North Slope, Alaska, Snow-Course and Lake Survey Data: January 2010

Air temperature shields impacted with snow and surface hoar at Duck Island meteorological station, photo by Jeff Derry.

by

Jeff Murray, Jeff Derry, and Michael Lilly

February 2010

Arctic Transportation Networks Project

Report GWS.TR.10.01

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A report on research sponsored by:

- U.S. Department of Energy
- National Energy Technology Laboratory
- Alaska Department of Natural Resources
- ConocoPhillips Alaska, Inc.
- Bureau of Land Management
- Geo-Watersheds Scientific

February 2010

Arctic Transportation Networks Project

Report Number GWS.TR.10.01

[1]Geo-Watersheds Scientific, Fairbanks, AK

Recommended Citation:

Murray, J., Derry, J., and Lilly, M. 2010. North Slope, Alaska, Snow-Course and Lake Survey Data: January 2010. Geo-Watersheds Scientific, Report GWS.TR.10.01, Fairbanks, Alaska. 17 pp (plus appendices).

Fairbanks, Alaska
February 2010

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

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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 (mm)
mile (mi)	1.609	kilometer (km)
	Area	
Acre	43559.826	square feet (ft^2)
Acre	0.407	hectare (ha)
Square foot (ft^2)	2.590	square mile (mi^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
gallon (gal)	3785	milliliter (mL)
Cubic foot (ft^3)	23.317	liter (L)
Acre-ft	1233	cubic meter (m^3)
	Velocity and Discharge	
foot per day (ft/d)	0.3048	meter per day (m/d)
Square foot per day (ft^2/d)	.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)	0.00115	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. Common regulations related to tundra travel and water use on the North Slope, Alaska, uses combinations of both English and SI units. 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, snow depth was reported in inches (in) followed by the value in centimeters (cm) 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:

$$°F = 1.8(°C) + 32$$

Snow Water Equivalent (SWE):

Water content of a given column of snow is determined by knowing the depth of the snowpack and density.

$$SWE = d_s * \rho_s / p_w$$

where:

d_s = snow depth

ρ_s = snow density

p_w = density of water.

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
ADNR	Alaska Department of Natural Resources
ASTM	American Society for Testing and Materials
atm	Atmospheres
ATN	Arctic Transportation Networks
C	Celsius (^{o}C)
cm	Centimeters
DO	Dissolved oxygen
DVM	Digital voltage multi-meter
F	Fahrenheit (^{o}F)
ft	Feet
GWS	Geo-Watersheds Scientific
in	Inches
kg	Kilograms
km^2	Square kilometers
kPa	Kilopascal
lb/in^2	Pounds per square inch
m	Meters
mg/L	Milligrams per liter
µg/L	Micrograms per liter
mi^2	Square miles
mm	Millimeters
µS/cm	Microsiemens per centimeter
mV	Millivolt
NGVD	National Geodetic Vertical Datum
NRCS	Natural Resources Conservation Service
NWIS	National Water Information System
ORP	Oxygen-reduction potential
ppm	Parts per million
QA	Quality assurance
QC	Quality control
Sag	Sagavanirktok River
SC25	Specific conductance at 25°C
SWE	Snow water equivalent
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 Arctic Transportation Network project covers a large area of the North Slope and benefits from a number of positive partnerships, all contributing to the overall project objectives.

- U.S. Department of Energy, National Energy Technology Laboratory (NETL)
- ConocoPhillips Alaska, Inc. (CPA)
- Bureau of Land Management
- Alaska Department of Natural Resources
- The Nature Conservancy
- Northern Alaska Environmental Center
- North Slope Borough
- National Weather Service
- Geo-Watersheds Scientific
- University of Alaska-Fairbanks
- Idaho National Laboratory

ACKNOWLEDGEMENTS

This material is based upon work supported by the U.S. Department of Energy [National Energy and Technology Laboratory] under Award Number DE-FE0001240. Field coordination and logistics support were provided by ConocoPhillips Alaska. Additional support was provided by other project cooperators, North Slope Borough, Bureau of Land Management, National Weather Service, and Geo-Watersheds Scientific, in the form of financial and in-kind match. Alaska Department of Natural Resources provided data and supporting information for snow survey sites in the study area.

North Slope, Alaska, Snow-Course and Lake Survey Data: January 2010

INTRODUCTION

Geo-Watersheds Scientific (GWS), University of Alaska Fairbanks (UAF), and Idaho National Laboratory (INL), together with project cooperators, initiated a study in October 2009 to collect field data for the development of management tools for various aspects of Arctic Transportation Networks (ATN). Some of the variables collected include data from 10 meteorological and lake stations (such as snow-depth, air and soil temperatures, unfrozen soil moisture, precipitation, wind and radiation data). Data is also collected at selected lakes and reservoirs. Lake data may include snow depth and density data, water-quality and water-level measurements and general observations of watershed conditions.

Snow depth is considered an important variable by regulatory agencies, since tundra travel operations in the Coastal Tundra Area can only commence once a spatially consistent snow depth of 6 in (15 cm) in the coastal plain management areas, or 9 in (23 cm) in the Foothills management areas is maintained. Soil temperatures are also used to manage tundra travel. The soil temperature must reach 23° F (-5°C) at a depth of 12 in (30 cm) (Bader, 2004) to meet tundra travel management criteria. The intent of the soil temperature criteria is to ensure frozen soil strengths are adequate in terms of reaching maximum soil strength. Many meteorological factors determine when these conditions will be met. An established network of meteorological stations and increased manual snow measurements – both amount collected and number of sites visited – will improve the understanding of the timing and amount of snow distribution and will assist in the development of predictive and management tools.

TRIP OBJECTIVES

The January field effort was primarily focused on conducting snow-courses and verification of weather station operations. Snow sampling was performed at ATN project sampling sites as well as co-located with Alaska Department of Natural Resources (ADNR) sites (Figure 1 and Figure 2). New snow-course sites were visited along the ice road near Alpine, CD-3, and Colville River

vehicle crossing. Concurrent with these activities, Duck Island Meteorological site was visited with maintenance performed and data downloaded, and a new SR50 snow depth sensor was installed at L9312 meteorological station. Also, a successful snowmobile traverse to Cottle Island was completed which included general system maintenance. A workplan was published prior to the January field campaign containing a site-by-site list of objectives (Hilton et al. 2010). Project accomplishments include the following:

1. Toolik NRSC Climate Site and Toolik Lake
   - Conduct snow surveys.
   - Measure lake ice parameters on Toolik Lake.

2. Dalton Highway ADNR Sites
   - Conduct snow surveys at Sag River ADOT.
   - Conduct snow surveys at 318 Mile.
   - Conduct snow surveys at 62 Mile.
   - Conduct snow surveys at 30 Mile.

3. Kuparuk and Prudhoe Bay Units/Areas
   - Conduct snow courses at Betty Pingo, P-Pad, 2M-Pad, 2L-Pad, Meltwater (2P-Pad), UGNU, visit PALM 2, and 1J-Pad.
   - Conduct snow courses at UAF 411 and ANFO Pad.

4. Duck Island
   - Station inspection/maintenance; verify snow depth under SR50 snow sensors.
   - Download station data at Duck Island.

5. Alpine Ice Road
   - Selected snow course measurements along ice road route (Alpine 1- Alpine 4).

6. Alpine- L9312
   - Conduct snow courses on tundra and lake sites.
   - Lake ice measurements.
   - Station inspection/maintenance.
   - Install new SR50 snow sensor.

7. Cottle Island
   - Station O/M.

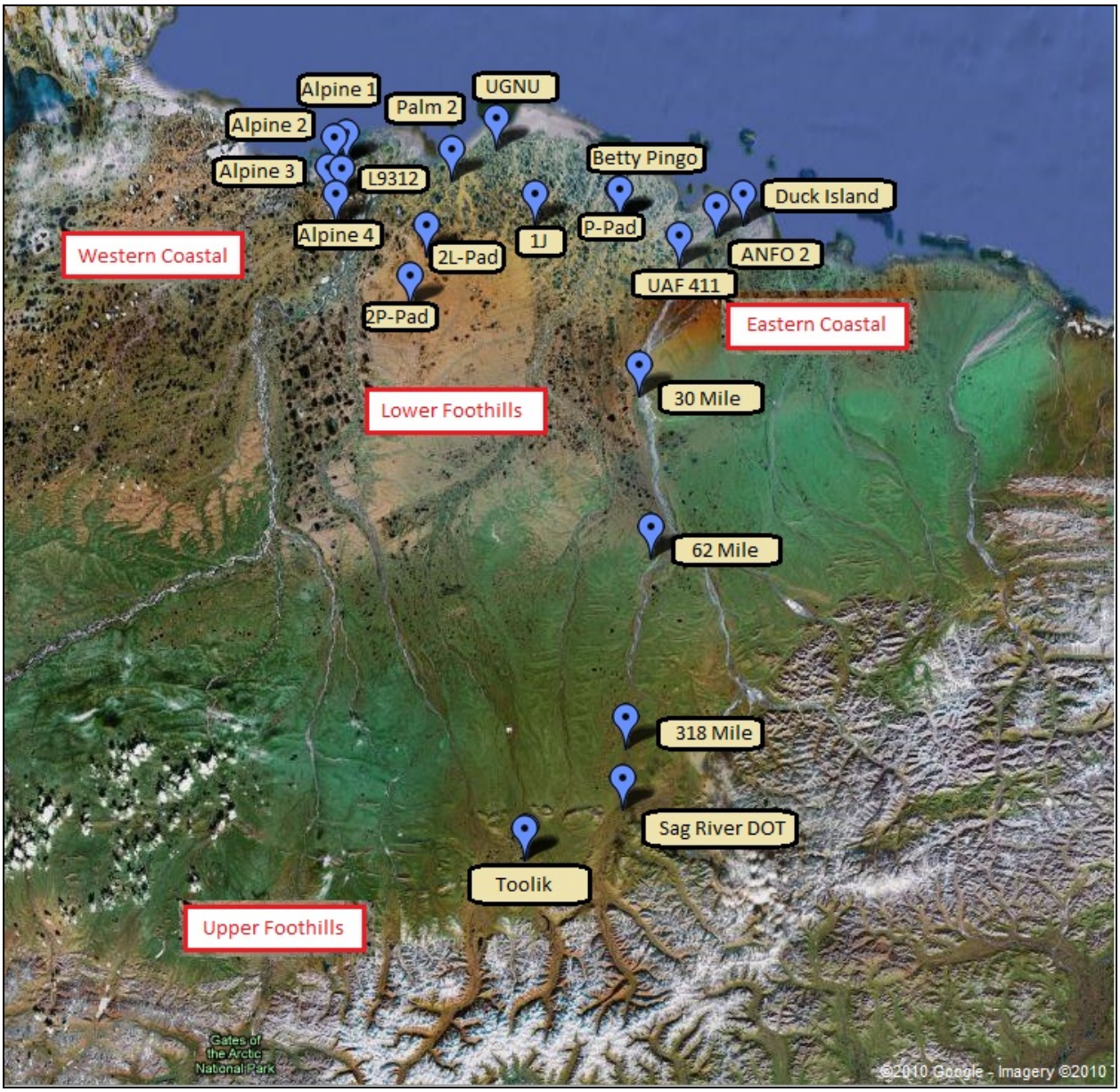

Figure 1. Snow-course locations visited in January 2010 by ATN personnel.

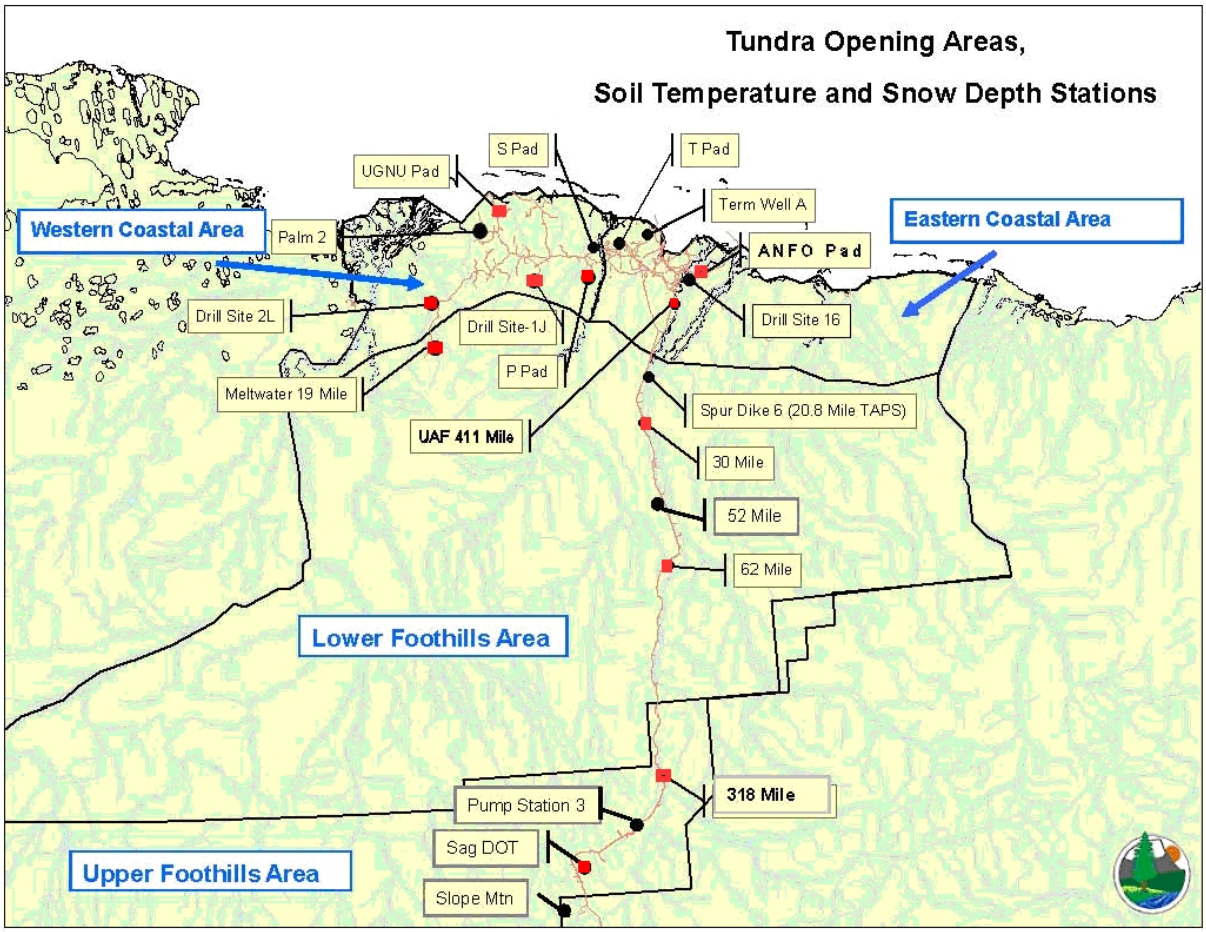

Figure 2. Map of ADNR snow and soil temperature sampling sites (ADNR, 2009). Sites marked in red were visited by ATN participants during the January field campaign to measure co-located snow-courses.

PROCEDURES

Snow-depth measurements were conducted in "L" shaped patterns on lake surfaces and/or tundra surfaces at predetermined locations according to ATN snow measurement methods (Derry et al. 2009). Snow-depth measurements were taken approximately every 3.3 ft (1 m) for 82 ft (25 m), then turning 90 degrees, and continuing for another 82 ft (25 m). Snow samples were also collected for density measurements with an Adirondack snow sampler. Five densities were collected at each location and averaged to establish a representative density. A number of sampling sites are co-located with ADNR snow and soil sampling sites to compare sampling methods. The ADNR method involves collecting 20 depth measurements along a transect spaced at 1.5 ft (0.5 m) increments and two density measurements collected with a Federal

Sampler (Derry et al. 2009). The intent of co-located sites is to provide data for ADNR and ATN project staff to compare measurement methods at representative sites.

At Lake L9312, a hole was drilled through the ice with a 2-inch diameter ice auger powered by a cordless drill. Physical measurements of depth (lake bottom to water surface), freeboard (water surface to top of ice), ice thickness (bottom of ice to top of ice), and snow depth (top of ice to top of snow, measured at the hole where snow was cleared to drill) were taken with a weighted flexible measuring tape. The same measurements were also recorded at Toolik Lake, but in this case, a 10-inch auger was used to drill through the ice.

SELECTED RESULTS

Snow courses were conducted at 20 different locations during the January trip. Eleven sites are co-located with ADNR sampling sites (Table 1).

Table 1. January snow sampling locations, locations in bold indicate site is co-located with ADNR snow and soil temperature sampling sites.

Station	Elevation Ft	North Latitude NAD 83	West Longitude NAD 83
Meltwater 19 (2P-Pad)	200	70° 03.853’	150° 26.779’
P-Pad	10	70° 16.967’	148° 54.807’
Sag River DOT	1,630	68° 45.686’	148° 52.746’
1J-Pad	82	70° 16.260'	149° 31.140'
2L-Pad	112	70° 11.481'	150° 19.397'
30 Mile	209	69° 50.333'	148° 45.461'
62 Mile	1,090	69° 25.320'	148° 40.140'
318 Mile	1,280	68° 55.328'	148° 51.004'
ANFO 2	27	70° 14.447'	148° 10.760'
UAF 411	78	70° 09.949'	148° 27.307'
UGNU	16	70° 27.480'	149° 48.540'
Alpine 1	2	70° 25.431'	150° 54.939'
Alpine 2	2	70° 24.564'	151° 00.601'
Alpine 3	2	70° 20.209'	151° 03.354'
Alpine 4	3	70° 16.164'	150° 59.820'
Betty Pingo (NRCS Site)	10	70° 16.772’	148° 53.741’
Duck Island	45	70° 16.206'	147° 59.265'
L9312 - Lake Surface	7	70° 20.008’	150° 57.083’
L9312 - Tundra Surface	7	70° 19.995’	150° 56.918’
NRCS Soil Monitoring Site (Toolik Camp)	2,362	68° 37.366’	149° 36.598’

Four select sites visited by ATN personnel (Meltwater 19 (2P-Pad), 2L-Pad, P-Pad, and Sag DOT) vary in snow accumulation compared to December measurements (Figure 3 & 6). A slight increase (~2.5 cm/1 in) in snow accumulation was measured at Meltwater 19 (2P-Pad), yet it is less than what ADNR reported near the same time in early January. An increase of approximately 5 cm (2 in) at 2L-Pad was measured. A decrease of 2.5 cm (1 in) is seen at P-Pad. Sag DOT showed a noticeable increase (~ 7cm /2.8 in) in snow depth compared to the previous month. More snow accumulation was seen at L9312 in the Alpine area to the west than at sample sites in the Kuparuk field area to the east (Table 2). The air temperatures were very cold the duration of the January trip with temperatures consistently near -40°C/-40°F all but the last 2 days. The cold and wind-compacted snowpack resulted in a person being able to walk on top of the snowpack a fair amount without falling through.

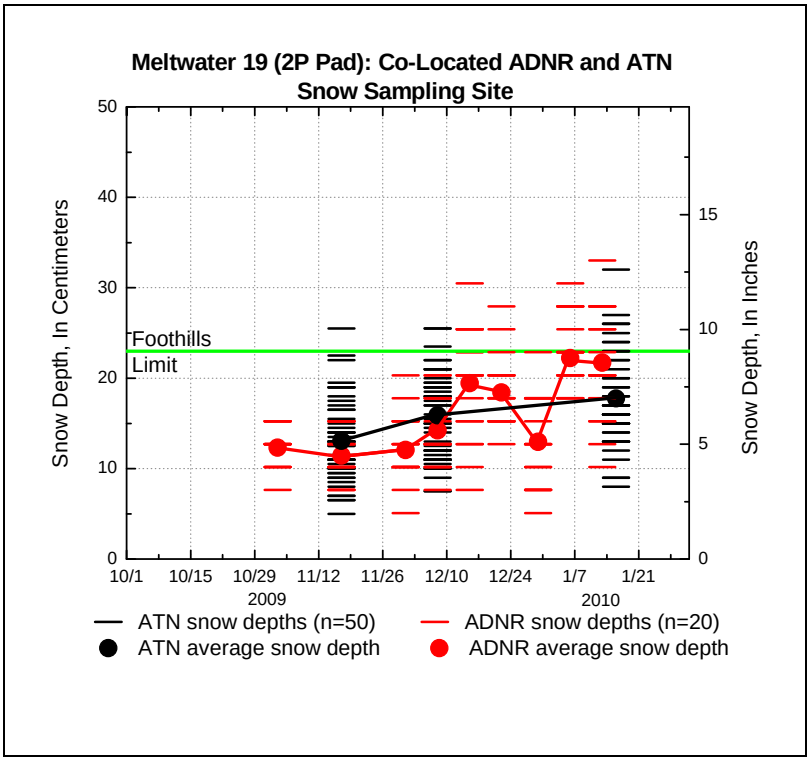

Figure 3. Snow depth comparison at Meltwater 19 (2P-Pad) located in the Lower Foothills Region, a co-located ADNR and ATN snow sampling site.

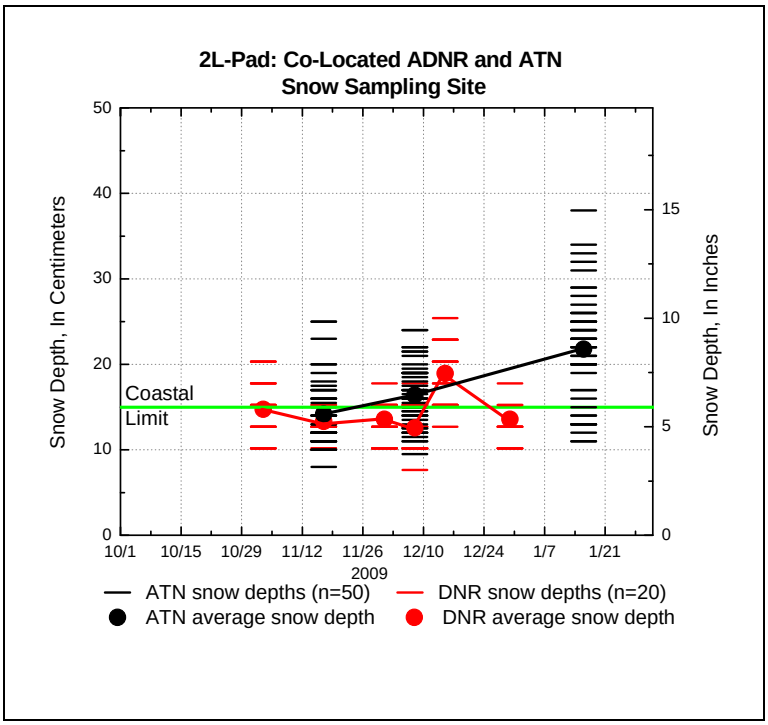

Figure 4. Snow depth comparison at 2L-Pad in the Western Coastal Region, a co-located ADNR and ATN snow sampling site.

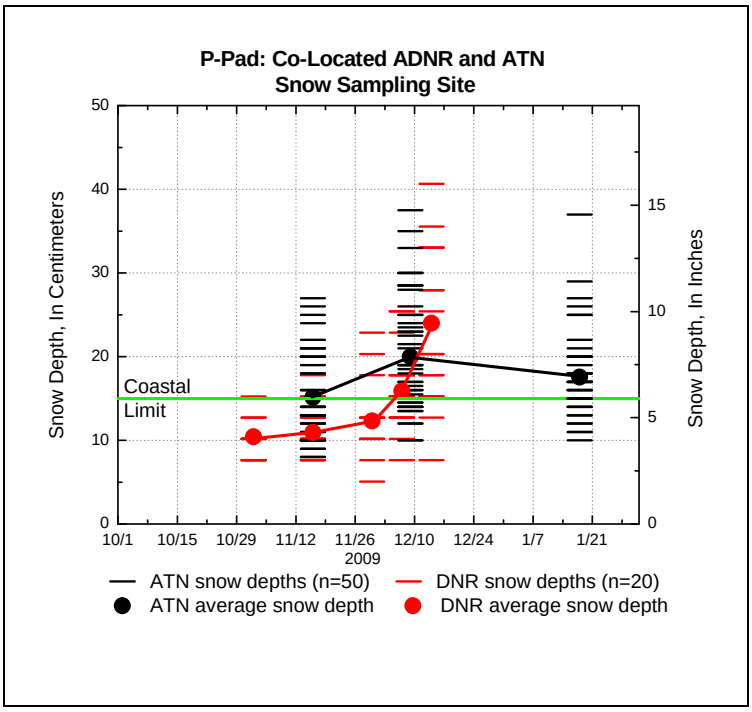

Figure 5. Snow depth comparison at P-Pad located in the Eastern Coastal Region, a co-located ADNR and ATN snow sampling site.

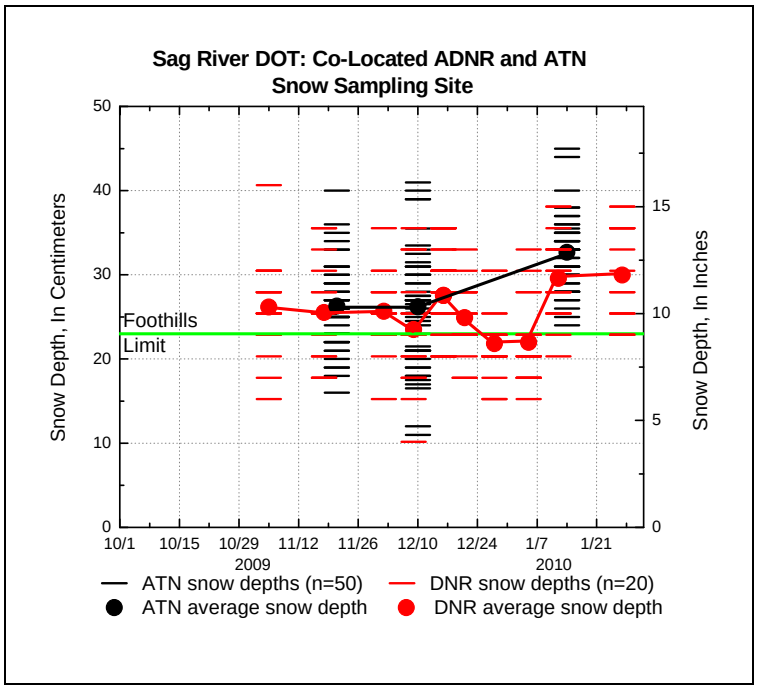

Figure 6. Snow depth comparison at Sag DOT located in the Upper Foothills Region, a co-located ADNR and ATN snow sampling site.

Once a region has been opened to tundra travel, ADNR generally does not continue snow sampling in that region. Thus, there are no reported snow depth values in the Eastern and Western Coastal regions from latter December through January (Table 3 & 5). Data collected by ADNR personnel in the Upper and Lower Foothills showed a steady increase in depth throughout the winter season (Table 3). ATN data collected in January on a regional basis, where field crews visited 2 of 4 ADNR sites in Upper Foothills, 3 of 5 sites in Lower Foothills, 3 of 5 sites in Western Coastal, 3 of 6 sites in Eastern Coastal, show a slight increase in snow depth in the Eastern and Western Coastal areas (Figure 7). ATN results in the Upper and Lower Foothills region show approximately 2.5 cm (1 in) greater snow depth and 4 cm (1.6 in) less snow depth, respectively, compared to ADNR results (Figure 7).

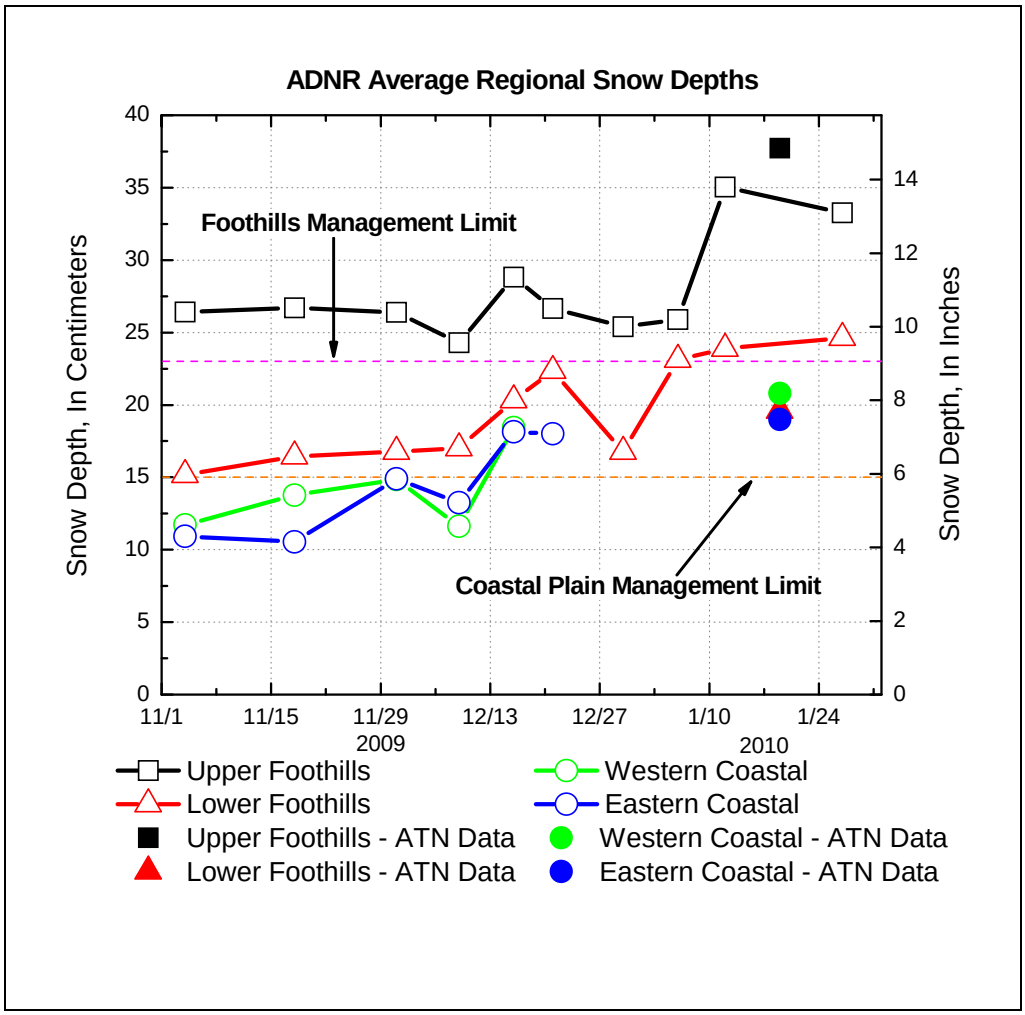

Figure 7. Regional average snow depth (snow depth average of all sites in each region) for ADNR field collection campaigns November 4 – January21, 2010 and ATN collection campaign in January 2010.

Table 2. Summary of snow depth, density and SWE values from sites visited by ATN personnel in January.

	ATN Snow Data Collected in January				
	Snow Depth		Density	SWE	
	cm	in	g/cm^3	cm	in
Eastern Coastal Area					
ANFO Pad	14.7	5.8	0.27	4.0	1.6
UAF 411 mi	24.8	9.8	0.30	7.4	2.9
P Pad	17.5	6.9	0.23	4.0	1.6
Duck Island	17.1	6.7	0.28	4.8	1.9
Betty Pingo	19.6	7.7	0.23	4.5	1.8
Area Averages	***18.7***	***7.4***	***0.26***	***4.9***	***1.9***
Western Coastal Area					
DS-1J	22.9	9.0	0.24	5.5	2.2
UGNU Pad	17.7	7.0	0.28	5.0	2.0
DS-2L (ASTAC)	21.8	8.6	0.30	6.5	2.6
L9312 - Tundra Surface	30.1	11.9	0.23	6.9	2.7
L9312 - Lake Surface	11.1	4.4	0.31	3.4	1.4
Alpine 1	25.7	10.1	0.27	6.9	2.7
Alpine 2	25.5	10.1	0.24	6.1	2.4
Alpine 3	16.4	6.5	0.22	3.6	1.4
Alpine 4	16.2	6.4	0.21	3.4	1.3
Area Averages	***20.8***	***8.2***	***0.26***	***5.3***	***2.1***
Lower Foothills Area					
30 Mile	12.4	4.9	0.26	3.2	1.3
62 Mile	28.7	11.3	0.20	5.7	2.3
Meltwater 19 (2-P Pad)	17.7	7.0	0.26	4.6	1.8
Area Averages	***19.6***	***7.7***	***0.24***	***4.5***	***1.8***
Upper Foothills Area					
318 Mile	42.8	16.8	0.19	8.1	3.2
Sag R. DOT	32.7	12.9	0.19	6.2	2.4
NRCS - Toolik	30.8	12.1	0.17	5.2	2.1
Area Averages	***35.4***	***13.9***	***0.18***	***6.5***	***2.6***

Table 3. Summary of average snow depth for measurements taken by ADNR at snow sampling sites from November 2, 2009 – January 29, 2010 (Empty cells are shown where no measurements were taken).

Snow Depth (in)										
	Nov 2-6	Nov 16-20	Nov30-Dec 4	Dec 7-11	Dec 14-18	Dec 19-23	Dec 28-31	Jan 4-8	Jan 11-13	Jan 26-29
Eastern Coastal Area										
ANFO Pad	2.1	3.0	4.1	3.4	6.6	6.1				
DS 16	5.7	5.4	6.9	5.9	8.7					
UAF 411 mi	4.3	4.5	9.7	7.1	6.7	7.2				
Term Well A	5.8	3.8	4.8	4.9	6.1	6.2				
P Pad	4.1	4.3	4.9	6.1	9.5					
T Pad	3.9	3.9	5.0	3.9	5.5	9.0				
Area Averages	***4.3***	***4.2***	***5.9***	***5.2***	***7.1***	***7.1***				
Western Coastal Area										
S Pad	4.1	5.5	5.3	4.0	6.3					
DS-1J	3.6	7.5	6.6	4.1	9.6					
UGNU Pad	4.3	4.1	4.9	4.1	6.5					
Palm 2	5.4	4.9	7.2	5.8	6.6					
DS-2L (ASTAC)	5.8	5.3	5.4	5.0	7.5		5.4			
Area Averages	***4.6***	***5.4***	***5.9***	***4.6***	***7.3***		***5.4***			
Lower Foothills Area										
SpurDike 6-20 Mi	4.0	7.1	5.3	3.9	5.5		4.8	7.3	7.4	8.8
30 Mile	2.8	3.5	4.6	4.5	4.8	6.2	2.8	6.2	7.3	6.3
52 Mile	9.3	8.8	9.6	11.9	13.2	12.5	10.8	11.9	14.0	14.3
62 Mile	9.1	8.6	8.8	7.8	9.0	9.2	9.8	11.3	9.8	9.5
Meltwater 19	4.9	4.5	4.8	5.6	7.7	7.3	5.1	8.8	8.6	
Area Averages	***6.0***	***6.5***	***6.6***	***6.7***	***8.0***	***8.8***	***6.6***	***9.1***	***9.4***	***9.7***
Upper Foothills Area										
318 Mile	12.2	12.8	13.3	11.9	14.4	14.2	14.0	13.9	17.2	16.6
Pump 3	9.9	10.8	9.5	10.3	12.0	10.8	10.1	10.8	15.9	14.2
Sag R. DOT	10.3	10.1	10.1	9.3	10.9	9.8	8.6	8.7	11.7	11.8
Slope Mountain	9.3	8.5	8.7	6.9	8.2	7.0	7.4	7.7	10.4	9.8
Area Averages	***10.4***	***10.5***	***10.4***	***9.6***	***11.4***	***10.5***	***10.0***	***10.2***	***13.8***	***13.1***

Table 4. Summary of average snow density for measurements taken by ADNR at snow sampling sites from November 2, 2009 – January 29, 2010 (Empty cells are shown where no measurements were taken).

Snow Density (g/cm^3)										
	Nov 2-6	Nov 16-20	Nov30 –Dec4	Dec 7-11	Dec 14-18	Dec 19-23	Dec 28-31	Jan 4-8	Jan 11-13	Jan 26-29
Eastern Coastal Area										
ANFO Pad		0.40	0.24	0.34	0.32	0.34				
DS 16	0.35	0.45	0.34	0.31	0.32					
UAF 411 mi	0.20	0.24	0.28	0.33	0.25	0.34				
Term Well A	0.26	0.21	0.23	0.25	0.24	0.24				
P Pad	0.19	0.23	0.13	0.28	0.30					
T Pad	0.23	0.30	0.23	0.14	0.33	0.29				
Area Averages	***0.24***	***0.30***	***0.24***	***0.27***	***0.29***	***0.30***				
Western Coastal Area										
S Pad		0.39	0.19	0.19	0.24					
DS-1J	0.19	0.29	0.45	0.28	0.35					
UGNU Pad	0.29	0.28	0.37	0.20	0.36					
Palm 2	0.25	0.21	0.32	0.28	0.22					
DS-2L (ASTAC)	0.19	0.21	0.20	0.25	0.23		0.21			
Area Averages	***0.23***	***0.28***	***0.30***	***0.24***	***0.28***		***0.21***			
Lower Foothills Area										
SpurDike 6-20 Mi	0.23	0.29	0.25	0.24	0.26			0.30	0.22	0.27
30 Mile		0.15	0.18	0.22	0.27	0.21	0.20	0.18	0.20	0.28
52 Mile	0.20	0.15	0.18	0.24	0.22	0.21	0.17	0.23	0.19	0.28
62 Mile	0.20	0.19	0.21	0.24	0.21	0.16	0.22	0.23	0.30	0.26
Meltwater 19	0.13	0.19	0.30	0.27	0.24	0.30	0.25	0.30	0.29	
Area Averages	***0.19***	***0.20***	***0.22***	***0.24***	***0.24***	***0.22***	***0.21***	***0.25***	***0.24***	***0.27***
Upper Foothills Area										
318 Mile	0.21	0.22	0.21	0.19	0.23	0.23	0.24	0.13	0.21	0.21
Pump 3	0.22	0.22	0.24	0.25	0.20	0.25	0.25	0.27	0.13	0.22
Sag R. DOT	0.24	0.23	0.25	0.22	0.26	0.30	0.23	0.27	0.20	0.28
Slope Mountain	0.14	0.21	0.21	0.21	0.13	0.18	0.17	0.24	0.18	0.30
Area Averages	***0.20***	***0.22***	***0.23***	***0.22***	***0.20***	***0.24***	***0.22***	***0.23***	***0.18***	***0.25***

Table 5. Summary of average SWE for measurements taken by ADNR at snow sampling sites from November 2, 2009 – January 29, 2010 (Empty cells are shown where no measurements were taken).

Snow Water Equivalent (in)										
	Nov 2-6	Nov 16-20	Nov 30-Dec 4	Dec 7-11	Dec 14-18	Dec 19-23	Dec 28-31	Jan 4-8	Jan 11-13	Jan 26-29
Eastern Coastal Area										
ANFO Pad		1.2	1.0	1.1	2.4	2.1				
DS 16	2.1	3.3	2.4	2.0	3.2					
UAF 411 mi	0.9	1.5	2.2	2.9	1.6	2.9				
Term Well A	2.2	0.8	1.1	1.3	1.2	1.1				
P Pad	0.9	0.9	0.6	1.8	2.8					
T Pad	1.1	1.4	1.2	0.7	3.2	2.2				
Area Averages	***1.4***	***1.5***	***1.4***	***1.6***	***2.4***	***2.0***				
Western Coastal Area										
S Pad		2.3	0.9	0.9	1.3					
DS-1J	0.8	2.3	4.4	1.2	3.7					
UGNU Pad	1.3	1.3	2.6	0.9	2.7					
Palm 2	1.5	1.1	2.0	1.6	1.4					
DS-2L (ASTAC)	1.3	1.3	1.3	1.2	1.6		0.9			
Area Averages	***1.2***	***1.6***	***2.2***	***1.2***	***2.1***		***0.9***			
Lower Foothills Area										
SpurDike 6-20 Mi	1.0	1.7	1.4	1.5	1.7			2.5	1.3	2.0
30 Mile		0.6	1.1	0.9	1.0	1.1	0.6	1.6	1.6	1.5
52 Mile	1.8	1.4	1.8	3.1	3.2	2.7	1.9	2.6	2.2	4.3
62 Mile	1.8	1.5	1.3	2.1	1.6	1.4	2.0	2.4	2.6	2.7
Meltwater 19	0.8	1.0	2.3	1.5	1.2	1.8	1.2	2.5	2.7	
Area Averages	***1.4***	***1.2***	***1.6***	***1.8***	***1.7***	***1.7***	***1.4***	***2.3***	***2.0***	***2.6***
Upper Foothills Area										
318 Mile	2.6	2.7	2.9	2.4	3.2	2.7	3.0	2.0	3.4	3.1
Pump 3	2.2	2.4	2.0	2.5	2.1	2.6	2.3	3.7	1.7	3.2
Sag R. DOT	2.4	2.0	1.6	2.8	2.8	2.8	2.0	2.3	2.3	3.0
Slope Mountain	1.2	1.3	1.5	1.7	1.0	1.2	1.0	1.2	1.7	2.6
Area Averages	***2.1***	***2.1***	***2.0***	***2.3***	***2.3***	***2.3***	***2.0***	***2.3***	***2.3***	***3.0***

Figure 8 shows a comparison of snow densities measured at sites visited by both ATN and ADNR over the span of three months, November 2009 – January 2010. Many density averages from both groups were between 0.2 and 0.3 g/cm³ during those months. Most density averages were between 0.15 and 0.4 g/cm³. In November, ATN's measurements were higher, while ADNR's densities were higher in December. In January, however, there was a wide range of densities found at the five co-located sites. Despite these differences, the densities all remained within about 0.05 g/cm³ of each other. Considering all of the outside variables, such as collection technique and weather factors, the slight differences are not surprising.

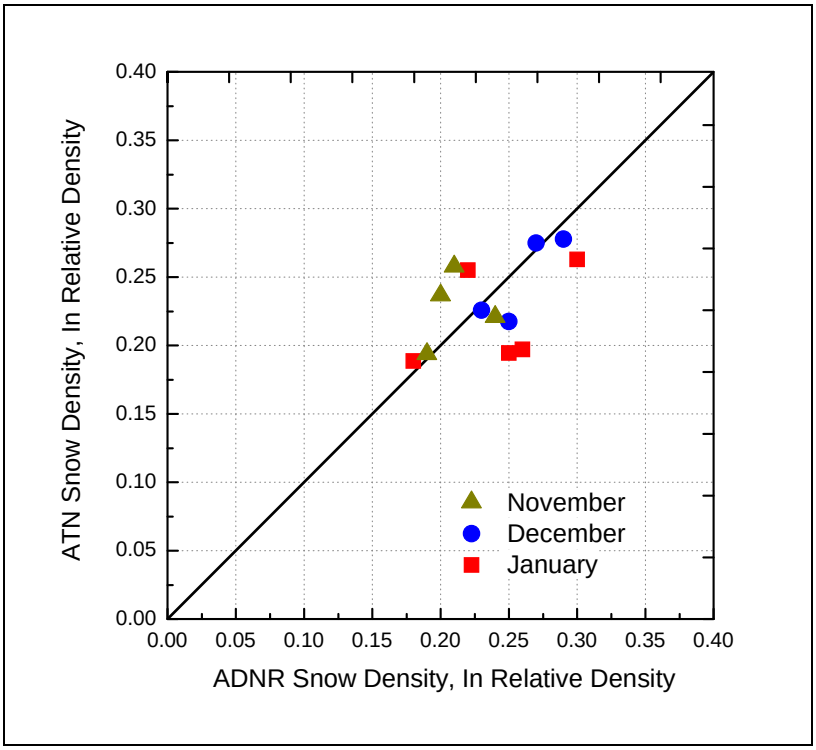

Figure 8. Comparison plot between ATN and ADNR snow density measurements for co-located sites from November 2009 – January 2010.

The December data report (Derry et al, 2010) noted that the ATN measurements were all greater than ADNR's snow depth recordings taken in December 2009. After plotting the data, as shown in Figure 9, that trend did not continue in January 2010. While there were even greater differences in depth measurements found at most locations in January than in December, neither group tended to record greater depths than the other.

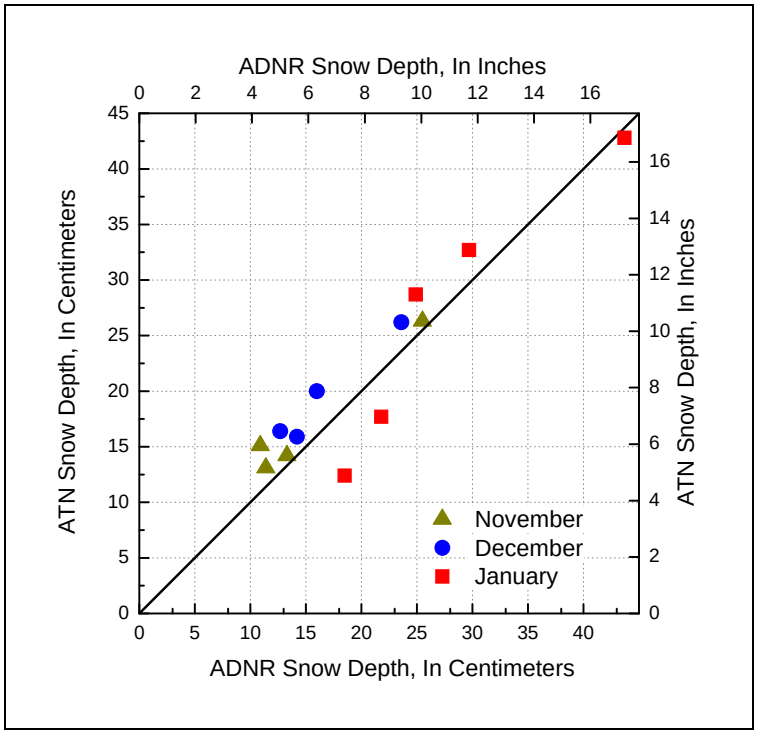

Figure 9. Comparison plot between ATN and ADNR snow depth measurements for co-located sites from November 2009 – January 2010.

The trend of the water level at Lake L9312 continued into 2010. Figure 10 shows a noticeable drop in lake level from December, but the lake level is still higher than it was in January 2009. The December data report (Derry et al, 2010) made the same observation of being at a higher level than the previous year. Despite the drop in lake height, the level is approximately the same as in January 2007.

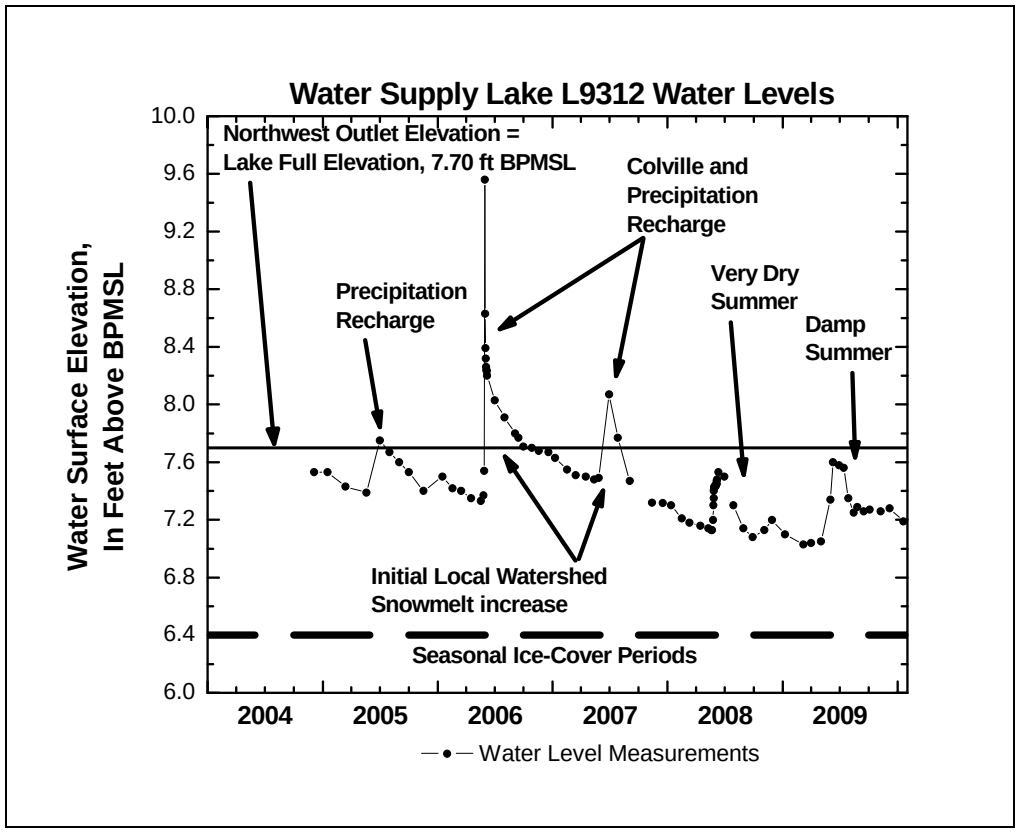

Figure 10. Plot of water level at L9312 through January 19, 2010.

SUMMARY

During the January ATN trip, we visited and repaired meteorological stations, including Cottle Island meteorological station. New snow-course sites were sampled in the Alpine operating area along the ice road. Cold temperatures with brisk winds prevailed during the ten day trip. Snow-depth values increased in the Upper and Lower Foothills and slightly increased in the Coastal Regions. Snow depths were greater in the Alpine area than in the Kuparuk area. The paired snow course measurements - in terms of depth and density - compare well between the ATN project and ADNR. Water levels are higher this January at L9312 than the previous year. The collection of snow and lake information related to Arctic transportation networks will help the development of regulatory and user management tools and forecast modeling tools. These tools will help with the increasing development of resources and variation of natural conditions in these extreme Arctic climates.

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APPENDIX A. SNOW SURVEY FORMS

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

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**ADNR J-Pad**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 1/16/2010	Time: 15:34

Location Description:	East of road before 1J-Pad, near soil thermistors. GWS measures to right (as looking at bore tube from road) and DNR measures to left.				
Survey objective:	Co-located snow survey site with DNR sampling site, tundra travel studies and management			Weather Observations	Cold (-25), breezy, dark
Latitude:	N 70° 16.260'	Longitude:	W 149° 31.140'	Datum:	NAD83
Elevation:	82 ft	Elevation Datum:	NGVD29	Reference Markers:	Black PVC Pipe
Drainage Basin:	Unnamed stream east of Ugnuravik River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	hard snow surface, wind not moving snow
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	18.0	27.0	16.0	22.0	35.0
2	15.0	20.0	18.0	23.0	31.0
3	16.0	22.0	18.0	17.0	31.0
4	15.0	26.0	29.0	19.0	23.0
5	16.0	19.0	31.0	14.0	26.0
6	16.0	16.0	35.0	13.0	26.0
7	11.0	23.0	32.0	28.0	23.0
8	19.0	24.0	25.0	34.0	21.0
9	22.0	24.0	26.0	33.0	22.0
10	28.0	13.0	21.0	37.0	26.0

	(cm)
Average snow depth =	**22.9**
Maximum snow depth =	37.0
Minimum snow depth =	11.0
Standard deviation =	6.6

	(inches)
Average snow depth =	**9.0**
Maximum snow depth =	**14.6**
Minimum snow depth =	**4.3**
Standard deviation =	**2.6**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
BL(5)	26	250.4	928.2	0.27	
:) 5	20	146.5	714.0	0.21	
E5	20	208.3	714.0	0.29	
B4	24	208.6	856.8	0.24	
BL(1)	18	119.2	642.6	0.19	

Average Density =	**0.239**	
Average Snow Water Equivalent (SWE) =	**5.5**	cm H2O
Average Snow Water Equivalent =	**2.16**	inches H2O
Average Snow Water Equivalent =	**0.18**	feet H2O

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

Data entered by: Jeff Murray Date: 1/17/2010

Data QA/QC by: Jeff Derry Date: 1/17/2010

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**ADNR 2L-Pad**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 1/16/2010	Time: 15:34

Location Description:	West of road between 2L-Pad and 2N-Pad, near soil thermistors. GWS measures to right (as looking at bore tube from road) and DNR measures to left.				
Survey objective:	Co-located snow survey site with DNR sampling site, tundra travel studies and management			Weather Observations	Cold (-25), strong breeze
Latitude:	N 70° 11.481'	Longitude:	W 150° 19.397'	Datum:	NAD83
Elevation:	112 ft	Elevation Datum:	NGVD29	Reference Markers:	Just northeast of weather station
Drainage Basin:	Miluveach River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	hard surface snow layer, wind not moving snow
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	11.0	24.0	13.0	22.0	20.0
2	13.0	28.0	12.0	24.0	14.0
3	14.0	34.0	16.0	20.0	21.0
4	14.0	22.0	25.0	13.0	24.0
5	23.0	20.0	24.0	29.0	26.0
6	25.0	20.0	32.0	26.0	23.0
7	21.0	17.0	38.0	25.0	29.0
8	25.0	33.0	31.0	20.0	26.0
9	19.0	17.0	27.0	15.0	22.0
10	13.0	23.0	23.0	11.0	22.0

	(cm)
Average snow depth =	**21.8**
Maximum snow depth =	38.0
Minimum snow depth =	11.0
Standard deviation =	6.4

	(inches)
Average snow depth =	**8.6**
Maximum snow depth =	**15.0**
Minimum snow depth =	**4.3**
Standard deviation =	**2.5**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
ZOE1	18	120.2	642.6	0.19	
Z5	14	252.5	499.8	0.51	
ZOE3	32	315.0	1142.4	0.28	
B1	17	140.1	606.9	0.23	
Z4	27	287.3	963.9	0.30	

Average Density =	**0.299**	
Average Snow Water Equivalent (SWE) =	**6.5**	cm H2O
Average Snow Water Equivalent =	**2.57**	inches H2O
Average Snow Water Equivalent =	**0.21**	feet H2O

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

Data entered by: Jeff Murray Date: 1/17/2010

Data QA/QC by: Jeff Derry Date: 1/17/2010

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**ADNR 2P-Pad**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 1/16/2010	Time: 14:18

Location Description:	West of road to 2P-Pad, North of 2P Pad, North of soil thermistors. GWS measures to right (as looking at bore tube from road) and DNR measures to left.				
Survey objective:	Co-located snow survey site with DNR sampling site, tundra travel studies and management			Weather Observations:	Cold (-25 F), strong breeze
Latitude:	N 70° 03.853'	Longitude:	W 150° 26.779'	Datum:	NAD83
Elevation:	200 ft	Elevation Datum:	NGVD29	Reference Markers:	none
Drainage Basin:	Kachemach River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	hard surface layer, top of grassy vegetation visible
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	15.0	25.0	14.0	20.0	32.0
2	15.0	13.0	15.0	26.0	17.0
3	22.0	15.0	16.0	18.0	21.0
4	13.0	19.0	13.0	14.0	17.0
5	9.0	26.0	8.0	16.0	24.0
6	23.0	17.0	23.0	26.0	27.0
7	15.0	16.0	13.0	17.0	20.0
8	22.0	23.0	18.0	16.0	15.0
9	12.0	16.0	16.0	16.0	19.0
10	11.0	14.0	9.0	24.0	16.0

	(cm)
Average snow depth =	**17.7**
Maximum snow depth =	32.0
Minimum snow depth =	8.0
Standard deviation =	5.1

	(inches)
Average snow depth =	**7.0**
Maximum snow depth =	**12.6**
Minimum snow depth =	**3.1**
Standard deviation =	**2.0**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
D2	25	240.9	892.5	0.27	
D3	10	69.6	357.0	0.19	
J2	23	254.5	821.1	0.31	
J5	8	56.4	285.6	0.20	
FB3	10	122.0	357.0	0.34	

Average Density =	**0.263**	
Average Snow Water Equivalent (SWE) =	**4.7**	cm H2O
Average Snow Water Equivalent =	**1.84**	inches H2O
Average Snow Water Equivalent =	**0.15**	feet H2O

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

Data entered by: Jeff Murray Date: 1/17/10
Data QA/QC by: Jeff Derry Date:1/17/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**30 Mile**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 1/17/2010	Time: 18:18

Location Description:	Near the black PVC pipe. GWS stays to right (as looking at the pipe) and DNR stays left.				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations	Dark, Cold, slight breeze
Latitude:	N 69° 50.337'	Longitude:	W 148° 45.458'	Datum:	NAD 83
Elevation:	209 ft	Elevation Datum:	NGVD29	Reference Markers:	Black PVC Pipe
Drainage Basin:	Sagavanirktok River	Slope Direction:	Flat	Vegetation Type:	Upland Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	strong surface layer, grassy vegetation visible, dark
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	7.0	28.0	18.0	12.0	18.0
2	8.0	16.0	19.0	12.0	13.0
3	11.0	9.0	12.0	10.0	11.0
4	2.0	10.0	10.0	10.0	21.0
5	16.0	9.0	10.0	14.0	20.0
6	4.0	11.0	2.0	17.0	21.0
7	3.0	7.0	11.0	8.0	24.0
8	10.0	6.0	11.0	14.0	25.0
9	13.0	6.0	10.0	14.0	11.0
10	12.0	13.0	12.0	17.0	14.0

	(cm)
Average snow depth =	**12.4**
Maximum snow depth =	28.0
Minimum snow depth =	2.0
Standard deviation =	5.6

	(inches)
Average snow depth =	**4.9**
Maximum snow depth =	**11.0**
Minimum snow depth =	**0.8**
Standard deviation =	**2.2**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
JM1	9	58.8	321.3	0.18	
JM2	20	234.5	714.0	0.33	
JM3	21	193.0	749.7	0.26	
JM4	17	200.7	606.9	0.33	
JM5	12	75.3	428.4	0.18	

Average Density =	**0.255**	
Average Snow Water Equivalent (SWE) =	**3.2**	cm H2O
Average Snow Water Equivalent =	**1.25**	inches H2O
Average Snow Water Equivalent =	**0.10**	feet H2O

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

Data entered by: Jeff Murray Date: 1/18/2010

Data QA/QC by: Jeff Derry Date: 1/18/2010

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**ADNR 318 Mile**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 1/14/2010	Time: 18:30

Location Description:	Off of Dalton Highway. Near PVC pipe. GWS stays to right (as looking at the pipe) and DNR stays left.				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations:	Cold (-40 F), Dark, Calm
Latitude:	N 68° 55.328'	Longitude:	W 148° 51.004'	Datum:	NAD 83
Elevation:	1,280 ft	Elevation Datum:	NGVD29	Reference Markers:	Black PVC Pipe
Drainage Basin:	Sagavanirktok River	Slope Direction:	Gently sloping to east	Vegetation Type:	Woody brush, Upland Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Deeper Snow, 40-50cm. Not wind blown, fluffy
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	44.0	35.0	53.0	48.0	44.0
2	39.0	37.0	51.0	42.0	43.0
3	40.0	39.0	53.0	48.0	41.0
4	49.0	54.0	50.0	35.0	43.0
5	48.5	36.0	53.0	43.0	39.0
6	42.0	34.0	46.0	45.0	42.0
7	37.0	46.0	37.0	45.0	34.0
8	32.0	41.0	29.0	44.0	40.0
9	39.0	48.0	46.0	43.0	34.0
10	45.0	50.0	43.0	45.0	44.0

	(cm)
Average snow depth =	**42.8**
Maximum snow depth =	54.0
Minimum snow depth =	29.0
Standard deviation =	5.9

	(inches)
Average snow depth =	**16.8**
Maximum snow depth =	**21.3**
Minimum snow depth =	**11.4**
Standard deviation =	**2.3**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
ZOE5	48	329.4	1713.6	0.19	
ZOE2	46	338.0	1642.2	0.21	
ZOE4	50	317.7	1785.0	0.18	
Z1	41	291.0	1463.7	0.20	
E4	34	205.1	1213.8	0.17	

Average Density =	**0.189**	
Average Snow Water Equivalent (SWE) =	**8.1**	cm H2O
Average Snow Water Equivalent =	**3.18**	inches H2O
Average Snow Water Equivalent =	**0.26**	feet H2O

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

Data entered by: Jeff Derry Date: 1/15/10
Data QA/QC by: Jeff Murray Date: 1/15/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**ADNR 62 Mile**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 1/14/2010	Time: 19:40

Location Description:	Off of Dalton Highway, top of ridge, east side of highway.				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations:	Cold (-40 F), Dark, Windy
Latitude:	N 69° 25.320'	Longitude:	W 148° 40.140'	Datum:	NAD 83
Elevation:	1,090 ft	Elevation Datum:	NGVD29	Reference Markers:	Stakes in ground
Drainage Basin:	Toolik River	Slope Direction:	Ridge Top	Vegetation Type:	Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Cold, shallow, wind blown snowpack
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	25.0	32.0	30.0	24.0	32.0
2	24.0	26.0	22.0	36.0	31.0
3	28.0	21.0	19.0	26.0	40.0
4	37.0	26.0	26.0	37.0	32.0
5	29.0	30.0	22.0	20.0	30.0
6	26.0	34.0	29.0	31.0	32.0
7	26.0	30.0	27.0	9.0	28.0
8	29.0	24.0	28.0	28.0	23.0
9	30.0	31.0	30.0	29.0	37.0
10	43.0	30.0	27.0	31.0	36.0

	(cm)
Average snow depth =	**28.7**
Maximum snow depth =	43.0
Minimum snow depth =	9.0
Standard deviation =	5.8

	(inches)
Average snow depth =	**11.3**
Maximum snow depth =	**16.9**
Minimum snow depth =	**3.5**
Standard deviation =	**2.3**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
mr	22	189.1	785.4	0.24	
mm	25	181.6	892.5	0.20	
me	21	110.9	749.7	0.15	
ma	14	93.3	499.8	0.19	
mu	25	184.3	892.5	0.21	

Average Density =	**0.197**	
Average Snow Water Equivalent (SWE) =	**5.6**	cm H2O
Average Snow Water Equivalent =	**2.22**	inches H2O
Average Snow Water Equivalent =	**0.19**	feet H2O

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

Data entered by: Jeff Derry Date: 1/15/10
Data QA/QC by: Jeff Murray Date: 1/15/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN**	Site Location/Lake ID:	**Alpine 1**
Survey Purpose:	**Determine snow depth, SWE**	Date: 1/19/2010	Time: 16:20

Location Description:	Along Alpine ice road. Proposed snow depth sampling location northeast of road.				
Survey objective:	Determine snow depth and density for application to lake recharge studies, and tundra travel management.			Weather Observations	Very Cold (-40s), Light Breeze, Light
Latitude:	N 70° 25.383'	Longitude:	W 150° 54.944'	Datum:	NAD 83
Elevation:	3 ft.	Elevation Datum:	NGVD29	Reference Markers:	Orange stakes
Drainage Basin:	Colville River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Haggland	Other:	
Snow Depth Probe Type:		T-probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	27.0	36.0	27.0	29.0	22.0
2	26.0	31.0	25.0	26.0	24.0
3	19.0	33.0	25.0	25.0	25.0
4	21.0	31.0	23.0	23.0	27.0
5	28.0	30.0	12.5	21.0	23.0
6	28.0	32.0	21.0	20.0	20.0
7	37.0	31.0	22.0	21.0	23.0
8	27.0	32.0	24.0	20.0	24.0
9	31.0	33.0	25.0	20.0	22.0
10	34.0	30.0	27.0	23.0	17.0

	(cm)
Average snow depth =	**25.7**
Maximum snow depth =	37.0
Minimum snow depth =	12.5
Standard variation =	5.1
	(inches)
Average snow depth =	**10.1**
Maximum snow depth =	**14.6**
Minimum snow depth =	**4.9**
Standard variation =	**2.0**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
JM1	22	233.1	785.4	0.30	
FE5	26	243.5	928.2	0.26	
JM5	38	432.0	1356.6	0.32	
JED3	18	161.5	642.6	0.25	
C1	22	176.1	785.4	0.22	

Average Density =	**0.271**	
Average Snow Water Equivalent (SWE) =	**6.9**	cm H2O
Average Snow Water Equivalent =	**2.73**	inches H2O
Average Snow Water Equivalent =	**0.23**	feet H2O

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

Data entered by: Jeff Murray Date: 1/20/10
Data QA/QC by: Jeff Derry Date: 1/28/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN**	Site Location/Lake ID:	**Alpine 2**
Survey Purpose:	**Determine snow depth, SWE**	Date: 1/19/2010	Time: 15:45

Location Description:	Along ice road. Proposed snow depth sampling location west of the road.				
Survey objective:	Determine snow depth and density for application to lake recharge studies, and tundra travel management.			Weather Observations	Very Cold (-40s), Light Breeze
Latitude:	N 70° 24.564'	Longitude:	W 151° 00.482'	Datum:	NAD 83
Elevation:	2 ft.	Elevation Datum:	NGVD29	Reference Markers:	Orange stakes
Drainage Basin:	Colville River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Haggland	Other:	E-3 had 1cm ice layer
Snow Depth Probe Type:		T-probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	27.0	25.0	28.0	27.0	15.0
2	31.0	23.0	23.0	30.0	18.0
3	31.0	27.0	25.0	23.0	20.0
4	28.0	28.0	29.0	21.0	21.0
5	29.0	30.0	29.0	27.0	15.0
6	31.0	29.0	24.0	28.0	22.0
7	32.0	28.0	23.0	29.0	22.0
8	34.0	28.0	14.0	29.0	25.0
9	29.0	23.0	20.0	29.0	23.0
10	25.0	31.0	29.0	22.0	18.0

	(cm)
Average snow depth =	**25.5**
Maximum snow depth =	34.0
Minimum snow depth =	14.0
Standard variation =	4.7

	(inches)
Average snow depth =	**10.1**
Maximum snow depth =	**13.4**
Minimum snow depth =	**5.5**
Standard variation =	**1.8**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
CF2	28	219.2	999.6	0.22	
K2	30	219.1	1071.0	0.20	
Y4	18	171.5	642.6	0.27	
E3	22	217.1	785.4	0.28	
E5	16	128.6	571.2	0.23	

Average Density =	**0.238**	
Average Snow Water Equivalent (SWE) =	**6.1**	cm H2O
Average Snow Water Equivalent =	**2.40**	inches H2O
Average Snow Water Equivalent =	**0.20**	feet H2O

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

Data entered by: Jeff Murray Date: 1/20/10
Data QA/QC by: Jeff Derry Date: 1/28/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN**	Site Location/Lake ID:	**Alpine 3**
Survey Purpose:	**Determine snow depth, SWE**	Date: 1/19/2010	Time: 15:00

Location Description:	Along ice road. Proposed snow depth sampling location west of the road.				
Survey objective:	Determine snow depth and density for application to lake recharge studies, and tundra travel management.			Weather Observations	Very Cold (-40s), Light Breeze, Light
Latitude:	N 70° 20.205'	Longitude:	W 151° 03.360'	Datum:	NAD 83
Elevation:	2 ft.	Elevation Datum:	NGVD29	Reference Markers:	Orange stakes
Drainage Basin:	Colville River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Haggland	Other:	
Snow Depth Probe Type:		T-probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	21.0	14.0	17.0	18.0	15.0
2	13.0	11.0	19.0	20.0	18.0
3	13.0	16.0	16.0	24.0	16.0
4	18.0	14.0	15.0	21.0	11.0
5	15.0	18.0	16.0	19.0	11.0
6	17.0	21.0	16.0	21.0	19.0
7	15.0	15.0	14.0	22.0	11.0
8	15.0	10.0	13.0	17.0	17.0
9	16.0	18.0	17.0	18.0	17.0
10	14.0	21.0	17.0	16.0	15.0

	(cm)
Average snow depth =	**16.4**
Maximum snow depth =	24.0
Minimum snow depth =	10.0
Standard variation =	3.1
	(inches)
Average snow depth =	**6.5**
Maximum snow depth =	**9.4**
Minimum snow depth =	**3.9**
Standard variation =	**1.2**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
K3	12	99.6	428.4	0.23	
Butt1	12	65.7	428.4	0.15	
Butt2	17	116.5	606.9	0.19	
Butt3	20	193.7	714.0	0.27	
Butt4	30	253.6	1071.0	0.24	

Average Density =	**0.217**	
Average Snow Water Equivalent (SWE) =	**3.6**	cm H2O
Average Snow Water Equivalent =	**1.40**	inches H2O
Average Snow Water Equivalent =	**0.12**	feet H2O

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

Data entered by: Jeff Murray Date: 1/20/2010
Data QA/QC by: Jeff Derry Date: 1/28/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN**	Site Location/Lake ID:	**Alpine 4**
Survey Purpose:	**Determine snow depth, SWE**	Date: 1/19/2010	Time: 16:20

Location Description:	Along ice road. Proposed snow depth sampling location west of the road.				
Survey objective:	Determine snow depth and density for application to lake recharge studies, and tundra travel management.			Weather Observations	Very Cold (-40s), Light Breeze, Light
Latitude:	N 70° 16.183'	Longitude:	W 150° 59.730'	Datum:	NAD 83
Elevation:	2 ft.	Elevation Datum:	NGVD29	Reference Markers:	Orange stakes
Drainage Basin:	Colville River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Haggland	Other:	
Snow Depth Probe Type:		T-probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	17.0	12.0	19.0	18.0	17.0
2	16.0	16.0	17.0	15.0	27.0
3	16.0	13.0	19.0	14.0	16.0
4	15.0	6.0	18.0	24.0	17.0
5	11.0	11.0	16.0	17.0	20.0
6	11.0	11.0	21.0	12.0	16.0
7	11.0	11.0	17.0	18.0	31.0
8	21.0	15.0	20.0	20.0	24.0
9	15.0	17.0	25.0	10.0	14.0
10	6.0	20.0	14.0	9.0	14.0

	(cm)
Average snow depth =	**16.2**
Maximum snow depth =	31.0
Minimum snow depth =	6.0
Standard variation =	4.9
	(inches)
Average snow depth =	**6.4**
Maximum snow depth =	**12.2**
Minimum snow depth =	**2.4**
Standard variation =	**1.9**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
L3	19	108.1	678.3	0.16	
JM2	18	97.5	642.6	0.15	
JM4	19	199.7	678.3	0.29	
ZOE3	16	93.2	571.2	0.16	
B3	29	265.4	1035.3	0.26	

Average Density =	**0.205**	
Average Snow Water Equivalent (SWE) =	**3.3**	cm H2O
Average Snow Water Equivalent =	**1.31**	inches H2O
Average Snow Water Equivalent =	**0.11**	feet H2O

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

Data entered by: Jeff Murray Date: 1/20/10
Data QA/QC by: Jeff Derry Date: 1/28/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**ANFO2**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 1/17/2010	Time: 16:30

Location Description:	Off road to the North. Near Duck Island gravel pit. Close to PVC pipe.. GWS stays to right (as looking at pipe) and DNR stays left.				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations	Cold, little wind
Latitude:	N 70° 14.460'	Longitude:	W 148° 10.800'	Datum:	NAD 83
Elevation:	27 ft.	Elevation Datum:	NGVD29	Reference Markers:	Black PVC pipe
Drainage Basin:	Sagavanirktok River	Slope Direction:	Flat	Vegetation Type:	Upland Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	almost dark
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	24.0	17.0	19.0	11.0	12.0
2	20.0	14.0	19.0	13.0	12.0
3	16.0	15.0	21.0	14.0	8.0
4	14.0	13.0	18.0	14.0	17.0
5	14.0	12.0	17.5	10.0	17.0
6	13.0	11.0	21.0	8.0	17.0
7	15.0	9.0	23.0	8.0	17.0
8	15.0	11.0	18.0	10.0	16.0
9	19.0	12.0	16.0	8.0	14.0
10	20.0	13.0	12.0	11.0	16.0

	(cm)
Average snow depth =	**14.7**
Maximum snow depth =	24.0
Minimum snow depth =	8.0
Standard deviation =	4.0

	(inches)
Average snow depth =	**5.8**
Maximum snow depth =	**9.4**
Minimum snow depth =	**3.1**
Standard deviation =	**1.6**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
WD1	13	118.8	464.1	0.26	
Z1	17	149.2	606.9	0.25	
Z2	10	107.7	357.0	0.30	
C1	12	108.9	428.4	0.25	
MR	15	152.5	535.5	0.28	

Average Density =	**0.268**	
Average Snow Water Equivalent (SWE) =	**3.9**	cm H2O
Average Snow Water Equivalent =	**1.55**	inches H2O
Average Snow Water Equivalent =	**0.13**	feet H2O

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

Data entered by: Jeff Murray Date: 1/18/2010

Data QA/QC by: Jeff Derry Date: 1/18/2010

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**Betty Pingo**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 1/18/2010	Time: 16:15

Location Description:	Near Wyoming gage. At staked snow site. Started east and then went north. Point of beginning is flagged rebar. Vertical snow gauge = 0.2'. Snow Depth under Judd sensor = 26 cm - center, 24, 24, 28, 27, average= 25.8cm . Wyoming Gauge = 31-1/2".				
Survey objective:	SWE and tundra travel studies and management			Weather Observations .	Almost Dark, -30F, slight breeze
Latitude:	N 70° 16.772'	Longitude:	W 148° 53.741'	Datum:	NAD83
Elevation:	34 ft.	Elevation Datum:	NVGD27	Reference Markers:	Re-bar and lathe
Drainage Basin:	Kuparuk River	Slope Direction:	Flat	Vegetation Type:	Lowland Moist Sedge-Shrub Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Hard Crust on most of snowpack
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	21.0	12.0	25.0	14.0	9.0
2	20.0	16.0	29.0	11.0	27.0
3	19.0	23.0	39.0	9.0	22.0
4	21.0	23.0	23.0	13.0	23.0
5	17.0	18.0	20.0	20.0	17.0
6	39.0	19.0	10.0	14.0	16.0
7	17.0	23.0	9.0	19.0	28.0
8	18.0	30.0	9.0	27.0	19.0
9	20.0	34.0	11.0	15.0	14.0
10	16.0	40.0	12.0	9.0	21.0

	(cm)
Average snow depth =	**19.6**
Maximum snow depth =	40.0
Minimum snow depth =	9.0
Standard variation =	7.8
	(inches)
Average snow depth =	**7.7**
Maximum snow depth =	**15.7**
Minimum snow depth =	**3.5**
Standard variation =	**3.1**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
E2	22	237.7	785.4	0.30	
ZOE1	33	318.7	1178.1	0.27	
FB3	10	73.7	357.0	0.21	
B4	12	70.5	428.4	0.16	
Z5	20	162.2	714.0	0.23	

Average Density =	**0.234**	
Average Snow Water Equivalent (SWE) =	**4.6**	cm H2O
Average Snow Water Equivalent =	**1.81**	inches H2O
Average Snow Water Equivalent =	**0.15**	feet H2O

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

Data entered by: Jeff Murray Date: 1/20/10

Data QA/QC by: Jeff Derry Date: 1/20/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**Duck Island MET**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 1/17/2010	Time: 14:20

Location Description:	Near Duck Island Meteorlogical station. Staked snow course. Snow depths under SR50 sensor: 18 cm, 17.5, 13, 17, 17 center. Average=16.5 cm				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations	Cold, slight breeze, light
Latitude:	N 70° 16.206'	Longitude:	W 147° 59.265'	Datum:	NAD 83
Elevation:	45 ft.	Elevation Datum:	NGVD29	Reference Markers:	Black PVC Pipe
Drainage Basin:	Sagavanirktok River	Slope Direction:	Flat	Vegetation Type:	Upland Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	started at stake near met.
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	16.0	18.0	18.0	18.0	16.0
2	9.0	22.0	23.0	20.0	10.0
3	10.0	16.5	20.0	28.0	13.0
4	9.0	14.5	22.0	27.0	13.0
5	13.0	14.0	18.0	26.0	15.0
6	14.0	24.0	15.0	21.0	10.0
7	13.0	26.0	17.0	20.0	15.0
8	15.0	26.0	16.0	19.0	10.0
9	13.0	15.0	18.0	24.0	10.5
10	17.0	23.0	18.5	16.5	9.0

	(cm)
Average snow depth =	**17.1**
Maximum snow depth =	28.0
Minimum snow depth =	9.0
Standard deviation =	5.1

	(inches)
Average snow depth =	**6.7**
Maximum snow depth =	**11.0**
Minimum snow depth =	**3.5**
Standard deviation =	**2.0**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
14	14	120.8	499.8	0.24	
18	18	204.9	642.6	0.32	
24	24	232.5	856.8	0.27	
12	12	125.2	428.4	0.29	
16	16	146.2	571.2	0.26	

Average Density =	**0.276**	
Average Snow Water Equivalent (SWE) =	**4.7**	cm H2O
Average Snow Water Equivalent =	**1.86**	inches H2O
Average Snow Water Equivalent =	**0.15**	feet H2O

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

Data entered by: Jeff Murray Date: 1/18/2010

Data QA/QC by: Jeff Derry Date: 1/18/2010

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID: **ATN** Site Location/Lake ID: **L9312 - Lake Surface**
Survey Purpose: **Determine snow depth, SWE** Date: 1/19/2010 Time: 10:30

Location Description:	On lake surface ~150 yards east from L9312 pumphouse.				
Survey objective:	Determine snow depth and density for application to lake recharge studies, and tundra travel management.			Weather Observations:	Very cold (-40s), breezy, getting light
Latitude:	N 70° 20.008'	Longitude:	W 150° 57.083'	Datum:	NAD 83
Elevation:	7 ft	Elevation Datum:	BPMSL	Reference Markers:	None, Ice surface
Drainage Basin:	Colville Basin	Slope Direction:	Flat	Vegetation Type:	None, Ice surface
Slope Angle:	Flat	Access Notes:	Haggland	Other:	Dense snow, drifting, patches of clear ice
Snow Depth Probe Type:		T- probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	9.0	12.0	9.0	13.0	14.0
2	8.0	8.0	7.0	12.0	12.0
3	6.0	11.0	7.0	23.0	10.0
4	8.0	12.0	10.0	15.0	18.0
5	12.0	13.0	13.0	21.0	15.0
6	9.0	12.0	8.0	21.0	12.0
7	6.0	9.0	5.0	11.0	12.0
8	7.0	8.0	8.0	6.0	13.0
9	11.0	11.0	16.0	6.0	13.0
10	11.0	9.0	14.0	8.0	10.0

	(cm)
Average snow depth =	**11.1**
Maximum snow depth =	23.0
Minimum snow depth =	5.0
Standard variation =	4.0

	(inches)
Average snow depth =	**4.4**
Maximum snow depth =	**9.1**
Minimum snow depth =	**2.0**
Standard variation =	**1.6**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
B4	10	81.6	357.0	0.23	
J2	6	75.3	214.2	0.35	
FB3	8	75.2	285.6	0.26	
E2	3	34.7	107.1	0.32	
ZOE1	15	199.9	535.5	0.37	

Average Density = **0.308**
Average Snow Water Equivalent (SWE) = **3.4** cm H2O
Average Snow Water Equivalent = **1.34** inches H2O
Average Snow Water Equivalent = **0.11** feet H2O

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

Data entered by: Jeff Murray Date: 1/20/10
Data QA/QC by: Jeff Derry Date: 1/28/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN**	Site Location/Lake ID:	**L9312 - Tundra**
Survey Purpose:	**Determine snow depth, SWE**	Date: 1/19/2010	Time: 12:30

Location Description:	On tundra on staked course, adjacent and north of L9312 weather station.				
Survey objective:	Determine snow depth and density for application to lake recharge studies, and tundra travel management.			Weather Observations	Very Cold (-40s), Breeze, Light
Latitude:	N 70° 19.995'	Longitude:	W 150° 56.918'	Datum:	NAD 83
Elevation:	7 ft	Elevation Datum:	BPMSL	Reference Markers:	Orange stakes
Drainage Basin:	Colville River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Haggland	Other:	Snow pack was fairly uniform, some slabbing
Snow Depth Probe Type:		T-probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Chris (LCMF)	

Snow Course Depths (cm)

	1	2	3	4	5
1	22.0	29.0	39.0	10.0	15.0
2	15.5	29.5	36.5	47.5	23.5
3	30.0	27.0	30.0	43.0	36.0
4	25.0	28.5	31.0	13.0	46.0
5	25.0	15.0	29.0	23.0	48.0
6	52.5	21.5	27.0	41.0	47.5
7	32.0	19.0	26.5	43.5	29.0
8	17.0	25.0	22.0	43.0	22.0
9	26.0	30.0	48.0	41.0	16.0
10	27.0	27.5	48.5	30.0	27.0

	(cm)
Average snow depth =	**30.1**
Maximum snow depth =	52.5
Minimum snow depth =	10.0
Standard variation =	10.7

	(inches)
Average snow depth =	**11.9**
Maximum snow depth =	**20.7**
Minimum snow depth =	**3.9**
Standard variation =	**4.2**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
ZOE4	26	256.9	928.2	0.28	
BL(5)	17	73.9	606.9	0.12	
BL(1)	14	92.1	499.8	0.18	
B5	36	381.3	1285.2	0.30	
B2	35	310.3	1249.5	0.25	

Average Density =	**0.226**	
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)

Data entered by: Jeff Murray Date: 1/20/10
Data QA/QC by: Jeff Derry Date: 1/28/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**ADNR P-Pad**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 1/18/2010	Time: 17:35

Location Description:	On access road to P-Pad, north side, near Betty Pingo, near soil thermistors. GWS measurements on right (as looking at sensor pipe from road) and DNR measurements on left.				
Survey objective:	Co-located snow survey site with DNR sampling site, tundra travel studies and management			Weather Observations	Dark, Cold, Light Breeze
Latitude:	N 70° 16.967'	Longitude:	W 148° 54.807'	Datum:	NAD83
Elevation:	33 ft.	Elevation Datum:	NGVD29	Reference Markers:	none
Drainage Basin:	Kuparuk River	Slope Direction:	Flat	Vegetation Type:	Lowland Moist Sedge-Shrub Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Top of snow was crusty
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	18.0	15.0	22.0	26.0	17.0
2	20.0	14.0	15.0	18.0	17.0
3	11.0	14.0	16.0	20.0	27.0
4	17.0	14.0	25.0	20.0	25.0
5	14.0	20.0	15.0	18.0	16.0
6	13.0	12.0	21.0	18.0	17.0
7	17.0	15.0	29.0	15.0	13.0
8	18.0	10.0	17.0	19.0	13.0
9	16.0	20.0	17.0	18.0	12.0
10	11.0	37.0	16.0	15.0	14.0

	(cm)
Average snow depth =	**17.5**
Maximum snow depth =	37.0
Minimum snow depth =	10.0
Standard variation =	5.0

	(inches)
Average snow depth =	**6.9**
Maximum snow depth =	**14.6**
Minimum snow depth =	**3.9**
Standard variation =	**2.0**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
D3	14	118.8	499.8	0.24	
J5	24	225.7	856.8	0.26	
J2	12	93.4	428.4	0.22	
B1	14	99.1	499.8	0.20	
ZOE3	25	200.1	892.5	0.22	

Average Density =	**0.228**	
Average Snow Water Equivalent (SWE) =	**4.0**	cm H2O
Average Snow Water Equivalent =	**1.58**	inches H2O
Average Snow Water Equivalent =	**0.13**	feet H2O

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

Data entered by: Jeff Murray Date: 1/20/10

Data QA/QC by: Jeff Derry Date: 1/28/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**Sag River DOT**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 1/14/2010	Time: 18:30

Location Description:	On Road to DOT garage. Near PVC pipe. GWS stays to right (as looking at pipe) and DNR stays left.				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations:	Cold (-40), Dark, Slight breeze from West
Latitude:	N 68° 45.686'	Longitude:	W 148° 52.746'	Datum:	NAD 83
Elevation:	1640 ft.	Elevation Datum:	NGVD29	Reference Markers:	Black PVC pipe
Drainage Basin:	Kuparuk River	Slope Direction:	Flat	Vegetation Type:	Upland Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Smooth snow, little drifting
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	26.0	33.0	31.0	34.0	30.0
2	33.0	35.0	34.0	33.0	38.0
3	31.0	30.0	33.0	33.0	37.0
4	31.0	45.0	32.0	35.0	29.0
5	28.0	36.0	32.0	37.0	30.0
6	25.0	32.0	27.0	33.0	28.0
7	31.0	29.0	44.0	33.0	36.0
8	33.0	34.0	24.0	35.0	28.0
9	35.5	34.0	28.0	27.0	40.0
10	34.0	34.0	38.0	31.0	35.0

	(cm)
Average snow depth =	**32.7**
Maximum snow depth =	45.0
Minimum snow depth =	24.0
Standard deviation =	4.3

	(inches)
Average snow depth =	**12.9**
Maximum snow depth =	**17.7**
Minimum snow depth =	**9.4**
Standard deviation =	**1.7**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
WD1	30	218.8	1071.0	0.20	
ML4	32	235.5	1142.4	0.21	
MD3	32	168.4	1142.4	0.15	
FE5	30	243.7	1071.0	0.23	
MC3	26	173.5	928.2	0.19	

Average Density =	**0.194**	
Average Snow Water Equivalent (SWE) =	**6.4**	cm H2O
Average Snow Water Equivalent =	**2.50**	inches H2O
Average Snow Water Equivalent =	**0.21**	feet H2O

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

Data entered by: Jeff Murray Date: 1/15/2010

Data QA/QC by: Jeff Derry Date: 1/15/2010

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**Toolik NRCS Site**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 1/14/2010	Time: 11:00

Location Description:	Near Tollik Camp and Toolik Lake. Adjacent and south and west of NRCS long-term Climate Station				
Survey objective:	SWE and tundra travel studies and management			Weather Observations:	-43F, light, calm
Latitude:	N 68° 37.366'	Longitude:	W 149° 36.598'	Datum:	NAD 83
Elevation:	2500 ft.	Elevation Datum:	NGVD27	Reference Markers:	NRCS Station
Drainage Basin:	Toolik Lake	Slope Direction:	East	Vegetation Type:	Upland Shrubby Tussuck Tundra
Slope Angle:	~10 degrees	Access Notes:	Walk from Toolik	Other:	Cold sintered snowpack
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry and Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	25.0	32.0	31.0	37.0	28.0
2	24.5	31.0	29.0	35.0	37.0
3	30.0	27.0	19.0	40.0	37.0
4	24.0	27.0	22.0	27.0	41.0
5	35.0	21.0	42.0	42.0	30.0
6	34.0	30.5	29.0	29.0	41.0
7	32.0	31.0	36.0	39.0	28.0
8	28.0	25.0	20.0	30.0	39.0
9	29.0	26.0	32.0	27.0	23.0
10	31.0	34.0	25.0	39.0	30.0

	(cm)
Average snow depth =	**30.8**
Maximum snow depth =	42.0
Minimum snow depth =	19.0
Standard deviation =	6.0

	(inches)
Average snow depth =	**12.1**
Maximum snow depth =	**16.5**
Minimum snow depth =	**7.5**
Standard deviation =	**2.3**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
C5	30	257.4	1071.0	0.24	
C2	28	186.7	999.6	0.19	
C1	22.5	76.7	803.3	0.10	
C3	21	94.8	749.7	0.13	
C4	26	186.5	928.2	0.20	

Average Density =	**0.170**	
Average Snow Water Equivalent (SWE) =	**5.2**	cm H2O
Average Snow Water Equivalent =	**2.06**	inches H2O
Average Snow Water Equivalent =	**0.17**	feet H2O

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

Data entered by: Jeff Murray Date: 1/15/10
Data QA/QC by: Jeff Derry Date: 1/15/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**UAF 411**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 1/17/2010	Time: 20:00

Location Description:	Off Dalton highway to the east. Near PVC pipe.				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations	Cold, slight breeze
Latitude:	N 70° 09.949'	Longitude:	W 148° 27.307'	Datum:	NAD 83
Elevation:	78 ft.	Elevation Datum:	NGVD29	Reference Markers:	Black PVC Pipe
Drainage Basin:	Sagavanirktok River	Slope Direction:	Flat	Vegetation Type:	Upland Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	dark
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	31.0	37.0	26.0	23.0	20.0
2	29.0	35.0	30.0	22.0	23.0
3	31.0	32.0	33.0	21.0	26.0
4	29.0	26.0	41.0	19.0	27.0
5	17.0	26.0	31.0	11.0	32.0
6	28.0	29.0	31.0	24.0	13.0
7	26.0	20.0	32.0	17.0	21.0
8	25.0	17.0	29.0	19.0	18.0
9	28.0	21.0	26.0	11.0	14.0
10	32.0	23.0	25.0	20.0	12.0

	(cm)
Average snow depth =	**24.8**
Maximum snow depth =	41.0
Minimum snow depth =	11.0
Standard deviation =	6.9

	(inches)
Average snow depth =	**9.8**
Maximum snow depth =	**16.1**
Minimum snow depth =	**4.3**
Standard deviation =	**2.7**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
JED4	32	387.9	1142.4	0.34	
JED1	24	249.7	856.8	0.29	
JED3	30	349.9	1071.0	0.33	
JED5	14	99.0	499.8	0.20	
JED2	16	184.3	571.2	0.32	

Average Density =	**0.296**	
Average Snow Water Equivalent (SWE) =	**7.3**	cm H2O
Average Snow Water Equivalent =	**2.88**	inches H2O
Average Snow Water Equivalent =	**0.24**	feet H2O

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

Data entered by: Jeff Murray Date: 1/18/2010

Data QA/QC by: Jeff Derry Date: 1/18/2010

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**ADNR UGNU**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 1/16/2010	Time: 15:34

Location Description:	East of road to xxx. East of Pad. GWS measures to right (as looking at PVC pipe from road) and DNR measures to left.				
Survey objective:	Co-located snow survey site with DNR sampling site, tundra travel studies and management			Weather Observations:	Cold (-25), strong breeze, dark
Latitude:	N 70° 27.480'	Longitude:	W 149° 48.540'	Datum:	NAD83
Elevation:	16 ft	Elevation Datum:	NGVD29	Reference Markers:	Black PVC Pipe
Drainage Basin:	Beaufort Sea Coastal Plain	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	hard surface snow layer, very dense snowpack
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Derry, Jeff Murray	

Snow Course Depths (cm)

	1	2	3	4	5
1	15.0	13.0	24.0	13.0	28.0
2	14.0	16.0	16.0	32.0	19.0
3	16.0	15.0	13.0	21.0	20.0
4	15.0	17.0	13.0	21.0	15.0
5	15.0	27.0	20.0	14.0	14.0
6	13.0	17.0	22.0	17.0	12.0
7	18.0	14.0	21.0	18.0	19.0
8	19.0	13.0	14.0	16.0	14.0
9	16.0	16.0	18.0	17.0	14.0
10	19.0	17.0	27.0	31.0	18.0

	(cm)
Average snow depth =	**17.7**
Maximum snow depth =	32.0
Minimum snow depth =	12.0
Standard deviation =	4.7

	(inches)
Average snow depth =	**7.0**
Maximum snow depth =	**12.6**
Minimum snow depth =	**4.7**
Standard deviation =	**1.9**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
E1	16	128.2	571.2	0.22	
Z3	16	119.7	571.2	0.21	
B5	14	126.7	499.8	0.25	
E2	21	283.4	749.7	0.38	
B2	22	248.8	785.4	0.32	

Average Density =	**0.276**	
Average Snow Water Equivalent (SWE) =	**4.9**	cm H2O
Average Snow Water Equivalent =	**1.93**	inches H2O
Average Snow Water Equivalent =	**0.16**	feet H2O

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

Data entered by: Jeff Murray Date: 1/17/2010
Data QA/QC by: Jeff Derry Date: 1/17/2010

APPENDIX B. DNR SNOW DATA

The following table reports snow information obtained by DNR.

Upper Foothills

Slope Mountain

Date																							average		
																							g/cm^3	in	cm
11/5/2009	depth (in)	8	9	10	9	9	8	10	10	6	8	9	9	9	11	10	11	10	11	9	10			9.30	23.62
	density (g/cm^3)	0.16	0.12																				0.14		
	SWE (in)	1.40	0.96																					1.18	2.99
11/18/2009	depth (in)	11	12	9	8	7	8	12	9	6	8	7	10	9	6	9	9	8	8	6	7			8.45	21.46
	density (g/cm^3)	0.24	0.18																				0.21		
	SWE (in)	1.30	1.23																					1.26	3.21
12/2/2009	depth (in)	8	10	11	9	10	9	7	7	6	7	8	7	7	6	8	13	9	8	13	11			8.70	22.10
	density (g/cm^3)	0.2282	0.1986																				0.21		
	SWE (in)	2.0542	0.9928																					1.52	3.87
12/9/2009	depth (in)	9	7	7	0	2	10	9	7	7	2	8	8	7	9	5	8	8	7	10	7			6.85	17.40
	density (g/cm^3)	0.2578	0.1576																				0.21		
	SWE (in)	2.1916	1.2607																					1.73	4.38
12/16/2009	depth (in)	7	6	6	11	7	9	7	4	8	10	6	9	10	12	13	11	7	6	7	8			8.20	20.83
	density (g/cm^3)	0.1221	0.1324																				0.13		
	SWE (in)	0.7935	1.192																					0.99	2.52
12/21/2009	depth (in)	6	7	7	9	9	10	7	7	7	7	4	6	9	7	8	6	7	7	4	6			7.00	17.78
	density (g/cm^3)	0.163	0.193																				0.18		
	SWE (in)	1.144	1.158																					1.15	2.92
12/28/2009	depth (in)	5	6	6	5	5	6	11	6	7	12	10	12	9	6	6	9	7	5	8	7			7.40	18.80
	density (g/cm^3)	0.14	0.193																				0.17		
	SWE (in)	1.12	0.773																					0.95	2.40
1/5/2009	depth (in)	5	8	8	7	6	4	7	5	6	13	13	6	6	7	8	11	9	7	8	10			7.70	19.56
	density (g/cm^3)	0.224	0.26																				0.24		
	SWE (in)	0.897	1.429																					1.16	2.95
1/12/2009	depth (in)	11	13	5	10	8	12	9	10	9	8	13	12	11	8	10	16	13	6	13	11			10.40	26.42
	density (g/cm^3)	0.161	0.204																				0.18		
	SWE (in)	1.447	2.04																					1.74	4.43
1/27/2009	depth (in)	11	9	8	8	9	8	8	10	12	9	10	9	11	9	14	9	13	8	11	10			9.80	24.89
	density (g/cm^3)	0.314	0.29																				0.30		
	SWE (in)	2.199	3.047																					2.62	6.66

Upper Foothills

Sag River DOT

Date																							average		
																							g/cm^3	in	cm
11/5/2009	depth (in)	9	12	11	12	9	10	11	10	11	7	9	12	10	12	6	10	16	11	10	8			10.30	26.16
	density (g/cm^3)	0.24	0.23																				0.24		
	SWE (in)	2.64	2.11																					2.38	6.03
11/18/2009	depth (in)	7	11	10	10	9	10	13	12	7	8	10	10	14	7	14	11	10	10	8	10			10.05	25.53
	density (g/cm^3)	0.25	0.22																				0.23		
	SWE (in)	2.50	1.42																					1.96	4.98
12/2/2009	depth (in)	10	9	11	11	10	12	10	11	11	12	9	9	14	10	11	9	10	8	9	6			10.10	25.65
	density (g/cm^3)	0.2442	0.251																				0.25		
	SWE (in)	1.5871	1.6317																					1.61	4.09
12/9/2009	depth (in)	8	10	10	6	10	9	13	4	7	11	10	10	8	8	13	9	9	7	9	14			9.25	23.50
	density (g/cm^3)	0.1724	0.2733																				0.22		
	SWE (in)	1.7245	3.8268																					2.78	7.05
12/16/2009	depth (in)	9	10	14	10	8	8	8	11	11	8	13	12	11	14	12	14	12	11	9	12			10.85	27.56
	density (g/cm^3)	0.2244	0.298																				0.26		
	SWE (in)	2.0199	3.576																					2.80	7.11
12/21/2009	depth (in)	9	13	11	11	10	9	10	12	10	10	7	11	9	7	9	11	9	9	11	8			9.80	24.89
	density (g/cm^3)	0.287	0.307																				0.30		
	SWE (in)	2.295	3.38																					2.84	7.21
12/28/2009	depth (in)	7	8	10	9	12	8	8	8	9	12	8	9	8	6	10	8	9	6	9	8			8.60	21.84
	density (g/cm^3)	0.237	0.222																				0.23		
	SWE (in)	2.013	1.889																					1.95	4.96
1/5/2009	depth (in)	7	7	8	9	8	8	7	9	9	13	12	8	11	6	11	7	8	7	9	9			8.65	21.97
	density (g/cm^3)	0.287	0.253																				0.27		
	SWE (in)	2.436	2.15																					2.29	5.82
1/12/2009	depth (in)	12	10	11	10	14	10	9	13	15	8	13	11	15	10	13	13	11	11	12	12			11.65	29.59
	density (g/cm^3)	0.22	0.185																				0.20		
	SWE (in)	2.642	2.04																					2.34	5.95
1/27/2009	depth (in)	9	14	13	9	10	15	14	10	10	14	11	14	10	12	12	12	12	15	11	9			11.80	29.97
	density (g/cm^3)	0.297	0.266																				0.28		
	SWE (in)	2.676	3.325																					3.00	7.62

Upper Foothills

Pump Station 3

Date																							average		
																							g/cm^3	in	cm
11/5/2009	depth (in)	9	10	9	10	10	11	9	10	10	10	10	9	9	10	9	11	9	10	11	11			9.85	25.02
	density (g/cm^3)	0.23	0.20																				0.22		
	SWE (in)	2.33	2.04																					2.18	5.54
11/18/2009	depth (in)	10	9	11	10	13	11	10	10	12	10	11	12	10	13	10	10	11	11	12	9			10.75	27.31
	density (g/cm^3)	0.22	0.23																				0.22		
	SWE (in)	2.27	2.56																					2.41	6.13
12/2/2009	depth (in)	7	9	9	10	10	11	10	12	10	9	11	7	11	10	7	9	10	9	10	8			9.45	24.00
	density (g/cm^3)	0.2052	0.2653																				0.24		
	SWE (in)	1.539	2.3874																					1.96	4.99
12/9/2009	depth (in)	11	10	10	10	12	11	10	8	11	11	10	11	10	10	10	10	9	10	11	10			10.25	26.04
	density (g/cm^3)	0.2398	0.2542																				0.25		
	SWE (in)	2.3978	2.542																					2.47	6.27
12/16/2009	depth (in)	9	11	10	12	13	12	12	14	13	13	11	12	13	10	12	11	14	13	12	12			11.95	30.35
	density (g/cm^3)	0.1921	0.2045																				0.20		
	SWE (in)	2.1126	2.147																					2.13	5.41
12/21/2009	depth (in)	11	13	13	12	8	11	12	13	11	11	8	10	12	10	9	9	11	12	9	11			10.80	27.43
	density (g/cm^3)	0.237	0.255																				0.25		
	SWE (in)	2.37	2.8																					2.59	6.57
12/28/2009	depth (in)	11	11	11	9	11	11	9	9	11	9	8	8	8	10	9	12	10	11	12	12			10.10	25.65
	density (g/cm^3)	0.247	0.256																				0.25		
	SWE (in)	2.343	2.178																					2.26	5.74
1/5/2009	depth (in)	13	11	8	11	11	12	12	12	13	10	11	10	10	9	12	10	12	9	9	10			10.75	27.31
	density (g/cm^3)	0.27	0.262																				0.27		
	SWE (in)	3.37	3.93																					3.65	9.27
1/12/2009	depth (in)	13	16	16	19	14	15	17	19	13	14	17	19	14	15	18	16	16	16	13	17			15.85	40.26
	density (g/cm^3)	0.169	0.083																				0.13		
	SWE (in)	2.202	1.25																					1.73	4.38
1/27/2009	depth (in)	15	15	14	13	16	16	17	16	14	12	13	16	15	14	11	14	15	14	12	12			14.20	36.07
	density (g/cm^3)	0.178	0.256																				0.22		
	SWE (in)	2.487	3.834																					3.16	8.03

Upper Foothills

318 Mile

Date																						average		
																						g/cm^3	in	cm
11/5/2009	depth (in)	9	12	11	11	12	13	12	9	12	12	13	15	13	12	11	13	13	15	11	14		12.15	30.86
	density (g/cm^3)	0.22	0.20																			0.21		
	SWE (in)	2.68	2.46																				2.57	6.53
11/18/2009	depth (in)	14	13	11	13	12	8	13	14	14	13	13	13	14	13	14	13	11	15	12	13		12.80	32.51
	density (g/cm^3)	0.23	0.21																			0.22		
	SWE (in)	2.79	2.68																				2.73	6.95
12/2/2009	depth (in)	10	11	10	13	15	16	17	15	14	14	12	15	14	15	14	14	11	13	13	10		13.30	33.78
	density (g/cm^3)	0.2083	0.2151																			0.21		
	SWE (in)	2.6039	3.1191																				2.86	7.27
12/9/2009	depth (in)	12	12	10	11	14	11	13	11	14	12	9	11	12	12	12	13	10	12	15	12		11.90	30.23
	density (g/cm^3)	0.1477	0.2326																			0.19		
	SWE (in)	1.4771	3.2565																				2.37	6.01
12/16/2009	depth (in)	16	17	17	15	15	17	16	16	13	14	10	14	16	16	15	7	9	13	15	17		14.40	36.58
	density (g/cm^3)	0.2508	0.2091																			0.23		
	SWE (in)	3.26	3.1363																				3.20	8.12
12/21/2009	depth (in)	14	14	13	16	17	14	16	11	16	15	16	13	13	12	12	14	12	16	16	14		14.20	36.07
	density (g/cm^3)	0.178	0.284																			0.23		
	SWE (in)	1.958	3.404																				2.68	6.81
12/28/2009	depth (in)	14	10	11	11	9	12	15	15	13	16	16	14	14	14	15	16	15	16	16	17		13.95	35.43
	density (g/cm^3)	0.248	0.241																			0.24		
	SWE (in)	2.236	3.741																				2.99	7.59
1/5/2009	depth (in)	14	16	15	10	10	11	10	14	15	16	16	17	15	13	11	14	13	15	16	16		13.85	35.18
	density (g/cm^3)	0.159	0.109																			0.13		
	SWE (in)	2.697	1.309																				2.00	5.09
1/12/2009	depth (in)	16	17	19	19	17	18	15	18	18	17	16	16	18	17	18	15	16	20	18	16		17.20	43.69
	density (g/cm^3)	0.207	0.214																			0.21		
	SWE (in)	3.937	2.889																				3.41	8.67
1/27/2009	depth (in)	17	17	18	15	18	16	19	18	17	14	20	16	15	15	20	17	12	16	16	16		16.60	42.16
	density (g/cm^3)	0.18	0.245																			0.21		
	SWE (in)	2.607	3.676																				3.14	7.98

Lower Foothills

62 Mile

Date																						average		
																						g/cm^3	in	cm
11/5/2009	depth (in)	5	9	8	10	9	10	9	9	8	10	11	10	11	6	10	8	9	10	9	10		9.05	22.99
	density (g/cm^3)	0.20	0.21																			0.20		
	SWE (in)	1.62	2.07																				1.85	4.69
11/18/2009	depth (in)	8	9	9	6	13	10	7	9	5	12	5	7	11	11	10	7	7	7	11	7		8.55	21.72
	density (g/cm^3)	0.20	0.18																			0.19		
	SWE (in)	1.68	1.38																				1.53	3.89
12/2/2009	depth (in)	12	11	12	9	11	10	8	8	9	10	9	8	7	9	6	6	9	7	8	6		8.75	22.23
	density (g/cm^3)	0.1861	0.2336																			0.21		
	SWE (in)	1.1164	1.4016																				1.26	3.20
12/9/2009	depth (in)	5	9	9	5	8	8	6	10	7	10	10	5	6	9	9	6	7	9	8	9		7.75	19.69
	density (g/cm^3)	0.2617	0.2278																			0.24		
	SWE (in)	2.7481	1.4806																				2.11	5.37
12/16/2009	depth (in)	6	9	10	6	9	11	11	9	9	10	10	6	8	9	8	10	12	7	9	10		8.95	22.73
	density (g/cm^3)	0.2149	0.2029																			0.21		
	SWE (in)	1.1817	1.9271																				1.55	3.95
12/21/2009	depth (in)	7	7	8	6	11	7	8	11	9	11	8	12	8	11	13	8	10	9	10	10		9.20	23.37
	density (g/cm^3)	0.148	0.179																			0.16		
	SWE (in)	1.336	1.432																				1.38	3.52
12/28/2009	depth (in)	10	11	9	11	10	12	11	12	12	10	11	11	9	11	8	11	11	5	5	5		9.75	24.77
	density (g/cm^3)	0.219	0.217																			0.22		
	SWE (in)	2.082	1.841																				1.96	4.98
1/5/2009	depth (in)	11	15	13	10	11	10	11	11	10	11	11	11	11	12	12	14	11	10	10	10		11.25	28.58
	density (g/cm^3)	0.231	0.234																			0.23		
	SWE (in)	2.422	2.339																				2.38	6.05
1/12/2009	depth (in)	9	10	8	9	6	12	10	10	8	4	14	11	8	8	11	13	6	9	17	12		9.75	24.77
	density (g/cm^3)	0.216	0.392																			0.30		
	SWE (in)	2.161	2.941																				2.55	6.48
1/27/2009	depth (in)	10	9	10	12	7	9	9	8	9	9	9	13	10	10	10	12	9	7	8	9		9.45	24.00
	density (g/cm^3)	0.226	0.289																			0.26		
	SWE (in)	2.15	3.325																				2.74	6.95

Lower Foothills

52 Mile

Date																						average		
																						g/cm^3	in	cm
11/6/2009	depth (in)	9	12	7	11	6	9	8	9	10	10	9	9	5	8	11	9	11	11	9	12		9.25	23.50
	density (g/cm^3)	0.20	0.21																			0.20		
	SWE (in)	1.62	2.07																				1.85	4.69
11/18/2009	depth (in)	8	7	10	12	7	12	6	8	12	10	5	5	5	10	8	14	7	9	11	10		8.80	22.35
	density (g/cm^3)	0.14	0.16																			0.15		
	SWE (in)	1.61	1.24																				1.43	3.63
12/2/2009	depth (in)	12	10	9	9	9	11	8	9	12	7	13	7	11	13	7	8	7	12	7	11		9.60	24.38
	density (g/cm^3)	0.168	0.1821																			0.18		
	SWE (in)	1.6798	2.0027																				1.84	4.68
12/9/2009	depth (in)	13	13	11	6	13	12	13	11	14	13	13	12	10	10	13	13	13	11	11	12		11.85	30.10
	density (g/cm^3)	0.2172	0.2621																			0.24		
	SWE (in)	2.8237	3.4077																				3.12	7.91
12/16/2009	depth (in)	10	14	14	10	9	10	13	9	15	16	14	8	14	12	16	16	13	16	17	17		13.15	33.40
	density (g/cm^3)	0.2375	0.2073																			0.22		
	SWE (in)	3.3252	3.1088																				3.22	8.17
12/21/2009	depth (in)	14	10	14	13	15	8	12	13	14	14	14	14	14	14	11	10	14	12	10	9		12.45	31.62
	density (g/cm^3)	0.231	0.197																			0.21		
	SWE (in)	3.119	2.171																				2.65	6.72
12/28/2009	depth (in)	7	11	13	12	11	12	13	9	12	11	12	11	13	8	11	9	11	11	8	11		10.80	27.43
	density (g/cm^3)	0.203	0.134																			0.17		
	SWE (in)	2.635	1.072																				1.85	4.71
1/5/2009	depth (in)	14	12	12	13	14	10	13	9	13	12	10	11	11	11	10	13	12	12	14	11		11.85	30.10
	density (g/cm^3)	0.216	0.234																			0.23		
	SWE (in)	2.81	2.453																				2.63	6.68
1/12/2009	depth (in)	16	14	15	15	9	16	16	14	14	16	12	15	11	12	15	16	12	11	16	15		14.00	35.56
	density (g/cm^3)	0.198	0.191																			0.19		
	SWE (in)	2.181	2.202																				2.19	5.57
1/27/2009	depth (in)	17	17	16	13	12	16	15	13	15	14	15	16	12	15	10	14	11	16	14	15		14.30	36.32
	density (g/cm^3)	0.296	0.257																			0.28		
	SWE (in)	5.039	3.603																				4.32	10.98

Lower Foothills

30 Mile

Date																							average		
																							g/cm^3	in	cm
11/6/2009	depth (in)	3	4	3	2	2	3	4	3	2	3	4	3	2	3	2	3	3	2	2	2			2.75	6.99
	density (g/cm^3)																								
	SWE (in)																								
11/18/2009	depth (in)	3	3	4	3	3	2	4	4	4	3	3	3	4	3	4	4	4	5	4	2			3.45	8.76
	density (g/cm^3)	0.18	0.13																				0.15		
	SWE (in)	0.62	0.52																					0.57	1.45
12/2/2009	depth (in)	3	4	4	4	4	5	4	4	4	4	3	4	4	4	4	4	6	6	8	9			4.60	11.68
	density (g/cm^3)	0.1832	0.1702																				0.18		
	SWE (in)	1.0993	1.1061																					1.10	2.80
12/9/2009	depth (in)	3	5	4	4	4	4	4	4	4	6	4	5	4	4	6	5	5	4	4	6			4.45	11.30
	density (g/cm^3)	0.2241	0.2061																				0.22		
	SWE (in)	0.8966	0.9275																					0.91	2.32
12/16/2009	depth (in)	5	4	4	6	6	5	4	6	3	4	4	5	5	6	7	4	5	5	4	4			4.80	12.19
	density (g/cm^3)	0.2817	0.2527																				0.27		
	SWE (in)	0.8451	1.137																					0.99	2.52
12/21/2009	depth (in)	9	10	9	8	5	5	5	7	5	5	6	6	5	7	7	5	5	5	5	5			6.20	15.75
	density (g/cm^3)	0.259	0.169																				0.21		
	SWE (in)	1.165	1.058																					1.11	2.82
12/28/2009	depth (in)	3	2	3	2	2	3	2	3	3	3	2	3	3	3	3	3	3	4	3	3			2.80	7.11
	density (g/cm^3)	0.189	0.203																				0.20		
	SWE (in)	0.567	0.711																					0.64	1.62
1/6/2009	depth (in)	7	6	6	6	6	6	5	5	6	7	7	6	7	7	6	6	5	6	7	7			6.20	15.75
	density (g/cm^3)	0.187	0.179																				0.18		
	SWE (in)	2.061	1.072																					1.57	3.98
1/12/2009	depth (in)	9	8	6	7	9	7	7	5	8	9	7	6	7	10	7	7	8	7	7	4			7.25	18.42
	density (g/cm^3)	0.195	0.205																				0.20		
	SWE (in)	1.556	1.539																					1.55	3.93
1/27/2009	depth (in)	8	6	4	11	7	3	5	7	8	4	7	5	9	5	8	3	7	4	10	4			6.25	15.88
	density (g/cm^3)	0.3	0.263																				0.28		
	SWE (in)	1.498	1.58																					1.54	3.91

Lower Foothills

Spur Dike 6 - 20 Mile

Date																							average		
																							g/cm^3	in	cm
11/6/2009	depth (in)	3	2	2	5	3	4	4	6	4	4	4	4	5	6	4	4	3	4	4	4			3.95	10.03
	density (g/cm^3)	0.20	0.26																				0.23		
	SWE (in)	0.79	1.31																					1.05	2.66
11/18/2009	depth (in)	6	8	4	8	8	10	6	8	10	8	6	5	7	7	7	9	5	6	8	6			7.10	18.03
	density (g/cm^3)	0.28	0.30																				0.29		
	SWE (in)	1.98	1.50																					1.74	4.42
12/2/2009	depth (in)	8	7	7	8	6	5	3	4	4	3	2	5	4	6	6	5	4	6	6	7			5.30	13.46
	density (g/cm^3)	0.2667	0.238																				0.25		
	SWE (in)	1.4668	1.3088																					1.39	3.53
12/9/2009	depth (in)	2	4	4	3	3	3	3	5	3	3	8	5	4	2	3	5	3	3	6	5			3.85	9.78
	density (g/cm^3)	0.2095	0.2716																				0.24		
	SWE (in)	1.0477	2.0371																					1.54	3.92
12/16/2009	depth (in)	7	5	7	8	6	5	5	4	5	5	4	7	5	4	4	3	5	7	8	5			5.45	13.84
	density (g/cm^3)	0.2915	0.2336																				0.26		
	SWE (in)	2.0405	1.4016																					1.72	4.37
12/21/2009	depth (in)																								
	density (g/cm^3)																								
	SWE (in)																								
12/28/2009	depth (in)	6	5	7	6	3	6	5	3	5	3	2	5	8	7	3	5	3	5	5	3			4.75	12.07
	density (g/cm^3)																								
	SWE (in)																								
1/6/2009	depth (in)	6	6	7	8	9	7	8	4	6	6	7	8	7	6	9	9	10	6	8	9			7.30	18.54
	density (g/cm^3)	0.269	0.328																				0.30		
	SWE (in)	2.15	2.872																					2.51	6.38
1/12/2009	depth (in)	5	8	12	8	5	10	10	7	5	8	6	8	6	7	5	10	8	7	4	9			7.40	18.80
	density (g/cm^3)	0.27	0.178																				0.22		
	SWE (in)	1.621	0.89																					1.26	3.19
1/27/2009	depth (in)	9	7	13	10	6	6	12	11	6	6	11	9	8	6	9	9	7	10	8	12			8.75	22.23
	density (g/cm^3)	0.276	0.257																				0.27		
	SWE (in)	2.205	1.8																					2.00	5.09

Lower Foothills

Meltwater 19

Date																							average		
																							g/cm^3	in	cm
11/3/2009	depth (in)	5	4	4	5	6	5	5	4	4	5	4	6	3	6	5	6	5	5	5	5			4.85	12.32
	density (g/cm^3)	0.12	0.15																				0.13		
	SWE (in)	0.72	0.87																					0.80	2.02
11/17/2009	depth (in)	3	4	4	5	5	5	6	4	4	4	4	6	3	6	5	3	6	4	5	4			4.50	11.43
	density (g/cm^3)	0.15	0.24																				0.19		
	SWE (in)	0.75	1.20																					0.97	2.47
12/1/2009	depth (in)	5	5	8	6	6	4	7	5	4	4	3	3	2	2	4	6	5	6	6	4			4.75	12.07
	density (g/cm^3)	0.3243	0.2787																				0.30		
	SWE (in)	1.6214	2.9268																					2.27	5.78
12/8/2009	depth (in)	8	4	3	7	5	7	7	7	5	6	4	5	7	5	5	8	5	5	5	4			5.60	14.22
	density (g/cm^3)	0.2494	0.2992																				0.27		
	SWE (in)	1.6214	1.3466																					1.48	3.77
12/15/2009	depth (in)	8	10	12	12	10	9	6	5	5	4	3	6	5	8	7	7	9	9	10	8			7.65	19.43
	density (g/cm^3)	0.2482	0.2279																				0.24		
	SWE (in)	0.9928	1.3672																					1.18	3.00
12/22/2009	depth (in)	10	7	7	7	7	7	11	8	9	7	7	8	6	8	6	6	5	6	7	6			7.25	18.42
	density (g/cm^3)	0.275	0.316																				0.30		
	SWE (in)	1.515	2.054																					1.78	4.53
12/30/2009	depth (in)	2	3	5	3	7	7	9	7	4	3	7	5	6	7	5	5	4	5	5	3			5.10	12.95
	density (g/cm^3)	0.219	0.286																				0.25		
	SWE (in)	0.766	1.573																					1.17	2.97
1/6/2009	depth (in)	8	8	8	7	9	12	11	9	8	7	8	9	11	9	11	10	9	7	7	7			8.75	22.23
	density (g/cm^3)	0.304	0.29																				0.30		
	SWE (in)	3.037	2.027																					2.53	6.43
1/13/2009	depth (in)	11	11	5	9	8	7	7	10	8	4	8	11	11	6	7	10	11	6	8	13			8.55	21.72
	density (g/cm^3)	0.321	0.266																				0.29		
	SWE (in)	3.212	2.13																					2.67	6.78

Eastern Coastal Area

UAF 411 Mile

Date																						average		
																						g/cm^3	in	cm
11/4/2009	depth (in)	5	5	4	5	4	5	5	5	2	4	5	5	5	4	4	3	4	5	3	4		4.30	10.92
	density (g/cm^3)	0.27	0.12																			0.20		
	SWE (in)	1.35	0.49																				0.92	2.33
11/18/2009	depth (in)	4	3	4	5	4	5	4	3	6	3	4	4	5	5	6	5	4	4	6	6		4.50	11.43
	density (g/cm^3)	0.25	0.23																			0.24		
	SWE (in)	1.50	1.53																				1.51	3.84
12/2/2009	depth (in)	10	8	11	10	11	15	15	14	9	10	9	9	9	9	7	7	7	9	9	5		9.65	24.51
	density (g/cm^3)	0.2679	0.2873																			0.28		
	SWE (in)	1.8756	2.4424																				2.16	5.48
12/10/2009	depth (in)	9	6	7	8	7	7	6	8	6	8	3	6	8	6	9	6	6	9	7	9		7.05	17.91
	density (g/cm^3)	0.3259	1.7313																			1.03		
	SWE (in)	2.281	3.4627																				2.87	7.29
12/16/2009	depth (in)	3	5	5	7	7	7	7	7	6	7	8	7	7	7	7	8	7	7	7	7		6.65	16.89
	density (g/cm^3)	0.1894	0.3035																			0.25		
	SWE (in)	1.5149	1.6695																				1.59	4.04
12/21/2009	depth (in)	6	6	7	7	9	8	6	7	5	6	6	9	9	9	6	8	7	6	8	8		7.15	18.16
	density (g/cm^3)	0.372	0.309																			0.34		
	SWE (in)	3.535	2.161																				2.85	7.23

Eastern Coastal Area

P Pad

Date																						average		
																						g/cm^3	in	cm
11/2/2009	depth (in)	3	4	4	4	4	4	4	4	3	5	5	5	4	3	4	5	4	6	3	4		4.10	10.41
	density (g/cm^3)	0.12	0.27																			0.19		
	SWE (in)	0.47	1.34																				0.91	2.30
11/16/2009	depth (in)	3	4	4	4	4	3	5	4	4	7	4	4	3	4	6	4	4	4	5	6		4.30	10.92
	density (g/cm^3)	0.20	0.26																			0.23		
	SWE (in)	1.00	0.79																				0.89	2.27
11/30/2009	depth (in)	9	9	8	4	4	4	3	3	3	3	2	5	5	4	5	5	5	7	5	4		4.85	12.32
	density (g/cm^3)	0.123	0.1391																			0.13		
	SWE (in)	0.6767	0.5565																				0.62	1.57
12/7/2009	depth (in)	6	7	5	6	4	3	9	5	6	6	7	10	6	6	5	5	10	6	5	4		6.05	15.37
	density (g/cm^3)	0.3062	0.2519																			0.28		
	SWE (in)	2.1435	1.5115																				1.83	4.64
12/14/2009	depth (in)	3	7	6	7	13	13	11	6	8	6	5	11	10	6	8	13	13	14	13	16		9.45	24.00
	density (g/cm^3)	0.3023	0.2948																			0.30		
	SWE (in)	2.2672	3.3905																				2.83	7.19

Eastern Coastal Area

T Pad

Date																						average		
																						g/cm^3	in	cm
11/2/2009	depth (in)	4	4	5	4	3	5	4	4	3	3	4	4	4	3	4	4	4	4	4	4		3.90	9.91
	density (g/cm^3)	0.30	0.15																			0.23		
	SWE (in)	1.50	0.60																				1.05	2.68
11/16/2009	depth (in)	4	2	4	2	3	5	4	5	4	4	4	5	4	5	5	3	5	1	5	4		3.90	9.91
	density (g/cm^3)	0.19	0.40																			0.30		
	SWE (in)	0.94	1.81																				1.38	3.49
11/30/2009	depth (in)	4	8	6	4	6	5	4	4	5	5	4	4	4	7	4	4	7	6	5	4		5.00	12.70
	density (g/cm^3)	0.3263	0.1331																			0.23		
	SWE (in)	1.958	0.5325																				1.25	3.16
12/7/2009	depth (in)	3	4	3	5	5	4	3	3	4	5	2	3	4	4	7	3	4	4	4	4		3.90	9.91
	density (g/cm^3)	0.0593	0.2142																			0.14		
	SWE (in)	0.237	1.1783																				0.71	1.80
12/14/2009	depth (in)	4	6	5	5	7	5	5	5	5	6	5	6	5	6	6	6	6	6	4	7		5.50	13.97
	density (g/cm^3)	0.3037	0.3641																			0.33		
	SWE (in)	2.2775	4.1875																				3.23	8.21
12/20/2009	depth (in)	11	12	12	12	12	12	9	6	5	6	6	8	9	8	10	7	9	8	10	7		8.95	22.73
	density (g/cm^3)	0.286																				0.29		
	SWE (in)	2.147																					2.15	5.45

Eastern Coastal Area

Term Well A

Date																						average		
																						g/cm^3	in	cm
11/2/2009	depth (in)	4	5	4	6	8	5	6	3	6	7	7	4	7	7	6	6	5	7	5	7		5.75	14.61
	density (g/cm^3)	0.14	0.38																			0.26		
	SWE (in)	0.84	3.46																				2.15	5.46
11/16/2009	depth (in)	4	5	3	5	3	2	4	5	4	4	3	4	4	3	4	4	3	3	3	6		3.80	9.65
	density (g/cm^3)	0.23	0.19																			0.21		
	SWE (in)	0.92	0.74																				0.83	2.11
11/30/2009	depth (in)	5	5	5	5	5	7	5	5	5	4	5	5	4	5	3	4	4	5	5	5		4.80	12.19
	density (g/cm^3)	0.2473	0.2205																			0.23		
	SWE (in)	0.9893	1.2126																				1.10	2.80
12/7/2009	depth (in)	5	4	2	3	4	5	3	5	8	5	8	5	2	8	4	5	7	4	5	6		4.90	12.45
	density (g/cm^3)	0.2343	0.2693																			0.25		
	SWE (in)	1.1714	1.3466																				1.26	3.20
12/14/2009	depth (in)	6	6	5	7	5	4	5	8	7	7	6	5	4	6	6	7	8	7	5	7		6.05	15.37
	density (g/cm^3)	0.2782	0.1965																			0.24		
	SWE (in)	1.3912	0.9825																				1.19	3.01
12/20/2009	depth (in)	7	7	7	8	7	6	7	6	6	6	5	5	6	5	6	5	6	6	7	6		6.20	15.75
	density (g/cm^3)	0.244																				0.24		
	SWE (in)	1.096																					1.10	2.78

Eastern Coastal Area

DS 16

Date																							average		
																							g/cm^3	in	cm
11/2/2009	depth (in)	7	7	4	6	6	6	6	6	6	6	4	6	6	5	5	6	6	6	6	4			5.70	14.48
	density (g/cm^3)	0.31	0.38																				0.35		
	SWE (in)	1.85	2.31																					2.08	5.28
11/16/2009	depth (in)	7	7	7	6	5	7	2	7	8	4	7	3	6	6	3	6	4	5	5	3			5.40	13.72
	density (g/cm^3)	0.50	0.40																				0.45		
	SWE (in)	4.03	2.57																					3.30	8.39
11/30/2009	depth (in)	7	6	3	5	6	4	5	7	7	7	5	7	5	7	6	8	9	10	11	12			6.85	17.40
	density (g/cm^3)	0.3626	0.3237																				0.34		
	SWE (in)	3.2634	1.4565																					2.36	5.99
12/7/2009	depth (in)	6	3	6	6	7	5	6	6	7	9	4	5	7	6	5	6	6	6	6	5			5.85	14.86
	density (g/cm^3)	0.3203	0.2933																				0.31		
	SWE (in)	2.0817	1.9065																					1.99	5.07
12/14/2009	depth (in)	9	10	7	11	9	9	9	8	10	6	7	7	8	8	9	10	8	10	9	9			8.65	21.97
	density (g/cm^3)	0.3187	0.3298																				0.32		
	SWE (in)	2.8684	3.4627																					3.17	8.04

Eastern Coastal Area

ANFO Pad

Date																						average		
																						g/cm^3	in	cm
11/2/2009	depth (in)	2	3	2	2	3	1	2	1	2	2	2	2	2	2	2	3	2	2	2	2		2.05	5.21
	density (g/cm^3)																							
	SWE (in)																							
11/16/2009	depth (in)	4	3	3	3	2	4	3	3	2	2	4	2	4	3	3	3	3	3	3	3		3.00	7.62
	density (g/cm^3)	0.47	0.34																			0.40		
	SWE (in)	1.40	1.01																				1.21	3.06
11/30/2009	depth (in)	5	4	4	4	3	3	4	3	4	5	5	5	6	4	4	3	3	5	4	3		4.05	10.29
	density (g/cm^3)	0.3135	0.1709																			0.24		
	SWE (in)	1.2538	0.6836																				0.97	2.46
12/7/2009	depth (in)	2	4	3	3	4	3	4	3	4	4	2	4	3	4	3	4	2	3	5	3		3.35	8.51
	density (g/cm^3)	0.3355	0.3445																			0.34		
	SWE (in)	1.0065	1.2057																				1.11	2.81
12/14/2009	depth (in)	6	7	5	7	6	6	6	6	6	5	7	8	7	8	7	8	8	8	5	5		6.55	16.64
	density (g/cm^3)	0.3092	0.3362																			0.32		
	SWE (in)	2.1642	2.6897																				2.43	6.16
12/20/2009	depth (in)	4	5	4	5	5	5	6	5	7	8	5	7	6	7	7	7	7	7	7	8		6.10	15.49
	density (g/cm^3)	0.391	0.297																			0.34		
	SWE (in)	2.93	1.189																				2.06	5.23

Western Coastal Area

DS-2L (ASTAC)

Date																							average		
																							g/cm^3	in	cm
11/3/2009	depth (in)	7	4	5	7	4	8	7	4	6	5	5	6	4	8	6	6	5	8	5	6			5.80	14.73
	density (g/cm^3)	0.18	0.21																				0.19		
	SWE (in)	1.06	1.46																					1.26	3.21
11/17/2009	depth (in)	5	5	5	4	5	4	5	5	5	6	6	5	6	6	6	6	6	5	5	5			5.25	13.34
	density (g/cm^3)	0.29	0.13																				0.21		
	SWE (in)	1.75	0.78																					1.26	3.21
12/1/2009	depth (in)	4	6	6	6	6	6	5	5	5	5	6	6	4	5	4	7	6	5	4	6			5.35	13.59
	density (g/cm^3)	0.2503	0.1434																				0.20		
	SWE (in)	2.0027	0.5737																					1.29	3.27
12/8/2009	depth (in)	4	4	6	5	5	4	3	6	4	7	5	6	6	6	4	5	5	5	5	4			4.95	12.57
	density (g/cm^3)	0.3061	0.1961																				0.25		
	SWE (in)	1.3775	1.0786																					1.23	3.12
12/15/2009	depth (in)	8	6	9	6	5	6	10	9	7	9	8	6	7	7	7	8	8	6	9	8			7.45	18.92
	density (g/cm^3)	0.217	0.238																				0.23		
	SWE (in)	1.8447	1.3088																					1.58	4.00
12/21/2009	depth (in)																								
	density (g/cm^3)																								
	SWE (in)																								
12/30/2009	depth (in)	5	5	4	6	6	6	5	5	5	4	7	7	5	4	6	6	6	6	5	4			5.35	13.59
	density (g/cm^3)	0.295	0.131																				0.21		
	SWE (in)	1.178	0.591																					0.88	2.25

Western Coastal Area

Palm 2

Date																							average		
																							g/cm^3	in	cm
11/3/2009	depth (in)	5	5	5	5	7	6	3	5	6	6	6	4	5	6	6	5	5	6	7	4			5.35	13.59
	density (g/cm^3)	0.25	0.25																				0.25		
	SWE (in)	1.25	1.76																					1.50	3.82
11/17/2009	depth (in)	5	5	4	5	5	6	5	5	5	5	3	5	5	5	5	5	7	4	4	4			4.85	12.32
	density (g/cm^3)	0.20	0.22																				0.21		
	SWE (in)	0.79	1.32																					1.06	2.68
12/1/2009	depth (in)	6	5	4	5	6	6	6	7	8	7	8	8	9	7	9	9	7	7	10	10			7.20	18.29
	density (g/cm^3)	0.3394	0.2968																				0.32		
	SWE (in)	1.697	2.226																					1.96	4.98
12/10/2009	depth (in)	6	6	6	5	6	6	7	5	6	6	8	5	3	6	5	8	5	6	5	6			5.80	14.73
	density (g/cm^3)	0.1903	0.3676																				0.28		
	SWE (in)	0.9515	2.2054																					1.58	4.01
12/15/2009	depth (in)	7	7	7	7	7	8	6	6	7	6	7	6	7	5	5	6	7	7	6	7			6.55	16.64
	density (g/cm^3)	0.2724	0.1643																				0.22		
	SWE (in)	1.9065	0.9859																					1.45	3.67

Western Coastal Area

Ugnu

Date																							average		
																							g/cm^3	in	cm
11/3/2009	depth (in)	4	9	3	5	5	3	8	3	4	2	3	4	4	4	3	5	5	4	4	3			4.25	10.80
	density (g/cm^3)	0.29	0.29																				0.29		
	SWE (in)	1.45	1.16																					1.31	3.32
11/17/2009	depth (in)	6	4	3	5	3	5	6	6	5	3	4	4	3	3	4	3	5	3	3	3			4.05	10.29
	density (g/cm^3)	0.38	0.17																				0.28		
	SWE (in)	1.90	0.69																					1.29	3.28
12/1/2009	depth (in)	8	10	11	8	6	5	6	3	3	4	3	2	3	4	3	3	4	3	4	4			4.85	12.32
	density (g/cm^3)	0.4024	0.3401																				0.37		
	SWE (in)	4.2253	1.0202																					2.62	6.66
12/10/2009	depth (in)	7	4	5	5	5	4	4	5	3	3	3	4	4	5	3	3	4	3	3	5			4.10	10.41
	density (g/cm^3)	0.1659	0.2425																				0.20		
	SWE (in)	0.5805	1.2126																					0.90	2.28
12/15/2009	depth (in)	7	6	5	3	3	6	11	6	6	3	5	9	6	11	6	5	9	6	11	6			6.50	16.51
	density (g/cm^3)	0.3504	0.3734																				0.36		
	SWE (in)	2.2775	3.1741																					2.73	6.92

Western Coastal Area

DS-1J

Date																							average		
																							g/cm^3	in	cm
11/3/2009	depth (in)	3	3	5	4	3	4	2	3	3	5	5	2	3	2	5	4	4	4	3	4			3.55	9.02
	density (g/cm^3)	0.21	0.17																				0.19		
	SWE (in)	1.05	0.52																					0.78	1.99
11/17/2009	depth (in)	10	9	5	6	7	9	13	6	6	5	11	7	8	10	5	9	3	5	9	6			7.45	18.92
	density (g/cm^3)	0.26	0.32																				0.29		
	SWE (in)	1.81	2.69																					2.25	5.72
12/1/2009	depth (in)	5	5	3	4	6	4	5	4	6	8	8	9	10	7	8	7	7	9	8	9			6.60	16.76
	density (g/cm^3)	0.353	0.5377																				0.45		
	SWE (in)	3.7066	5.1081																					4.41	11.19
12/10/2009	depth (in)	4	3	4	3	3	3	4	4	5	4	4	3	5	2	6	4	7	5	5	4			4.10	10.41
	density (g/cm^3)	0.1649	0.3944																				0.28		
	SWE (in)	0.4947	1.9718																					1.23	3.13
12/15/2009	depth (in)	9	7	7	10	10	10	10	9	11	9	13	10	11	10	10	6	8	11	11	9			9.55	24.26
	density (g/cm^3)	0.3176	0.3756																				0.35		
	SWE (in)	3.4936	3.9436																					3.72	9.45

Western Coastal Area

S Pad

Date																							average		
																							g/cm^3	in	cm
11/3/2009	depth (in)	5	2	3	6	4	3	3	4	6	7	4	2	4	4	3	4	3	6	4	5			4.10	10.41
	density (g/cm^3)																								
	SWE (in)																								
11/17/2009	depth (in)	4	5	5	6	7	3	5	6	6	6	3	5	6	8	7	4	5	6	7	6			5.50	13.97
	density (g/cm^3)	0.58	0.21																				0.39		
	SWE (in)	3.76	0.92																					2.34	5.95
12/1/2009	depth (in)	3	4	4	4	5	5	5	6	6	5	6	8	6	6	6	7	5	7	4	3			5.25	13.34
	density (g/cm^3)	0.1518	0.2191																				0.19		
	SWE (in)	0.8347	0.9859																					0.91	2.31
12/8/2009	depth (in)	5	4	4	3	3	4	4	3	3	4	3	5	3	3	5	7	4	4	4	4			3.95	10.03
	density (g/cm^3)	0.1718	0.2061																				0.19		
	SWE (in)	0.8588	1.0306																					0.94	2.40
12/14/2009	depth (in)	6	7	6	6	7	8	8	6	5	7	6	7	6	6	6	5	5	6	5	7			6.25	15.88
	density (g/cm^3)	0.3456	0.1345																				0.24		
	SWE (in)	1.7279	0.8073																					1.27	3.22

APPENDIX C. L9312 ELEVATION SURVEY FORM

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

Arctic Transportation Networks
Form F-011: Elevation Survey Form

Project ID: **ATN** Site Location/Lake ID: L9312
Survey Purpose: **Water-Level Elevations** Date: 1/19/2010 Time: 11:35

Location:	Lake L9312, located southeast of Alpine pad, survey by pump house benchmarks							
Survey objective:	Determine FWS Elevation.					Weather Observations:		
Instrument Type:	Leica NA720		Instrument ID:	5482372 (GWS owned)				
Rod Type:	Fiberglass		Rod ID:	Crane Fiber Glass		-43°F, Clear. Slight breeze		
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		Chris (LCMF), Jeff Derry		
L9312"P"	CP	11.73	na	na				
Station	**BS (ft)**	**HI (ft)**	**FS (ft)**	**Elevation (fasl)**	**Distance (ft)**	**Horizontal Angle**	**Vertical Angle**	**Remarks**
TBM "P"	2.49	14.22		11.73				Top of inlet pipe support
TBM "O"		14.22	2.78	11.44				Top of inlet pipe support. BM Elev=11.44'
99-32-59		14.22	-0.31	14.53				Top of Pumphouse SE VSM. BM Elev = 14.53
L9312 WL		14.22	7.03	**7.19**				
Turn on L9312 Ice								
L9312 WL	6.87	14.06		7.19				**WL = 7.19**
99-32-59		14.06	-0.47	14.53				
TBM"O"		14.06	2.62	11.44				
TBM"P"		14.06	2.33	11.73				close survey to 0.00'

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

APPENDIX D. LAKE ICE PHYSICAL MEASURMENTS

The following form reports physical measurements pertaining to lake ice obtained during field sampling.

Arctic Transportation Networks Project

FORM F-005: WATER-LEVEL MEASUREMENT FORM

Lake or Site ID: **Toolik Lake**

Local Number:

	Survey ID	NAD83	
All measurements in feet, unless noted	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (dd-mm.mmm)
	2382 ft.	N 68° 37.729'	W 149° 36.083'

Vertical-Datum Corrections, reference survey notes in site folders

ABBREVIATIONS

BOI, bottom of ice
Calib, used to calibrate PT
IS, ice surface
LB, lake bottom
LS, land surface
MP, measuring point
N/A, not available
WS, water surface
WD, water depth

Date	Time	Method	Snow Depth	Total Depth IS to LB	Estimated Error	Ice Thickness (IS to BOI)	Freeboard (IS to WS)	WD	IS Elevation	Remarks
1/14/10	13:27	Levels	0.417'	19.383'	+/- 0.01	2.4'	0.083'	19.3'		

Collected Data Values

Lake-Full Elevation = measured at staff gage or near vertical benchmark after lake outflow ceased following spring snowmelt
Freeboard (FB) = Height of ice level over water level in open hole
Ice Thickness (IT) = Measured distance between top and bottom of ice
Total Depth (TD) = Measured distance from water surface to lake bottom
Estimated Error = Field estimate of water level measurement error

Calculated Values

Ice Surface (IS) Elevation = Water Elevation + Freeboard
Ice Bottom (IB) Elevation = Ice Surface Elevation - Ice Thickness

Arctic Transportation Networks Project

FORM F-005: WATER-LEVEL MEASUREMENT FORM

Lake or Site ID: **L9312**
Local Number: Survey ID NAD83

All measurements in feet, unless noted	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (dd-mm.mmm)
	7.00	N 70° 19.995'	W 150° 56.918'

Vertical-Datum Corrections, reference survey notes in site folders

Date	MP ID	MP Elevation (feet above BP Sea Level)	
3/26/2004	"P"	11.61	
1/16/2006	"P"	11.73	(BM elevation adjusted)

ABBREVIATIONS
BOI, bottom of ice
Calib, used to calibrate PT
IS, ice surface
LB, lake bottom
LS, land surface
MP, measuring point
N/A, not available
WS, water surface

Date	Time	Method	Snow Depth	Total Depth IS to LB	Estimated Error	Ice Thickness (IS to BOI)	Freeboard (IS to WS)	WS Elevation	IS Elevation	Remarks
11/18/09	17:27	Levels	0.04	6.95	+/- 0.01	1.58	0.04	7.26		
12/7/09	13:00	Levels	0.2	10.55	+/- 0.01	2.26	0.00	7.28		
1/19/10	10:00	Levels	0.44	8.20	+/- 0.01	nm	0.00	7.19		
Likely an error in ice thickness measurement on 1/19/10, needs to be verified on later visits and LCMF data.										

Collected Data Values
Lake-Full Elevation = measured at staff gage or near vertical benchmark after lake outflow ceased following spring snowmelt
Freeboard (FB) = Height of ice level over water level in open hole
Ice Thickness (IT) = Measured distance between top and bottom of ice
Total Depth (TD) = Measured distance from water surface to lake bottom
Estimated Error = Field estimate of water level measurement error

Calculated Values
Ice Surface (IS) Elevation = Water Elevation + Freeboard
Ice Bottom (IB) Elevation = Ice Surface Elevation - Ice Thickness