

# **Snowmelt and Lake Recharge Monitoring for Selected North Slope, Alaska, Lakes: May/June 2007**



*Alpine Facility from L9312 during flood event, Photo by C. Cormack*

by

Kristie Holland, Dan Reichardt, Chad Cormack, Jeff Derry, Greta  
Myerchin, Horacio Toniolo, and Michael Lilly

August 2008

North Slope Lakes Hydrologic Modeling Project  
Report No. INE/WERC 07.21

Water and Environmental  
Research Center



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Kristie Holland<sup>1</sup>, Dan Reichardt<sup>1</sup>, Chad Cormack<sup>2</sup>, Jeff Derry<sup>1</sup>, Greta Myerchin<sup>2</sup>,  
Horacio Toniolo<sup>2</sup>, Michael Lilly<sup>1</sup>

### **A report on research sponsored by:**

- U.S. Department of Energy
- National Energy Technology Laboratory
- BP Exploration (Alaska), Inc.
- ConocoPhillips Alaska, Inc.
- Bureau of Land Management
- Geo-Watersheds Scientific

August 2008

North Slope Lakes Hydrologic Project

Report Number INE/WERC 07.21

<sup>1</sup>Geo-Watersheds Scientific

<sup>2</sup>University of Alaska Fairbanks, Water and Environmental Research Center

**Recommended Citation:**

Holland, K., Reichardt, D., Cormack, C., Derry, J., Myerchin, G., Toniolo, H., and Lilly, M.R. 2008. Snowmelt and lake recharge monitoring for selected North Slope, Alaska, lakes: May/June 2007. University of Alaska Fairbanks, Water and Environmental Research Center, Report INE/WERC 07.21, Fairbanks, Alaska, 11 p.

Fairbanks, Alaska  
August 2008

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**For additional information write to:**

Publications,  
Water and Environmental Research Center  
University of Alaska Fairbanks  
Fairbanks, Alaska 99775  
[www.uaf.edu/water/](http://www.uaf.edu/water/)

**For Project Information write to:**

Daniel White – Project Manager  
Box 5860, WERC. UAF  
Fairbanks, AK 99775-5860  
907-474-6222  
[ffdmw@uaf.edu](mailto:ffdmw@uaf.edu)

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## **DISCLAIMER**

The contents of this report reflect the views of the authors, who are responsible for the accuracy of the data presented herein. This research was funded by the U.S. Department of Energy (DOE) and the National Energy Technology Laboratory (NETL). Funding and support was also provided by the Bureau of Land Management (BLM), BP Exploration (Alaska) Inc.(BPX), ConocoPhillips Alaska, Inc. (CPA), and Geo-Watersheds Scientific (GWS). The contents of the report do not necessarily reflect the views or policies of the DOE, NETL, BLM, BPX, CPA, GWS, or any local sponsor. This work does not constitute a standard, specification, or regulation.

The use of trade and firm names in this document is for the purpose of identification only and does not imply endorsement by the University of Alaska Fairbanks, DOE, NETL, BLM, BPX, CPA, GWS, or other project sponsors.

# CONVERSION FACTORS, UNITS, WATER QUALITY UNITS, VERTICAL AND HORIZONTAL DATUM, ABBREVIATIONS AND SYMBOLS

## Conversion Factors

Multiply	By	To obtain
<u>Length</u>		
inch (in)	25.4	millimeter (mm)
inch (in)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
<u>Area</u>		
Acre	43560.0	square feet (ft <sup>2</sup> )
Acre	0.405	hectare (ha)
square foot (ft <sup>2</sup> )	3.587e-8	square mile (mi <sup>2</sup> )
square mile (mi <sup>2</sup> )	2.590	square kilometer (km <sup>2</sup> )
<u>Volume</u>		
gallon (gal)	3.785	liter (L)
gallon (gal)	3785.412	milliliter (mL)
cubic foot (ft <sup>3</sup> )	28.317	liter (L)
Acre-ft	1233.482	cubic meter (m <sup>3</sup> )
Acre-ft	325851.43	gallon(gal)
gallon(gal)	0.1337	cubic feet (ft <sup>3</sup> )
<u>Velocity and Discharge</u>		
foot per day (ft/d)	0.3048	meter per day (m/d)
Square foot per day (ft <sup>2</sup> /d )	0.0929	square meter per day (m <sup>2</sup> /d)
cubic foot per second (ft <sup>3</sup> /s)	0.02832	cubic meter per second (m <sup>3</sup> /sec)
<u>Hydraulic Conductivity</u>		
foot per day (ft/d)	0.3048	meter per day (m/d)
foot per day (ft/d)	0.00035	centimeter per second (cm/sec)
meter per day (m/d)	0.00116	centimeter per second (cm/sec)
<u>Hydraulic Gradient</u>		
foot per foot (ft/ft)	5280	foot per mile (ft/mi)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
<u>Pressure</u>		
pound per square inch (lb/in <sup>2</sup> )	6.895	kilopascal (kPa)

## Units

For the purposes of this report, both English and Metric (SI) units were employed. The choice of “primary” units employed depended on common reporting standards for a particular property or parameter measured. Whenever possible, the approximate value in the “secondary” units was also provided in parentheses. Thus, for instance, stream flow was reported in cubic feet per second (cfs) followed by the value in cubic meters per second (m<sup>3</sup>/s) in parentheses.

### Physical and Chemical Water-Quality Units:

#### Temperature:

Water and air temperature is given in degrees Celsius (°C) and in degrees Fahrenheit (°F). Degrees Celsius can be converted to degrees Fahrenheit by use of the following equation:

$$^{\circ}\text{F} = 1.8(^{\circ}\text{C}) + 32$$

#### Electrical Conductance (Actual Conductivity and Specific Conductance):

In this report conductivity of water is expressed as Actual Conductivity [AC] in microSiemens per centimeter (μS/cm). This unit is equivalent to micromhos per centimeter. Elsewhere, conductivity is commonly expressed as Specific Conductance at 25°C [SC25] in μS/cm which is temperature corrected. To convert AC to SC25 the following equation can be used:

$$SC25 = \frac{AC}{1 + r(T - 25)}$$

where:

SC25 = Specific Conductance at 25°C, in μS/cm

AC = Actual Conductivity, in μS/cm

R = temperature correction coefficient for the sample, in °C

T = temperature of the sample, in °C

Milligrams per liter (mg/L) or micrograms per liter (µg/L):

Milligrams per liter is a unit of measurement indicating the concentration of chemical constituents in solution as weight (milligrams) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is the same as for concentrations in parts per million (ppm).

Millivolt (mV):

A unit of electromotive force equal to one thousandth of a volt.

Vertical Datum:

In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929), a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called *Sea Level Datum of 1929*.

Horizontal Datum:

The horizontal datum for all locations in this report is the North American Datum of 1983 or North American Datum of 1927.

## Abbreviations, Acronyms, and Symbols

AC	Actual conductivity
ADOT&PF	Alaska Department of Transportation and Public Facilities
ASTM	American Society for Testing and Materials
atm	atmospheres
C	Celsius
DO	Dissolved oxygen
DVM	digital voltage multi-meter
e-tape	electric tape
F	Fahrenheit (°F).
ft	feet
GWS	Geo-Watersheds Scientific
GWSI	USGS Ground-Water Site Inventory
km <sup>2</sup>	square kilometers
kPa	kilopascal
lb/in <sup>2</sup>	pounds per square inch
m	meters
mg/L	milligrams per liter, equivalent to ppm
µg/L	micrograms per liter
mi <sup>2</sup>	square miles
mm	millimeters
µS/cm	microsiemens per centimeter
mV	Millivolt
NGVD	National Geodetic Vertical Datum
NPR-A	National Petroleum Reserve - Alaska
NTU	Nephelometric Turbidity Units
NWIS	National Water Information System
ORP	oxygen-reduction potential
ppm	parts per million, equivalent to mg/L
SC25	specific conductance at 25°C
SWE	Snow Water Equivalent
QA	quality assurance
QC	quality control
UAF	University of Alaska Fairbanks
USACE	U.S. Army Corps of Engineers, Alaska District
USGS	U.S. Geological Survey
WERC	Water and Environmental Research Center
WWW	World Wide Web
YSI	Yellow Springs Instruments

## Lake Nomenclature

KDA	Kuparuk Dead Arm (Prudhoe Bay field, serves Prudhoe Bay field operations)
MSB	Mine Site B (Prudhoe Bay field, serves Milne Point and Kuparuk field operations)
L9312	Lake L9312 (Alpine field, serves Alpine field operations)
L9817	Lake L9817 (Alpine field, serves Alpine field operations)
K113	Lake K113 (Prudhoe Bay field, not currently used for field operations)

## **PROJECT COOPERATORS**

The North Slope Lakes project covers a large area of the North Slope and benefits from a number of positive partnerships, all contributing to the overall project objectives.

- BP Exploration (Alaska) Inc.
- ConocoPhillips Alaska (CPA)
- Bureau of Land Management
- Alaska Department of Natural Resources
- The Nature Conservancy
- Northern Alaska Environmental Center

## **ACKNOWLEDGEMENTS**

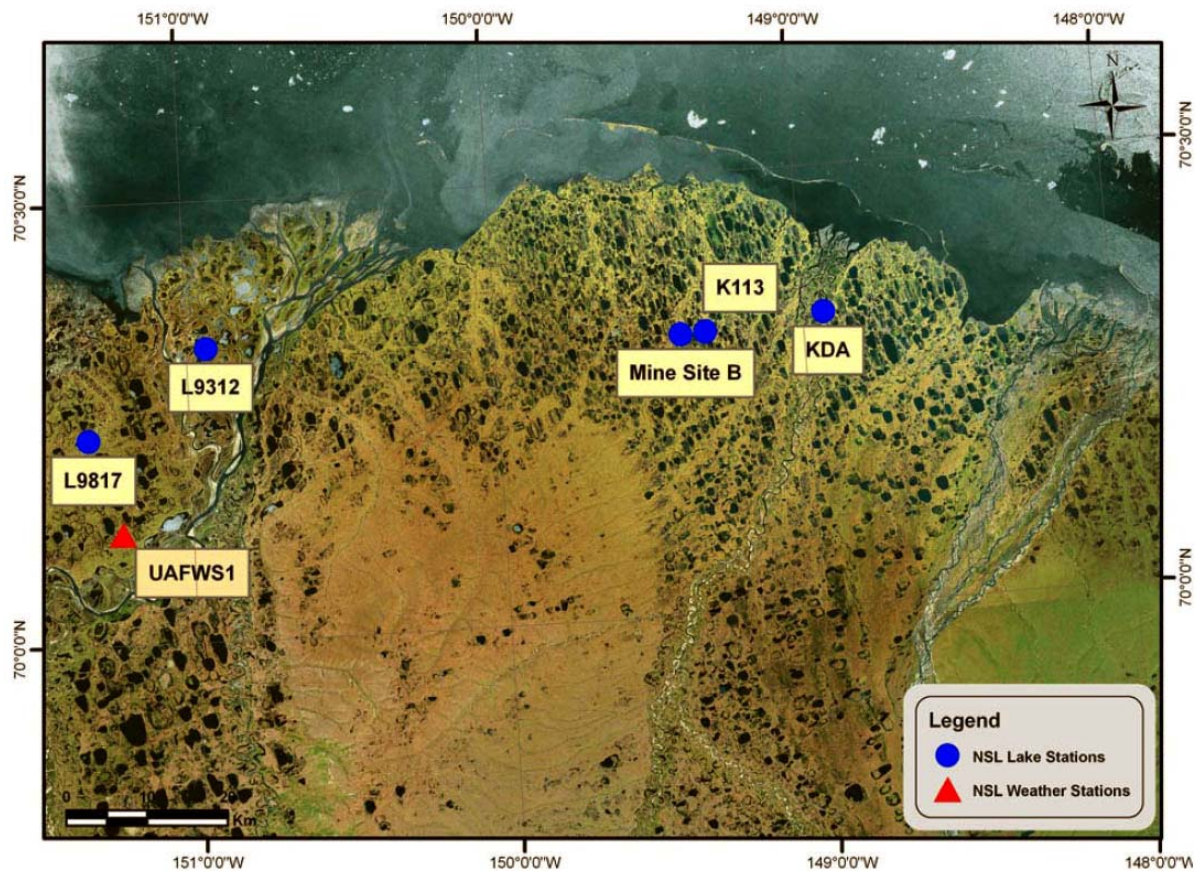
This project was funded by cooperative agreement number DE-FC26\_01NT41248, from the U.S. Department of Energy's (DOE) Arctic Energy Office to the University of Alaska Fairbanks Arctic Energy Technology Development Laboratory (AETDL). Field coordination and logistics support were provided by BP Exploration (Alaska) Inc. and ConocoPhillips Alaska. Additional support was provided by other project cooperators, North Slope Borough, Bureau of Land Management (BLM), National Weather Service, and Geo-Watersheds Scientific (GWS), in the form of financial and in-kind match.

# **Lake Chemistry and Physical Data For Selected North Slope, Alaska, Lakes: May-June 2007**

## **INTRODUCTION**

The University of Alaska Fairbanks (UAF) Water and Environmental Research Center (WERC) and Geo-Watersheds Scientific (GWS), together with project cooperators, initiated a study in the Fall of 2002 (Phase One) to obtain baseline information about the physical and chemical characteristics of North Slope tundra lakes. The project was extended in 2005 (Phase Two). The location of study lakes changed and was expanded to include other reservoirs so as to further develop the understanding and simulation tools necessary for water-source management (Figure 1). K113 is an un-pumped lake in the Kuparuk oilfield and is sampled on selected field trips during the year. L9312 is a natural lake studied in the Alpine operations area. L9817 is a natural lake in eastern NPRA, west of Nuiqsut. This lake has been used in previous years for ice-road construction, but was not used during winter 2005-06, nor will it be used during the winter of 2006-07. Two reservoir systems (mine sites) were added to the study in 2005. Mine Site B, also known as Six-mile Lake, is located near the Milne Point facility at the intersection of the Spine Road with the Milne Point Road and has two cells connected to East Milne Creek. The Kuparuk Reservoir System (Kuparuk Deadarm Lakes) has 9 reservoirs. The three southernmost reservoir cells (1-3) are included in the study to observe ground-water and surface-water interactions between each cell and the adjacent Kuparuk River.

Water-quality and hydrologic data is collected in the field during monthly visits to the lakes and water samples are collected from priority locations for further analysis at the UAF-WERC chemistry laboratories. The purposes of this publication are to 1) report data collected during the snowmelt period of 2007 (end of May through beginning of June), 2) summarize accomplished field trip objectives.



**Figure 1. Location of study lakes in the NPR-A, Alpine, Kuparuk, and Prudhoe Bay field operating areas, North Slope, Alaska.**

## TRIP OBJECTIVES

The goal of each regular sampling trip is to collect physical and chemical data from each study lake, however, the purpose of the May/June trip is primarily for observation of snowmelt and lake recharge processes. For each lake, a series of water level elevation and snow distribution surveys were conducted. Logistical, personnel, and weather constraints, can limit the amount of time available in the field for sampling which may result in deviation from the project work plan which was distributed before the trip outlining the sampling schedule (Lilly and others, 2007). The spring snowmelt trip duration was from 17 May, 2007 to 15 June, 2007. During the trip we focused on the following locations/tasks:

1. Lake L9312: Alpine operating area.
  - Survey water level to local elevation control.



- Conduct snow-course measurements and document snow ablation processes.
  - Conduct snow depth transects across selected sections of lake to help identify available recharge volumes.
  - Document observations of lake recharge processes, including photographs, field measurements of snowmelt, inflow and lake outflows.
  - Document timing of initial melt water on lake/reservoir ice, initial stream flow and lake outflow.
2. Mine Site B: Kuparuk operating area.
- Survey water level to local elevation control.
  - Conduct snow-course measurements and document snow ablation processes.
  - Conduct snow depth transects across selected sections of lake to help identify available recharge volumes.
  - Document observations of lake recharge processes, including photographs, field measurements of snowmelt, inflow and lake outflows.
  - Document timing of initial melt water on lake/reservoir ice, initial stream flow and lake outflow.
3. Kuparuk Dead Arm (KDA) Reservoirs: Prudhoe Bay operating area.
- Survey water level to local elevation controls.
  - Conduct snow-course measurements and document snow ablation processes.
  - Conduct snow depth transects across selected sections of lake to help identify available recharge volumes.
  - Document observations of lake recharge processes, including photographs, field measurements of snowmelt, inflow and lake outflows.
  - Document timing of initial melt water on lake/reservoir ice, initial stream flow and lake outflow.
4. West Dock, Prudhoe Bay operating area.
- Daily snow surveys document snow ablation processes at L9312, Kuparuk Deadarm Reservoirs and Mine Site B.
  - Snow depth transects across selected sections of each lake/reservoir watershed to help identify available recharge volumes.

5. Betty Pingo, Prudhoe Bay operating area.

- Daily snow surveys document show ablation processes at L9312, Kuparuk Deadarm Reservoirs and Mine Site B.
- Snow depth transects across selected sections of each lake/reservoir watershed to help identify available recharge volumes.

## PROCEDURES

All field work follows the specified health, safety, and environmental guidelines outlined by BPX and CPA (White and Lilly, 2007*a,b,c*).

### Snowmelt Monitoring

Snowmelt surveying took place at L9312, Mine Site B, Kuparuk Deadarm Reservoir, West Dock, and Betty Pingo. Standard snow course measurements were made throughout the snowmelt period. Standard field methods and forms were used for snow water equivalent (SWE) data. Some of the key snowmelt dates of interest recorded for each site include:

- Maximum SWE date
- Beginning of snowmelt
- End of snowmelt date for snow courses
- End of visible snow distribution in local watershed area

### Lake and Reservoir Recharge Monitoring

Lake and reservoir recharge monitoring included a combination of water level surveying, staff gage readings, potential flow observations in channels, and general field observations of runoff and recharge conditions to lake and reservoirs. Elevation surveys used standard project methods and field forms. Permanent or temporary staff gages were used for water surface elevation surveys, such as at L9312. Temporary staff gages may have been used at Mine Site B and Kuparuk Deadarm Lakes to make daily water elevation measurements more efficient. Some of the specific recharge observations made at these sites may include the following;

- First melt-water date observed on lake ice (with photographs)

- Date of first ponding and moating around lake and reservoir shorelines (with photographs)
- Date inflow was first observed at lake/reservoir inlets or overland drainages
- Date outflow was first observed at lake/reservoir outlets or overland drainages
- Date of any recharge by surface water flooding, such as L9312
- Timing of flood recession
- Daily photographs taken of the primary snow survey area at each location, or another representative area, to document the snow melt.

Field water-quality meters were used to help characterize the changes in water quality in inflowing channels, lake/reservoir perimeters, outlets and other points of interest. Field water quality meters were checked against water quality standards weekly, or as required.

### Snow Surveys

Small-scale snow depth measurements were conducted in “L” shaped patterns on the lake surface and/or tundra surface at predetermined snow-course locations. Snow depth measurements were taken every 3.3 ft (1 m) for 82 ft (25 m), then turning 90 degrees, and continuing for another 82 ft (25 m). Snow-density samples were also collected at even intervals along transects with an Adirondack snow sampler. Five samples were collected from points along the snow courses and averaged to establish a representative density. Larger-scale snow-depth measurements were conducted at L9312 along general east/west and north/south transects. Depth measurements were typically recorded every 10 ft (3 m, 2 paces). Measurements at transition zones from tundra to lake were recorded 5 ft (1.5 m, 1 pace), and on homogeneous lake surfaces depths were recorded every 20 ft (6.1 m, 4 paces).

### L9312/L9817 Snow Grids:

Snow depth measurements were conducted across a grid that overlaid the watershed areas at L9312 and L9817. The grid was spaced approximately 500 ft. by 500 ft. and contained snow depths on both the lake and tundra. At each location along the grid, 5 snow depths were taken spaced 1 ft. apart. The L9312 grid contained 34 nodes (170 depth measurements), and the L9817 grid contained 42 nodes (210 depth measurements). These grids were performed to gain a better estimate of the spatial distribution of snow within the watershed areas of L9312 and L9817.



**Figure 2. Chad Cormack conducting an elevation survey, photo by D. Reichardt.**

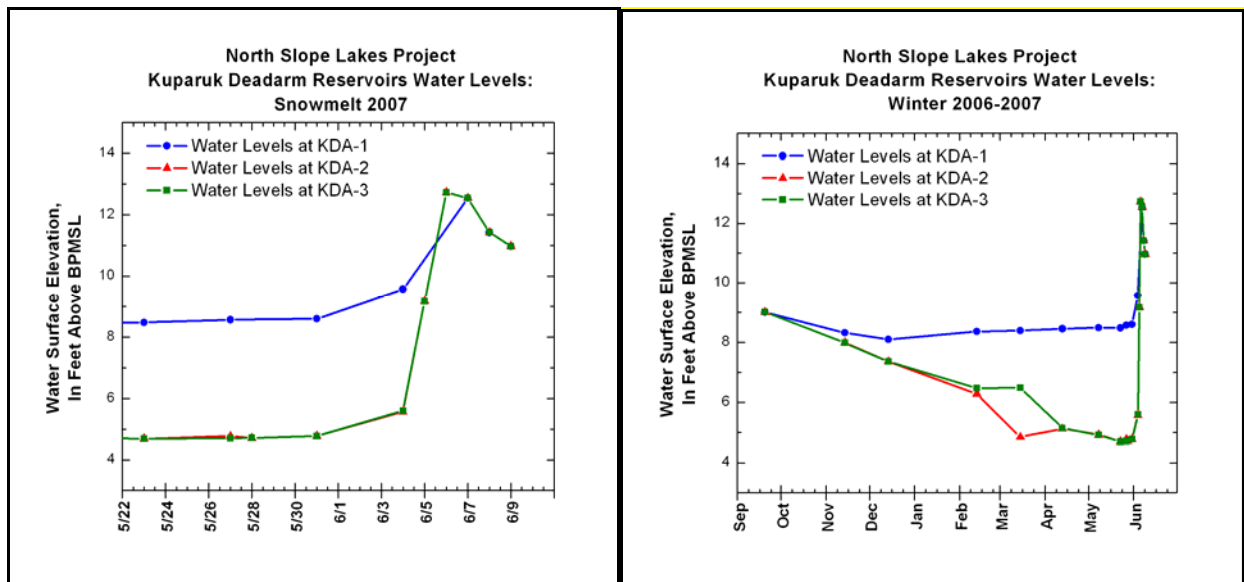
## **SELECTED SNOWMELT AND RECHARGE MONITORING OBSERVATIONS**

Sampling occurred at Kuparuk Deadarm Lakes, Mine Site B, L9312, Betty Pingo, and West Dock during the Snowmelt trip field activities.

### **Kuparuk Deadarm Reservoirs:**

On 5/23/07 the Kuparuk Deadarm Reservoirs were observed to have minimal snowmelt and/or standing water in the parking lots around KDA 1-3. On 5/25/07, a pool of water approximately 500 square feet was noticed in the southern end of the parking lot, south of the water filling area. Additional pools and wet spots had begun forming in all 3 cells and the snow began to disappear around the edges and top of berms. On 5/27/07, little change had been observed due to cold weather. Water rested on top of approximately 5 feet of ice with a layer of ice above it on all 3 cells. There was no evidence of water entering the system at this point, however the tundra became exposed around cells 1-3. On 5/28/07, open water was detected on

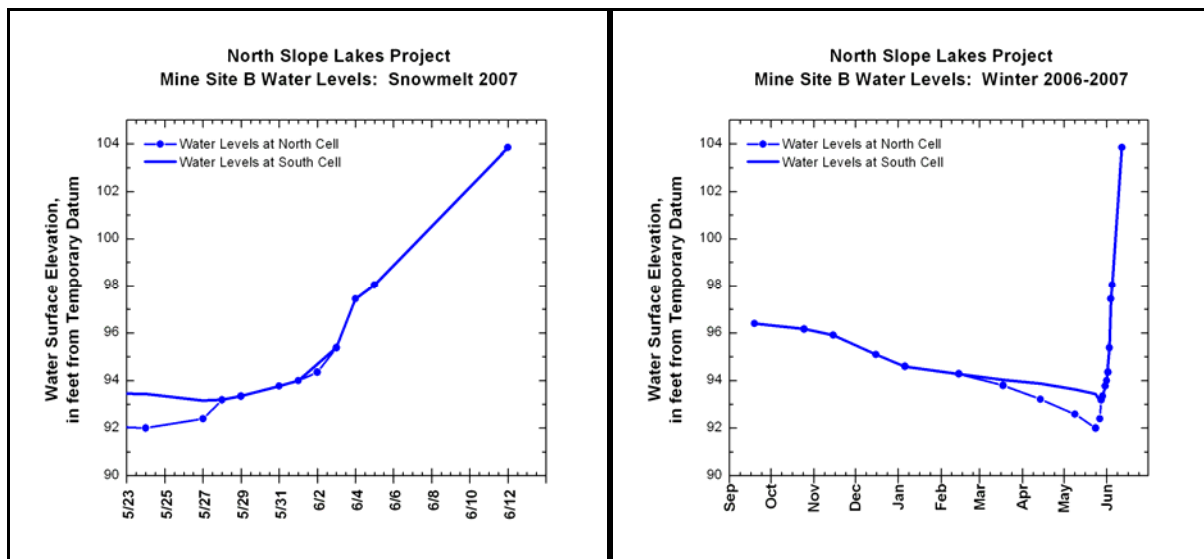
cell 3, but was re-frozen by 5/29/07. On 6/5/07, consistent flow into KDA3, and subsequently KDA2, was observed going through culverts from KDA4. At this time, two of the larger culverts and two of the smaller culverts were flowing at near full for several hours. These culverts appeared to manage the flow so that the road was not overtopped. There was still no evidence of water flow from the Kuparuk river to KDA1 through the culverts. On 6/6/07, water began flowing freely between KDA3 and KDA4 over the road. KDA1, KDA2, and KDA3 had also become hydraulically connected. At this point the primary source of water into the cells was the culverts from the Kuparuk river. By 6/8/07, the water levels had decreased by several feet in all 3 cells. Water was still flooding from the Kuparuk river. On 6/9/07, it was recognized that KDA 1-3 were near maximum capacity and all excess flood water had runoff through the culverts to cell 4. The culvert which connects cell 1 with the Kuparuk river had dried up, as the Kuparuk river elevation had dropped below the culver inflow elevation. KDA1 and KDA2 were barely connected through a small shallow channel. This connection ended by 6/10/07, however cells 1 and 2 remained connected through a culvert at the northern end of the berm. At this point the water levels had also dropped slightly in all 3 cells (KDA 1-3).



**Figure 3. Kuparuk Deadarm Reservoirs, cells 1-3, water levels. First figure shows changes throughout snowmelt period, second figure shows cumulative change throughout entire winter.**

Mine Site B:

On 5/22/07, it was observed that the western and lowest portion of the road was melting, this was the first snowmelt into the Mine Site B cells. On 5/23/07, 2 runoff areas were identified on the roadway to the north of the northern cell, one at a low spot east of the waterfill spigot, and the other up hill of the western waterfill spigot. On 5/25/07, there was little to no snow on the roadway north of the northern cell. A pool was forming in the turnaround area east of the weather station which was running off into the eastern side of the north cell. By 5/28/07, liquid water was seen on the North Cell. Cracks had begun to form along the boundaries and vertical displacement of ice ranged from 10 to 15 cm. A channel, approximately 30 inches wide and 1.25 inches deep, was detected on the South Cell. There was still no obvious main surface water input/output in the system, however, the main stream was well defined upstream of the south cell. In addition, near-channel areas were recharging the south cell. On 5/29/07 water began flowing from Milne Creek to the South Cell in two locations. By 6/5/07, flow from the west into the south cell had increased. Flow was added through the main channel and from another side stream to the east of the South Cell. This stream had increased the flow significantly which contributed to the increase in water levels of both the North and South Cells from the previous day. Unfortunately, due to the Kuparuk river bridge closing, Mine Site B was not visited again on this trip.

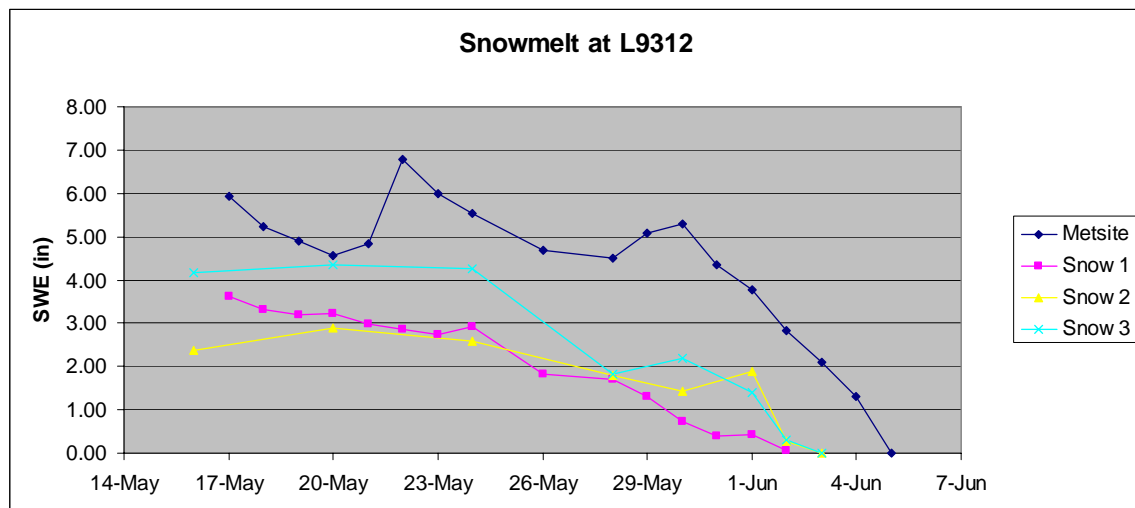


**Figure 4. Mine Site B water levels. First figure shows changes throughout snowmelt period, second figure shows cumulative change throughout entire winter.**

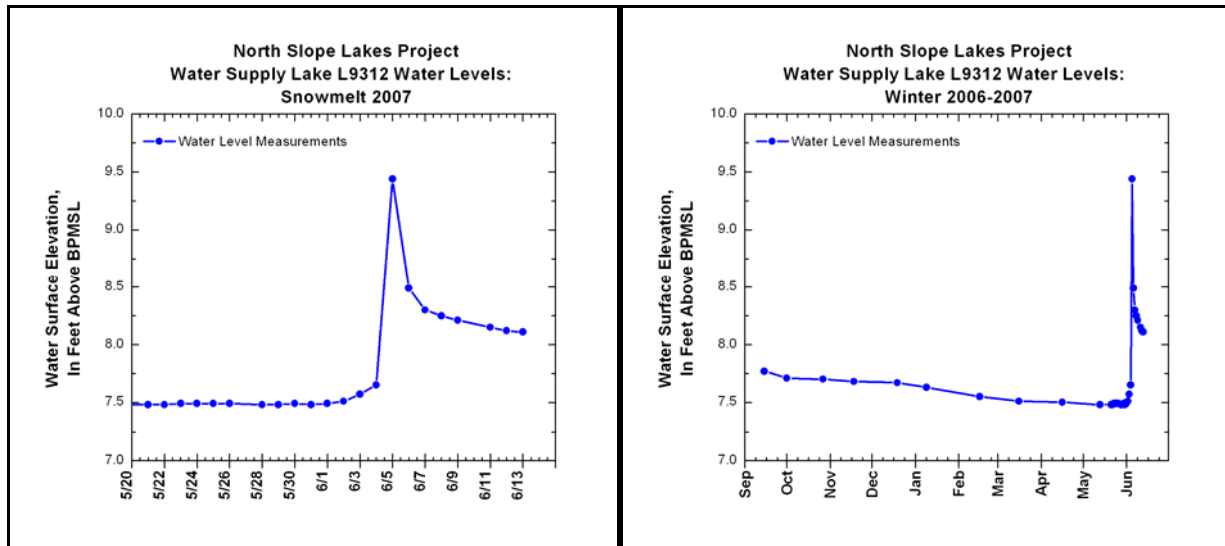
L9312:

Four locations on the tundra around L9312 were chosen to be snow course sites. Snow courses were conducted every 1 to 2 days to calculate SWE. As seen in Figure 5, snowmelt began around 5/25/07 and continued until early June.

As seen in the L9312 water level graphs (Figure 6), recharge of the lake began on 6/1/2007. Over the next four days, the snowmelt from the watershed raised the water level by 0.16 ft. The lake was very close to recharging on its own before the entire area was flooded on 6/6/2007. On this day, the entire north end of the watershed was 3-4 ft high with water. By 5/7/2007 the floodwaters had receded considerably, however inflow was observed from the southeast end of the lake until 6/9/2007 when the flow stopped. The northwest outlet was flowing at a high rate until 6/10/2007. Flow was slowed after this date, but was still observed until 6/14/2007 when field work ended.



**Figure 5. Snow water equivalence changes at L9312 during snowmelt 2007.**



**Figure 6. L9312 water levels. First figure shows changes throughout snowmelt period, second figure shows cumulative change throughout entire winter.**

## SUMMARY

Monthly monitoring of water-quality parameters and spatial distribution of snow cover at North Slope lakes throughout the winter will help in the understanding and development of simulation tools necessary for water-resources management. As lake water levels change due to freezing and pumping activities in the winter, it is important to identify the changing water chemistry as well as the potential spring-snowmelt recharge. This information is important for permitting agencies as well as industry professionals who depend on water assets for facility use and ice road/pad construction. Through monthly hydrologic assessments, water-chemistry testing, and water-sample analysis, we will continue to answer some of the questions on the hydrology of North Slope lakes and adaptive management strategies.



## REFERENCES

- Lilly, M.R., Reichardt, D., and Derry, J. 2007. A Workplan for Lake Chemistry Sampling and Surveying, Snowmelt, and Lake Recharge Monitoring at Study Lakes in NPRA, Alpine, Kuparuk River, and Prudhoe Bay Areas: May 2007. Water and Environmental Research Center, University of Alaska Fairbanks. 21 p.
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- White, D.M., and Lilly, M.R. 2007*c*. ConocoPhillips Alaska, Inc.: Health, Safety, and Environmental Plan. Water and Environmental Research Center, University of Alaska Fairbanks. 5 p.

## **APPENDIX A. WATER QUALITY FIELD SAMPLING FORMS**

The following forms report the data collected with the water quality meters during field sampling.

## Form F-004a: Water Quality Field-Sampling General

Site Location/Lake ID: KDA4  
Date: 5/16/07 Time: 16:01

GPS Coord. Northing:	<u>N70°20.438'</u>	Easting: <u>W148°50.071'</u>	Datum: <u>NAD27</u>
Measurements By:	<u>DAR/GMM</u>	Time: <u>16:01</u>	
Water Depth (ft):	<u>47.3</u>	Ice Thickness (ft): <u>5.45</u>	
Freeboard (ft):	<u>0.5</u>	Snow Depth (ft): <u>0.20</u>	
Elev. (BPMSL +/- .02):	<u>18.82</u>	Survey By: <u>JED/HT</u>	Date: <u>6/2/07</u> Time: <u>15:30</u>
Water Sampling By:	<u>GMM</u>	Sample Depths BWS (ft):	Date: <u>5/16/07</u> Time: <u>16:01</u>
		1 <u>6</u>	
		2 <u>25</u>	
		3 <u>37.5</u>	

**WATER QUALITY METER INFORMATION**

### WATER QUALITY METER INFORMATION

[illegible]

Probe:					
Depth (ft)					
Temp (°C)					
pH					
Eh					

[illegible]

Field-Form Filled Out By:	<u>A. Blackburn</u>	Date:	<u>8/15/08</u>
QAQC Check By:	<u>K. Holland</u>	Date:	<u>8/18/08</u>

## Form F-004a: Water Quality Field-Sampling General

Site Location/Lake ID: KDA4  
Date: 5/16/07 Time: 16:01

GPS Coord. Northing:	<u>N70°20.438'</u>	Easting: <u>W148°50.071'</u>	Datum: <u>NAD27</u>
Measurements By:	<u>DAR/GMM</u>	Time: <u>16:01</u>	
Water Depth (ft):	<u>47.3</u>	Ice Thickness (ft): <u>5.45</u>	
Freeboard (ft):	<u>0.5</u>	Snow Depth (ft): <u>0.20</u>	
Elev. (BPMSL +/- .02):	<u>18.82</u>	Survey By: <u>JED/HT</u>	Date: <u>6/2/07</u> Time: <u>15:30</u>
Water Sampling By:	<u>GMM</u>	Sample Depths BWS (ft): <u>1      6</u>	Date: <u>5/16/07</u> Time: <u>16:01</u>
		<u>2      25</u>	
		<u>3      37.5</u>	

**WATER QUALITY METER INFORMATION**

## WATER QUALITY METER INFORMATION

### Calibration Information

[illegible]

Probe:					
Depth (ft)					
Temp (°C)					
pH					
Eh					

[illegible]

Remarks: Log 2007-05-16 16:28

Field-Form Filled Out By:	<u>A. Blackburn</u>	Date:	<u>8/15/08</u>
QAQC Check By:	<u>K. Holland</u>	Date:	<u>8/18/08</u>

## Form F-004a: Water Quality Field-Sampling General

Site Location/Lake ID: KDA5  
Date: 5/17/07 Time: 14:06

GPS Coord. Northing:	<u>N70°20.642'</u>	Easting: <u>W148°56.135'</u>	Datum: <u>NAD83</u>
Measurements By:	<u>DAR/GMM</u>	Time: <u>14:06</u>	
Water Depth (ft):	<u>54.0</u>	Ice Thickness (ft): <u>5.85</u>	
Freeboard (ft):	<u>0.40</u>	Snow Depth (ft): <u>0.20</u>	
Elev. (BPMSL +/- .02):	<u>12.63</u>	Survey By: <u>JED/GMM</u>	Date: <u>6/6/07</u> Time: <u>11:35</u>
Water Sampling By:	<u>DAR</u>	Sample Depths BWS (ft): 1 <u>6</u>	Date: <u>5/17/07</u> Time: <u>14:06</u>
		2 <u>26</u>	
		3 <u>37.5</u>	

**WATER QUALITY METER INFORMATION**

### WATER QUALITY METER INFORMATION

[illegible]

Depth (ft)					
Temp (°C)					
pH					
Eh					

[illegible]

Remarks: No log recorded on In-Situ.

Field-Form Filled Out By:	<u>A. Blackburn</u>	Date:	<u>8/15/08</u>
QAQC Check By:	<u>K. Holland</u>	Date:	<u>8/18/08</u>

## Form F-004a: Water Quality Field-Sampling General

Site Location/Lake ID: KDA5  
Date: 5/17/07 Time: 14:06

GPS Coord. Northing:	<u>N70°20.642'</u>	Easting:	<u>W148°56.135'</u>	Datum:	<u>NAD83</u>
Measurements By:	<u>DAR/GMM</u>	Time:	<u>14:06</u>		
Water Depth (ft):	<u>54.0</u>	Ice Thickness (ft):	<u>5.85</u>		
Freeboard (ft):	<u>0.40</u>	Snow Depth (ft):	<u>0.20</u>		
Elev. (BPMSL +/- .02):	<u>12.63</u>	Survey By:	<u>JED/GMM</u>	Date:	<u>6/6/07</u> Time: <u>11:35</u>
Water Sampling By:	<u>DAR</u>	Sample Depths BWS (ft):	<u>1      6</u>	Date:	<u>5/17/07</u> Time: <u>14:06</u>
			<u>2      26</u>		
			<u>3      37.5</u>		
<b>WATER QUALITY METER INFORMATION</b>					

### WATER QUALITY METER INFORMATION

[illegible]

Probe:					
Depth (ft)					
Temp (°C)					
pH					
Eh					

[illegible]

Remarks: No log recorded on In-Situ.

Field-Form Filled Out By:	<u>A. Blackburn</u>	Date:	<u>8/15/08</u>
QAQC Check By:	<u>K. Holland</u>	Date:	<u>8/18/08</u>

## Form F-004a: Water Quality Field-Sampling General

Site Location/Lake ID: KDA9  
Date: 5/18/07 Time: 16:05

GPS Coord. Northing:	<u>N70°20.526'</u>	Easting: <u>W148°56.854'</u>	Datum: <u>NAD83</u>
Measurements By:	<u>DAR/GMM</u>	Time: <u>16:05</u>	
Water Depth (ft):	<u>13.5</u>	Ice Thickness (ft): <u>5.80</u>	
Freeboard (ft):	<u>0.45</u>	Snow Depth (ft): <u>0.30</u>	
Elev. (BPMSL +/- .02):	<u>n/a</u>	Survey By: <u>n/a</u>	Date: <u>n/a</u> Time: <u>n/a</u>
Water Sampling By:	<u>DAR /GMM</u>	Sample Depths BWS (ft): <u>1      6</u>	Date: <u>5/18/07</u> Time: <u>16:05</u>
		<u>2      9</u>	
		<u>3      12</u>	
<b>WATER QUALITY METER INFORMATION</b>			

### WATER QUALITY METER INFORMATION

### Calibration Information

[illegible]

Probe:

Depth (ft)				
Temp (°C)				
pH				
Eh				

[illegible]

Remarks: \_\_\_\_\_

Field-Form Filled Out By:	<u>A. Blackburn</u>	Date:	<u>8/15/08</u>
QAQC Check By:	<u>K. Holland</u>	Date:	<u>8/18/08</u>

## **APPENDIX B. WATER QUALITY METER CALIBRATION FORMS**

The following forms report the pre- and post-calibration checks for the water quality meters used during field sampling.



**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-004e: Water Quality Meter Calibration Form**

Project ID: North Slope Lakes Site Location/Lake ID: L9817  
Sample Purpose: Lake Water Quality

**WATER QUALITY METER INFORMATION**

Meter Make: Insitu Make: Troll 9000  
Owner: GWS S/N: 33033

**CALIBRATION AND QUALITY ASSURANCE INFORMATION**

**Pre-Sampling QA**

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	5/12/07	1631	Oakton	2610411	Oct-08	4.04 @ 9.32	Pass
pH 7.00	5/12/07	1634	Oakton	2612531	Dec-08	7.03 @ 9.81	Pass
pH 10.00	5/12/07	1638	Oakton	2612532	Jun-08	10.15 @ 10.78	Pass
Conductivity	5/12/07	1640	Oakton 447us/cm	2701471	Apr-08	447 @ 17.08	Pass
DO 100	5/12/07	1625	Bubbled Nanopure	---	---	92.1 @ 7.38	Pass
DO 0	5/10/07	1934	Hanna H17040	G1012	Feb-11	0.01 @17.45	Pass

**Post-Sampling QA**

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	5/16/07	2124	Oakton	2612530	Dec-08	4.09 @ 19.75	Pass
pH 7.00	5/16/07	2127	Oakton	2612531	Dec-08	7.07 @ 19.25	Pass
pH 10.00	5/16/07	2130	Oakton	2612532	Jun-08	10.20 @ 19.21	Pass
Conductivity	5/16/07	2133	Oakton 447us/cm	260977	Sep-07	404.3 @ 19.45	Pass
DO 100	5/16/07	2158	Bubbled Nanopure	---	---	93.2 @ 15.73	Pass
DO 0	5/16/07	2204	Hanna H17040	G1012	Feb-11	0.01 @15.23	Pass

Remarks: Insitu leaked into device and removed from service on 5/14/07. Fixed and placed in service 5/16/07.

Field-Form Filled Out By: Greta Myerchin Date: 6/12/2007  
QAQC Check By: A. Blackburn Date: 7/21/2007

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-004e: Water Quality Meter Calibration Form**

Project ID: North Slope Lakes Site Location/Lake ID: L9817  
Sample Purpose: Lake Water Quality

**WATER QUALITY METER INFORMATION**

Meter Make: Insitu Make: Troll 9000  
Owner: UAF S/N: 33205

**CALIBRATION AND QUALITY ASSURANCE INFORMATION**

**Pre-Sampling QA**

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	5/15/07	1829	Oakton	2610411	Oct-08	4.10 @ 18.68	Pass
pH 7.00	5/15/07	1836	Oakton	2612531	Dec-08	7.05 @ 18.20	Pass
pH 10.00	5/15/07	1844	Oakton	2612532	Jun-08	10.04 @ 18.61	Pass
Conductivity	5/15/07	1825	Oakton 447us/cm	260977	Sep-07	350.1 @ 18.03	Pass
DO 100	5/15/07	1701	Bubbled Nanopure	---	---	109 @ 18.0	Pass

**Post-Sampling QA**

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
No Post QAQC performed on UAF Insitu							

Remarks: \_\_\_\_\_

Field-Form Filled Out By: Greta Myerchin Date: 6/12/2007  
QAQC Check By: A. Blackburn Date: 7/21/2007

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-004e: Water Quality Meter Calibration Form**

Project ID: North Slope Lakes Site Location/Lake ID: L9817  
Sample Purpose: Lake Water Quality

**WATER QUALITY METER INFORMATION**

Meter Make: Insitu Make: Troll 9000  
Owner: GWS S/N: 33033

**CALIBRATION AND QUALITY ASSURANCE INFORMATION**

**Pre-Sampling QA**

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	5/16/07	2124	Oakton	2610411	Oct-08	4.09 @ 19.75	Pass
pH 7.00	5/16/07	2127	Oakton	2612531	Dec-08	7.07 @ 19.25	Pass
pH 10.00	5/16/07	2130	Oakton	2612532	Jun-08	10.20 @ 19.21	Pass
Conductivity	5/16/07	2133	Oakton 447us/cm	260977	Sep-07	404.3 @ 19.45	Pass
DO 100	5/16/07	2158	Bubbled Nanopure	---	---	93.2 @ 15.73	Pass
DO 0	5/16/07	2204	Hanna H17040	G1012	Feb-11	0.01 @15.23	Pass

**Post-Sampling QA**

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	5/18/07	1008	Oakton	2612530	Dec-08	4.01 @ 16.36	Pass
pH 7.00	5/18/07	1010	Oakton	2612531	Dec-08	6.96 @ 15.97	Pass
pH 10.00	5/18/07	1014	Oakton	2612532	Jun-08	9.99 @ 16.12	Pass
Conductivity	5/18/07	1106	Oakton 1413 us/cm	2501347	Jan-06	1128 @ 14.92	Pass
DO 100	5/18/07	1139	Bubbled Nanopure	---	---	95.7 @ 16.12	Pass
DO 0	5/18/07	1144	Hanna H17040	G1012	Feb-11	0.01 @14.12	Pass

Remarks: \_\_\_\_\_

Field-Form Filled Out By: Greta Myerchin Date: 6/12/2007  
QAQC Check By: A. Blackburn Date: 7/21/2007

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-004e: Water Quality Meter Calibration Form**

Project ID: North Slope Lakes Site Location/Lake ID: L9817  
Sample Purpose: Lake Water Quality

**WATER QUALITY METER INFORMATION**

Meter Make: Insitu Make: Troll 9000  
Owner: GWS S/N: 33033

**CALIBRATION AND QUALITY ASSURANCE INFORMATION**

**Pre-Sampling QA**

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	5/18/07	1008	Oakton	2612530	Dec-08	4.01 @ 16.36	Pass
pH 7.00	5/18/07	1010	Oakton	2612531	Dec-08	6.96 @ 15.97	Pass
pH 10.00	5/18/07	1014	Oakton	2612532	Jun-08	9.99 @ 16.12	Pass
Conductivity	5/18/07	1106	Oakton 1413 us/cm	2501347	Jan-06	1128 @ 14.92	Pass
DO 100	5/18/07	1139	Bubbled Nanopure	---	---	93.2 @ 15.73	Pass
DO 0	5/18/07	1144	Hanna H17040	G1012	Feb-11	0.01 @15.23	Pass

**Post-Sampling QA**

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	5/19/07	1131	Oakton	2612530	Dec-08	4.17 @ 16.58	Pass
pH 7.00	5/19/07	1132	Oakton	2612531	Dec-08	7.15 @ 15.12	Pass
pH 10.00	5/19/07	1135	Oakton	2612532	Jun-08	10.13 @ 15.04	Pass
Conductivity	5/19/07	1105	Oakton 146 us/cm	Mix	Nov-07	1164 @ 16.43	Pass
Conductivity	5/19/07	1105	Oakton 1413 us/cm	2501347	Jan-06	150.5 @ 25.14	Pass
DO 100	5/19/07	1145	Bubbled Nanopure	---	---	91.8 @ 15.26	Pass
DO 0	5/19/07	1151	Hanna H17040	G1012	Feb-11	0.01 @13.91	Pass

Remarks: Conductivity 146 us/cm solution = 0.74 g KCL to 1 L of DO. Solution from Arctic Fox Environmental, Deadho

Field-Form Filled Out By: Greta Myerchin Date: 6/12/2007  
QAQC Check By: A. Blackburn Date: 7/21/2007

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-004e: Water Quality Meter Calibration Form**

Project ID: North Slope Lakes Site Location/Lake ID: Ca/Mg Sampling and  
 Sample Purpose: Lake Water Quality Chemistry - post Breakup

**WATER QUALITY METER INFORMATION**

Meter Make: Insitu Make: Troll 9000  
 Owner: GWS S/N: 33033

**CALIBRATION AND QUALITY ASSURANCE INFORMATION**

**Pre-Sampling QA**

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	5/19/07	1131	Oakton	2612530	Dec-08	4.17 @ 16.58	Pass
pH 7.00	5/19/07	1132	Oakton	2612531	Dec-08	7.15 @ 15.12	Pass
pH 10.00	5/19/07	1135	Oakton	2612532	Jun-08	10.13 @ 15.04	Pass
Conductivity	6/8/07	1002	Oakton 447 us/cm	2701471	Jan-08	364.7 @ 14.58	Pass

**Post-Sampling QA**

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	6/8/07	1606	Oakton	2612530	Dec-08	4.20 @ 16.88	Pass
pH 7.00	6/8/07	1613	Oakton	2612531	Dec-08	6.95 @ 16.63	Pass
pH 10.00	6/8/07	1616	Oakton	2612532	Jun-08	10.09 @ 16.70	Pass
Conductivity	6/8/07	1618	Oakton 447 us/cm	2701471	Jan-08	393.1 @ 17.60	Pass

Remarks: Conductivity 146 us/cm solution = 0.74 g KCL to 1 L of DO.

Solution from Arctic Fox Enviromental, Deadhorse.

Field-Form Filled Out By: Greta Myerchin Date: 6/12/2007  
 QAQC Check By: A. Blackburn Date: 7/21/2007

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-004e: Water Quality Meter Calibration Form**

Project ID: North Slope Lakes Site Location/Lake ID: Ca/Mg Sampling and  
Sample Purpose: Lake Water Quality Chemistry - post Breakup

**WATER QUALITY METER INFORMATION**

Meter Make: Insitu Make: Troll 9000  
Owner: GWS S/N: 33033

**CALIBRATION AND QUALITY ASSURANCE INFORMATION**

**Pre-Sampling QA**

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	6/8/07	1606	Oakton	2612530	Dec-08	4.20 @ 16.88	Pass
pH 7.00	6/8/07	1613	Oakton	2612531	Dec-08	6.95 @ 16.63	Pass
pH 10.00	6/8/07	1616	Oakton	2612532	Jun-08	10.09 @ 16.70	Pass
Conductivity	6/8/07	1618	Oakton 447 us/cm	2701471	Jan-08	393.1 @ 17.60	Pass

**Post-Sampling QA**

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	6/10/07	1731	Oakton	2612530	Dec-08	4.20 @ 17.04	Pass
pH 7.00	6/10/07	1733	Oakton	2612531	Dec-08	7.18 @ 16.73	Pass
pH 10.00	6/10/07	1735	Oakton	2612532	Jun-08	10.15 @ 16.62	Pass
Conductivity	6/10/07	1727	Oakton 447 us/cm	2701471	Jan-08	373.0 @ 16.49	Pass

Remarks: Conductivity 146 us/cm solution = 0.74 g KCL to 1 L of DO. Solution from Arctic Fox Environmental, Deadho

Field-Form Filled Out By: Greta Myerchin Date: 6/12/2007  
QAQC Check By: A. Blackburn Date: 7/21/2007

## **APPENDIX C. ELEVATION SURVEY FORMS**

The following form reports the elevation survey information obtained during field sampling.

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 5/23/2007 Time: 11:00am

Location:	Kuparuk Deadarm Reservoirs Cells 4, 5, 9							
Survey objective:	Lake water elevation survey					Weather Observations:		thin overcast
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)			~10F, overcast, visibility 0.5 miles		
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		DAR, GMM		
BM#1 WQ040768	BP	19.32'	N70 20.048 NAD83	W148 56.367 NAD83				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (fasl)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
BM3	0.72	19.62		18.90				Shooting from cell 1
SH4		19.62	14.63	4.99				
TOI 4		19.62	13.22	<b>6.40</b>				<b>WL 4= 6.40'</b>
TOI 5		19.62	13.86	<b>5.76</b>				<b>WL 5 =5.76'</b>
SH 5		19.62	14.69	4.93				
TP1		19.62	13.21	6.41				
Move instrument								
TP1	4.91	11.32		6.41				
TP2		11.32	5.85	5.47				
Move instrument to								
TP2	8.43	13.90		5.47				
TOC 9		13.90	6.34	7.56				
KDA9		13.90	8.65	5.25				
Move instrument								
KDA9	8.80	14.05		5.25				
TOI 9		14.05	6.51	7.54				Close survey

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasl; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL



**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 5/23/2007 Time: 11:00am

Location:	Kuparuk Deadarm Reservoirs Cells 1, 2, 3							
Survey objective:	Lake water elevation survey					Weather Observations:		thin overcast
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)			~5 Degrees F 5MPH wind, bright sunshine		
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		GM,JED		
BM#1 WQ040768	BP	19.32'	N70 20.048 NAD83	W148 56.367 NAD83				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (fast)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
TBM_1	1.32	20.64		19.32				
KDA3-SH		20.64	15.95	<b>4.69</b>				<b>KDA3-WL</b>
KDA2-SH		20.64	15.95	<b>4.69</b>				<b>KDA2-WL</b>
Turn on KDA2-SH1, move instrument to ^2								
KDA2-SH	16.11	20.80		4.69				
KDA3-SH		20.80	16.11	4.69				
TBM_1		20.80	1.47	19.33				
Move instrument to Island, turn on KDA2 Water Surface. Shooting from ^3								
KDA2-SH	11.35	16.04		4.69				
KDA1-SH		16.04	7.56	<b>8.48</b>				<b>KDA1 WL</b>
Move instrument to ^4, turn on KDA1-SH								
KDA1-SH	7.14	15.62		8.48				
KDA2-SH		15.62	10.92	4.70				

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

## Form F-011: Elevation Survey Form

[illegible]

C-4

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 5/27/2007 Time: 12:30pm

Location:	Kuparuk Deadarm Reservoirs Cells 1, 2, 3							
Survey objective:	Lake water elevation survey					Weather Observations:		thin overcast, windy
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)					
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	GM,JED			
BM#1 WQ040768	BP	19.32'	N70 20.048 NAD83	W148 56.367 NAD83				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (ft)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
TBM_1	1.60	20.92		19.32				Shot to flagged benchmark
KDA3-SH		20.92	16.22	<b>4.70</b>				<b>KDA3-WL</b>
KDA2-SH		20.92	16.15	<b>4.77</b>				<b>KDA2-WL</b>
Turn on KDA2-SH1, move instrument to ^2								
KDA2-SH	16.39	21.16		4.77				
KDA3-SH		21.16	16.46	4.70				
TBM_1		21.16	1.84	19.32				Close survey to 0.00
Move instrument to Island, turn on KDA2 Water Surface. Shooting from ^3								
KDA2-SH	11.23	16.00		4.77				
KDA1-SH		16.00	7.43	<b>8.57</b>				<b>KDA1 WL</b>
Move instrument to ^4, turn on KDA1-SH								
KDA1-SH	7.31	15.88		8.57				
KDA2-SH		15.88	11.12	4.76				Close survey to 0.01'

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

## Form F-011: Elevation Survey Form

[illegible]

C-6

## Form F-011: Elevation Survey Form

[illegible]

C-7

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 5/29/2007 Time: nr

Location:	Kuparuk Deadarm Reservoirs Cells 5, and re-bar that serve as stage markers							
Survey objective:	Lake water elevation survey				Weather Observations:		overcast, snow	
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)					
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:					Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	GMM?JED			
BM#1 WQ040766	BP	100	70 20 22.0 WGS 84	148 56 18.3 WGS 84				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (ft)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
TBM_1	1.12	101.12		100.00				
KDA_5		101.12	15.06	<b>86.06</b>				<b>KDA5-WL</b>
RB1		101.12	11.09	90.03				
KDA4		101.12	14.98	86.14				
move instrument to ^2								
KDA4	15.20	101.34		<b>86.14</b>				Re-bar: RB3 elevation
KDA5		101.34	15.27	<b>86.07</b>				Re-bar: RB2 elevation
RB1		101.34	11.32	90.02				
TBM_1		101.34	1.34	100.00				Close survey to 0.00

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 5/30/2007 Time: 11:00

Location:	Kuparuk Deadarm Reservoirs Cells 5, and re-bar that serve as stage markers							
Survey objective:	Lake water elevation survey					Weather Observations:		overcast, snow
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)					
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	HT, JED			
BM#1 WO040766	BP	18.90'	70 20 22.0 WGS 84	148 56 18.3 WGS 84				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (fasl)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
WO040766 B	1.27	20.17		18.90				Shot to flagged benchmark
KDA_5		20.17	15.20	<b>4.97</b>				<b>KDA5-WL</b>
RB2		20.17	10.94	9.23				
RB3		20.17	8.75	11.42				
Turn on KDA5-SH1, move instrument to ^2								
RB3	8.96	20.38		<b>11.42</b>				Re-bar: RB3 elevation
RB2		20.38	11.15	<b>9.23</b>				Re-bar: RB2 elevation
KDA_5		20.38	15.41	4.97				
WO040766 B		20.38	1.48	18.91				Close survey to 0.005

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasl; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

## Form F-011: Elevation Survey Form

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C-10





**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 5/31/2007 Time: 12:25pm

Location: KDA 4 and 5, and re-bar RB1 that serve as stage markers. Second time RB1 is surveyed for QA/QC reasons.								
Survey objective:		Lake water elevation survey				Weather Observations:		Partly cloudy
Instrument Type:		Leica NA720		Instrument ID: 5482367 (GWS owned)				
Rod Type:		Craine fiberglass 20'		Rod ID: GWS owned				
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		HT, JED		
BM#3 WO040766	BP	18.90'	70 20 22.0 WGS 84	148 56 18.3 WGS 84				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (fasl)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
WO040766 B	1.37	20.27		18.90				Shot to flagged benchmark
KDA_4 - culvert		20.27	14.43	<b>5.84</b>				<b>KDA_4-culvert elevation</b>
RB1		20.27	11.36	<b>8.91</b>				
Turn on RB1, move instrument to ^2								
RB1	11.50	20.41		8.91				Re-bar: RB1 elevation
KDA_4-culvert		20.41	14.57	5.84				
WO040766 B		20.41	1.51	18.90				Close survey to 0.00'
At 12:30pm, measured down to water surface from RB1			2.80	<b>6.11</b>				<b>KDA 5 WL</b>
At 1:00pm, measured down to water surface from RB1			2.40	<b>6.51</b>				<b>KDA 5 WL</b>
At 4:30pm, measured down to water surface from RB1			1.50	<b>7.41</b>				<b>KDA 5 WL</b>

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasl; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 5/31/2007 Time: 1:30pm

Location:	Kuparuk Deadarm Reservoirs Cells 1, 2, 3							
Survey objective:	Lake water elevation survey					Weather Observations:		partly cloudy
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)					
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	HT, JED			
BM#1 WQ040768	BP	19.32'	N70 20.048 NAD83	W148 56.367 NAD83				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (ft)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
TBM_1	2.27	21.59		19.32				
KDA3-SH		21.59	16.82	4.77				KDA3-WL
KDA2-SH		21.59	16.81	4.78				KDA2-WL
Turn on KDA2-SH1, move instrument to ^2								
KDA2-SH	16.95	21.73		4.78				
KDA3-SH		21.73	16.97	4.76				Close survey to 0.01
TBM_1		21.73	2.41	19.32				Close survey to 0.00'
Move instrument to Island, turn on KDA2 Water Surface. Shooting from ^3								
KDA2-SH	11.21	15.99		4.78				
KDA1-SH		15.99	7.39	8.60				KDA1 WL
Move instrument to ^4, turn on KDA1-SH								
KDA1-SH	7.53	16.13		8.60				
KDA2-SH		16.13	11.35	4.78				Close survey to 0.00'

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL



## Form F-011: Elevation Survey Form

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C-15



**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 6/1/2007 Time: 10:50am

Location:	Kuparuk Deadarm Reservoirs Cells 6 and 7. Used TBM_RD to survey water level.							
Survey objective:	Lake water elevation survey				Weather Observations:		overcast and windy	
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)					
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:					Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	HT,JED			
BM#1 WO040766	BP	18.90'	70 20 22.0 WGS 84	148 56 18.3 WGS 84				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (fasl)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
TBM_RD	3.13	17.87		14.74				Shot to TBM_RD between KDA 6 and 7
KDA_6_7		17.87	8.80	<b>9.07</b>				<b>KDA_6_7-WL</b>
Turn on KDA_6_7, move instrument to ^2								
KDA_6_7	8.90	17.97		9.07				Shot to KDA_6 and 7 - WL
TBM_RD		17.97	3.23	<b>14.74</b>				<b>Close survey to 0.00'</b>

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasl; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 6/1/2007 Time: 5.00pm

Location:	Kuparuk Deadarm Reservoirs Cells 6 and 7. Used TBM_RD to survey water level.							
Survey objective:	Lake water elevation survey				Weather Observations:		overcast	
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)					
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	HT,JED			
BM#1 WO040766	BP	18.90'	70 20 22.0 WGS 84	148 56 18.3 WGS 84				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (fasl)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
TBM_RD	2.98	17.72		14.74				Shot to TBM_RD between KDA 6 and 7
TBM_HT		17.72	6.91	<b>10.81</b>				<b>TBM_HT elevation</b>
Turn on TBM_HT, move instrument to ^2								
TBM_HT	7.05	17.86		10.81				
TBM_RD		17.86	3.12	<b>14.74</b>				Close survey to 0.00'

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasl; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL



**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 6/2/2007 Time: 3:30pm

Location:	Used TBM_RD to run re-bar TBM's down to the river and kda 7 junction							
Survey objective:	Lake water elevation survey				Weather Observations:		Scattered clouds and windy	
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)					
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:					Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, Horacio Toniolo			
BM#1 WO040766	BP	18.90'	70 20 22.0 WGS 84	148 56 18.3 WGS 84				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (fasl)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
TBM_RD	4.50	19.24		14.74				Shot to TBM_RD between KDA 6 and 7
TBM_RD2		19.24	1.48	<b>17.76</b>				<b>West of TBM_RD</b>
Turn on TBM_RD2, move instrument to ^2								
TBM_RD2	1.36	19.12		17.76				Elevation of TBM_RD2
TBM_RD		19.12	4.38	<b>14.74</b>				<b>Close survey to 0.00'</b>
Survey in re-bar TBM_RD3								
TBM_RD2	2.10	19.86		17.76				Shot to TBM_RD2
TBM_RD3		19.86	1.69	<b>18.17</b>				<b>West of TBM_RD2</b>
Turn on TBM_RD3, move instrument to ^2								
TBM_RD3	1.78	19.95		18.17				Elevation of TBM_RD3
TBM_RD2		19.95	2.19	<b>17.76</b>				<b>Close survey to 0.00'</b>
Survey in re-bar TBM_RD4								
TBM_RD3	3.22	21.39		18.17				Shot to TBM_RD3
TBM_RD4		21.39	2.57	<b>18.82</b>				<b>West of TBM_RD3</b>
Turn on TBM_RD4, move instrument to ^2								
TBM_RD4	2.68	21.50		18.82				Elevation of TBM_RD4
TBM_RD3		21.50	3.33	<b>18.17</b>				<b>Close survey to 0.00'</b>

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasl; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 6/3/2007 Time: 2:30pm

Location:		Kuparuk Deadarm Reservoirs Cells 1, 2, 3						
Survey objective:		Lake water elevation survey				Weather Observations:		
Instrument Type:	Leica NA720	Instrument ID:	5482372 (GWS owned)			~5 Degrees F 5MPH wind, bright sunshine		
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		DAR,JED		
TBM__	nr	100' Temp.	na	na				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (fasl)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
Survey in re-bar TBM_RD6 (Survey continued from previous page)								
TBM_RD5	3.27	20.41		17.14				Shot to TBM_RD5
TBM_RD6		20.41	3.34	<b>17.07</b>				<b>North of TBM_RD5</b>
Turn on TBM_RD6, move instrument to ^2								
TBM_RD6	3.47	20.54		17.07				Elevation of TBM_RD6
TBM_RD5		20.54	3.40	<b>17.14</b>				<b>Close survey to 0.00'</b>
Survey Kuparuk River and KDA 7at approximately 3:30pm								
TBM_RD6	0.09	17.16		17.07				Shot to TBM_RD6
KDA_7		17.16	8.03	<b>9.14</b>				Water surface of KDA_7
K_River		17.16	7.91	<b>9.25</b>				Water surface of K_River
Turn on K_River, move instrument to ^2								
K_River	8.09	17.34		9.25				<b>K_River - WL</b>
KDA_7		17.34	8.20	<b>9.14</b>				<b>KDA_7 - WL</b>
TBM_RD6		17.34	0.27	<b>17.07</b>				<b>Close survey to 0.00'</b>

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 6/4/2007 Time: 2:30pm

Location:	Kuparuk Deadarm Reservoirs Cells 1, 2, 3 using TBM_23 east of lakes							
Survey objective:	Lake water elevation survey					Weather Observations:		Sunny, calm
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)					
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, Rob Geick			
BM#1 WQ040768	BP	19.32'	N70 20.048 NAD83	W148 56.367 NAD83				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (ft)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
TBM_23	0.03	19.08		19.05				Shot to re-bar TBM_23
KDA2-SH		19.08	13.51	5.57				KDA2-WL
KDA3-SH		19.08	13.48	5.60				KDA3-WL
Turn on KDA3-SH, move instrument to ^2								
KDA3-SH	13.74	19.34		5.60				
KDA2-SH		19.34	13.78	5.56				
TBM_23		19.34	0.30	19.05				Close survey to 0.00
Move instrument to Island, turn on KDA2 Water Surface. Shooting from ^3								
KDA2-SH	10.35	15.92		5.57				
KDA1-SH		15.92	6.35	9.57				KDA1 WL
Move instrument to ^4, turn on KDA1-SH								
KDA1-SH	6.56	16.13		9.57				
KDA2-SH		16.13	10.55	5.58				Close survey to 0.01'

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 6/5/2007 Time: 14:30

Location: Kuparuk Deadarm Reservoirs Cells 2, 3 using TBM_23 to install TBM_RG								
Survey objective: Lake water elevation survey					Weather Observations:		Sunny, windy	
Instrument Type: Leica NA720		Instrument ID: 5482367 (GWS owned)						
Rod Type: Craine fiberglass 20'		Rod ID: GWS owned						
Bench Mark Information:					Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, Greta Myerchin			
BM#1 WQ040768	BP	19.32'	N70 20.048 NAD83	W148 56.367 NAD83				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (ft)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
TBM_23	1.31	20.36		19.05				Shot to re-bar TBM_23
TBM_RG		20.36	8.42	<b>11.94</b>				<b>Re-bar labeled TBM_RG</b>
Turn on TBM_RG, move instrument to ^2								
TBM_RG	8.25	20.19		11.94				TBM_RG - Elevation
TBM_23		20.19	1.14	19.05				Close survey to 0.00
Measured down to water surface from TBM_RG on KDA 3								
TBM_RG				11.94				
At 19:20, measured down from top of TBM_RG			2.77	<b>9.17</b>				<b>KDA 2 and 3 - WL</b>
Notes: KDA cells 2 and 3 are hydrologically connected								

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

## Form F-011: Elevation Survey Form

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C-23

## Form F-011: Elevation Survey Form

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**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 6/6/2007 Time: 13:30

Location:	Kuparuk Deadarm Reservoirs Cells 2, 3 using TBM_23 to install TBM_ML							
Survey objective:	Lake water elevation survey					Weather Observations:		Sunny, warm, calm
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)					
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, Greta Myerchin			
BM#1 WQ040768	BP	19.32'	N70 20.048 NAD83	W148 56.367 NAD83				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (ft)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
TBM_23	1.70	20.75		19.05				Shot to re-bar TBM_23
TBM_ML		20.75	4.94	15.81				Re-bar labeled TBM_ML
Turn on TBM_ML, move instrument to ^2								
TBM_ML	5.18	20.99		15.81				TBM_ML - Elevation
TBM_23		20.99	1.94	19.05				Close survey to 0.00
Measured down to water surface from TBM_ML on KDA 3								
TBM_ML				15.81				
KDA 3	At 13:10 KDA 2 and 3 tape down measurement		3.08	12.73				KDA 2 and 3 - WL
Notes: KDA cells 2 and 3 are hydrologically connected								

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL



## Form F-011: Elevation Survey Form

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C-27

## Form F-011: Elevation Survey Form

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**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 6/6/2007 Time: 3:30pm

Location: Surveyed elevations from USGS M_3 on M-pad to a gravel spit in order to ascertain bridge elevation.								
Survey objective: River water elevation survey					Weather Observations: Sunny, warm, calm			
Instrument Type: Leica NA720		Instrument ID: 5482367 (GWS owned)						
Rod Type: Craine fiberglass 20'		Rod ID: GWS owned						
Bench Mark Information:					Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, Greta Myerchin			
USGS_M3	USGS	25.34'						
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (fasm)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
USGS_M3	7.62	32.96		25.34				Shot to USGS_M3
TP1		32.96	5.56	<b>27.40</b>				Temporary turning point
Turn on TP1, move instrument to ^2								
TP1	5.19	32.59		27.40				TP1 elevation
USGS_M3		32.59	7.24	25.35				Close survey to 0.01'
Moved station								
TP1	5.93	33.33		27.40				Shot to TP1
TP2		33.33	6.62	<b>26.71</b>				Temporary turning point
Turn on TP2, move instrument to ^3								
TP2	6.36	33.07		26.71				TP2 elevation
TP1		33.07	5.67	27.40				Close survey to 0.00
Moved station (Survey continued on following page)								

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 6/6/2007 Time: 3:30pm

Location:	Surveyed elevations from USGS M_3 on M-pad to a gravel spite in order to ascertain bridge elevation.								
Survey objective:	River water elevation survey					Weather Observations:		Sunny, warm, calm	
Instrument Type:	Leica NA720		Instrument ID:		5482367 (GWS owned)				
Rod Type:	Craine fiberglass 20'		Rod ID:		GWS owned				
Bench Mark Information:						Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		Jeff Derry, Greta Myerchin			
USGS_M3	USGS	25.34'							
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (ft)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>	
Moved station (Survey continued from previous page)									
TP2	5.11	31.82		26.71				Shot to TP2	
TP3		31.82	3.52	<b>28.30</b>				Temporary turning point	
Turn on TP3, move instrument to ^4									
TP3	3.39	31.69		28.30				TP3 elevation	
TP2		31.69	4.98	26.71				Close survey to 0.00	
Moved station									
TP3	4.05	32.35		28.30				Shot to TP3	
TP4		32.35	5.63	<b>26.72</b>				Temporary turning point	
Turn on TP4, move instrument to ^5									
TP4	5.47	32.19		26.72				TP4 elevation	
TP3		32.19	3.89	28.30				Close survey to 0.00	
Moved station (Survey continued on following page)									

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 6/6/2007 Time: 3:30pm

Location:	Surveyed elevations from USGS M_3 on M-pad to a gravel spit in order to ascertain bridge elevation.								
Survey objective:	River water elevation survey					Weather Observations:		Sunny, warm, calm	
Instrument Type:	Leica NA720		Instrument ID:		5482367 (GWS owned)				
Rod Type:	Craine fiberglass 20'		Rod ID:		GWS owned				
Bench Mark Information:						Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		Jeff Derry, Greta Myerchin			
USGS_M3	USGS	25.34'							
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (fasm)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>	
Moved station (Survey continued from previous page)									
TP4	4.53	31.25		26.72				Shot to TP4	
TP5		31.25	3.11	<b>28.14</b>				Temporary turning point	
Turn on TP5, move instrument to ^6									
TP5	3.01	31.15		28.14				TP5 elevation	
TP4		31.15	4.44	26.71				Close survey to 0.01'	
Moved station									
TP5	4.24	32.38		28.14				Shot to TP5	
TP6		32.38	6.50	<b>25.88</b>				Temporary turning point	
Turn on TP6, move instrument to ^7									
TP6	6.68	32.56		25.88				TP6; aka TBM_rlx elevation	
TP5		32.56	4.42	28.14				Close survey to 0.00	

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL



**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 6/9/2007 Time: 14:00:00 PM

Location:	Compare TBM #1, #2, #3 at KDA to make sure they did not move over the winter months.							
Survey objective:	Lake water elevation survey					Weather Observations:		Sunny and very windy
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)					
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, Greta Myerchin			
BM#3 WQ040766	BP	18.90'	70 20 22.0 WGS 84	148 56 18.3 WGS 84				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (ft)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
TBM_3	3.33	22.23		18.90				Elevation of Re-bar TBM_# 3
TP1		22.23	2.47	19.76				
Turn on TP1, move instrument to ^2								
TP1	2.74	22.50		19.76				
TBM_3		22.50	3.60	18.90				Close survey to 0.00'
Survey to TP2								
TP1	4.91	24.67		19.76				Elevation of Re-bar TP1
TP2		24.67	3.98	20.69				
Turn on TP2, move instrument to ^2								
TP2	4.16	24.85		20.69				
TP1		24.85	5.10	19.75				Close survey to +0.01'
Survey to TP3 (Survey continued on following page)								

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 6/9/2007 Time: 14:00:00 PM

Location:	Compare TBM #1, #2, #3 at KDA to make sure they did not move over the winter months.							
Survey objective:	Lake water elevation survey					Weather Observations:		Sunny and very windy
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)					
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, Greta Myerchin			
BM#3 WQ040766	BP	18.90'	70 20 22.0 WGS 84	148 56 18.3 WGS 84				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (fasl)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
Survey to TP3 (Survey continued from previous page)								
TP2	3.19	23.88		20.69				Elevation of Re-bar TP2
TBM2		23.88	4.77	19.11				
TP3		23.88	3.18	20.70				
Turn on TP2, move instrument to ^2								
TP3	3.44	24.14		20.70				Elevation of Re-bar TP3
TBM2		24.14	5.04	19.10				
TP2		24.14	3.44	20.70				Close survey to +0.01'
Survey to TP4								
TP3	4.62	25.32		20.70				Elevation of Re-bar TP3
TP4		25.32	4.15	21.17				
Turn on TP4, move instrument to ^2								
TP4	4.29	25.46		21.17				Elevation of Re-bar TP4
TP3		25.46	4.75	20.71				Close survey to +0.01'
Survey to TBM_1 (Survey continued on following page)								

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL



**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: KDA  
 Survey Purpose: Water-Level Elevations Date: 6/9/2007 Time: 14:00:00 PM

Location:	Compare TBM #1, #2, #3 at KDA to make sure they did not move over the winter months.							
Survey objective:	Lake water elevation survey					Weather Observations:		Sunny and very windy
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)					
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, Greta Myerchin			
BM#3 WQ040766	BP	18.90'	70 20 22.0 WGS 84	148 56 18.3 WGS 84				
<b>Station</b>	<b>BS (ft)</b>	<b>HI (ft)</b>	<b>FS (ft)</b>	<b>Elevation (fasl)</b>	<b>Distance (ft)</b>	<b>Horizontal Angle</b>	<b>Vertical Angle</b>	<b>Remarks</b>
Survey to TBM_1 (Survey continued from previous page)								
TP4	4.25	25.42		21.17				Elevation of Re-bar TP4
TBM_1		25.42	6.08	19.34				
Turn on TP2, move instrument to ^2								
TBM_1	6.29	25.63		19.34				Elevation of TBM_1
TP4		25.63	4.45	21.18				Close survey to +0.01'
Notes: TBM_1 = 19.34'. TBM_2 = 19.10'/19.11'. TBM_3 = 18.90								

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: Mine Site B  
 Survey Purpose: Water-Level Elevations Date: 5/24/2007 Time: 12:30

Location: Mine Site B, NE corner of North Cell, temporary datum								
Survey objective: Lake water elevation survey						Weather Observations:		
Instrument Type:	Leica NA720		Instrument ID:	Leica Runner 24 Serial # 5482367		23F, 5 mph wind, overcast		
Rod Type:	Craine Fiberglass 20'		Rod ID:	GWS				
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		Daniel Reichardt Michael Lilly		
"Post"	WERC	100 Temp.	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
Post TBM1	5.45	105.45		100.00				Top of nail in post, temp elevation
NC-WL		105.45	13.45	92.00				North Cell, closest to north bank
TBM3		105.45	1.99	103.46				VSM 387A on Pipeline, north side
TBM2		105.45	1.61	103.84				VSM 387B on Pipeline, south side
Move instrument to ^2, turn on TBM2								
TBM2	1.72	105.56		103.84				VSM 387B on Pipeline
TBM3		105.56	2.09	103.47				VSM 387A on Pipeline, +0.01
NC-WL		105.56	13.56	<b>92.00</b>				North Cell, closest to north bank, +0.00
TBM1		105.56	5.56	100.00				close survey to +0.00
Move instrument to island, turn on MSBN Water Level.								
NC-WL	11.19	103.19		92.00				Frozen water level
SC-WL		103.19	9.76	93.43				TBM, tripod
Move to ^4, use MSBS as TP.								
SC-WL	9.57	103.00		<b>93.43</b>				South Cell, unfrozen, water level
NC-WL		103.00	10.99	92.01				close survey to +0.01

Note: Unfrozen water levels measured by following method. Rod placed on wood lathe and added to measured depth from top of lathe to water level.

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: Mine Site B  
 Survey Purpose: Water-Level Elevations Date: 5/27/2007 Time: 10:30

Location:	Mine Site B, NE corner of North Cell, temporary datum							
Survey objective:	Lake water elevation survey				Weather Observations:			
Instrument Type:	Leica NA720	Instrument ID:	Leica Runner 24 Serial # 5482372		Overcast, windy			
Rod Type:	Craine Fiberglass 20'	Rod ID:	GWS					
Bench Mark Information:					Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, Greta Myerchin			
"Post"	WERC	100 Temp.	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
Post TBM1	5.36	105.36		100.00				Top of nail in post, temp elevation
NC-WL		105.36	12.97	92.39				North Cell, closest to north bank
Move instrument to ^2, turn on TBM2								
NC-WL	13.13	105.52		<b>92.39</b>				North Cell, closest to north bank, +0.00
TBM1		105.52	5.53	99.99				close survey to 0.01
Move instrument to island, turn on MSBN Water Level.								
NC-WL	10.49	102.88		92.39				
SC-WL		102.88	9.72	93.16				TBM, tripod
Move to ^4, use MSBS as TP.								
SC-WL	9.49	102.65		<b>93.16</b>				South Cell
NC-WL		102.65	10.24	92.41				close survey to 0.02
Note:								
Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasl; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL								

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: Mine Site B  
 Survey Purpose: Water-Level Elevations Date: 5/28/2007 Time: 12:00

Location:	Mine Site B, NE corner of North Cell, temporary datum							
Survey objective:	Lake water elevation survey				Weather Observations:			
Instrument Type:	Leica NA720	Instrument ID:	Leica Runner 24 Serial # 5482372		Overcast, windy			
Rod Type:	Craine Fiberglass 20'	Rod ID:	GWS					
Bench Mark Information:					Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, Greta Myerchin			
"Post"	WERC	100 Temp.	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
Post TBM1	5.16	105.16		100.00				Top of nail in post, temp elevation
NC-WL		105.16	11.98	<b>93.18</b>				North Cell, closest to north bank
SC-WL		105.16	11.97	<b>93.19</b>				South Cell
Move instrument to ^2, turn on TBM2								
SC-WL	11.74	104.93		93.19				
NC-WL		104.93	11.75	93.18				close survey to 0.00
TBM1		104.93	4.92	100.01				close survey to 0.01
Note:								
Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL								

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: Mine Site B  
 Survey Purpose: Water-Level Elevations Date: 5/29/2007 Time: 10:30

Location:	Mine Site B, NE corner of North Cell, temporary datum							
Survey objective:	Lake water elevation survey and determining rebar elevations for spring melt					Weather Observations:		
Instrument Type:	Leica NA720	Instrument ID:	Leica Runner 24 Serial # 5482367		Overcast, Breezy			
Rod Type:	Craine Fiberglass 20'	Rod ID:	GWS					
Bench Mark Information:					Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, Greta Myerchin			
"Post"	WERC	100 Temp.	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
Post TBM1	1.50	101.50		100.00				Top of nail in post, temp elevation
NC-WL		101.50	8.16	<b>93.34</b>				<b>North Cell Water Elevation</b>
RB4		101.50	2.67	98.83				Re-bar 4, most NW
RB3		101.50	2.05	99.45				Re-bar 3, most NE
RB2		101.50	2.86	98.64				
Turn on RB2.								
RB2	2.70	101.34		98.64				
RB3		101.34	1.88	99.46				RB3 closes to 0.01'
RB4		101.34	2.51	98.83				RB4 closes to 0.00
NC-WL		101.34	8.00	93.34				North Cell, closest to north bank, +0.00
TBM1		101.34	1.33	100.01				Close survey to 0.01'
Move instrument								
RB2	2.67	101.31		98.64				
SC-WL		101.31	7.96	<b>93.35</b>				<b>South Cell Water Elevation</b>
RB1		101.31	2.30	99.02				Re-bar #1
Turn on RB1								
RB1	2.50	101.51		99.02				
SC-WL		101.51	8.16	93.35				SC-WL closes to 0.00'
RB2		101.51	2.87	98.64				Survey closes to 0.00'

Note:

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: Mine Site B  
 Survey Purpose: Water-Level Elevations Date: 5/31/2007 Time: 10:30

Location:	Mine Site B, NE corner of North Cell, temporary datum							
Survey objective:	Lake water elevation survey and determining rebar elevations for spring melt					Weather Observations:	partly cloudy	
Instrument Type:	Leica NA720	Instrument ID:	Leica Runner 24 Serial # 5482367					
Rod Type:	Craine Fiberglass 20'	Rod ID:	GWS					
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, HT			
"Post"	WERC	100 Temp.	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
Post TBM1	0.89	100.89		100.00				Top of nail in post, temp elevation
NC-WL		100.89	7.13	93.76				North Cell, closest to north bank
SC-WL		100.89	7.13	93.76				South Cell
Move instrument, turn on SC-WL.								
SC-WL	7.25	101.01		93.76				
NC-WL		101.01	7.24	93.77				
Post TBM1		101.01	1.00	100.01				Close survey to 0.01'
Survey of water level of pooled water at edge of NC-WL								
Post TBM1	4.17	104.17		100.00				Top of nail in post, temp elevation
NC-WL		104.17	10.40	93.77				
Move instrument, turn on NC-WL.								
NC-WL	10.60	104.37		93.77				NC-WL
Post TBM1		104.37	4.36	100.01				Close survey to 0.01'

Note:

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: Mine Site B  
 Survey Purpose: Water-Level Elevations Date: 6/1/2007 Time: 12:10

Location:	Mine Site B, water levels of open water pools at edge of both cells and levels from drilled holes.							
Survey objective:	Lake water elevation survey and determining rebar elevations for spring melt					Weather Observations:	partly cloudy	
Instrument Type:	Leica NA720	Instrument ID:	Leica Runner 24 Serial # 5482367					
Rod Type:	Craine Fiberglass 20'	Rod ID:	GWS					
Bench Mark Information:					Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, HT			
"Post"	WERC	100	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
Post TBM1	3.66	103.66		100.00				Top of nail in post, temp elevation
NC_Pool		103.66	9.68	93.98				North Cell, pooled water near south end
NC		103.66	9.68	93.98				North Cell, level from drilled holes in ice
Move instrument, turn on North Cell water level from drilled ice location.								
NC	9.57	103.55		<b>93.98</b>				NC - WL
NC_Pool		103.55	9.57	93.98				NC_Pool - WL
Post TBM1		103.55	3.55	100.00				Close survey to 0.00'
Below: Survey of water level of South Cell. Both pooled surface water and two from drilled holes								
NC_Pool	5.25	99.23		93.98				Top of nail in post, temp elevation
SC_SW		99.23	5.26	<b>93.97</b>				SC_SW - WL
SC		99.23	5.24	93.99				
Move instrument, turn on SC.								
SC	5.38	99.37		<b>93.99</b>				SC_S - WL
SC_SW		99.37	5.38	93.99				
NC_Pool		99.37	5.37	94.00				Close survey to 0.02'
Below: Survey of water level of pooled water in the South Cell of Mine Site B.								
SC_SW	5.63	99.60		93.97				SC_SW - WL
SC_Pool		99.60	5.61	93.99				
Move instrument, turn on SC_Pool.								
SC_Pool	5.74	99.73		93.99				SC_Pool - WL
SC_SW		99.73	5.75	93.98				Survey closes to 0.01

Note: See Jeff Derry logbook. SC = South cell, SC\_SW = South cell southwest location, SC\_Pool = South cell pooled surface water. NC = North cell, NC\_Pool = North cell pooled surface water.

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: Mine Site B  
 Survey Purpose: Water-Level Elevations Date: 6/2/2007 Time: 13:15

Location:	Mine Site B water level of north and south cells. Also water elevation of stream just west of							
Survey objective:	Lake water elevation survey and determining rebar elevations for spring melt				Weather Observations:		Broken cloud cover. Windy.	
Instrument Type:	Leica NA720	Instrument ID:	Leica Runner 24 Serial # 5482367					
Rod Type:	Craine Fiberglass 20'	Rod ID:	GWS					
Bench Mark Information:					Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, Horacio Toniolo			
"Post"	WERC	100 Temp.	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
Post TBM1	1.14	101.14		100.00				Top of nail in post, temp elevation
ST_WS		101.14	4.94	<b>96.20</b>				ST_WS - WL
MSB_WS		101.14	6.795	94.35				
Move instrument, turn on North Cell water level from drilled ice location.								
MSB_WS	6.905	101.26		<b>94.35</b>				NC - WL
ST_WS		101.26	5.05	96.21				Water surface at stream
Post TBM1		101.26	1.25	100.01				Close survey to 0.01'

Note: ST\_WS = Stream water surface.

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL



**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: Mine Site B  
 Survey Purpose: Water-Level Elevations Date: 6/3/2007 Time: 12:50

Location:	Mine Site B water level of north and south cells. Also, hammered RB4 further in ground and re-surveyed							
Survey objective:	Lake water elevation survey				Weather Observations:		Scattered clouds, calm winds, warm.	
Instrument Type:	Leica NA720	Instrument ID:	Leica Runner 24 Serial # 5482367					
Rod Type:	Craine Fiberglass 20'	Rod ID:	GWS					
Bench Mark Information:					Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)	Jeff Derry, Horacio Toniolo			
"Post"	WERC	100 Temp.	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasi)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
Post TBM1	3.89	103.89		100.00				Top of nail in post, temp elevation
MSB_WS		103.89	8.51	<b>95.38</b>				<b>MSB_WS - WL</b>
RB4		103.89	5.20	98.69				Re-bar number 4
Move instrument, turn on RB4.								
RB4	5.33	104.02		<b>98.69</b>				<b>Elevation of RB4</b>
MSB_WS		104.02	8.65	95.38				Water surface of north and south cells
Post TBM1		104.02	4.02	100.00				Close survey to 0.00'

Note: MSB\_WS is the hydrologically connected water surface of the north and south cells.

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

**University of Alaska Fairbanks, Water and Environmental Research Center**

**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: Mine Site B  
 Survey Purpose: Water-Level Elevations Date: 6/12/2007 Time: 16:00

Location:	Mine Site B, NE corner of North Cell, temporary datum							
Survey objective:	Lake water elevation survey and determining rebar elevations for spring melt					Weather Observations:		
Instrument Type:	Leica NA720	Instrument ID:	Leica Runner 24 Serial # 5482367		Overcast, Breezy			
Rod Type:	Craine Fiberglass 20'	Rod ID:	GWS					
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		Greta Myerchin, Michael Lilly		
"Post"	WERC	100 Temp.	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
TBM1	5.26	105.26		100.00				Top of nail in post, temp elevation
TBM2		105.26	7.81	97.45				TMB2
MSB-WL		105.26	1.42	<b>103.84</b>				<b>North Cell WL</b>
Move instrument, turn on TBM1.								
MSB-WL	1.60	105.44		103.84				
TBM2		105.44	8.00	97.44				closes to 0.01'
TBM1		105.44	5.44	100.00				closes to 0.01'
Rob Picture WL Elev.		105.44	3.73	101.71				estimated WL - not need to close

Note:

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

## **APPENDIX D. SNOW SURVEY FORMS**

The following forms report the snow survey information obtained during field sampling.

**University of Alaska Fairbanks, Water and Environmental Research Center**  
**Form F-012: Snow Survey Form**

Project ID: Tundra Lakes Site Location/Lake ID: KDA 2 CT  
 Survey Purpose: Snow Water Equivalent Date: 5/23/2007 Time: 15:00

Location Description:	KDA - Cell 2				
Survey objective:	Estimate SWE			Weather	cloudy
				Observations:	
Latitude:	N70°19.9776'	Longitude:	W148°56.4462'	Datum:	WGS84
Elevation:		Elevation Datum:		Reference Markers:	Site staked with lathe
Drainage Basin:	Kuparuk	Slope Direction:	flat	Vegetation Type:	Snow Survey located on ice
Slope Angle:	Flat	Access Notes:	none	Other:	1 meter increments
Snow Depth Probe Type:				Snow-Survey Team Names	
Snow Tube Type:	Adirondak, 6.74 cm diameter cutter, area = 35.7cm <sup>2</sup>			Horacio Toniolo	

Snow Course Depths (cm)

	1	2	3	4	5
1	15.0	11.0	10.0	7.0	11.0
2	13.0	8.0	9.0	10.0	9.0
3	12.0	8.0	10.0	9.0	15.0
4	11.0	8.0	10.0	12.0	17.0
5	14.0	9.0	11.0	12.0	14.0
6	9.0	7.0	9.0	11.0	11.0
7	11.0	9.0	8.0	11.0	9.0
8	13.0	9.0	9.0	10.0	14.0
9	12.0	8.0	7.0	9.0	12.0
10	11.0	8.0	8.0	9.0	12.0

(cm)  
 Average snow depth = 10.4  
 Maximum snow depth = 17.0  
 Minimum snow depth = 7.0  
 Standard variation = 2.3

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (g)	Volume (cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )
FE1	13	128.2	464.1	0.28
FE3	8	85.2	285.6	0.30
FE4	8	83.0	285.6	0.29
FB2	9	69.3	321.3	0.22
FB3	10	92.1	357.0	0.26

Average Density = 0.27  
 Average Snow Water Equivalent (SWE) = 2.8 cm H<sub>2</sub>O  
 Average Snow Water Equivalent = 1.10 inches H<sub>2</sub>O  
 Average Snow Water Equivalent = 0.09 feet H<sub>2</sub>O

SWE = avg. snow depth\*(density snow/density water)

**University of Alaska Fairbanks, Water and Environmental Research Center**  
**Form F-012: Snow Survey Form**

Project ID: Tundra Lakes Site Location/Lake ID: MSB N  
 Survey Purpose: Snow Water Equivalent Date: 5/24/2007 Time: 11:15

Location Description:	Mine Site B - Center North Cell				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather	cloudy
				Observations:	
Latitude:	N70 31. 134	Longitude:	W149 40.015	Datum:	NAD27
Elevation:		Elevation Datum:		Reference Markers:	representative area
Drainage Basin:	Mine Site B	Slope Direction:	Flat	Vegetation Type:	Ice Surface
Slope Angle:	Flat	Access Notes:	none	Other:	1 meter increments
Snow Depth Probe Type:				Snow-Survey Team Names	
Snow Tube Type:	Adirondak, 6.74 cm diameter cutter, area = 35.7cm <sup>2</sup>			Horacio Toniolo	

Snow Course Depths (cm)

	1	2	3	4	5
1	20.0	10.0	15.0	14.0	11.0
2	22.0	9.0	14.0	11.0	10.0
3	27.0	9.0	17.0	10.0	8.0
4	19.0	10.0	15.0	10.0	7.0
5	17.0	9.0	13.0	8.0	8.0
6	15.0	11.0	12.0	5.0	6.0
7	14.0	13.0	11.0	6.0	9.0
8	13.0	13.0	15.0	9.0	8.0
9	9.0	12.0	16.0	9.0	10.0
10	10.0	15.0	15.0	9.0	12.0

(cm)  
 Average snow depth = 12.0  
 Maximum snow depth = 27.0  
 Minimum snow depth = 5.0  
 Standard variation = 4.3

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (g)	Volume (cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )
AB1	21	290.5	749.7	0.39
AB2	10	135.9	357.0	0.38
AB3	14	201.8	499.8	0.40
AB4	8	107.8	285.6	0.38
AB5	7	85.2	249.9	0.34

Average Density = 0.38  
 Average Snow Water Equivalent (SWE) = 4.5 cm H<sub>2</sub>O  
 Average Snow Water Equivalent = 1.79 inches H<sub>2</sub>O  
 Average Snow Water Equivalent = 0.15 feet H<sub>2</sub>O

SWE = avg. snow depth\*(density snow/density water)

**University of Alaska Fairbanks, Water and Environmental Research Center**  
**Form F-012: Snow Depth and Water Content Survey Form**

Project ID: North Slope Lakes Project Site Location/Lake ID: L9312  
 Survey Purpose: Snow Depth and Water Content Date: 5/19/2007 Time: 13:00

Location Description:	Snow course located directly north of the Met Site next to the pumphouse.				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather Observations:	
Latitude:	N 70°19.9444'	Longitude:	W 150° 57.047'	Datum:	NAD27 Alaska
Elevation:		Elevation Datum:	BPMSL	Reference Markers:	Site staked with lathe
Drainage Basin:	L9312	Slope Direction:	Flat	Vegetation Type:	Tussock
Slope Angle:	Flat	Access Notes:	Hagglund	Other:	1 meter increments
Snow Depth Probe Type:	T-handle snow depth probe,			Snow-Survey Team Names	
Snow Tube Type:	Adirondak, 6.74 cm diameter cutter, area = 35.7 cm <sup>2</sup>			Horacio Roniolo	

Snow Course Depths, in cm.

	1	2	3	4	5
1	47	54	40	60	51
2	52	46	49	44	77
3	49	49	44	41	80
4	57	57	30	45	66
5	56	55	24	36	56
6	50	50	20	40	46
7	57	35	30	34	51
8	68	29	29	23	57
9	64	22	33	35	65
10	59	25	41	47	58

(cm)  
 Average snow depth = 46.7  
 Maximum snow depth = 80.0  
 Minimum snow depth = 20.0  
 Standard variation = 14.1

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm <sup>3</sup> )	Density (gr/cm <sup>3</sup> )
SWE1	35.56	352.7	1269.5	0.28
SWE2	36.83	231.3	1314.8	0.18
SWE3	38.1	335	1360.2	0.25
SWE4	35.56	398.5	1269.5	0.31
SWE5	58.42	663.8	2085.6	0.32

Average Density = 0.27 gr/cm<sup>3</sup>  
 Average Snow Water Equivalent (SWE) = 12.4 cm H<sub>2</sub>O  
 Average Snow Water Equivalent = 4.89 inches H<sub>2</sub>O  
 Average Snow Water Equivalent = 0.41 feet H<sub>2</sub>O

SWE = avg. snow depth\*(density snow/density water)

**University of Alaska Fairbanks, Water and Environmental Research Center**  
**Form F-012: Snow Depth and Water Content Survey Form**

Project ID: North Slope Lakes Project Site Location/Lake ID: L9312  
 Survey Purpose: Snow Depth and Water Content Date: 5/19/2007 Time: 14:00

Location Description:	Located on South end of lake. Marked with three orange poles				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather Observations:	
Latitude:	N 70°19.9444'	Longitude:	W 150° 57.047'	Datum:	NAD27 Alaska
Elevation:		Elevation Datum:	BPMSL	Reference Markers:	Site staked with lathe
Drainage Basin:	L9312	Slope Direction:	Flat	Vegetation Type:	Tussock
Slope Angle:	Flat	Access Notes:	Hagglund	Other:	1 meter increments
Snow Depth Probe Type:	T-handle snow depth probe,			Snow-Survey Team Names	
Snow Tube Type:	Adirondak, 6.74 cm diameter cutter, area = 35.7 cm <sup>2</sup>			Horacio Toniolo	

Snow Course Depths, in cm.

	1	2	3	4	5
1	42	27	24	43	
2	47	24	41	33	
3	22	29	44	24	
4	31	28	38	30	
5	35	25	20	23	
6	36	26	42	24	
7	30	20	44	30	
8	33	44	29	47	
9	26	48	30	36	
10	31	35	45	26	

(cm)  
 Average snow depth = 32.8  
 Maximum snow depth = 48.0  
 Minimum snow depth = 20.0  
 Standard variation = 8.4

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm <sup>3</sup> )	Density (gr/cm <sup>3</sup> )
SWE1	30.48	229.5	1088.1	0.21
SWE2	20.32	236.1	725.4	0.33
SWE3	40.64	390.4	1450.8	0.27
SWE4	45.72	435	1632.2	0.27
SWE5	22.86	130.1	816.1	0.16

Average Density = 0.25 gr/cm<sup>3</sup>  
 Average Snow Water Equivalent (SWE) = 8.1 cm H<sub>2</sub>O  
 Average Snow Water Equivalent = 3.18 inches H<sub>2</sub>O  
 Average Snow Water Equivalent = 0.27 feet H<sub>2</sub>O

SWE = avg. snow depth\*(density snow/density water)

**University of Alaska Fairbanks, Water and Environmental Research Center**  
**Form F-012: Snow Depth and Water Content Survey Form**

Project ID: North Slope Lakes Project Site Location/Lake ID: L9817  
 Survey Purpose: Snow Depth and Water Content Date: 5/25/2007 Time: 13:30

Location Description:	Did "L" shape, started at stake between belford gauge and snow sensor. 25 x 25 meters at 1 meter increments. Went East, then North.				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather Observations:	Foggy, 30 F
Latitude:	N 70° 16.832	Longitude:	W 148° 53.856	Datum:	NAD83 Alaska
Elevation:	100' approximately	Elevation Datum:	BPMSL	Reference Markers:	Site marked with GPS
Drainage Basin:	L9817	Slope Direction:	flat	Vegetation Type:	snow depth on tundra surface
Slope Angle:	Flat	Access Notes:		Other:	1 meter increments
Snow Depth Probe Type:	T-handle snow depth probe,			Snow-Survey Team Names	
Snow Tube Type:	Adirondak, 6.74 cm diameter cutter, area = 35.7 cm <sup>2</sup>			Chad Cormack, Dan Reichardt	

Snow Course Depths, in cm.

	1	2	3	4	5
1	21	23	31	36	35
2	17	23	26	25	35
3	5	23	35	29	36
4	11	17	34	38	30.0
5	25	9	34	42	33
6	33	2.0	26	37	33
7	9	0	29	44.0	34
8	28	8	30.0	37	34
9	26	14	34	40	29
10	22	9.0	18	16	23

(cm)  
 Average snow depth = 25.8  
 Maximum snow depth = 44.0  
 Minimum snow depth = 0.0  
 Standard variation = 10.9

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm <sup>3</sup> )	Density (gr/cm <sup>3</sup> )
SWE1	15.24	224.9	544.1	0.41
SWE2	21.59	161.1	770.8	0.21
SWE3	31.75	285.1	1133.5	0.25
SWE4	40.64	402.9	1450.8	0.28
SWE5	30.48	284.2	1088.1	0.26

Average Density = 0.28 gr/cm<sup>3</sup>  
 Average Snow Water Equivalent (SWE) = 7.3 cm H<sub>2</sub>O  
 Average Snow Water Equivalent = 2.87 inches H<sub>2</sub>O  
 Average Snow Water Equivalent = 0.24 feet H<sub>2</sub>O

SWE = avg. snow depth\*(density snow/density water)



**University of Alaska Fairbanks, Water and Environmental Research Center**  
**Form F-012: Snow Survey Form**

Project ID: Tundra Lakes Site Location/Lake ID: Betty Pingo  
 Survey Purpose: Snow Water Equivalent Date: 5/24/2007 Time: 16:02

Location Description:	Betty Pingo near Wyoming gauge.				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather	cloudy
				Observations:	
Latitude:	N 70.28085	Longitude:	W 148.89304	Datum:	NAD27 Alaska
Elevation:		Elevation Datum:	BPMSL	Reference Markers:	Near weather station
Drainage Basin:		Slope Direction:		Vegetation Type:	Tussock
Slope Angle:	Flat	Access Notes:	Truck	Other:	1 meter increments
Snow Depth Probe Type:	T-handle			Snow-Survey Team Names	
Snow Tube Type:	Adirondak, 6.74 cm diameter cutter, area = 35.7cm <sup>2</sup>			Jed, Horachio	

Snow Course Depths (cm)

	1	2	3	4	5
1	27.0	33.0	26.0	31.0	49.0
2	31.0	32.0	0.0	12.0	41.0
3	25.0	34.0	8.0	14.0	41.0
4	26.0	32.0	9.0	54.0	36.0
5	24.0	34.0	12.0	36.0	23.0
6	23.0	32.0	15.0	42.0	23.0
7	30.0	36.0	18.0	46.0	37.0
8	32.0	33.0	28.0	50.0	21.0
9	35.0	36.0	28.0	44.0	35.0
10	31.0	28.0	33.0	50.0	55.0

(cm)  
 Average snow depth = 30.6  
 Maximum snow depth = 55.0  
 Minimum snow depth = 0.0  
 Standard variation = 11.9

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (g)	Volume (cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )
AB6	31	352.0	1106.7	0.32
AB7	27	263.7	963.9	0.27
AB8	31	285.0	1106.7	0.26
AB9	24	188.5	856.8	0.22
AB10	27	258.6	963.9	0.27

Average Density = 0.27  
 Average Snow Water Equivalent (SWE) = 8.2 cm H<sub>2</sub>O  
 Average Snow Water Equivalent = 3.22 inches H<sub>2</sub>O  
 Average Snow Water Equivalent = 0.27 feet H<sub>2</sub>O

SWE = avg. snow depth\*(density snow/density water)

**University of Alaska Fairbanks, Water and Environmental Research Center**  
**Form F-012: Snow Survey Form**

Project ID: Tundra Lakes Site Location/Lake ID: Betty Pingo  
 Survey Purpose: Snow Water Equivalent Date: 5/26/2007 Time: 2:00pm

Location Description:	Betty Pingo near Wyoming gauge.				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather Observations:	Breezy, cold, overcast
Latitude:	N 70.28085	Longitude:	W 148.89304	Datum:	NAD27 Alaska
Elevation:		Elevation Datum:	BPMSL	Reference Markers:	Near weather station
Drainage Basin:		Slope Direction:		Vegetation Type:	Tussock
Slope Angle:	Flat	Access Notes:	Truck	Other:	1 meter increments
Snow Depth Probe Type:	T-handle			Snow-Survey Team Names	
Snow Tube Type:	Adirondak, 6.74 cm diameter cutter, area = 35.7cm <sup>2</sup>			Jed, Horachio	

Snow Course Depths (cm)

	1	2	3	4	5
1	22.0	25.0	19.0	21.0	19.0
2	25.0	22.0	12.0	33.0	41.0
3	27.0	23.0	10.0	40.0	50.0
4	17.0	31.0	4.0	44.0	41.0
5	28.0	29.0	11.0	52.0	47.0
6	25.0	31.0	16.0	53.0	44.0
7	32.0	28.0	24.0	52.0	39.0
8	35.0	35.0	29.0	49.0	22.0
9	29.0	30.0	34.0	55.0	40.0
10	25.0	31.0	29.0	40.0	33.0

(cm)  
 Average snow depth = 31.1  
 Maximum snow depth = 55.0  
 Minimum snow depth = 4.0  
 Standard variation = 12.0

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (g)	Volume (cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )
1	24	219.2	856.8	0.26
2	28	279.4	999.6	0.28
3	26	281.8	928.2	0.30
4	50	541.6	1785.0	0.30
5	22	211.8	785.4	0.27

Average Density = 0.28  
 Average Snow Water Equivalent (SWE) = 8.8 cm H<sub>2</sub>O  
 Average Snow Water Equivalent = 3.45 inches H<sub>2</sub>O  
 Average Snow Water Equivalent = 0.29 feet H<sub>2</sub>O

SWE = avg. snow depth\*(density snow/density water)

**University of Alaska Fairbanks, Water and Environmental Research Center**  
**Form F-012: Snow Survey Form**

Project ID: Tundra Lakes Site Location/Lake ID: Betty Pingo  
 Survey Purpose: Snow Water Equivalent Date: 5/28/2007 Time: 11:07am

Location Description:	Near Wyoming gauge				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather overcast, light breeze Observations:	
Latitude:	N 70.28085	Longitude:	W 148.89304	Datum:	NAD27 Alaska
Elevation:		Elevation Datum:	BPMSL	Reference Markers:	wyoming gauge
Drainage Basin:		Slope Direction:		Vegetation Type:	Tussock tundra
Slope Angle:	flat	Access Notes:	truck	Other:	1 meter increments
Snow Depth Probe Type:	T-handle			Snow-Survey Team Names	
Snow Tube Type:	Adirondak, 6.74 cm diameter cutter, area = 35.7cm <sup>2</sup>			JED, GM	

Snow Course Depths (cm)

	1	2	3	4	5
1	11.0	22.0	25.0	28.0	34.0
2	20.0	26.0	26.0	27.0	37.0
3	21.0	25.0	25.0	37.0	41.0
4	14.0	17.0	22.0	41.0	39.0
5	22.0	23.0	27.0	38.0	41.0
6	29.0	25.0	10.0	44.0	36.0
7	27.0	25.0	0.0	43.0	38.0
8	25.0	27.0	7.0	63.0	40.0
9	23.0	21.0	20.0	44.0	30.0
10	19.0	34.0	25.0	16.0	33.0

(cm)  
 Average snow depth = 27.9  
 Maximum snow depth = 63.0  
 Minimum snow depth = 0.0  
 Standard variation = 11.2

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (g)	Volume (cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )
1	18	148.1	642.6	0.23
2	28	366.8	999.6	0.37
3	25	307.7	892.5	0.34
4	19	240.4	678.3	0.35
5	18	226.2	642.6	0.35

Average Density = 0.33  
 Average Snow Water Equivalent (SWE) = 9.2 cm H<sub>2</sub>O  
 Average Snow Water Equivalent = 3.62 inches H<sub>2</sub>O  
 Average Snow Water Equivalent = 0.30 feet H<sub>2</sub>O

SWE = avg. snow depth\*(density snow/density water)

**University of Alaska Fairbanks, Water and Environmental Research Center**  
**Form F-012: Snow Survey Form**

Project ID: Tundra Lakes Site Location/Lake ID: West Dock  
 Survey Purpose: Snow Water Equivalent Date: 5/24/2007 Time: 5:07pm

Location Description:	lathes mark West Dock snow course location.				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather Observations:	Overcast, low winds
Latitude:	N 70°21.553'	Longitude:	W 148° 34.116'	Datum:	NAD27 Alaska
Elevation:		Elevation Datum:	BPMSL	Reference Markers:	Site staked with lathe
Drainage Basin:	L9312	Slope Direction:	Flat	Vegetation Type:	Tussock
Slope Angle:	Flat	Access Notes:	Hagglund	Other:	1 meter increments
Snow Depth Probe Type:	T-handle			Snow-Survey Team Names	
Snow Tube Type:	Adirondak, 6.74 cm diameter cutter, area = 35.7cm <sup>2</sup>			JED, GM, Horachio	

Snow Course Depths (cm)

	1	2	3	4	5
1	16.0	24.0	31.0	22.0	36.0
2	13.0	25.0	29.0	22.0	35.0
3	15.0	31.0	24.0	26.0	35.0
4	13.0	33.0	18.0	29.0	36.0
5	15.0	32.0	14.0	31.0	33.0
6	21.0	37.0	23.0	28.0	34.0
7	23.0	40.0	22.0	32.0	35.0
8	22.0	41.0	22.0	34.0	37.0
9	28.0	43.0	22.0	36.0	36.0
10	23.0	42.0	24.0	37.0	39.0

(cm)  
 Average snow depth = 28.4  
 Maximum snow depth = 43.0  
 Minimum snow depth = 13.0  
 Standard variation = 8.2

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (g)	Volume (cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )
1	17	187.5	606.9	0.31
2	14	112.9	499.8	0.23
3	24	267.5	856.8	0.31
4	18	207.6	642.6	0.32
5	19	242.1	678.3	0.36

Average Density = 0.31  
 Average Snow Water Equivalent (SWE) = 8.7 cm H<sub>2</sub>O  
 Average Snow Water Equivalent = 3.41 inches H<sub>2</sub>O  
 Average Snow Water Equivalent = 0.28 feet H<sub>2</sub>O

SWE = avg. snow depth\*(density snow/density water)

**University of Alaska Fairbanks, Water and Environmental Research Center**  
**Form F-012: Snow Survey Form**

Project ID: Tundra Lakes Site Location/Lake ID: West Dock  
 Survey Purpose: Snow Water Equivalent Date: 5/26/2007 Time: 0:00

Location Description:	West dock located at the coordinates given by Rob Geick				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather overcast, breezy, cold, Observations: snow,	
Latitude:	70 21.553	Longitude:	148 34.116	Datum:	NAD 83
Elevation:		Elevation Datum:		Reference Markers:	lathe
Drainage Basin:		Slope Direction:		Vegetation Type:	tussock tundra
Slope Angle:	flat	Access Notes:	truck	Other:	
Snow Depth Probe Type:	T-handle			Snow-Survey Team Names	
Snow Tube Type:	Adirondak, 6.74 cm diameter cutter, area = 35.7cm <sup>2</sup>			G. Myerchin, J. Derry	

Snow Course Depths (cm)

	1	2	3	4	5
1	12.0	30.0	19.0	32.0	10.0
2	24.0	30.0	13.0	34.0	18.0
3	29.0	29.0	12.0	49.0	12.0
4	33.0	27.0	10.0	24.0	25.0
5	32.0	29.0	10.0	22.0	0.0
6	32.0	30.0	15.0	25.0	0.0
7	26.0	29.0	22.0	28.0	7.0
8	34.0	26.0	34.0	21.0	12.0
9	31.0	21.0	42.0	31.0	17.0
10	32.0	26.0	39.0	0.0	14.0

(cm)  
 Average snow depth = 23.2  
 Maximum snow depth = 49.0  
 Minimum snow depth = 0.0  
 Standard variation = 10.8

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (g)	Volume (cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )
1	22	173.0	785.4	0.22
2	27	252.9	963.9	0.26
3	20	157.3	714.0	0.22
4	26	267.7	928.2	0.29
5	26	315.0	928.2	0.34

Average Density = 0.27  
 Average Snow Water Equivalent (SWE) = 6.2 cm H<sub>2</sub>O  
 Average Snow Water Equivalent = 2.43 inches H<sub>2</sub>O  
 Average Snow Water Equivalent = 0.20 feet H<sub>2</sub>O

SWE = avg. snow depth\*(density snow/density water)

**University of Alaska Fairbanks, Water and Environmental Research Center**  
**Form F-012: Snow Survey Form**

Project ID: Tundra Lakes Site Location/Lake ID: West Dock  
 Survey Purpose: Snow Water Equivalent Date: 5/28/2007 Time: 10:07am

Location Description:	West dock located at the coordinates given by Rob Geick				
Survey objective:	Estimate SWE			Weather overcast slight breeze Observations:	
Latitude:	70 21.553	Longitude:	148 34.116	Datum:	NAD 83
Elevation:		Elevation Datum:		Reference Markers:	
Drainage Basin:		Slope Direction:		Vegetation Type:	tussock tundra
Slope Angle:	flat	Access Notes:	truck	Other:	
Snow Depth Probe Type:	T-handle			Snow-Survey Team Names	
Snow Tube Type:	Adirondak, 6.74 cm diameter cutter, area = 35.7cm <sup>2</sup>			JED, GM	

Snow Course Depths (cm)

	1	2	3	4	5
1	24.0	35.0	19.0	25.0	19.0
2	14.0	30.0	6.0	33.0	16.0
3	10.0	24.0	0.0	19.0	15.0
4	10.0	25.0	17.0	25.0	13.0
5	0.0	27.0	16.0	23.0	9.0
6	11.0	29.0	0.0	24.0	16.0
7	25.0	35.0	15.0	26.0	16.0
8	33.0	37.0	15.0	18.0	14.0
9	34.0	36.0	0.0	20.0	10.0
10	33.0	37.0	18.0	15.0	15.0

(cm)  
 Average snow depth = 19.7  
 Maximum snow depth = 37.0  
 Minimum snow depth = 0.0  
 Standard variation = 10.1

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (g)	Volume (cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )
1	25	269.0	892.5	0.30
2	36	390.7	1285.2	0.30
3	37	460.0	1320.9	0.35
4	38	467.3	1356.6	0.34
5	15	120.8	535.5	0.23

Average Density = 0.30  
 Average Snow Water Equivalent (SWE) = 6.0 cm H<sub>2</sub>O  
 Average Snow Water Equivalent = 2.37 inches H<sub>2</sub>O  
 Average Snow Water Equivalent = 0.20 feet H<sub>2</sub>O

SWE = avg. snow depth\*(density snow/density water)