

# Lake Chemistry and Physical Data For Selected North Slope, Alaska, Lakes: May-June 2006



*Lake L9312 Outlet Control Point, Photo by D. Reichardt*

by  
Kristie Holland, Dan Reichardt, Elizabeth Binning, and Michael  
Lilly

January 2008

North Slope Lakes Hydrologic Modeling Project  
Report No. INE/WERC 06.08

Water and Environmental  
Research Center



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By:

Kristie Holland<sup>1</sup>, Dan Reichardt<sup>1</sup>, Elizabeth Binning<sup>2</sup>, Michael Lilly<sup>1</sup>

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

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**DISCLAIMER**

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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:

$$\text{where: } \text{SC25} = \text{AC} / (1 + r(T - 25))$$

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

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# **Lake Chemistry and Physical Data For Selected North Slope, Alaska, Lakes: May-June 2006**

## **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 for the months of May and June 2006, 2) summarize accomplished field trip objectives.

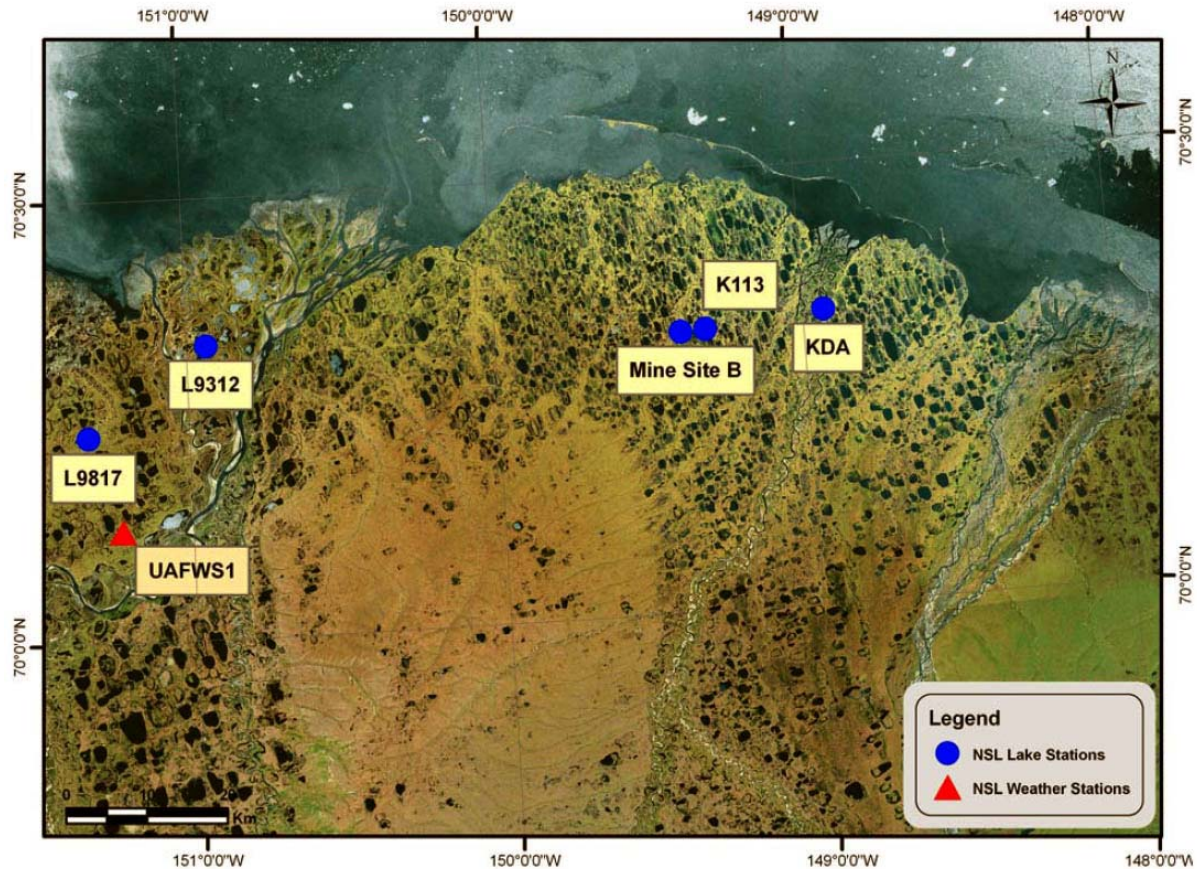


Figure 1. Location of study lakes in the NPR-A, Alpine, Kuparuk, and Prudhoe Bay field operating areas, North Slope, Alaska.

## TRIP OBJECTIVES

The goal of each sampling trip is to collect physical and chemical data from each study lake. For each lake, a series of holes are drilled at designated sampling locations. Logistical, personnel, and weather constraints, can limit the amount of time available in the field for sampling. A project work plan was distributed before the trip outlining the sampling schedule (Lilly and others, 2006). In addition to the information collected on each monthly sampling trip, the May-June trip was extended in order to observe spring snowmelt. The trip duration was from 16 May, 2006 to 8 June, 2006. During the trip we focused on the following locations/tasks:

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

- Collect water-column samples from Raft “B”.
  - Automated data collection station maintenance (Figure 2).
  - Conduct snow-course measurements.
2. Lake L9817: NPR-A.
    - Survey water level to local BLM elevation control.
    - Collect water-quality profile data.
    - Collect water-column samples from hole 1.
    - Automated data collection station maintenance.
    - Conduct snow course measurements.
  3. Mine Site B: Kuparuk operating area.
    - Survey water levels to local elevation control on North and South cells.
    - Additional physical measurements will be taken in the reservoir channels connecting the north and south cells to determine whether North and South cells are hydraulically connected.
    - Measure water-quality profile parameters on North and South cells and adjacent stream as practical.
    - Collect water-column samples from North Cell and South Cell sampling locations.
  4. Kuparuk Dead Arm (KDA) Reservoirs: Prudhoe Bay operating area.
    - Survey water levels to local elevation control on cells 1, 2, and 3.
    - Measure water-quality profile parameters in cells 1, 2, and 3.
    - Collect water-column samples from cells 1, 2, and 3
  5. K113: Kuparuk operating area.
    - Collect water-quality profile data.
    - Collect water-column samples from sampling locations.
  6. Webster Reservoir, Prudhoe Bay operating area.
    - Collect water-quality profile data.
  7. 2M-Pad, Kuparuk operating area.
    - Automated data collection station maintenance
  8. 2006 Spring Snowmelt Monitoring

- 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.
- 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.

## **PROCEDURES**

### Water Chemistry Sampling

All field work follows the specified health, safety, and environmental guidelines outlined by BPX and CPA (White and Lilly, 2006*a,b,c*). Using a gas powered auger, holes were drilled through the ice at specified locations at each study lake. Physical measurements of water depth (top of water to bottom of lake), ice thickness (top of ice to bottom of ice), freeboard (top of water to top of ice), and snow depth (top of ice to top of snow), were taken at each sampling location. Water-surface elevation surveys were conducted using closed level loops and optical levels (Figure 2). Water quality parameters such as temperature, pH, turbidity, oxygen reduction potential (ORP), conductivity, and dissolved oxygen (DO) were obtained by using an In-Situ Troll 9000 (submersible meter), at multiple depths throughout the water column. The precision with which physical measurements were reported takes into account field conditions. The calibration of each parameter was checked before and after each day of sampling using the criteria in Table 1.

Water samples were also collected at 3 depths (1 ft. (0.3 m) below bottom of ice, varying depths within the central part of the water column, and 1 ft. (0.3 m) above lake bottom). Some of these samples were preserved for further analysis at UAF, while other samples were analyzed with a Hach spectrophotometer at Prudhoe Bay and Alpine facilities. UAF laboratory chemistry analysis will be reported separately.

**Table 1. In-Situ Troll 9000 calibration quality control criteria.**

<b>Parameter</b>	<b>Standards used</b>	<b>Acceptable deviation from calibration standard value</b>
Turbidity	Factory calibrated	± 2 (NTU)
pH	4.01, 7.0, 10.0	± 0.2
Conductivity	447 (µs/cm)	within 10%
100% DO	100 % saturated	within 10%
0% DO	0 % saturated solution	within 0.3 mg/L
ORP	InSitu QuickCal 224 mV	within 10%

### 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).



**Figure 2. Inspecting deployed conductivity probe at L9312, photo by D. Reichardt.**

## **SELECTED RESULTS**

Sampling occurred at Kuparuk Deadarm Lakes, K113, Mine Site B, L9312, L9817, and Webster Reservoir during the May/June field activities. Due to weather constraints, the work plan was not followed exactly as planned. However, with some rescheduling, all trip objectives were completed. Table 2 summarizes these conditions at “priority sampling sites”. Median results represent all values measured from the listed sampling site. Each lake we visit has one or more locations where we draw water samples from multiple depths for laboratory analysis. These locations have more historical data than other locations on the lakes, and have been chosen as representative of the deeper portion of the respective lakes.

The thickest ice was recorded at KDA-1 (4.90 ft, 1.49 m), whereas the thinnest ice was recorded at K113 (4.02 ft, 1.22 m), with all of the ice thickness falling between 4 and 5 ft (1.22-1.52 m). The greatest median DO value was found at KDA-1 (12.78 mg/L) and the lowest were observed at L9817 (1.41 mg/L). The other locations were all above 9.5 mg/L. The large difference in dissolved oxygen concentrations between L9817 and the other sample sites is most likely a result of the shallow depth at L9817 and the continual consumption of oxygen throughout the winter by fish and/or sediments. Conductivity measurements were much more variable with the lowest conductivity at L9312 (97.00 uS/cm) and the highest values at K113 (434.0 uS/cm), with a similar median conductivity level at L9817 (413.1 uS/cm). All 3 Kugaruk Deadarm Reservoirs (KDA 1-3) and Mine Site B (North and South Cells) had conductivity values between 139.41 uS/cm and 167.4 uS/cm in May.

With the increasing rate of snowmelt and the accompanying contributions to the adjacent watersheds, all of the lakes which were sampled showed an increase in water levels in May when compared to the April sampling trip as demonstrated in Table 2.

**Table 2. Ice thickness, Median DO Concentration, Median Actual Conductance and Monthly Water Change for North Slope lakes in mid-May.**

<b>Sampling Site</b>	<b>Ice Thickness [ft; (m)]</b>	<b>Median DO Concentration [mg/L]</b>	<b>Median Actual Conductivity [μS/cm]</b>	<b>Water level change since mid April [ft; (m)]</b>
<b>K113-CT</b>	4.02; (1.22)	-	434.0	-
<b>KDA1-CT</b>	4.90; (1.49)	12.78	167.4	+1.54; (0.469)
<b>KDA2-CT</b>	4.45; (1.36)	11.54	165.8	-
<b>KDA3-CT</b>	4.60; (1.40)	12.56	138.19	+1.57; (0.478)
<b>L9312 Raft B</b>	4.62; (1.41)	9.64	97.00	+4.37; (1.331)
<b>L9817-1</b>	4.35; (1.33)	1.41	413.1	-
<b>MSBN-CT</b>	4.19; (1.28)	10.4	139.41	+1.2; (0.365)
<b>MSBS-CT</b>	4.42; (1.35)	-	162.45	+1.22; (0.372)

Figure 3 displays the water level changes at Mine Site B in both the North and South Cells throughout the winter of 2005-2006. Figure 4 outlines the winter appropriation limits set for each of the cells and their relationship to the water usage at Mine Site B. Figures 5 and 6 present the water level changes at L9312 during the snowmelt period and winter of 2005-2006.

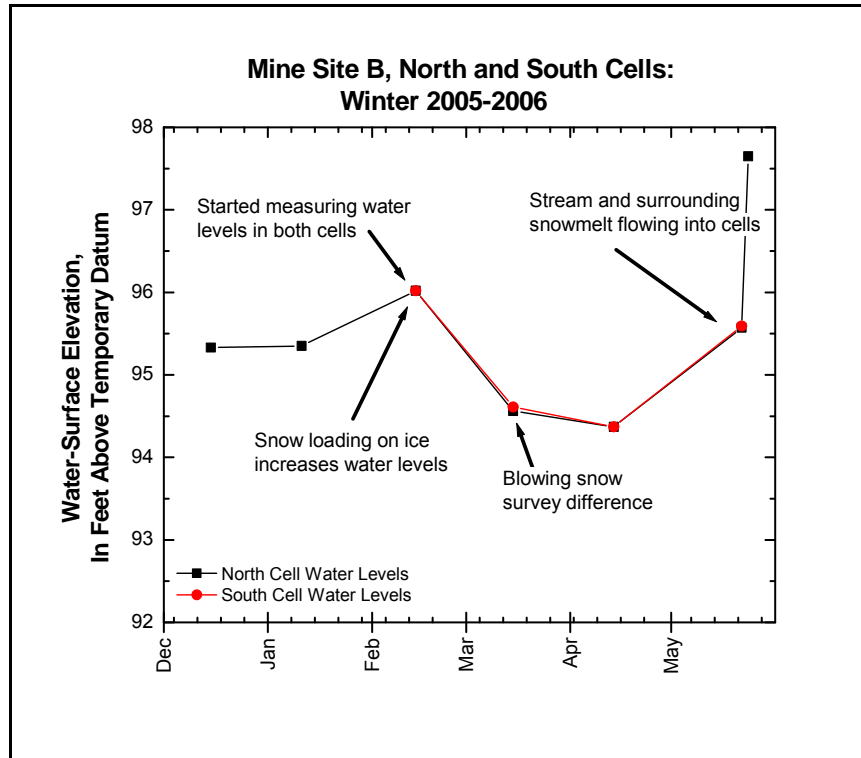


Figure 3. Water levels at Mine Site B (North and South Cells), winter 2005-2006.

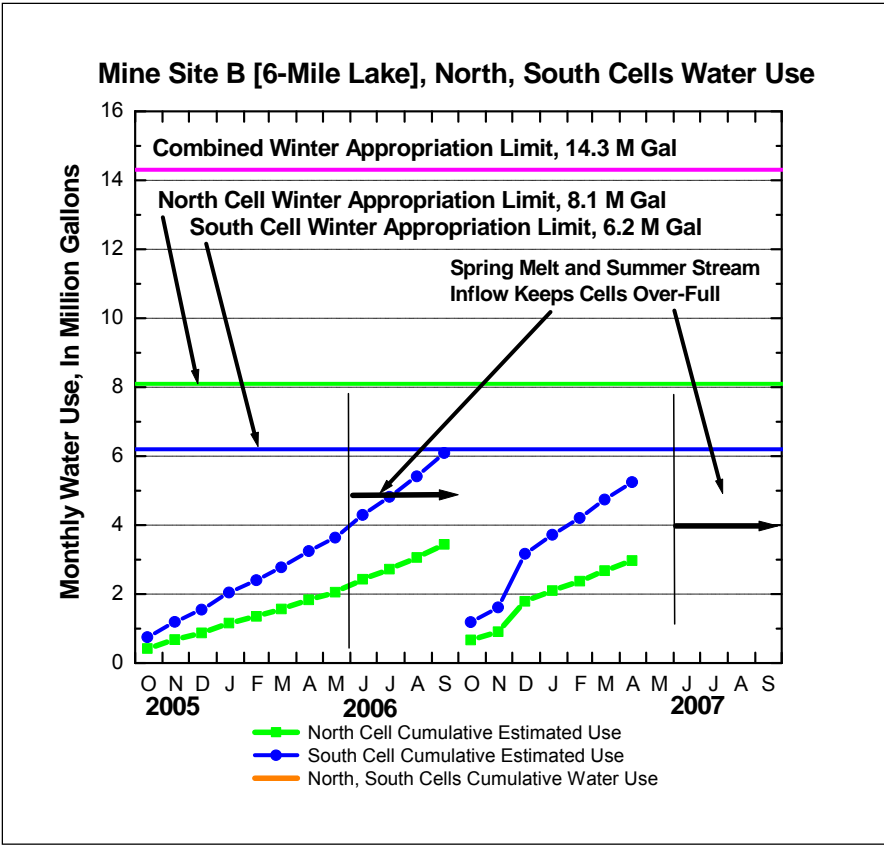


Figure 4. Mine Site B (North and South Cells) 2005-2006 water use.

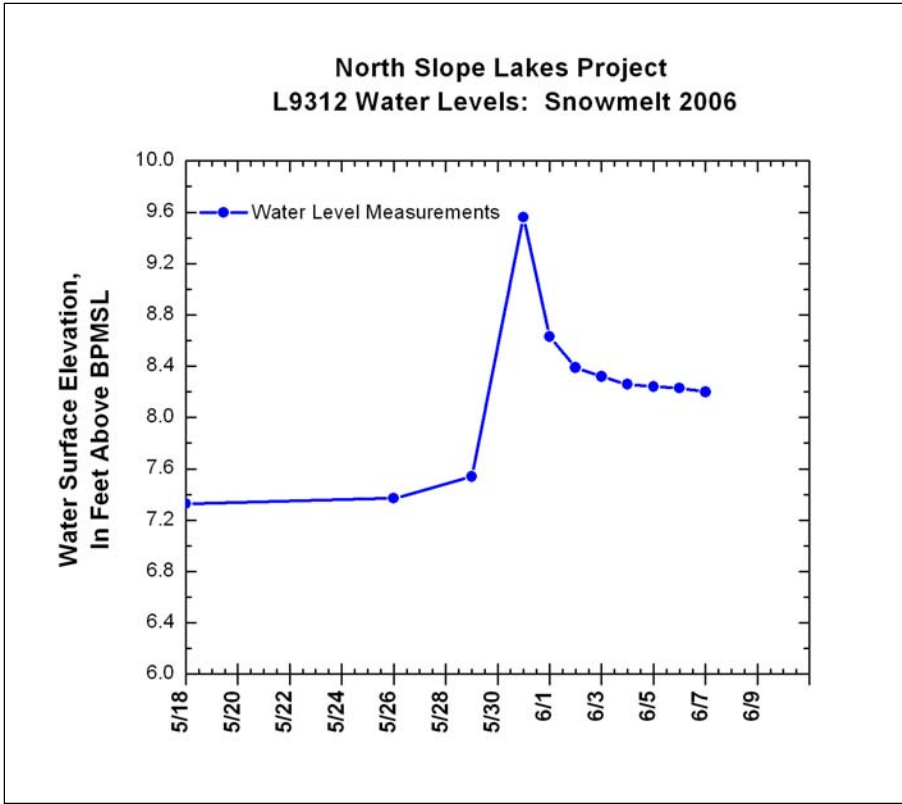


Figure 5. L9312 water levels during snowmelt 2006.

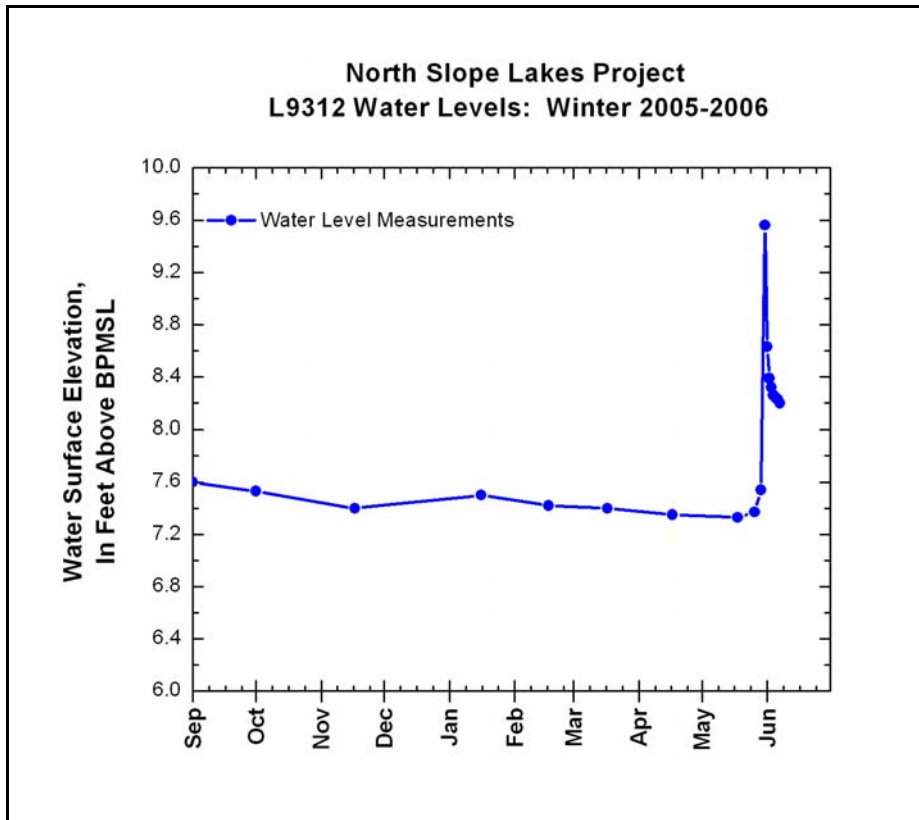


Figure 6. L9312 water levels for winter 2005-2006.

## SELECTED SNOWMELT OBSERVATIONS

Kuparuk Deadarm Reservoirs:

On 5/23/06 KDA-1 was observed to have significant water flowing into it from the parking lot, and in the northeast corner of the lake 2 channels had been cut into the lake bed. Water was also flowing onto the surface of the ice at this time, however, the ice still seemed to maintain it's integrity. By 5/25/06 the water from KDA-4 was flowing to KDA-3 through a culvert. The overflowing water from the nearby parking lot also began to cut channels through KDA-3 and a moat of standing water was created around KDA-2. On 5/26/06, it appeared as if the water level of KDA-2 had risen to match the level of KDA-3, and by 6/2/06, KDA 1, 2, and 3 were completely connected and had receded to their designated areas.

#### Mine Site B:

On 5/22/06 MSB was observed to have standing water on the ice which formed ½"-1" of hard crust on the lake surface. On 5/24/06, East Milne Creek (located directly next to MSB) was studied. At this time, the southern fork of the stream was measured at 30' wide, with the eastern channel of the stream noted to be around 1' deep and the western channel at approximately 2' deep, with a flow estimate of .5 ft/sec. Water levels at MSB appeared to have increased at least 8" since the previous day. By 5/25/06, the amount of surface water had increased again, the North Cell had become almost completely separated, and the stream had melted to the bottom in most places along the east side. By 5/29/06, water was flowing out of 2 of the culverts and the ice sheet in the North Cell had shifted 4-6 ft towards the northeast corner. The water levels continued to rise significantly until 6/2/06 when it was noted that there was a high water mark above the existing water level which indicated that the water level was beginning to drop back down. At this time the island was also completely submerged.

#### L9312:

On 5/25/06 the tundra around L9312 was wet and partially thawed to approximately ½". When re-visited on 5/26/06, it was estimated that approximately 45-60% of the lake was still covered in snow and the remaining 40-55% of the lake had water on top of the ice. Point 554 was also identified as the lake outlet at this time because of the large amount of water on the ice. By 5/28/06, there was water flowing through a channel by the pump house to the conductivity sampling hole where significant ice melt was beginning to occur. On 5/31/06 it was noted that there was flooding from potentially 3 locations, and that the Niqqlik channel had filled a flood plain immediately west of the CD4 pipeline which flooded a slough that passes under CD4-VSM 395 and connects to the Sagoonang channel. By 6/2/06 it was observed that the outlet was mostly dried up and the inlet side was still flooded. On 6/4/06 the ridge at L9312-OUT-HP was moist with puddles of water at low points but was not flowing. Documentation of near zero flow was confirmed by the presence of a thin layer of ice on top of the puddles that the outlet would flow through.

## **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.

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- Lilly, M.R., Reichardt, D., and Hilton, K. 2006. A Workplan for Snowmelt Monitoring and Lake Chemistry Sampling and Surveying at Study Lakes in NPRA, Alpine, and Kuparuk River Areas: May 2006. Water and Environmental Research Center, University of Alaska Fairbanks. 14 p.
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## **APPENDIX A. WATER QUALITY FIELD SAMPLING FORMS**

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





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

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

Project ID: North Slope Lakes  
 Sample Purpose: Lake Water Quality

Site Location/Lake ID: L9817-3  
 Date: 5/17/06 Time: nr

**FIELD MEASUREMENTS**

GPS Coord. Northing: N70.23402 Easting: W151.33061 Datum: NAD 27  
 Measurements By: DAR Time: nr  
 Water Depth (ft): 8.25 Ice Thickness (ft): 3.96  
 Freeboard (ft): 0.03 Snow Depth (ft): 1.25  
 Elev. (BPMSL +/- .02): 53.49 Survey By: MRL Date: 5/17/06 Time: nr  
 Water Sampling By: na Sample Depths BWS (ft): 1 na Date: na Time: na  
 2 \_\_\_\_\_  
 3 \_\_\_\_\_

**WATER QUALITY METER INFORMATION**

Calibration Information

Parameter (s)	Owner	Meter Make/Model		Serial No.		Pre-Sampling QAQC Check	Post-Sampling QAQC Check		
Multi	GWS	In-Situ Troll 9000		33033		yes	yes		
<b>Parameters</b>		<b>Field Measurements</b>							
Time:	15:42	15:46	16:06	16:11	16:13	16:15			
Depth BWS (ft):	4.0	5.0	6.0	7.0	8.0	8.2			
Temp (°C):	-0.11	-0.07	0.19	0.40	0.63	0.72			
pH:	7.19	7.17	7.20	7.21	7.40	7.84			
Barometric (mmHg):	758.3	758.2	758.3	758.4	758.4	758.4			
Pressure (kPa):	10.69	13.53	16.33	19.52	22.41	23.107			
Conductivity (µS/cm):	426.9	431.5	440.1	443.7	462.4	484.5			
RDO (ppm): (mg/L)	2.29	1.25	1.15	0.79	0.54	0.43			
Turbidity (NTU):	5.7	6.2	7.1	6.6	13.1	32.7			
ORP	100	103	117	119	24	67			
Hach LDO (UAF) mg/L									
Hach temp °C									

**FIELD TESTING OF WATER SAMPLES (if small probe is used)**

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

**NORTH SLOPE LAB CHEMISTRY ANALYSIS**

Parameter	Depth BWS (ft): _____			Depth BWS (ft): _____			Depth BWS (ft): _____			Method
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as CaCO <sub>3</sub> )										Digital titrator 10-4000 mg/L as CaCO <sub>3</sub>
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH <sub>3</sub> -N)****										0.01-0.50 mg/L NH <sub>3</sub> -N
Ammonia/ Iron dilution										

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

Field-Form Filled Out By: A. Blackburn Date: 6/8/06  
 QAQC Check By: Hilton Date: 7/9/06

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

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

Project ID: North Slope Lakes  
 Sample Purpose: Lake Water Quality

Site Location/Lake ID: L9817-4  
 Date: 5/17/06 Time: 16:23

**FIELD MEASUREMENTS**

GPS Coord. Northing: N70.23365 Easting: W151.33006 Datum: NAD 27  
 Measurements By: DAR Time: 16:23  
 Water Depth (ft): 6.2 Ice Thickness (ft): 4.50  
 Freeboard (ft): 0.10 Snow Depth (ft): 0.75  
 Elev. (BPMSL +/- .02): 53.49 Survey By: MRL Date: 5/17/06 Time: nr  
 Water Sampling By: na Sample Depths BWS (ft): 1 na Date: na Time: na  
 2 \_\_\_\_\_  
 3 \_\_\_\_\_

**WATER QUALITY METER INFORMATION**

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
all	GWS	In-Situ Troll 9000	33033	yes	yes
<b>Parameters</b>					
<b>Field Measurements</b>					
Time:	16:35	16:38	16:41	16:42	
Depth BWS (ft):	4.0	5.0	6.0	6.2	
Temp (°C):	-0.20	-0.19	0.07	0.08	
pH:	7.18	7.18	7.18	7.18	
Barometric (mmHg):	757.9	758.0	758.0	758.0	
Pressure (kPa):	10.32	13.53	16.74	17.020	
Conductivity (µS/cm):	439.0	439.3	442.2	442.6	
RDO (ppm): (mg/L)	1.51	0.83	0.49	0.36	
Turbidity (NTU):	7.5	8.2	54.3	170.8	
ORP	97	99	98	89.00	
Hach LDO (UAF) mg/L					
Hach temp °C					

**FIELD TESTING OF WATER SAMPLES** (if small probe is used)

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

**NORTH SLOPE LAB CHEMISTRY ANALYSIS**

Parameter	Depth BWS (ft): _____			Depth BWS (ft): _____			Depth BWS (ft): _____			Method
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as CaCO <sub>3</sub> )										Digital titrator 10-4000 mg/L as CaCO <sub>3</sub>
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH <sub>3</sub> -N)****										0.01-0.50 mg/L NH <sub>3</sub> -N
Ammonia/ Iron dilution										

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

Field-Form Filled Out By: Hilton Date: 7/7/06  
 QAQC Check By: Blackburn Date: 7/17/06

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

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

Project ID: North Slope Lakes Site Location/Lake ID: L9817-20  
 Sample Purpose: Lake Water Quality Date: 5/17/06 Time: nr

**FIELD MEASUREMENTS**

GPS Coord. Northing: N70.23492 Easting: W151.32963 Datum: NAD 27  
 Measurements By: DAR/EAB Time: 16:52  
 Water Depth (ft): 9.55 Ice Thickness (ft): 3.60  
 Freeboard (ft): -0.03 Snow Depth (ft): 1.42  
 Elev. (BPMSL +/- .02): 53.49 Survey By: MRL Date: 5/17/06 Time: nr  
 Water Sampling By: na Sample Depths BWS (ft): 1 na Date: na Time: na  
 2 \_\_\_\_\_  
 3 \_\_\_\_\_

**WATER QUALITY METER INFORMATION**

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check					
all	GWS	In-Situ Troll 9000	33033	yes	yes					
<b>Parameters</b>										
<b>Field Measurements</b>										
Time:	17:11	17:16	17:18	17:19	17:23	17:30	17:28			
Depth BWS (ft):	4.0	5.0	6.0	7.0	8.0	9.5	9.0			
Temp (°C):	-0.16	-0.03	0.24	0.48	0.57	0.53	0.56			
pH:	7.21	7.19	7.20	7.26	7.34	8.96	8.92			
Barometric (mmHg):	758.0	758.0	758.1	758.1	758.2	758.3	758.2			
Pressure (kPa):	10.48	13.45	16.47	19.46	22.54	27.24	25.670			
Conductivity (µS/cm):	419.3	423.4	431.7	442.3	453.9	752.4	700.9			
RDO (ppm): (mg/L)	0.86	0.37	0.34	0.30	0.20	0.22	0.18			
Turbidity (NTU):	21.3	21.9	19.6	19.8	29.0	83.8	21.2			
ORP	125	120	115	78	18	-272	-261.00			
Hach LDO (UAF) mg/L										
Hach temp °C										

FIELD TESTING OF WATER SAMPLES (if small probe is used)					
Probe:					
Depth (ft)					
Temp (°C)					
pH					
Eh					

**NORTH SLOPE LAB CHEMISTRY ANALYSIS**

Parameter	Depth BWS (ft): _____			Depth BWS (ft): _____			Depth BWS (ft): _____			Method
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as CaCO <sub>3</sub> )										Digital titrator 10-4000 mg/L as CaCO <sub>3</sub>
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH <sub>3</sub> -N)****										0.01-0.50 mg/L NH <sub>3</sub> -N
Ammonia/ Iron dilution										

Remarks: Small methane bubbles were released when the bottom was disturbed. Bug surfaced during testing (1/2" long, 1/4" diameter)- looked like a beetle.

Field-Form Filled Out By: Hilton Date: 7/7/06  
 QAQC Check By: Blackburn Date: 7/31/03

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

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

Project ID: North Slope Lakes  
 Sample Purpose: Lake Water Quality

Site Location/Lake ID: L9312-SH  
 Date: 5/18/06 Time: 15:48

**FIELD MEASUREMENTS**

GPS Coord. Northing: N70.33392 Easting: W150.94803 Datum: NAD 27  
 Measurements By: DAR Time: 15:48  
 Water Depth (ft): 9.3 Ice Thickness (ft): 4.62  
 Freeboard (ft): 0 Snow Depth (ft): 1.15  
 Elev. (BPMSL +/- .02): 11.72 Survey By: MRL/EB Date: 5/18/06 Time: 9:55  
 Water Sampling By: na Sample Depths BWS (ft): 1 na Date: na Time: na  
 2 \_\_\_\_\_  
 3 \_\_\_\_\_

**WATER QUALITY METER INFORMATION**

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check	
Multi	UAF	In-Situ Troll 9000	33205	yes	yes	
<b>Parameters</b>						
	<b>Field Measurements</b>					
Time:	15:49	15:58	16:05	16:10	16:12	16:16
Depth BWS (ft):	5.0	6.0	7.0	8.0	9.0	9.2
Temp (°C):	0.07	0.28	0.53	0.83	1.01	1.15
pH:	6.91	6.67	6.62	6.61	6.58	6.58
Barometric (mmHg):	760.1	760.1	760.1	760.1	760.1	760.2
Pressure (kPa):	13.26	16.38	19.82	23.18	25.38	26.61
Conductivity (µS/cm):	85.6	99.3	103.3	107.9	108.3	108.4
RDO (ppm): (mg/L)	13.50	10.41	7.98	6.99	6.11	4.47
Turbidity (NTU):	0.8	0.1	0.8	1.2	2.3	2.8
ORP	289	303	309	314	317	308

FIELD TESTING OF WATER SAMPLES (if small probe is used)						
Probe:						
Depth (ft)						
Temp (°C)						
pH						
Eh						

**NORTH SLOPE LAB CHEMISTRY ANALYSIS**

Parameter	Depth BWS (ft): _____			Depth BWS (ft): _____			Depth BWS (ft): _____			Method
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as CaCO <sub>3</sub> )										titrator 10-4000
Total iron--UF (mg/L)										0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										0.02-3.00
Ammonia (mg/L NH <sub>3</sub> -N)****										0.01-0.50
Ammonia/ Iron dilution										

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

Field-Form Filled Out By: Hilton Date: 7/26/06  
 QAQC Check By: A. Blackburn Date: 8/23/07















































































**University of Alaska Fairbanks, Water and Environmental Research Center**  
**Form F-011: Elevation Survey Form**

Project ID: North Slope Lakes Site Location/Lake ID: L9312  
 Survey Purpose: Water-Level Elevations Date: 5/18/2006 Time: 9:55

Location:	Lake L9312, located southeast of Alpine pad, survey by pump house benchmarks							
Survey objective:	Lake water elevation survey					Weather Observations:		
Instrument Type:	Leica NA720	Instrument ID:	5482372 (GWS owned)		n/r			
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)		M. Lilly, E. Benning		
L9312 "P"	CP	11.72 BPMSL	70-20.032 NAD83	150-57.138 NAD83				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
P	2.27	17.00		11.73				
O	2.53	14.00		11.47				
PH-WS	0.57	14.00		14.57				
WS	6.66	14.00		<b>7.34</b>				WS= <b>7.34'</b>
TBM	6.38	14.00		7.62				
move instrument								
TBM	6.23	13.85		7.62				
WS	6.52	13.85		7.33				0.01
PHV3M	0.72	13.85		14.57				0
O	2.37	13.85		11.48				0.01
P	2.12	13.85		11.73				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: L9312  
 Survey Purpose: Water-Level Elevations Date: 5/26/2006 Time: 9:30

Location:		Lake L9312,survey by pump house benchmarks						
Survey objective:		Lake water elevation survey			Weather Observations:			
Instrument Type:	Leica NA720	Instrument ID:	5482372 (GWS owned)		n/r			
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)	D. Reichardt, E. Benning			
L9312 "P"	CP	11.72 BPMSL	70-20.032 NAD83	150-57.138 NAD83				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
39-O	3.03	14.50		14.47				TBM-LCMF-02-01-39-O-P
move instrument ^1								
39-P		14.50	2.77	11.73				TBM-LCMF-02 39-P
L9312-Cond		14.50	7.13	<b>7.37</b>				Water surface = <b>7.37'</b>
Staff TOI		14.50	6.77	7.73				TOI
Staff GA		14.50	14.46	0.04				
move instrument ^2								
Staff TOI	6.73	14.46		7.73				
Staff GA		14.46	14.43	0.03				
L9312-Cond		14.46	7.08	7.38				
39-O		14.46	2.72	11.74				
39-P		14.46	2.99	11.47				Close survey

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: Kuparuk Deadarm 1,2,3  
 Survey Purpose: Water-Level Elevations Date: 5/21/2006 Time: 6:30

Location: Kuparuk Deadarm Mine Sites, reservoir 1, 2, 3. Adjacent to Kuparuk River								
Survey objective: Determine elevations in reservoirs 3,2					Weather Observations:			
Instrument Type: Leica NA720		Instrument ID: 5482372 (GWS owned)		NR				
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)		M. Lilly E. Benning		
BM #1 W0040768	BP	19.32	N70 20.065 NAD27	W148 56.183 NAD27				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
BM	0.78	20.10		19.32				
C3-WL1		20.10	12.78	7.32				Cell 3 WL1- primary WL below ice
C2-WL1		20.10	14.04	6.06				Cell 2
C2-WL 2		20.10	16.95	3.15				WL2- on top of ice
move instrument								
C2-WL2	14.74	17.89		3.15				
C2-WL1		17.89	14.74	<b>3.15</b>				<b>Cell 2= 3.15'</b>
C3-WL2		17.89	12.96	4.93				
C3-WL1		17.89	12.72	<b>5.17</b>				<b>Cell 3= 5.17'</b>
BM		17.89	0.70	17.19				Close survey
Note: Field notes use temporary datum for BM #1 = 100.00 ft.								

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: Kuparuk Deadarm Mine Sites  
 Survey Purpose: Water-Level Elevations Date: 6/2/2006 Time: 14:30

Location:	Kuparuk Deadarm Mine Sites, reservoir 1, 2, 3. Adjacent to Kuparuk River							
Survey objective:	Determine elevations in reservoirs 1, 2, 3					Weather Observations:		
Instrument Type:	Leica NA720	Instrument ID:	5482372 (GWS owned)			NR		
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)		E. Benning		
BM #1 WO040768	BP	19.32	N70 20.065 NAD27	W148 56.183 NAD27				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
BM#1	0.53	19.85		19.32				Bell Assoc. Benchmark
TP1		19.85	9.66	10.19				
Move instrument								
TP1	9.87	20.06		10.19				
BM #2		20.06	0.75	19.31				
TBM1		20.06	6.84	13.22				6/2 W.L.=0.00
TBM2		20.06	5.06	15.00				5/31 W.L= .20
TBM3		20.06	3.47	16.59				5/30 W.L.=.38 5/29 W.L.=.50
TBM4		20.06	2.95	17.11				5/28 W.L= .52
Move instrument east of peak 2.48								
TBM4	2.82	19.93		17.11				
TBM3		19.93	3.33	16.6				
TBM2		19.93	4.92	15.01				
TBM1		19.93	6.7	13.23				
TBM1		19.93	14.66	5.27				
TBM2		19.93	16.66	3.27				
TBM3		19.93	21.92					Estimate of peak 12.55 move instr.
TBM3			21.73					
TBM1			14.46					
Note: Field notes use temporary datum for BM #1 = 100.00 ft.								

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: 5/22/2006 Time: 19:00

Location:		Mine Site B, NE corner of North Cell, temporary datum						
Survey objective:		Lake water elevation survey			Weather Observations:			
Instrument Type:		Optical Survey Level	Instrument ID:	Leica Runner 24 Serial # 404374		Overcast, some light snow, ~30F		
Rod Type:		Fiberglass	Rod ID:	Sokkia Fiber Glass				
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		Michael Lilly Liz Binning		
"Post"	WERC	100 Temp.	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
Post TBM1	5.33	105.33		100.00				Top of nail in post, temp elevation
TBM2		105.33	1.49	103.84				VSM on Pipeline, south side
TBM3		105.33	1.86	103.47				VSM on Pipeline, north side
TBM4		105.33	3.95	101.38				Top of old cutoff VSM
WL1-TBM		105.33	7.62	97.71				North Cell, closest to north bank
NC-WL offset			2.14	<b>95.57</b>				Depth to WL from TBM = 2.14
								moved Instr., used WL1-TBM as turn
WL1-TBM	7.49	105.20		97.71				TBM, Auger extension in snow
TBM4		105.20	3.84	101.36				Top of old cutoff VSM
TBM3		105.20	1.75	103.45				VSM on Pipeline, north side
TBM2		105.20	1.38	103.82				VSM on Pipeline, south side
Post TBM1		105.20	5.21	99.99				close survey to -0.01
NC-WLTBM	6.88	106.88		100.00				TBM, ice scoop extension in snow
NC-WL			0.35	99.65				Depth to WL from TMP = 0.35
NSC-West Channel		106.88	7.23	99.65				Water level in channel on west side of island
NSC-East Channel		106.88	7.22	99.66				Water level in channel on east side of island
SC-WLTBM		106.88	5.24	101.64				TBM, tripod
SC-WL			1.97	99.67				Depth to WL from TMP = 1.97
								moved Instr., used WL as turn point

SC-WLTBM	5.08	106.72		101.64			TBM, Auger extension in snow
NSC-East Channel		106.72	7.06	99.66			North Cell, closest to island
NSC-West Channel		106.72	7.05	99.67			South Cell, closest to island
NC-WLTBM		106.72	6.72	100.00			close survey to +0.02
Elevation adjustment for south cell water levels							
North Cell, WL1				<b>95.57</b>			<b>North Cell, closest to island = 95.57'</b>
South Cell, WL2				<b>95.59</b>			<b>South Cell, closest to island = 95.59'</b>
NSC-East Channel				<b>95.58</b>			
NSC-West Channel				<b>95.59</b>			

Note: WL within 0.02 feet on all side of island, establishe 3 new TBMs

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 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: 5/17/2006 Time: 14:00

Location Description:	On lake, starting at hole #2 towards hole #3 then left towards shore.				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather Observations:	nr
Latitude:	N 70°20.123'	Longitude:	W 150° 56.499'	Datum:	NAD27 Alaska
Elevation:		Elevation Datum:	BPMSL	Reference Markers:	Starts at water chemistry test hole
Drainage Basin:	L9817	Slope Direction:	Flat	Vegetation Type:	N/A
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>			Liz Binning, Jack (LCMF)	

Snow Course Depths, in cm.

	1	2	3	4	5
1	32.0	26.0	25.5	20.5	17.5
2	30.0	25.5	23.0	22.5	20.0
3	31.0	26.5	32.0	20.0	20.0
4	35.0	22.0	30.5	21.5	20.5
5	31.0	23.5	28.0	22.0	21.0
6	26.0	31.0	27.0	19.5	19.0
7	29.0	31.0	23.5	17.0	16.5
8	32.0	34.5	21.5	18.5	17.5
9	37.5	31.5	20.0	18.0	20.0
10	39.5	32.0	19.5	18.0	23.5

(cm)  
 Average snow depth = 25.0  
 Maximum snow depth = 39.5  
 Minimum snow depth = 16.5  
 Standard variation = 6.0

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm <sup>3</sup> )	Density (gr/cm <sup>3</sup> )
DW1-1	26	537.0	928.2	0.58
DW1-2	10	314.0	357.0	0.88
DW1-3	28	344.0	999.6	0.34
DW1-4	18	250.0	642.6	0.39
DW1-5	25	278.0	892.5	0.31

Average Density = 0.50  
 Average Snow Water Equivalent (SWE) = 12.5 cm H2O  
 Average Snow Water Equivalent = 4.93 inches H2O  
 Average Snow Water Equivalent = 0.41 feet H2O

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: 5/17/2006 Time: 15:00

Location Description:	Snow survey on shore. Site marked by lathe				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather Observations:	nr
Latitude:	N 70°20.123'	Longitude:	W 150° 56.499'	Datum:	NAD27 Alaska
Elevation:		Elevation Datum:	BPMSL	Reference Markers:	Site marked by lathe
Drainage Basin:	L9817	Slope Direction:	Flat	Vegetation Type:	N/A
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>			Liz Binning, Jack (LCMF)	

Snow Course Depths, in cm.

	1	2	3	4	5
1	40.0	33.0	27.0	43.5	38.5
2	38.0	28.0	32.5	43.0	35.0
3	38.0	34.0	34.5	46.0	34.5
4	45.5	31.0	33.0	47.5	30.0
5	49.0	30.0	35.0	46.0	32.0
6	47.0	27.0	35.5	41.5	30.0
7	41.5	27.5	34.5	39.5	33.5
8	37.5	26.0	37.0	39.0	29.0
9	38.5	28.5	34.0	38.5	33.5
10	43.0	28.0	36.0	44.0	32.5
11	36.5	29.0	40	34.0	

(cm)  
 Average snow depth = 36.0  
 Maximum snow depth = 49.0  
 Minimum snow depth = 26.0  
 Standard variation = 6.0

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm <sup>3</sup> )	Density (gr/cm <sup>3</sup> )
9817-2-1	38	346.0	1356.6	0.26
9817-2-2	26	221.0	928.2	0.24
9817-2-3	29	214.0	1035.3	0.21
9817-2-4	41	524.0	1463.7	0.36
9817-2-5	46	452.0	1642.2	0.28

Average Density = 0.27  
 Average Snow Water Equivalent (SWE) = 9.6 cm H2O  
 Average Snow Water Equivalent = 3.78 inches H2O  
 Average Snow Water Equivalent = 0.32 feet H2O

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: 5/16/2006 Time: 16:00

Location Description:	West side of water pump house, first length parallel to water pipeline, second length perpendicular to water pipeline moving away from the pipeline.				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather Observations:	Sunny, windy
Latitude:	N 70°20.123'	Longitude:	W 150° 56.499'	Datum:	NAD27 Alaska
Elevation:		Elevation Datum:	BPMSL	Reference Markers:	Site staked with lathe
Drainage Basin:	L9312	Slope Direction:	Southwest	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>			Liz Binning, Dan Reichardt	

Snow Course Depths, in cm.

	1	2	3	4	5
1	43.0	40.0	45.0	0.0	55.5
2	42.0	42.5	44.5	24.0	53.5
3	34.5	38.0	47.0	54.0	44.0
4	43.0	42.0	51.0	65.5	36.0
5	45.5	39.5	50.0	27.0	25.0
6	49.0	37.5	49.5	19.0	18.5
7	45.0	36.5	50.0	0.0	27.5
8	47.0	39.0	47.0	17.5	62.0
9	39.0	44.0	34.0	43.0	67.0
10	38.5	44.5	15.5	49.0	55.5

(cm)  
 Average snow depth = 40.1  
 Maximum snow depth = 67.0  
 Minimum snow depth = 0.0  
 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> )
DW2-1	38	412.0	1356.6	0.30
DW2-2	38	439.0	1356.6	0.32
DW2-3	42	434.0	1499.4	0.29
DW2-4	49.5	455.0	1767.2	0.26
DW2-5	58	589.0	2070.6	0.28

Average Density = 0.29  
 Average Snow Water Equivalent (SWE) = 11.7 cm H2O  
 Average Snow Water Equivalent = 4.61 inches H2O  
 Average Snow Water Equivalent = 0.38 feet H2O

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: 5/18/2006 Time: 11:00

Location Description:	On lake starting at the midpoint between holes A and B. First leg is towards hole B and second leg is right towards shore.				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather Observations:	Overcast, low winds
Latitude:	N 70°20.123'	Longitude:	W 150° 56.499'	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>			Liz Binning, Jack (LCMF)	

Snow Course Depths, in cm.

	1	2	3	4	5
1	23.5	13.0	17.5	15.0	14.5
2	24.0	14.5	16.0	19.0	12.5
3	22.5	18.0	18.0	20.0	16.0
4	21.5	20.5	16.0	18.5	17.0
5	20.5	20.0	17.5	18.0	16.5
6	15.0	18.0	16.5	16.5	15.5
7	16.5	17.5	16.5	16.0	13.5
8	17.0	17.0	17.0	14.5	14.5
9	12.5	18.5	13.5	11.5	15.0
10	13.5	16.5	14.5	15.0	14.5

(cm)  
 Average snow depth = 16.7  
 Maximum snow depth = 24.0  
 Minimum snow depth = 11.5  
 Standard variation = 2.8

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm <sup>3</sup> )	Density (gr/cm <sup>3</sup> )
DW3-1	24	374.0	856.8	0.44
DW3-2	18	218.0	642.6	0.34
DW3-3	17	215.0	606.9	0.35
DW3-4	14	173.0	499.8	0.35
DW3-5	14	160.0	499.8	0.32

Average Density = 0.36  
 Average Snow Water Equivalent (SWE) = 6.0 cm H2O  
 Average Snow Water Equivalent = 2.37 inches H2O  
 Average Snow Water Equivalent = 0.20 feet H2O

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: 5/18/2006 Time: 12:15

Location Description:	West side of water pump house, first length parallel to water pipeline, second length perpendicular to water pipeline moving away from the pipeline.				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather Observations:	Overcast, low winds
Latitude:	N 70°20.123'	Longitude:	W 150° 56.499'	Datum:	NAD27 Alaska
Elevation:		Elevation Datum:	BPMSL	Reference Markers:	Site staked with lathe
Drainage Basin:	L9312	Slope Direction:	Southwest	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>			Liz Binning, Jack (LCMF)	

Snow Course Depths, in cm.

	1	2	3	4	5
1	43.5	32.0	45.5	16.0	49.5
2	44.0	37.0	47.0	0.0	54.0
3	34.5	37.0	50.5	24.0	51.5
4	42.0	37.0	48.5	53.0	40.5
5	45.0	34.0	30.5	56.5	33.0
6	48.5	37.0	51.0	27.5	24.0
7	43.0	34.5	48.0	15.5	29.5
8	41.5	40.5	49.5	0.0	29.0
9	33.5	41.5	47.0	11.5	60.5
10	34.5	42.5	29.5	43.5	64.5

(cm)  
 Average snow depth = 38.3  
 Maximum snow depth = 64.5  
 Minimum snow depth = 0.0  
 Standard variation = 13.6

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm <sup>3</sup> )	Density (gr/cm <sup>3</sup> )
DW4-1	42	486.0	1499.4	0.32
DW4-2	32	339.0	1142.4	0.30
DW4-3	50	482.0	1785.0	0.27
DW4-4	28	210.0	999.6	0.21
DW4-5	62	633.0	2213.4	0.29

Average Density = 0.28  
 Average Snow Water Equivalent (SWE) = 10.6 cm H2O  
 Average Snow Water Equivalent = 4.18 inches H2O  
 Average Snow Water Equivalent = 0.35 feet H2O

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: West Dock  
 Survey Purpose: Snow Depth and Water Content Date: 5/24/2006 Time: 20:00

Location Description:	Snow course at west dock. Beginning of course marked with lathe.				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather Observations:	nr
Latitude:	nr	Longitude:	nr	Datum:	nr
Elevation:		Elevation Datum:	BPMSL	Reference Markers:	Marked with lathe
Drainage Basin:		Slope Direction:	Flat	Vegetation Type:	Tussock
Slope Angle:	Flat	Access Notes:	Truck	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>			DAR, EB	

Snow Course Depths, in cm.

	1	2	3	4	5
1	30.0	0.0	15.5	35.5	34.5
2	25.0	7.5	18.0	27.0	32.0
3	28.5	4.0	22.5	0.0	30.5
4	13.5	9.5	22.5	0.0	30.0
5	26.0	15.0	23.5	0.0	28.5
6	23.0	17.0	22.5	30.0	26.0
7	27.0	26.5	27.0	33.5	22.0
8	28.5	22.5	27.5	33.0	19.5
9	28.5	12.5	21.0	36.5	21.5
10	17.0	26.0	37.5	38.0	17.5

(cm)  
 Average snow depth = 22.4  
 Maximum snow depth = 38.0  
 Minimum snow depth = 0.0  
 Standard variation = 10.1

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm <sup>3</sup> )	Density (gr/cm <sup>3</sup> )
WD24-1	16	240.0	571.2	0.42
WD24-2	23	236.0	821.1	0.29
WD24-3	25	216.0	892.5	0.24
WD24-4	24	227.0	856.8	0.26
WD24-5	26	281.0	928.2	0.30

Average Density = 0.30  
 Average Snow Water Equivalent (SWE) = 6.8 cm H2O  
 Average Snow Water Equivalent = 2.68 inches H2O  
 Average Snow Water Equivalent = 0.22 feet H2O

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: 5/18/2006 Time: 11:00

Location Description:	On lake starting at the midpoint between holes A and B. First leg is towards hole B and second leg is right towards shore.				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather Observations:	Overcast, low winds
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>			Liz Binning, Jack (LCMF)	

Snow Course Depths, in cm.

	1	2	3	4	5
1	23.5	13.0	17.5	15.0	14.5
2	24.0	14.5	16.0	19.0	12.5
3	22.5	18.0	18.0	20.0	16.0
4	21.5	20.5	16.0	18.5	17.0
5	20.5	20.0	17.5	18.0	16.5
6	15.0	18.0	16.5	16.5	15.5
7	16.5	17.5	16.5	16.0	13.5
8	17.0	17.0	17.0	14.5	14.5
9	12.5	18.5	13.5	11.5	15.0
10	13.5	16.5	14.5	15.0	14.5

(cm)  
 Average snow depth = 16.7  
 Maximum snow depth = 24.0  
 Minimum snow depth = 11.5  
 Standard variation = 2.8

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm <sup>3</sup> )	Density (gr/cm <sup>3</sup> )
DW3-1	24	142.0	856.8	0.17
DW3-2	18	181.0	642.6	0.28
DW3-3	17	180.0	606.9	0.30
DW3-4	14	518.0	499.8	1.04
DW3-5	14	196.0	499.8	0.39

Average Density = 0.43  
 Average Snow Water Equivalent (SWE) = 7.3 cm H2O  
 Average Snow Water Equivalent = 2.86 inches H2O  
 Average Snow Water Equivalent = 0.24 feet H2O

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: Betty Pingo  
 Survey Purpose: Snow Depth and Water Content Date: 5/24/2006 Time: 18:40

Location Description:	Snow course near weather stations at Betty Pingo.				
Survey objective:	Snow depths and snow-water content for lake recharge estimates			Weather Observations:	nr
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 depth probe,			Snow-Survey Team Names	
Snow Tube Type:	Adirondak, 6.74 cm diameter cutter, area = 35.7 cm <sup>2</sup>			DAR, Binning	

Snow Course Depths, in cm.

	1	2	3	4	5
1	12.0	25.5	21.0	23.0	0.0
2	13.0	28.0	31.5	23.0	18.5
3	0.0	35.0	32.5	22.5	19.0
4	21.5	37.5	23.5	20.5	12.0
5	19.5	35.5	24.5	0.0	16.0
6	22.0	32.0	21.5	20.0	13.5
7	24.5	28.5	39.0	25.5	16.5
8	31.5	27.0	32.0	13.5	17.0
9	28.0	22.5	27.0	24.0	14.0
10	30.5	16.5	28.5	24.5	16.5

(cm)  
 Average snow depth = 22.2  
 Maximum snow depth = 39.0  
 Minimum snow depth = 0.0  
 Standard variation = 8.8

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm <sup>3</sup> )	Density (gr/cm <sup>3</sup> )
BP24-1	13	142.0	464.1	0.31
BP24-2	18	181.0	642.6	0.28
BP24-3	14	180.0	499.8	0.36
BP24-4	38	518.0	1356.6	0.38
BP24-5	22	196.0	785.4	0.25

Average Density = 0.32  
 Average Snow Water Equivalent (SWE) = 7.0 cm H2O  
 Average Snow Water Equivalent = 2.76 inches H2O  
 Average Snow Water Equivalent = 0.23 feet H2O

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