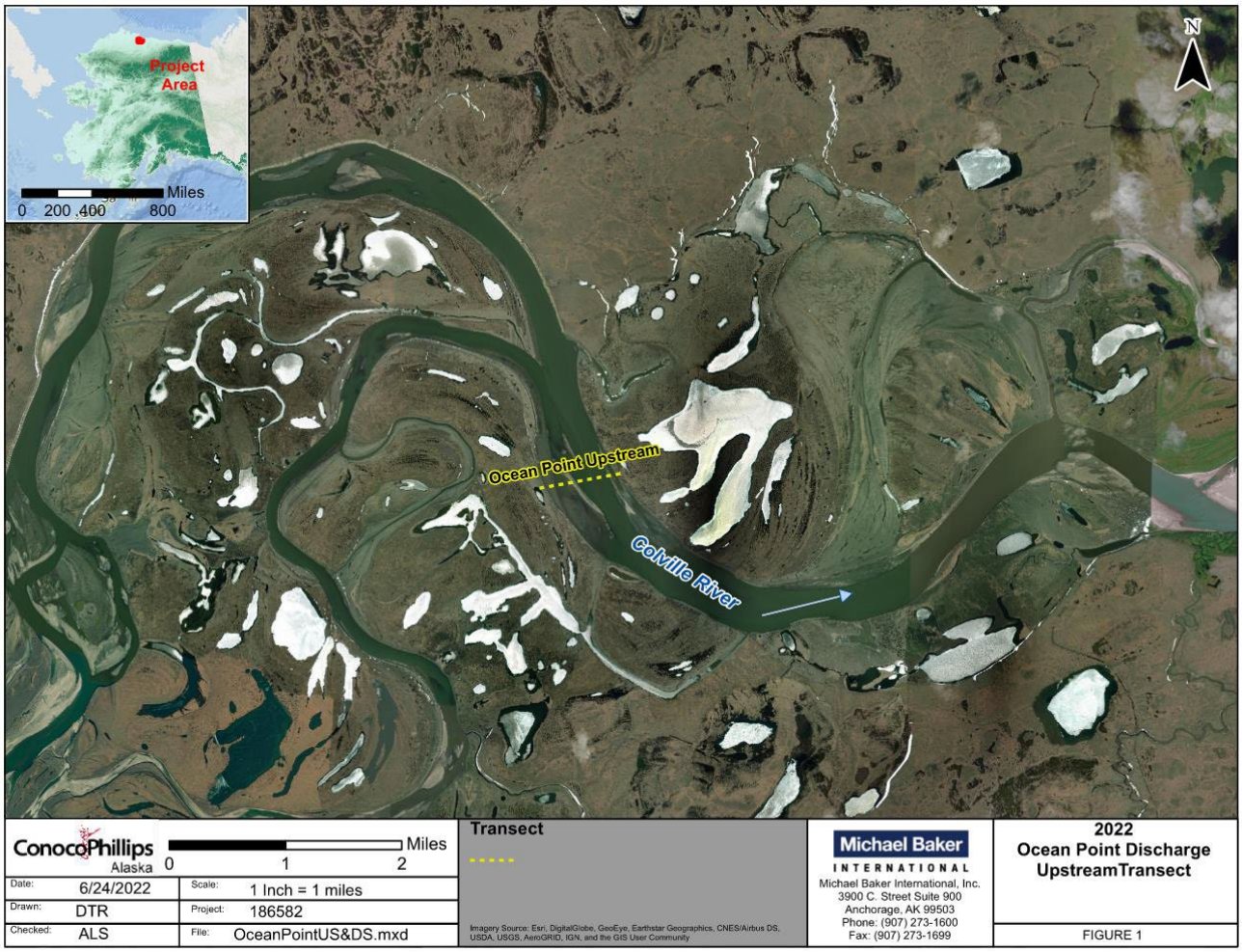
[a] Channel ice was grounded to the riverbed during field event.

[b] Planned field event was cancelled.

Table 2: Data Collected

Data Type	Data Collected	Units
Discharge	water depth	ft
	water depth, under ice	ft
	ice thickness	ft
	snow depth	ft
	freeboard	ft
	flow width	ft
	velocity	ft/s
	discharge	cfs
Water Quality	temperature	°C
	conductivity	µS/cm
	specific conductance	µS/cm
	salinity	ppt
	dissolved oxygen	% sat
	dissolved oxygen	mg/L
Water Surface Elevation	water surface elevation	ft NAVD88

Figure 1: Colville River Ocean Point Upstream Transect



3.0 METHODS

Field sampling methods were based on United States Geological Survey (USGS 2006a and 2006b) methods. Safety precautions were followed using the North Slope Water Resources 2021 Health, Safety, and Environment Plan (Michael Baker 2021a) and the 2021-2022 Winter Hydrology Programs – Job Safety Analysis (Michael Baker 2021b).

Measuring discharge under ice cover is subject to limitations not applicable to open water measurements. Unlike open water where it is obvious where the edge of water exists, it is not possible to see the extents of the cross-sectional area of flow under the ice. Further, it is not possible to profile the entire measurable cross-section since velocity measurements are limited to only where holes are drilled through the ice. It is assumed that the cross-sectional area is reasonably uniform upstream, downstream, and between measurement stations. However, the potential exists for "unseen" grounded or relatively shallow areas which would influence measured velocity direction and magnitude if occurring upstream or downstream of a measurement station. Grounded areas between measurement stations would reduce the estimated cross-sectional area of flow and resulting discharge.

Six field trips were performed to investigate the trend in discharge and water quality over the course of the ice-cover season. The ice-cover season typically initiates with freeze-up in mid-October and ends with spring breakup in mid-May. Ice-cover field events were one day apiece. The trips ranged from Mid-February to the end of April.

A one-person Michael Baker field crew conducted all events, supported by an ICE engineer who performed crossing bathymetric profiling. UMIAQ and NES provided transportation to the sampling locations and general field support. The sites were accessed by Hägglund and Rolligon.

Thermal drill probing was performed by ICE to identify the extents of under-ice water bounded by ice grounded against the channel bed. Water measurements were facilitated by mechanically drilling through the river ice. Investigation of soils or groundwater within the channel bed was not performed. Discharge was determined using USGS mid-section techniques. Velocity was measured using a handheld Hach flow meter. The meter was attached to a fixed rod and lowered to 60% of the water depth below the ice. In-situ water quality measurements were collected at the deepest section. Field crew used a YSI ProSolo meter to collect temperature, conductivity, salinity, and dissolved oxygen. Measurements were taken at multiple depths throughout the water column, if possible.

Photo 3.2: Crew measuring ice thickness; 3/15/22

Previously submitted ice cover season field data is provided in Attachment A including ICE profiles of the crossing for all six trips.

4.0 RESULTS AND CONCLUSIONS

A summary of Colville River water resources information collected at Ocean Point during the 2021-2022 winter field season is provided below. No overflow, aufeis, or evidence of any other notable hydraulic occurrence was observed at the transect during the ice-cover field events. Discharge decreased as the ice-cover season progressed.

4.1 DISCHARGE MEASUREMENTS

The first field event occurred on February 16. ICE profiled the crossing and Michael Baker measured velocity through 4 holes before the velocity meter battery malfunctioned due to the cold temperatures. Two main flow paths were identified at the crossing: the main channel and the western path. Freeboard in the western path (Sta. 0+50 to 1+00) and the main channel were 1.0 foot and 0.0 feet, respectively. The western path was likely grounded out upstream and water in this channel is backwater from downstream where it connects to the main flow path. To estimate the discharge, the main flow path velocities were applied to the missing velocity measurements with the same general depth range. The estimated discharge was 9.8 cubic-feet-per-second (cfs). The crew collected in-situ water quality measurements at the deepest location.

The second trip occurred on March 3. The field crew collected discharge and water quality measurements at the crossing. This included under-ice cross-sectional bathymetric profiles, velocity, water depth, ice thickness, water surface elevation, site conditions related to overflow, and in-situ water quality. The channel ice was grounded in the middle of the channel creating 2 flow paths. The western flow path (3+30 to 3+60) was deep enough to collect flow measurements, but the eastern path (4+40 to 4+50) was too shallow for the velocity meter to fit under the ice. Discharge was measured at 0.04 cfs.

The third trip occurred on March 15. The field crew collected discharge and water quality measurements at the crossing. This included under-ice cross-sectional bathymetric profiles, velocity, water depth, ice thickness, water surface elevation, site conditions related to overflow, and in-situ water quality. The eastern flow path had frozen in and the western flow path was flowing water. Velocities had increased slightly from the previous trip. Discharge was measured at 0.20 cfs.

The last three trips occurred on March 30, April 12 and April 27. The channel ice was completely grounded, leaving no liquid water. A summary of Colville River discharges measured at Ocean Point are provided in Table 3.

Table 3: Colville River Discharge Summary

Date	Average Ice Thickness (ft)	Average Water Depth Under Ice (ft)	Effective Width (ft)	Average Velocity (ft/s)	Measured Discharge (cfs)	Rating
9/5/2019	0	5.0	1,270	3.0	29,000	good
12/31/2019	2.7	1.5	650	0.15	135	poor
2/25/2020	4.8	0.8	304	0.04	9	fair
2/17/2021	4.6	1.1	450	0.03	13.8	poor
3/10/2021	5.0	0.4	118	0.01	0.7	poor
4/8/2021	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]
4/21/2021	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]
2/16/2022	3.0	0.4	200	0.04	9.8[b]	poor
3/3/2022	3.2	0.3	20	0.01	0.04	poor
3/15/2022	3.2	0.3	20	0.03	0.2	poor
3/30/2022	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]
4/12/2022	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]
4/27/2022	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]

Notes: ND (no data).

[a] Channel was grounded by ice.

[b] Velocity meter malfunctioned and only a partial measurement was collected. Velocities were applied to the profile to estimate the discharge.

4.2 WATER QUALITY MEASUREMENTS

Water quality measurements were collected on February 16, March 3, and March 15. Slightly elevated salinity and conductivity measurements suggest this location may have had minor coastal influence similar to last year. The dissolved oxygen measurements were low which is typical because the ice cover prevents the introduction and mixing of atmospheric oxygen into the water. Table 4 presents the results of the water quality measurements on Colville River at Ocean Point.

Table 4: Colville River Ocean Point Water Quality Summary

Date	total depth (ft)	temperature (°C)	conductivity (µS/cm)	specific conductance (µS/cm)	dissolved oxygen (mg/L)	dissolved oxygen (%)	salinity (ppt)
9/5/2019	9.0	9.9	204	289	11.23	99.2	0.14
12/31/2019	5.0	0.1	225	440	5.75	39.5	0.2
2/25/2020	5.5	0.4	288	557.0	2.56	17.7	0.3
2/17/2021	ND[b]	ND[b]	ND[b]	ND[b]	ND[b]	ND[b]	ND[b]
3/10/2021	4.6	-0.1	509	1,002.0	4.44	30.4	0.5
2/16/2022	3.5	-0.1	495	975	5.22	35.7	0.46
4/8/2021	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]
4/21/2021	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]
2/16/2022	3.5	-0.1	495	975	5.22	35.7	0.46
3/3/2022	3.5	0.1	393	767	2.70	18.6	0.36
3/15/2022	3.5	-0.1	382	751	4.26	29.1	0.36
3/30/2022	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]
4/12/2022	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]
4/27/2022	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]	ND[a]

Notes: ND (no data).

[a] Channel ice was grounded.

[b] Field crew had to abandon the trip before water quality measurements were obtained.

5.0 REFERENCES

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Appendix A - Field Data

Michael Baker INTERNATIONAL

Discharge Measurement Notes

Location Name: Colville River at Ocean Point - Transect #1 Date Collected: 2/16/2022

Field Party: S. Orizotti, R. Baldwin (UMIAQ) Computed By: M. Wharton Checked By: DTR

Start Time: 14:50 Finish Time: 16:00 Weather: winds 15 mph, Cloudy Temp: -25 °F

Channel Characteristics: Effective Width: 400 ft Average Velocity: 0.04 fps

Effective Area: 200 sq ft Discharge: 9.8 cfs

Measurement Details: Method: Midsection; 0.6 depth Number of Sections: 8

Crossing: Wading Cable [Under Ice] Boat Meter: HACH FH950

Side of bridge: Upstream Downstream [N/A] N/A ft above bottom of weight

GAGE READINGS			
Gage	Start	Finish	Change
Sta 3+50	4.6 ft NAVD88	-	

Weight: N/A lbs

Count: N/A

Spin Test: N/A revolutions

after N/A minutes

Measurement Rated: Excellent Good Fair [Poor] based on "Descriptions"

Descriptions:

From Field Notes: Ice grounded out from stations 0+00 to 0+50 and 6+00 to 7+50.

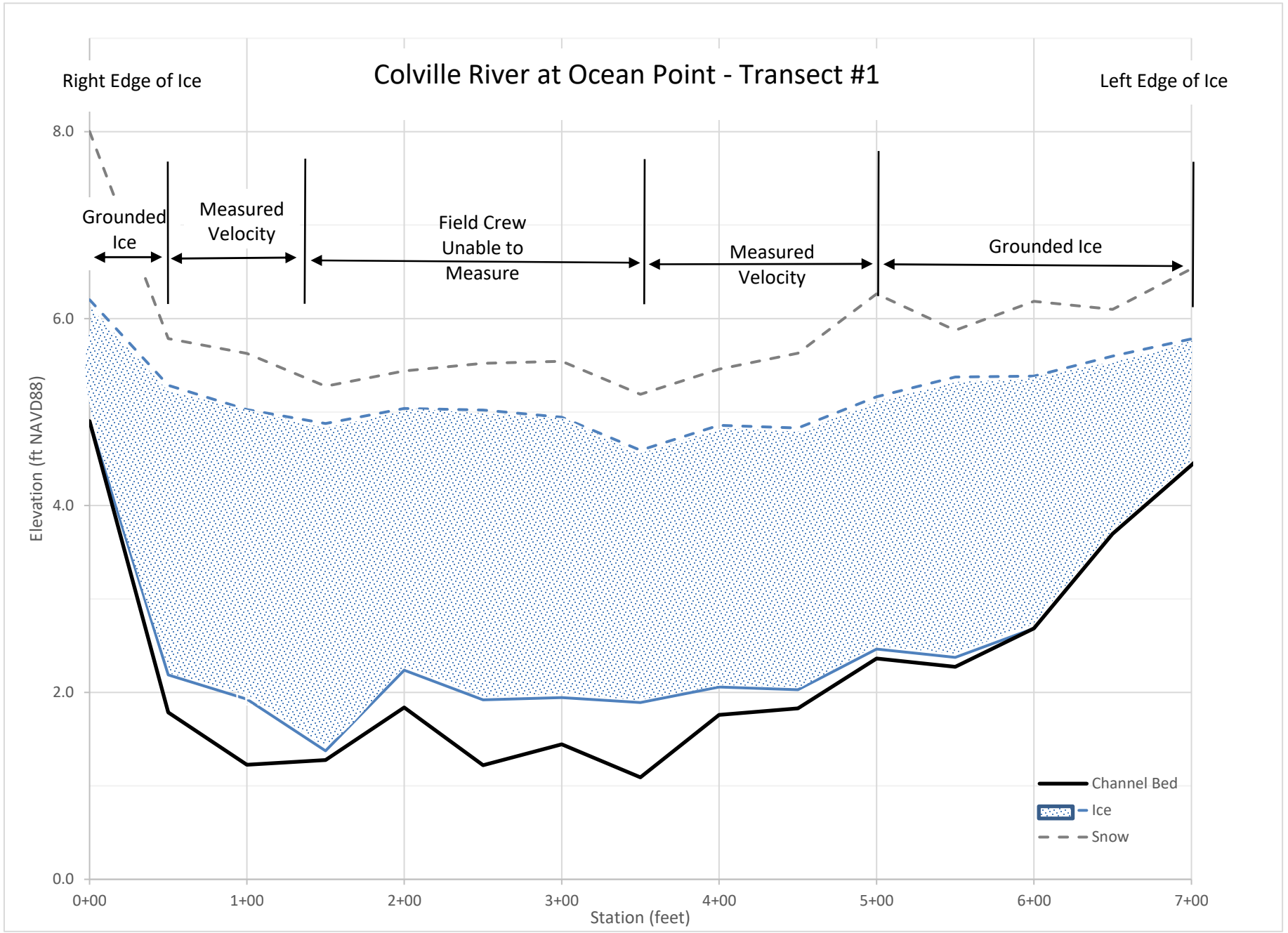
Freeboard ranged from 0.0 to 1.1 feet below the ice. Field crew was unable to measure velocity from 1+50 to 3+50 and 4+00 due to the HACH flow meter battery dying due to the cold.

Calculation Notes: Average velocity adjusted by coefficient of 0.92 to account for measurements collected at 0.6 feet of depth

To estimate discharge in the channel, the measured velocities were applied to stations with similar depths with missing velocities. The measured velocity at station 3+50 was applied to stations 2+00, 2+50, 3+00 and the measured velocity at station 4+00 was applied to 4+50.

Colville River at Ocean Point Transect #1
Date Collected: 02/16/2022

Distance from initial point (ft)	Total Depth (ft)	Ice Thickness (ft)	Freeboard (ft)	Measurement Depth Below Top of Ice (ft)	Effective Depth (ft)	Section Width (ft)	Effective Area (ft^2)	VELOCITY					Discharge (cfs)
								V1 (fps)	V2 (fps)	V3 (fps)	Average V (fps)	Adjusted Average V (fps)	
0+00	1.3	1.3	grounded										
0+50	3.5	3.1	1.1	3.3	0.4	50.0	20.0	0.01	0.01	0.02	0.01	*0.01*	**0.2**
1+00	3.8	3.1	0.9	3.5	0.7	50.0	35.0	0.08	0.11	0.09	0.09	*0.09*	**3.0**
1+50	3.6	3.5	Too shallow for the velocity meter.										
2+00	3.2	2.8			0.4	50.0	20.0	Meter malfunctioned, velocity from 3+50				*0.05*	**1.0**
2+50	3.8	3.1			0.7	50.0	35.0					*0.05*	**1.8**
3+00	3.5	3.0			0.5	50.0	25.0					*0.05*	**1.3**
3+50	3.5	2.7	0.0	3.1	0.8	50.0	40.0	0.05	0.05	0.06	0.05	*0.05*	**2.0**
4+00	3.1	2.8			0.3	50.0	15.0	Meter malfunctioned, velocity from 4+50				*0.02*	**0.3**
4+50	3.0	2.8	0.1	2.9	0.2	50.0	10.0	0.02	0.02	0.04	0.03	*0.02*	**0.2**
5+00	2.8	2.7	Too shallow for the velocity meter.										
5+50	3.1	3.0	Too shallow for the velocity meter.										
6+00	2.7	2.7	grounded										
6+50	1.9	1.9	grounded										
7+00	0.8	0.8	grounded										
7+50	0.9	0.9	grounded										
											Total Discharge:		**9.8**


Colville River at Ocean Point - Transect #1
Right Edge of Ice
Left Edge of Ice
Grounded Ice
Measured Velocity
Field Crew Unable to Measure
Measured Velocity
Grounded Ice
Elevation (ft NAVD88)
8.0
6.0
4.0
2.0
0.0
0+00
1+00
2+00
3+00
4+00
5+00
6+00
7+00
Station (feet)
Channel Bed
Ice
Snow

Colville River at Ocean Point- Transect #1
Water Quality

Michael Baker INTERNATIONAL

Sample Date: February 16, 2022

Location & Time	Water Depth (ft)	Ice Thickness (ft)	Freeboard (ft)	Sample Depth (ft)	Temp (°C)	Conductivity (µS/cm)	Specific Conductance (µS/cm)	DO (mg/L)	DO (% Saturation)	Salinity (ppt)
Sta 3+50 N70.05329° W151.37445° 2:50 PM	3.5	2.7	0.0	3.0	-0.1	495	975	5.22	35.7	0.5

Notes:
(1) Sample location coordinates referenced to NAD83 datum.
(2) Freeboard is the distance from the top of ice to the water surface.
(3) Sample depth is measured from the water surface.
(4) Temperature, salinity, dissolved oxygen, and conductivity were measured using a YSI ProSolo meter.
(5) Specific conductance (referenced to 25°C) was obtained using a conversion coefficient of 0.0196 based on empirical data.
(6) Time shown indicates the start of the measurement.
(7) Temperature measurements have an accuracy of +/- 0.2^{o}C

Michael Baker INTERNATIONAL

Discharge Measurement Notes

Location Name: Colville River at Ocean Point - Transect #1 Date Collected: 3/3/2022

Field Party: D. Roe, M. Rourick (UMIAQ) Computed By: M. Wharton Checked By: KDB

Start Time: 13:35 Finish Time: 14:00 Weather: winds 0 mph, Sunny Temp: 12 °F

Channel Characteristics: Effective Width: 20 ft Average Velocity: 0.01 fps

Effective Area: 6 sq ft Discharge: 0.04 cfs

Measurement Details: Method: Midsection; 0.6 depth Number of Sections: 2

Crossing: Wading Cable [Under Ice] Boat Meter: HACH FH950

Side of bridge: Upstream Downstream [N/A] N/A ft above bottom of weight

GAGE READINGS			
Gage	Start	Finish	Change
Sta 3+50	3.7 ft NAVD88	-	

Weight: N/A lbs

Count: N/A

Spin Test: N/A revolutions

after N/A minutes

Measurement Rated: Excellent Good Fair [Poor] based on "Descriptions"

Descriptions:

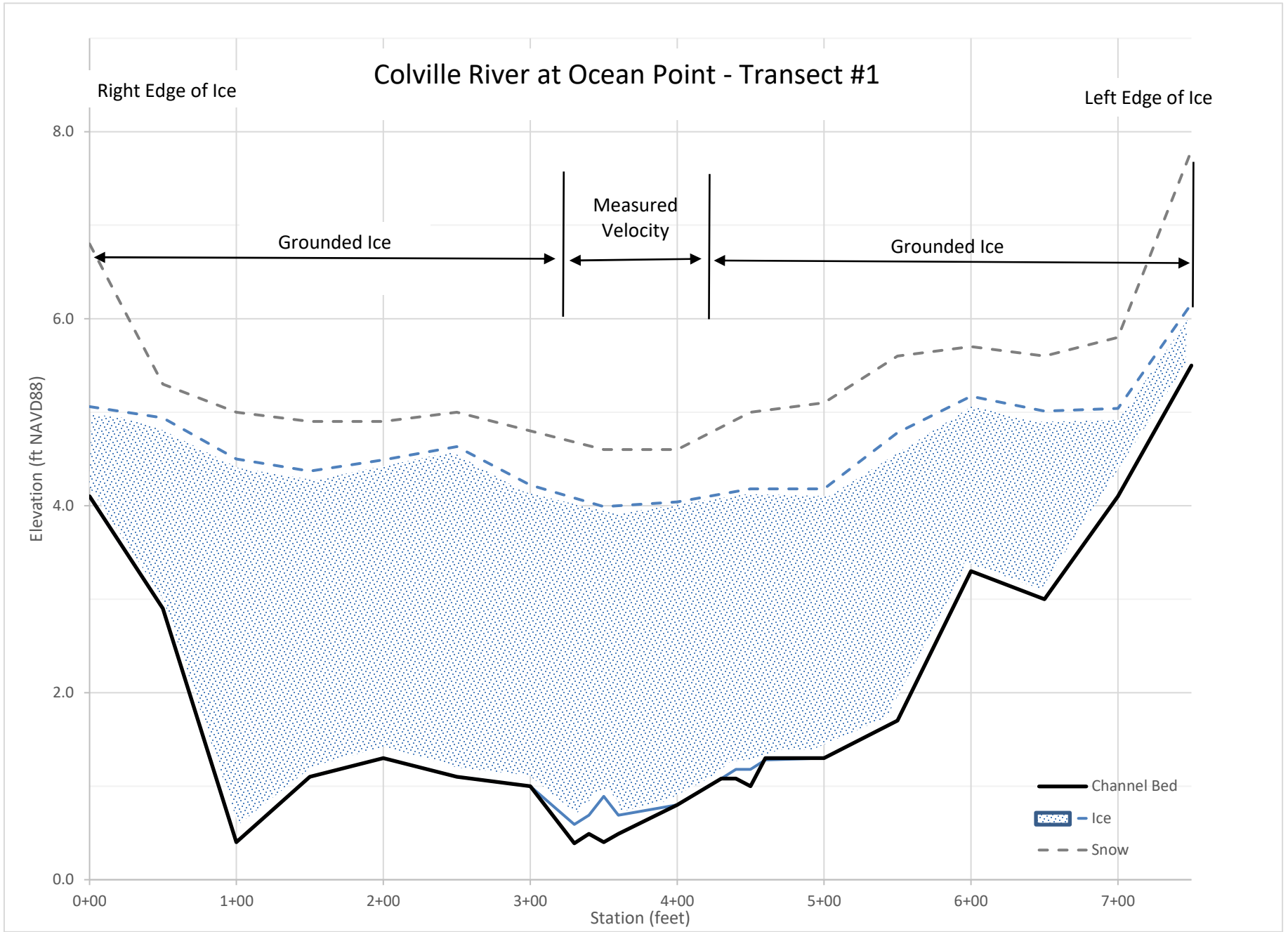
From Field Notes: Ice grounded out from stations 0+00 to 3+30, 4+00 to 4+30, and 4+60 to 7+50.

Freeboard ranged from 0.0 to 0.3 feet below the ice.

Calculation Notes: Average velocity adjusted by coefficient of 0.92 to account for measurements collected at 0.6 feet of depth

Colville River at Ocean Point Transect #1
Date Collected: 03/02/2022

Distance from initial point (ft)	Total Depth (ft)	Ice Thickness (ft)	Freeboard (ft)	Measurement Depth Below Top of Ice (ft)	Effective Depth (ft)	Section Width (ft)	Effective Area (ft^2)	VELOCITY					Discharge (cfs)
								V1 (fps)	V2 (fps)	V3 (fps)	Average V (fps)	Adjusted Average V (fps)	
0+00	1.0	1.0	grounded										
0+50	2.0	2.0	grounded										
1+00	4.1	4.1	grounded										
1+50	3.3	3.3	grounded										
2+00	3.2	3.2	grounded										
2+50	3.5	3.5	grounded										
3+00	3.2	3.2	grounded										
3+30	3.6	3.4	slush										
3+40	3.5	3.3	0.2	3.4	0.2	10.0	2.0	0.01	0.01	0.01	0.01	*0.01*	**0.02**
3+50	3.5	3.1	0.3	3.4	0.4	10.0	4.0	0.01	0.00	0.01	0.01	*0.01*	**0.02**
3+60	3.5	3.3	slush										
4+00	3.2	3.2	grounded										
4+30	3.1	3.1	grounded										
4+40	3.1	3.0	slush										
4+50	3.1	3.0	slush										
4+60	2.9	2.9	grounded										
5+00	2.9	2.9	grounded										
5+50	3.0	3.0	grounded										
6+00	1.9	1.9	grounded										
6+50	2.0	2.0	grounded										
7+00	0.9	0.9	grounded										
7+50	0.7	0.7	grounded										
											Total Discharge:		**0.04**


Colville River at Ocean Point - Transect #1
Right Edge of Ice
Left Edge of Ice
Grounded Ice
Measured Velocity
Grounded Ice
Elevation (ft NAVD88)
8.0
6.0
4.0
2.0
0.0
0+00
1+00
2+00
3+00
4+00
5+00
6+00
7+00
Station (feet)
Channel Bed
Ice
Snow

Colville River at Ocean Point- Transect #1
Water Quality

Michael Baker INTERNATIONAL

Sample Date: **March 3, 2022**

Location & Time	Water Depth (ft)	Ice Thickness (ft)	Freeboard (ft)	Sample Depth (ft)	Temp (°C)	Conductivity (µS/cm)	Specific Conductance (µS/cm)	DO (mg/L)	DO (% Saturation)	Salinity (ppt)
Sta 3+50 N70.05329° W151.37445° 1:25 PM	3.5	3.1	0.3	3.5	0.1	393	767	2.70	18.6	0.36

Notes:
(1) Sample location coordinates referenced to NAD83 datum.
(2) Freeboard is the distance from the top of ice to the water surface.
(3) Sample depth is measured from the water surface.
(4) Temperature, salinity, dissolved oxygen, and conductivity were measured using a YSI ProSolo meter.
(5) Specific conductance (referenced to 25°C) was obtained using a conversion coefficient of 0.0196 based on empirical data.
(6) Time shown indicates the start of the measurement.
(7) Temperature measurements have an accuracy of +/- 0.2^{o}C

Michael Baker INTERNATIONAL

Discharge Measurement Notes

Location Name: Colville River at Ocean Point - Transect #1 Date Collected: 3/15/2022

Field Party: M. Wharton Computed By: SAO Checked By: DTR

Start Time: 13:35 Finish Time: 14:00 Weather: winds 0 mph, Sunny Temp: -10 °F

Channel Characteristics: Effective Width: 20 ft Average Velocity: 0.03 fps

Effective Area: 6 sq ft Discharge: 0.20 cfs

Measurement Details: Method: Midsection; 0.6 depth Number of Sections: 2

Crossing: Wading Cable [Under Ice] Boat Meter: HACH FH950

Side of bridge: Upstream Downstream [N/A] N/A ft above bottom of weight

GAGE READINGS			
Gage	Start	Finish	Change
		-	

Weight: N/A lbs

Count: N/A

Spin Test: N/A revolutions

after N/A minutes

Measurement Rated: Excellent Good Fair [Poor] based on "Descriptions"

Descriptions:

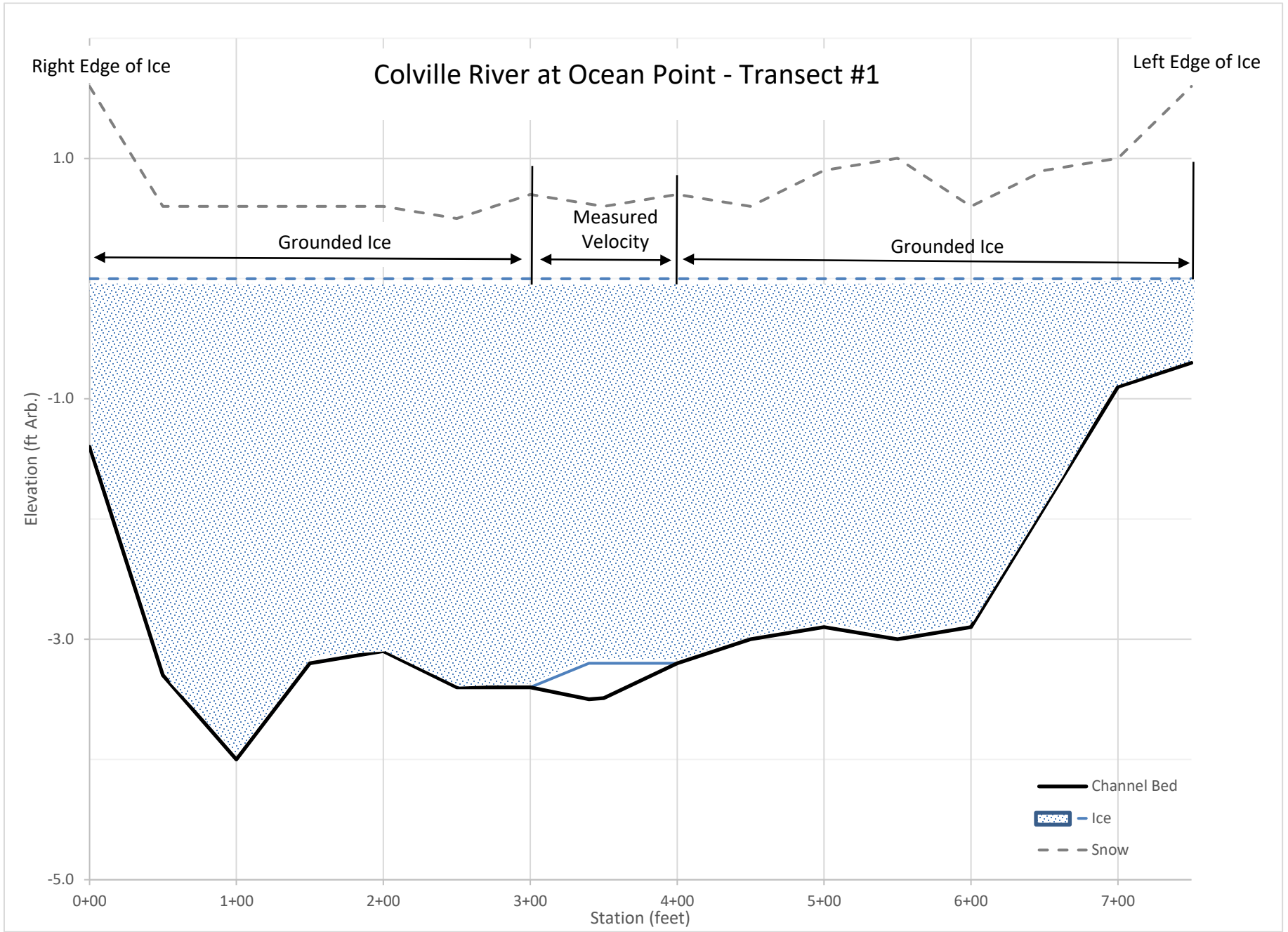
From Field Notes: Ice grounded out from stations 0+00 to 3+30 and 3+60 to 7+00.

Freeboard ranged from 0.2 to 0.3 feet below the ice. Water surface elevation was not measured.

Calculation Notes: Average velocity adjusted by coefficient of 0.92 to account for measurements collected at 0.6 feet of depth

Colville River at Ocean Point Transect #1
Date Collected: 03/15/2022

Distance from initial point (ft)	Total Depth (ft)	Ice Thickness (ft)	Freeboard (ft)	Measurement Depth Below Top of Ice (ft)	Effective Depth (ft)	Section Width (ft)	Effective Area (ft^2)	VELOCITY					Discharge (cfs)
								V1 (fps)	V2 (fps)	V3 (fps)	Average V (fps)	Adjusted Average V (fps)	
0+00	1.4	1.4	grounded										
0+50	3.3	2.0	grounded										
1+00	4.0	4.0	grounded										
1+50	3.2	3.2	grounded										
2+00	3.1	3.1	grounded										
2+50	3.4	3.4	grounded										
3+00	3.4	3.4	grounded										
3+30	3.6	3.4	grounded										
3+40	3.5	3.2	0.3	3.5	0.3	10.0	3.0	0.03	0.03	0.08	0.05	*0.04*	**0.13**
3+50	3.5	3.2	0.2	3.4	0.3	10.0	3.0	0.03	0.02	0.03	0.03	*0.02*	**0.07**
3+60	3.5	3.3	grounded										
4+00	3.2	3.2	grounded										
4+30	3.1	3.1	grounded										
4+40	3.1	3.0	grounded										
4+50	3.0	3.0	grounded										
4+60	2.9	2.9	grounded										
5+00	2.9	2.9	grounded										
5+50	3.0	3.0	grounded										
6+00	2.9	2.9	grounded										
6+50	1.9	1.9	grounded										
7+00	0.9	0.9	grounded										
7+50	0.7	0.7	grounded										
											Total Discharge:		**0.20**


Colville River at Ocean Point - Transect #1
Right Edge of Ice
Left Edge of Ice
Grounded Ice
Measured Velocity
Grounded Ice
1.0
-1.0
-3.0
-5.0
Elevation (ft Arb.)
0+00
1+00
2+00
3+00
4+00
5+00
6+00
7+00
Station (feet)
Channel Bed
Ice
Snow

Colville River at Ocean Point- Transect #1
Water Quality

Michael Baker INTERNATIONAL

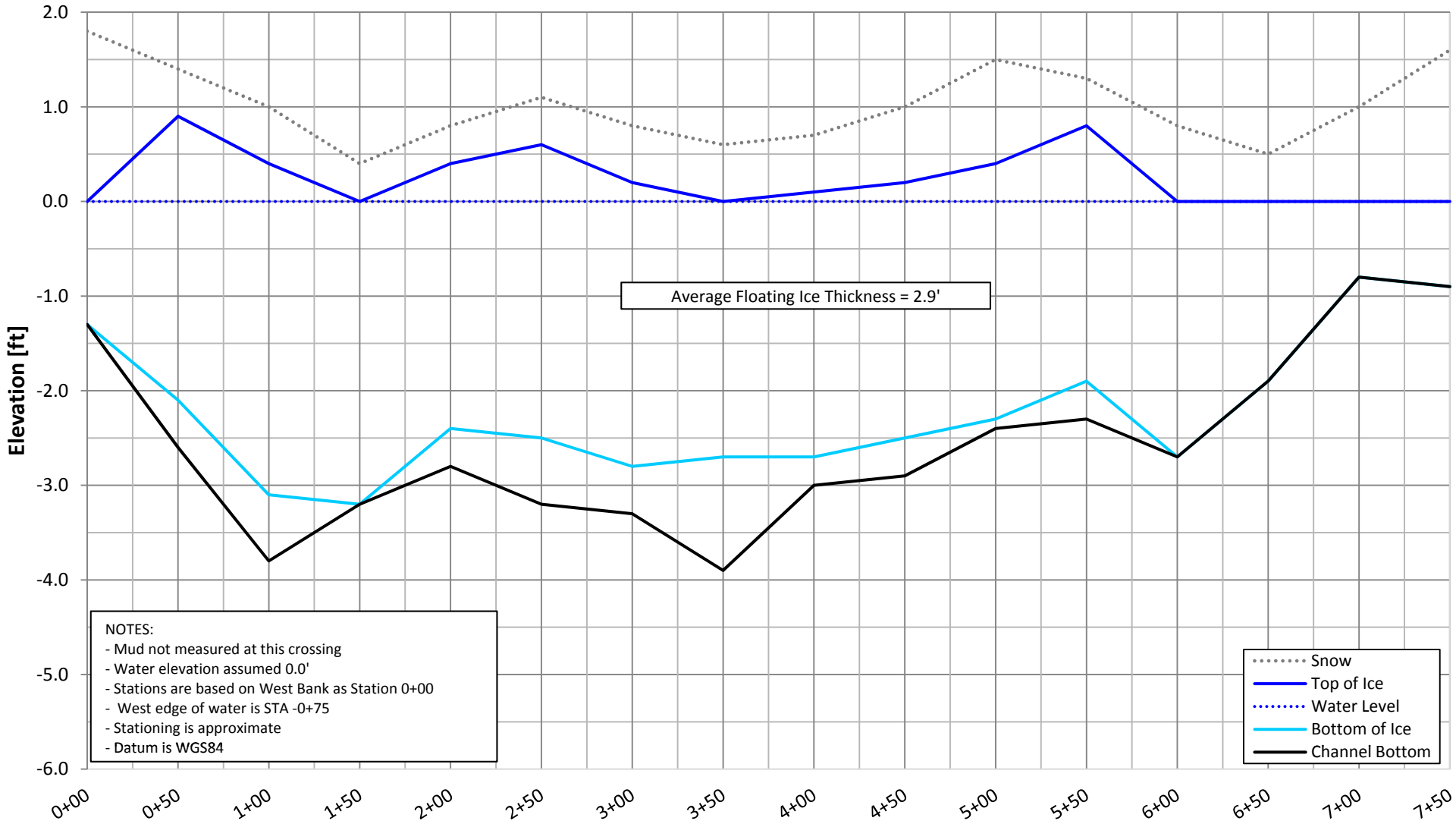
Sample Date: March 15, 2022

Location & Time	Water Depth (ft)	Ice Thickness (ft)	Freeboard (ft)	Sample Depth (ft)	Temp (°C)	Conductivity (µS/cm)	Specific Conductance (µS/cm)	DO (mg/L)	DO (% Saturation)	Salinity (ppt)
Sta 3+50 N70.05329° W151.37445° 1:23 PM	3.5	3.2	0.2	3.5	-0.1	382	751	4.26	29.1	0.36

Notes:
(1) Sample location coordinates referenced to NAD83 datum.
(2) Freeboard is the distance from the top of ice to the water surface.
(3) Sample depth is measured from the water surface.
(4) Temperature, salinity, dissolved oxygen, and conductivity were measured using a YSI ProSolo meter.
(5) Specific conductance (referenced to 25°C) was obtained using a conversion coefficient of 0.0196 based on empirical data.
(6) Time shown indicates the start of the measurement.
(7) Temperature measurements have an accuracy of +/- 0.2^{o}C

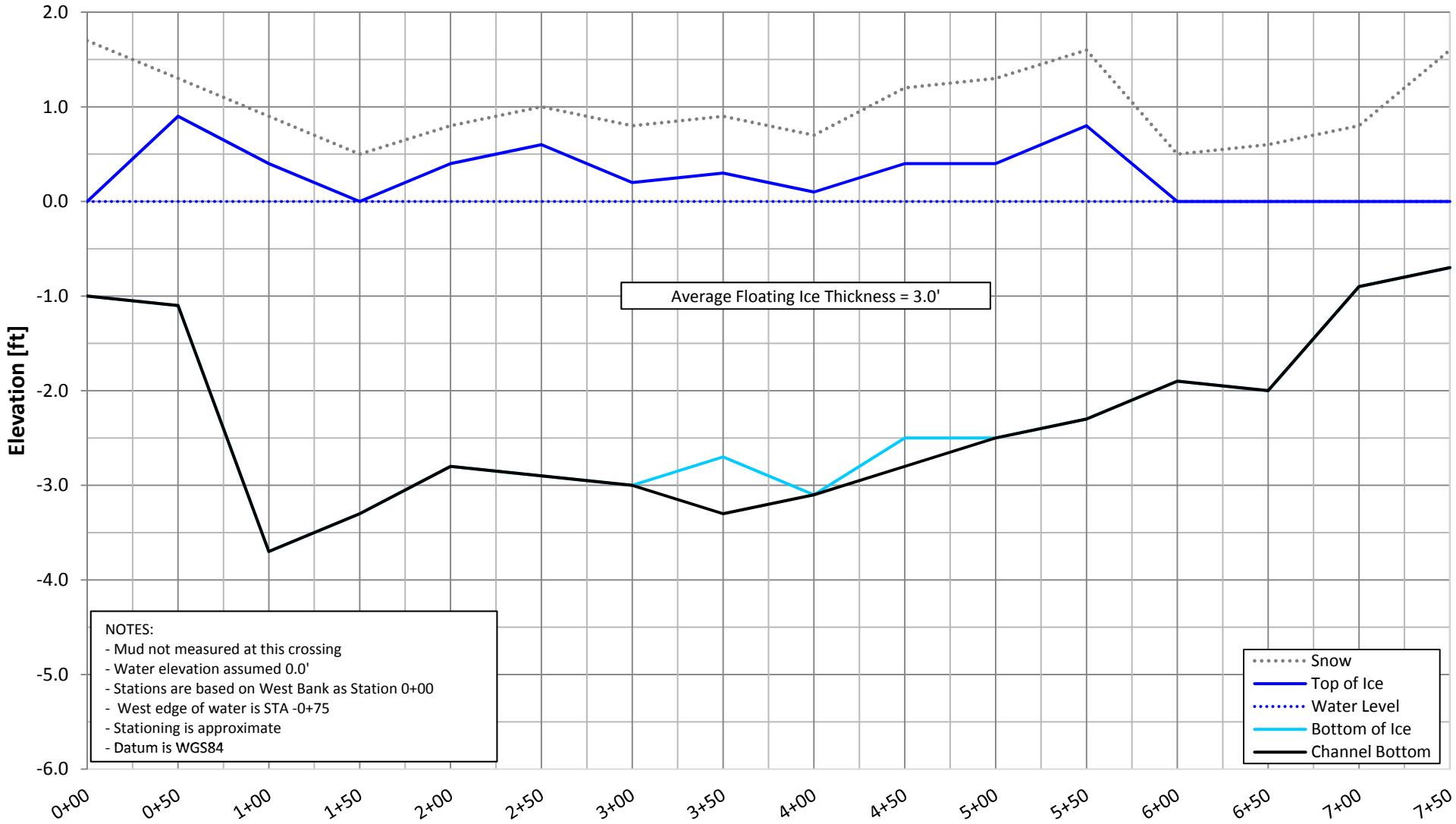
Submitted By: M. Hendee
Conducted By: ICE Design Group

Ocean Point Crossing Profile
February 16, 2022



Submitted By: M. Hendee
Conducted By: ICE Design Group

Ocean Point Crossing Profile
March 3, 2022



Submitted By: E. Keib
Conducted By: ICE Design Group

Ocean Point Crossing Profile
March 15, 2022

Waypoint	Station	Ice Thickness [ft]	Total Depth [ft]	Freeboard	Snow [ft]	Top of Ice Elevation [ft]	Comments
	0+00	1.4	1.4	Grounded	1.6	4.58	West Side (from 2P) N70.05314, W151.37498
	0+50	3.3	3.3	Grounded	0.6	4.46	
	1+00	4.0	4.0	Grounded	0.6	4.02	
	1+50	3.2	3.2	Grounded	0.6	3.89	
	2+00	3.1	3.1	Grounded	0.6	4.02	
	2+50	3.4	3.4	Grounded	0.5	4.15	
	3+00	3.4	3.4	Grounded	0.7	3.74	
	3+50	3.2	3.5	0.2	0.8	3.51	
	4+00	3.2	3.2	Grounded	0.7	3.56	
	4+50	3.0	3.0	Grounded	0.6	3.47	
	5+00	2.9	2.9	Grounded	0.9	3.70	
	5+50	3.0	3.0	Grounded	1.0	3.85	
	6+00	2.9	2.9	Grounded	0.6	4.30	
	6+50	1.9	1.9	Grounded	0.9	4.69	
	7+00	0.9	0.9	Grounded	1.0	4.53	
	7+50	0.7	0.7	Grounded	1.6	4.56	East Side (from GMT2) N70.05338, W151.36866
						5.68	
	US PT	3.5	3.9	0.4	0.4		Upstream pressure transducer N70.05370, W151.37273
	DS PT	3.4	4.5	0.1	0.5		Downstream pressure transducer N70.05239, W151.37378

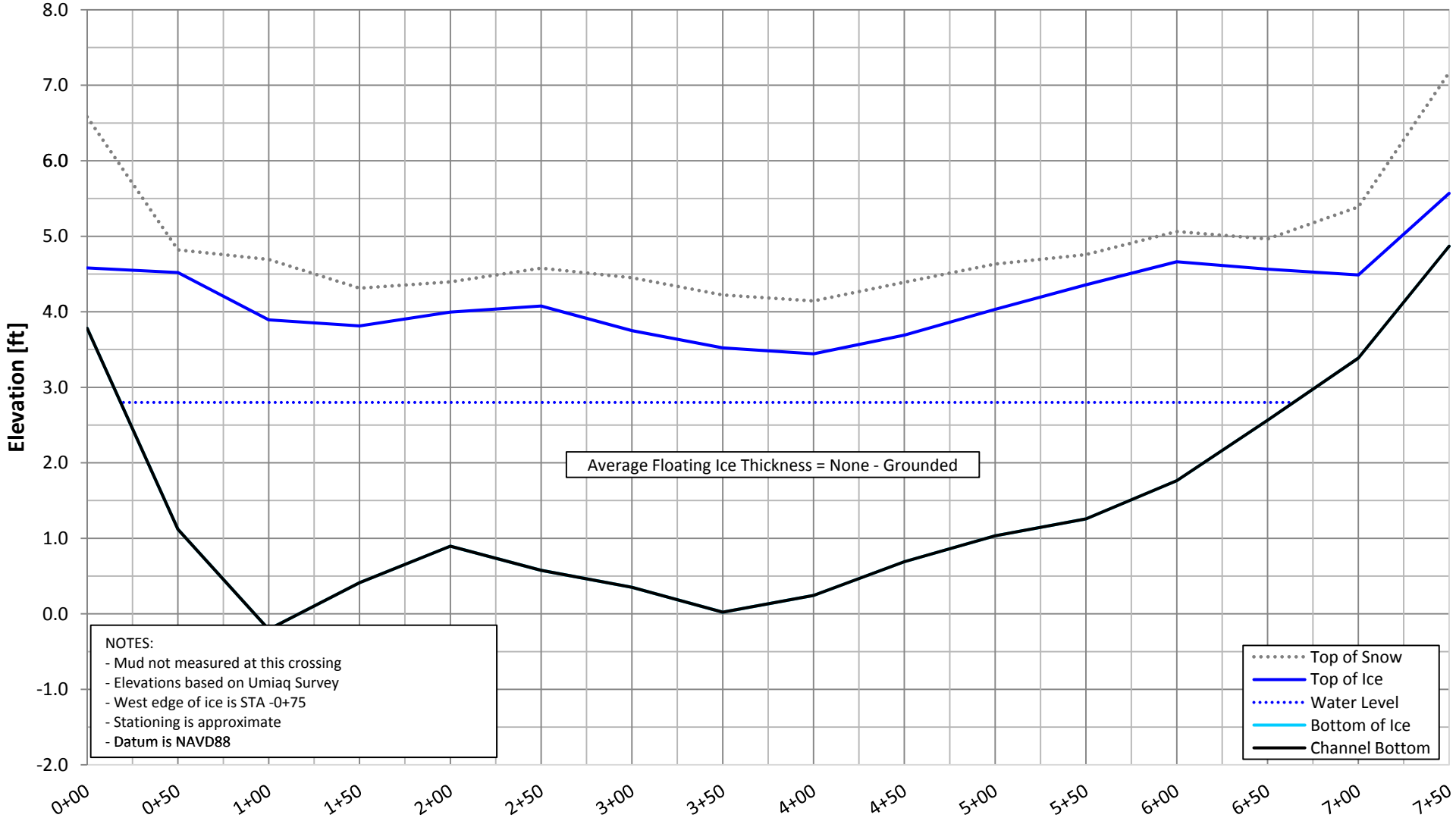
Avg floating ice thickness = 3.1

General Comments:

GPS coordinates given in WGS84. Mud not measured.

Submitted By: E. Keib
Conducted By: ICE Design Group

Ocean Point Crossing Profile
March 30, 2022

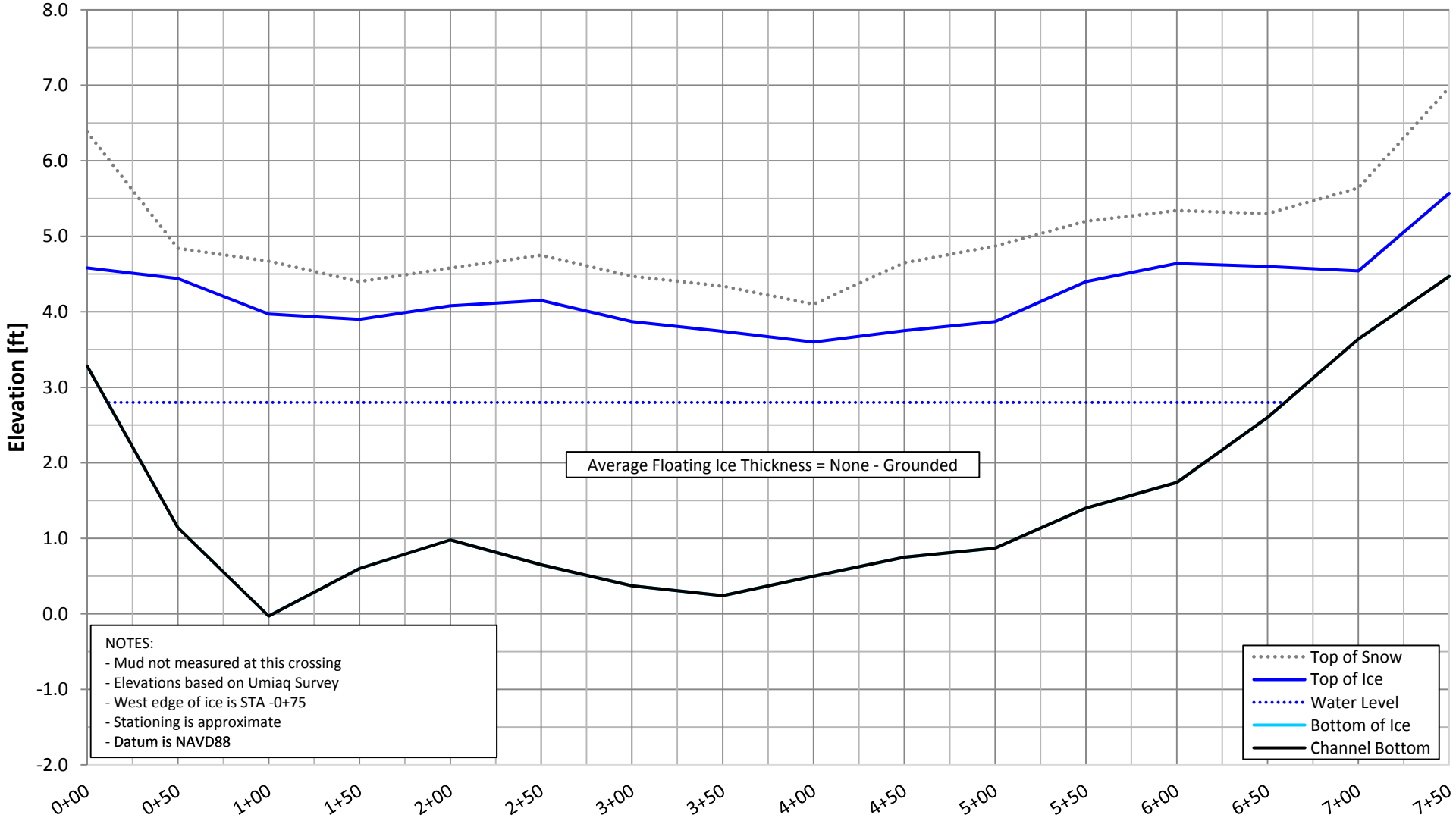


West End Of Crossing
N70.05314 W151.37498

East End of Crossing
N70.05338 W151.36866

Submitted By: E. Keib
Conducted By: ICE Design Group

Ocean Point Crossing Profile
April 12, 2022



Submitted By: E. Keib
Conducted By: ICE Design Group

Ocean Point Crossing Profile
April 27, 2022