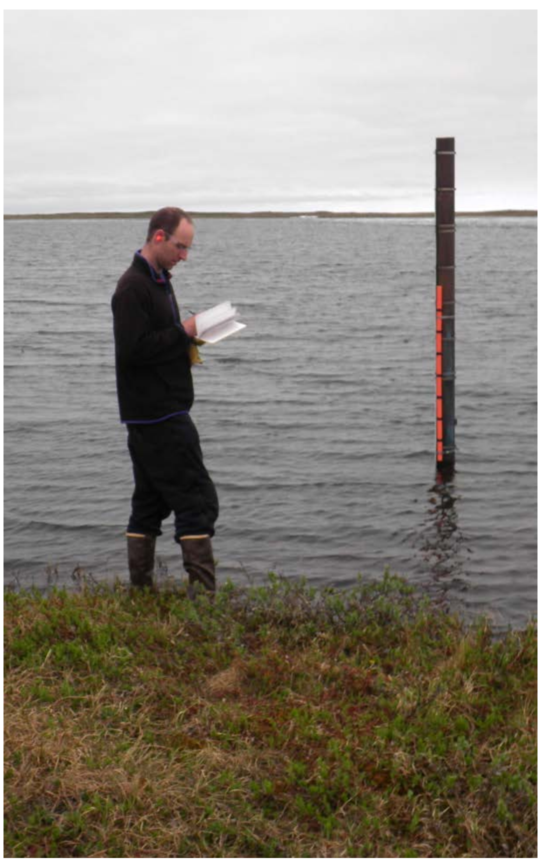
Final Alpine Area Lakes Recharge Studies

2012



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ACRONYMS AND ABBREVIATIONS

ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
Baker	Michael Baker Jr., Inc.
BPMSL	British Petroleum Mean Sea Level
CPAI	ConocoPhillips Alaska, Inc.
CRD	Colville River Delta
GPS	Global Positioning System
HWM	High Water Mark
LCMF	Umiaq/LCMF, LLC
NAD 83	North American Datum of 1983
NRCS	Natural Resources Conservation Service
Mgal	million gallons
SWE	Snow Water Equivalent
TBM	Temporary Benchmark
WSE	Water Surface Elevation

DEFINITIONS

Bankfull	the water level or stage at which a stream, river or lake is at the top of its banks, and any further rise would result in water moving into the flood plain
Freeboard	the distance from the top of the ice to the water surface
Recharge	replacement of water volumes withdrawn for facilities maintenance/construction of ice roads and pads during the winter season and lost naturally through evaporation and transpiration

1.0 INTRODUCTION

ConocoPhillips Alaska, Inc., (CPAI) withdraws water and ice from lakes within the Colville River Delta (CRD). The use of ice roads and pads during the winter months is necessary for maintenance and operations at the Alpine oil field. This temporary infrastructure supports overland transportation of resources. Winter seasonal construction of ice roads and pads requires withdrawal of millions of gallons of fresh water and ice chips from area lakes, typically between December and May.

To comply with stipulations of Alaska Department of Fish and Game (ADF&G) Fish Habitat Permits and Alaska Department of Natural Resources (ADNR) Temporary Water Use Permits, CPAI conducts studies at water withdrawal lakes to document seasonal recharge. Michael Baker Jr., Inc. (Baker) conducted late season snow surveys and spring lake recharge studies to monitor water levels and provide photo documentation for permit compliance. This report summarizes the hydrologic observations, measurements, and analyses undertaken for this project.

Baker was supported during field monitoring by CPAI Alpine Environmental Coordinators, Umiaq/LCMF, LLC (LCMF), and Bristow Helicopters. All Baker and support team crew members are recognized for their contribution to an incident-free field effort.

1.1 STUDY OVERVIEW

The objectives of the 2012 Alpine Area Lakes Recharge Studies include collection and analysis of spring breakup recharge data at ten water withdrawal lakes.

For the purposes of this report, the lakes are grouped as Detailed Study Lakes (M9602 and M9605) and General Study Lakes. The 2012 study lakes include:

Detailed Study Lakes	
M9602	M9605

General Study Lakes			
M9607	M9525	B8531/L9326	L9324
L9323	B8530	B8534/L9282	B8533

Determination of recharge at all of the study lakes (except B8533) requires pre-breakup and breakup monitoring, collection of water surface elevations (WSE), and photographic evidence of hydrologic connections. The recharge study at Lake B8533 requires only photo documentation of flooding from the Sakoonang Channel slough. Late-season snow surveys and calculation of available recharge volumes were conducted for the Detailed Study Lakes, M9602 and M9605.

The location of each lake in relation to other relevant features within the study area is shown in Figure 1.1.

ConocoPhillips
Alaska

Miles
0 1.5 3

Date: 07/12/2012	Project: 127660
Drawn: BTG	File: Figure 1.1
Checked: SME	Scale: 1 in = 1.5 miles

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2012 ALPINE AREA LAKES

RECHARGE STUDIES

MONITORING LOCATIONS

FIGURE: 1.1

(SHEET 1 of 1)

Staff gages were used to measure WSE. Lake recharge was determined using hydrographs, visual observations, and analysis of photos focusing on key hydrologic features, including peak water levels, hydraulic connectivity with other bodies of water, and inflow/outflow locations. The B8533 recharge study required only photo documentation of flooding from the Sakoonang Channel slough. A gage was not installed at this location and WSE was not measured.

Delineation of lake catchment basins and determination of basin-specific snow water equivalent (SWE) values were performed for lakes M9602 and M9605 to calculate the 2012 potential snowmelt contribution and estimated recharge volumes. Catchment basins were delineated prior to field investigations using available topography and aerial imagery. Basin-specific SWE was calculated using data collected during late-season snow surveys performed prior to breakup. Potential snowmelt contribution was calculated using SWE values and delineated catchment basin areas. Estimated recharge volumes were calculated using WSE data and delineated lake specific area.

1.2 Lake Recharge Background

Annual recharge of lakes in the CRD occurs as a result of three primary mechanisms: spring breakup flooding, snow melt, and precipitation. Of these, spring breakup flooding and snow melt were investigated for this report and are considered overland flow. Lake elevation, proximity to streams, and local topography typically dictate the recharge mechanism. Lakes located within annually inundated stream floodplains or otherwise hydraulically connected areas recharge primarily from spring breakup flood flows. Lakes not inundated by flood flow because of distance or topographical limitations depend solely on snowmelt runoff and precipitation for recharge.

Lake recharge varies annually. The magnitude of spring breakup flooding differs from year to year in terms of stage and discharge. If flood stage is relatively low, recharge may not occur depending on topography and elevation. In addition to spring flooding, flow extents are affected by the unpredictable establishment and release of ice jams during breakup. Presence and location of ice jams can determine whether or not a lake becomes hydraulically connected to a stream recharge source regardless of flood magnitude.

The amount of snowmelt runoff a lake receives depends on terrain, topography, and the properties of the snow in the catchment basin. SWE of a basin can be determined by the depth and density of snow available within a catchment in the spring when melting occurs and is directly proportional to the quantity of potential snowmelt recharge. SWE will vary with the type of terrain and may be presented as a weighted, basin-specific value. For lakes sharing similar topographical and climatological features with those previously studied, average SWE values may be multiplied by catchment basin area to calculate a conservative estimate of potential snowmelt recharge. This method was previously used for lakes M9602 and M9605 (Baker 2010); a comparison of the 2010, 2011, and 2012 results is included in section 4.1.5.

In this study, the lake catchment basin terrain is designated as lake or tundra. Snowmelt contribution from lakes may be reduced to account for the potential of floating ice to displace water and artificially inflate WSE. Lake areas were assumed to contribute all snowmelt based on analysis of snow survey data and estimated recharge volumes. However, all tundra snowmelt will not directly contribute to lake recharge because of variations in vegetation and topography relative to the lake. Lower wetlands areas, for example, may retain a portion of snowmelt with recharge contribution dependent on snowmelt quantities and wetland elevation relative to the lake. The quantity of snowmelt retained in tundra areas differs for each lake catchment basin.

Kane et al. (1999) performed a study in the Kuparuk River Basin to determine an average quantity of snowmelt retained in tundra areas of lake catchment basins as a percentage of total potential snowmelt contribution based on estimated recharge quantities. Study findings suggest applying an average runoff coefficient of 0.67 to tundra SWE as a reduction factor to account for snowmelt retention.

In 2007, Baker performed a recharge monitoring study for lakes within the CRD. Results suggested an average tundra SWE runoff coefficient of 0.67, further validating the value obtained by Kane et al. (Baker 2007). Similar topography and proximity to the CRD and Kuparuk River basins justifies using a runoff coefficient of 0.67 for calculating the total estimated snowmelt contribution for lakes M9602 and M9605.

2.0 PERMITS AND WATER USE

The ten study lakes included in this report are permitted for water use by the ADNR, ADF&G, or both. Permits are granted on the condition of CPAI compliance with fish habitat and temporary water use requirements to regulate water withdrawal and maintain conditions supportive of fish habitat. To maintain fish habitat, lakes must seasonally recharge water volumes borrowed during the winter season and lost naturally through evaporation. Fish Habitat and Temporary Water Use permits stipulate the quantities of water that may be withdrawn each water year. Water year is defined as one year beginning and ending with spring breakup. Actual withdrawal quantities are reported by the user per water year. Maximum water withdrawal by CPAI is less than or equal to the lesser allowable quantity if two permits are issued for one lake.

The permits regulating use at the ten study lakes additionally specify the form of water that may be borrowed from each lake, which varies as either liquid only, specific quantities of liquid and ice, or a total of both without designation of individual quantities. Lakes M9602, M9605, and M9525 were permitted for specific borrow quantities of liquid and ice. Lakes B8534/L9282 and B8530 are permitted for liquid use only, and lakes L9323, L9324, B8531/L9326, B8533, and M9607 are permitted for a total of both without designation of individual quantities. Ice aggregate removal is permitted only over naturally grounded ice.

Water and ice was withdrawn from eight of the ten study lakes during the 2011/2012 ice road construction season. Lakes B8534/L9282 and M9525 were not used as water sources. During the 2011/2012 season, lakes M9602 and M9605 were used as water and ice sources. Water withdrawal occurred at the remaining Alpine recharge study lakes.

Table 2.1 summarizes the permits regulating water use and purpose at the ten source lakes. The permitted versus actual withdrawal volumes by form are included in Table 2.1 and are based on fourth quarter 2011 and first and second quarter 2012 water use reports (CPAI 2011, 2012a, and 2012b).

Table 2.1: Summary of Permitted and Actual Withdrawal Volumes

Lake	Permit		Permit Expiration	Water Use Purpose	Permitted Volume[1]			Withdrawal Volume[3]		
	ADF&G	ADNR			Liquid	Ice	Total Water[2]	Liquid	Ice	Total Water
					(mgal)			(mgal)		
M9602	FH05-III-0327 #2	TWUP A2010-119 ICE	12/2/2015	Ice Road/Pad	0.78	30.63	31.41	0.08	1.42	1.5
M9605	FH05-III-0328 #2	TWUP A2010-119 H2O TWUP A2010-119 ICE	12/2/2015	Ice Road/Pad	8.52	13.62	22.14	7.51	2.63	10.14
B8534/L9282	FG02-III-0104 #1	LAS 23897	5/13/2013	Unknown	10	--	10	--	--	--
M9525	FG03-III-0379 #2	TWUP A2008-180	12/31/2013	Unknown	0.02	3.49	3.51	--	--	--
L9323	FG03-III-0380 #3	LAS 18597, TWUP A2008-181	5/15/02 12/16/2013	Drilling Makeup, Camp Supply, DS/Wells, Dust Control, Ice Road/Pad	--	--	8.51	2.6	--	2.6
L9324	FG03-III-0381 #3	TWUP A2008-181	12/16/2013	Ice Road/Pad	--	--	1.65	1.01	--	1.01
B8531/L9326	FG03-III-0382 #1	TWUP A2008-180	12/16/2013	Ice Road/Pad	--	--	6.59	2.36	--	2.36
B8530	FG03-III-0383 #1	TWUP A2008-180	12/16/2013	Ice Road/Pad	32	--	32	6.1	--	6.1
B8533	FH03-III-0377 #1	TWUP A2011-153	12/5/2016	Ice Road/Pad, DS/Wells	--	--	32.22	27.62	--	27.62
M9607	FG03-III-0384 #3	TWUP A2008-180	12/16/2013	Ice Road/Pad	--	--	5.47	2.59	--	2.59

Notes:
1. Per water year
2. Total permitted withdrawal may be either ice, water or a combination
3. Total withdrawal volume between June 1, 2011 and May 31, 2012

3.0 Study Methods

3.1 Catchment Basin Area Delineation (Detailed Study Lakes)

The catchment basins including lake and tundra areas for lakes M9602 and M9605 were delineated using satellite imagery, topographic maps, and visual assessment of the local topography prior to the field study. Topographic data for this area is limited, and the catchment basin delineation for both lakes is subjective as a result. In addition to limited topography, seasonal data about nearby water bodies such as wetlands and ponds that potentially contribute to recharge flow in the lakes is lacking. These areas have additional capacity and were not included within the catchment basin delineation.

3.2 Water Surface Elevation Surveys

To estimate lake water recharge, changes in WSE were measured at each study lake except B8533. Prior to spring breakup 2011, a staff gage was installed at the edge of each lake and tied in to either local control or British Petroleum Mean Sea Level (BPMSL) control if available within a reasonable distance. Gages were assessed and rehabilitated as needed for 2012 and additional gages were installed as necessary as breakup progressed. WSE monitoring was conducted at nine study lakes during the pre-breakup, breakup, and post-breakup periods.

A staff gage assembly consists of a metal gage faceplate mounted on a two-by-four timber. The timber is attached with U-bolts to a 1.5-inch wide angle iron driven approximately 2 feet into the ground. All gages installed are indirect-read staff gages; meaning, the values read on the gage faceplate do not directly correspond to a known elevation. Photo 3.1 shows the gage setup at L9324. A tabulated list of gage and TBM locations is included in Appendix A.

Photo 3.1: Staff gages at Lake L9324, pre-breakup; May 5, 2012

Standard differential leveling techniques were used to establish staff gage elevations with local temporary benchmarks (TBM). A single new TBM was installed when a preexisting TBM was farther than ¼ mile of the study lake. New TBM were all given an assumed elevation of 100.000 feet.

Elevations of the staff gages at lakes M9525, L9323, and L9324 were based on preexisting TBMs tied to BPMSL. Elevations of gages at the remaining six lakes were based on TBMs established in 2010 with assumed elevations of 100.000 feet; therefore, WSE recorded at staff gages tied to assumed elevations are relative. A staff gage tied to an assumed elevation is used to illustrate a change in WSE for a specific lake, and does not provide BPMSL elevations.

Pre-breakup WSE at all lakes except M9525 and B8533 was found by using an electric drill to auger a 2-inch sampling hole in the ice covering the lake. Ice surface elevation was determined through differential leveling. WSE was calculated by subtracting measured freeboard (the distance from the top of ice to the water surface) from the ice surface elevation at the sample hole. Freeboard was measured using a pocket rod.

During site visits, the observed water level on the gage faceplates was recorded. Chalk was applied to the angle iron during each site visit to capture high water marks (HWM). Subsequent HWMs were recorded during field visits when floodwaters removed the chalk. When water levels were not sufficiently high to be recorded on the staff gage face plates, standard differential leveling techniques were used to measure WSE. The horizontal position of each staff gage and TBM was recorded using a handheld GPS in North American Datum of 1983 (NAD83). Gage readings associated with local ponding were recorded, but were not used to generate the lake recharge hydrograph.

3.3 Snow Water Equivalent Surveys (Detailed Study Lakes)

3.3.1 Double Sampling Method

A double sampling method snow survey was conducted on lakes M9602 and Lake M9605, as recommended in various industry papers and the 2007 CRD lakes recharge report (Baker 2007). Prior to fieldwork, snow sampling points were identified along predetermined transects.

Each snow survey transect was positioned to align across or perpendicular to snow features, such as drifts and local topography (Woo 1997). For the double sampling method, measurements were recorded by measuring snow depth and mass at a smaller number of points, and by measuring snow depth at a larger number of points. While vegetation is not a major factor affecting snow distribution in the arctic, terrain has a major effect. Terrain-based snow surveys allow for more accurate determinations of mean catchment snow values and produces sufficient spatial snow information for most hydrological studies (Woo 1997). For the purposes of this study, terrain was identified in the field as either lake (based on the presence of ice) or tundra (based on the presence of vegetation) for each sample collected. Terrain was verified using existing maps in GIS.

3.3.2 Sampling Transects and Points

Aerial imagery and topographic contours were used to delineate the lake catchment basins. Transects were aligned radiating outwards from the estimated center of the lake to the edge of the drainage basin to account for variability of drifted snow across the ice and at and over banks. Additional transects were selected to capture irregularities including basin arms or other departures from a classic bowl shape.

Sampling points were then established along transects at a uniform spacing of approximately 200 feet. The total number of sampling points was dependent on the length of the transect and the anticipated variability in snow within the terrain unit. By placing a sampling point at the intersection of transects and spacing sampling points at a uniform distance along transects, random sampling was accomplished. Each terrain type covered by a single transect included at least one snow mass sampling point. Sampling points were stored in two GPS units.

At the Detailed Study Lakes, isolated mechanically disturbed areas of snow of various size and shapes were encountered. Berms were formed by snow clearing to access lake surface ice for aggregate removal, and by the accumulation of snow drifts. Prior to the survey, additional snow had re-covered previously cleared lake surfaces though not necessarily to the median natural depth. Snowmelt contribution from the berms was considered an additional lake recharge source. A double sampling snow survey was performed to estimate quantities for the berms. Transects were cut across representative features and areas were found by recording circumnavigation tracks in a global positioning system (GPS) unit. Berm snowmelt contribution calculations were performed assuming natural median snow depth on the cleared areas was reached at the time of investigation.

3.3.3 Snow Density Sampling

Density measurements were conducted according to procedures outlined in *National Resource Conservation Service (NRCS) Snow Survey Sampling Guide* (NRCS 2006) and *British of Columbia Snow Survey Manual* (BC Ministry of Environment 1981), using a $1^{5}/_{8}$-inch ID Model 3600 Mt. Rose (Standard Federal) snow sampling tube and scale. This sampler was chosen based on its common acceptance and use by the NRCS. Snow depth alone was sampled using a graduated snow pole. If shallow snow was encountered having a SWE of less than 2 inches, estimated by having a depth of less than one tube section (30 inches), bulk sampling was conducted (NRCS 2006). Bulk sampling is a grouping of multiple samples collected in the immediate area of the sample point, recording sample depth of each sample and averaging, then weighing pooled core samples and dividing by the number of samples collected to determine an average weight for the sample location (Baker 2007). Photo 3.2 shows the Model 3600 Mt. Rose snow sampler and pooled snow samples.

Photo 3.2: Model 360 Mt. Rose Snow Sampler (top) and bucket with pooled snow samples (bottom) with sample holes (2011 file photo); May 3, 2011

3.3.4 SWE Lake Recharge Methods

The methods and equations used in this report for calculating SWE and the potential recharge contribution are the same used in the Baker 2007 report. The two primary terrain types within the catchment basins of lakes M9602 and M9605 are lake and tundra. Terrain-specific average snow depths were collected by field crews using the graduated snow pole (Photo 3.3) and snow sampler at M9602 and M9605. To calculate the terrain specific snow depth for each lake catchment, Equation 1 was used.

Photo 3.3: Field crew taking snow depth measurements with a graduated snow pole; April 23, 2012

Equation 1 - Terrain Specific Snow Depth of Catchment

$$d_i = \left[\sum_{l=1}^{p} d_l \right] \Big/ p$$

$$d_i = \text{Terrain Specific Snow Depth of Catchment } (in)$$
$$l = \text{Individual Sample}$$
$$p = \text{Total Number of Terrain Specific Depth Samples}$$
$$d_l = \text{Measured Snow Depth } (in)$$

Terrain specific average snow densities were then calculated for lakes M9602 and M9605 using the snow sampler's cross sectional area, core depth, and the weights of the snow samples using Equation 2.

Equation 2 – Terrain Specific Snow Density of Catchment

$$\rho_i = \left[\sum_{k=1}^{m} \left(\frac{M_{snow}}{A_{core} d_{snow}} \right)_k \right] \Big/ m$$

$$\rho_i = Terrain\ Specific\ Snow\ Density\ of\ Catchment\ \left(lb/in^3\right)$$
$$k = Individual\ Sample$$
$$m = Total\ Number\ of\ Terrain\ Specific\ Core\ Samples$$
$$M_{snow} = Measured\ Mass\ of\ Snow\ Sample\ (lb)$$
$$A_{core} = Area\ of\ Sampling\ Tube\ \left(in^2\right)$$
$$d_{snow} = Depth\ of\ Snow\ Sample\ (in)$$

Using the terrain specific snow densities, terrain specific SWE were then calculated using Equation 3.

Equation 3 – Terrain Specific Snow Water Equivalent of Catchment

$$SWE_i = \frac{(\rho_i d_i)}{\rho_w}$$

$$SWE_i = Terrain\ Specific\ Snow\ Water\ Equivalent\ of\ Catchment\ (in)$$
$$\rho_i = Terrain\ Specific\ Snow\ Density\ \left(lb/in^3\right)$$
$$d_i = Terrain\ Specific\ Snow\ Depth\ (in)$$
$$\rho_w = Density\ of\ Fresh\ Water\ \left(lb/in^3\right)$$

An area weighted SWE was calculated for Lakes M9602 and M9605 catchment basins using Equation 4. This calculation is based on Woo (1997) and Rovansek, Kane, and Hinzman (1993).

Equation 4 – Catchment Specific, Area Weighted Snow Water Equivalent

$$SWE_C = \frac{\left(\sum_{i=1}^{n} \rho_i d_i A_i \Big/ \sum_{i=1}^{n} A_i \right)}{\rho_w}$$

$$SWE_C = Catchment\ Specific\ Snow\ Water\ Equivalent\ (in)$$
$$i = Terrain$$
$$n = Total\ Terrains\ Sampled\ in\ Catchment$$
$$\rho_i = Terrain\ Specific\ Snow\ Density\ (lb/in^3)$$
$$d_i = Terrain\ Specific\ Snow\ Depth\ (in)$$
$$A_i = Terrain\ Specific\ Area\ (ft^2)$$
$$\rho_w = Density\ of\ Fresh\ Water\ (lb/in^3)$$

Total calculated potential snowmelt contribution (V_P) and estimated recharge (V_O) were found for each lake using Equation 5 and Equation 6.

Equation 5 –Total Calculated Potential Snowmelt Contribution, per Lake

$$V_P = C_1 (SWE_l\ A_l + 0.67\ SWE_t\ A_t)$$

$$V_P = Total\ Calculated\ Potential\ Snowmelt\ Contribution\ (gal)$$
$$C_1 = Gallons\ of\ Water\ /\ ft^3\ /\ in$$
$$SWE_l = Lake\ Specific\ Average\ Snow\ Water\ Equivalent\ (in)$$
$$SWE_t = Tundra\ Specific\ Average\ Snow\ Water\ Equivalent\ (in)$$
$$A_l = Lake\ Specific\ Area\ (ft^2)$$
$$A_t = Tundra\ Specific\ Area\ (ft^2)$$
$$0.67 = 2007\ Delta-wide\ Runoff\ Coefficient$$

Equation 6 – Estimated Recharge, per Lake

$$V_O = C_2\ A_l\ WSE_\Delta$$

$$V_O = Estimated\ \mathrm{Re}charge\ (gal)$$
$$C_2 = Gallons\ of\ Water\ /\ ft^3$$
$$A_l = Lake\ Specific\ Area\ (ft^2)$$
$$WSE_\Delta = Difference\ Between\ \mathrm{Pr}e-Breakup\ and\ Peak\ WSE\ (ft)$$

3.4 Lake Recharge Observations

Throughout breakup each lake was monitored for changes in WSE. Aerial photographs were taken from a helicopter using a GPS camera. Photos were taken from various perspectives to capture the extent of snow melt, flow pattern, potential lake water recharge sources, and hydraulic connectivity with other water bodies. Written documentation of visual observations combined with time-stamped GPS photos support identification of each lake's recharge mechanism(s), extent, and timeline.

Hydrographs showing change in WSE over time were used to determine lake recharge. Recession of floodwaters is evident in a negative slope after peak stage, indicating a lake has recharged over bankfull conditions and is discharging excess water by means of overbank flow. The ten lakes were studied during a pre-breakup through post-breakup monitoring period. WSE was not monitored for a sufficient amount of time after post-breakup to establish a plateau on the hydrograph; a consistent WSE over time is indicative of bankfull elevation.

3.5 2011/2012 Ice Road Contributions

As-built drawings for the 2011/2012 ice road construction season were used to estimate the volume of ice road melt water recharge contributed to lakes M9602 and M9605 catchment basins. Ice road contributions were determined using an estimated value of one million gallons of water per mile of ice road (ASCG 2005).

4.0 STUDY RESULTS

4.1 DETAILED STUDY LAKES

The catchment basin delineations, snow survey and SWE, WSE, lake recharge results, and a comparison of the 2010, 2011, and 2012 results for lakes M9602 and M9605 are presented in this section.

4.1.1 CATCHMENT BASIN DELINEATION

Catchment basin delineations for lakes M9602 and M9605 are presented in Figure 4.1 and Figure 4.2, respectively. The delineations are conservative based on available data (see Section 3.1). Lake areas for M9602 and M9605 were taken from bathymetry reports provided by CPAI in Appendix B.

A small channel conveys flow out of Lake M9602 downstream into Lake M9601 (Photo 4.1) to the northeast until equalization between the two water bodies or reduction of stage occurs. There is no evidence to suggest flow is conveyed in the opposite direction. During breakup monitoring in 2011 and 2012, no overland flow sources were identified as contributing to the recharge of Lake M9602 aside from local snowmelt. The catchment basin delineated in 2011 was not adjusted in 2012.

Photo 4.1: Outflow from Lake M9602 into Lake M9601, looking northwest; June 26, 2012

Hydraulic connections were identified between Lake M9605 and adjacent water bodies, including an outflow channel conveying flow to an unnamed lake to the north (Photo 4.2) and an inflow channel draining a wetlands area to the south (Figure 4.2). The catchment basin delineated in 2011 and used in 2012 includes a portion of this wetland; the area of the basin is likely conservative.

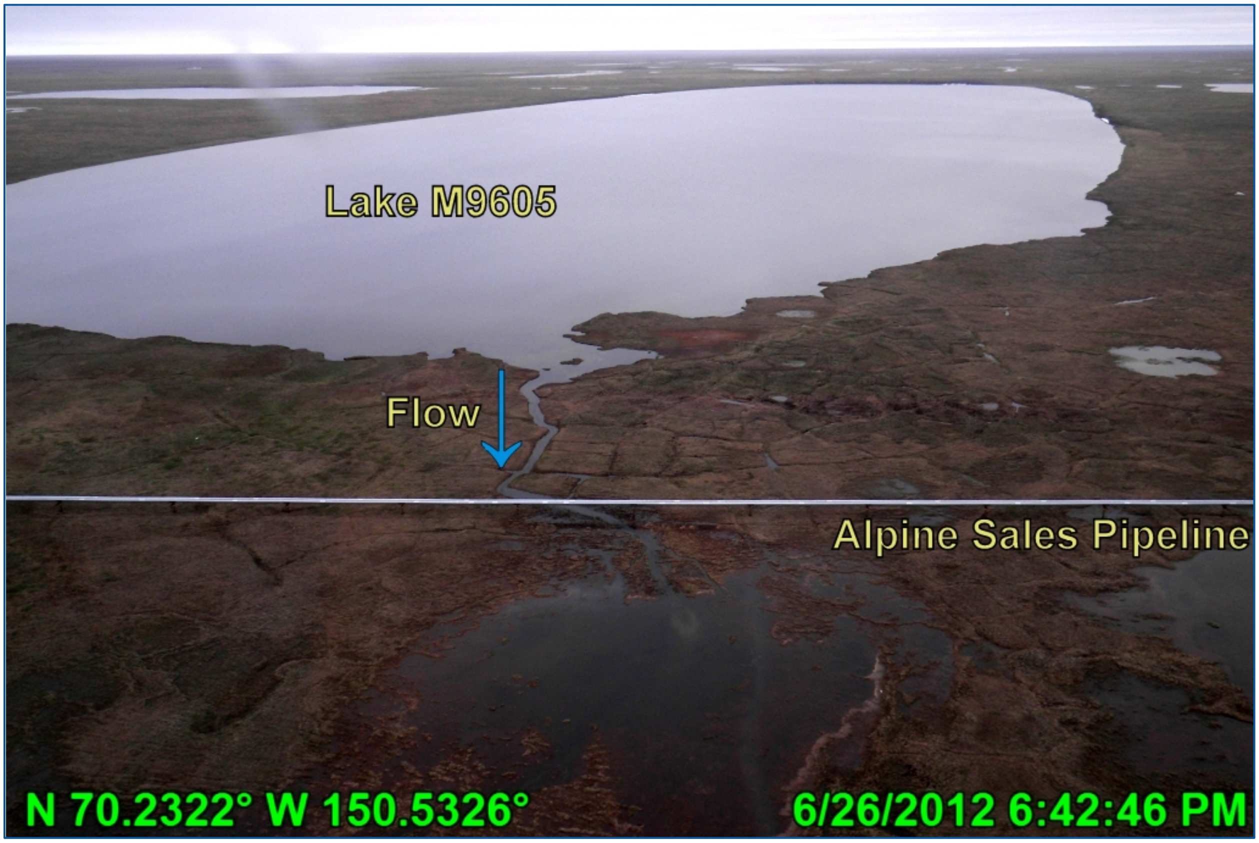
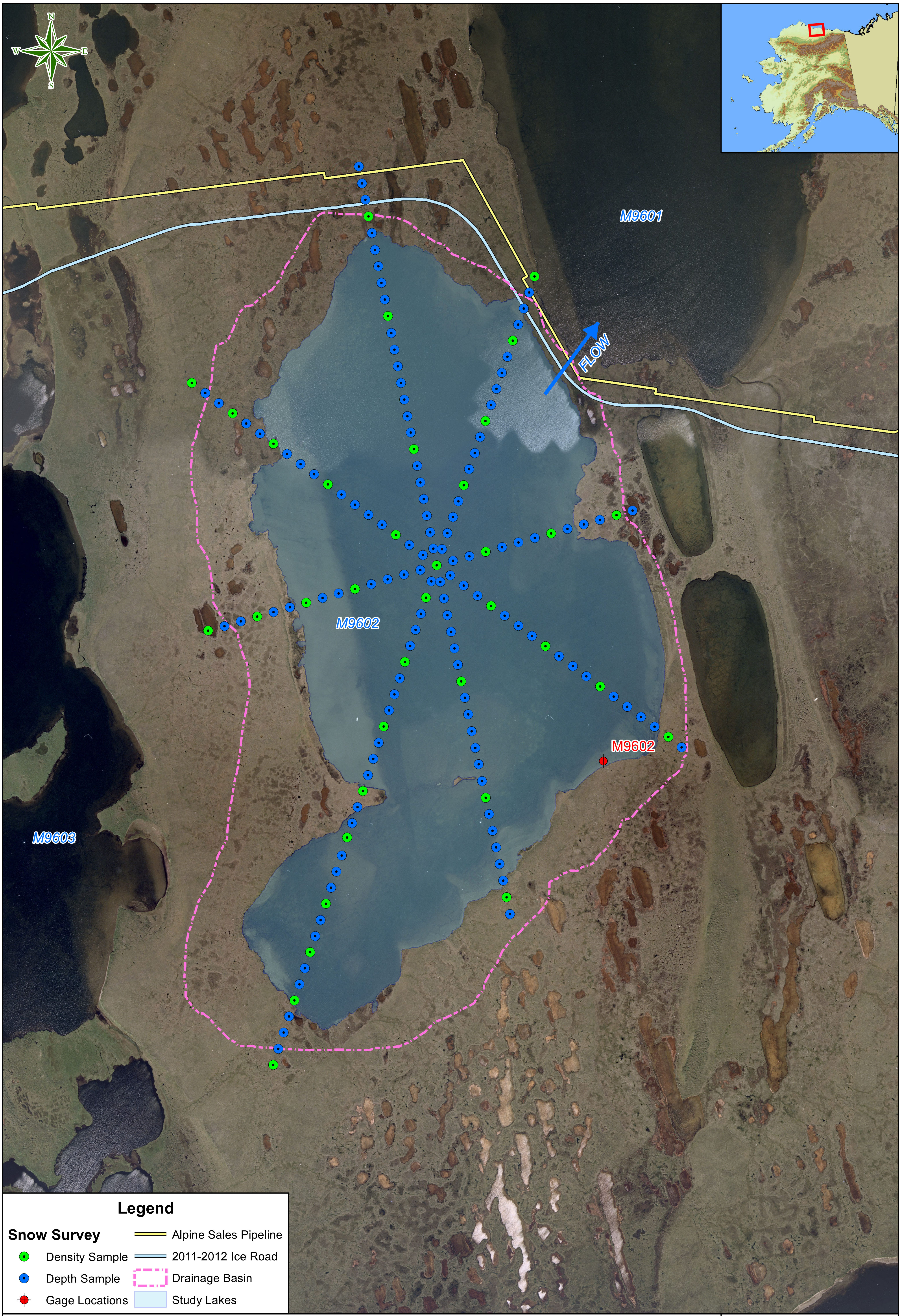


Photo 4.2: Channel from Lake M9605 flowing north into unnamed lake, looking southeast; June 26, 2012



ConocoPhillips Alaska

Feet
0 500 1,000

Date:	07/12/2012	Project:	127660
Drawn:	BTG	File:	Figure 4.1
Checked:	SME	Scale:	1 in = 1,000 feet

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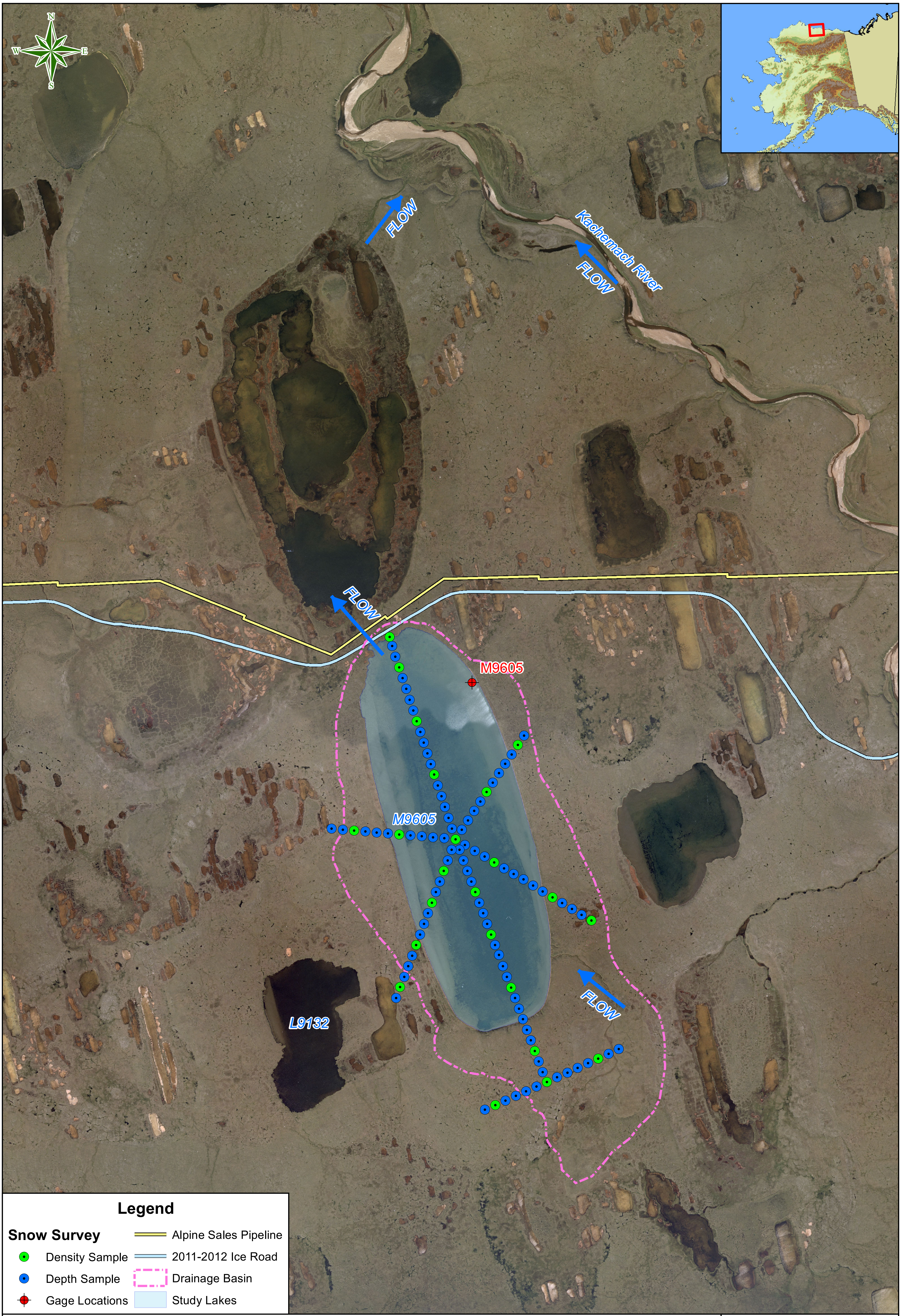
M9602

DRAINAGE BASIN DELINEATION & SNOW SURVEY LOCATIONS

FIGURE: 4.1

(SHEET 1 of 1)



ConocoPhillips Alaska

Feet
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Checked:	SME	Scale:	1 in = 1,500 feet

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M9605

DRAINAGE BASIN DELINEATION & SNOW SURVEY LOCATIONS

FIGURE: 4.2

(SHEET 1 of 1)

4.1.2 Snow Survey and Snow Water Equivalent

Snow surveys were conducted at Lake M9602 on April 23, and 24, 2012; and at Lake M9605 on April 22, and 24, 2012. Snow surveys were conducted prior to CRD spring breakup setup. Sampling locations were pre-determined based on catchment basin delineations and topographic features identified in aerial imagery.

Seasonal snow cover conditions at both lakes sampled in 2012 were generally consistent with results found by Baker in 2007 and 2011. Overall snow depths measured in 2012 were less than measured in previous years. In general, lake snow cover was thinner, denser, and comprised less SWE than adjacent tundra. This is likely related to the potential of tundra vegetation to accumulate snow and to prevailing wind patterns, as snow depth tended to increase on lake ice towards the west with the deepest snow encountered closest to the bank.

At lakes M9602 and M9605, isolated disturbed areas of snow associated with ice and water withdrawal was evident from the cleared areas surrounded by berms with snow drift accumulation. Evidence of berms and drifts at Lake M9605 early in breakup are apparent in Photo 4.3 and Photo 4.4. Visual observations of wind-driven snow quantities accumulated in the previously cleared areas and around the berms suggest mechanized clearing and piling snow on ice may facilitate snow deposition and potential recharge in lakes. Berm snowmelt contribution calculations were performed assuming natural median snow depth on the cleared areas was reached at the time of investigation. This was not likely considering conditions encountered in the field. In addition to the investigation along predetermined courses, supplemental snow surveys were performed on representative berms to quantify the amount of potential snowmelt. Representative snow depths and density measurements were collected, and the extent of the berm areas was calculated. Overall depth and density of the berms was greater than adjacent naturally accumulated snow; both contribute to increased SWE for these features. The SWE summaries for lakes M9602 and M9605 and their respective berms are presented below in Table 4.1. Comprehensive snow survey data sheets are included in Appendix C.

Table 4.1: Detailed Study Lakes Snow Survey Summary

Location	Area[1] (ft^2)		Average Snow Depth (in)		Average Density (lb/in^3)		Average SWE (in)		Weighted SWE[2]
	Tundra	Lake	Tundra	Lake	Tundra	Lake	Tundra	Lake	(in)
M9602	14,475,000	29,000,000	16.6	9.9	0.009	0.010	4.3	2.8	3.3
M9602 *Berm A*[3]	2,000	33,000	13.8	45.1	0.011	0.011	4.2	13.9	13.3
M9605	17,884,000	14,653,000	17.7	10.3	0.009	0.011	4.5	3.1	3.9
M9605 *Berm C*	55,000	364,000	43.7	32.4	0.011	0.012	13.4	11.1	11.4
M9605 *Berm D*	153,000	229,000	43.1	41.7	0.011	0.012	13.2	14.1	13.7
M9605 *Berm C and D* Totals:	208,000	593,000							
M9605 *Berm C and D* Averages:			43.4	37.1	0.011	0.012	13.3	12.6	12.5

Notes: 1. Calculated from delineated drainage basins determined from aerial imagery for lakes and GPS tracks for berms
2. Specific to feature per lake and tundra contribution based on respective areas
3. Only one of the two berms encountered at Lake M9602 were appropriate for snow survey measurement, the other was composed of ice

Photo 4.3: Lake M9605 berm and associated snow drifts; April 25, 2012

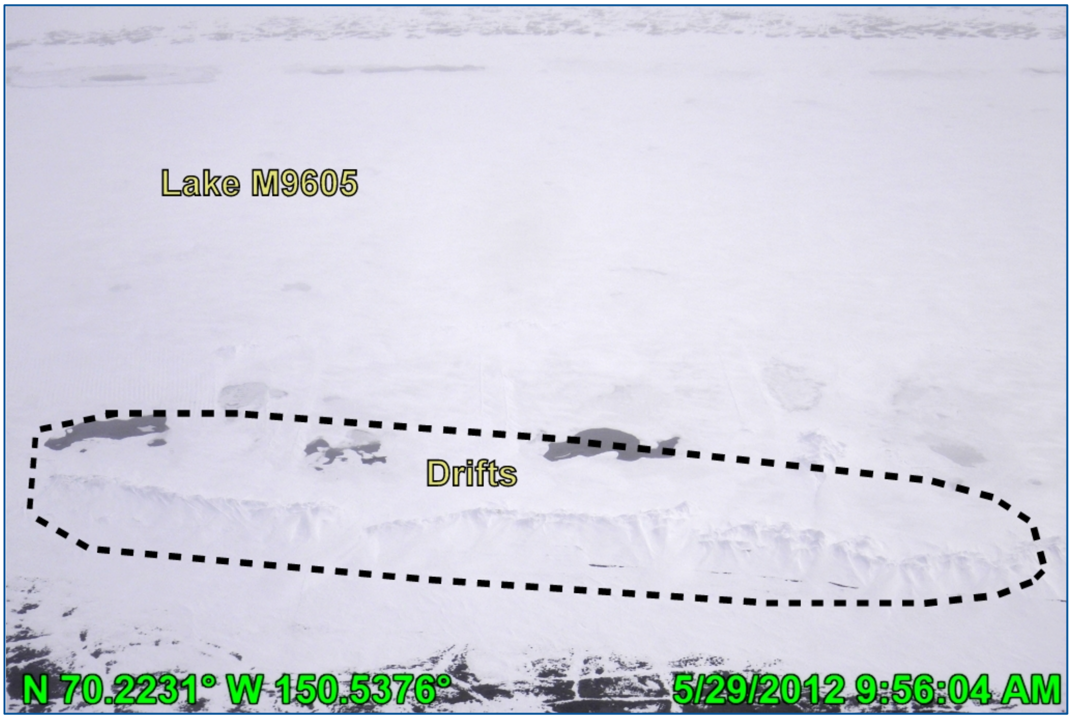


Photo 4.4: Cleared area at Lake M9605 with berms and associated drifts; May 29,2012

4.1.3 Water Surface Elevation

Water surface elevation was measured before and after spring breakup at lakes M9602 and M9605. Pre-breakup WSE was surveyed through a hole drilled into the lake ice on May 25 at Lake M9602 and on May 27 at Lake M9605; WSE was 95.18 feet and 96.17 feet, respectively.

Spring breakup melting of ice and snow at lakes M9602 and M9605 occurred more slowly than other study lakes because they are outside of the CRD and lack significant channelized and overland flow. No flow was observed into or out of M9602, no water was measured on the gage, and substantial ice and snow covered the lake surface during CRD breakup monitoring.

By the final field visit to Lake M9602 on June 26, the snow in the catchment had melted (Photo 4.5). WSE increased from initial measurements to 96.00 feet. This lake likely experienced a higher peak WSE at some time between June 7 and June 26. HWM was not recorded because the monitoring gage was severely tilting, most likely due to frost jacking and thawing of the active layer. The increase of WSE at Lake M9602 is primarily attributed to local snowmelt.

Photo 4.5: Snow and ice no longer present within M9602 catchment; June 26, 2012

A final field visit to Lake M9605 on June 26 revealed snow in the catchment had melted (Photo 4.6). WSE increased from initial measurements to 96.53 feet. A peak of 97.21 feet, based on a HWM, was recorded on June 26. The HWM was estimated to have occurred between June 7 and June 26. The increase of WSE at Lake M9605 was attributed to local snowmelt and some channelized flow.

Photo 4.6: Snow and ice no longer present within M9605 catchment; June 26, 2012

WSE data and graphic representations for lakes M9602 and M9605 are presented in Table 4.2 and Table 4.3.

Table 4.2: WSE Data for Lake M9602

Date and Time	WSE (feet) M9602	Observations
5/25/12 4:10 PM	95.81	**Pre-breakup** survey to WSE - no local melt
5/27/12 11:45 AM	-	No flow in or out of lake, no local melt
6/2/12 11:20 AM	-	No flow in or out of lake, no water on gage
6/5/12 4:45 PM	-	No flow in or out of lake, some local melt, no water on gage
6/7/12 6:20 PM	-	No flow in or out of lake, substantial ice remains on lake, no water on gage
6/26/12 6:50 PM	96.00	survey to WSE, gage malfunction; channelized outflow to M9601 observed

Gage malfunction prevented the capture of a HWM. As a result, the WSE observations suggest only partial lake recharge; however, channelized outflow was observed at the north end of lake indicating bankfull recharge was achieved and exceeded.

Notes:

1. Elevations are assumed based on TBM M9602-X at 100.00 feet, installed by Baker in May 2011.

2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct.

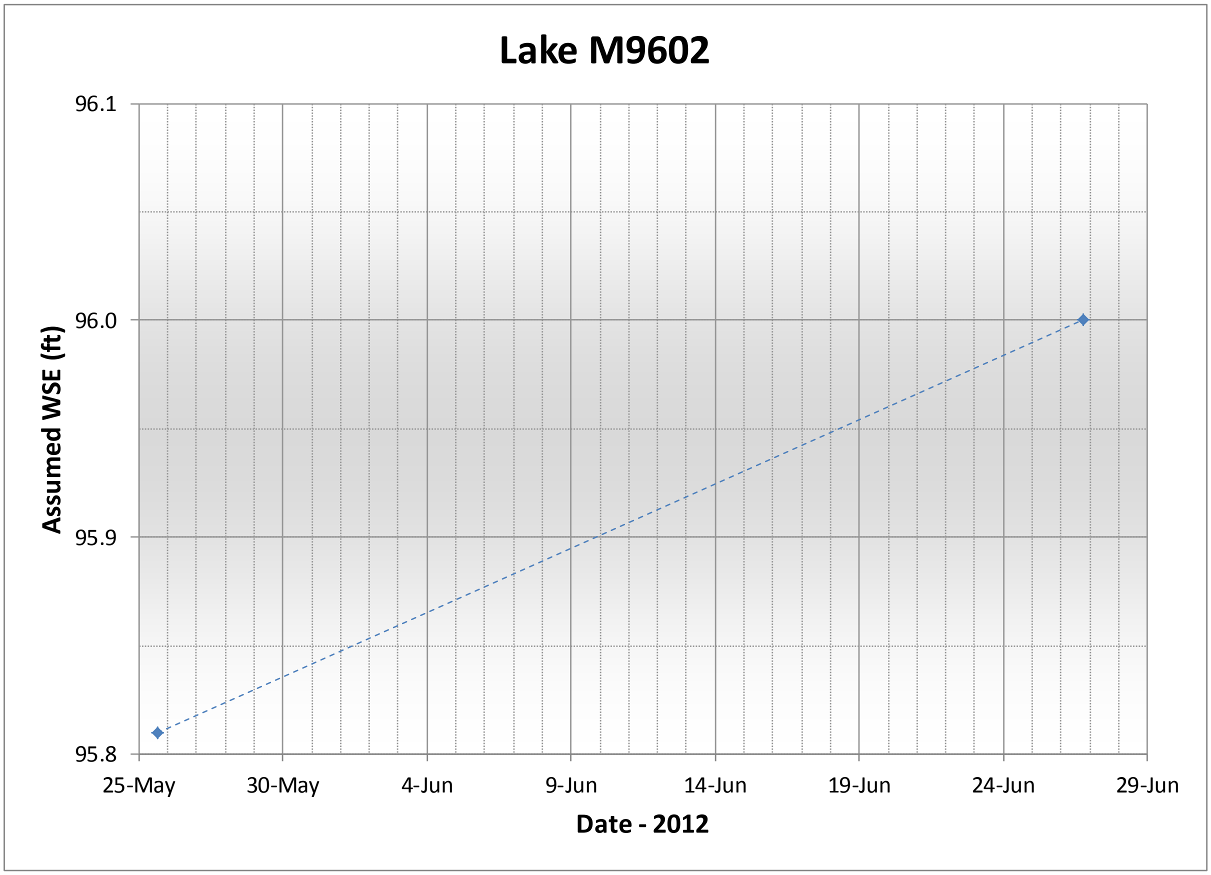


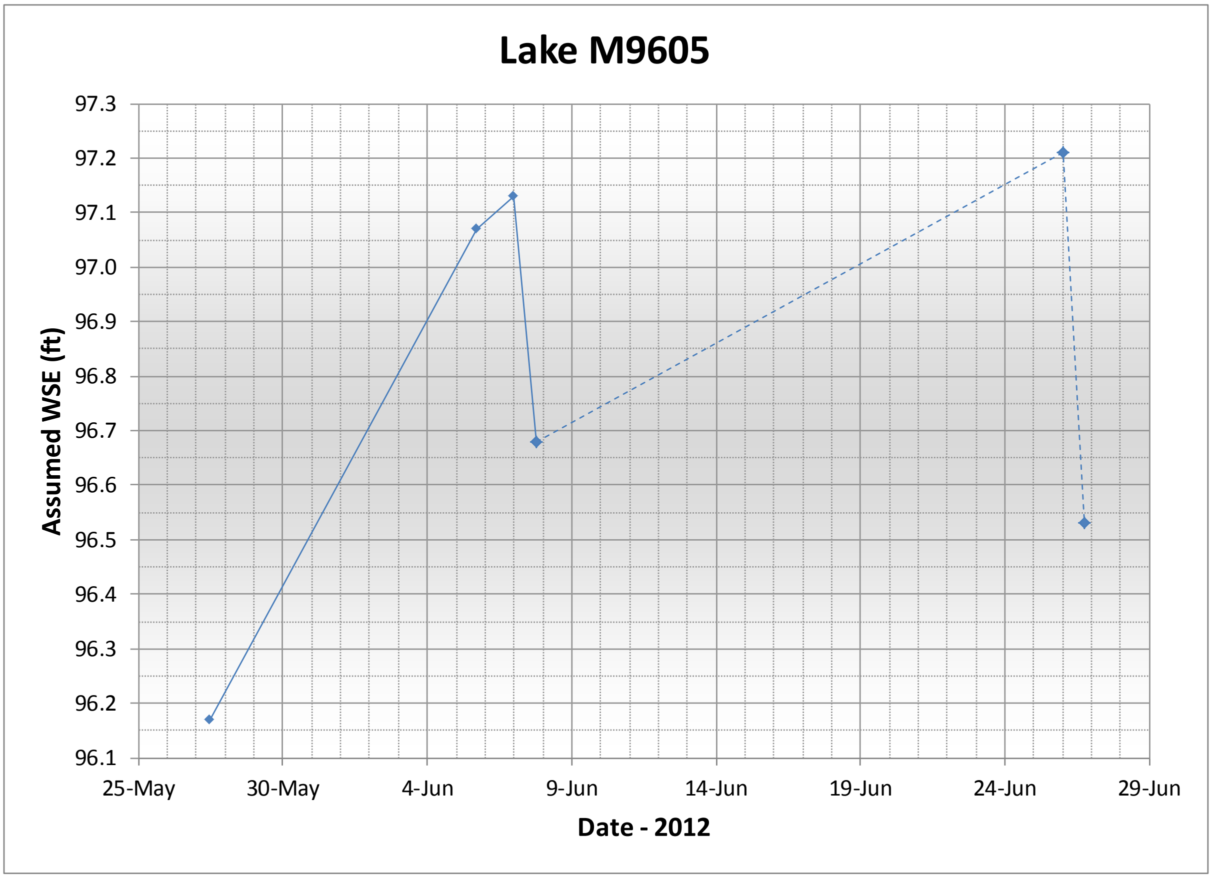
Table 4.3: WSE Data for Lake M9605

Date and Time	WSE (feet)	Observations
	M9605	
5/27/12 11:35 AM	96.17	**Pre-breakup** survey to WSE (freeboard=0.16 ft) - no local melt
6/2/12 11:15 AM	-	No flow in or out of lake, no water on gage
6/5/12 4:35 PM	97.07	Channelized inflow from ponded area to southeast observed, no outflow
6/7/12 12:00 AM	97.13	HWM
6/7/12 6:10 PM	96.68	Substantial ice remains on lake
6/26/12 12:00 AM	97.21	**Peak Stage** based on HWM, time and date estimated
6/26/12 6:31 PM	96.53	Channelized outflow to unnamed lake north observed; drainages in no longer flowing

Notes:

1. Elevations are assumed based on TBM M9605-X at 100.00 feet, installed by Baker in May 2011.

2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct.



4.1.4 Lake Recharge

Potential snowmelt contributions were calculated for lakes M9602 and M9605 based on SWE and lake areas. Estimates of potential snowmelt contribution for mechanically formed berms and associated drifted snow accumulation were also determined. Snow accumulated on lakes is assumed to directly contribute to lake recharge. Snow accumulated over tundra areas will not directly contribute all melt to lakes because of the storage capacity of vegetated soils over uneven ground. A runoff coefficient of 0.67 was applied to snowmelt contributed from tundra areas to account for reduced tundra contribution. Potential snowmelt contribution values are presented below in Table 4.4.

During the 2012 monitoring period, Lake M9602 recharged over bankfull conditions as observed by channelized outflow to M9601 (Photo 4.1). Lake M9605 recharged over bankfull as observed by channelized outflow to an unnamed lake to the north (Photo 4.2), and the rise and recession of WSE presented in the hydrographs (Table 4.3). Potential snowmelt contributions for both lakes were calculated using the 2007 delta-wide runoff coefficient (0.67) for tundra contribution and 2012 SWE values. Estimated recharge volume was determined by multiplying the lake surface area by the difference between peak and pre-breakup WSE for Lake M9605 based on a recorded peak HWM. Since no peak HWM was recorded for Lake M9602, a more conservative estimate of recharge volume was calculated by multiplying lake area by the difference in pre-breakup and post-breakup WSE.

These values are presented with calculated potential snowmelt contributions along with permitted and actual water use quantities for lakes M9602 and M9605 in Table 4.4.

Table 4.4: Detailed Study Lakes Spring Breakup Recharge Summary

Location	Calculated Potential Snowmelt Contribution[1]			Estimated Recharge[2]	Permitted Annual Water Use[3]	Actual Water Use[4]
	Lake	Tundra	Total	May 25/26 - June 26, 2012	Current	June 2011 - May 2012
	(Mgal)					
M9602	51.0	26.2	77.5	41.3	31.41	1.50
M9602 *Berms*	0.3	0.004				
M9605	28.2	33.5	67.6	118.6	22.14	10.14
M9605 *Berms*	4.6	1.2				

Notes:
1. Using the 2007 delta-wide runoff coefficient (0.67) for tundra contribution and 2012 SWE.
2. Area of lake surface multiplied by the difference between pre-breakup and peak WSE for M9605, and pre-breakup and post-breakup WSE for M9602.
3. Per permits FH05-III-0327 Amd #2 & TWUP A2010-119 ICE for Lake M9602 and FH05-III-0328 Amd #2, TWUP A2010-119 H2O, & TWUP A2010-119 ICE for Lake M9605; expiration date of all permits is 12/2/15.
4. Total combined liquid and ice as water equivalent per CPAI water use report.

Estimated recharge volumes were greater than the permitted and actual water use quantities for both lakes.

Recharge of Lake M9602 was primarily a result of local snowmelt within the catchment basin. No evidence of channelized inflow was observed at this lake during the spring breakup 2012 monitoring period. The calculated potential snowmelt contribution for Lake M9602 is greater than the estimated recharge volume. This can be attributed mainly to the lack of recorded peak WSE. Approximately 0.75 miles of ice road or 0.75 million gallons (Mgal) of water was located within the M9602 drainage basin and partially contributed to lake recharge.

The volume of total calculated potential snowmelt contribution for Lake M9605 was less than the estimated recharge volume. This is likely attributed to additional unaccounted for recharge quantities from small ephemeral channels and non-channelized overland flow into the lake. Two primary channels conveyed flow into the lake from the southeast and southwest (Figure 4.2). The southeastern channel was well defined and connected a large wetland area south of the lake. The southwestern channel was small, less defined, and drained from a wetland area near Lake L9132. Lake M9605 potentially receives flood flow from the Kachemach River; however, a hydraulic connection was not observed during 2012 spring breakup monitoring. An additional source of snowmelt contribution is ice road runoff similar to Lake M9602. Approximately 0.2 miles of ice road and 0.2 Mgal of water was located within the M9605 drainage basin and partially contributed to lake recharge.

4.1.5 Discussion of Historic Results

Potential snowmelt contributions to lakes M9602 and M9605 calculated in 2012 are greater than 2010 calculations (Table 4.5). Values from 2010 were based on empirical data and are considered conservative. Drainage basin delineations were refined in 2011; the same delineations were used in 2012. Overall snow depths measured in 2012 were less than measured in 2011.

Table 4.5: Comparison of Historical Results

Comparison of Historical Total Estimated Snowmelt Contributions			
Lake	2010 [1]	2011 [2]	2012 [2]
	(Mgal)		
M9602	48.3	101.1	77.5
M9605	40.6	61.8	67.6
Notes: 1. Determined based on empirical data 2. Determined based on measured data			

4.2 General Study Lakes

Water surface elevation data and lake recharge results for lakes B8534/L9282, M9525, L9323, L9324, B8531/L9326, B8530, M9607, and B8533 (lake recharge only) are presented in this section.

4.2.1 Water Surface Elevation

The WSE was measured before, during, and after spring breakup at lakes B8534/L9282, M9525, L9323, L9324, B8531/L9326, B8530, and M9607. The WSE at B8533 was not measured; recharge was determined by visual observation and aerial photographs. Photos were taken pre-breakup, breakup and post-breakup (Appendix D) to document changes at the lakes.

Generally, WSE at the study lakes increased during recharge and then decreased from outflow. The WSE data and hydrographs are presented in Table 4.6 through Table 4.12.

Table 4.6: WSE Data for Lake B8534/L9282

Date and Time	WSE (feet) B8534/L9282	Observations
5/25/12 11:00 AM	96.33	**Pre-breakup** survey to WSE (no local melt)
6/2/12 10:00 AM	-	No flow in or out of lake, no local melt
6/5/12 5:30 PM	-	No flow in or out of lake, some local melt, no water on gage
6/7/12 7:00 PM	96.22	Local melt - hydraulically isolated, substantial ice remains on lake
6/27/12 12:00 AM	96.50	**Peak Stage** based on HWM, time and date estimate
6/27/12 4:23 PM	96.02	Lake draining into Sakoonang; recharge due to local melt only

Notes:

1. Elevations are assumed based on TBM B8534/L9282-X at 100.00 feet, installed by Baker in May 2011.
2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct.

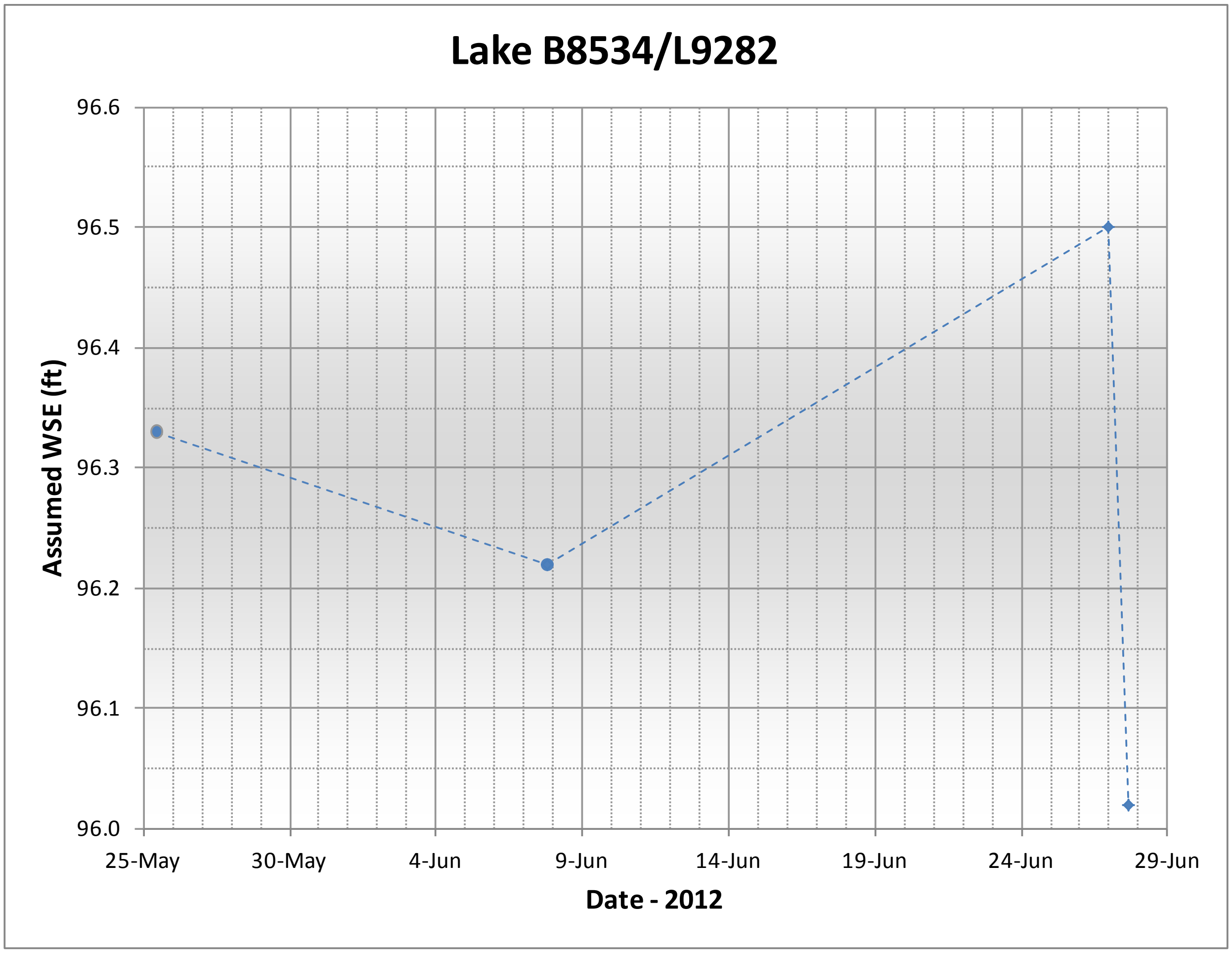


Table 4.7: WSE Data for Lake M9525

Date and Time	WSE (feet BPMSL)	Observations
	M9525	
5/24/12 4:30 PM	3.15	Ponded water on top of lake ice at gage
5/25/12 4:05 PM	3.20	Local lake ice melting observed
5/26/12 11:15 AM	3.17	Inflow from the Sakoonang via north paleolake
5/27/12 8:25 PM	7.27	Outflow into Lake L9313
5/28/12 12:00 AM	7.80	HWM
5/28/12 7:10 PM	7.63	
5/29/12 3:30 PM	7.10	
5/30/12 2:00 PM	6.28	Observed recharge from L9323 via CD4 culverts
5/31/12 2:20 PM	5.38	
6/2/12 2:20 PM	6.37	No longer connected to L9313, inflow continues from Sakoonang via north paleolake
6/4/12 12:00 AM	8.66	**Peak Stage** based on HWM, time and date estimate
6/4/12 8:15 AM	7.93	Once again connected to L9313
6/5/12 12:00 AM	8.07	HWM, time and date estimate
6/6/12 4:30 PM	6.27	

Notes:

1. Elevations are based on top of culvert CD4-6E at 14.577 feet BPMSL, surveyed by LCMF in May 2012.

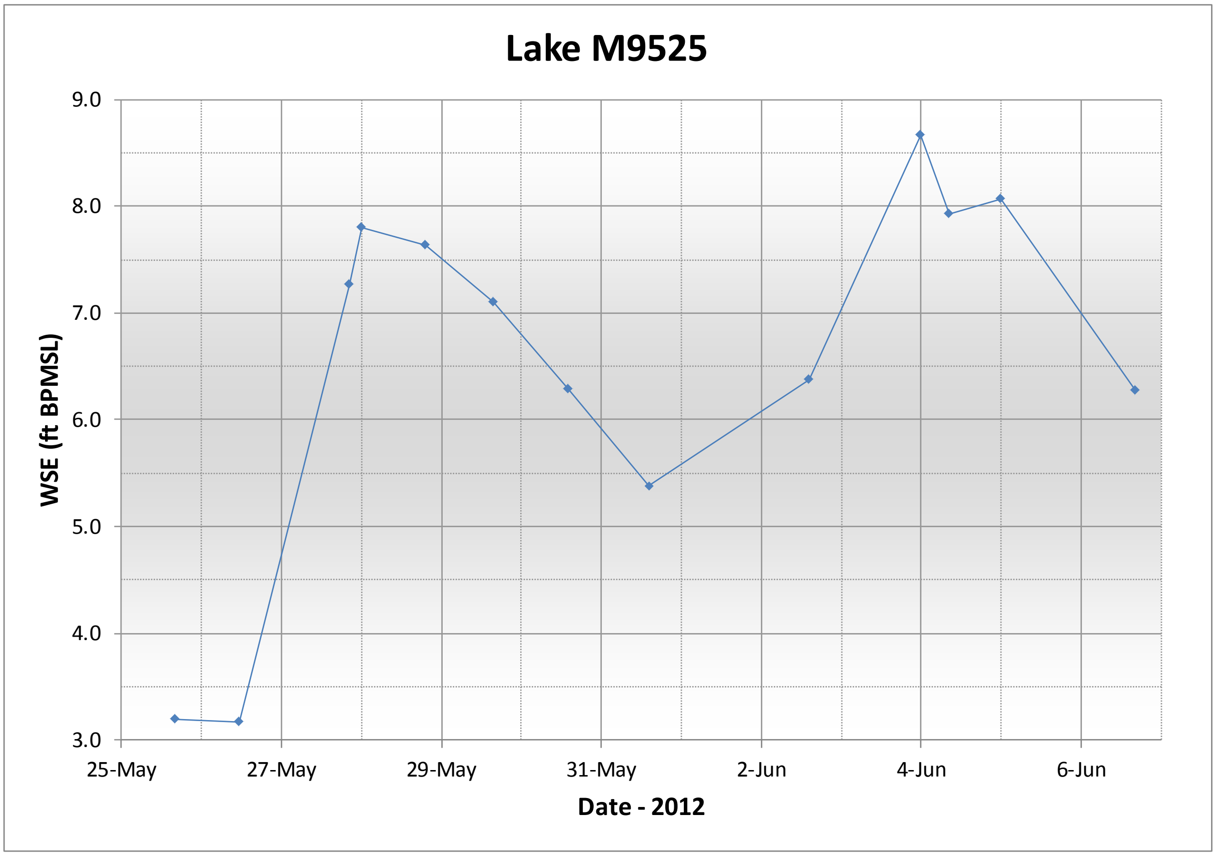


Table 4.8: WSE Data for Lake L9323

Date and Time	WSE (feet BPMSL)	Observations
	L9323	
5/25/12 3:55 PM	8.38	Local melt observed at gage
5/26/12 10:00 AM	8.38	**Pre-breakup** survey to WSE (freeboard = 0.51 ft)
5/27/12 4:20 PM	8.43	Ponded water at gage, hydraulically isolated
5/29/12 2:45 PM	8.45	
5/30/12 2:25 PM	8.47	Observed outflow to Lake M9525
6/3/12 12:00 AM	8.61	HWM, date and time estimate
6/3/12 6:00 PM	8.57	Limited drainage into lake basin via single culvert CD4-24, limited connection with Lake M9525 via CD4 road culvert battery
6/4/12 12:00 AM	8.74	**Peak Stage** based on HWM, time and date estimated
6/4/12 8:50 AM	8.60	
6/6/12 11:05 AM	8.63	Outflow observed draining north toward Lake M9525

Notes:

1. Elevations are based on Monument NANUQ 4 at 12.758 feet BPMSL, surveyed by LCMF in May 2011.

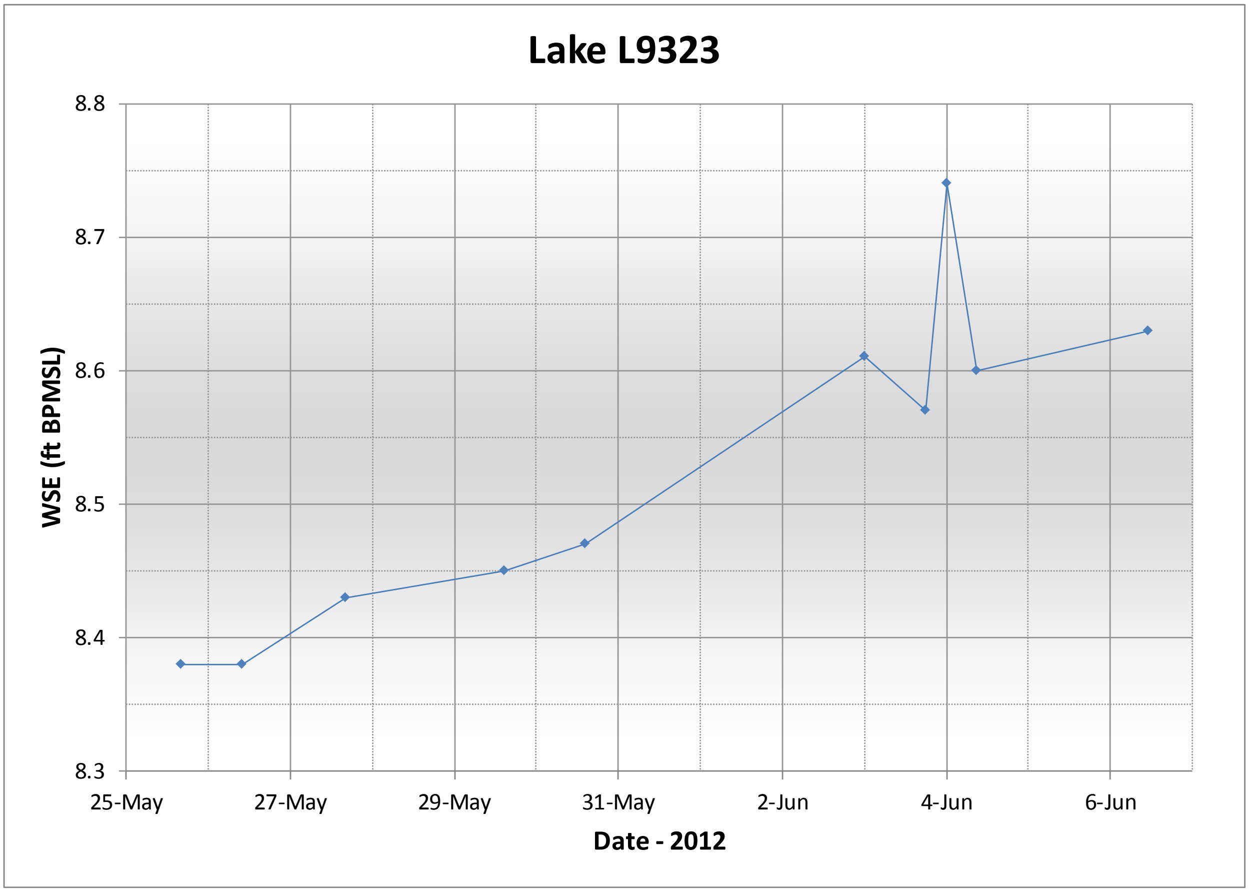


Table 4.9: WSE Data for Lake L9324

Date and Time	WSE (feet BPMSL) L9324	Observations
5/25/12 3:00 PM	6.64	**Pre-breakup** survey to WSE
5/27/12 12:00 AM	9.52	HWM
5/27/12 3:55 PM	9.18	Recharge in from the Sakoonang via south paleolake; connectivity to Nigliq Channel and Tapped Lake
5/28/12 7:50 PM	8.58	
5/29/12 2:20 PM	7.82	
5/30/12 3:00 PM	7.29	Water no longer on gage, survey to WSE
6/2/12 12:00 AM	10.09	HWM
6/2/12 2:20 PM	9.81	Recharge in from the Sakoonang via south paleolake; connectivity to Nigliq Channel and Tapped Lake
6/3/12 12:00 AM	10.13	**Peak Stage** based on HWM, time and date estimated
6/3/12 6:00 PM	9.06	
6/4/12 12:00 AM	9.10	HWM
6/4/12 8:50 AM	8.67	
6/5/12 12:00 AM	9.09	HWM
6/5/12 10:50 AM	7.42	

Notes:

1. Elevations are based Monument NANUQ 5 at 17.461 feet BPMSL, surveyed by LCMF in May 2011.

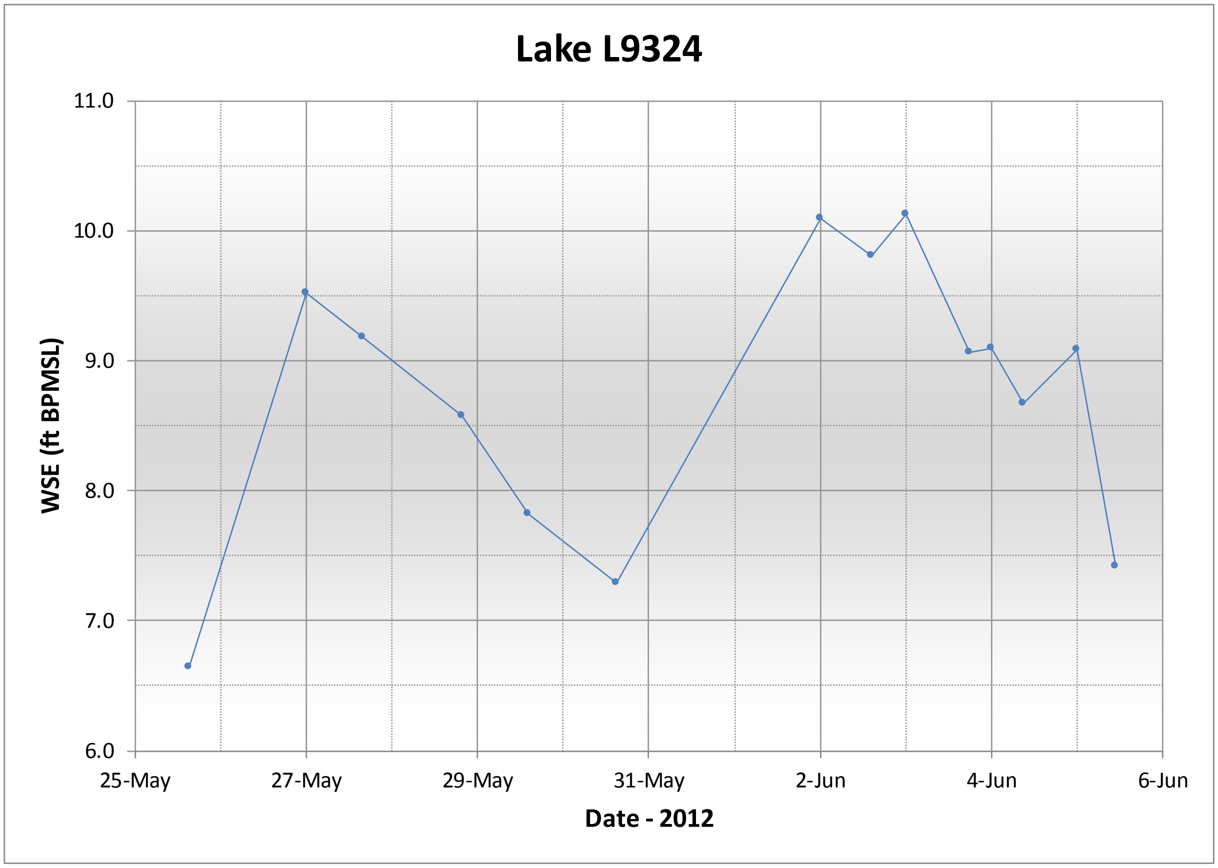


Table 4.10: WSE Data for Lake B8531/L9326

Date and Time	WSE (feet) B8531/L9326	Observations
5/25/12 1:00 PM	92.89	**Pre-breakup** survey to WSE - no local melt
6/1/12 8:20 PM	-	No observable flow in or out of lake, no water on gage
6/2/12 1:50 PM	-	Inflow from Sakoonang via M9934 observed, no water on gage
6/4/12 12:00 AM	95.30	**Peak Stage** based on HWM, time and date estimated (possible recharge from Nigliq Channel via Lake M9606)
6/4/12 5:45 PM	94.83	
6/5/12 3:45 PM	94.42	
6/7/12 6:35 PM	93.87	
6/27/12 5:31 PM	93.06	Observed outflow north into Toolbox Creek via Lake M9934

Notes:

1. Elevations are assumed based on TBM B8531/L9326-X at 100.00 feet, installed by Baker in May 2011.

2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct.

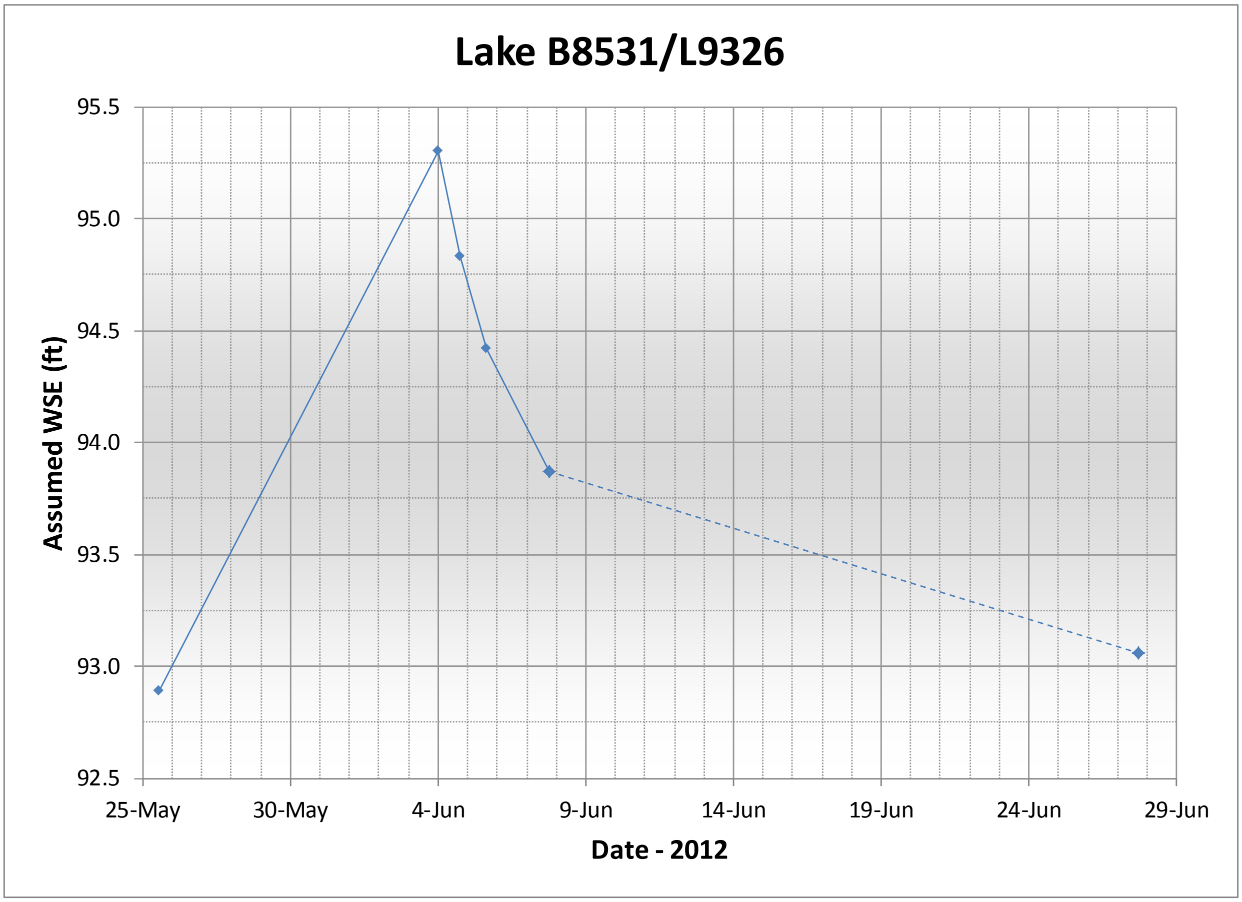


Table 4.11: WSE Data for Lake B8530

Date and Time	WSE (feet) B8530	Observations
5/25/12 2:00 PM	95.29	**Pre-breakup** survey to WSE - no local melt
6/2/12 12:00 PM	-	Limited local melt, no water on gage
6/5/12 12:00 AM	95.88	**Peak Stage** based on HWM, time and date estimated
6/5/12 4:05 PM	95.60	Limited drainage in from Lake M9607; potential inflow from Nigliq via Lake M9608
6/7/12 5:45 PM	95.69	Local melt, substantial ice remains on lake
6/26/12 8:00 PM	95.30	No outflow observed

Notes:

1. Elevations are assumed based on TBM B8530-X at 100.00 feet, installed by Baker in May 2011.

2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct.

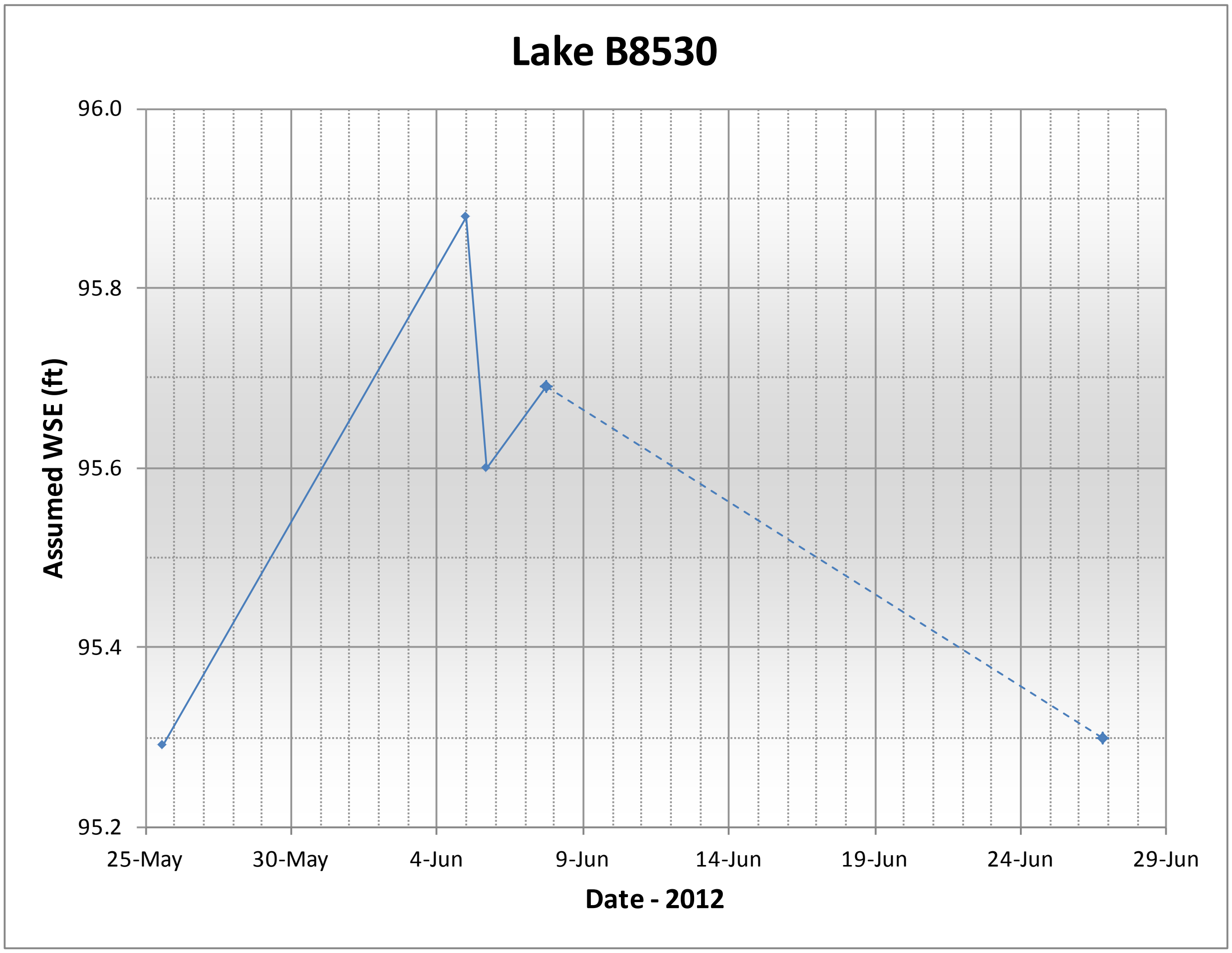


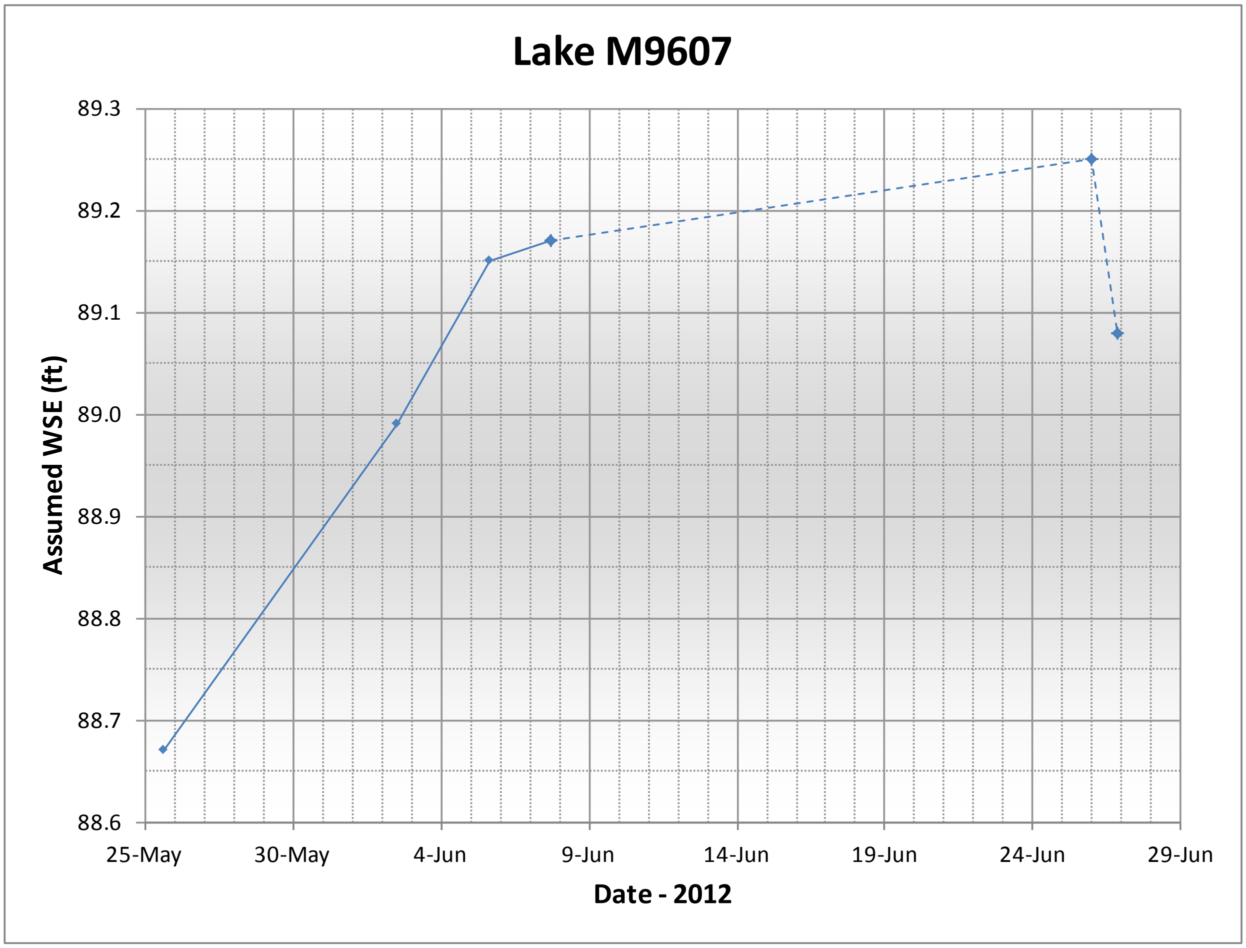
Table 4.12: WSE Data for Lake M9607

Date and Time	WSE (feet) M9607	Observations
5/25/12 2:45 PM	88.67	**Pre-breakup** survey to WSE (freeboard=0.62 ft) - no local melt
6/2/12 12:00 PM	88.99	Local melt
6/5/12 4:15 PM	89.15	Local melt, limited drainage out toward Lake B8530
6/7/12 5:40 PM	89.17	Local melt, substantial ice remains on lake
6/26/12 12:00 AM	89.25	**Peak Stage** based on HWM, time and date estimated
6/26/12 7:40 PM	89.08	Potential limited drainage out toward Sakoonang Channel

Notes:

1. Elevations are assumed based on TBM M9607-X at 100.00 feet, installed by Baker in May 2011.

2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct.



4.2.2 Lake Recharge

All General Study Lakes were observed to fully recharge over bankfull during the 2012 monitoring season. This was evident by visual observations and the rise and recession of WSE in the hydrographs. Lakes B8534/L9282, L9323, B8530, M9607, and B8533 recharged primarily from local melt. All of these lakes, except B8530, were observed draining into nearby water bodies.

Lakes M9525, L9324, and B8531/L9326 recharged primarily from Sakoonang Channel flow. Recharge was indirect via paleolakes. Lake recharge summary observations are included in Table 4.13.

All General Study Lakes were hydraulically connected to water bodies during spring breakup 2012. Most of these connections are likely seasonal and limited to increased stage conditions during spring breakup. The lakes should be considered hydraulically isolated, except for Lake B8530 and potentially Lake B8534/L9282. For the purposes of water withdrawal quantities, Lake B8530 is hydraulically connected to Lake M9608 during the open water season. Potential snowmelt contribution should be determined from their combined catchments when considering lake water recharge as it relates to water withdrawal volumes. Additionally, Lake B8534/L9282 is likely frequently connected to lakes L9342, L9283, and M9527 and similar considerations should be made when determining recharge volumes.

4.3 Summary of Lake Recharge Observations

At the time of the study, all lakes appeared to recharge to or above bankfull elevations via either channelized spring breakup flood flow or local melt. A compilation of hydrologic observations is provided in Table 4.13.

Table 4.13: Summary of 2012 Hydrologic Recharge Observations

Study Lake	Recharge to Bankfull	Primary Recharge Mechanism	Additonal Hydraulic Connection[1]	
			Flow In	Flow Out
Detailed Study Lakes				
M9602	√	Local melt	No channelized drainage into lake	Lake M9601 northeast via small drainage across ice road
M9605	√	Local melt	Small drainages from wetlands southeast and southwest	Unnamed lake north via small drainage across ice road
General Study Lakes				
B8534/L9282[2]	√	Local melt	No channelized drainage into lake	Sakoonang via channel south
M9525	√	Sakoonang via paleolake east	Lake L9323 south via CD4 culverts	Lake L9313 northeast
L9323	√	Local melt	Limited drainage into basin from Sakoonang via CD4 culvert south	Limited drainage into Lake M9525 north via CD4 road culverts
L9324	√	Sakoonang via paleolake southeast	Nigliq Channel and Tapped Lake northwest	
B8531/L9326	√	Sakoonang via paleolake into M9934 northeast	Potential from Nigliq Channel via Lake M9606 south	Nigliq Channel via Lake M9934 northeast into Toolbox Creek
B8530[3]	√	Local melt	No channelized drainage into lake; limited flow from M9607 east via marshy area	No channelized drainage out of lake
M9607	√	Local melt	No channelized drainage into lake	Limited flow into Lake B8530 west across ice road via marshy area
B8533	√	Local melt	No channelized drainage into lake	Limited flow into Sakoonang west via marshy area

Notes: 1. Observations between May 5 and June 27, 2012. Unless specified, hydraulic connections are likely seasonal only.
2. Additional annual connection with lakes L9342 west, L9283 east, and M9527 southeast likely
3. Additional annual connection with Lake M9608 west

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Appendix A Gage and TBM Locations

Pooled Snow Survey Data Sheet

Date: 4/24/2012	**Start Time:** 9:45		**End Time:** 16:15		**Observers:** KRH/BTG	
Catchment Basin: M9602			**Snow Sampler:** Mt. Rose Model 3600, 1.625" I.D.		**Driving Wrench Used:** No	
Snow Sample No.	**Pooled Sample #**	**Terrain Type**	**Snow Depth (in) w/ Plug**	**Snow Depth (in) w/o Plug**	**Calculations**	
PS023	1	Lake	8	8.0	**Bucket & Core Weight (lb) =**	1.70
	2		8.5	8.0	**Empty Bucket Weight (lb) =**	0.82
	3		8.5	8.5	**Average Mass (lb) =**	0.18
	4		8	7.5	**Core Area (in^2) =**	2.0739
	5		8	8.0	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 13' 20.3"		**Sum (in) =**	**40.0**	**Average Density (lb/in^3) =**	**0.011**
Longitude	W 150° 44' 20.0"		**Average (in) =**	**8.0**	**Average SWE (in) =**	**2.35**
PS024	1	Lake	8.5	8.5	**Bucket & Core Weight (lb) =**	1.74
	2		9.5	9.5	**Empty Bucket Weight (lb) =**	0.82
	3		9	9.0	**Average Mass (lb) =**	0.18
	4		9	9.0	**Core Area (in^2) =**	2.0739
	5		8	7.5	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 13' 29.7"		**Sum (in) =**	**43.5**	**Average Density (lb/in^3) =**	**0.010**
Longitude	W 150° 44' 11.0"		**Average (in) =**	**8.7**	**Average SWE (in) =**	**2.46**
PS025	1	Lake	6.5	6.5	**Bucket & Core Weight (lb) =**	1.78
	2		6.5	6.5	**Empty Bucket Weight (lb) =**	0.82
	3		7	6.5	**Average Mass (lb) =**	0.19
	4		7	7.0	**Core Area (in^2) =**	2.0739
	5		6.5	6.5	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 13' 37.2"		**Sum (in) =**	**33.0**	**Average Density (lb/in^3) =**	**0.014**
Longitude	W 150° 44' 03.8"		**Average (in) =**	**6.6**	**Average SWE (in) =**	**2.56**
PS026	1	Lake	13	13.0	**Bucket & Core Weight (lb) =**	2.30
	2		15	15.0	**Empty Bucket Weight (lb) =**	0.82
	3		14	13.5	**Average Mass (lb) =**	0.30
	4		14.5	14.5	**Core Area (in^2) =**	2.0739
	5		14.5	14.5	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 13' 46.6"		**Sum (in) =**	**70.5**	**Average Density (lb/in^3) =**	**0.010**
Longitude	W 150° 43' 54.7"		**Average (in) =**	**14.1**	**Average SWE (in) =**	**3.95**
PS027	1	Tundra	46	46.0	**Bucket & Core Weight (lb) =**	2.00
	-		-	-	**Empty Bucket Weight (lb) =**	0.82
	-		-	-	**Average Mass (lb) =**	1.18
	-		-	-	**Core Area (in^2) =**	2.0739
	-		-	-	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 13' 54.1"		**Sum (in) =**	**46.0**	**Average Density (lb/in^3) =**	**0.012**
Longitude	W 150° 43' 47.5"		**Average (in) =**	**46.0**	**Average SWE (in) =**	**15.76**
PS028	1	Lake	8	8.0	**Bucket & Core Weight (lb) =**	1.70
	2		6	5.5	**Empty Bucket Weight (lb) =**	0.82
	3		9.5	9.0	**Average Mass (lb) =**	0.18
	4		6.5	6.5	**Core Area (in^2) =**	2.0739
	5		7	6.5	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 13' 22.5"		**Sum (in) =**	**35.5**	**Average Density (lb/in^3) =**	**0.012**
Longitude	W 150° 43' 57.6"		**Average (in) =**	**7.1**	**Average SWE (in) =**	**2.35**

Note 1: Locations are referenced to WGS 84 datum.

Pooled Snow Survey Data Sheet						
Date: 4/24/2012	Start Time: 9:45		End Time: 16:15		Observers: KRH/BTG	
Catchment Basin: M9602			Snow Sampler: Mt. Rose Model 3600, 1.625" I.D.		Driving Wrench Used: No	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Plug	Snow Depth (in) w/o Plug	Calculations	
PS029	1	Lake	10	10.0	Bucket & Core Weight (lb) =	1.90
	2		11	11.0	Empty Bucket Weight (lb) =	0.82
	3		12	11.5	Average Mass (lb) =	0.22
	4		10.5	10.5	Core Area (in^2) =	2.0739
	5		12	12.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 24.2"		Sum (in) =	**55.0**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150° 43' 40.8"		Average (in) =	**11.0**	Average SWE (in) =	**2.89**
PS030	1	Tundra	23	21.0	Bucket & Core Weight (lb) =	3.08
	2		22.5	22.0	Empty Bucket Weight (lb) =	0.82
	3		22.5	21.5	Average Mass (lb) =	0.45
	4		20.5	20.0	Core Area (in^2) =	2.0739
	5		23	22.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 26.4"		Sum (in) =	**107.0**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150° 43' 18.4"		Average (in) =	**21.4**	Average SWE (in) =	**6.04**
PS031	1	Lake	8.0	8.0	Bucket & Core Weight (lb) =	1.70
	2		8.5	8.5	Empty Bucket Weight (lb) =	0.82
	3		9.0	9.0	Average Mass (lb) =	0.18
	4		9.0	9.0	Core Area (in^2) =	2.0739
	5		9.5	9.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 26.4"		Sum (in) =	**44.0**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150° 44' 01.1"		Average (in) =	**8.8**	Average SWE (in) =	**2.35**
PS032	1	Lake	9.5	9.5	Bucket & Core Weight (lb) =	1.86
	2		10.0	10.0	Empty Bucket Weight (lb) =	0.82
	3		11.0	11.0	Average Mass (lb) =	0.21
	4		10.5	10.5	Core Area (in^2) =	2.0739
	5		10.5	10.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 11.1"		Sum (in) =	**51.5**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150° 43' 42.2"		Average (in) =	**10.3**	Average SWE (in) =	**2.78**
PS033	1	Lake	8.0	8.0	Bucket & Core Weight (lb) =	1.66
	2		8.5	8.5	Empty Bucket Weight (lb) =	0.82
	3		8.5	8.0	Average Mass (lb) =	0.17
	4		7.5	7.5	Core Area (in^2) =	2.0739
	5		8.0	8.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 06.5"		Sum (in) =	**40.0**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150° 43' 23.3"		Average (in) =	**8.0**	Average SWE (in) =	**2.24**
PS034	1	Tundra	13	12.0	Bucket & Core Weight (lb) =	2.44
	2		21	20.0	Empty Bucket Weight (lb) =	0.82
	3		20	19.0	Average Mass (lb) =	0.32
	4		13	12.0	Core Area (in^2) =	2.0739
	5		18.5	16.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 00.7"		Sum (in) =	**79.5**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150° 42' 59.7"		Average (in) =	**15.9**	Average SWE (in) =	**4.33**
Note 1: Locations are referenced to WGS 84 datum.						

Pooled Snow Survey Data Sheet						
Date: 4/24/2012	Start Time: 9:45		End Time: 16:15		Observers: KRH/BTG	
Catchment Basin: M9602			Snow Sampler: Mt. Rose Model 3600, 1.625" I.D.		Driving Wrench Used: No	

Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Plug	Snow Depth (in) w/o Plug	Calculations	
PS035	1	Lake	11.0	11.0	Bucket & Core Weight (lb) =	1.76
	2		11.0	11.0	Empty Bucket Weight (lb) =	0.82
	3		10.5	10.5	Average Mass (lb) =	0.19
	4		10.5	10.5	Core Area (in^2) =	2.0739
	5		10.5	10.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 16.6"		Sum (in) =	**53.5**	Average Density (lb/in^3) =	**0.008**
Longitude	W 150° 44' 23.5"		Average (in) =	**10.7**	Average SWE (in) =	**2.51**
PS036	1	Lake	9.5	9.5	Bucket & Core Weight (lb) =	2.00
	2		9.5	9.5	Empty Bucket Weight (lb) =	0.82
	3		9.0	9.0	Average Mass (lb) =	0.24
	4		10.0	10.0	Core Area (in^2) =	2.0739
	5		10.0	10.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 09.0"		Sum (in) =	**48.0**	Average Density (lb/in^3) =	**0.012**
Longitude	W 150° 44' 30.5"		Average (in) =	**9.6**	Average SWE (in) =	**3.15**
PS037	1	Lake	13.5	13.5	Bucket & Core Weight (lb) =	2.44
	2		12.5	12.5	Empty Bucket Weight (lb) =	0.84
	3		12.5	12.0	Average Mass (lb) =	0.32
	4		12.5	12.0	Core Area (in^2) =	2.0739
	5		13.5	13.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 01.5"		Sum (in) =	**63.0**	Average Density (lb/in^3) =	**0.012**
Longitude	W 150° 44' 37.4"		Average (in) =	**12.6**	Average SWE (in) =	**4.27**
PS038	1	Tundra	14.5	13.5	Bucket & Core Weight (lb) =	2.40
	2		14.5	14.0	Empty Bucket Weight (lb) =	0.82
	3		17	15.0	Average Mass (lb) =	0.32
	4		17	15.0	Core Area (in^2) =	2.0739
	5		15.5	14.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 12' 54.0"		Sum (in) =	**72.0**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150° 44' 44.4"		Average (in) =	**14.4**	Average SWE (in) =	**4.22**
PS039	1	Lake	6.5	6.5	Bucket & Core Weight (lb) =	1.42
	2		7.0	7.0	Empty Bucket Weight (lb) =	0.82
	3		6.5	6.5	Average Mass (lb) =	0.12
	4		6.5	6.5	Core Area (in^2) =	2.0739
	5		6.5	6.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 12'48.3"		Sum (in) =	**33.0**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150° 44' 49.6"		Average (in) =	**6.6**	Average SWE (in) =	**1.60**
PS040	1	Lake	10.0	10.0	Bucket & Core Weight (lb) =	1.74
	2		9.5	9.5	Empty Bucket Weight (lb) =	0.82
	3		10.0	10.0	Average Mass (lb) =	0.18
	4		10.0	10.0	Core Area (in^2) =	2.0739
	5		9.5	9.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 12' 40.8"		Sum (in) =	**49.0**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150° 44' 56.5"		Average (in) =	**9.8**	Average SWE (in) =	**2.46**

Note 1: Locations are referenced to WGS 84 datum.

Pooled Snow Survey Data Sheet						
Date: 4/24/2012	Start Time: 9:45		End Time: 16:15		Observers: KRH/BTG	
Catchment Basin: M9602			Snow Sampler: Mt. Rose Model 3600, 1.625" I.D.		Driving Wrench Used: No	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Plug	Snow Depth (in) w/o Plug	Calculations	
PS041	1	Lake	6.5	6.0	Bucket & Core Weight (lb) =	1.32
	2		6.0	6.0	Empty Bucket Weight (lb) =	0.84
	3		6.0	6.0	Average Mass (lb) =	0.10
	4		6.5	6.5	Core Area (in^2) =	2.0739
	5		7.0	7.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 12'35.2"		Sum (in) =	**31.5**	Average Density (lb/in^3) =	**0.007**
Longitude	W 150° 45' 01.8"		Average (in) =	**6.3**	Average SWE (in) =	**1.28**
PS042	1	Lake	13.0	13.0	Bucket & Core Weight (lb) =	2.22
	2		13.5	13.5	Empty Bucket Weight (lb) =	0.82
	3		15.5	15.5	Average Mass (lb) =	0.28
	4		15.0	15.0	Core Area (in^2) =	2.0739
	5		14.0	14.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 12' 29.5"		Sum (in) =	**71.0**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150° 45' 07.0"		Average (in) =	**14.2**	Average SWE (in) =	**3.74**
PS043	1	Tundra	15.5	13.5	Bucket & Core Weight (lb) =	1.68
	2		13.5	12.0	Empty Bucket Weight (lb) =	0.82
	3		12	11.0	Average Mass (lb) =	0.17
	4		13	11.5	Core Area (in^2) =	2.0739
	5		16	13.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 12' 22.2"		Sum (in) =	**61.5**	Average Density (lb/in^3) =	**0.007**
Longitude	W 150° 45' 14.0"		Average (in) =	**12.3**	Average SWE (in) =	**2.30**
PS044	1	Lake	14.0	14.0	Bucket & Core Weight (lb) =	2.20
	2		13.5	13.5	Empty Bucket Weight (lb) =	0.82
	3		11.5	11.0	Average Mass (lb) =	0.28
	4		12.0	12.0	Core Area (in^2) =	2.0739
	5		12.5	12.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 17.5"		Sum (in) =	**63.0**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150° 44' 47.9"		Average (in) =	**12.6**	Average SWE (in) =	**3.69**
PS045	1	Lake	9.0	9.0	Bucket & Core Weight (lb) =	2.04
	2		9.0	9.0	Empty Bucket Weight (lb) =	0.84
	3		9.0	9.0	Average Mass (lb) =	0.24
	4		10.0	10.0	Core Area (in^2) =	2.0739
	5		9.5	9.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 15.8"		Sum (in) =	**46.5**	Average Density (lb/in^3) =	**0.012**
Longitude	W 150° 45' 04.7"		Average (in) =	**9.3**	Average SWE (in) =	**3.21**
PS046	1	Tundra	14	12.0	Bucket & Core Weight (lb) =	2.12
	2		10.5	10.0	Empty Bucket Weight (lb) =	0.84
	3		17.5	16.5	Average Mass (lb) =	0.26
	4		17.5	17.0	Core Area (in^2) =	2.0739
	5		17	16.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 14.1"		Sum (in) =	**72.0**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150° 45' 21.4"		Average (in) =	**14.4**	Average SWE (in) =	**3.42**

Note 1: Locations are referenced to WGS 84 datum.

Pooled Snow Survey Data Sheet						
Date: 4/24/2012	Start Time: 9:45		End Time: 16:15		Observers: KRH/BTG	
Catchment Basin: M9602			Snow Sampler: Mt. Rose Model 3600, 1.625" I.D.		Driving Wrench Used: No	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Plug	Snow Depth (in) w/o Plug	Calculations	
PS047	1	Lake	10.5	10.5	Bucket & Core Weight (lb) =	1.68
	2		10.0	10.0	Empty Bucket Weight (lb) =	0.82
	3		8.5	8.5	Average Mass (lb) =	0.17
	4		9.5	9.5	Core Area (in^2) =	2.0739
	5		9.5	9.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 12.4"		Sum (in) =	**48.0**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150° 45' 38.2"		Average (in) =	**9.6**	Average SWE (in) =	**2.30**
PS048	1	Lake	8.0	8.0	Bucket & Core Weight (lb) =	1.82
	2		9.5	9.5	Empty Bucket Weight (lb) =	0.82
	3		10.5	10.5	Average Mass (lb) =	0.20
	4		8.5	8.5	Core Area (in^2) =	2.0739
	5		9.5	9.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 23.8"		Sum (in) =	**46.0**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150° 44' 34.1"		Average (in) =	**9.2**	Average SWE (in) =	**2.67**
PS049	1	Lake	8.0	7.5	Bucket & Core Weight (lb) =	1.58
	2		9.0	8.0	Empty Bucket Weight (lb) =	0.84
	3		8.0	8.0	Average Mass (lb) =	0.15
	4		8.5	8.5	Core Area (in^2) =	2.0739
	5		9.0	9.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 29.6"		Sum (in) =	**41.0**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150° 44' 57.7"		Average (in) =	**8.2**	Average SWE (in) =	**1.98**
PS050	1	Tundra	19.5	19.0	Bucket & Core Weight (lb) =	2.98
	2		18.5	18.5	Empty Bucket Weight (lb) =	0.82
	3		19.0	18.5	Average Mass (lb) =	0.43
	4		20.0	19.5	Core Area (in^2) =	2.0739
	5		20.0	19.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 34.2"		Sum (in) =	**94.5**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150° 45' 16.6"		Average (in) =	**18.9**	Average SWE (in) =	**5.77**
PS051	1	Tundra	13	11.0	Bucket & Core Weight (lb) =	1.76
	2		12.5	12.0	Empty Bucket Weight (lb) =	0.82
	3		8.5	7.5	Average Mass (lb) =	0.19
	4		13	11.0	Core Area (in^2) =	2.0739
	5		12	10.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 37.7"		Sum (in) =	**51.5**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150° 45' 30.7"		Average (in) =	**10.3**	Average SWE (in) =	**2.51**
PS052	1	Tundra	11.5	9.5	Bucket & Core Weight (lb) =	1.76
	2		12.5	12.0	Empty Bucket Weight (lb) =	0.84
	3		13.5	12.5	Average Mass (lb) =	0.18
	4		11	9.0	Core Area (in^2) =	2.0739
	5		9.5	7.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 41.2"		Sum (in) =	**50.5**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150° 45' 44.9"		Average (in) =	**10.1**	Average SWE (in) =	**2.46**

Note 1: Locations are referenced to WGS 84 datum.

Pooled Snow Survey Data Sheet						
Date: 4/24/2012	Start Time: 9:45		End Time: 16:15		Observers: KRH/BTG	
Catchment Basin: M9602			Snow Sampler: Mt. Rose Model 3600, 1.625" I.D.		Driving Wrench Used: No	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Plug	Snow Depth (in) w/o Plug	Calculations	
PS053	1	Lake	7.5	7.5	Bucket & Core Weight (lb) =	1.62
	2		7.5	7.5	Empty Bucket Weight (lb) =	0.84
	3		7.5	7.5	Average Mass (lb) =	0.16
	4		8.0	8.0	Core Area (in^2) =	2.0739
	5		8.0	8.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70º 13' 33.8"		Sum (in) =	**38.5**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150º 44' 28.3"		Average (in) =	**7.7**	Average SWE (in) =	**2.08**
PS054	1	Lake	16.0	16.0	Bucket & Core Weight (lb) =	2.88
	2		14.0	14.0	Empty Bucket Weight (lb) =	0.84
	3		17.5	17.5	Average Mass (lb) =	0.41
	4		18.0	18.0	Core Area (in^2) =	2.0739
	5		14.5	14.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70º 13' 49.2"		Sum (in) =	**80.0**	Average Density (lb/in^3) =	**0.012**
Longitude	W 150º 44' 37.7"		Average (in) =	**16.0**	Average SWE (in) =	**5.45**
PS055	1	Tundra	9.0	8.5	Bucket & Core Weight (lb) =	1.86
	2		13.0	11.0	Empty Bucket Weight (lb) =	0.82
	3		14.5	14.5	Average Mass (lb) =	0.21
	4		11.5	11.0	Core Area (in^2) =	2.0739
	5		18.0	17.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70º 14' 00.8"		Sum (in) =	**62.5**	Average Density (lb/in^3) =	**0.008**
Longitude	W 150º 44' 44.9"		Average (in) =	**12.5**	Average SWE (in) =	**2.78**
PS056	1	Lake	8.0	8.0	Bucket & Core Weight (lb) =	1.60
	2		8.0	8.0	Empty Bucket Weight (lb) =	0.82
	3		8.5	8.5	Average Mass (lb) =	0.16
	4		8.5	8.5	Core Area (in^2) =	2.0739
	5		8.5	8.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70º 13' 06.9"		Sum (in) =	**41.5**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150º 44' 11.0"		Average (in) =	**8.3**	Average SWE (in) =	**2.08**
PS057	1	Lake	15.0	15.0	Bucket & Core Weight (lb) =	2.48
	2		14.0	14.0	Empty Bucket Weight (lb) =	0.84
	3		13.0	13.0	Average Mass (lb) =	0.33
	4		13.0	13.0	Core Area (in^2) =	2.0739
	5		14.0	14.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70º 12' 53.4"		Sum (in) =	**69.0**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150º 44' 02.2"		Average (in) =	**13.8**	Average SWE (in) =	**4.38**
PS058	1	Tundra	15.5	13.0	Bucket & Core Weight (lb) =	1.98
	2		14.0	14.0	Empty Bucket Weight (lb) =	0.82
	3		15.0	14.0	Average Mass (lb) =	0.23
	4		15.0	12.0	Core Area (in^2) =	2.0739
	5		15.5	14.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70º 12' 41.8"		Sum (in) =	**67.5**	Average Density (lb/in^3) =	**0.008**
Longitude	W 150º 43' 54.6"		Average (in) =	**13.5**	Average SWE (in) =	**3.10**
Note 1: Locations are referenced to WGS 84 datum.						

Pooled Snow Survey Data Sheet						
Date: 4/23/2012	Start Time: 11:00		End Time: 17:00		Observers: HLR/KRH	
Catchment Basin: M9605			Snow Sampler: Mt. Rose Model 3600, 1.625" I.D.		Driving Wrench Used: No	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Plug	Snow Depth (in) w/o Plug	Calculations	
PS001	1	Lake	20.5	20.5	Bucket & Core Weight (lb) =	2.84
	2		18	17.5	Empty Bucket Weight (lb) =	0.80
	3		15	15.0	Average Mass (lb) =	0.41
	4		15.5	15.0	Core Area (in^2) =	2.0739
	5		18	18.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 16.0"		Sum (in) =	**86.0**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150° 30' 56.6"		Average (in) =	**17.20**	Average SWE (in) =	**5.45**
PS002	1	Lake	17.5	17.0	Bucket & Core Weight (lb) =	2.82
	2		18.5	18.5	Empty Bucket Weight (lb) =	0.82
	3		17	17.0	Average Mass (lb) =	0.40
	4		13	12.5	Core Area (in^2) =	2.0739
	5		16	16.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 27.3"		Sum (in) =	**81.0**	Average Density (lb/in^3) =	**0.012**
Longitude	W 150° 31' 07.9"		Average (in) =	**16.2**	Average SWE (in) =	**5.34**
PS003	1	Lake	5	5.0	Bucket & Core Weight (lb) =	1.36
	2		5	5.0	Empty Bucket Weight (lb) =	0.78
	3		6	6.0	Average Mass (lb) =	0.12
	4		4.5	4.5	Core Area (in^2) =	2.0739
	5		5	5.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 36.6"		Sum (in) =	**25.5**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150° 31' 17.1"		Average (in) =	**5.1**	Average SWE (in) =	**1.55**
PS004	1	Lake	23.5	23.5	Bucket & Core Weight (lb) =	3.70
	2		18.5	18.5	Empty Bucket Weight (lb) =	0.84
	3		19.0	19.0	Average Mass (lb) =	0.57
	4		21.0	21.0	Core Area (in^2) =	2.0739
	5		21.0	21.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 45.9"		Sum (in) =	**103.0**	Average Density (lb/in^3) =	**0.013**
Longitude	W 150° 31' 26.4"		Average (in) =	**20.6**	Average SWE (in) =	**7.64**
PS005	1	Lake	6.5	6.0	Bucket & Core Weight (lb) =	NOT RECORDED
	2		6.0	6.0	Empty Bucket Weight (lb) =	0.84
	3		8.0	8.0	Average Mass (lb) =	--
	4		10.0	10.0	Core Area (in^2) =	2.0739
	-		9.0	9.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 24.3"		Sum (in) =	**39.0**	Average Density (lb/in^3) =	--
Longitude	W 150° 30' 40.7"		Average (in) =	**7.8**	Average SWE (in) =	--
PS006	1	Tundra	7.0	6.0	Bucket & Core Weight (lb) =	1.32
	2		9.5	7.5	Empty Bucket Weight (lb) =	0.82
	3		7.0	5.5	Average Mass (lb) =	0.10
	4		5.5	4.0	Core Area (in^2) =	2.0739
	5		9.0	8.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 32.6"		Sum (in) =	**31.5**	Average Density (lb/in^3) =	**0.008**
Longitude	W 150° 30' 24.9"		Average (in) =	**6.3**	Average SWE (in) =	**1.34**

Note 1: Locations are referenced to WGS 84 datum.

Note 2: Gaps in numbering are deliberate.

Pooled Snow Survey Data Sheet						
Date: 4/23/2012	Start Time: 11:00		End Time: 17:00		Observers: HLR/KRH	
Catchment Basin: M9605		Snow Sampler: Mt. Rose Model 3600, 1.625" I.D.			Driving Wrench Used: No	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Plug	Snow Depth (in) w/o Dirt Plug	Calculations	
PS007	1	Lake	10.5	10.5	Bucket & Core Weight (lb) =	1.72
	2		10	10.0	Empty Bucket Weight (lb) =	0.82
	3		10.5	10.5	Average Mass (lb) =	0.18
	4		9	8.5	Core Area (in^2) =	2.0739
	5		9.5	9.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 12.0"		Sum (in) =	**49.0**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150° 30' 35.6"		Average (in) =	**9.8**	Average SWE (in) =	**2.40**
PS008	1	Tundra	9.0	6.5	Bucket & Core Weight (lb) =	1.34
	2		6.5	3.0	Empty Bucket Weight (lb) =	0.82
	3		8.0	6.5	Average Mass (lb) =	0.10
	4		9.5	6.5	Core Area (in^2) =	2.0739
	5		8.5	6.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 06.0"		Sum (in) =	**28.5**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150° 30' 06.4"		Average (in) =	**5.7**	Average SWE (in) =	**1.39**
PS009	1	Tundra	18	17.5	Bucket & Core Weight (lb) =	2.40
	2		17.5	17.0	Empty Bucket Weight (lb) =	0.86
	3		19	19.0	Average Mass (lb) =	0.31
	4		15.5	13.5	Core Area (in^2) =	2.0739
	5		15.5	11.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 02.0"		Sum (in) =	**78.5**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150° 29' 46.3"		Average (in) =	**15.7**	Average SWE (in) =	**4.11**
PS010	1	Lake	7.5	7.0	Bucket & Core Weight (lb) =	1.60
	2		7.0	7.0	Empty Bucket Weight (lb) =	0.82
	3		7.5	7.5	Average Mass (lb) =	0.16
	4		8.0	8.0	Core Area (in^2) =	2.0739
	5		8.0	8.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 06.8"		Sum (in) =	**37.5**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150° 30' 46.1"		Average (in) =	**7.5**	Average SWE (in) =	**2.08**
PS011	1	Lake	8.5	8.0	Bucket & Core Weight (lb) =	1.74
	2		9.0	9.0	Empty Bucket Weight (lb) =	0.82
	3		9.0	9.0	Average Mass (lb) =	0.18
	4		7.5	7.5	Core Area (in^2) =	2.0739
	5		9.0	9.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 12' 59.4"		Sum (in) =	**42.5**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150° 30' 37.8"		Average (in) =	**8.5**	Average SWE (in) =	**2.46**
PS012	1	Lake	3.5	3.5	Bucket & Core Weight (lb) =	1.10
	2		3.5	3.5	Empty Bucket Weight (lb) =	0.82
	3		3.0	3.0	Average Mass (lb) =	0.06
	4		3.0	3.0	Core Area (in^2) =	2.0739
	5		3.0	3.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 12' 50.2"		Sum (in) =	**16.0**	Average Density (lb/in^3) =	**0.008**
Longitude	W 150° 30' 27.4"		Average (in) =	**3.2**	Average SWE (in) =	**0.75**
Note 1: Locations are referenced to WGS 84 datum.						

Pooled Snow Survey Data Sheet						
Date: 4/23/2012	**Start Time:** 11:00		**End Time:** 17:00		**Observers:** HLR/KRH	
Catchment Basin: M9605			**Snow Sampler:** Mt. Rose Model 3600, 1.625" I.D.		**Driving Wrench Used:** No	
Snow Sample No.	**Pooled Sample #**	**Terrain Type**	**Snow Depth (in) w/ Plug**	**Snow Depth (in) w/o Dirt Plug**	**Calculations**	
PS013	1	Tundra	14.5	12.5	**Bucket & Core Weight (lb) =**	1.96
	2		13.5	12.0	**Empty Bucket Weight (lb) =**	0.82
	3		13	11.5	**Average Mass (lb) =**	0.23
	4		13	11.0	**Core Area (in^2) =**	2.0739
	5		14	13.5	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 12' 39.2"		**Sum (in) =**	**60.5**	**Average Density (lb/in^3) =**	**0.009**
Longitude	W 150° 30' 14.9"		**Average (in) =**	**12.1**	**Average SWE (in) =**	**3.05**
PS014	1	Tundra	15	13.0	**Bucket & Core Weight (lb) =**	2.08
	2		13	11.5	**Empty Bucket Weight (lb) =**	0.84
	3		17	15.5	**Average Mass (lb) =**	0.25
	4		14	12.0	**Core Area (in^2) =**	2.0739
	5		13	12.5	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 12' 33.8"		**Sum (in) =**	**64.5**	**Average Density (lb/in^3) =**	**0.009**
Longitude	W 150° 30' 08.5"		**Average (in) =**	**12.9**	**Average SWE (in) =**	**3.31**
PS015	1	Tundra	21	20.0	**Bucket & Core Weight (lb) =**	3.00
	2		21	19.0	**Empty Bucket Weight (lb) =**	0.80
	3		22	21.0	**Average Mass (lb) =**	0.44
	4		22	21.0	**Core Area (in^2) =**	2.0739
	5		22.5	20.5	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 12' 29.7"		**Sum (in) =**	**101.5**	**Average Density (lb/in^3) =**	**0.010**
Longitude	W 150° 30' 35.0"		**Average (in) =**	**20.3**	**Average SWE (in) =**	**5.88**
PS016	1	Tundra	13.5	13.0	**Bucket & Core Weight (lb) =**	2.28
	2		15	14.5	**Empty Bucket Weight (lb) =**	0.82
	3		15.5	15.0	**Average Mass (lb) =**	0.29
	4		15	14.5	**Core Area (in^2) =**	2.0739
	5		12.5	12.0	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 12' 38.0"		**Sum (in) =**	**69.0**	**Average Density (lb/in^3) =**	**0.010**
Longitude	W 150° 29' 42.1"		**Average (in) =**	**13.8**	**Average SWE (in) =**	**3.90**
PS017	1	Lake	5.5	5.5	**Bucket & Core Weight (lb) =**	1.70
	2		6.5	6.5	**Empty Bucket Weight (lb) =**	0.82
	3		8.0	7.5	**Average Mass (lb) =**	0.18
	4		7.5	7.5	**Core Area (in^2) =**	2.0739
	5		7.5	7.0	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 13' 10.5"		**Sum (in) =**	**34.0**	**Average Density (lb/in^3) =**	**0.012**
Longitude	W 150° 31' 02.5"		**Average (in) =**	**6.8**	**Average SWE (in) =**	**2.35**
PS018	1	Lake	7.0	7.0	**Bucket & Core Weight (lb) =**	1.50
	2		6.5	6.5	**Empty Bucket Weight (lb) =**	0.80
	3		7.0	7.0	**Average Mass (lb) =**	0.14
	4		7.5	7.5	**Core Area (in^2) =**	2.0739
	5		7.0	6.5	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 13' 04.9"		**Sum (in) =**	**34.5**	**Average Density (lb/in^3) =**	**0.010**
Longitude	W 150° 31' 08.5"		**Average (in) =**	**6.9**	**Average SWE (in) =**	**1.87**
Note 1: Locations are referenced to WGS 84 datum.						

Pooled Snow Survey Data Sheet						
Date: 4/23/2012		**Start Time:** 11:00		**End Time:** 17:00	**Observers:** HLR/KRH	
Catchment Basin: M9605			**Driving Wrench Used:** No		**Tube Section Used:** 1-2	
Snow Sample No.	**Pooled Sample #**	**Terrain Type**	**Snow Depth (in) w/ Plug**	**Snow Depth (in) w/o Dirt Plug**	**Calculations**	
PS019	1	Tundra	11.5	9.5	**Bucket & Core Weight (lb) =**	1.72
	2		15.5	13.5	**Empty Bucket Weight (lb) =**	0.82
	3		11	7.0	**Average Mass (lb) =**	0.18
	4		9	6.5	**Core Area (in^2) =**	2.0739
	5		15.5	14.5	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 12' 57.5"		**Sum (in) =**	**51.0**	**Average Density (lb/in^3) =**	**0.009**
Longitude	W 150° 31' 16.5"		**Average (in) =**	**10.2**	**Average SWE (in) =**	**2.40**
PS020	1	Tundra	20	18.0	**Bucket & Core Weight (lb) =**	2.96
	2		20	19.0	**Empty Bucket Weight (lb) =**	0.84
	3		23.5	23.5	**Average Mass (lb) =**	0.42
	4		19.5	18.5	**Core Area (in^2) =**	2.0739
	5		22.5	22.0	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 12' 50.1"		**Sum (in) =**	**101.0**	**Average Density (lb/in^3) =**	**0.010**
Longitude	W 150° 31' 24.5"		**Average (in) =**	**20.2**	**Average SWE (in) =**	**5.66**
PS021	1	Lake	16.5	16.5	**Bucket & Core Weight (lb) =**	2.88
	2		16.0	16.0	**Empty Bucket Weight (lb) =**	0.82
	3		17.0	17.0	**Average Mass (lb) =**	0.41
	4		18.5	18.5	**Core Area (in^2) =**	2.0739
	5		18.5	18.5	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 13' 16.8"		**Sum (in) =**	**86.5**	**Average Density (lb/in^3) =**	**0.011**
Longitude	W 150° 31' 25.6"		**Average (in) =**	**17.3**	**Average SWE (in) =**	**5.50**
PS022	1	Tundra	14.5	12.5	**Bucket & Core Weight (lb) =**	1.76
	2		13.5	13.0	**Empty Bucket Weight (lb) =**	0.80
	3		11.5	9.0	**Average Mass (lb) =**	0.19
	4		14	11.0	**Core Area (in^2) =**	2.0739
	5		13.5	13.0	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70° 13' 17.4"		**Sum (in) =**	**58.5**	**Average Density (lb/in^3) =**	**0.008**
Longitude	W 150° 31' 48.9"		**Average (in) =**	**11.7**	**Average SWE (in) =**	**2.56**
Note 1: Locations are referenced to WGS 84 datum.						

Pooled Snow Survey Data Sheet								
Date: 4/24/2012	**Start Time:** 10:30			**End Time:** 15:50			**Observers:** HLR/BTG/AJG(LCMF)	
Catchment Basin: M9602			**Snow Sampler:** Mt. Rose Model 3600, 1.625" I.D.				**Driving Wrench Used:** No	
Snow Sample No.	**Pooled Sample #**	**Terrain Type**	**Snow Depth (in) w/ Plug**	**plug**	**w/o Plug**	**Calculations**		
BSS9	1	Leeward	42.5	0	42.5	**Bucket & Core Weight (lb) =**	1.88	
	2		-	-	-	**Empty Bucket Weight (lb) =**	0.84	
	3		-	-	-	**Average Mass (lb) =**	1.04	
	4		-	-	-	**Core Area (in^2) =**	2.0739	
	5		-	-	-	**Freshwater Density (lb/in^3) =**	0.0361	
Latitude	N 70° 13' 56.1"		**Sum (in) =**		**42.5**	**Average Density (lb/in^3) =**	**0.012**	
Longitude	W 150° 44' 25.5"		**Average (in) =**		**42.5**	**Average SWE (in) =**	**13.89**	
BSS10	1	Lake	36.0	0	36.0	**Bucket & Core Weight (lb) =**	1.62	
	2		-	-	-	**Empty Bucket Weight (lb) =**	0.84	
	3		-	-	-	**Average Mass (lb) =**	0.78	
	4		-	-	-	**Core Area (in^2) =**	2.0739	
	5		-	-	-	**Freshwater Density (lb/in^3) =**	0.0361	
Latitude	N 70° 13' 56.6"		**Sum (in) =**		**36.0**	**Average Density (lb/in^3) =**	**0.010**	
Longitude	W 150° 44' 25.3"		**Average (in) =**		**36.0**	**Average SWE (in) =**	**10.42**	
Note 1: Locations are referenced to WGS 84 datum.								

Pooled Snow Survey Data Sheet							
Date: 4/24/2012	Start Time: 10:30			End Time: 15:50		Observers: HLR/BTG/AJG(LCMF)	
Catchment Basin: M9605		Snow Sampler: Mt. Rose Model 3600, 1.625" I.D.				Driving Wrench Used: No	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Plug	Snow Depth (in) plug	Snow Depth (in) w/o Plug	Calculations	
BSS1	1	Windward	41.0	0	41.0	Bucket & Core Weight (lb) =	1.86
	2		-	-	-	Empty Bucket Weight (lb) =	0.84
	3		-	-	-	Average Mass (lb) =	1.02
	4		-	-	-	Core Area (in^2) =	2.0739
	-		-	-	-	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 44.3"	Sum (in) =			**41.0**	Average Density (lb/in^3) =	**0.012**
Longitude	W 150° 31' 41.4"	Average (in) =			**41.0**	Average SWE (in) =	**13.62**
BSS2	1	Leeward	32.5	1	31.5	Bucket & Core Weight (lb) =	1.64
	2		-	-	-	Empty Bucket Weight (lb) =	0.84
	3		-	-	-	Average Mass (lb) =	0.80
	4		-	-	-	Core Area (in^2) =	2.0739
	5		-	-	-	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 44.4"	Sum (in) =			**31.5**	Average Density (lb/in^3) =	**0.012**
Longitude	W 150° 31' 43.0"	Average (in) =			**31.5**	Average SWE (in) =	**10.69**
BSS3	1	Windward	48.5	0	48.5	Bucket & Core Weight (lb) =	2.10
	2		-	-	-	Empty Bucket Weight (lb) =	0.82
	3		-	-	-	Average Mass (lb) =	1.28
	4		-	-	-	Core Area (in^2) =	2.0739
	5		-	-	-	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 37.6"	Sum (in) =			**48.5**	Average Density (lb/in^3) =	**0.013**
Longitude	W 150° 31' 43.0"	Average (in) =			**48.5**	Average SWE (in) =	**17.10**
BSS4	1	Leeward	21.5	0.5	21.0	Bucket & Core Weight (lb) =	3.30
	2		22.0	0	22.0	Empty Bucket Weight (lb) =	0.82
	3		23.0	0.5	22.5	Average Mass (lb) =	0.50
	4		21.0	1	20.0	Core Area (in^2) =	2.0739
	5		23.0	0.5	22.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70° 13' 37.2"	Sum (in) =			**108.0**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150° 31' 46.4"	Average (in) =			**21.6**	Average SWE (in) =	**6.63**

Note 1: Locations are referenced to WGS 84 datum.

Pooled Snow Survey Data Sheet								
Date: 4/24/2012	Start Time: 10:30			End Time: 15:50		Observers: HLR/BTG/AJG(LCMF)		
Catchment Basin: M9605		Snow Sampler: Mt. Rose Model 3600, 1.625" I.D.				Driving Wrench Used: No		
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Plug	plug	w/o Plug	Calculations		
BSS5	1	Leeward	42.5	0	42.5	Bucket & Core Weight (lb) =	1.90	
	2		-	-	-	Empty Bucket Weight (lb) =	0.82	
	3		-	-	-	Average Mass (lb) =	1.08	
	4		-	-	-	Core Area (in^2) =	2.0739	
	-		-	-	-	Freshwater Density (lb/in^3) =	0.0361	
Latitude	N 70° 13' 21.4"	Sum (in) =			**42.5**	Average Density (lb/in^3) =	**0.012**	
Longitude	W 150° 30' 26.0"	Average (in) =			**42.5**	Average SWE (in) =	**14.43**	
BSS6	1	Windward	48.0	0	48.0	Bucket & Core Weight (lb) =	2.08	
	2		-	-	-	Empty Bucket Weight (lb) =	0.82	
	3		-	-	-	Average Mass (lb) =	1.26	
	4		-	-	-	Core Area (in^2) =	2.0739	
	5		-	-	-	Freshwater Density (lb/in^3) =	0.0361	
Latitude	N 70° 13' 21.7"	Sum (in) =			**48.0**	Average Density (lb/in^3) =	**0.013**	
Longitude	W 150° 30' 22.4"	Average (in) =			**48.0**	Average SWE (in) =	**16.83**	
BSS7	1	Leeward	46.0	0	46.0	Bucket & Core Weight (lb) =	1.98	
	2		-	-	-	Empty Bucket Weight (lb) =	0.82	
	3		-	-	-	Average Mass (lb) =	1.16	
	4		-	-	-	Core Area (in^2) =	2.0739	
	5		-	-	-	Freshwater Density (lb/in^3) =	0.0361	
Latitude	N 70° 13' 32.6"	Sum (in) =			**46.0**	Average Density (lb/in^3) =	**0.012**	
Longitude	W 150° 30' 36.2"	Average (in) =			**46.0**	Average SWE (in) =	**15.49**	
BSS8	1	Windward	52.5	0	52.5	Bucket & Core Weight (lb) =	2.10	
	2		-	-	-	Empty Bucket Weight (lb) =	0.84	
	3		-	-	-	Average Mass (lb) =	1.26	
	4		-	-	-	Core Area (in^2) =	2.0739	
	5		-	-	-	Freshwater Density (lb/in^3) =	0.0361	
Latitude	N 70° 13' 32.9"	Sum (in) =			**52.5**	Average Density (lb/in^3) =	**0.012**	
Longitude	W 150° 30' 31.8"	Average (in) =			**52.5**	Average SWE (in) =	**16.83**	
Note 1: Locations are referenced to WGS 84 datum.								

Snow Depth Survey Data Sheet				
Date: 4/24/2012		**Start Time:** 15:00		**Observers:** BTG/HLR/AJG
Catchment Basin: M9602		**End Time:** 15:50		
Snow Sample No.	**Terrain Type**	**Snow Depth (in)**	**Location (WGS 84)**	
			Latitude	**Longitude**
Lake M9602 - Berm A cross section #1				
BSS140	lake	10.2	N 70° 13' 56.1"	W 150° 44' 25.5"
BSS141	lake	15.4	N 70° 13' 56.1"	W 150° 44' 25.4"
BSS142	lake	17.3	N 70° 13' 56.1"	W 150° 44' 25.4"
BSS143	lake	17.7	N 70° 13' 56.2"	W 150° 44' 25.4"
BSS144	lake	23.6	N 70° 13' 56.2"	W 150° 44' 25.4"
BSS145	lake	28.0	N 70° 13' 56.2"	W 150° 44' 25.4"
BSS146	lake	28.0	N 70° 13' 56.2"	W 150° 44' 25.3"
BSS147	lake	37.8	N 70° 13' 56.2"	W 150° 44' 25.3"
BSS148	lake	41.3	N 70° 13' 56.3"	W 150° 44' 25.3"
BSS149	lake	54.7	N 70° 13' 56.3"	W 150° 44' 25.3"
BSS150	lake	67.7	N 70° 13' 56.3"	W 150° 44' 25.3"
BSS151	lake	66.5	N 70° 13' 56.3"	W 150° 44' 25.3"
BSS152	lake	69.3	N 70° 13' 56.4"	W 150° 44' 25.3"
BSS153	lake	74.8	N 70° 13' 56.4"	W 150° 44' 25.3"
BSS154	lake	78.7	N 70° 13' 56.4"	W 150° 44' 25.3"
BSS155	lake	70.1	N 70° 13' 56.4"	W 150° 44' 25.3"
BSS156	lake	64.6	N 70° 13' 56.4"	W 150° 44' 25.3"
BSS157	lake	55.1	N 70° 13' 56.5"	W 150° 44' 25.2"
BSS158	lake	48.0	N 70° 13' 56.5"	W 150° 44' 25.2"
BSS159	tundra	33.5	N 70° 13' 56.5"	W 150° 44' 25.2"
BSS160	tundra	10.6	N 70° 13' 56.5"	W 150° 44' 25.2"
BSS161	tundra	7.5	N 70° 13' 56.5"	W 150° 44' 25.2"
BSS162	tundra	12.2	N 70° 13' 56.6"	W 150° 44' 25.2"
BSS163	tundra	12.2	N 70° 13' 56.6"	W 150° 44' 25.2"
BSS164	tundra	7.1	N 70° 13' 56.6"	W 150° 44' 25.3"
Lake M9602 - Berm B was primarily composed of ice and therefore unmeasureable using snow survey equipment and techniques				
Note: Snow berm depth samples were taken at approximately even intervals along a straight line between identified starting and ending locations.				

Snow Depth Survey Data Sheet				
Date: 4/24/2012		**Start Time:** 10:00		**Observers:** BTG/HLR/AJG
Catchment Basin: M9605		**End Time:** 14:30		
Snow Sample No.	**Terrain Type**	**Snow Depth (in)**	**Location (WGS 84)**	
			Latitude	**Longitude**
Lake M9605 - Berm C cross section #1				
BS1	lake	10.2	N 70° 13' 44.3"	W 150° 31' 41.4"
BS2	lake	13.4	N 70° 13' 44.3"	W 150° 31' 41.3"
BS3	lake	15.7	N 70° 13' 44.3"	W 150° 31' 41.4"
BS4	lake	19.3	N 70° 13' 44.3"	W 150° 31' 41.4"
BS5	lake	22.0	N 70° 13' 44.3"	W 150° 31' 41.5"
BS6	lake	26.0	N 70° 13' 44.3"	W 150° 31' 41.6"
BS7	lake	29.5	N 70° 13' 44.4"	W 150° 31' 41.6"
BS8	lake	29.5	N 70° 13' 44.4"	W 150° 31' 41.7"
BS9	lake	31.5	N 70° 13' 44.4"	W 150° 31' 41.8"
BS10	lake	33.9	N 70° 13' 44.4"	W 150° 31' 41.8"
BS11	lake	37.8	N 70° 13' 44.4"	W 150° 31' 41.9"
BS12	lake	45.7	N 70° 13' 44.4"	W 150° 31' 41.9"
BS13	lake	53.9	N 70° 13' 44.4"	W 150° 31' 42.0"
BS14	lake	68.9	N 70° 13' 44.4"	W 150° 31' 42.1"
BS15	lake	55.5	N 70° 13' 44.4"	W 150° 31' 42.1"
BS16	lake	46.5	N 70° 13' 44.4"	W 150° 31' 42.2"
BS17	lake	35.0	N 70° 13' 44.4"	W 150° 31' 42.3"
BS18	lake	32.3	N 70° 13' 44.4"	W 150° 31' 42.3"
BS19	lake	33.1	N 70° 13' 44.4"	W 150° 31' 42.4"
BS20	lake	33.1	N 70° 13' 44.4"	W 150° 31' 42.4"
BS21	lake	31.1	N 70° 13' 44.4"	W 150° 31' 42.5"
BS22	lake	26.8	N 70° 13' 44.4"	W 150° 31' 42.6"
BS23	lake	28.7	N 70° 13' 44.4"	W 150° 31' 42.6"
BS24	lake	24.8	N 70° 13' 44.4"	W 150° 31' 42.7"
BS25	lake	24.8	N 70° 13' 44.4"	W 150° 31' 42.8"
BS26	lake	24.0	N 70° 13' 44.4"	W 150° 31' 42.8"
BS27	lake	20.5	N 70° 13' 44.4"	W 150° 31' 43.0"

Note: Snow berm depth samples were taken at approximately even intervals along a straight line between identified starting and ending locations.

Snow Depth Survey Data Sheet				
Date: 4/24/2012		**Start Time:** 10:00		**Observers:** BTG/HLR/AJG
Catchment Basin: M9605		**End Time:** 14:30		
Snow Sample No.	**Terrain Type**	**Snow Depth (in)**	**Location (WGS 84)**	
			Latitude	**Longitude**
Lake M9605 - Berm C cross section #2				
BS28	lake	19.7	N 70° 13' 37.6"	W 150° 31' 42.0"
BS29	lake	24.4	N 70° 13' 37.6"	W 150° 31' 42.1"
BS30	lake	26.4	N 70° 13' 37.6"	W 150° 31' 42.2"
BS31	lake	29.1	N 70° 13' 37.6"	W 150° 31' 42.3"
BS32	lake	33.5	N 70° 13' 37.6"	W 150° 31' 42.5"
BS33	lake	34.6	N 70° 13' 37.5"	W 150° 31' 42.6"
BS34	lake	33.5	N 70° 13' 37.5"	W 150° 31' 42.7"
BS35	lake	33.5	N 70° 13' 37.5"	W 150° 31' 42.8"
BS36	lake	35.0	N 70° 13' 37.5"	W 150° 31' 42.9"
BS37	lake	41.7	N 70° 13' 37.5"	W 150° 31' 43.0"
BS38	lake	42.9	N 70° 13' 37.5"	W 150° 31' 43.1"
BS39	tundra	44.5	N 70° 13' 37.5"	W 150° 31' 43.2"
BS40	tundra	43.3	N 70° 13' 37.5"	W 150° 31' 43.4"
BS41	tundra	40.9	N 70° 13' 37.5"	W 150° 31' 43.5"
BS42	tundra	37.0	N 70° 13' 37.4"	W 150° 31' 43.6"
BS43	tundra	34.6	N 70° 13' 37.4"	W 150° 31' 43.7"
BS44	tundra	31.1	N 70° 13' 37.4"	W 150° 31' 43.8"
BS45	tundra	32.7	N 70° 13' 37.4"	W 150° 31' 43.9"
BS46	tundra	37.4	N 70° 13' 37.4"	W 150° 31' 44.0"
BS47	tundra	39.4	N 70° 13' 37.4"	W 150° 31' 44.2"
BS48	tundra	40.6	N 70° 13' 37.4"	W 150° 31' 44.3"
BS49	tundra	43.7	N 70° 13' 37.4"	W 150° 31' 44.4"
BS50	tundra	48.8	N 70° 13' 37.3"	W 150° 31' 44.5"
BS51	tundra	50.4	N 70° 13' 37.3"	W 150° 31' 44.6"
BS52	tundra	53.1	N 70° 13' 37.3"	W 150° 31' 44.7"
BS53	tundra	55.9	N 70° 13' 37.3"	W 150° 31' 44.8"
BS54	tundra	59.4	N 70° 13' 37.3"	W 150° 31' 44.9"
BS55	tundra	57.1	N 70° 13' 37.3"	W 150° 31' 44.9"
BS56	tundra	67.3	N 70° 13' 37.3"	W 150° 31' 45.1"
BS57	tundra	78.3	N 70° 13' 37.3"	W 150° 31' 45.2"
BS58	tundra	87.4	N 70° 13' 37.3"	W 150° 31' 45.3"
BS59	tundra	75.2	N 70° 13' 37.3"	W 150° 31' 45.4"
BS60	tundra	53.1	N 70° 13' 37.2"	W 150° 31' 45.5"
BS61	tundra	38.6	N 70° 13' 37.2"	W 150° 31' 45.6"
BS62	tundra	33.5	N 70° 13' 37.2"	W 150° 31' 45.7"
BS63	tundra	25.6	N 70° 13' 37.2"	W 150° 31' 45.9"
BS64	tundra	21.7	N 70° 13' 37.2"	W 150° 31' 46.0"
BS65	tundra	25.6	N 70° 13' 37.2"	W 150° 31' 46.1"
BS66	tundra	23.2	N 70° 13' 37.2"	W 150° 31' 46.2"
BS67	tundra	26.0	N 70° 13' 37.2"	W 150° 31' 46.3"
BS68	tundra	29.1	N 70° 13' 37.2"	W 150° 31' 46.4"
Note: Snow berm depth samples were taken at approximately even intervals along a straight line between identified starting and ending locations.				

Snow Depth Survey Data Sheet				
Date: 4/24/2012		**Start Time:** 10:00		**Observers:** BTG/HLR/AJG
Catchment Basin: M9605		**End Time:** 14:30		
Snow Sample No.	**Terrain Type**	**Snow Depth (in)**	**Location (WGS 84)**	
			Latitude	**Longitude**
Lake M9605 - Berm D cross section #1				
BS69	lake	9.8	N 70° 13' 21.4"	W 150° 30' 26.0"
BS70	lake	11.8	N 70° 13' 21.4"	W 150° 30' 25.9"
BS71	lake	11.8	N 70° 13' 21.4"	W 150° 30' 25.8"
BS72	lake	11.8	N 70° 13' 21.4"	W 150° 30' 25.7"
BS73	lake	13.8	N 70° 13' 21.4"	W 150° 30' 25.6"
BS74	lake	15.4	N 70° 13' 21.4"	W 150° 30' 25.5"
BS75	lake	19.3	N 70° 13' 21.4"	W 150° 30' 25.4"
BS76	lake	21.3	N 70° 13' 21.4"	W 150° 30' 25.3"
BS77	lake	23.2	N 70° 13' 21.4"	W 150° 30' 25.1"
BS78	lake	26.0	N 70° 13' 21.5"	W 150° 30' 25.0"
BS79	lake	28.0	N 70° 13' 21.5"	W 150° 30' 24.9"
BS80	lake	31.5	N 70° 13' 21.5"	W 150° 30' 24.8"
BS81	lake	34.3	N 70° 13' 21.5"	W 150° 30' 24.7"
BS82	lake	35.4	N 70° 13' 21.5"	W 150° 30' 24.6"
BS83	lake	38.6	N 70° 13' 21.5"	W 150° 30' 24.5"
BS84	lake	40.6	N 70° 13' 21.5"	W 150° 30' 24.4"
BS85	lake	44.1	N 70° 13' 21.5"	W 150° 30' 24.3"
BS86	lake	46.1	N 70° 13' 21.5"	W 150° 30' 24.2"
BS87	lake	50.0	N 70° 13' 21.5"	W 150° 30' 24.1"
BS88	lake	50.4	N 70° 13' 21.6"	W 150° 30' 24.0"
BS89	lake	51.2	N 70° 13' 21.6"	W 150° 30' 23.9"
BS90	lake	64.6	N 70° 13' 21.6"	W 150° 30' 23.8"
BS91	lake	70.1	N 70° 13' 21.6"	W 150° 30' 23.7"
BS92	lake	76.0	N 70° 13' 21.6"	W 150° 30' 23.6"
BS93	lake	72.0	N 70° 13' 21.6"	W 150° 30' 23.5"
BS94	lake	56.3	N 70° 13' 21.6"	W 150° 30' 23.4"
BS95	lake	53.1	N 70° 13' 21.6"	W 150° 30' 23.3"
BS96	tundra	50.8	N 70° 13' 21.6"	W 150° 30' 23.2"
BS97	tundra	49.6	N 70° 13' 21.7"	W 150° 30' 23.1"
BS98	tundra	49.2	N 70° 13' 21.7"	W 150° 30' 23.0"
BS99	tundra	50.4	N 70° 13' 21.7"	W 150° 30' 22.9"
BS100	tundra	50.4	N 70° 13' 21.7"	W 150° 30' 22.8"
BS101	tundra	48.8	N 70° 13' 21.7"	W 150° 30' 22.7"
BS102	tundra	48.8	N 70° 13' 21.7"	W 150° 30' 22.6"
BS103	tundra	50.4	N 70° 13' 21.7"	W 150° 30' 22.4"
Note: Snow berm depth samples were taken at approximately even intervals along a straight line between identified starting and ending locations.				

Snow Depth Survey Data Sheet				
Date: 4/24/2012		**Start Time:** 10:00		**Observers:** BTG/HLR/AJG
Catchment Basin: M9605		**End Time:** 14:30		
Snow Sample No.	**Terrain Type**	**Snow Depth (in)**	**Location (WGS 84)**	
			Latitude	**Longitude**
Lake M9605 - Berm D cross section #2				
BS104	lake	15.4	N 70° 13' 32.6"	W 150° 30' 36.2"
BS105	lake	19.7	N 70° 13' 32.6"	W 150° 30' 36.1"
BS106	lake	18.5	N 70° 13' 32.6"	W 150° 30' 36.0"
BS107	lake	22.0	N 70° 13' 32.6"	W 150° 30' 35.8"
BS108	lake	22.4	N 70° 13' 32.6"	W 150° 30' 35.7"
BS109	lake	23.2	N 70° 13' 32.6"	W 150° 30' 35.6"
BS110	lake	25.6	N 70° 13' 32.6"	W 150° 30' 35.5"
BS111	lake	29.9	N 70° 13' 32.6"	W 150° 30' 35.3"
BS112	lake	30.3	N 70° 13' 32.6"	W 150° 30' 35.2"
BS113	lake	33.1	N 70° 13' 32.6"	W 150° 30' 35.1"
BS114	lake	35.0	N 70° 13' 32.6"	W 150° 30' 34.9"
BS115	lake	37.8	N 70° 13' 32.6"	W 150° 30' 34.8"
BS116	lake	42.9	N 70° 13' 32.6"	W 150° 30' 34.7"
BS117	lake	46.1	N 70° 13' 32.7"	W 150° 30' 34.5"
BS118	lake	49.2	N 70° 13' 32.7"	W 150° 30' 34.4"
BS119	lake	57.5	N 70° 13' 32.7"	W 150° 30' 34.3"
BS120	lake	59.4	N 70° 13' 32.7"	W 150° 30' 34.2"
BS121	lake	59.8	N 70° 13' 32.7"	W 150° 30' 34.0"
BS122	lake	64.6	N 70° 13' 32.7"	W 150° 30' 33.9"
BS123	lake	63.4	N 70° 13' 32.7"	W 150° 30' 33.8"
BS124	lake	60.6	N 70° 13' 32.7"	W 150° 30' 33.6"
BS125	lake	59.1	N 70° 13' 32.7"	W 150° 30' 33.5"
BS126	lake	60.6	N 70° 13' 32.7"	W 150° 30' 33.4"
BS127	lake	58.7	N 70° 13' 32.7"	W 150° 30' 33.2"
BS128	lake	57.5	N 70° 13' 32.8"	W 150° 30' 33.1"
BS129	lake	57.9	N 70° 13' 32.8"	W 150° 30' 33.0"
BS130	lake	57.9	N 70° 13' 32.8"	W 150° 30' 32.9"
BS131	lake	61.0	N 70° 13' 32.8"	W 150° 30' 32.7"
BS132	lake	64.2	N 70° 13' 32.8"	W 150° 30' 32.6"
BS133	lake	61.0	N 70° 13' 32.8"	W 150° 30' 32.5"
BS134	lake	57.9	N 70° 13' 32.8"	W 150° 30' 32.3"
BS135	lake	52.8	N 70° 13' 32.8"	W 150° 30' 32.2"
BS136	tundra	48.8	N 70° 13' 32.8"	W 150° 30' 32.1"
BS137	tundra	46.5	N 70° 13' 32.8"	W 150° 30' 31.9"
BS138	tundra	34.3	N 70° 13' 32.8"	W 150° 30' 31.8"
BS139	tundra	37.4	N 70° 13' 32.9"	W 150° 30' 31.8"

Note: Snow berm depth samples were taken at approximately even intervals along a straight line between identified starting and ending locations.

Snow Depth Survey Data Sheet				
Date: 4/23/2012		**Start Time:** 10:00		**Observers:** HLR
Catchment Basin: M9602		**End Time:** 16:30		
Snow Sample No.	**Terrain Type**	**Snow Depth (in)**	**Location (WGS 84)**	
			Latitude	**Longitude**
SS085	Lake	10.2	N 70^o 13' 22.2"	W 150^o 44' 18.2"
SS086	Lake	10.6	N 70^o 13' 24.1"	W 150^o 44' 16.4"
SS087	Lake	8.3	N 70^o 13' 26.0"	W 150^o 44' 14.6"
SS088	Lake	11.0	N 70^o 13' 27.8"	W 150^o 44' 12.8"
SS089	Lake	11.4	N 70^o 13' 31.6"	W 150^o 44' 09.2"
SS090	Lake	7.9	N 70^o 13' 33.4"	W 150^o 44' 07.4"
SS091	Lake	6.7	N 70^o 13' 35.3"	W 150^o 44' 05.6"
SS092	Lake	9.8	N 70^o 13' 39.1"	W 150^o 44' 02.0"
SS093	Lake	8.3	N 70^o 13' 40.9"	W 150^o 44' 00.2"
SS094	Lake	3.9	N 70^o 13' 42.8"	W 150^o 43' 58.4"
SS095	Lake	13.0	N 70^o 13' 44.7"	W 150^o 43' 56.5"
SS096	Tundra	15.0	N 70^o 13' 48.4"	W 150^o 43' 52.9"
SS097	Tundra	34.3	N 70^o 13' 50.3"	W 150^o 43' 51.1"
SS098	Tundra	9.1	N 70^o 13' 52.2"	W 150^o 43' 49.3"
SS099	Lake	10.6	N 70^o 13' 20.9"	W 150^o 44' 14.4"
SS100	Lake	10.6	N 70^o 13' 21.4"	W 150^o 44' 08.8"
SS101	Lake	9.8	N 70^o 13' 22.5"	W 150^o 43' 57.6"
SS102	Lake	10.2	N 70^o 13' 23.1"	W 150^o 43' 52.0"
SS103	Lake	7.9	N 70^o 13' 23.6"	W 150^o 43' 46.4"
SS104	Lake	11.8	N 70^o 13' 24.7"	W 150^o 43' 35.2"
SS105	Tundra	8.3	N 70^o 13' 25.3"	W 150^o 43' 29.6"
SS106	Tundra	16.1	N 70^o 13' 25.9"	W 150^o 43' 24.0"
SS107	Tundra	9.4	N 70^o 13' 27.0"	W 150^o 43' 12.9"
SS108	Lake	9.8	N 70^o 13' 19.2"	W 150^o 44' 15.3"
SS109	Lake	6.7	N 70^o 13' 18.0"	W 150^o 44' 10.6"
SS110	Lake	13.4	N 70^o 13' 16.9"	W 150^o 44' 05.8"
SS111	Lake	6.7	N 70^o 13' 14.5"	W 150^o 43' 56.4"
SS112	Lake	10.6	N 70^o 13' 13.4"	W 150^o 43' 51.7"
SS113	Lake	10.2	N 70^o 13' 12.2"	W 150^o 43' 47.0"
SS114	Lake	6.3	N 70^o 13' 09.9"	W 150^o 43' 37.5"
SS115	Lake	9.1	N 70^o 13' 08.8"	W 150^o 43' 32.8"
SS116	Lake	6.7	N 70^o 13' 07.6"	W 150^o 43' 28.1"
SS117	Lake	7.9	N 70^o 13' 05.3"	W 150^o 43' 18.6"
SS118	Lake	6.7	N 70^o 13' 04.1"	W 150^o 43' 13.9"
SS119	Lake	6.7	N 70^o 13' 03.0"	W 150^o 43' 09.2"

Snow Depth Survey Data Sheet				
Date: 4/23/2012		**Start Time:** 10:00		**Observers:** HLR
Catchment Basin: M9602		**End Time:** 16:30		
Snow Sample No.	**Terrain Type**	**Snow Depth (in)**	**Location (WGS 84)**	
			Latitude	**Longitude**
SS120	Tundra	17.7	N 70° 13' 01.8"	W 150° 43' 04.5"
SS121	Tundra	9.4	N 70° 12' 59.5"	W 150° 42' 55.1"
SS122	Lake	7.9	N 70° 13' 18.4"	W 150° 44' 21.7"
SS123	Lake	9.4	N 70° 13' 14.7"	W 150° 44' 25.2"
SS124	Lake	7.9	N 70° 13' 12.8"	W 150° 44' 27.0"
SS125	Lake	11.4	N 70° 13' 10.9"	W 150° 44' 28.7"
SS126	Lake	7.9	N 70° 13' 07.1"	W 150° 44' 32.2"
SS127	Lake	9.4	N 70° 13' 05.3"	W 150° 44' 34.0"
SS128	Lake	10.6	N 70° 13' 03.4"	W 150° 44' 35.7"
SS129	Lake	102.4	N 70° 12' 59.6"	W 150° 44' 39.2"
SS130	Lake	7.1	N 70° 12' 57.7"	W 150° 44' 40.9"
SS131	Lake	9.1	N 70° 12' 55.8"	W 150° 44' 42.7"
SS132	Tundra	11.0	N 70° 12' 52.1"	W 150° 44' 46.2"
SS133	Lake	11.4	N 70° 12' 50.2"	W 150° 44' 47.9"
SS134	Lake	5.5	N 70° 12' 46.4"	W 150° 44' 51.4"
SS135	Lake	6.7	N 70° 12' 44.6"	W 150° 44' 53.1"
SS136	Lake	9.1	N 70° 12' 42.7"	W 150° 44' 54.9"
SS137	Lake	9.4	N 70° 12' 38.9"	W 150° 44' 58.3"
SS138	Lake	11.8	N 70° 12' 37.0"	W 150° 45' 00.1"
SS139	Lake	9.1	N 70° 12' 33.3"	W 150° 45' 03.6"
SS140	Lake	16.9	N 70° 12' 31.4"	W 150° 45' 05.3"
SS141	Tundra	17.7	N 70° 12' 27.6"	W 150° 45' 08.8"
SS142	Tundra	17.7	N 70° 12' 25.7"	W 150° 45' 10.5"
SS143	Tundra	18.5	N 70° 12' 23.9"	W 150° 45' 12.3"
SS144	Lake	8.3	N 70° 13' 19.8"	W 150° 44' 25.6"
SS145	Lake	12.2	N 70° 13' 19.2"	W 150° 44' 31.1"
SS146	Lake	11.0	N 70° 13' 18.6"	W 150° 44' 36.7"
SS147	Lake	10.6	N 70° 13' 18.1"	W 150° 44' 42.3"
SS148	Lake	10.2	N 70° 13' 16.9"	W 150° 44' 53.5"
SS149	Lake	7.5	N 70° 13' 16.4"	W 150° 44' 59.1"
SS150	Lake	25.2	N 70° 13' 15.2"	W 150° 45' 10.2"
SS151	Tundra	10.6	N 70° 13' 14.7"	W 150° 45' 15.8"
SS152	Tundra	19.3	N 70° 13' 13.5"	W 150° 45' 27.0"
SS153	Tundra	14.2	N 70° 13' 13.0"	W 150° 45' 32.6"
SS154	Lake	9.8	N 70° 13' 21.5"	W 150° 44' 24.7"
SS155	Lake	13.0	N 70° 13' 22.6"	W 150° 44' 29.4"

Snow Depth Survey Data Sheet				
Date: 4/23/2012		**Start Time:** 10:00		**Observers:** HLR
Catchement Basin: M9602		**End Time:** 16:30		
Snow Sample No.	**Terrain Type**	**Snow Depth (in)**	**Location (WGS 84)**	
			Latitude	**Longitude**
SS156	Lake	10.2	N 70° 13' 25.0"	W 150° 44' 38.9"
SS157	Lake	9.8	N 70° 13' 26.1"	W 150° 44' 43.6"
SS158	Lake	13.4	N 70° 13' 27.3"	W 150° 44' 48.3"
SS159	Lake	14.6	N 70° 13' 28.4"	W 150° 44' 53.0"
SS160	Lake	15.7	N 70° 13' 30.7"	W 150° 45' 02.4"
SS161	Lake	4.7	N 70° 13' 31.9"	W 150° 45' 07.1"
SS162	Lake	12.6	N 70° 13' 33.1"	W 150° 45' 11.8"
SS163	Tundra	22.4	N 70° 13' 35.4"	W 150° 45' 21.3"
SS164	Tundra	14.2	N 70° 13' 36.5"	W 150° 45' 26.0"
SS165	Tundra	15.7	N 70° 13' 38.9"	W 150° 45' 35.4"
SS166	Tundra	18.5	N 70° 13' 40.0"	W 150° 45' 40.2"
SS167	Lake	13.0	N 70° 13' 22.2"	W 150° 44' 21.2"
SS168	Lake	12.2	N 70° 13' 24.2"	W 150° 44' 22.4"
SS169	Lake	5.1	N 70° 13' 26.1"	W 150° 44' 23.5"
SS170	Lake	8.7	N 70° 13' 28.0"	W 150° 44' 24.7"
SS171	Lake	12.2	N 70° 13' 30.0"	W 150° 44' 25.9"
SS172	Lake	7.9	N 70° 13' 31.9"	W 150° 44' 27.1"
SS173	Lake	8.7	N 70° 13' 35.7"	W 150° 44' 29.5"
SS174	Lake	11.4	N 70° 13' 37.6"	W 150° 44' 30.6"
SS175	Lake	11.8	N 70° 13' 39.6"	W 150° 44' 31.8"
SS176	Lake	14.6	N 70° 13' 41.5"	W 150° 44' 33.0"
SS177	Lake	8.7	N 70° 13' 43.4"	W 150° 44' 34.2"
SS178	Lake	6.7	N 70° 13' 45.4"	W 150° 44' 35.4"
SS179	Lake	10.6	N 70° 13' 47.3"	W 150° 44' 36.6"
SS180	Lake	10.6	N 70° 13' 51.2"	W 150° 44' 38.9"
SS181	Lake	8.7	N 70° 13' 53.1"	W 150° 44' 40.1"
SS182	Lake	7.5	N 70° 13' 55.0"	W 150° 44' 41.3"
SS183	Lake	7.1	N 70° 13' 56.9"	W 150° 44' 42.5"
SS184	Tundra	33.5	N 70° 13' 58.9"	W 150° 44' 43.7"
SS185	Tundra	13.0	N 70° 14' 02.7"	W 150° 44' 46.0"
SS186	Tundra	9.1	N 70° 14' 04.7"	W 150° 44' 47.2"
SS187	Tundra	14.6	N 70° 14' 06.6"	W 150° 44' 48.4"
SS188	Lake	8.7	N 70° 13' 18.4"	W 150° 44' 18.6"
SS189	Lake	9.4	N 70° 13' 16.5"	W 150° 44' 17.3"
SS190	Lake	10.2	N 70° 13' 14.5"	W 150° 44' 16.0"

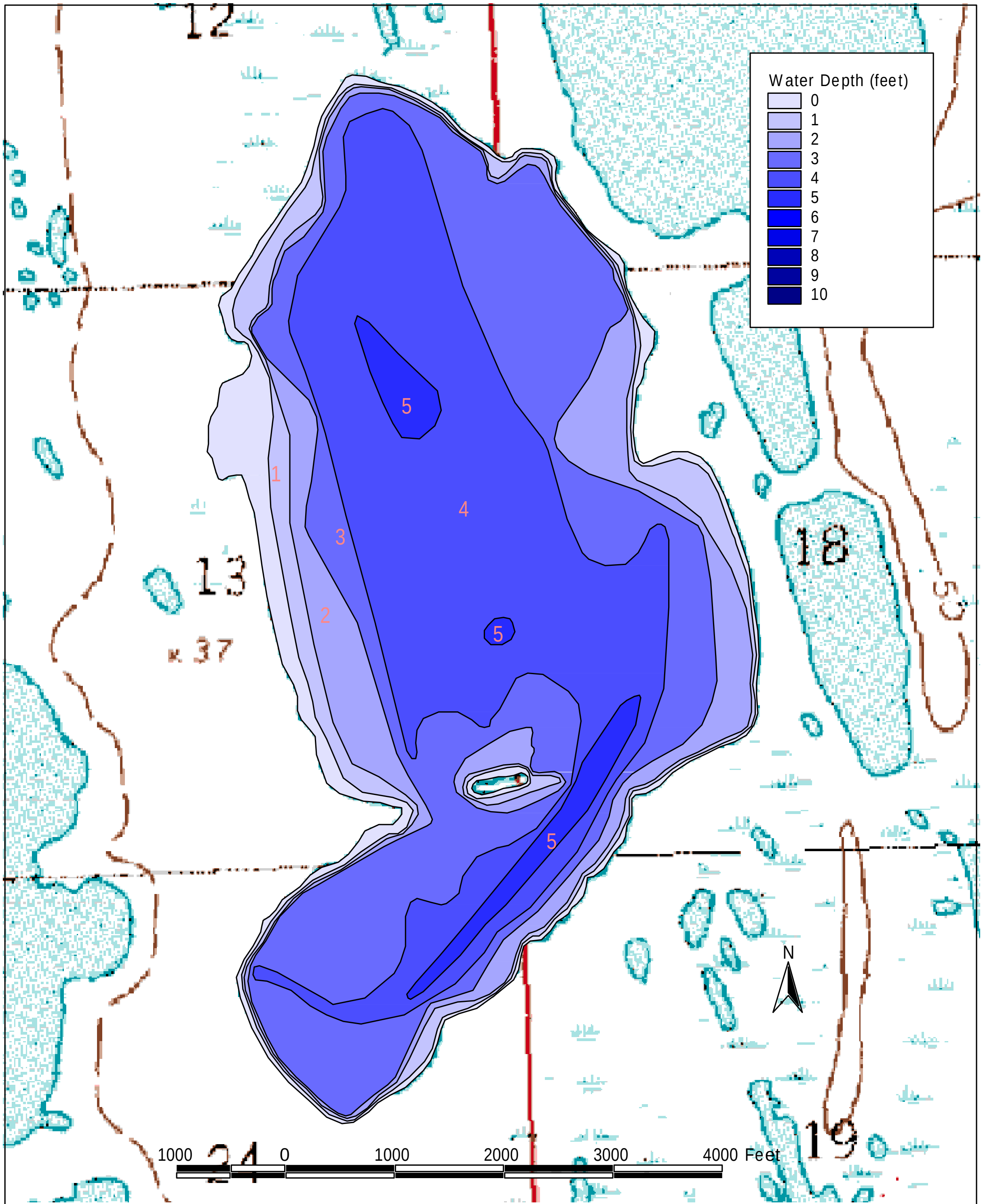
Snow Depth Survey Data Sheet				
Date: 4/23/2012		**Start Time:** 10:00		**Observers:** HLR
Catchement Basin: M9602		**End Time:** 16:30		
Snow Sample No.	**Terrain Type**	**Snow Depth (in)**	**Location (WGS 84)**	
			Latitude	**Longitude**
SS191	Lake	20.1	N 70° 13' 12.6"	W 150° 44' 14.8"
SS192	Lake	9.4	N 70° 13' 10.7"	W 150° 44' 13.5"
SS193	Lake	10.6	N 70° 13' 08.8"	W 150° 44' 12.3"
SS194	Lake	11.8	N 70° 13' 05.0"	W 150° 44' 09.8"
SS195	Lake	9.8	N 70° 13' 03.0"	W 150° 44' 08.5"
SS196	Lake	9.4	N 70° 13' 01.1"	W 150° 44' 07.2"
SS197	Lake	9.8	N 70° 12' 59.2"	W 150° 44' 06.0"
SS198	Lake	5.9	N 70° 12' 57.2"	W 150° 44' 04.7"
SS199	Lake	10.2	N 70° 12' 55.3"	W 150° 44' 03.4"
SS200	Lake	9.1	N 70° 12' 51.4"	W 150° 44' 00.9"
SS201	Lake	6.7	N 70° 12' 49.5"	W 150° 43' 59.6"
SS202	Lake	9.1	N 70° 12' 47.6"	W 150° 43' 58.4"
SS203	Lake	11.4	N 70° 12' 45.7"	W 150° 43' 57.1"
SS204	Tundra	32.3	N 70° 12' 43.7"	W 150° 43' 55.8"
SS205	Tundra	17.7	N 70° 12' 39.8"	W 150° 43' 53.3"

Snow Depth Survey Data Sheet				
Date: 4/22/2012		Start Time: 10:45		Observers: BTG
Catchment Basin: M9605		End Time: 17:15		
Snow Sample No.	Terrain Type	Snow Depth (in)	Location (WGS 84)	
			Latitude	Longitude
SS001	Lake	12.2	N 70 13' 17.9"	W 150 30' 58.4"
SS002	Lake	19.3	N 70 13' 19.7"	W 150 31' 00.3"
SS003	Lake	7.9	N 70 13' 21.6"	W 150 31' 02.1"
SS004	Lake	7.1	N 70 13' 23.5"	W 150 31' 04.0"
SS005	Lake	6.3	N 70 13' 25.4"	W 150 31' 05.9"
SS006	Lake	15.0	N 70 13' 29.1"	W 150 31' 09.6"
SS007	Lake	13.4	N 70 13' 30.9"	W 150 31' 11.5"
SS008	Lake	11.0	N 70 13' 32.8"	W 150 31' 13.3"
SS009	Lake	9.4	N 70 13' 34.7"	W 150 31' 15.2"
SS010	Lake	8.7	N 70 13' 38.4"	W 150 31' 18.9"
SS011	Lake	7.9	N 70 13' 40.3"	W 150 31' 20.9"
SS012	Lake	5.5	N 70 13' 42.2"	W 150 31' 22.7"
SS013	Lake	8.3	N 70 13' 44.0"	W 150 31' 24.5"
SS014	Lake	7.5	N 70 13' 47.8"	W 150 31' 28.4"
SS015	Lake	5.5	N 70 13' 49.6"	W 150 31' 30.1"
SS016	Lake	9.8	N 70 13' 17.7"	W 150 30' 53.4"
SS017	Lake	5.9	N 70 13' 19.3"	W 150 30' 50.2"
SS018	Lake	8.7	N 70 13' 21.0"	W 150 30' 47.1"
SS019	Lake	4.3	N 70 13' 22.6"	W 150 30' 43.9"
SS020	Lake	8.7	N 70 13' 25.9"	W 150 30' 37.6"
SS021	Lake	5.5	N 70 13' 27.6"	W 150 30' 34.4"
SS022	Tundra	57.1	N 70 13' 29.2"	W 150 30' 31.2"
SS023	Tundra	26.8	N 70 13' 30.9"	W 150 30' 28.1"
SS024	Tundra	4.3	N 70 13' 34.2"	W 150 30' 21.7"
SS025	Lake	7.5	N 70 13' 15.0"	W 150 30' 51.7"
SS026	Lake	9.1	N 70 13' 14.0"	W 150 30' 46.6"
SS027	Lake	4.3	N 70 13' 13.0"	W 150 30' 41.5"
SS028	Lake	11.4	N 70 13' 11.0"	W 150 30' 31.5"
SS029	Lake	5.9	N 70 13' 10.0"	W 150 30' 26.5"
SS030	Lake	9.4	N 70 13' 09.1"	W 150 30' 21.4"
SS031	Lake	27.2	N 70 13' 08.0"	W 150 30' 16.4"
SS032	Tundra	18.1	N 70 13' 07.0"	W 150 30' 11.4"
SS033	Tundra	12.6	N 70 13' 05.0"	W 150 30' 01.3"
SS034	Tundra	13.0	N 70 13' 04.0"	W 150 29' 56.3"
SS035	Tundra	12.6	N 70 13' 03.0"	W 150 29' 51.3"
SS036	Lake	10.6	N 70 13' 14.2"	W 150 30' 54.5"
SS037	Lake	11.0	N 70 13' 12.3"	W 150 30' 52.4"
SS038	Lake	7.5	N 70 13' 10.5"	W 150 30' 50.3"

Snow Depth Survey Data Sheet				
Date: 4/22/2012		**Start Time:** 9:15		**Observers:** BTG
Catchement Basin: M9605		**End Time:** 17:15		
Snow Sample No.	**Terrain Type**	**Snow Depth (in)**	**Location (WGS 84)**	
			Latitude	**Longitude**
SS039	Lake	8.7	N 70 13' 08.7"	W 150 30' 48.2"
SS040	Lake	14.6	N 70 13' 05.0"	W 150 30' 44.1"
SS041	Lake	9.8	N 70 13' 03.1"	W 150 30' 42.0"
SS042	Lake	7.1	N 70 13' 01.3"	W 150 30' 39.9"
SS043	Lake	13.4	N 70 12' 57.6"	W 150 30' 35.7"
SS044	Lake	5.5	N 70 12' 55.9"	W 150 30' 33.6"
SS045	Lake	4.3	N 70 12' 53.9"	W 150 30' 31.5"
SS046	Lake	5.9	N 70 12' 52.1"	W 150 30' 29.5"
SS047	Lake	7.9	N 70 12' 48.4"	W 150 30' 25.3"
SS048	Lake	4.7	N 70 12' 46.6"	W 150 30' 23.2"
SS049	Lake	65.0	N 70 12' 44.7"	W 150 30' 21.1"
SS050	Tundra	17.7	N 70 12' 42.9"	W 150 30' 19.0"
SS051	Tundra	23.2	N 70 12' 41.0"	W 150 30' 17.0"
SS052	Tundra	11.8	N 70 12' 37.3"	W 150 30' 12.8"
SS053	Tundra	13.8	N 70 12' 35.5"	W 150 30' 10.7"
SS054	Tundra	9.4	N 70 12' 33.0"	W 150 30' 13.8"
SS055	Tundra	13.4	N 70 12' 32.1"	W 150 30' 19.1"
SS056	Tundra	26.8	N 70 12' 31.3"	W 150 30' 24.4"
SS057	Tundra	20.9	N 70 12' 30.5"	W 150 30' 29.7"
SS058	Tundra	13.4	N 70 12' 28.8"	W 150 30' 40.3"
SS059	Tundra	13.8	N 70 12' 34.6"	W 150 30' 03.2"
SS060	Tundra	19.7	N 70 12' 35.5"	W 150 29' 57.9"
SS061	Tundra	17.3	N 70 12' 36.3"	W 150 29' 52.7"
SS062	Tundra	22.8	N 70 12' 37.1"	W 150 29' 47.4"
SS063	Tundra	10.2	N 70 12' 38.8"	W 150 29' 36.8"
SS064	Tundra	10.2	N 70 12' 39.6"	W 150 29' 31.5"
SS065	Lake	10.2	N 70 13' 14.2"	W 150 30' 58.5"
SS066	Lake	11.4	N 70 13' 12.3"	W 150 31' 00.5"
SS067	Lake	5.5	N 70 13' 08.6"	W 150 31' 04.5"
SS068	Lake	6.3	N 70 13' 06.7"	W 150 31' 06.5"
SS069	Lake	9.8	N 70 13' 03.0"	W 150 31' 10.5"
SS070	Lake	9.4	N 70 13' 01.2"	W 150 31' 12.5"
SS071	Tundra	38.6	N 70 12' 59.3"	W 150 31' 14.5"
SS072	Tundra	19.3	N 70 12' 55.6"	W 150 31' 18.5"
SS073	Tundra	15.0	N 70 12' 53.8"	W 150 31' 20.4"
SS074	Tundra	11.4	N 70 12' 51.9"	W 150 31' 22.4"
SS075	Tundra	15.0	N 70 12' 48.2"	W 150 31' 26.4"

Snow Depth Survey Data Sheet				
Date: 4/22/2012		**Start Time:** 9:15		**Observers:** BTG
Catchement Basin: M9605		**End Time:** 17:15		
Snow Sample No.	**Terrain Type**	**Snow Depth (in)**	**Location (WGS 84)**	
			Latitude	**Longitude**
SS076	Lake	12.6	N 70 13' 16.2"	W 150 31' 02.4"
SS077	Lake	8.7	N 70 13' 16.3"	W 150 31' 08.2"
SS078	Lake	9.8	N 70 13' 16.5"	W 150 31' 14.0"
SS079	Lake	7.5	N 70 13' 16.6"	W 150 31' 19.8"
SS080	Tundra	68.9	N 70 13' 16.9"	W 150 31' 31.4"
SS081	Tundra	8.3	N 70 13' 17.1"	W 150 31' 37.2"
SS082	Tundra	15.4	N 70 13' 17.2"	W 150 31' 43.0"
SS083	Tundra	15.4	N 70 13' 17.5"	W 150 31' 54.7"
SS084	Tundra	18.9	N 70 13' 17.7"	W 150 32' 00.5"

Appendix B Lake Bathymetry: M9602 and M9605



Depth contours of lake M9602 based on transects surveyed on July 12, 2005.
(depths in 1 foot intervals)

(not to be used for navigation or to direct use of heavy equipment)

Lake M9602

Other Names: AA10.1
Location: 70.22147°N 150.73865°W
USGS Quad Sheet: Harrison Bay A-2: T10N R5/6E, Sec 112/13/24/7/18/19
Habitat: Tundra
Lake Area: 658
acres Maximum Depth:
6.4 feet
Active Outlet: No
Total Lake Volume: 734.9 million gallons (2005 data)
Volume Under 4 ft of ice: 42.9 million
gallons Volume Under 5 ft of ice: 2.6
million gallons Volume Under 7 ft of ice:
0.0 million gallons
Potential Aggregate: 391.5 acres (water depth 4 ft or less)

Maximum Recommended Winter Removal: 0.78 million gallons
(30% of volume under 5 feet of ice)
(does not include volume associated with ice aggregate)

Water Use History:

Year	Water Removed (all sources) (mill. Gals)
1998/1999	3.03
2000/2001	7.96
2001/2002	2.84
2002/2003	13.69
2003/2004	3.65
2004/2005	7.83

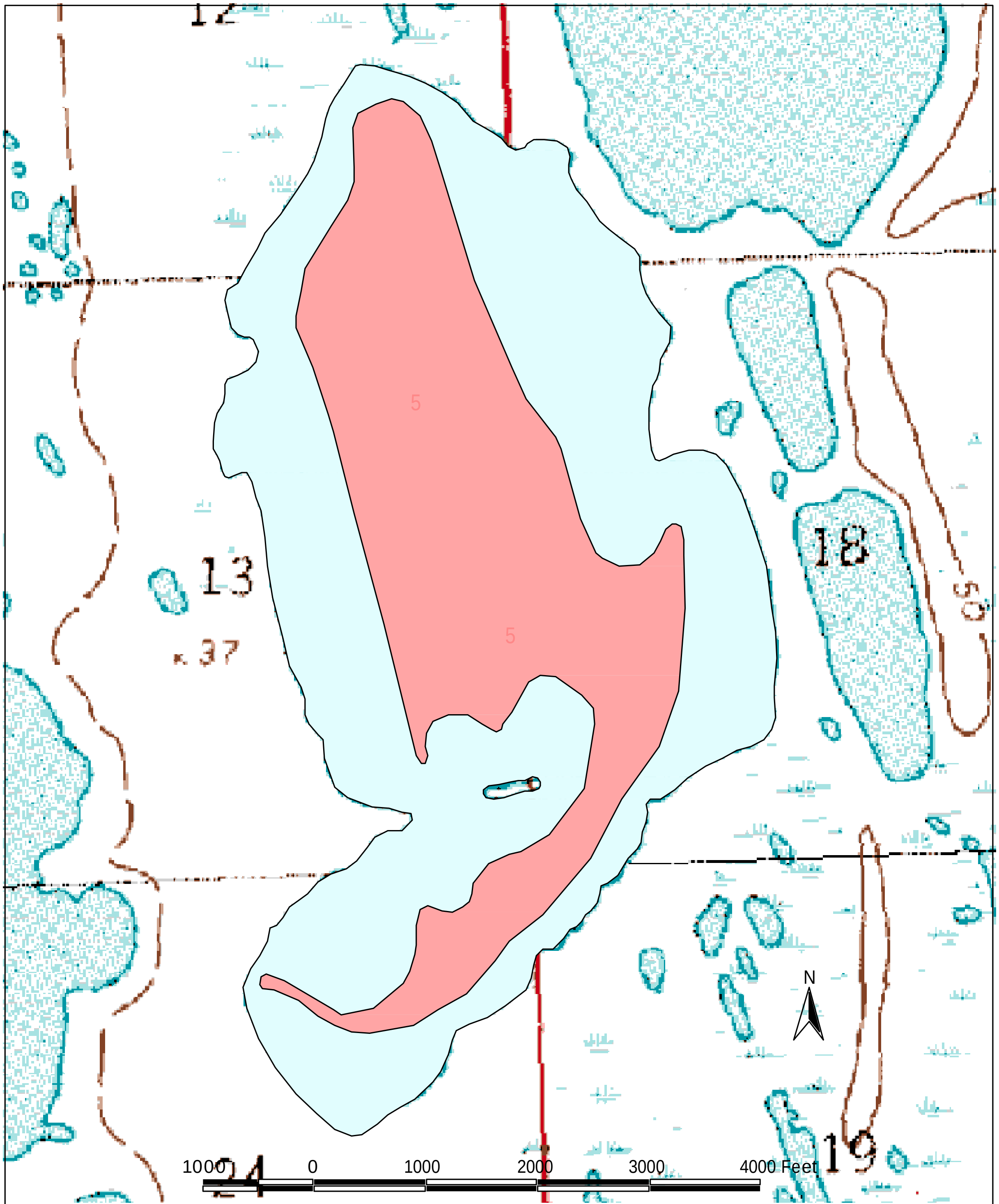
Water Chemistry:

Year of Test	Calcium (mg/l)	Magnesium (mg/l	Chloride (mg/l)	Sodium (mg/l)	Total Hardness [CaCO3] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	So
1996	15.9	13.5	2.9	31.5	90				J. Lo
1997								8.04	
2002						209	0.8	8.02	
2005	25.0	2.3	14.8	4.9	72	142	1.5	8.00	

Catch Record:

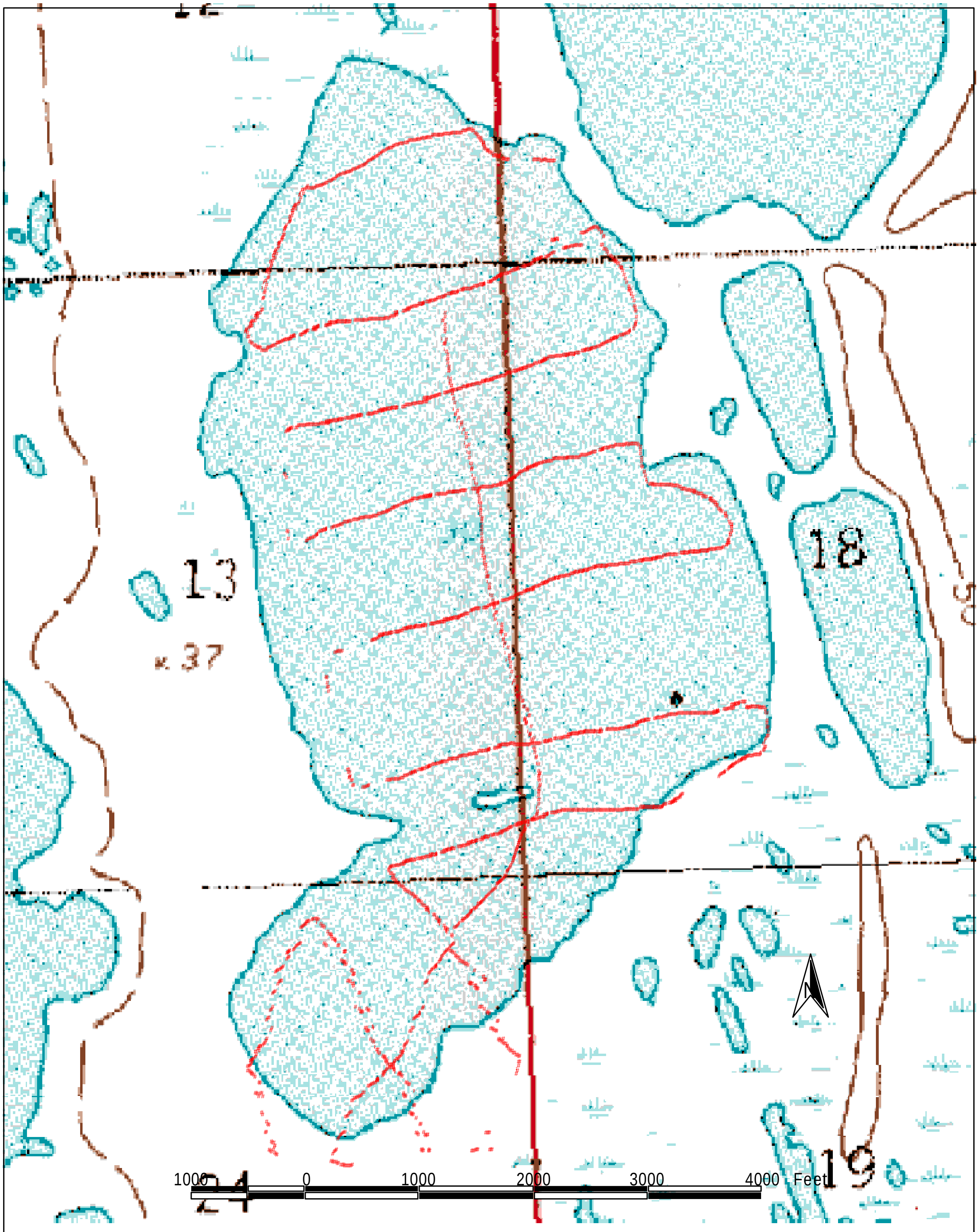
Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 26 96	10.7	None	0
Observed	Jul 15 02		Ninespine stickleback	many

Last Revised: September 30, 2005

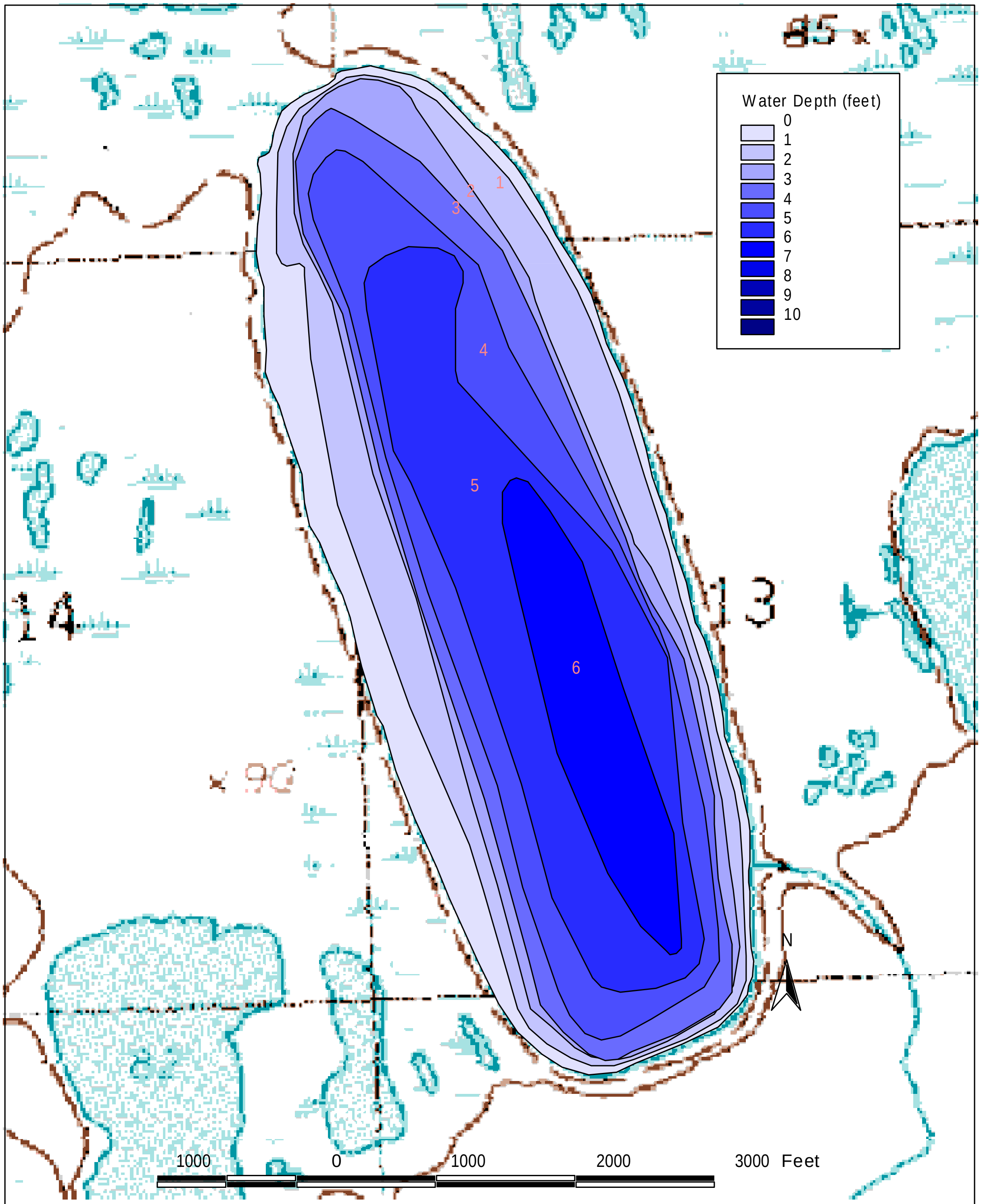


Regions of lake M9602 less than 4 feet deep (light shaded) and likely to be available for ice chips, based on transects surveyed on July 12, 2005.

(not to be used for navigation or to direct use of heavy equipment)



Depth transects measured at lake M9602 on July 12, 2005.



Depth contours of lake M9605 based on transects surveyed on July 20, 2005.

(not to be used for navigation or to direct use of heavy equipment)

Lake M9605

Other Names: AA14.1
Location: 70.22099°N 150.51572°W
USGS Quad Sheet: Harrison Bay A-1: T10N R6E, Sec 11/12/13/14/24
Habitat: Tundra Lake
Area: 350 acres
Maximum Depth: 7.2 feet
Active Outlet: No
Total Lake Volume: 408.9 million gallons (2005 data)
Volume Under 4 ft of ice: 75.9 million gallons
Volume Under 5 ft of ice: 28.4 million gallons
Volume Under 7 ft of ice: 0.0 million gallons
Potential Aggregate: 174.1 acres (water depth 4 ft or less)

Maximum Recommended Winter Removal: 8.52 million gallons
(30% of volume under 5 feet of ice)
(does not include volume associated with ice aggregate)

Water Use History:

Year	Water Removed (all sources) (mill. Gals)
1998/1999	6.13
2000/2001	18.26
2001/2002	9.22
2002/2003	17.34
2003/2004	5.89
2004/2005	12.82

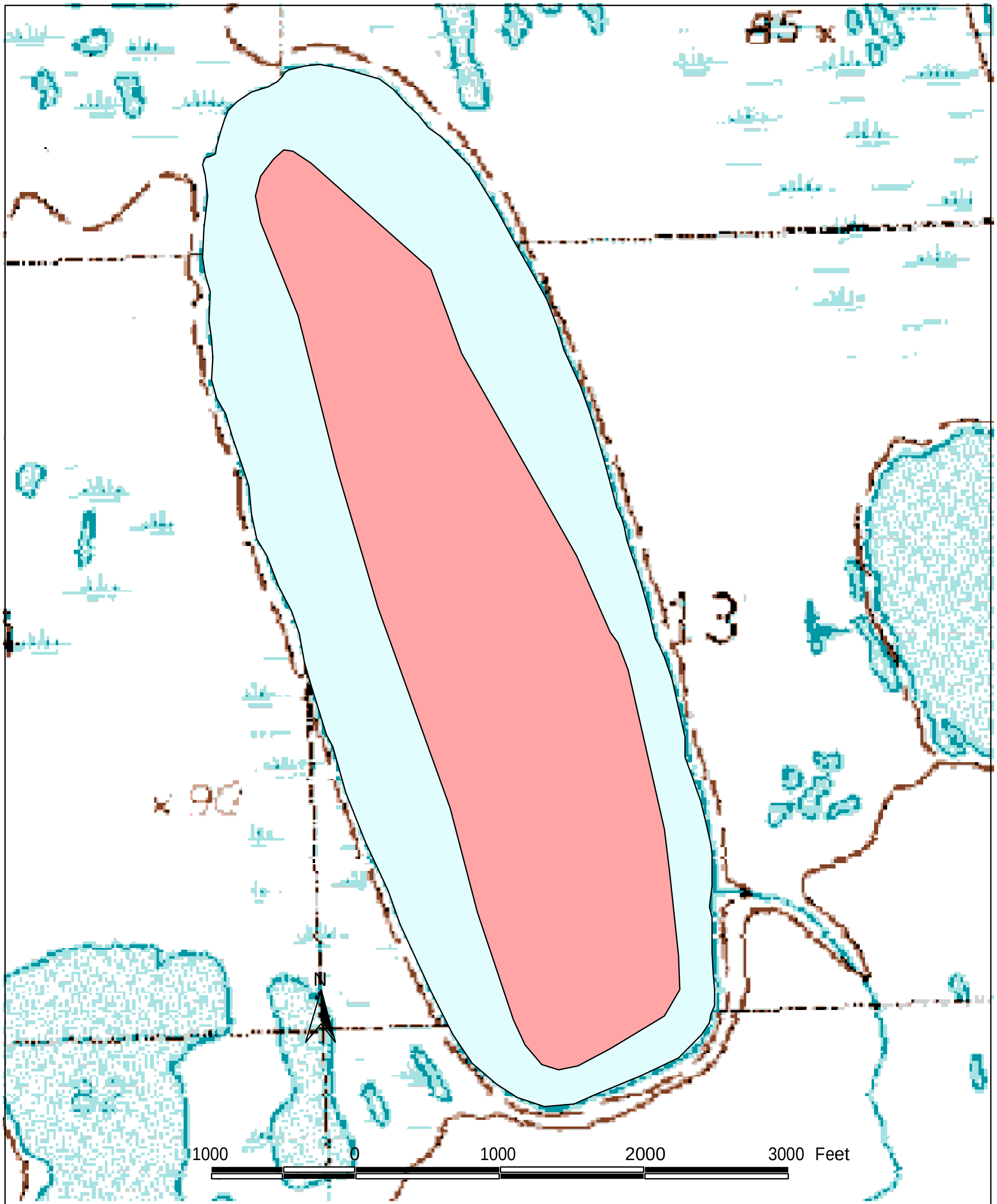
Water Chemistry:

Year of Test	Calcium (mg/l	Magnesium (mg/l)	Chloride (mg/l)	Sodium (mg/l)	Total Hardness [CaCO3] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
1996	9.8	9.8	2.9	31.2	90				J. Lobdell
2005	21.0	1.7	8.9	3.3	59	137	0.7	8.10	

Catch Record:

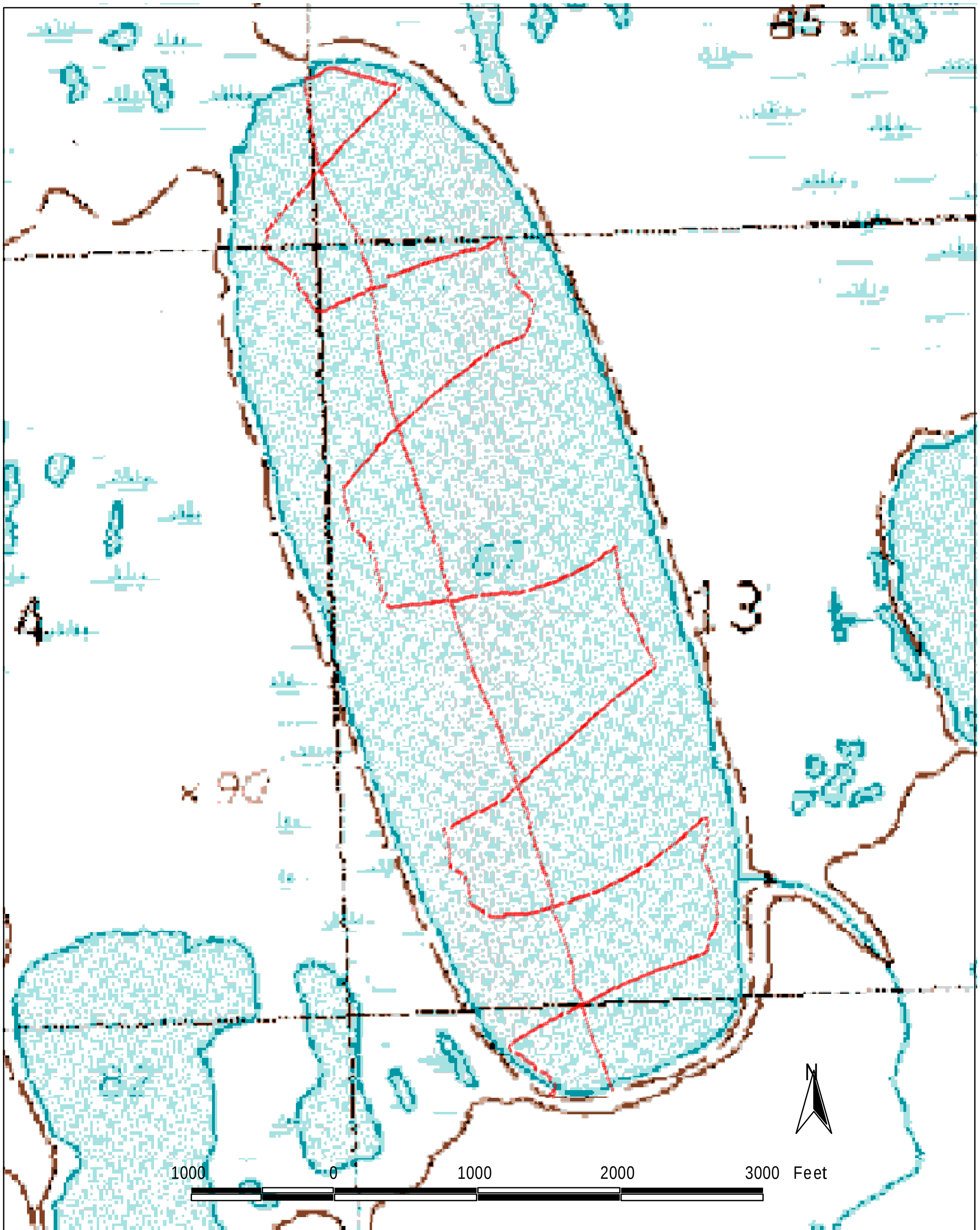
Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 18 96	4.3	None	0
Gill Net	Jul 20 05	6.7	None	0
Minnow Traps	Jul 20 05	12.2	Ninespine stickleback	1

Last Revised: September 30, 2005



Regions of lake M9605 less than 4 feet deep (light shaded) and likely to be available for ice chips, based on transects surveyed on July 20, 2005.

(not to be used for navigation or to direct use of heavy equipment)



Depth transects measured at lake M9605 on July 20, 2005.

Appendix C Snow Survey Sheets: M9602 and M9605

Monitoring Location	Site Name	Type	Latitude (WGS84)	Longitude (WGS84)
Alpine Area Recharge Lakes				
B8534/L9282	L9282/B8534-A	Gage	N 70° 20' 38.5"	W 150° 53' 12.5"
	L9282/B8534-X	TBM	N 70° 20' 38.7"	W 150° 53' 14.1"
M9525	M9525-A	Gage	N 70° 20' 03.7"	W 150° 58' 11.5"
	M9525-B	Gage	N 70° 20' 04.0"	W 150° 58' 14.0"
	CD4-6E	TBM - Culvert Top	N 70° 20' 05.2"	W 150° 58' 14.8"
L9323	L9323-A	Gage	N 70° 17' 44.0"	W 150° 59' 02.5"
	NANUQ 4	TBM LCMF 2003 3"ALCAP	N 70° 17' 43.6"	W 150° 58' 53.0"
L9324	L9324-A	Gage	N 70° 17' 29.1"	W 150° 58' 52.7"
	L9324-B	Gage	N 70° 17' 29.1"	W 150° 58' 52.9"
	NANUQ 5	TBM LCMF 2000 3"ALCAP	N 70° 17' 30.0"	W 150° 58' 50.4"
B8531/L9326	L9326/B8531-A	Gage	N 70° 16' 21.6"	W 150° 59' 41.0"
	L9326/B8531-X	TBM	N 70° 16' 21.3"	W 150° 59' 41.2"
B8530	B8530-A	Gage	N 70° 14' 37.3"	W 150° 52' 54.6"
	B8530-X	TBM	N 70° 14' 36.8"	W 150° 52' 53.7"
M9607	M9607-A	Gage	N 70° 14' 38.2"	W 150° 52' 05.0"
	M9607-X	TBM	N 70° 14' 38.6"	W 150° 52' 03.8"
M9602	M9602-A	Gage	N 70° 12' 57.2"	W 150° 43' 22.7"
	M9602-X	TBM	N 70° 12' 57.0"	W 150° 43' 22.6"
M9605	M9605-A	Gage	N 70° 13' 49.8"	W 150° 31' 02.7"
	M9605-X	TBM	N 70° 13' 50.0"	W 150° 31' 03.1"
B8533	B8533	Aerial Photos Only		

Appendix D General Study Lake Photos

Photo D. 1: Lake B8534/L9282 pre-breakup, looking northeast; May 30, 2012

Photo D. 2: Lake B8534/L9282 during breakup, looking northeast; June 5, 2012

Photo D. 3: Lake B8534/L9282 post-breakup outflow into the Sakoonang Channel, looking northeast; June 27, 2012

Photo D. 4: Lake M9525 pre-breakup, looking southeast; May 25, 2012

Photo D. 5: **Lake M9525 outflow into L9313 during breakup, looking northeast; June 3, 2012**

Photo D. 6: **Lake M9525 post-breakup, looking southwest; June 27, 2012**

Photo D. 7: Lake L9323 pre-breakup (north arm), looking east; May 27, 2012

Photo D. 8: Lake L9323 during breakup, looking north; June 4, 2012

Photo D. 9: **Lake L9323 post-breakup, looking southeast; June 27, 2012**

Photo D. 10: **Lake L9324 pre-breakup, looking south; May 24, 2012**

Photo D. 11: **Lake L9324 outflow to the Nigliq Channel during breakup, looking east; June 5, 2012**

Photo D. 12: **Lake L9324 post-breakup, looking north; June 27, 2012**

Photo D. 13: **Lake B8531/L9326 pre-breakup, looking east; May 25, 2012**

Photo D. 14: **Lake B8531/L9326 during breakup, looking east; June 7, 2012**

Photo D. 15: Lake B8531/L9326 post-breakup outflow into the Nigliq Channel via Lake M9934 into Toolbox Creek, looking southeast; June 27, 2012

Photo D. 16: Lake B8530 pre-breakup, looking southwest; May 27, 2012

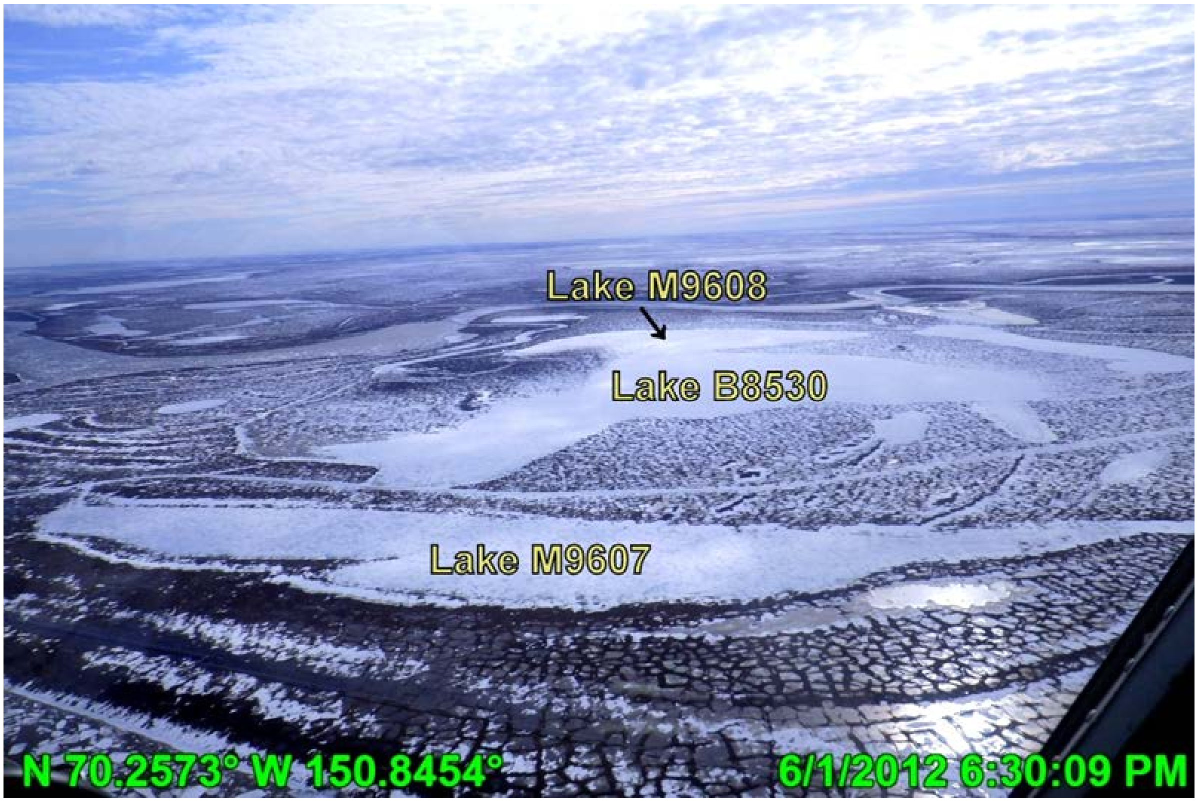


Photo D. 17: Lake B8530 during breakup, looking west; June 1, 2012

Photo D. 18: Lake B8530 post-breakup, looking east; June 26, 2012

Photo D. 19: Lake M9607 pre-breakup, looking west; May 30, 2012

Photo D. 20: Lake M9607 during breakup, looking northwest; June 5, 2012

Photo D. 21: Lake M9607 post-breakup, looking north; June 26, 2012

Photo D. 22: Lake M9602 pre-breakup, looking north; May 25, 2012

Photo D. 23: Lake M9602 during breakup, looking east; June 7, 2012:

Photo D. 24: Lake M9602 post-breakup outflow to Lake M9601, looking south; June 26, 2012

Photo D. 25: Lake M9605 pre-breakup, looking northwest; May 29, 2012

Photo D. 26: Lake M9605 Inflow from wetlands to the southeast during breakup, looking northwest; June 7, 2012

Photo D. 27: Lake M9605 post-breakup, looking southwest; June 26, 2012

Photo D. 28: Lake B8533 pre-breakup, looking east; May 29, 2012

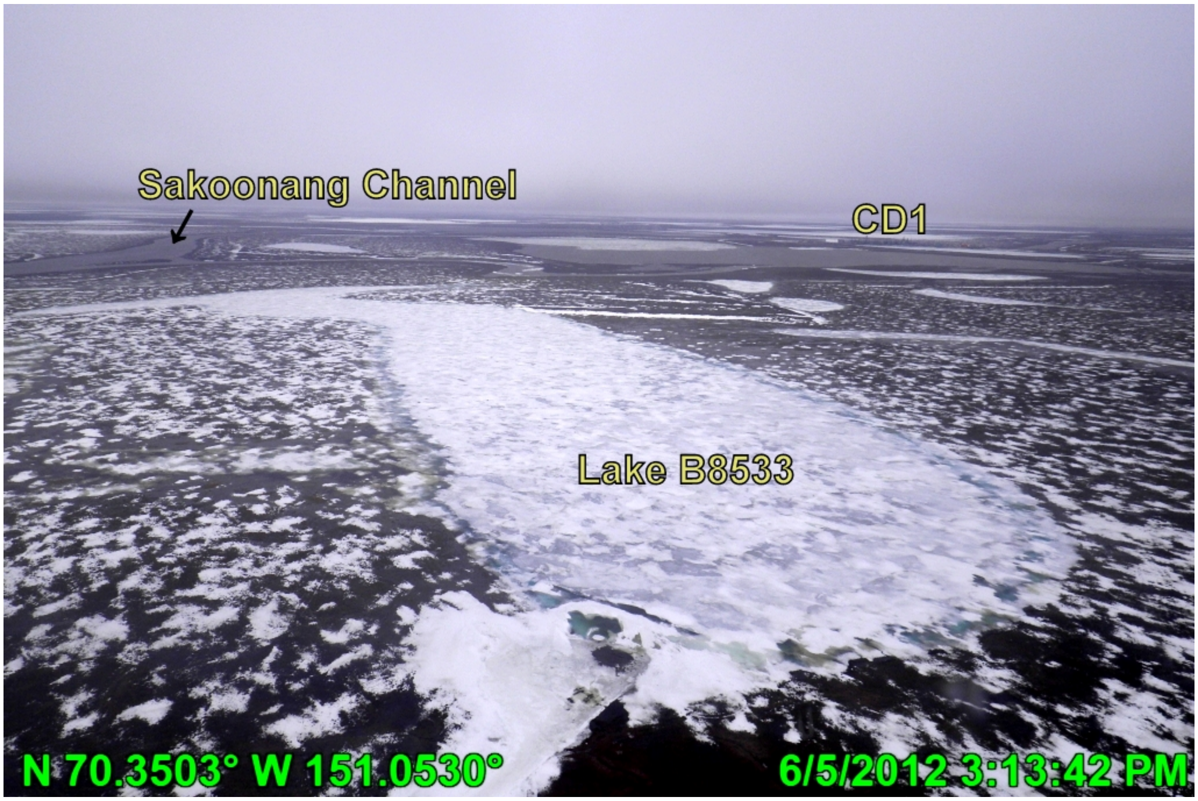


Photo D. 29: Lake B8533 during breakup, looking east; June 5, 2012

Photo D. 30: Lake B8533 post-breakup limited drainage into the Sakoonang Channel, looking west; June 27, 2012

Final 2012 Alpine Area Lakes Recharge Studies