# Lake Chemistry and Physical Data For Selected North Slope, Alaska, Lakes: October 2006

*Photo of October conditions in the Brooks Range, by J. Derry.*


by

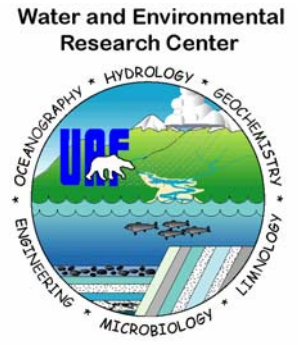
Kristie Holland, Michael Lilly, Jeff Derry, and Daniel Reichardt



September 2007

North Slope Lakes Hydrologic Modeling Project

Report No. INE/WERC 07.02

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by

Kristie Holland[1], Michael Lilly[1], Jeff Derry[1], Dan Reichardt[1]

A report on research sponsored by the

**Alaska Department of Energy, National Energy Technology Laboratory, BP Exploration (Alaska) Inc., ConocoPhillips Alaska, Inc., and the Bureau of Land Management.**

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[1]Geo-Watersheds Scientific, Fairbanks, Alaska

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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), 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 |
|---|---|---|
| | Length | |
| Inch (in) | 25.4 | millimeter (mm) |
| Inch (in) | 2.54 | centimeter (cm) |
| Foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |
| | Area | |
| Acre | 43560.0 | square feet ($ft^2$) |
| Acre | 0.405 | hectare (ha) |
| square foot ($ft^2$) | 3.587e-8 | square mile ($mi^2$) |
| square mile ($mi^2$) | 2.590 | square kilometer ($km^2$) |
| | Volume | |
| gallon (gal) | 3.785 | liter (L) |
| gallon (gal) | 3785.412 | milliliter (mL) |
| cubic foot ($ft^3$) | 28.317 | liter (L) |
| Acre-ft | 1233.482 | cubic meter ($m^3$) |
| Acre-ft | 325851.43 | gallon(gal) |
| gallon(gal) | 0.1337 | cubic feet ($ft^3$) |
| | Velocity and Discharge | |
| foot per day (ft/d) | 0.3048 | meter per day (m/d) |
| Square foot per day ($ft^2$/d ) | 0.0929 | square meter per day ($m^2$/d) |
| cubic foot per second ($ft^3$/s) | 0.02832 | cubic meter per second ($m^3$/sec) |
| | Hydraulic Conductivity | |
| 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) |
| | Hydraulic Gradient | |
| foot per foot (ft/ft) | 5280 | foot per mile (ft/mi) |
| foot per mile (ft/mi) | 0.1894 | meter per kilometer (m/km) |
| | Pressure | |
| pound per square inch ($lb/in^2$ ) | 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 ($m^3/s$) 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:

$$°F = 1.8(°C) + 32$$

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:

"Sea level" in the following report 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 ($^{o}$F). |
| ft | feet |
| GWS | Geo-Watersheds Scientific |
| GWSI | USGS Ground-Water Site Inventory |
| $km^2$ | square kilometers |
| kPa | kilopascal |
| $lb/in^2$ | pounds per square inch |
| m | meters |
| mg/L | milligrams per liter, equivalent to ppm |
| µg/L | micrograms per liter |
| $mi^2$ | square miles |
| mm | millimeters |
| µS/cm | microsiemens per centimeter |
| mV | Millivolt |
| NGVD | National Geodetic Vertical Datum |
| NWIS | National Water Information System |
| ORP | oxygen-reduction potential |
| ppm | parts per million, equivalent to mg/L |
| SC25 | specific conductance at 25$^{o}$C |
| 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 |

## 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.

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

## ACKNOWLEDGEMENTS

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# Lake Chemistry and Physical Data For Selected North Slope, Alaska, Lakes: October 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 the 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. 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. L9817 has been used in previous years for ice-road construction, but was not used during winter 2005-06, nor will 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 access road and has two cells connected to Milne Creek. The Kuparuk Reservoir System (Kuparuk Deadarm Lakes) has nine reservoirs. The three southernmost reservoir cells (1-3) are included in the study to observe ground-water and surface-water interactions between each cells 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 month of October 2006, 2) summarize accomplished field trip objectives.

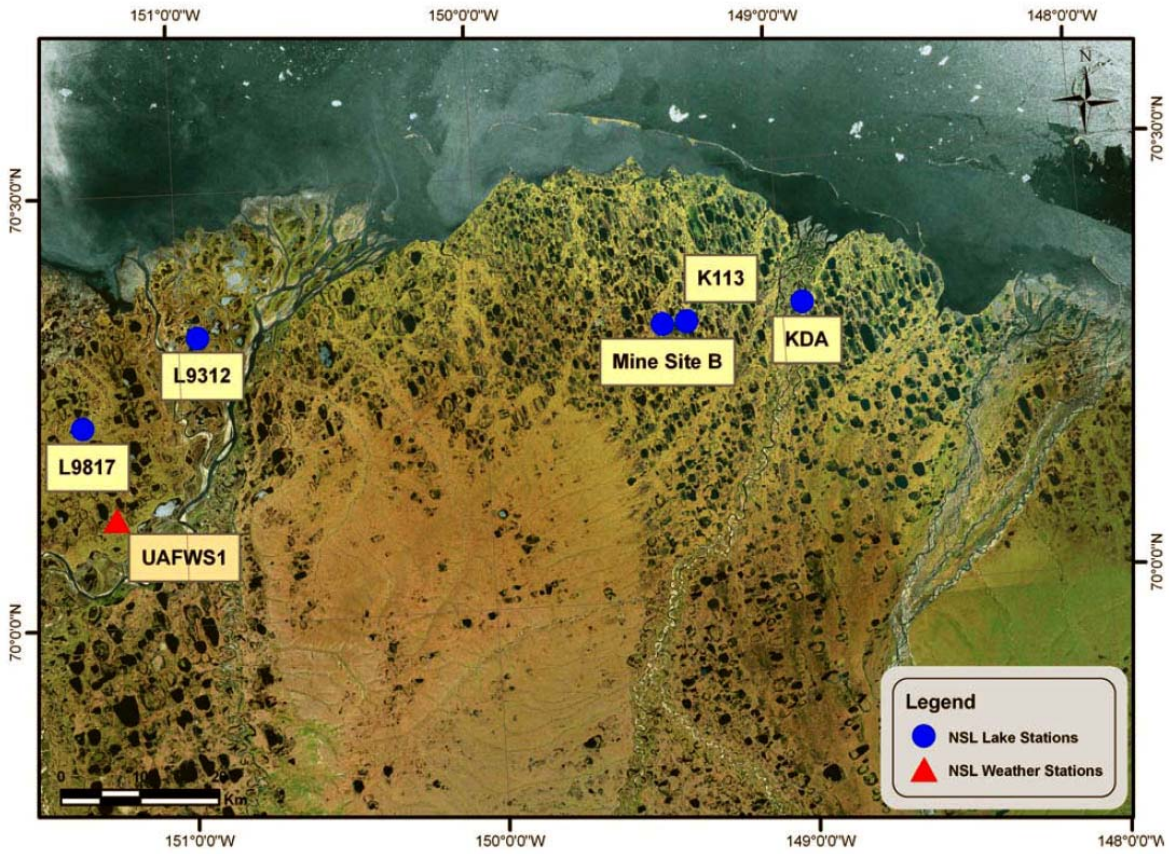


**Figure 1. Location of study lakes in NPR-A, Alpine, Kuparuk, and Prudhoe Bay field operating areas, North Slope, Alaska.**

## 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 workplan was distributed before the trip outlining the sampling schedule (Lilly and others, 2006). In October, we focused on the following locations/tasks:

1. Kuparuk Dead Arm Reservoirs (1-5): Prudhoe Bay operating area.
    - Survey water levels to local elevation control on cells 1, 2, 3, and 4.
    - Install automated data collection stations at cell 2 for water temperature monitoring.
    - Measure snow depth, ice thickness, and field water quality parameters for cell 2.
    - Conduct snow survey.

2. Mine Site B: Prudhoe Bay operating area.
    - Survey water levels to North and South Cells.
    - Install automated data collection stations at North cell for water temperature monitoring.
    - Measure water quality parameters at North Cell and stream.
    - Establish snow survey location for the winter of 2006.
3. L9312: Alpine Facility.
    - Survey water surface elevation of lake and surface gradient transect.
    - Survey lake outlet control elevation system and inspect for problems.
    - Inspect automated data-collection system and service Belfort snow gage.
    - Conduct snow survey.

## PROCEDURES

All field work follows the specified health, safety, and environmental guidelines outlined by BPX and CPA (White and Lilly, 2006 *a,b,c*). 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 quality parameters such as temperature, pH, conductivity, and dissolved oxygen (DO) were obtained in-situ by using an In-Situ Troll 9000 (submersible meter), at several depths throughout the water column. The precision with which physical measurements were reported takes into account field conditions, and the calibration of each parameter was checked before and after each day of sampling using the criteria in Table 1.

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

| Parameter | Standards used | Acceptable deviation from calibration standard value |
|---|---|---|
| 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 | In-Situ Quick Cal 224 mV | within 10% |

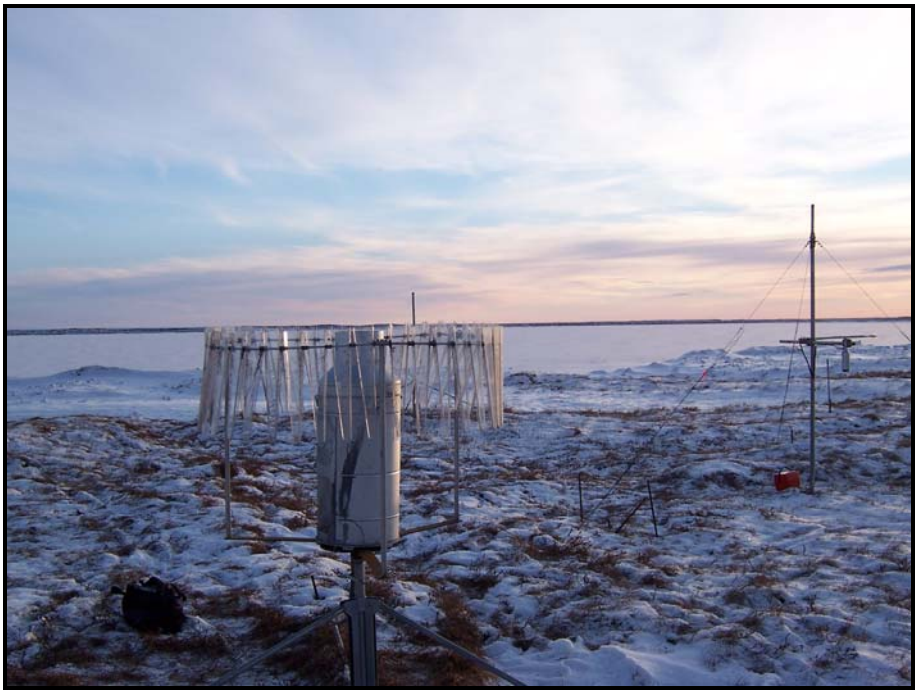

**Figure 2. . Precipitation gauge at the L9312 weather station, photo by J. Derry.**

## SELECTED RESULTS

Water quality sampling was limited due to time restrictions and prior obligations to installation of weather stations and winter sampling preparation. A few locations were chosen for baseline measurements which could be used for comparative purposes throughout the year. Table 2 summarizes conditions at the priority sampling sites. These locations have more historical data and have been chosen to represent other water bodies in the area.

**Table 2. Ice thickness, Median DO Concentration, Median Actual Conductance, Median Temperature, and Median Depth of selected locations in mid-October.**

| Sampling Site | Median DO Concentration[mg/L] | Median Actual Conductivity[μS/cm] | Median Temperature [C] | Median Depth [ft] |
|---|---|---|---|---|
| **KDA-2** | - | 93.35 | 0.18 | 12 |
| **MSB-NC** | 12.67 | - | 0.155 | 19 |
| **MSB-Stream** | 8.18 | 207.7 | -0.25 | 2.5 |

The October sampling trip was unique in that the primary objective was not to collect data, but to solidify winter sampling procedures and to install new data stations at the Kuparuk Deadarm Reservoirs (KDA-2) and at Mine Site B (North Cell). Snow surveys were conducted at L9312 and KDA, but were not possible at Mine Site B due to a lack of snow. Table 3 summarizes the results. In addition to the installation/maintenance of data stations and identifying winter snow survey locations, thorough elevation surveys were conducted at each lake while weather conditions were optimal. Once winter is in full force, these tasks may be hindered by snow, wind, and/or temperature.

**Table 3. Average and maximum snow depths for L9312 and KDA-2 [cm].**

| | Average Depth (cm) | Maximum Depth (cm) |
|---|---|---|
| **L9312** | **7.4** | **18.0** |
| **KDA-2** | **5.2** | **8.0** |

Water quality parameters such as dissolved oxygen, pH, temperature, conductivity, and/or

turbidity were collected at Mine Site B and the Kuparuk Deadarm Reservoir Cell 2 for baseline information. Figure 3 summarizes the conditions at MSB before the onset of winter.

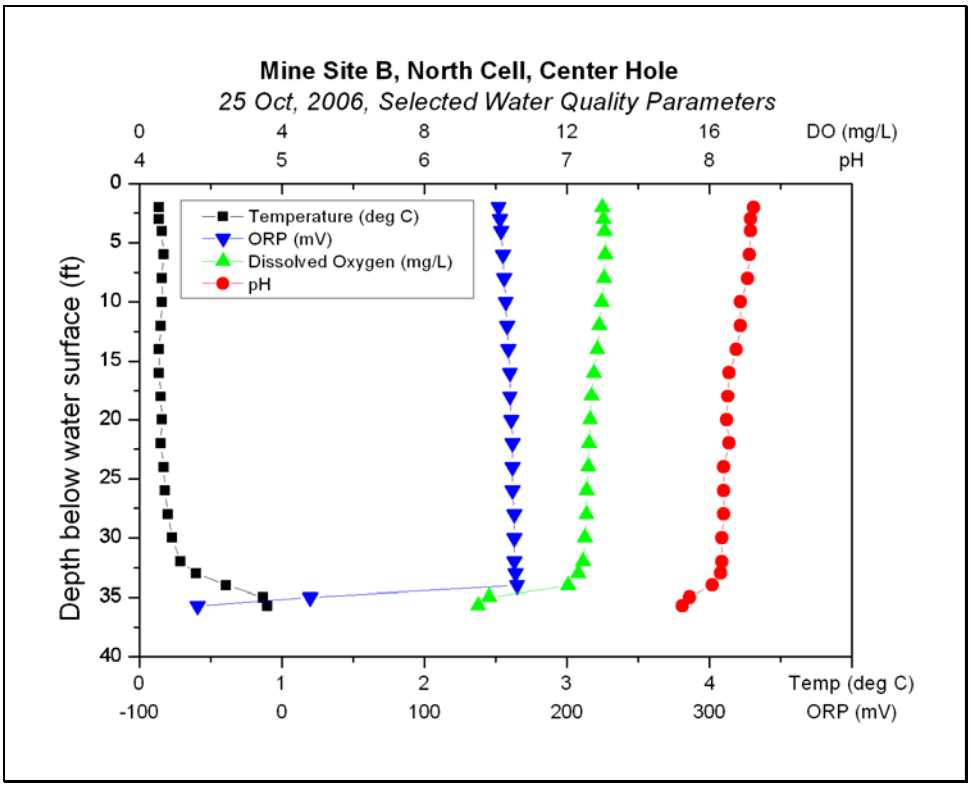


**Figure 3. Water quality profile of Mine Site B- North Cell, including temperature DO, ORP and pH.**

## SUMMARY

Continuous monitoring of the water-quality parameters seen in North Slope lakes throughout the winter will help in the understanding and development of simulation tools necessary for water resource management. As 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 recharge. This information is important for permitting agencies as well as the industry professionals who depend on this resource for facility use and ice road/pad construction. Through monthly hydrologic assessments, water-chemistry testing, and water-sample analysis, we hope to answer some of the questions brought forth on the effects of mid-winter pumping of North Slope lakes.

## REFERENCES

Lilly, M.R., Derry, J., and Reichardt, D. 2006. A Workplan for Chemistry Sampling and Surveying at Lakes in NPRA, Alpine, and Kuparuk River Areas: October 2006. Water and Environmental Research Center, University of Alaska Fairbanks. 13 p.

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White, D.M., and Lilly, M.R. 2006 *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.

***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: MSBN-CT

Sample Purpose: **Lake Water Quality** Date: 10/25/06 Time: nr

**FIELD MEASUREMENTS**

GPS Coord. Northing: N70°19.280' Easting: W149°24.009' Datum: NAD83

Measurements By: DAR Time: nr

Water Depth (ft): n/a Ice Thickness (ft): n/a

Freeboard (ft): n/a Snow Depth (ft): n/a

Elev. (BPMSL +/- .02): 96.16 Survey By: MRL Date: 10/25/07 Time: nr

Water Sampling By: DAR 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 | PASS | PASS |

| **Parameters** | **Field Measurements** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time: | nr | nr | nr | nr | nr | nr | nr | nr | nr | nr |
| Depth BWS (ft): | 2 | 3 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 |
| Temp (°C): | 0.14 | 0.14 | 0.16 | 0.17 | 0.16 | 0.16 | 0.15 | 0.14 | 0.14 | 0.15 |
| pH: | 8.31 | 8.29 | 8.29 | 8.28 | 8.27 | 8.22 | 8.22 | 8.19 | 8.14 | 8.13 |
| *Barometeric (mmHg):* | | | | | | | | | | |
| *Pressure (kPa):* | | | | | | | | | | |
| Conductivity (µS/cm): | | | | | | | | | | |
| RDO (ppm): (mg/L) | 13.00 | 13.03 | 13.06 | 13.08 | 13.05 | 12.98 | 12.91 | 12.85 | 12.76 | 12.69 |
| Turbidity (NTU): | | | | | | | | | | |
| ORP | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 160 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| **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 $CaCO_3$) | | | | | | | | | | 10-4000 mg/L as CaCO3 |
| 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 $NH_3$-N)**** | | | | | | | | | | 0.01-0.50 mg/L NH3- |
| Ammonia/ Iron dilution | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

Remarks: Sample taken from Raw Water tap. Supply is from L9312.

Field-Form Filled Out By: K. Holland Date: 9/9/07

QAQC Check By: A. Blackburn Date: 9/12/07

***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: MSBN-CT

Sample Purpose: **Lake Water Quality** Date: 10/25/06 Time: nr

**FIELD MEASUREMENTS**

GPS Coord. Northing: N70°19.280' Easting: W149°24.009' Datum: NAD83

Measurements By: DAR Time: nr

Water Depth (ft): n/a Ice Thickness (ft): n/a

Freeboard (ft): n/a Snow Depth (ft): n/a

Elev. (BPMSL +/- .02): 96.16 Survey By: MRL Date: 10/25/07 Time: nr

Water Sampling By: DAR 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 | PASS | PASS |

| **Parameters** | **Field Measurements** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time: | nr | nr | nr | nr | nr | nr | nr | nr | nr | nr |
| Depth BWS (ft): | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 35 | 35.7 |
| Temp (°C): | 0.16 | 0.15 | 0.17 | 0.18 | 0.20 | 0.23 | 0.29 | 0.61 | 0.87 | 0.9 |
| pH: | 8.12 | 8.14 | 8.10 | 8.10 | 8.10 | 8.09 | 8.09 | 8.02 | 7.86 | 7.81 |
| *Barometeric (mmHg):* | | | | | | | | | | |
| *Pressure (kPa):* | | | | | | | | | | |
| Conductivity (µS/cm): | | | | | | | | | | |
| RDO (ppm): (mg/L) | 12.65 | 12.62 | 12.60 | 12.56 | 12.55 | 12.51 | 12.46 | 12.04 | 9.82 | 9.51 |
| Turbidity (NTU): | | | | | | | | | | |
| ORP | 161 | 162 | 162 | 162 | 163 | 163 | 163 | 165 | 20 | -59 |
| | | | | | | | | | | |
| | | | | | | | | | | |

**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 $CaCO_3$) | | | | | | | | | | 10-4000 mg/L as CaCO3 |
| 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 $NH_3$-N)**** | | | | | | | | | | 0.01-0.50 mg/L NH3- |
| Ammonia/ Iron dilution | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

Remarks: Sample taken from Raw Water tap. Supply is from L9312.

Field-Form Filled Out By: K. Holland Date: 9/9/07

QAQC Check By: A. Blakcburn Date: 9/12/07

***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: MSB-MC1

Sample Purpose: **Lake Water Quality** Date: 10/25/07 Time: 19:32

**FIELD MEASUREMENTS**

GPS Coord. Northing: nr Easting: nr Datum: na

Measurements By: DAR Time: 19:32

Water Depth (ft): nr Ice Thickness (ft): nr

Freeboard (ft): nr Snow Depth (ft): nr

Elev. (BPMSL +/- .02): 96.15 Survey By: DAR/JED Date: 6/25/06 Time: nr

Water Sampling By: DAR 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 | PASS | PASS |

| **Parameters** | **Field Measurements** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time: | 19:32 | | | | | | | | | |
| Depth BWS (ft): | 2.5 | | | | | | | | | |
| Temp (°C): | -0.25 | | | | | | | | | |
| pH: | 7.36 | | | | | | | | | |
| *Barometeric (mmHg):* | 752.0 | | | | | | | | | |
| *Pressure (kPa):* | 6.760 | | | | | | | | | |
| Conductivity (µS/cm): | 207.7 | | | | | | | | | |
| RDO (ppm): (mg/L) | 8.18 | | | | | | | | | |
| Turbidity (NTU): | 1.1 | | | | | | | | | |
| ORP | 74 | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

**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 $CaCO_3$) | | | | | | | | | | Digital titrator 10-4000 mg/L as CaCO3 |
| 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 $NH_3$-N)**** | | | | | | | | | | 0.01-0.50 mg/L NH3-N |
| Ammonia/ Iron dilution | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

Remarks: MC1 is Milne Creek above junction with MSB.

Field-Form Filled Out By: A. Blackburn Date: 7/10/07

QAQC Check By: K. Holland Date: 9/6/07

***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: KDA2-T1 (1 of 2)

Sample Purpose: **Lake Water Quality** Date: 10/29/06 Time: 16:37

**FIELD MEASUREMENTS**

GPS Coord. Northing: N70° 20.011' Easting: W148° 56.365' Datum: NAD 83

Measurements By: DAR/JD Time: 16:37

Water Depth (ft): 18.9 Ice Thickness (ft): 0.8

Freeboard (ft): 0.1 Snow Depth (ft): no snow

Elev. (BPMSL): 97.32 Survey By: DAR/JED Date: 10/24/06 Time: 14:16

Water Sampling By: DAR/JD 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 | PASS | PASS |

| **Parameters** | **Field Measurements** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time: | 16:39 | 16:40 | 16:40 | 16:41 | 16:41 | 16:42 | 16:43 | 16:44 | 16:45 | 16:46 |
| Depth BWS (ft): | 2.0 | 3.0 | 4.0 | 5.0 | 7.0 | 9.0 | 11.0 | 13.0 | 15.0 | 16.0 |
| Temp (°C): | 0.12 | 0.12 | 0.14 | 0.14 | 0.16 | 0.16 | 0.17 | 0.19 | 0.24 | 0.28 |
| pH: | | | | | | | | | | |
| *Barometeric (mmHg):* | | | | | | | | | | |
| *Pressure (kPa):* | | | | | | | | | | |
| Conductivity (µS/cm): | 98.1 | 94.5 | 94.2 | 94.0 | 93.6 | 93.4 | 93.3 | 93.4 | 93.6 | 93.72 |
| RDO (ppm): (mg/L) | | | | | | | | | | |
| Turbidity (NTU): | -0.1 | -0.2 | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 | 0.0 | 0.00 |
| ORP | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

| **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 $CaCO_3$) | | | | | | | | | | Digital titrator 10-4000 mg/L as $CaCO_3$ |
| 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 $NH_3$-N)**** | | | | | | | | | | Hach spec 0.01-0.50 mg/L $NH_3$-N |
| Ammonia/ Iron dilution | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

Remarks: GWS In-Situ does not have pH and RDO probe

Field-Form Filled Out By: A. Blackburn Date: 7/11/07

QAQC Check By: A.Brown Date: 7/14/07

***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: KDA2-T1 (2 of 2)

Sample Purpose: **Lake Water Quality** Date: 10/29/06 Time: 16:37

**FIELD MEASUREMENTS**

GPS Coord. Northing: N70° 20.011' Easting: W148° 56.365' Datum: NAD 83

Measurements By: DAR/JD Time: 16:37

Water Depth (ft): 18.9 Ice Thickness (ft): 0.8

Freeboard (ft): 0.1 Snow Depth (ft): no snow

Elev. (BPMSL): 97.32 Survey By: DAR/JED Date: 10/24/06 Time: 14:16

Water Sampling By: DAR/JD 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 Trolle 9000 | 33033 | PASS | PASS |

| **Parameters** | **Field Measurements** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time: | 16:46 | 16:46 | 16:47 | 16:48 | | | | | | |
| Depth BWS (ft): | 17.0 | 18.0 | 19.0 | Bot | | | | | | |
| Temp (°C): | 0.36 | 0.49 | 0.98 | 1.01 | | | | | | |
| pH: | | | | | | | | | | |
| *Barometeric (mmHg):* | | | | | | | | | | |
| *Pressure (kPa):* | | | | | | | | | | |
| Conductivity (µS/cm): | 94.3 | 95.7 | 107.5 | 115.0 | | | | | | |
| RDO (ppm): (mg/L) | | | | | | | | | | |
| Turbidity (NTU): | -0.1 | 0.3 | 26.0 | -0.6 | | | | | | |
| ORP | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

**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 $CaCO_3$) | | | | | | | | | | Digital titrator 10-4000 mg/L as $CaCO_3$ |
| 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 $NH_3$-N)**** | | | | | | | | | | Hach spec 0.01-0.50 mg/L $NH_3$-N |
| Ammonia/ Iron dilution | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

Remarks: GWS In-Situ does not have pH and RDO probe

Field-Form Filled Out By: A. Blackburn Date: 7/11/07

QAQC Check By: A.Brown Date: 7/14/07

# 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: SRT

Sample Purpose: **Lake Water Quality**

**WATER QUALITY METER INFORMATION**

Meter Make: In-Situ Model: 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 | 10/19/06 | 0:05 | Oakton pH 4.01 | 240479 | Mar-06 | 4.04 @ 21.00 | Pass |
| pH 7.00 | 10/19/06 | 0:10 | In-Situ pH 7.00 | 531034-3 | Sep-06 | 7.02 @ 22.07 | Pass |
| pH 10.01 | 10/19/06 | 0:14 | In-Situ pH 10.01 | 531001-1 | Sep-06 | 9.91 @ 21.86 | Pass |
| ORP | 10/19/06 | 22:57 | In-Situ Quick-Cal | 9406B | Nov-06 | 244 @ 21.95 | Pass |
| 100% DO | 10/19/06 | 23:35 | Nanopure | --- | --- | 8.74 @ 21.30 | Pass |
| Zero DO | 10/19/06 | 23:47 | Hanna HI 7040 | 690 | Dec-06 | 0.0 @ 19.48 | Pass |
| Conductivity | 10/19/06 | 23:50 | Oakton 447uS | 2603492 | Mar-07 | 412.1 @ 21.07 | Pass |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

**Post-Sampling QA**

| Parameter | Date | Time | Standard | Lot No. | Exp. | Meter Reading | Pass/Fail |
|---|---|---|---|---|---|---|---|
| pH 4.01 | 10/23/06 | 19:19 | Oakton | 521202 | Nov-07 | 4.10 @ 15.62 | Pass |
| pH 7.00 | 10/23/06 | 19:19 | Oakton | 2512282 | Dec-07 | 7.22 @ 15.62 | Fail |
| ORP | 10/23/06 | 19:27 | In-Situ QuickCal | 9406B | Nov-06 | 240 @ 17.0 | Pass |
| 100% DO | 10/23/06 | 19:33 | Nanopure | --- | --- | 9.77 @ 16.4 | Pass |
| Zero DO | 10/23/06 | 19:42 | Hanna HI 746 | 690 | Dec-06 | 0.10 | Pass |
| Conductivity | 10/23/06 | 19:24 | Oakton 447uS | 2603492 | Mar-07 | 342.3 @ 16.4 | Pass |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Remarks: pH was recalibrated on Post cal check

Field-Form Filled Out By: A. Blackburn Date: 8/28/2007

QAQC Check By: K. Holland Date: 9/5/2007

*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: SRT

Sample Purpose: **Lake Water Quality**

**WATER QUALITY METER INFORMATION**

Meter Make: In-Situ Model: 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 | 10/23/06 | 19:19 | Oakton | 2512012 | Nov-07 | 4.04 @ 16.8 | Pass |
| pH 7.00 | 10/23/06 | 19:19 | Oakton | 2512282 | Dec-07 | 7.04 @ 16.5 | Pass |
| pH 10.01 | 10/23/06 | 19:21 | Oakton | 2512278 | Jun-07 | 10.01 @ 16.12 | Pass |
| ORP | 10/23/06 | 19:27 | In-Situ QuickCal | 9406B | Nov-06 | 240 @ 17.0 | Pass |
| 100% DO | 10/23/06 | 19:33 | Nanopure | --- | --- | 9.77 @ 16.4 | Pass |
| Zero DO | 10/23/06 | 19:42 | Hanna HI 746 | 690 | Dec-06 | 0.10 | Pass |
| Conductivity | 10/23/06 | 19:24 | Oakton 447uS | 2603492 | Mar-07 | 342.3 @ 16.4 | Pass |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

**Post-Sampling QA**

| Parameter | Date | Time | Standard | Lot No. | Exp. | Meter Reading | Pass/Fail |
|---|---|---|---|---|---|---|---|
| pH 4.01 | 10/26/06 | 9:44 | Oakton | 2512012 | Nov-07 | 4.09 @ 14.41 | Pass |
| pH 7.00 | 10/26/06 | 9:45 | Oakton | 2512282 | Dec-07 | 7.12 @ 14.50 | Pass |
| pH 10.01 | 10/26/06 | 9:47 | Oakton | 2512278 | Jun-07 | 10.12 @ 14.49 | Pass |
| ORP | 10/26/06 | 9:56 | In-Situ QuickCal | 9406B | Nov-06 | 249 @ 14.50 | Pass |
| 100% DO | 10/26/06 | 9:25 | Nanopure | --- | --- | 10.52 @ 14.07 | Pass |
| Zero DO | 10/26/06 | 9:34 | Hanna HI 746 | 690 | Dec-06 | 0.00 @ 13.35 | Pass |
| Conductivity | 10/26/06 | 9:48 | Oakton 447uS | 531284-15 | Apr-05 | 119.5 @ 14.69 | Pass |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Remarks:

Field-Form Filled Out By: A. Blackburn Date: 8/28/2007

QAQC Check By: A. Brown Date: 8/31/2007

# 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: Kuparuk Dead Arm

Survey Purpose: **Water-Level Elevations** Date: 10/24/2006 Time: 14:45

| Location: | Kuparuk Deadarm Reservoirs Cells 1, 2, 3, 4, 5 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Survey objective: | Lake water elevation survey | | | | | Weather Observations: | | |
| Instrument Type: | Leica NA720 | | Instrument ID: | 5482372 (GWS owned) | | 19 Degrees F, calm, overcast, flat light 1.5" of snow accumulation in last 24 hrs | | |
| 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) | | Dan Reichardt<br>Jeff Derry | | |
| TBM___ | nr | 100 Temp. | N70 20.045 NAD27 | W148 56.375 NAD27 | | | | |

| **Station** | **BS (ft)** | **HI (ft)** | **FS (ft)** | **Elevation (fasl)** | **Distance (ft)** | **Horizontal Angle** | **Vertical Angle** | **Remarks** |
|---|---|---|---|---|---|---|---|---|
| KDA2-SHB | 7.80 | 96.88 | | 89.08 | | | | Close within .00 |
| Shooting from ^5, KDA3 FWS=89.08 | | | | | | | | |
| KDA3-SH> | | 89.21 | 0.13 | 89.08 | | | | FWS |
| KDA3-SHC | | 95.99 | 6.78 | 89.21 | | | | TOI |
| KDA4-SHA | | 95.99 | | 85.83 | | | | TOI FB=0.00 |
| Use KDA4-SHA as TP, move to ^6 | | | | | | | | |
| KDA4-SHA | 9.35 | 95.18 | | 85.83 | | | | |
| TP1 | | 95.18 | 4.06 | 91.12 | | | | Close within 0.02 |
| Use TP1 as TP, move to ^7 | | | | | | | | |
| TP1 | 6.84 | 97.96 | | 91.12 | | | | |
| KDA3-SHC | | 97.96 | 8.73 | 89.23 | | | | Close to within 0.02 |
| Shooting from ^8, KDA4 FWS=85.83 | | | | | | | | |
| KDA5-SHA> | 6.68 | 92.51 | | **85.83** | | | | **KDA 5 Water Level** |
| KDA4-SHB> | | 92.51 | 6.68 | 85.83 | | | | |
| Use KDA4-SHB> as TP, move to ^9 | | | | | | | | |
| KDA4-SHB> | 7.14 | 92.97 | | **85.83** | | | | **KDA 4 Water Level** |
| KDA5-SHA> | | 92.97 | 7.15 | 85.82 | | | | Close to within 0.01 |
| | | | | | | | | |

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: Kuparuk Dead Arm

Survey Purpose: **Water-Level Elevations** Date: 10/24/2006 Time: 14:45

| Location: | Kuparuk Deadarm Reservoirs Cells 1, 2, 3, 4, 5 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Survey objective: | Lake water elevation survey | | | | | Weather Observations: | | |
| Instrument Type: | Leica NA720 | | Instrument ID: | 5482372 (GWS owned) | | 19 Degrees F, calm, overcast, flat light 1.5" of snow accumulation in last 24 hrs | | |
| 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) | | Dan Reichardt<br>Jeff Derry | | |
| TBM___ | nr | 100 Temp. | N70 20.045 NAD27 | W148 56.375 NAD27 | | | | |
| **Station** | **BS (ft)** | **HI (ft)** | **FS (ft)** | **Elevation (fasl)** | **Distance (ft)** | **Horizontal Angle** | **Vertical Angle** | **Remarks** |
| TBM___ | 0.00 | 100.00 | | 100.00 | | | | Survey begins at TBM ^1 |
| KDA3-SHA | | 100.00 | 10.72 | 89.29 | | | | TOI |
| KDA3-SHA> | | 89.29 | 0.21 | 89.08 | | | | FWS |
| KDA3-SHB | | 100.00 | 10.90 | 89.10 | | | | TOI |
| KDA3-SHB> | | 89.10 | 0.02 | **89.08** | | | | FWS<br>**KDA 3 Water** |
| KDA2-SHA | | 100.00 | 10.90 | 89.11 | | | | TOI |
| KDA2-SHA> | | 89.11 | 0.03 | **89.08** | | | | FWS<br>**KDA 2 Water** |
| Use KDA2-SHA as TP, move to ^2. | | | | | | | | |
| KDA2-SHA | 11.60 | 100.71 | | 89.11 | | | | |
| KDA3-SHB | | 100.71 | 11.62 | 89.09 | | | | Close within .01 |
| TBM___ | | 100.71 | 0.71 | 100.00 | | | | Close within .01 |
| Shooting from ^3, KDA2 FWS=89.08' | | | | | | | | |
| KDA2-SHB> | 0.00 | 89.08 | | 89.08 | | | | FWS |
| KDA2-SHB | | 97.32 | 8.24 | 89.08 | | | | TOI |
| KDA1-SHA | | 97.32 | 7.96 | 89.36 | | | | TOI |
| KDA1-SHA> | | 89.36 | 0.03 | 89.33 | | | | FWS |
| Use KDA1-SHA as TP, move to ^4 | | | | | | | | |
| KDA1-SHA | | 96.88 | 7.52 | **89.36** | | | | **KDA 1 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: 10/25/2006 Time: nr

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 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: | 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- | Longitude (ddd-mm.mmm) | | D. Reichardt, J. Derry | | |
| TBM___ | nr | 100 Temp. | na | na | | | | |
| **Station** | **BS (ft)** | **HI (ft)** | **FS (ft)** | **Elevation (fasl)** | **Distance (ft)** | **Horizontal Angle** | **Vertical Angle** | **Remarks** |
| TBM___ | 1.80 | 101.80 | | 100.00 | | | | Shooting from ^1 |
| MSBN-A> | | 101.80 | 5.64 | 96.16 | | | | |
| MSBS-A> | | 101.80 | 5.64 | 96.16 | | | | |
| Turn to MSBS-A>, shooting from ^2. | | | | | | | | |
| MSBS-A> | 5.67 | 101.83 | | 96.16 | | | | |
| MC1> | | 101.83 | 5.68 | 96.15 | | | | |
| MC2> | | 101.83 | 5.67 | 96.16 | | | | |
| MC3> | | 101.83 | 5.68 | 96.15 | | | | |
| MC40> | | 101.83 | 5.69 | 96.14 | | | | |
| Turn to MC40, shooting from ^3 | | | | | | | | |
| MC40> | 5.46 | 101.60 | | 96.14 | | | | TOI |
| WC1 | | 101.60 | 4.96 | 96.64 | | | | TOI |
| WC2 | | 101.60 | 5.22 | 96.38 | | | | TOI |

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: 10/25/2006 Time: nr

| 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: | 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) | | D. Reichardt, J. Derry | | |
| TBM___ | nr | 100 Temp. | na | na | | | | |

| **Station** | **BS (ft)** | **HI (ft)** | **FS (ft)** | **Elevation (fasl)** | **Distance (ft)** | **Horizontal Angle** | **Vertical Angle** | **Remarks** |
|---|---|---|---|---|---|---|---|---|
| WC3 | | 101.60 | 5.34 | 96.26 | | | | TOI |
| WC4 | | 101.60 | 5.43 | 96.17 | | | | TOI |
| WC5 | | 101.60 | 5.42 | 96.18 | | | | TOI |
| WC6 | | 101.60 | 5.41 | 96.19 | | | | TOI |
| WC7 | | 101.60 | 5.41 | 96.19 | | | | TOI |
| WC8 | | 101.60 | 5.41 | 96.19 | | | | TOI |
| WC9 | | 101.60 | 5.41 | 96.19 | | | | TOI |
| WC10 | | 101.60 | 5.42 | 96.18 | | | | TOI |
| WC11 | | 101.60 | 5.43 | 96.17 | | | | TOI |
| WC12 | | 101.60 | 5.4 | 96.20 | | | | TOI |
| WC13 | | 101.60 | 5.28 | 96.32 | | | | TOI |
| WC14 | | 101.60 | 4.90 | 96.70 | | | | TOI |
| MSBS-A> | | 101.60 | 5.44 | 96.16 | | | | TOI |

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: 10/25/2006 Time: nr

| 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: | 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) | | D. Reichardt, J. Derry | | |
| TBM___ | nr | 100 Temp. | na | na | | | | |
| **Station** | **BS (ft)** | **HI (ft)** | **FS (ft)** | **Elevation (fasl)** | **Distance (ft)** | **Horizontal Angle** | **Vertical Angle** | **Remarks** |
| WC-MD | 5.41 | 101.60 | | 96.19 | | | | |
| MSBN-A> | | 101.60 | 5.44 | 96.16 | | | | |
| TBM___ | | 101.60 | 1.61 | 99.99 | | | | |
| Move insturment to ^3, use TBM___ ASTP | | | | | | | | |
| TBM___ | | 103.09 | | 99.99 | | | | |
| MC50> | 6.95 | 103.09 | | 96.14 | | | | |
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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: L9312_PHT (pg 1 of 2)

Survey Purpose: **Water-Level Elevations** Date: 10/27/07 Time: 14:30

| Location: | L9312 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Survey objective: | Lake water elevation survey | | | | | Weather Observations: | | |
| Instrument Type: | Leica NA720 | Instrument ID: | 5482372 (GWS owned) | | | 15F 8mph North wind 20% cloud cover | | |
| 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, J. Derry | | |
| 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** |
| shooting from inst. 1 | | | | | | | | |
| TBM 39 "P" | 2.80 | 14.52 | | 11.72 | | | | SW corner of HSM in lake near pumphouse |
| TBM 39 "O" | | 14.52 | 3.13 | 11.39 | | | | Reads 0.07' low |
| PHT 2 | | 14.52 | 6.63 | 7.89 | | | | TOI |
| PHT 3 | | 14.52 | 6.35 | 8.17 | | | | puddle has dirt botom (frozen) |
| PHT 4 | | 14.52 | 6.60 | 7.92 | | | | TOI |
| PHT 5 | | 14.52 | 6.51 | 8.01 | | | | TOI |
| PHT 6 | | 14.52 | 6.21 | 8.31 | | | | puddle has dirt botom (frozen) |
| PHT 7 | | 14.52 | 6.28 | 8.24 | | | | TOI |
| PHT 8 | | 14.52 | 5.69 | 8.83 | | | | TOI |
| PHT 9 | | 14.52 | 5.75 | 8.77 | | | | TOI |
| PHT 10 | | 14.52 | 5.74 | 8.78 | | | | TOI |
| PHT 11 | | 14.52 | 5.64 | 8.87 | | | | TOI |
| PHT 12 | | 14.52 | 6.46 | 8.06 | | | | TOI |
| TP1 | | 14.52 | 5.94 | 8.58 | | | | |
| move instrument to inst. 2 TP1 as TP | | | | | | | | |
| TP1 | 4.54 | 13.12 | | 8.58 | | | | |
| L9312 OC | | 13.12 | 5.39 | 7.73 | | | | outlet control on North Shore. TOI |

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: L9312_PHT (pg 2 of 2)

Survey Purpose: **Water-Level Elevations** Date: 10/27/07 Time: 14:30

| Location: | L9312 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Survey objective: | Lake water elevation survey | | | | | Weather Observations: | | |
| Instrument Type: | Leica NA720 | Instrument ID: | 5482372 (GWS owned) | | | 15F 8mph North wind 20% cloud cover | | |
| 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, J. Derry | | |
| 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** |
| DSC 1 | | 13.12 | 5.49 | 7.63 | | | | |
| DSC 2 | | 13.12 | 5.65 | 7.47 | | | | |
| L9312SH_v | | 13.12 | 5.42 | **7.70** | | | | **L9312 Water Level** |
| SH-PH-mid_ice | | 13.12 | 5.38 | 7.74 | | | | |
| SH-PH-mid_v | | 13.12 | 5.42 | 7.70 | | | | |
| TBM "O" | | 13.12 | 1.65 | 11.47 | | | | |
| TBM"P" | | 13.12 | 1.40 | 11.72 | | | | |
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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 form reports 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: **Kuparuk Dead Arm**
Survey Purpose: **Snow Depth and Water Content** Date: 10/26/2006 Time: 11:30

| | | | | | |
|---|---|---|---|---|---|
| Location Description: | From KDA2-CT, snow course goes North 25m, west 25m. Depth in cm. North. | | | | |
| Survey objective: | Snow depths and snow-water content for lake recharge estimates | | | Weather Observations: | 15F, 7mph N. wind |
| Latitude: | nr | Longitude: | nr | Datum: | na |
| Elevation: | | Elevation Datum: | nr | 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: | | T-handle snow depth probe, | | Snow-Survey Team Names | |
| Snow Tube Type: | Adirondak, 6.74 cm diameter cutter, area = 35.7 cm^2 | | | D. Reichardt, J. Derry | |

Snow Course Depths, in cm.

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | 5.0 | 3.5 | 5.0 | 6.0 | 4.5 |
| 2 | 5.5 | 6.5 | 5.0 | 5.0 | 5.0 |
| 3 | 4.5 | 6.0 | 4.5 | 4.5 | 4.5 |
| 4 | 4.5 | 5.5 | 5.0 | 4.5 | 4.5 |
| 5 | 5.0 | 5.5 | 4.5 | 5.0 | 5.0 |
| 6 | 4.5 | 4.0 | 5.0 | 4.5 | 5.0 |
| 7 | 5.0 | 5.0 | 5.0 | 4.5 | 6.0 |
| 8 | 5.0 | 7.5 | 5.0 | 4.5 | 8.0 |
| 9 | 4.0 | 6.0 | 5.5 | 5.0 | 8.0 |
| 10 | 4.0 | 6.0 | 6.0 | 5.0 | 8.0 |

(cm)
Average snow depth = **5.2**
Maximum snow depth = 8.0
Minimum snow depth = 3.5
Standard variation = 1.0

Snow Sample Depths and Weights

| Bag # | Depth (cm) | Weight (gr) | Volume (cm^3) | Density (gr/cm^3) |
|---|---|---|---|---|
| | | | | |

Average Density =
Average Snow Water Equivalent (SWE) = _____ cm H2O
Average Snow Water Equivalent = _____ inches H2O
Average Snow Water Equivalent = _____ 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: 10/27/2007 | Time: 15:00 |

| | | | | | |
|---|---|---|---|---|---|
| Location Description: | Point 1 to 25 Proceeds North Point 25 to 50 Proceeds West 1 Meter Incrememts | | | | |
| Survey objective: | Snow depths and snow-water content for lake recharge estimates | | | Weather Observations: | nr |
| Latitude: | N 70º19.9444' | Longitude: | W 150º 57.047' | Datum: | NAD27 Alaska |
| Elevation: | | Elevation Datum: | BPMSL | Reference Markers: | Site marked with GPS |
| Drainage Basin: | L9312 | Slope Direction: | flat | Vegetation Type: | snow depth on ice 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^2 | | | D. Reichardt, J. Derry | |

Snow Course Depths, in cm.

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | 5.0 | 13.5 | 1.0 | 7.0 | |
| 2 | 4.5 | 7.0 | 8.5 | 5.0 | |
| 3 | 4.0 | 5.0 | 9.0 | 4.0 | |
| 4 | 6.0 | 5.5 | 7.0 | 10.0 | |
| 5 | 5.0 | 6.0 | 8.5 | 11.0 | |
| 6 | 3.0 | 5.5 | 10.0 | 11.5 | |
| 7 | 5.0 | 6.0 | 13.0 | 12.5 | |
| 8 | 9.0 | 8.0 | 18.0 | 15.0 | |
| 9 | 3.0 | 0.0 | 8.0 | 13.0 | |
| 10 | 1.0 | 3.0 | 8.0 | 11.0 | |

| | (cm) |
|---|---|
| Average snow depth = | **7.4** |
| Maximum snow depth = | 18.0 |
| Minimum snow depth = | 0.0 |
| Standard variation = | 4.0 |

Snow Sample Depths and Weights

| Bag # | Depth (cm) | Weight (gr) | Volume (cm^3) | Density (gr/cm^3) |
|---|---|---|---|---|
| | | | | |

Average Density =

Average Snow Water Equivalent (SWE) = _____ cm H2O

Average Snow Water Equivalent = _____ inches H2O

Average Snow Water Equivalent = _____ feet H2O

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