


National Petroleum Reserve – Alaska

NPR-A

2002 Lake Monitoring and Recharge Study


Prepared for

ConocoPhillips

By

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1.0 Introduction

This report summarizes hydrologic observations and measurements made during a lake monitoring and recharge study conducted in the National Petroleum Reserve-Alaska (NPR-A) in 2002 by Michael Baker Jr., Inc. (Baker). The study was performed at the request of ConocoPhillips Alaska, Inc. (CPA, formerly Phillips Alaska, Inc., PAI). It consisted of multi-season water surface elevation, depth, and ice thickness surveys; in situ physical and water quality parameter measurements; analytical water quality sampling and testing; and lake recharge observations at nine fresh water lakes over a period of eight months. The study area was located generally west of the village of Nuiqsut in the northeast planning area of NPR-A (see Figure 1-1).

This report presents the results of the 2002 NPR-A study and compares those results with previously conducted NPR-A lake studies. This report also summarizes results from similar lake monitoring and recharge studies that were carried out in 2002 in the Alpine and Kuparuk areas, and makes trend-wise comparisons of the results of those studies with results of the NPR-A program. An overview of long-term water withdrawal programs on the North Slope that focuses on those communities where lakes are, and have historically been, the only source of potable water is also presented.

Lake names used throughout this report consist of a letter, typically L or M, followed by four numerals. At any given lake, the letter designates the last name of the person, in this case Moulton or Lobdell, who first conducted an investigation at that particular lake. The first two numbers represent the year that the lake was first investigated, and the second two numbers represent the actual lake number. For example, Lake L9911 was the eleventh lake investigated by Lobdell in 1999.

1.1 Acknowledgements

This investigation could not have been completed without the assistance of numerous people and organizations. Survey support was provided by Robert F. Bell & Associates. Ground transportation was provided by Robert F. Bell and Kuukpik/LCMF, Inc. and air transportation was provided by Maritime Helicopters. At Alpine, we would like to recognize Justin Harth, Jessica Adema, and Tom Manson, all of ConocoPhillips, and "Squeak" at Alaska Clean Seas. Thanks also to Patrick Walsh, Doug Sanford, Ron Gunderson, and the ice crew at "Gundyville," Peak Oilfield Service's temporary NPR-A field camp ("…a nice place to be when the weather's Phase III!"). Bureau of Land Management hydrologist Richard Kemnitz provided invaluable insight and support during the spring field effort; his comments on the Draft version of this report were especially helpful. Caryn Rea, ConocoPhillips Environmental Manager, was instrumental in the investigation as a whole, from its conception to its conclusion.

1.2 Overview and Purpose of the Monitoring and Recharge Study

Ongoing petroleum and natural gas exploration programs in the NPR-A use ice roads and pads for access and transportation during the winter. Each exploration season, millions of gallons of fresh water are withdrawn from regional lakes to construct this ice road and pad network. Water withdrawals for construction may begin as early as December and continue through April. The road network is usually completed by mid-winter; however, water withdrawals for ice road and pad maintenance continue throughout the exploration season. In addition to ice road and pad construction, fresh water lakes are also used as potable water supplies for temporary rig and exploration camps, and as sources of make-up water for exploratory drilling operations.

The United States Department of the Interior, Bureau of Land Management (BLM) oversees exploration permitting in the NPR-A. The primary purpose of the 2002 NPR-A Lake Monitoring and Recharge Study was to complete an in-depth, multi-seasonal investigation of winter use lakes that satisfied permit requirements set forth by the BLM. Applicable BLM permits stipulate in part that:

> *"The concern exists in the case of multiple-year use of lakes for ice road construction, where the assumption is that recharging will be acceptable for the continuing use of these lakes. Applicant is to develop a monitoring plan to measure water volumes before use, measuring amounts used, and lake drawdown. An annual plan for water use will be required for the use of multi-year lake use after the first year of use."*

The BLM further stipulates that:

> *"The intent of the lake monitoring program is not simply to observe lake levels during the year, but rather to determine the quantity and quality of free water available under the ice that provides over-wintering habitat for fish and aquatic invertebrates as well as to see if the lake returns to normal levels after breakup during the summer…"*

To satisfy the requirements of the BLM stipulations, the monitoring and recharge study was designed to be a comparative analysis of lakes from which water was withdrawn for ice road and pad construction (pump lakes) and nearby lakes from which no water was withdrawn (reference lakes). The lakes included in the study consisted of four pump lakes: L9911, M9912, M9922, and M9923; and four reference lakes: L9807, L9823, M0024, and M9914. A fifth pump lake, L9817, was added in March at the request of CPA, bringing the total number of pump lakes to five. The lakes selection process is detailed in Section 3.2. Site visits were scheduled such that lake conditions during pre-pump, post-pump, post-breakup, and pre-freeze-up periods were represented.

In addition to the primary goal of the study - satisfying BLM permit stipulations - a number of secondary goals were identified in the planning phase of the project. These secondary goals included:

- Establishing baseline conditions from which comparisons can be made, and from which meaningful changes in water quantity and quality can be measured;
- Designing the study such that it can be used in combination with fisheries data collected in lakes during the summer to assess the threshold criteria for water withdrawal that is still protective of fish;
- Designing the study such that it complements and builds upon information obtained during similar lake monitoring and recharge studies previously completed in the NPR-A; and,
- Widening the baseline knowledge of North Slope water withdrawal programs, with an emphasis on the use of fresh water lakes as water sources in North Slope communities.

1.3 Previous NPR-A Lake Studies

The earliest lake investigations in the NPR-A focused primarily on the collection of physical and biological information to document fish presence and habitat use. Field studies conducted in 1999 for ARCO Alaska, Inc. (ARCO) and in 1999-2000 for PAI consisted of biological sampling with gill nets along predetermined transects. Selected water quality parameters were also measured to assess fish habitat and suitability for use. Limited bathymetric data were collected along each transect and used to estimate lake volumes (MJM, 2000a, b).

Eight of the lakes included in the current lake monitoring and recharge study were included in the 1999 ARCO field study (L9911, M9912, M9922, M9923, L9817, L9807, L9823, and M9914), while the ninth lake from the current study (M0024) was included in the 1999/2000 PAI field study. Data presented in the 2000 PAI study reports that are specific to the nine lakes of interest in the current study are presented in Attachment I.

Another NPR-A lake study completed in 2000 for PAI consisted of the measurement of lake depths and a limited number of in situ water quality parameters of 32 lakes identified as potential water sources for ice road and pad construction. Volume estimates were produced for each lake (Reanier & Associates, 2000). One of the lakes included in the current lake monitoring and recharge study was also included in this 2000 PAI study (L9911, referred to as R0061 in the report).

Two lake investigations specifically dealing with over-winter water use and lake recharge were carried out during the winter of 2000/2001. British Petroleum Exploration-Alaska (BPX) initiated one program and PAI initiated the other. Both studies were developed in coordination with BLM, and are summarized below.

The BPX study sought to investigate whether winter water withdrawals had a measurable effect on water quality, and also to quantify water surface elevation changes due to pumping. Six pump lakes and three reference lakes near the Trailblazer exploration area were identified for investigation. The sampling plan originally called for measurements of water surface elevations and water quality parameters to be performed at each lake both prior to and after pumping. Several problems arose during the course of the investigation, however. Due to methodological and logistical difficulties, the effect of pumping on water levels could only be measured on three of the pumped lakes; and even for those, measurements only captured a portion of the water withdrawal. Furthermore, pre-pump water quality samples were collected at only a portion of the lakes, and post-pump sampling was in some cases performed while water was still being actively pumped from a lake. In addition, water quality sampling and depth measurement inconsistencies were noted.

The BPX study concluded that, within the limitations of the methodology used, there was little evidence that water quality changed as a result of pumping. The study further concluded that water surface elevation changes in pumped lakes were well within the range of changes seen in reference lakes, and that changes in water surface elevations were highly correlated with changes in ice thickness (Oasis, 2001). None of the lakes in the 2001 BPX study coincide with any of the nine lakes included in the current 2002 lake monitoring and recharge study.

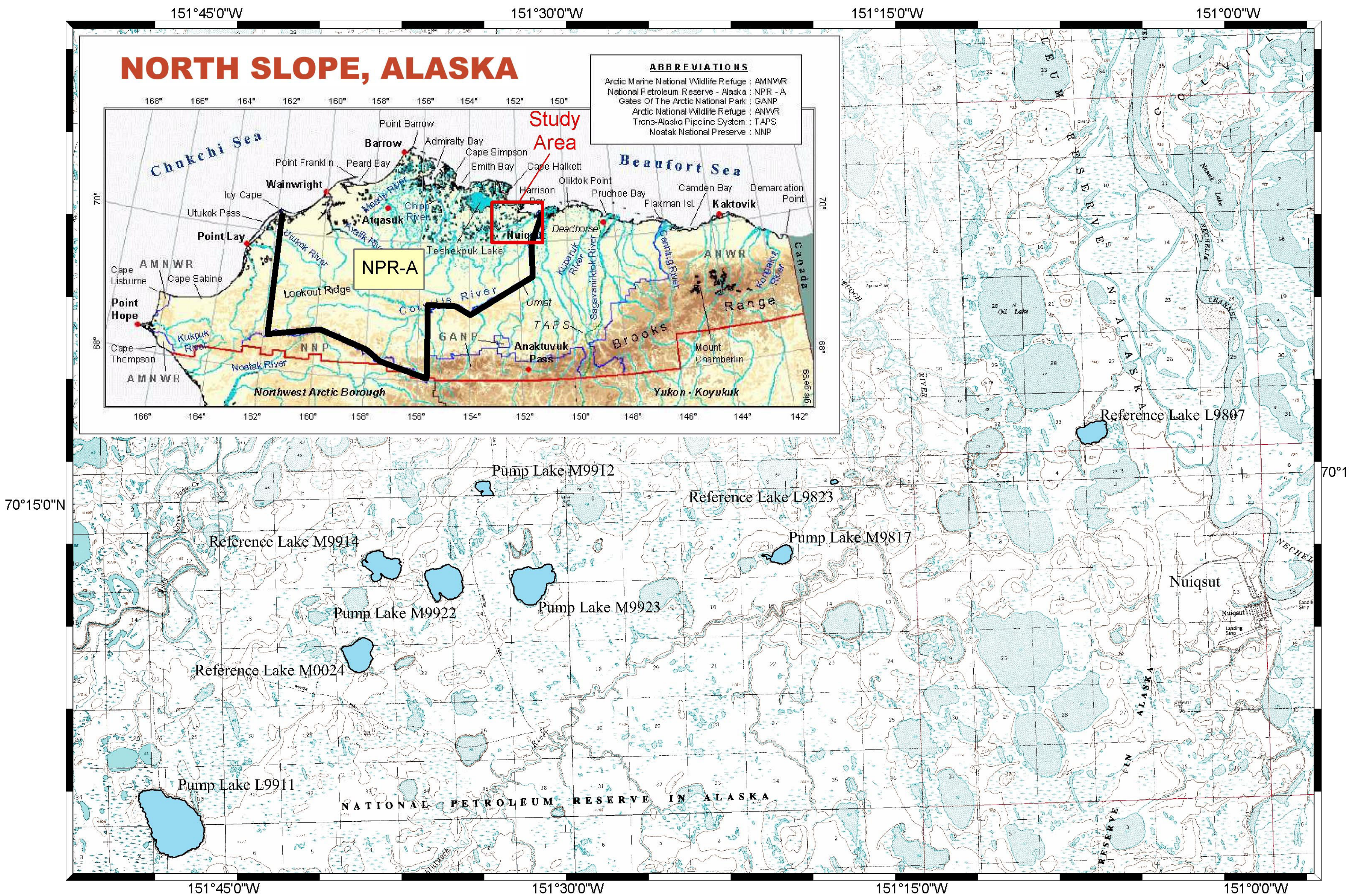
The winter 2000/2001 PAI study was designed to monitor water levels and water quality at both pump and reference lakes, determine the amount of free water under the ice, and assess the amount of recharge to the lakes in the summer. The program was also to have included a fish overwintering habitat analysis. Three pump and three reference lakes were chosen, but only two of each type were actually studied due to changes in the pumping program by the ice road subcontractor. The final lakes studied were not fish bearing, thus canceling the overwintering habitat component of the program. Water surface elevation measurements, and in situ and analytical water sampling were performed during pre-pump, post-pump, breakup, and pre-freeze-up sampling events (URS, 2001).

Based on the data collected, the PAI study concluded that water level decreases caused by pumping did not advance the freezing rate of the study lakes, and that water levels depressed by pumping returned to pre-pump levels prior to freeze-up. In view of in situ and analytical water quality results, the study concluded that pumping did not appear to cause significant degradation of water quality in the study lakes. None of the lakes in the 2001 PAI study coincide with any of the nine lakes included in the current 2002 lake monitoring and recharge study.

A fairly rigorous compilation of baseline water quality data from North Slope lakes was completed in 1999 (Radian International, 1999). The study, however, did not encompass the geographic region of the NPR-A. Furthermore, the baseline data were collected in summer months only; no winter baseline information was available.

The NPR-A studies described above provide an important first step in developing baseline levels of water quality data for fresh water lakes in the NPR-A. The 2001 BPX and PAI studies are also important in that they provide water quality information collected in the NPR-A during the winter months.

Figure 1-1 Study Area



2.0 Winter 2002 - Water Use and Weather

While the winter of 2002 in NPR-A was normal with regard to water withdrawal, with approximately 75 miles of ice roads built, including a major ice bridge at the Colville River, it was unique in terms of weather. The winter was one of the driest on record with mid- to late-winter snowpack and precipitation totals well below normal. Additionally, March and April temperatures were well above normal, resulting in an early spring breakup of rivers and streams in and around the Colville River delta and the NPR-A.

2.1 Winter 2002 NPR-A Lake Water Use

Of the nearly 2.3 billion gallons permitted for removal in the 16 lakes used during the winter 2002 exploration season in the NPR-A, roughly three percent or nearly 65 million gallons, were withdrawn. Daily water use totals from each of these NPR-A lakes for the months January through May are summarized in Appendix A. Information in Appendix A was downloaded from the PAI Extranet water use website on August 8, 2002.

Table 2-1 presents a monthly summary of water volumes withdrawn at NPR-A lakes. Also included in the table is the relative ranking of each lake in terms of the total volume of water withdrawn.

Based on information obtained from the NRCS, the winter of 2002 can be generally characterized as having had considerably below normal snowfall for the winter as a whole, and above normal mid- to late-winter air temperatures. Comparatively, the winter of 2001 had moderately below normal precipitation (79% of normal through May 1), and air temperatures that were significantly higher than normal in January and February (4º and 15ºF, respectively), slightly below normal in March (<1ºF), then higher again in April (NRCS, 2001a, b). The winter of 2000 had a roughly normal snowpack (94% of normal through May 5), and air temperatures that were very slightly warmer (<1ºF) than normal in January and February, and slightly warmer (about 4ºF) in March and April (NRCS, 2000a, b).

On-site observations made in 2002 during lake sampling events, and especially spring breakup programs in and around NPR-A and the Colville River delta, suggest that snowpack and air

Table 2-1 2002 NPR-A Lakes Water Withdrawal Volumes

Lake	Location	Total Gallons Permitted	Pumped Volume in Gallons January	February	March	April	May	Total	Rank	Percent Used of Total Permitted
R0052	Hunter	1,520,000	628,220	222,000	315,000	117,000	18,000	1,300,220	12	86%
R0053	Hunter	24,000,000	9,000	0	0	0	0	9,000	16	0.04%
R0054	Hunter	23,690,000	990,192	0	0	0	0	990,192	15	4%
R0056	Hunter	339,670,000	3,426,474	444,000	330,000	0	0	4,200,474	5	1%
L9911	Rendezvous	463,590,000	0	1,226,744	0	0	0	1,226,744	13	0.3%
L9804	E. NPRA	106,860,000	87,990	2,441,376		0	0	2,529,366	8	2%
L9806	E. NPRA	262,980,000	8,277,528	526,907	113,400	0	0	8,917,835	3	3%
L9817	Peak Camp	72,150,000	2,400,696	10,330,410	3,444,060	1,115,106	0	17,290,272	1	24%
M9602	Colville	415,900,000	2,479,428	358,974	0	0	0	2,838,402	7	0.7%
M9605	Colville	238,300,000	3,336,228	303,450	1,687,350	1,001,700	56,700	6,385,428	4	3%
M9606	Colville	3,900,000	476,322	596,232	0	0	0	1,072,554	14	28%
M9912	Mitre	27,610,000	0	9,112,176	919,800	0	0	10,031,976	2	36%
M9915	Rendezvous	23,360,000	0	297,360	1,158,780	0	0	1,456,140	10	6%
M9922	Spark/Mitre	108,650,000	0	874,440	764,064	0	0	1,638,504	9	2%
M9923	Spark/Mitre	175,890,000	0	3,126,807	217,728	0	0	3,344,535	6	2%
M0183	Puviaq	2,000,000	0	0	0	1,405,800	27,000	1,432,800	11	72%
Total		**2,290,070,000**						**64,664,442**		**3%**

Note: 2002 study lakes are highlighted in blue temperature conditions in the NPR-A were similar in nature to those recorded at Barrow, namely, higher than normal temperatures and a lower than normal snowpack. These conditions resulted in a relatively rapid spring breakup that occurred in late May, about two weeks earlier than had been observed in recent years. Because of the below normal snowpack, there was less meltwater for tundra lake recharge than would typically be available in an average year, and in 2001 and 2000 specifically.

2.2 Winter 2001/2002 North Slope Weather

Physical processes on the North Slope are dominated by Arctic weather conditions. As a result, the prevailing 2001/2002 winter weather conditions played a large role in the measurements and observations recorded during the 2002 NPR-A Lake Monitoring and Recharge Study. A brief overview of two weather components that were especially important - temperature and precipitation - is presented below.

National Resource Conservation Service (NRCS) Basin Outlook Reports from April and May 2000, 2001, and 2002 were used as a source of summarized weather data. The Basin Outlook Reports provided a short, concise overview of weather data. The NRCS weather station located at Pumphouse 1 near Deadhorse was the closest weather station to the project area. Unfortunately, data at that station for the period in question typically went unreported. The NRCS station at Barrow was found to have a relatively complete record, and the following discussion is based on data from that location. Mr. Rick McClure of NRCS stated that an examination of summary data from the Barrow station would result in a reasonable overall understanding of 2002 North Slope weather, with the caveat that precipitation totals typically increase from west to east across the Slope. That Barrow is located approximately 150 miles northwest of the study area means that precipitation totals at the study lakes may be slightly higher than reported at Barrow (McClure, 2002).

Between October 1, 2001 and April 1, 2002, the recording station at Barrow indicated that precipitation was only 57 percent of normal, a record low (NRCS, 2002a). For the Arctic Coast as a whole, the NRCS estimated that the snowpack was 57 percent of normal over the same time period. By May 1, Barrow precipitation totals had increased somewhat but were still low, being approximately 67 percent of normal (NRCS, 2002b). For the Arctic Coast as a whole, the NRCS estimated that the snowpack on May 1 was 79 percent of normal.

Temperatures at Barrow were slightly below normal in February, but in March were about 15 ^{o}F (8^{o}C) above normal. The elevated March temperatures were followed by April temperatures that were 5 ^{o}F (approximately 3 ^{o}C) above normal.

3.0 2002 Study Methods

The 2002 NPR-A lake monitoring and recharge study was designed to build on previously completed lake recharge investigations. The study was organized on a comparative framework between pump and reference lakes, similar to the two programs completed in 2001, but was modified in several areas based on input from PAI, BLM, and the Alaska Department of Fish and Game (ADF&G). These modifications consisted of the inclusion of a greater number of lakes than in the previous studies, an investigation of lake recharge magnitudes and mechanisms, and the addition of analyses of water samples for biochemical and chemical oxygen demand.

3.1 Study Overview and Approach

The original scope of the 2002 study included ten study lakes, an expansion of scope over previous studies. The ten lakes were to consist of five lake pairs, with a lake pair being defined as a pump lake and a reference lake of similar size and physical characteristics. Due to changes in the ice road contractor's pumping program during the lake selection process, the lake pair concept had to be abandoned. A detailed discussion of the process used to select the nine lakes included in the study is provided in Section 3.2.

Site visits to complete various sampling and monitoring tasks were scheduled during four milestone periods: (1) before water withdrawal (pre-pump), (2) after pumping was completed (post-pump), (3) during spring recharge (breakup), and (4) in late summer prior to freeze-up (pre-freeze-up).

Specific tasks completed during each site visit varied according to season, but as a whole included level loop surveys to measure changes in lake levels, ice thicknesses, and water depths; monitoring of in situ water quality parameters; collection of analytical water quality samples; and evaluation of recharge mechanisms at each study lake.

Those site visits where in situ and analytical sampling took place (pre-pump, post-pump, and pre-freeze-up) were termed sampling events. More detailed discussions of individual sampling and monitoring tasks are provided below in Sections 3.3 through 3.5. The specifics of each site visit including completion dates, tasks accomplished, and difficulties encountered are detailed in Section 4.0.

While four site visits were originally planned for the 2002 study, opportunities for two additional visits resulted in a total of six site visits. The first additional site visit was associated with spring breakup to evaluate recharge. The spring recharge site visit was originally scheduled for the end of June, so that the magnitudes and mechanisms of spring recharge to each lake could be evaluated. An early spring breakup in the surrounding area required a change in schedule to fully capture the impacts of breakup. This visit was conducted in early June. The second site visit to evaluate spring recharge took place as scheduled in late June after the lakes became ice-free. This second site visit was necessary because a full data set could not be collected in early June due to field conditions.

The second additional site visit, which occurred in September, consisted of observations of pre-freeze-up lake inflows and outflows. It was accomplished in conjunction with other field studies occurring at that time.

3.2 Lake and Sampling Location Selection

The preliminary lake selection process was begun prior to the initial site visit and was based on input from PAI and Peak Oilfield Services (Peak), the ice road contractor. In an attempt to build on previous investigations, lakes that were sampled in the two 2001 lake monitoring studies were considered for inclusion in the 2002 study. Unfortunately, all of the lakes included in the 2001 studies eventually had to be eliminated from consideration. The 2001 BPX lakes were eliminated because they were located well west of the main area of 2002 exploration activities in the NPR-A and were deemed too distant for inclusion in the 2002 program. The 2001 PAI lakes were eliminated because they either had not been previously pumped and had no historical data to build on, or because Peak did not anticipate using the lakes during the 2002 exploration season.

The selection process evolved over a month-long period. Historic pumping records and preliminary ice road routes and pad locations were used to analyze possible pump and reference lake pairings. Lake pair options were routinely modified or eliminated in response to ice road routing and priorities plans that changed almost daily. A total of 12 lake pairs and eight alternate lakes were evaluated throughout the pre-field lake selection process.

Five lake pairs were eventually selected prior to leaving for the field to conduct the first sampling event. The pairs were similar in size and depth, and were all located in relatively close proximity to the Peak field camp at Lake L9817. According to Peak's best estimates, and historic water use records provided by PAI, it appeared relatively certain that each of the pump lakes chosen would in fact be pumped, and each of the reference lakes would not.

Ultimately, each of the five lake pairs was eliminated within the first 24 hours of the first sampling event due to ongoing changes in the road and pad building field program. After arrival at Peak's remote camp, it was determined that some sections of ice road had been rerouted or eliminated altogether while others had been added. Additionally, proposed reference lakes were scheduled for pumping, or had already been pumped, and proposed pump lakes were either not being used, or had already been pumped before monitoring could begin.

The lake selection process continued in the field as an iterative process. Variables such as road routing, snow removal, and lake pumping and chipping priorities changed hourly and further complicated selection. The concept of pump/reference pairs was abandoned as impractical early in the process. Peak personnel provided updated information as it became available, and assisted in attempts to identify representative pump and reference lakes. A suitable suite composed of four pump and four reference lakes was eventually identified. One additional pump lake (Lake L9817) was added after the pre-pump sampling event at the request of CPA.

Lake locations are shown on Figure 3-1, a through d. Pertinent physical and environmental information for the nine study lakes, including the total volume of water removed from pump lakes, is summarized in Table 3-2. Pump and reference lakes compared marginally well on the basis of physical characteristics, with the exception of the relatively large pump lake L9911, and the relatively small reference lake L9823.

Table 3-1 Summary of Study Lakes

Lake Number	General Location	Estimated Surface Area[1] (acres)	Estimated Maximum Depth[1] (ft)	Permitted Volume[2] (mil. gal.)	Habitat[1]	Fish Presence[1]	Winter 2002 Water Volume Withdrawn[2] (mil. gal.)	Percent Withdrawn of Total Permitted
PUMP LAKES								
L9911	Rendezvous	540	8	463.6	Tundra Lake	No	1.2	0.3%
M9912	Mitre	33	7.8	27.6	Tundra Lake	No	10.0	36%
M9922	Spark/Mitre	191	5.3	108.6	Tundra Lake	No	1.6	2%
M9923	Spark/Mitre	252	6.5	175.9	Tundra Lake	No	3.3	2%
L9817	Peak Camp	75	9.0	72.1	Tundra Lake	No	17.3	24%
Total				**847.8**			**33.4**	**4%**
REFERENCE LAKES								
L9807	Colville River	94	8.2	--	Tundra Lake	Yes(?)	n/a	--
L9823	Ublutuoch River	5	12.0	--	Tundra Lake	No	n/a	--
M0024	Nova	139	7.3	--	None Specified	No	n/a	--
M9914	Spark/Mitre	127	7.8	--	Tundra Lake	No	n/a	--

Notes:
1 - Data from *Fish Utilization of Lakes in Eastern NPR-A: 1999-2000, Final Data Report*, November 2000, MJM Research.
2 - January -May 2002. Data from PAI Extranet water use website (https://bizak.phillips66.com/water_use).

Table 3-2 summarizes month-by-month pumping volumes in lakes specific to this study, and ranks those volumes within the scope of the study. Table 3-2 also translates total volume removed into estimated ice-free water elevation drawdown in each of the study lakes. Lake surface areas and depths used for drawdown calculations are shown in Table 3-1.

Table 3-2 2002 NPR-A Study Lakes Water Withdrawal Volume and Estimated Drawdown

Lake	Location	Pumped Volume in Gallons						Rank	Ice -free
		January	February	March	April	May	Totals		Drawdown
L9911	Rendezvous	0	1,226,744	0	0	0	1,226,744	5	0.01 ft.
M9912	Mitre	0	9,112,176	919,800	0	0	10,031,976	2	0.93 ft.
M9922	Spark/Mitre	0	874,440	764,064	0	0	1,638,504	4	0.03 ft.
M9923	Spark/Mitre	0	3,126,807	217,728	0	0	3,344,535	3	0.04 ft.
L9817	Peak Camp	2,400,696	10,330,410	3,444,060	1,115,106	0	17,290,272	1	0.71 ft.
Totals		**2,400,696**	**24,670,577**	**5,345,652**	**1,115,106**	**0**	**33,532,031**		

Water withdrawn from the five 2002 NPR-A study pump lakes accounted for just over fifty percent of total 2002 NPR-A water withdrawals. Two study lakes, L9817 and M9912, were ranked (respectively) #1 and #2 overall for volumes withdrawn. Lake L9817 was added after the pre-pump sampling event because of the high volume of water removed; therefore, pre-pump data for that lake were not collected.

Using available depth data (MJM, 2000a, b), a preliminary sampling location was established on each lake. Sampling location selection was based solely on depth. Selected sampling locations represented points where depths were at or close to the deepest known depth in the lake. In several cases, sampling locations were adjusted in the field. Each sampling point was marked with a six-foot HDPE snow pole and the location recorded using a hand-held GPS unit referenced to North American Datum of 1927 (NAD27). Sampling locations at each lake are shown on Figure 3-1, a through d.

3.3 Physical Parameter Measurements

The physical parameter measurement portion of the program consisted of the installation of temporary benchmarks (TBMs) at each lake to facilitate measurement of ice and water surface elevations, and determination of ice thickness, total water depth, and freeboard. Additionally, the recharge mechanism and the magnitude of recharge for each of the study lakes were defined. Each of these tasks is discussed in detail below.

During the first sampling event, four TBMs from which water surface and ice elevations would be referenced were established at each lake. Each TBM consisted of a 3-foot section of one-half-inch rebar that was pounded almost its full length into the ground using a two-cycle rebar pounder. The TBM location was marked with crossed lathe and the rebar itself was marked with a surveyor whisker and bailing wire. Each TBM was tied to the British Petroleum mean sea level (BPMSL) datum. TBM locations at each lake are identified on Figure 3-1, a through d.

During the winter sampling events, a two-cycle power auger was used to drill a six-inch sampling hole through the ice. Total water depth was measured using a weighted tag line. Freeboard, the distance from the top of ice to the water surface in the sample hole, was measured using a pocket rod. Ice thickness was determined using a pole with a wire hook on the end. The rod was lowered into the hole until the hook found the underside of the ice. The rod was then withdrawn and the pocket rod used to measure the resultant ice thickness as marked along the pole. All measurements were made to the nearest hundredth-foot and were referenced to the top of ice.

During each site visit, a level survey was performed to determine the elevation of the water surface. The survey was tied to the TBMs using standard level loop techniques. During the two winter site visits, the elevation of the water surface was calculated by subtracting the measured freeboard from the elevation of the top of the ice in the immediate vicinity of the sample hole.

Lake recharge mechanisms and water levels were investigated during the third and fourth site visits. The first of these two events (the breakup site visit) took place in early June, immediately following spring breakup on the streams in the region. At that time, recharge was just beginning to occur within the drainage basins of the lakes but the surfaces of all of the lakes were still completely ice-covered. Because of this, only preliminary observations of lake recharge could be made, and water level measurements were not possible at all lakes. The second of the two events (the post-breakup site visit) took place in late June after the surfaces of the lakes were ice-free.

During the two lake recharge site visits, ground reconnaissance was used to document recharge at each lake. Recharge findings made on the ground were verified and documented with aerial photography. Photographs that showed recharge as it was occurring at each lake were taken from a helicopter at an altitude of approximately 1,000 feet. The magnitude of recharge at each lake was calculated by comparing breakup water surface elevations to those surveyed after spring breakup and prior to freeze-up.

Figure 3-1 Sampling Locations

Figure 3-1 a Sampling Location – Lake L9911

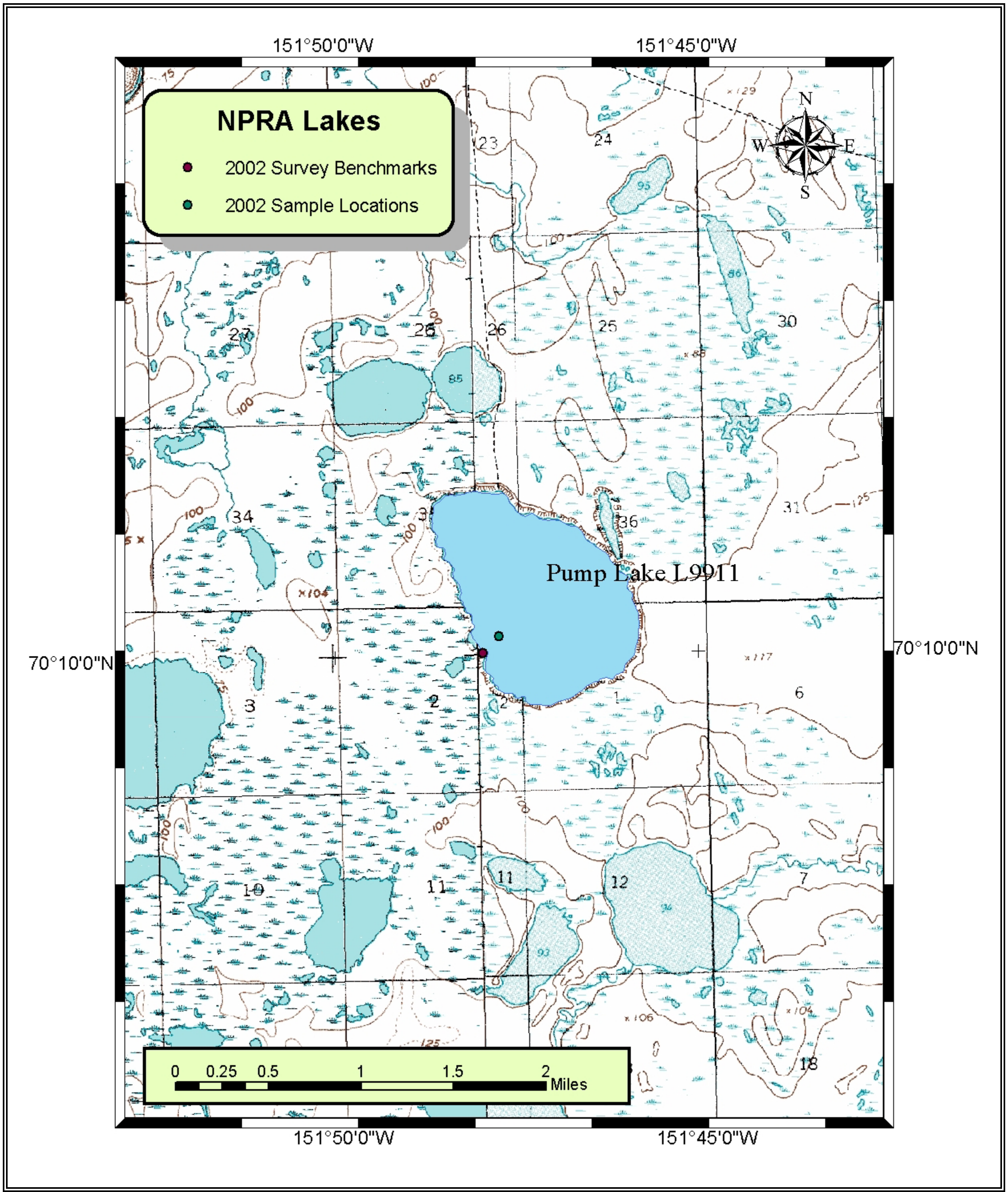


Figure 3-1 b   Sampling Locations – Lakes M9912, M9914, M9922, M9923, and M0024

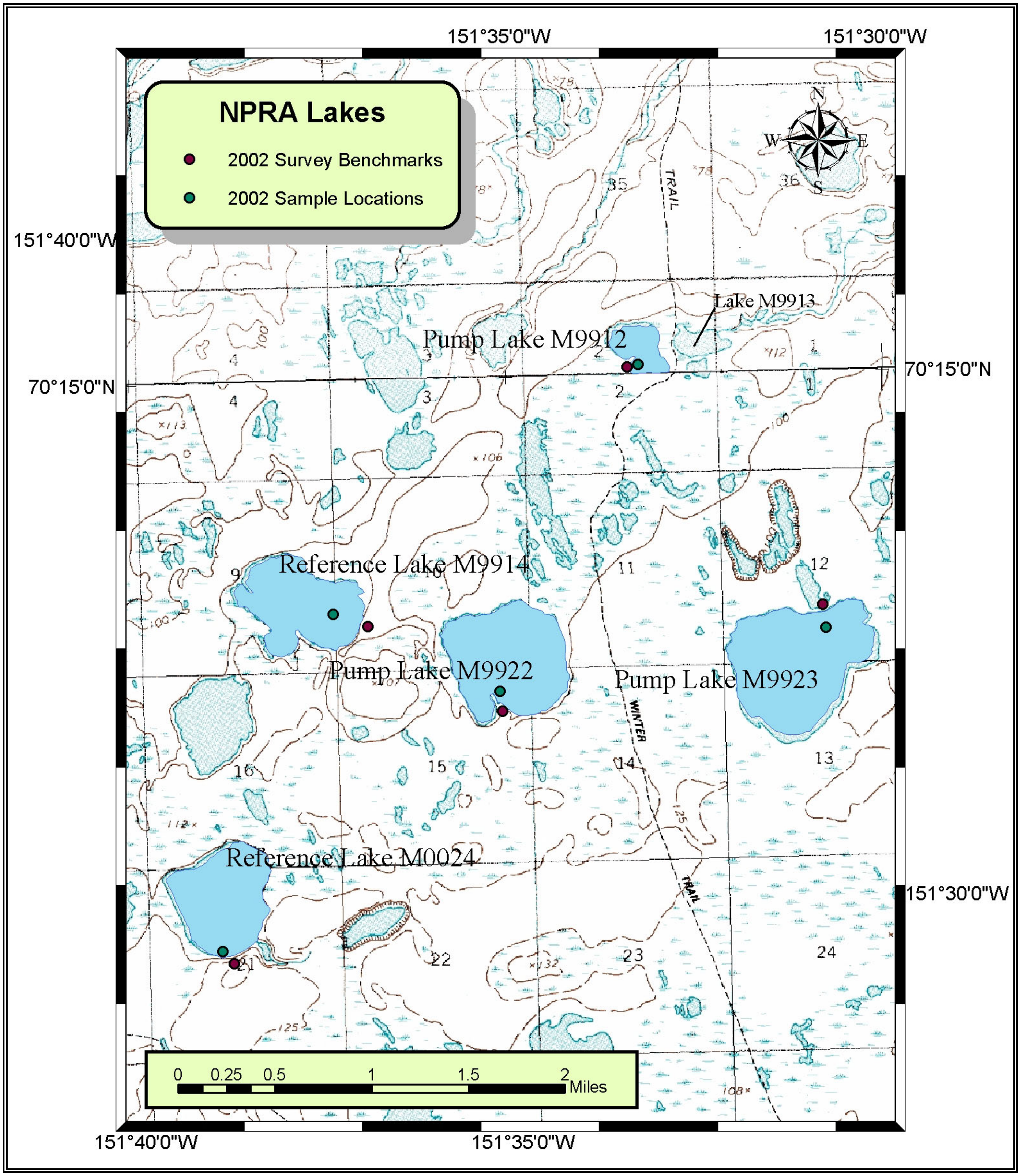


Figure 3-1 c   Sampling Locations – Lakes M9817 and L9823

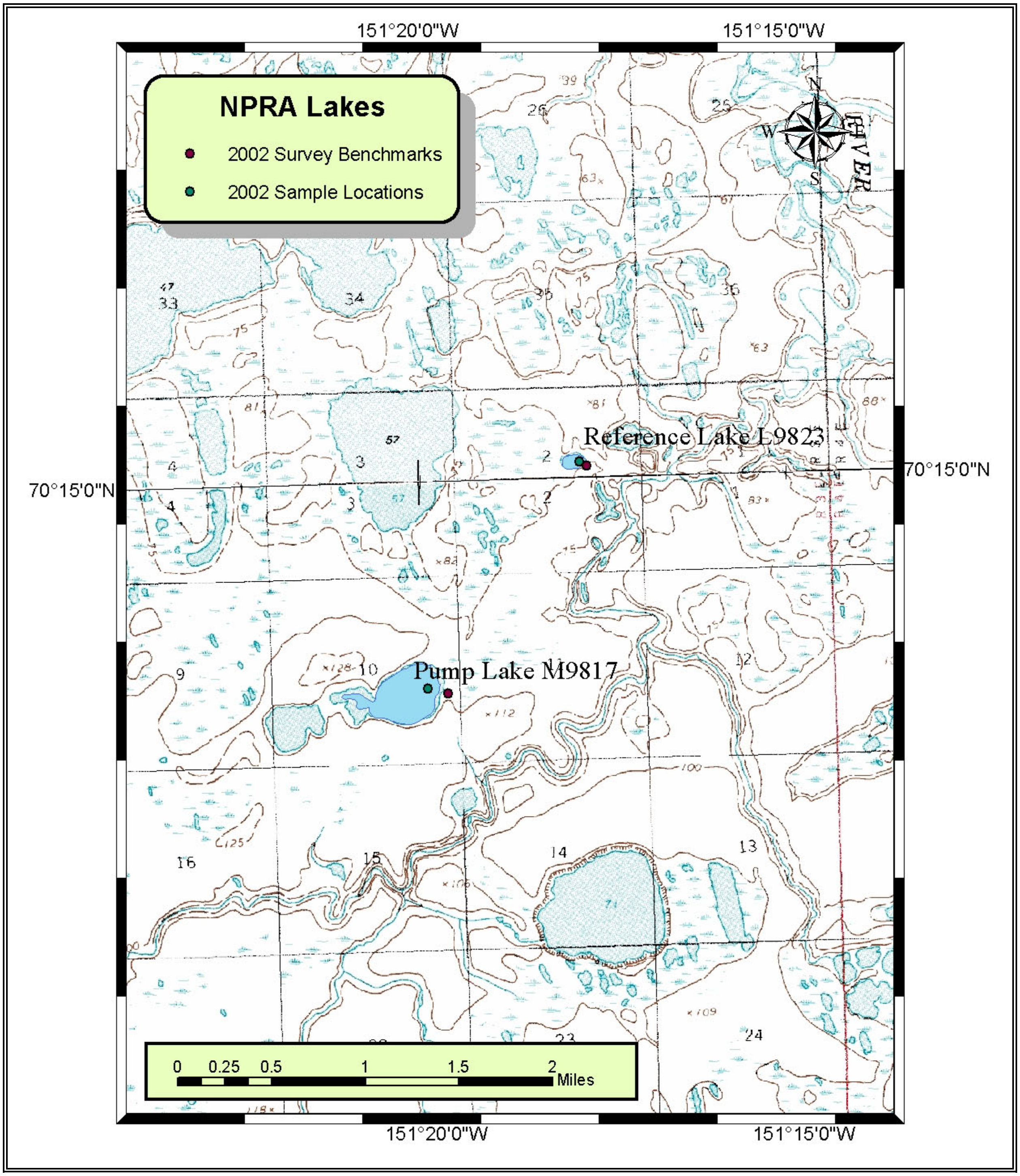
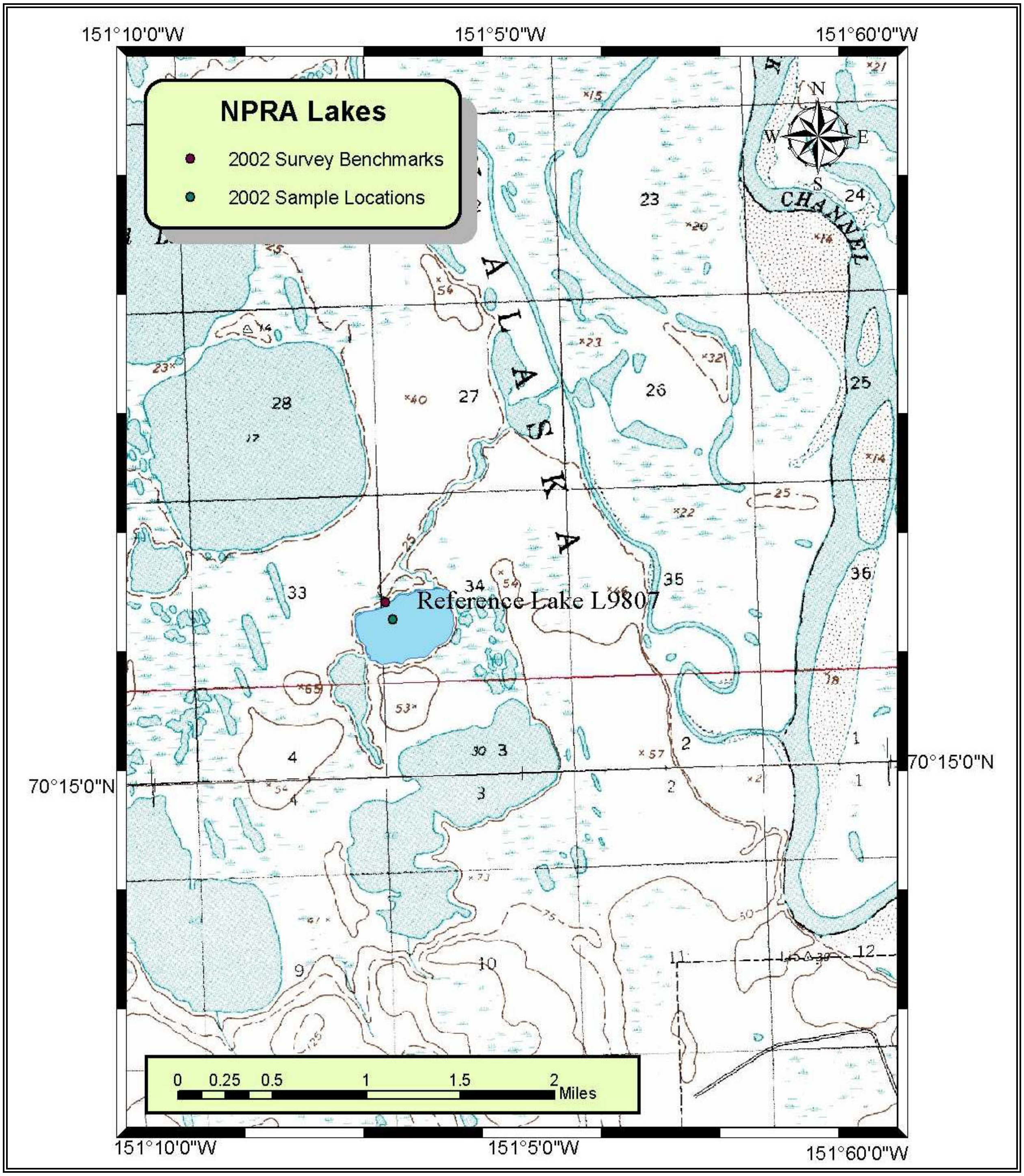


Figure 3-1 d Sampling Location – Lake L9807



3.4 In Situ Parameters

A Horiba U-10 in situ water quality meter was used to measure the following in situ water parameters:

- Temperature in degrees Celsius (^{o}C)
- pH in standard units
- Conductivity in microsiemens per centimeter (uS/cm)
- Dissolved oxygen in milligrams per liter (mg/L)
- Turbidity in nephlometric turbidity units (NTU)
- Salinity in milligrams per liter (mg/L)

During the two winter sampling events, in situ samples were collected at approximately one-half the depth of the water below the bottom of the ice. During the pre-freeze-up sampling event, samples were collected at a depth approximately equal to the average of the two winter sampling depths at each location. Because the accuracy of in situ turbidity measurements made with the Horiba U-10 was questionable, a second turbidity measurement was made at each sampling location using a Hach 2100P turbidimeter. The meter was portable, and analysis was completed either onsite or in the field office at the end of the day. Turbidity samples were collected immediately following analytical sampling and prior to any other sampling activities at each location.

Measures were taken to ensure that the instruments were protected from the cold. Two Horiba meters and two Hach turbidimeters were on hand at all times in case of meter damage or failure.

3.4.1 Instrument Calibration

All meters were calibrated according to the manufacturer’s specifications. A summary of calibration procedures is outlined below.

Horiba U-10

Daily: Prior to sampling, a calibration check was performed using the meter’s auto-calibrate function and calibration solution provided by the manufacturer. The calibration check was again performed at the end of the day if any results read during the course of the sampling day were suspect.

After Each Sampling Event: The meter was returned to the manufacture's representative for complete maintenance servicing, performed in accordance with the manufacturer's specifications. The servicing included multi-point calibration on all probes using span and zero check solutions, cleaning of all probes, and replacement of the semi-permeable membrane on the dissolved oxygen probe.

Hach 2100P Turbidimeter

Daily: Prior to sampling, a calibration check was performed using Gelex secondary particulate suspension standards provided by the manufacturer. The calibration was again performed at the end of the day if any results read during the course of the sampling day were suspect. If calibration check readings were not within 5 percent of the value of the standard, a complete recalibration using formazin standards was done before the meter was used in the field.

Prior to the Field Season: StablCal stabilized formazin standards in 20-, 100-, and 800-NTU concentrations were used to recalibrate the instrument.

3.5 Analytical Parameters

Water samples for analytical evaluation were collected in lab-provided containers. During the two winter sampling events, analytical samples were collected at approximately one-half the depth of the water below the bottom of the ice. During the pre-freeze-up sampling event, samples were collected at a depth approximately equal to the average of the two winter sampling depths at each location. A discrete-depth sampler was used to assure that water was collected from the desired depth.

Each sample container was labeled with pertinent sampling information and stored in an ice chest for transport to the analytical lab under standard chain-of-custody procedures. During the two winter sampling events, chemical pack hand warmers were placed in the sample cooler to prevent the samples from freezing. During the pre-freeze-up sampling event, refreezable gel packs were placed in the sample cooler to keep the samples adequately chilled.

Study lake water samples were analyzed for the following parameters:

- Iron
- Calcium
- Magnesium
- Potassium
- Sodium
- Sulfate
- Nitrate
- Chloride
- Biochemical oxygen demand (BOD)
- Chemical oxygen demand (COD)
- Hardness
- Total dissolved solids (TDS)

Laboratory analysis of conductivity was not planned but was added at all study lakes during the post-pump sampling event as a means to confirm high in situ conductivities. All metals analyses were completed as total metals and field filtration was not necessary.

BOD and COD analyses were added to the investigation at the request of ADF&G as a means of evaluating fish habitat.

4.0 Program Implementation Overview

This section presents field implementation summaries for each of the six site visits conducted during the 2002 NPR-A lake monitoring and recharge study. These summaries are a synopsis of information documented in field notebooks carried by field personnel and are intended to provide useful supplemental information that may otherwise go unreported.

4.1 Pre-Pump Sampling Event

The first 2002 NPR-A site visit was the pre-pump sampling event. It was conducted February 1 through 6. Robert F. Bell & Associates (Bell), the survey subcontractor for the NPR-A work, sent two representatives. All personnel departed from Alpine on the morning of February 1 for Peak's temporary camp located near Lake L9817. Transportation was by a Hagglund tracked vehicle, provided by Bell. Monitoring tasks at Lake L9807 were completed en route to the camp, and tasks at Lake L9823 were completed later the same day. Monitoring tasks were completed at three lakes (M9923, M9922, and M9914) on the following day, February 2. Only one lake (L9911) was sampled the morning of February 3 as Phase III weather conditions developed and prevailed for the remainder of the afternoon. Phase III weather conditions cancelled all off-pad work on February 4 and 5. Tasks at the remaining two lakes (M0024 and M9912) were completed on the morning of February 6.

Temperatures during the first sampling event ranged from approximately -10 to -45 ^{o}F (-23 to -43 ^{o}C). Wind speeds up to 60 miles per hour during the Phase III conditions resulted in wind chills below -90 ^{o}F (-68 ^{o}C) and visibility of less than 50 feet at times. All sampling and monitoring equipment worked well under the conditions, although minor problems were encountered with frozen monitoring probes and in situ sampler components. The Horiba U-10 proved to be reliable for measurement of all in situ measurements except turbidity. Mechanical difficulties with the Hagglund's heating and electrical systems, and an overall lack of dependability of the vehicle represented the most significant problem during the sampling event.

4.2 Post-Pump Sampling Event

The second site visit was the post-pump sampling event, which was conducted March 22 through 25. The scope of the second sampling event had been increased at the request of PAI to include Lake L9817 as a pump lake. BLM hydrologist Richard Kemnitz accompanied the sampling team. Bell again sent two surveyors. Mechanical problems with Bell's Hagglund required the use of the Kuukpik/LCMF Hagglund and driver. All team members were billeted at Alpine. Each morning they drove a motor-pool pickup truck via the ice road to the ice pad at Lake L9817, where the Hagglund was staged. Weather during the sampling event was generally sunny and clear with little wind. Temperatures ranged from 10 to 40 ^{o}F (-12 to +4 ^{o}C).

Monitoring tasks at all nine lakes were completed in two and a half days due to the excellent weather. All sampling and monitoring equipment worked well. The Horiba U-10 again proved to be unreliable for measurement of in situ turbidity. Auger influence with regard to suspended solids was an issue at a number of lakes. In most lakes, ice thicknesses had increased to the extent that very little free water existed, and the auger generally impacted the lake bottom when it broke through the ice. Bailing of the auger hole was performed in an attempt to remove bottom material suspended by auger impact. The effectiveness of bailing was questionable. There were some difficulties with sample cooler shipment and delivery to the contract laboratory in Anchorage, which resulted in late delivery of analytical samples.

4.3 Recharge Evaluation

The recharge evaluation site visit was originally conceived as a single event that would occur sometime near the end of June after breakup on the lakes was well underway. Water surface elevation measurements, observations of recharge, and aerial photography at each lake were the only planned tasks as it was assumed that partial ice cover at most lakes would make it unsafe for lake water sampling or in situ monitoring.

The early arrival of spring breakup on area streams, however, necessitated an accelerated schedule and resulted in a two-stage recharge evaluation. On June 2, the breakup site visit was conducted, but due to unusual ice conditions at two locations, water surface elevation measurements were completed at only seven of the nine lakes. Because a complete set of lake water surface elevation measurements could not be made during the first breakup site visit, a second water surface elevation survey, termed the post-breakup site visit, was conducted on June 28. The specifics of these two recharge evaluation site visits are detailed below.

4.3.1 Breakup Site Visit

On June 2, water surface elevations were surveyed at seven of the nine lakes. At the remaining two lakes, partial ice cover resulted in water elevation measurement difficulties. Differentially perched water on bottomfast ice at Lake M9923 made it impossible to accurately determine the elevation of the water surface. Thin ice cancelled the survey at Lake L9817. Recharge mechanisms were evaluated at each lake while the crew was on the ground conducting the water surface elevation surveys. In most cases, the team was able to observe recharge as it was occurring. Aerial verification and photography of recharge mechanisms were completed at all lakes. Aerial photographs taken of each lake during this and subsequent site visits are provided in Appendix B.

4.3.2 Post-Breakup Site Visit

On June 28, all nine lakes were ice-free and water surface elevation surveys were completed at each lake. Recharge mechanisms that were previously documented during the breakup site visit were evaluated again both on the ground and from the air. Additional aerial photographs were taken at all lakes. In several cases, recharge mechanisms that were not yet fully developed during the June 2 site visit were documented and photographed.

4.4 Pre-Freeze-Up Sampling Event

The pre-freeze-up sampling event was completed on August 12 and 13, 2002. This site visit was the most rigorous in terms of the number of tasks performed. Water surface elevation measurements, aerial photography, in situ water monitoring, and analytical water sampling tasks were completed at all nine NPR-A study lakes. Monitoring tasks on Lakes L9911, M0024, M9922, M9914, and L9923 were completed on August 12, 2002. Monitoring tasks on Lakes M9912, L9817, L9823, and L9807 were completed on August 13, 2002.

Lake water surface elevations were surveyed at each site immediately following lake sampling efforts. Transportation to each lake was by helicopter from Alpine and the lakes were sampled from inflatable kayaks. The elevation from which the aerial photography was taken varied due to cloud cover. All lakes were free of ice and weather conditions were cloudy with light wind. Air temperatures ranged between 35°F (1.6°C) and 45°F (7.2°C). Sampling and survey efforts went well and work was completed without incident.

4.5 September 10 Site Visit

A second pre-freeze-up site visit occurred in early September in conjunction with other field work. While water elevation surveys were not conducted due to time constraints, the field team did re-examine recharge mechanisms and took additional aerial and ground photographs at each of the lakes. Flow rates were estimated wherever inflows and outflows were noted.

5.0 Results

This section presents the results of the 2002 NPR-A lake monitoring and recharge study. The results are subdivided with respect to physical, in situ, and analytical parameters. Typically, results of a given parameter are illustrated by means of a line graph depicting trends over time. It should be understood that the lines on these graphs were drawn by the graphing software and represent a best fit between known, discrete values. These lines are included for comparative purposes only and line values between known data points should be interpreted as approximate. No inferences with respect to unknown values between the known data points should be made based on the position of the lines.

5.1 Physical Parameters

5.1.1 Water Surface Elevations

Water surface elevation measurements are presented in Appendix C, Table C-1. The winter water surface elevation for each lake was calculated by measuring the top of ice elevation and then subtracting the freeboard measurement.

Table 5-1 compares the magnitudes of water surface elevation changes between successive site visits at pump and reference lakes. Water surface elevation trends in pump lakes were comparable to trends measured in reference lakes. In general, water surface elevations decreased in all lakes surveyed between the pre- and post-pump site visits with the exception of reference lakes L9807 and M9914, which both experienced slight increases. Magnitudes of water surface elevation changes were greater in pump lakes with the exception of Lake L9911. Water surface elevations increased at all lakes surveyed between the post-pump and breakup site visits, and decreased in all lakes surveyed between the breakup and pre-freeze-up site visits.

Table 5-1 Magnitude of Lake Water Surface Elevation Changes Between Site Visits

Site Visits Compared	Magnitude of Water Surface Elevation Change (ft)								
	Pump Lakes					Reference Lakes			
	L9911	M9912	M9922	M9923	L9817	L9807	L9823	M0024	M9914
Pre-pump vs. post-pump	-0.03	-0.77	-0.42	-0.32	N/A	+0.01	-0.07	-0.14	+0.09
Post-pump vs. breakup	+0.32	+0.99	+0.95	+0.52*	N/A	+0.25	+0.43	+0.31	+0.40
Breakup vs. post-breakup	-0.16	-0.18	-0.34	N/A	N/A	-0.09	-0.22	-0.17	-0.29
Post-breakup vs. pre-freeze-up	-0.38	-0.34	-0.34	-0.38	-0.17	-0.35	-0.33	-0.29	-0.36
	Average Magnitude of Change					**Average Magnitude of Change**			
Pre-pump vs. post-pump	-0.38					-0.03			
Post-pump vs. breakup	+0.75					+0.35			
Breakup vs. post-breakup	-0.23					-0.19			
Post-breakup vs. pre-freeze-up	-0.32					-0.33			
Overall Average	**-0.18**					**-0.20**			

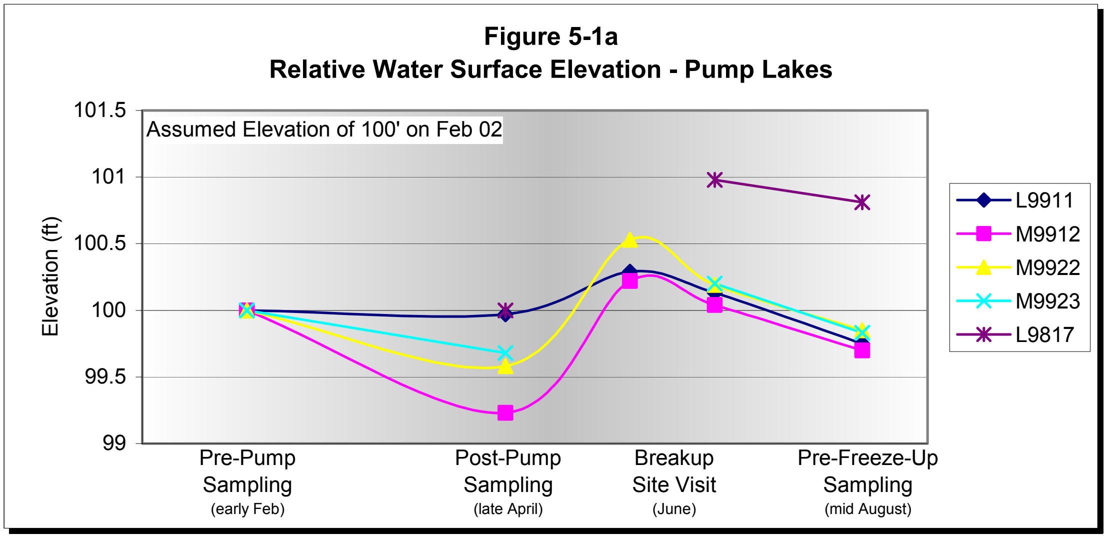
* Breakup reading for Lake M9923 was not available; the value represents the increase between pre-pump and post-breakup site visits, effectively documenting recharge.

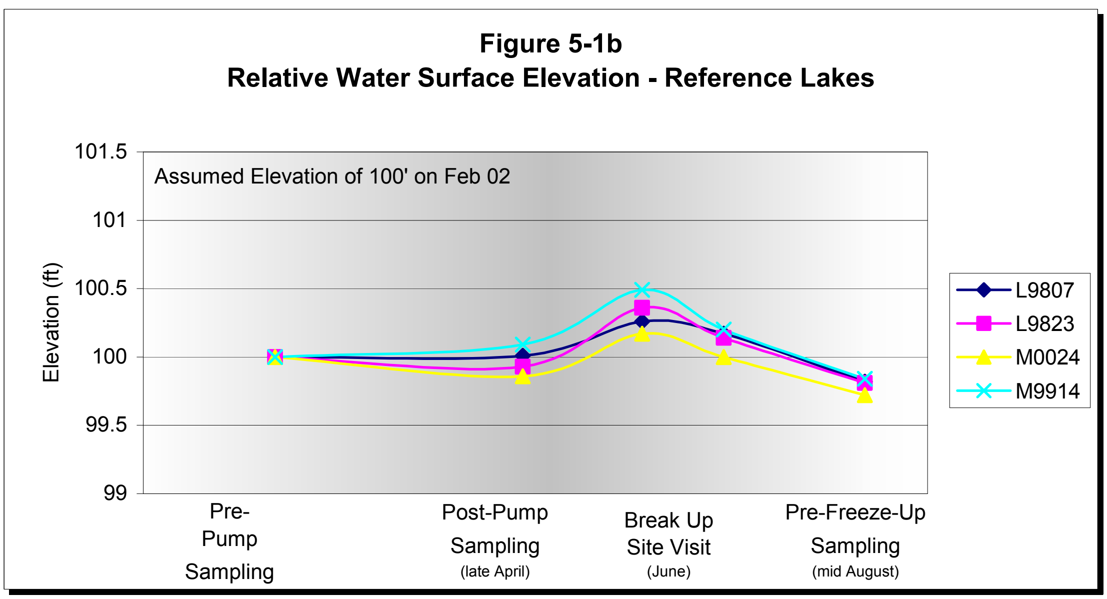
Table 5-1 suggests that, for the 2002 study lakes:

- The water surface elevations in pump lakes decreased more than those in reference lakes between the pre-pump and post-pump site visits;
- The water surface elevation increase due to spring recharge in pump lakes was more than that measured in reference lakes;
- The water surface elevation in all lakes increased to levels above those measured during the pre-pump site visit due to spring recharge;
- Water surface elevations at all lakes decreased after the lakes were recharged in the spring;
- Water surface elevations at both pump and reference lakes continued to decrease at a comparable rate during the summer period; and
- Magnitudes of water surface elevation changes from the beginning to the end of the study period were similar for all lakes, regardless of whether water was withdrawn during the winter.

The above points are illustrated graphically on Figure 5-1, a and b, where the beginning water surface elevation of each lake has been assigned an arbitrary value of 100 feet so that the magnitude of change at each lake can be compared.

Figure 5-1 Relative Water Surface Elevation Comparison



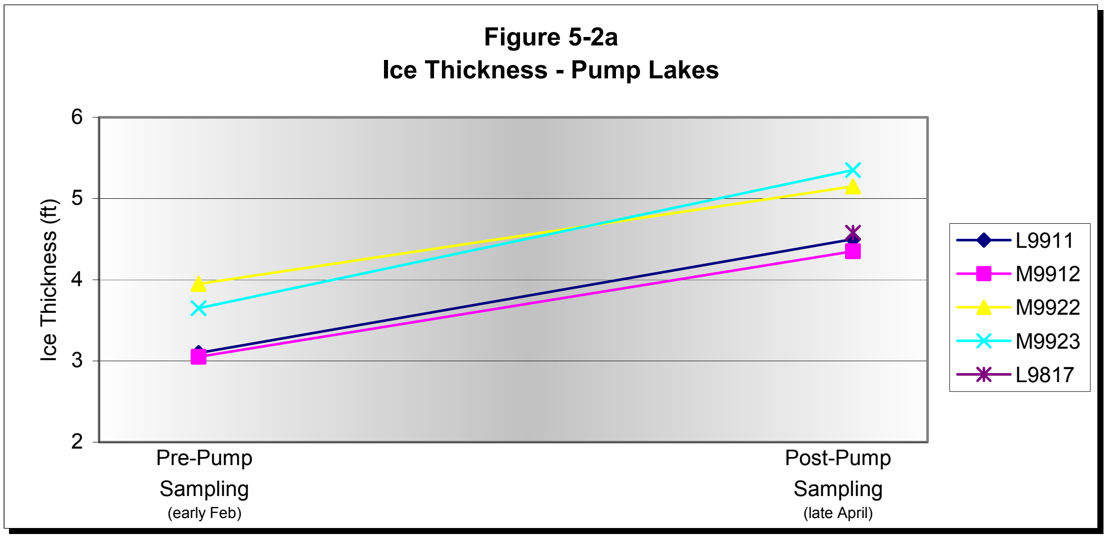


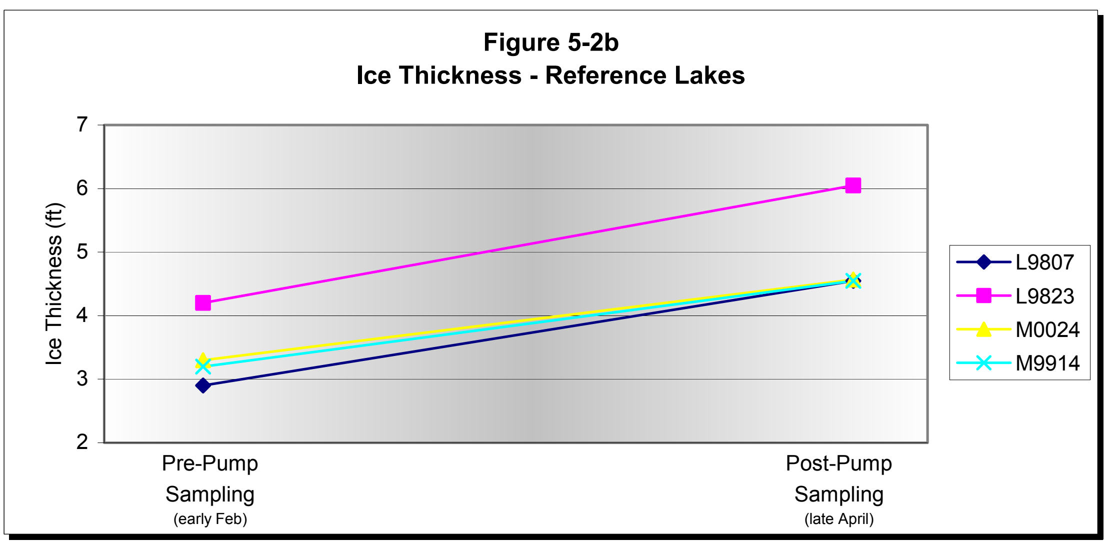
From Figures 5-1, a and b, it is clear that both pump and reference lakes had been recharged. After spring recharge, all lakes behaved similarly with respect to water loss.

5.1.2 Ice Thickness

Ice thickness measurements are presented in Appendix C, Table C-1, and are shown graphically in Figure 5-2, a and b.

Figure 5-2 Ice Thickness Comparison





Ice thicknesses measured at pump and reference lakes during the pre-pump and post-pump sampling events were comparable. The average ice thickness during the first sampling event was 3.44 feet at pump lakes and 3.40 feet at reference lakes. Average ice thicknesses at pump and reference lakes during the second sampling event were 4.84 and 4.93 feet, respectively. Average ice growth over the period was 1.40 feet in pump lakes and 1.53 feet in reference lakes.

5.1.3 Recharge Magnitudes and Mechanisms

Recharge of lakes in the NPR-A occurs through three mechanisms: melting of winter snow accumulations within a lake's drainage basin; overbank flooding from nearby streams; and rainfall precipitation. Of the three mechanisms, the first two are by far the most important in terms of the volume of lake recharge. None of the nine study lakes were affected by stream flooding in 2002. The melting of winter snow accumulations within each lake's drainage basin was therefore the dominant mechanism of recharge in the study lakes.

Magnitudes of spring recharge to the study lakes can be approximated by estimating volumes based on measured water surface elevation changes between the post-pump and breakup site visits (or between the post-pump and post-breakup site visits for lakes that could not be surveyed during the breakup site visit). These two events represent the lowest measured winter water levels and the highest measured spring water levels for each lake. Estimates of spring recharge magnitudes were developed by applying the magnitude of these water surface elevation changes to the surface area of each lake.

Table 5-2 presents estimates of recharge for the nine study lakes. The table also presents the volumes of water withdrawn from each pump lake, and the difference between that volume and estimated recharge. From Table 5-2 it can be seen that all pump lakes received spring recharge in excess of winter withdrawal volumes. Recharge and surplus volumes at each lake were calculated from discrete measurements and thus did not include that volume of excess water that entered and subsequently exited the lake during, and in the months following, breakup. Accordingly, recharge and surplus volumes shown on Table 5-2 should be viewed as minimum amounts and are presented to show that all pump lakes received recharge volumes in excess of that withdrawn.

Recharge mechanisms and paths of inflows and outflows were observed and documented by ground reconnaissance and aerial photography. Aerial photographs for each of the lakes are presented in Appendix B. Recharge observations are summarized below.

Table 5-2 Water Withdrawal and Spring Recharge Volumes

Lake	Water Surface Elevation (ft)				Lake Area[1] (acres)	Lake Volume[1] (mil gal)	Minimum Recharge Volume[2] (mil gal)	Total Withdrawal[3] (mil gal)	Minimum Surplus Volume (mil gal)
	Post-Pump	Breakup	Post-Breakup	Recharge					
PUMP LAKES									
L9911	68.35	68.67	--	0.32	540	464.6	56.3	1.2	55.1
M9912	40.64	41.63	--	0.99	33	27.6	10.6	10.0	0.6
M9922	49.88	50.83	--	0.95	191	108.6	59.1	1.6	57.5
L9923	57.44	--	57.96	0.52	252	175.9	42.7	3.3	39.4
L9817	53.98	--	54.96	0.98	75	72.2	23.9	17.3	6.6
REFERENCE LAKES									
L9807	28.40	28.65	--	0.25	94	83	7.7	0.0	7.7
L9823	24.88	25.31	--	0.43	5	6.4	0.7	0.0	0.7
M0024	56.95	57.26	--	0.31	139	108.8	14.0	0.0	14.0
M9914	47.16	47.56	--	0.40	127	106.8	16.6	0.0	16.6

Notes:
1. Data from Fish Utilization of Lakes in Eastern NPR-A: 1999-2000, Final Data Report, November 2000, MJM Research.
2. Based on water surface elevation changes.
3. January –May 2002. Data from PAI Extranet water use website (https://bizak.phillips66.com/water_use).
4. Recharge and surplus volumes are considered minimum amounts, as these values do not include recharge volumes that flowed into and subsequently out of the lakes.

Recharge: Pump Lakes

Lake L9911 (Refer to photos B-1, a-e): Recharge was due to local melt and runoff that was noted entering the lake on the southeast and north ends on June 2. Inflows were not noted during a September 10 site visit. No outflow point was identified prior to the September site visit when outflows estimated at approximately 45-110 gallons per minute (gpm)/0.1-0.25 cubic feet per second (cfs) were observed in a channel at the north end of the lake. Water surface elevations confirm that the lake was recharged to the point of overflow (see Table 5-2 and Figure 5-1a).

Lake M9912 (Refer to photos B-2, a-e): Recharge flows due to local melt/runoff were observed entering the northwest portion of the lake on June 2. No inflows were noted during a September 10 site visit. At times, a hydraulic connection existed between lakes M9912 into M9913. Although no flow was documented between the lakes on a June 28 site visit, an estimated outflow of approximately 450-900 gpm (1-2 cfs) from Lake M9912 was observed during the September site visit.

Lake M9922 (Refer to photos B-3, a-f): Recharge was due to local melt and runoff that was noted flowing into the east and west ends of the lake on June 2. Although no outflow point was identified during either of the two June site visits, water surface elevation measurements suggest that the lake was recharged to the point of overflow during the spring (see Table 5-2 and Figure 5-1a). On a September 10 site visit, an estimated outflow of approximately 450 gpm (1 cfs) was noted in a well-defined channel at the northeast corner of the lake. On the same site visit, an inflow of approximately 45-225 gpm (0.1-0.5 cfs) was observed coming from a marsh into the southeast corner of the lake.

Lake M9923 (Refer to photos B-4, a-d): Recharge was from local melt/runoff sources only. No outflow was observed until June 28 when flows were noted within an approximately 2-foot-wide channel that hydraulically connected Lake M9923 with the small oblong lake immediately to the north. Outflow within this channel was steady and estimated at approximately 5-10 gpm (0.01-0.02 cfs). No inflows or outflows were noted at the lake during a September 10 site visit.

Lake L9817 (Refer to photos B-5, a-c): Recharge due to local melt/runoff was observed flowing into Lake L9817 on June 2 from the area immediately southwest of the lake. No outlet was noted during any of the site visits but water surface elevations suggest that the lake was recharged to the point of overflow (see Table 5-2 and Figure 5-1a). Post-breakup water losses from the lake were likely in the form of shallow overland flows in the direction of the Ublutuoch River located just to the southeast. No inflows or outflows were noted at the lake during a September 10 site visit.

Recharge: Reference Lakes

Lake L9807 (Refer to photos B-6, a-e): Recharge was due to local melt/runoff, flow from a lake located immediately southwest of Lake L9807, and flow from a source area on the east side of the lake. A small but well-defined outlet channel between L9807 and the Nigliq Slough was identified on June 2. On that day flow in the channel was noted from the air only, and an estimate of the flow rate was not made. During a September 10 site visit, this channel was observed to have an estimated outflow of approximately 450-900 gpm (1-2 cfs) toward the Nigliq Slough.

Lake L9823 (Refer to photos B-7, a-e): Recharge due to local melt/runoff was noted flowing into the west end of the lake on June 2. On a September 10 site visit, inflow to the west end of the lake was observed at an estimated rate of approximately 45-225 gpm (0.1-0.5 cfs). Outflow towards the Ublutuoch River via a wide swale located on the southeast end of the lake was observed on June 2. Steady flow from the lake toward the river was again noted in the swale on June 28 when the flow rate was estimated at approximately 5 gpm (0.01 cfs), and on September 10 with an estimated flow of approximately 45-225 gpm (0.1-0.5 cfs).

Lake M0024 (Refer to photos B-8, a-e): A small channel was noted on the southeast end of the lake on June 2. Standing water was observed in this channel, however, water was not observed entering the lake. This channel appeared to be a potential recharge pathway. Water surface elevation measurements suggest that the lake was recharged to the point of overflow in the spring (see Table 5-2 and Figure 5-1b). During the September 10 site visit, inflows estimated at approximately 45-225 gpm (0.1-0.5 cfs) were noted in the small channel at the southeast end of the lake. Outflow from the northwest end of Lake M0024 toward a large lake immediately to the west was observed during the September site visit and, outflows estimated at approximately 45 gpm (0.1 cfs) or less were noted.

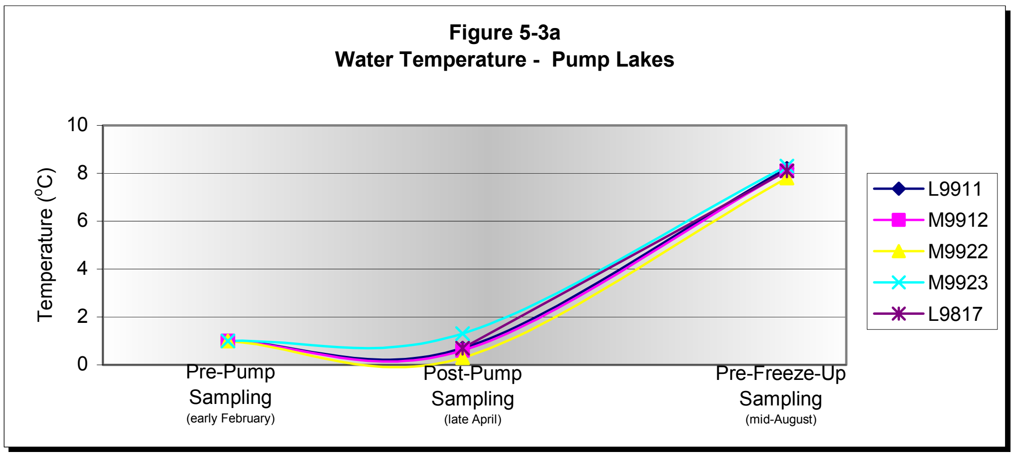
Lake M9914 (Refer to photos B-9, a-e): Active inflow recharge to Lake M9914 was noted on the south end of the lake on June 2. Spring recharge flows were the result of local melt/runoff and flowed primarily in a well-defined channel from Lake R0071, a small lake immediately to the south. No inflows were noted during a June 28 site visit, however, inflow at an estimated rate of approximately 450-1,350 gpm (1-3 cfs) was observed during a September 10 site visit. Outflow from the northeast end of the lake via a well-defined beaded channel was noted on the June 2, June 28, and September 10 site visits. Outflows estimated at approximately 900-2,250 gpm (2-5 cfs) were observed during the September 10 site visit.

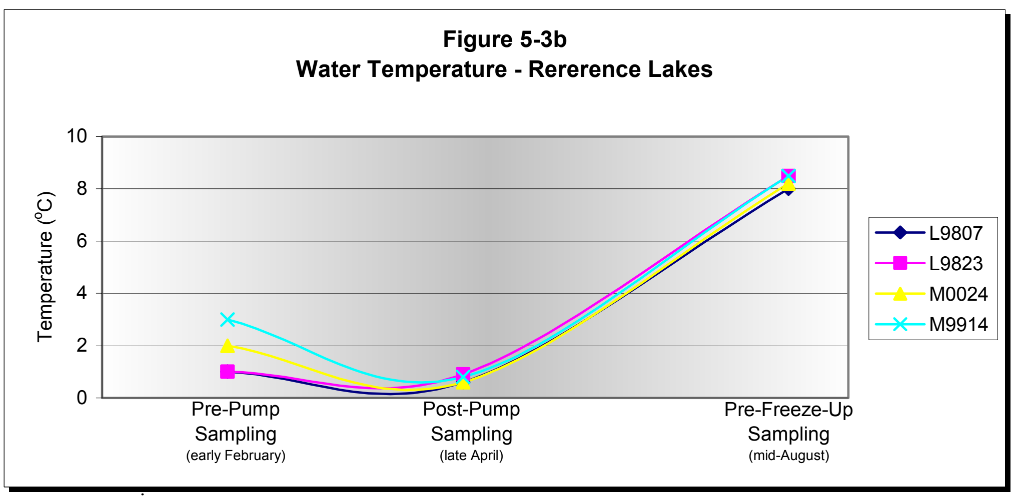
5.2 In Situ Parameters

5.2.1 Water Temperature

Graphical representations of water temperature measurements over the course of the investigation are shown in Figure 5-3, a and b. Temperature measurements are presented in tabular format in Appendix C.

Figure 5-3 Water Temperature Comparison



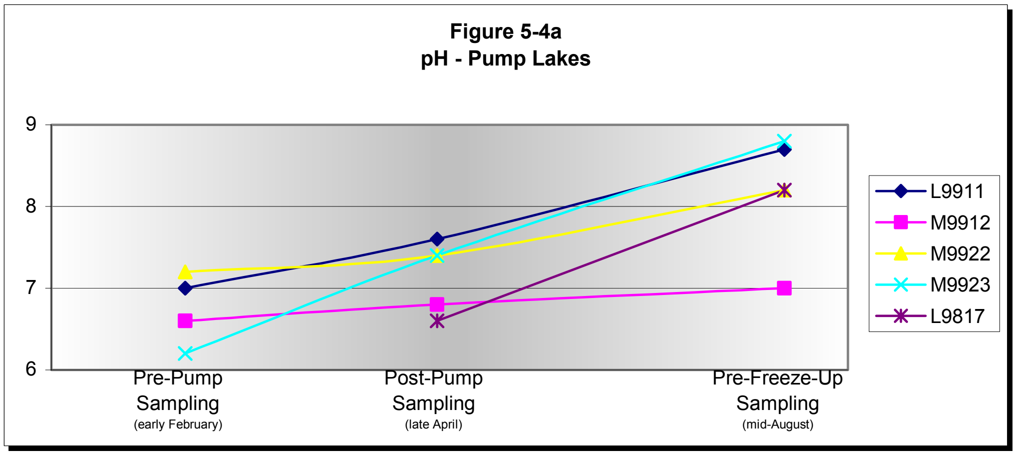


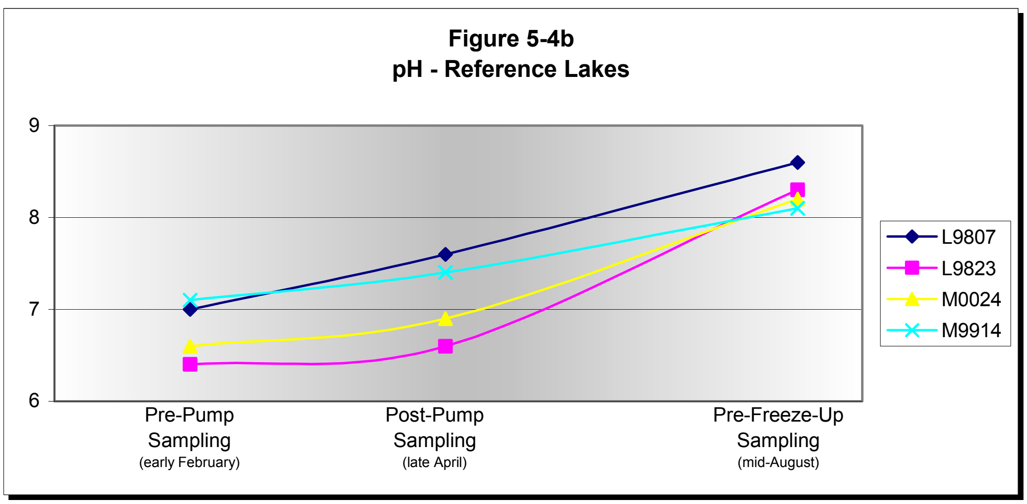
Pre-pump temperatures in pump lakes averaged 1.0°C while in reference lakes the pre-pump average was slightly warmer at 1.8°C. Post-pump temperatures in both pump and reference lakes averaged 0.72°C. The magnitude of seasonal warming of the lakes, as reflected in measurements made during the pre-freeze-up sampling event, were essentially equal between pump and reference lakes. Average late summer temperatures in pump lakes were 8.1°C. Reference lakes averaged slightly warmer at 8.3°C.

5.2.2 pH

Graphical representations of pH measurements over the course of the investigation are shown in Figure 5-4, a and b. Measured values of pH are presented in tabular format in Appendix C.

Figure 5-4 pH Comparison





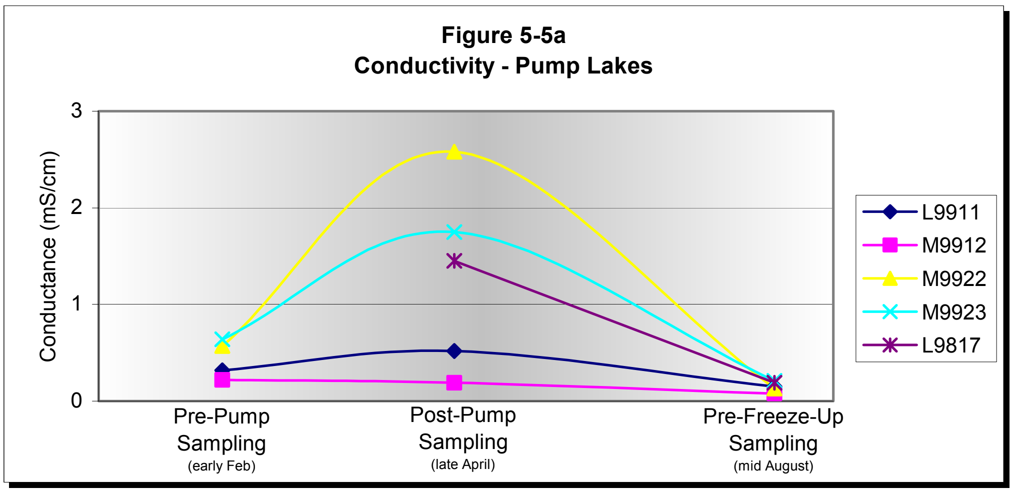
As seen on Figure 5-4, pH values ranged from 6.2 to 8.8 in pump lakes and from 6.4 to 8.6 in reference lakes. Between the pre-pump and pre-freeze-up sampling events, pH values increased slightly. Increases in pH at pump and reference lakes appear to be comparable.

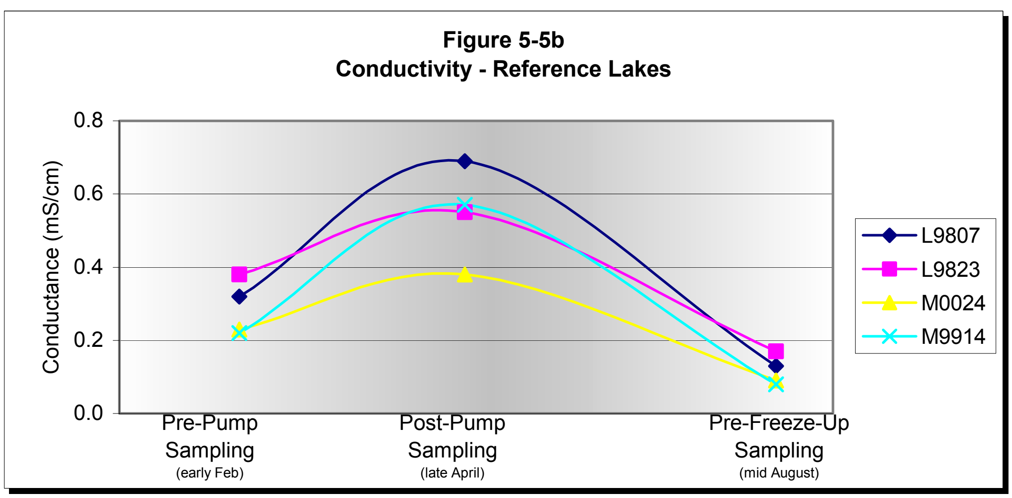
Between the pre-pump and pre-freeze-up sampling events, pH values at all lakes experienced gradual increases. Pump lake pH increased an average of 1.43 while pH at reference lakes increased an average of 1.52. Similar incidences of increases in pH have been documented by previous investigations (URS, 2001 and Oasis, 2001).

5.2.3 In Situ Conductivity

Graphical representations of in situ conductivity measurements over the course of the investigation are shown in Figure 5-5, a and b. Measured values are presented in tabular format in Appendix C. From Figure 5-5 it can be seen that, in all lakes, conductivity values increased between the pre-pump and post-pump sampling events, and then decreased to below pre-pump values by the time pre-freeze-up sampling was performed.

Figure 5-5 Conductivity Comparison





During the investigation, conductivity was typically measured in situ. During the post-pump sampling event, however, higher than expected measured values of in situ conductivities prompted collection of grab samples for analytical verification at all locations. The discussion in the remainder of this section is subdivided accordingly.

In Situ Conductivity

In situ conductivity generally tended to increase over the winter as the thickening of ice increased dissolved constituent concentrations in the free water. The magnitude of increases in two of the pump lakes, M9922 and M9923, were approximately an order of magnitude greater than increases in each of the reference lakes. These lakes were the two shallowest pump lakes and were ranked #3 and #4 in terms of water withdrawal.

Analytical Conductivity

Analytical conductivity results are comparable to in situ measurements with one exception. During the post-pump sampling event, a conductivity of 0.2 mS/cm was read with the Horiba in situ meter at Lake M9912. Lab analyses of the grab sample from that lake, however, indicated a conductance of 6.0 mS/cm, a concentration nearly 32 times that of the in situ value. The reason for the disparity is unknown, but the lab result is suspect for several reasons:

1. All other in situ and analytical parameters at Lake M9912 appear to have measured within normal ranges during the post-pump sampling event;
2. Conductivity in other lakes tended to increase and decrease in direct proportion to salinity concentrations over the course of the investigation (see Appendix C, Lake M9922). In situ salinity concentration in Lake M9912, however, measured at 0.0 mg/L during the post-pump sampling event;
3. Conductivity can be used to make a rapid estimate of the amount of dissolved solids in water; total dissolved solids concentrations were not noted as being abnormally high during the sampling event (see Section 5.3 and Appendix C); and
4. A concentration of 6.0 mS/cm would mean that the lake had a conductance that was roughly six times that of ordinary distilled water (about 1.0 mS/cm) or about one-eighth that of seawater (approximately 50 mS/cm) (Hem, 1989).

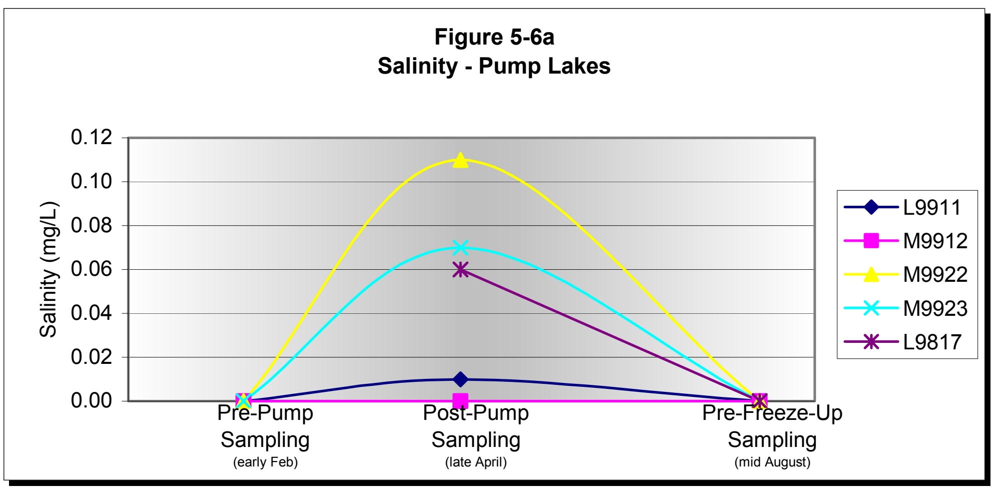
Based on the above qualitative and quantitative evidence, it is considered to be a very high probability that the analytical sample from Lake M9912 was compromised or contaminated in some way, either during collection, or during analysis, and should be disregarded.

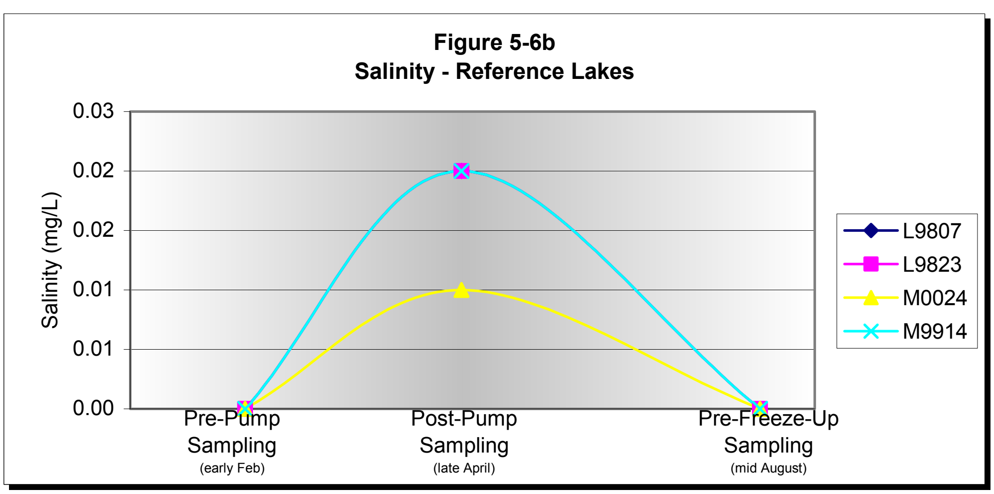
5.2.4 Salinity

Graphical representations of salinity measurements over the course of the investigation are shown in Figure 5-6, a and b. Measured salinity values are presented in tabular format in Appendix C.

With the exception of pump Lake M9912, both pump and reference lakes saw increases in salinity concentrations during the winter that were proportional to increases in conductance during the same period. The salinity concentration increase in one of the pump lakes, M9922, was an order of magnitude greater than increases seen in the other pump and reference lakes. As previously discussed, of the five study lakes, M9922 was rated fourth in terms of volume removed. With a maximum depth of 5.3 feet (MJM, 2000), it was also the shallowest of the pump lakes.

Figure 5-6 Salinity Comparison

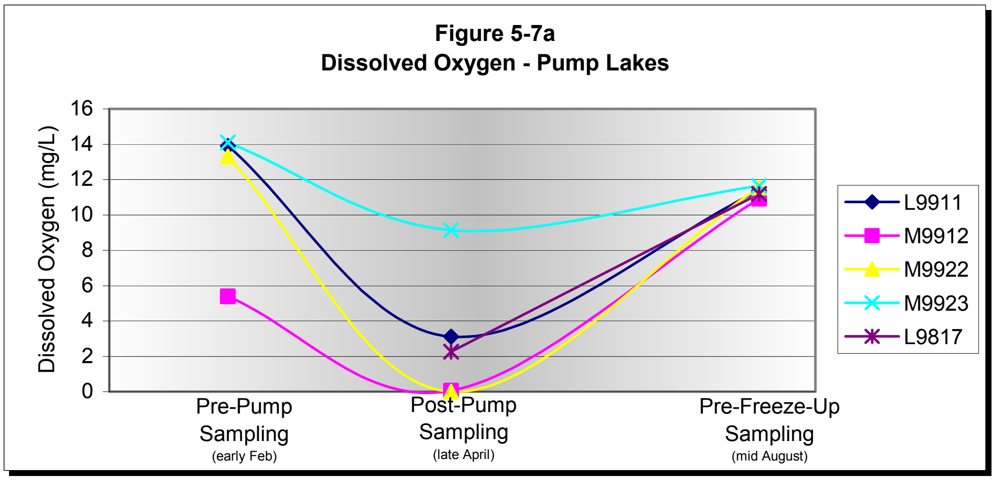


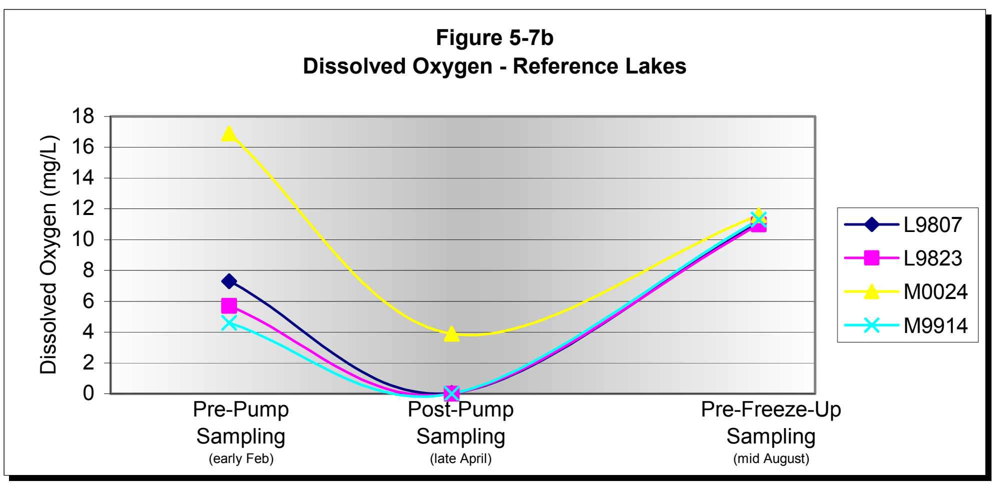


5.2.5 Dissolved Oxygen

Graphical representations of dissolved oxygen measurements over the course of the investigation are shown in Figure 5-7, a and b. Measured values of dissolved oxygen are presented in tabular format in Appendix C.

Figure 5-7 Dissolved Oxygen Comparison





The nature of the trends measured in dissolved oxygen concentrations was comparable between pump and reference lakes. In all lakes, dissolved oxygen was seen to decrease as ice thickness increased. The magnitudes of the decreases were similar in pump and reference lakes. Between the pre- and post-pump sampling events, pump lakes showed an average decrease of 8.6 mg/L while reference lake decreases averaged 7.6 mg/L.

Pump lakes appear to have remained more oxygenated through the mid-winter period; with average post-pump dissolved oxygen concentrations of 2.9 mg/L, which is nearly three times the average concentration of 1.0 mg/L measured in reference lakes. Higher levels of oxygenation in pump lakes may be a result of pumping methods used by the ice road subcontractor. In portable pumphouses, an approximately 2-inch recirculating line pulled water from the pump manifold and returned it to the lake to keep the hole in the ice open. The line, which ran 24 hours a day whenever the pumphouse was on the lake, may have acted like a bubbler in a fish tank, providing a constant source of highly oxygenated water to the lake.

Once the lakes became ice free, dissolved oxygen concentrations rebounded strongly and consistently in all lakes. During the pre-freeze-up sampling event, measured dissolved oxygen concentrations in pump and reference lakes were all within 0.7 mg/L of each other.

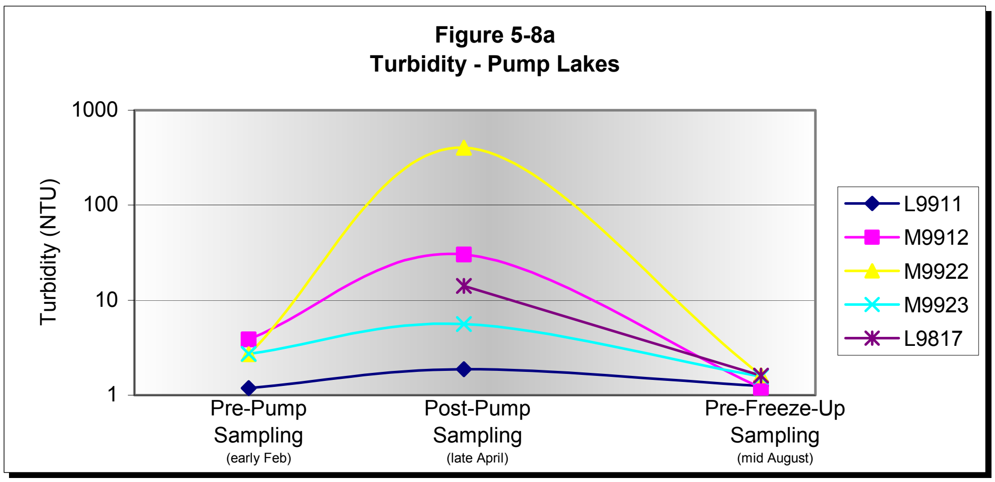
5.2.6 Turbidity

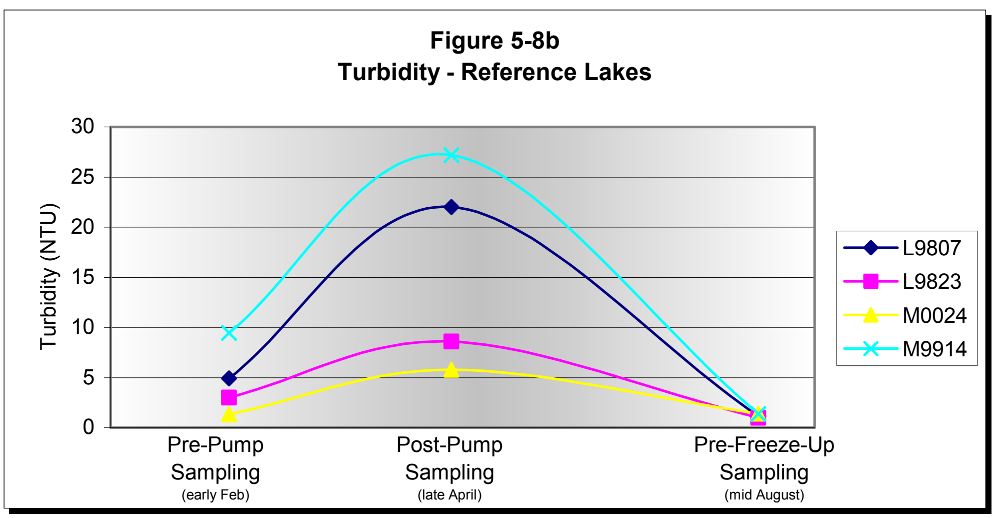
As previously discussed, turbidity measurements were made both in situ, using the Horiba, and ex situ using a Hach 2100P turbidimeter. The in situ method proved to be extremely unreliable and typically resulted in error messages, negative values, or other unusable data. Results from the turbidimeter appeared to be of good quality both in terms of accuracy and precision. As a result of the inconsistencies noted with the Horiba, all in situ data have been disregarded and subsequent turbidity discussions focus on data that were measured ex situ with the turbidimeter.

Graphical representations of turbidity measurements over the course of the investigation are shown in Figure 5-8, a and b. Measured turbidity values are presented in tabular format in Appendix C.

Turbidity increased in all lakes between the pre-pump and post-pump sampling events. The magnitude of turbidity increases between pump and reference lakes were comparable, with one notable exception. At Lake M9922, the post-pump turbidity was approximately thirteen times higher than the next highest turbidity measured in any of the other study lakes during that sampling event. This anomalous increase can almost certainly be attributed to a sampling artifact, namely ice auger impact with the relatively soft lake bottom. On the day that the anomalous measurement was taken, total water depth at Lake M9922 was 5.57 feet and the ice was 5.15 feet thick. Thus, free water was less than one-half foot deep. Field documentation of the sampling event substantiates the auger impact hypothesis. According to field notes, the impact of the auger was such that sampling personnel bailed water from the borehole in an attempt to collect a representative sample. It does not appear that a representative sample was obtained, however, based on this, the data from Lake M9922 can arguably be disregarded.

Figure 5-8 Turbidity Comparison





If the measurement at Lake M9922 is disregarded, trends in turbidity at pump and reference lakes appears to have increased similarly. Pump lakes increased an average of 10 NTU, while turbidity at reference lakes increased an average of 25 NTU. Once ice cover at the lakes had melted, turbidity in all lakes decreased similarly to values that were between 1.0 and 1.6 NTU.

5.3 Analytical Parameters

5.3.1 Metals

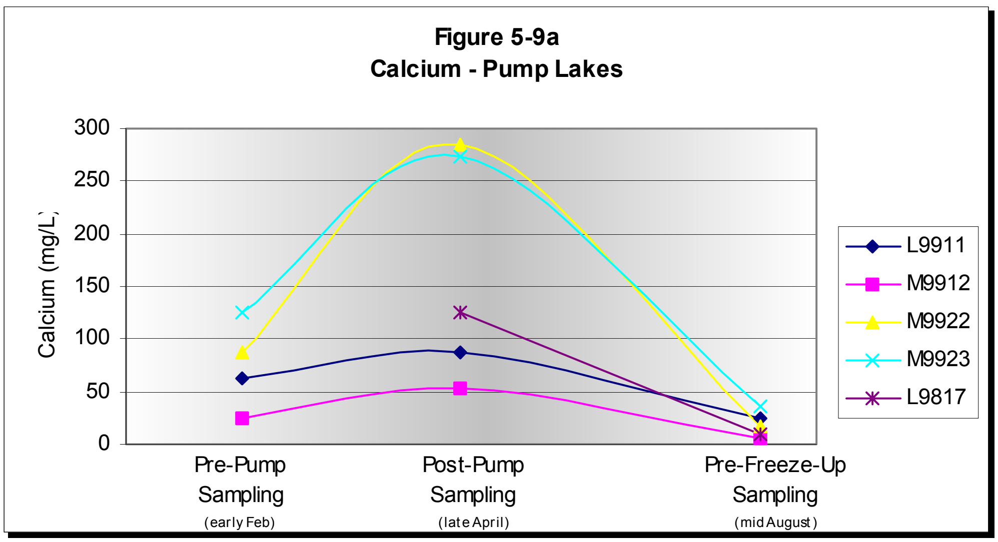
The metals program included laboratory analyses of calcium, magnesium, sodium, potassium, and iron. All metals analyses were completed as total metals. Accordingly, samples were collected in unpreserved containers and were not field-filtered.

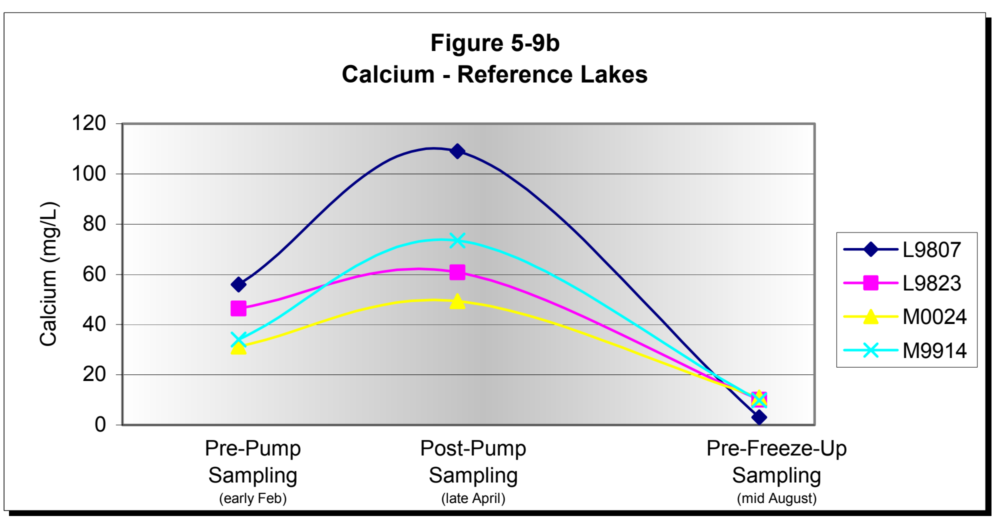
Graphical representations of the above metals concentrations over the course of the investigation are shown in Figure 5-9 through Figure 5-13. Measured values are summarized in tabular format in Appendix C, and copies of the laboratory reports are provided in Appendix D. Dissolved constituents are excluded during the formation of ice. Analyte concentrations, therefore, increased in direct proportion to ice formation.

Calcium

Pre-pump calcium concentrations were generally higher in pump lakes than in reference lakes. Increases in calcium concentrations were noted between the pre- and post-pump sampling events at all lakes. Pump lakes M9922 and M9923, the two shallowest pump lakes, showed the highest calcium increases with measured increases of 199 and 149 mg/L, respectively. The highest calcium increase in a reference lake, 53 mg/L, was seen at Lake L9807. Overall, increases in pump lakes between the pre-pump and post-pump sampling events averaged approximately 100 mg/L, while increases in reference lakes averaged about 31 mg/L. By August, calcium concentrations at all lakes had decreased to below pre-pump levels.

Figure 5-9 Calcium Comparison

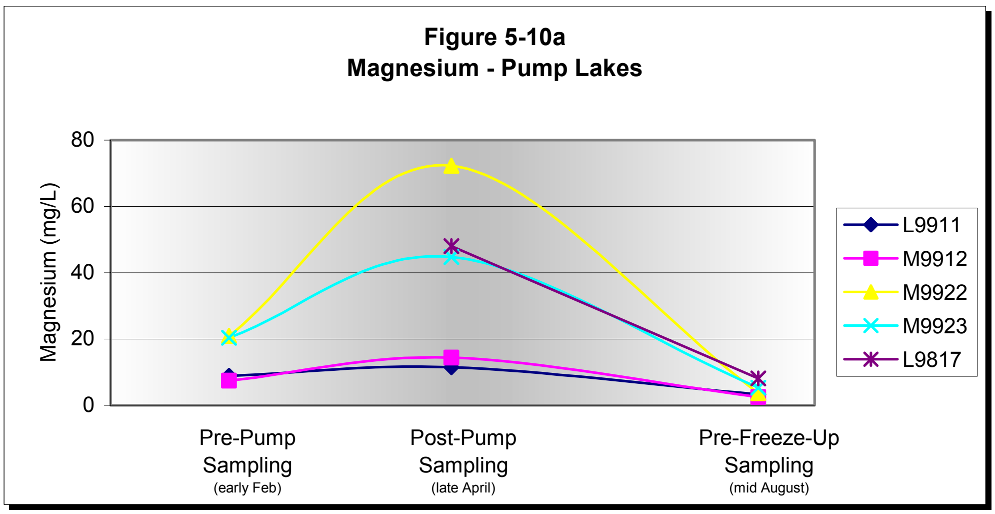


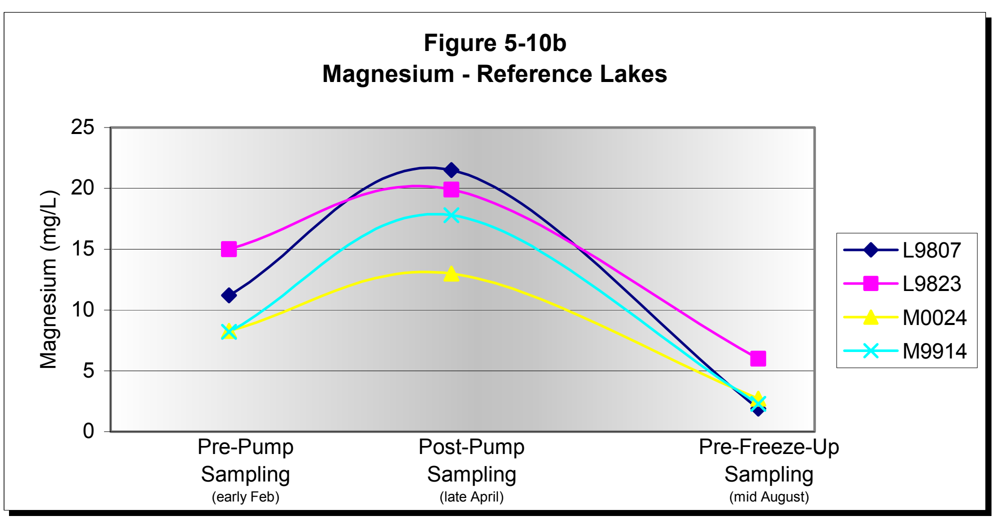


Magnesium

Pre-pump magnesium concentrations were generally comparable in pump and reference lakes. Magnesium concentration increases ranging from 2.6 to 51.3 mg/L were observed in pump and reference lakes between the pre-pump and post-pump sampling events. The highest increases in analyte concentration were seen in the shallowest pump lakes, M9922 and M9923. Overall, increases in pump lakes between the pre-pump and post-pump sampling events averaged roughly 21 mg/L, while increases in reference lakes averaged about 7 mg/L. By August, magnesium concentrations in all lakes had decreased to below pre-pump levels.

Figure 5-10 Magnesium Comparison

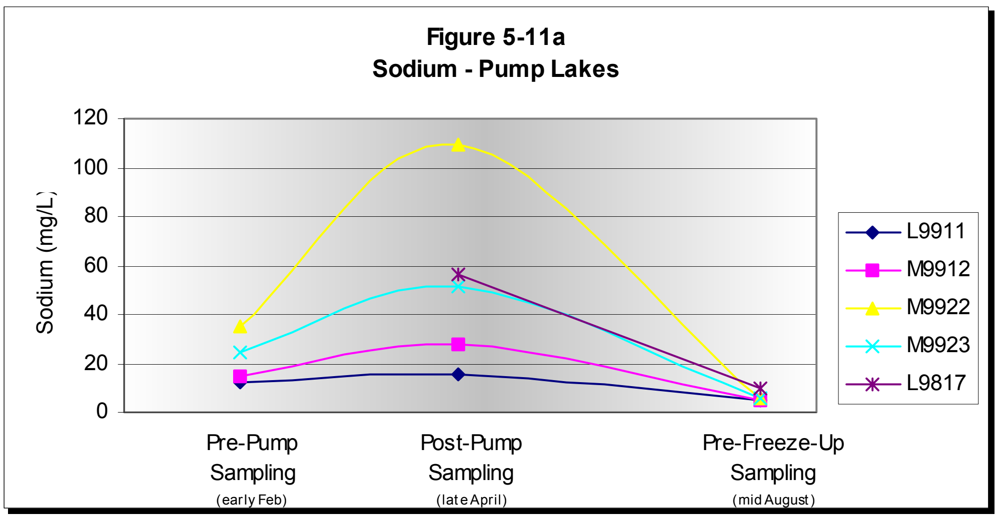


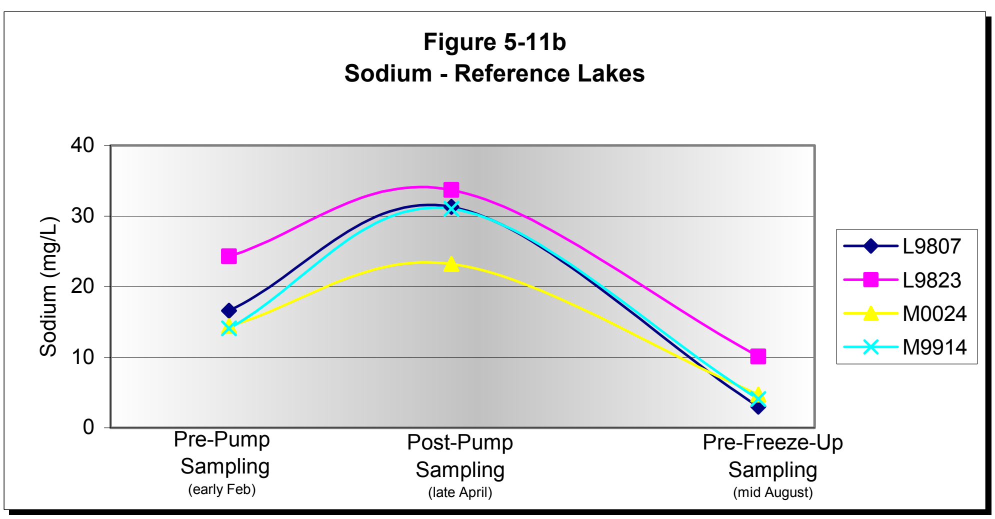


Sodium

Pre-pump sodium concentrations in pump lakes were comparable to those in reference lakes. Concentration increases between the pre-pump and post-pump sampling events at pump lakes were comparable to increases at reference lakes with one exception. While sodium concentration increases in all other lakes ranged from 3 to 27 mg/L, the concentration at Lake M9922, the shallowest pump lake, increased almost 74 mg/L. Overall, increases in pump lakes between the pre-pump and post-pump sampling events averaged roughly 29 mg/L, while increases in reference lakes averaged about 12 mg/L. By August, sodium concentrations in all lakes had decreased to below pre-pump levels.

Figure 5-11 Sodium Comparison

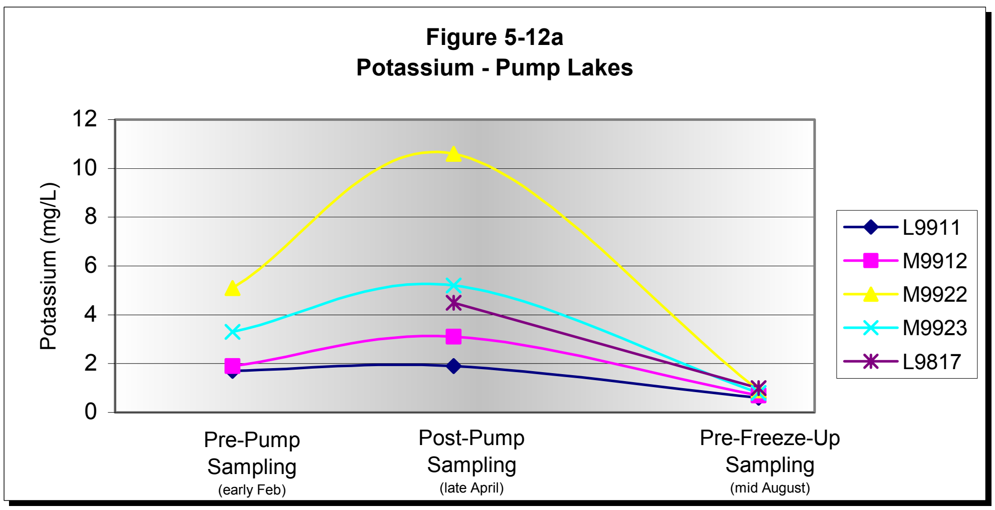


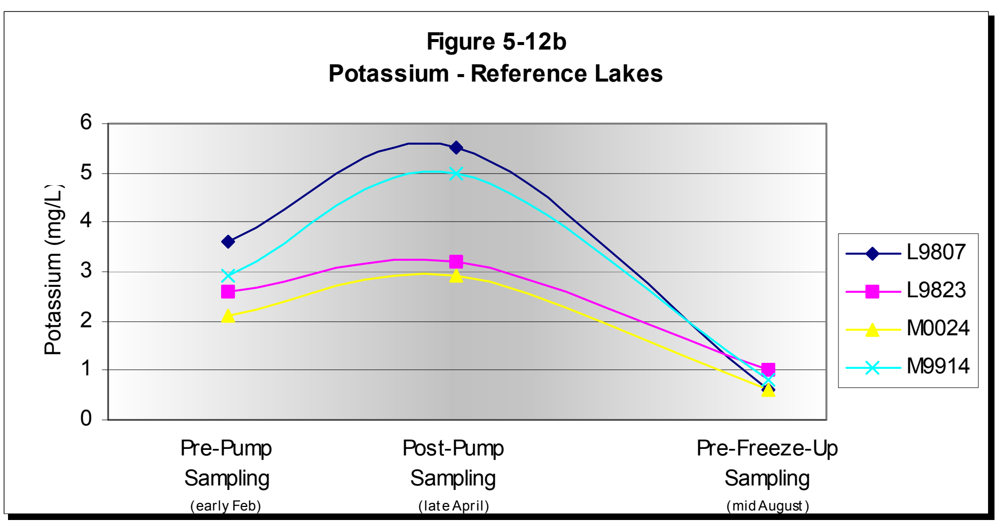


Potassium

Pre-pump potassium concentrations in pump lakes were comparable to those in reference lakes. Increases in potassium concentrations were noted between the pre-pump and post-pump sampling events at all lakes. The most significant increase was again seen at the shallowest pump lake, M9922, where potassium levels rose 5.5 mg/L. In other lakes, increases ranged from 0.2 to 2.1 mg/L. Overall, increases between the pre-pump and post-pump sampling events in pump lakes averaged roughly 2.2 mg/L, while increases in reference lakes averaged about 1.4 mg/L. By August, potassium concentrations at all lakes had decreased to below pre-pump levels.

Figure 5-12 Potassium Comparison

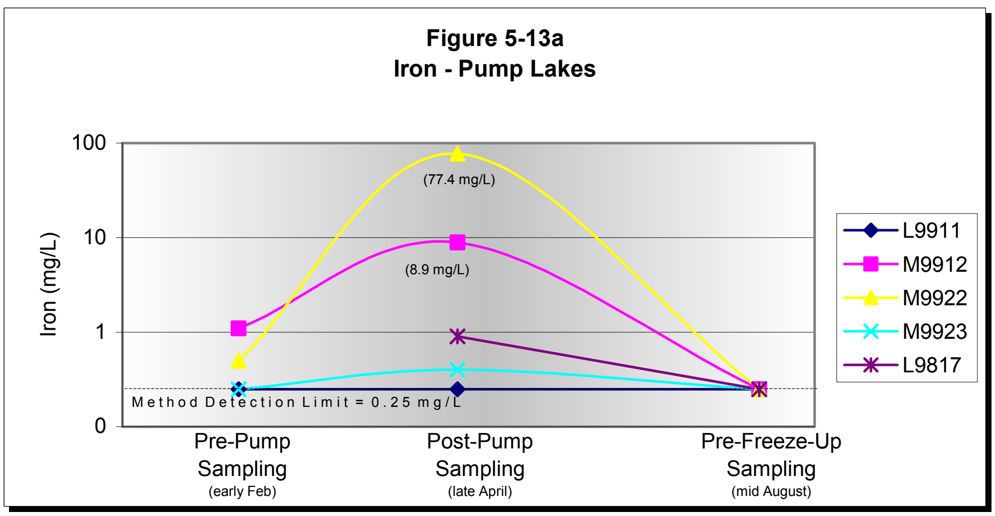


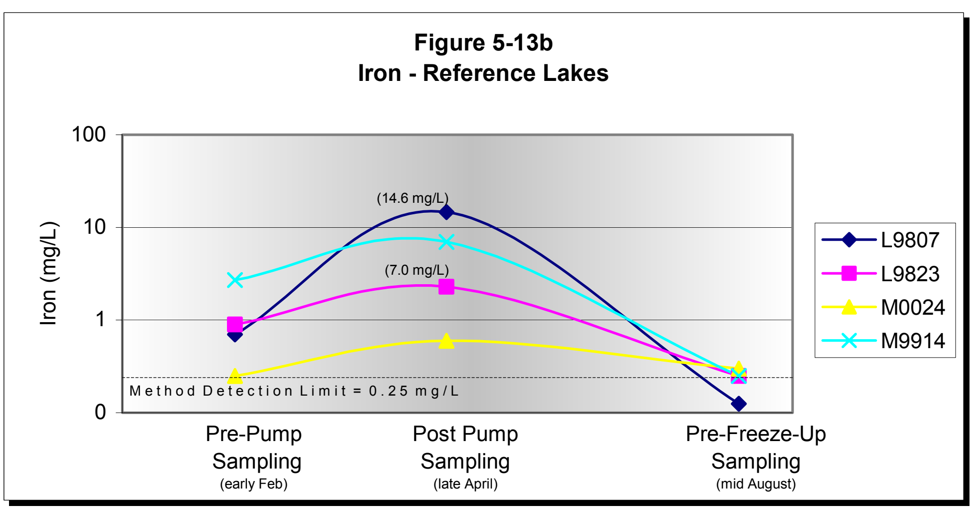


Iron

During the pre-pump sampling event, three of the eight study lakes measured had iron concentrations below the method detection limit of 0.25 mg/L. Iron concentrations at the five remaining lakes were relatively low, ranging from 0.5 to 2.7 mg/L. Concentration increases between the pre-pump and post-pump sampling events were noted at all lakes except one pump lake, L9911. Lake L9911 was the second deepest pump lake, and was the least pumped lake in the study. The highest iron concentration increase between the pre-pump and post-pump sampling events (76.9 mg/L) was measured at the shallowest pump lake, M9922. Increases at other lakes ranged from 0.15 to 13.9 mg/L. By August, iron concentrations at eight of the nine study lakes were below the method detection limit of 0.25 mg/L.

Figure 5-13 Iron Comparison





5.3.2 Anions

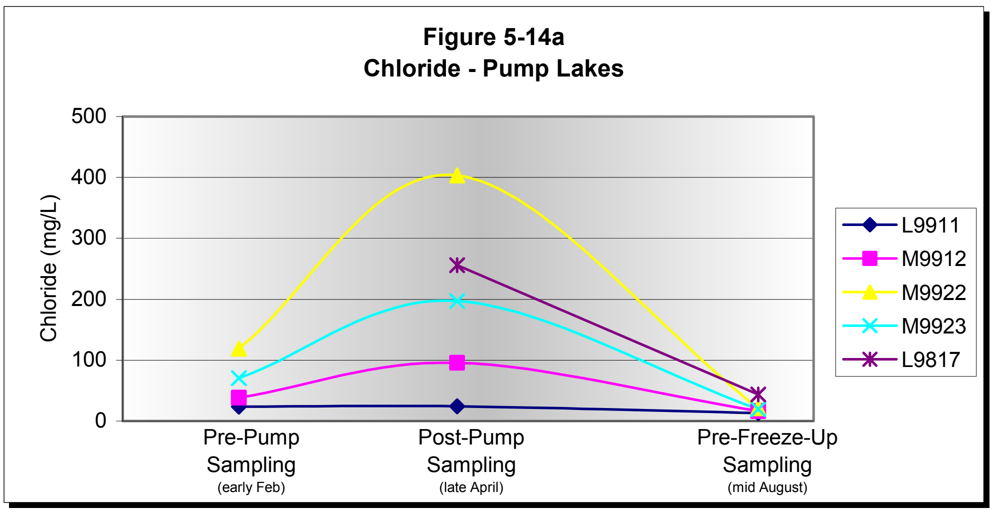
The anions program included laboratory analyses of chloride, sulfate, and nitrate.

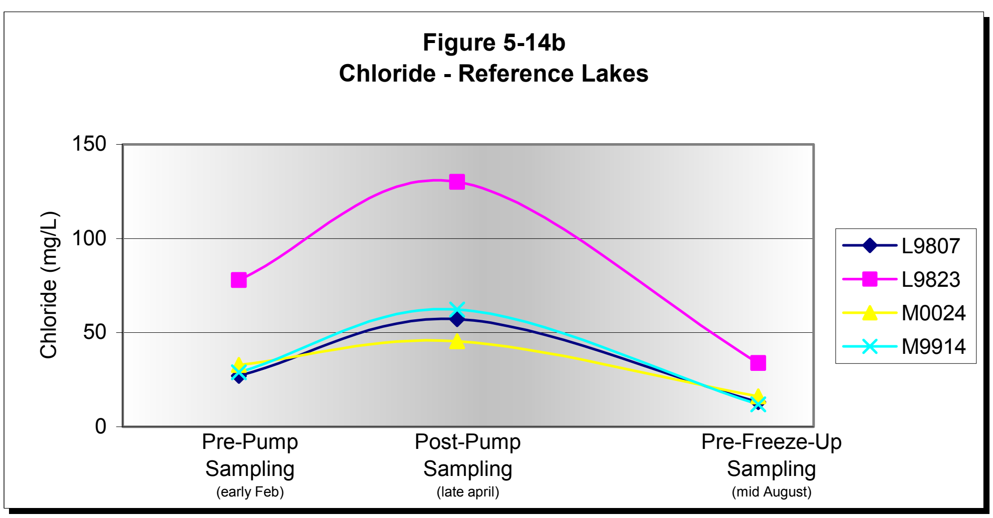
Graphical representations of concentrations of the above anions over the course of the investigation are shown in Figure 5-14 through Figure 5-16. Measured values are summarized in tabular format in Appendix C, and copies of the laboratory reports are provided in Appendix D. Overall, anion concentration trends were comparable between pump and reference lakes. Similar to metals concentrations, anion concentration increases were directly proportional to ice formation.

Chloride

With one exception, pre-pump chloride concentrations in pump lakes were comparable to those in reference lakes. The exception was at the shallowest pump lake, M9922, where the chloride concentration was significantly higher than concentrations measured in the other lakes. The magnitude of chloride concentration increases between pre-pump and post-pump sampling events were more typical of increases seen in total metals and in situ parameters. Overall, chloride increases in pump lakes averaged 117 mg/L, with the most significant increases again observed in the two shallowest lakes, M9922 and M9923. Average chloride increases in reference lakes averaged about 32 mg/L. The highest chloride concentration increase in reference lakes was observed in the deepest lake, L9823.

Figure 5-14 Chloride Comparison

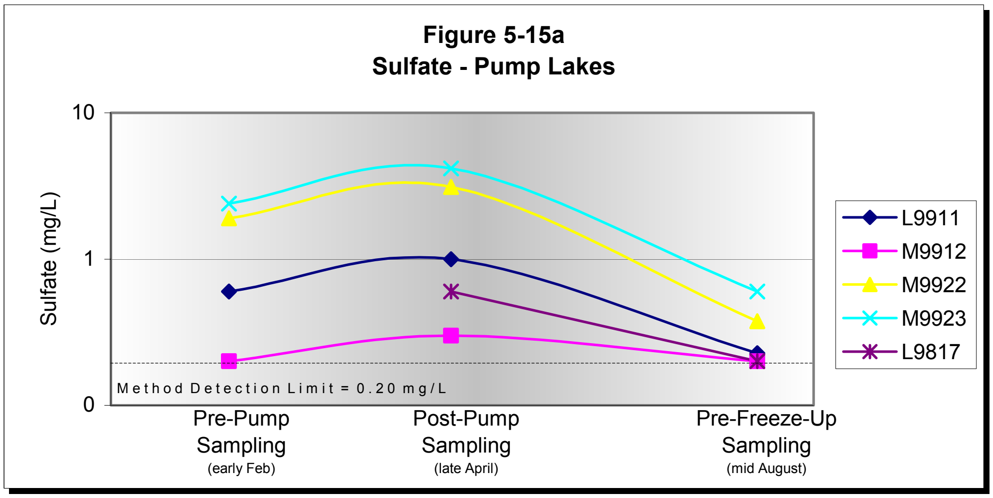


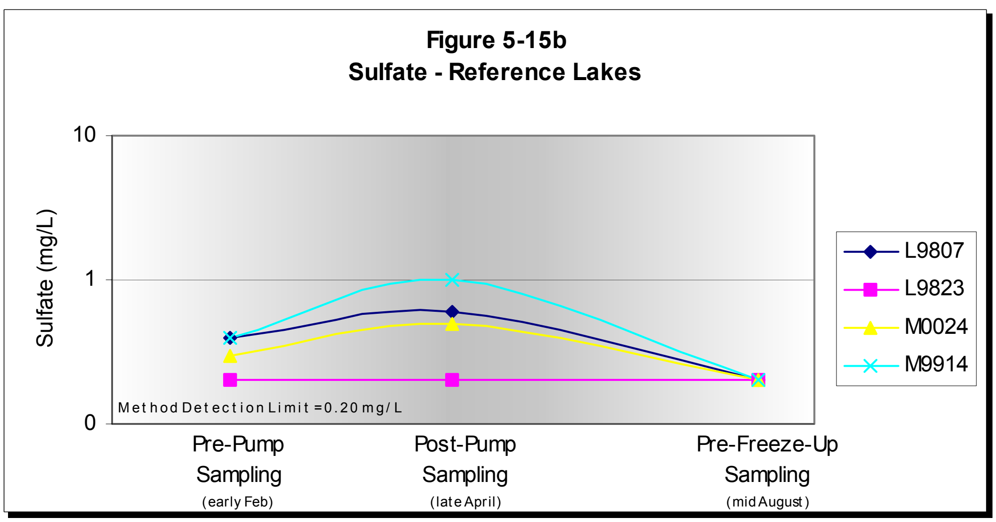


Sulfate

Sulfate concentration increases between the pre-pump and post-pump sampling events, which ranged from 0.0 to 1.8 mg/L in pump and reference lakes, were small. The trends, however, between pump and reference lakes were similar.

Figure 5-15 Sulfate Comparison

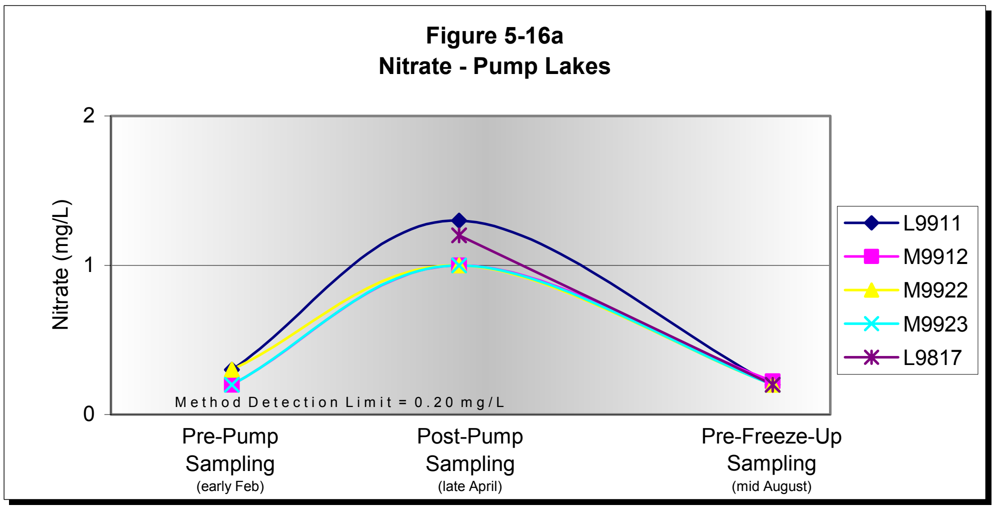


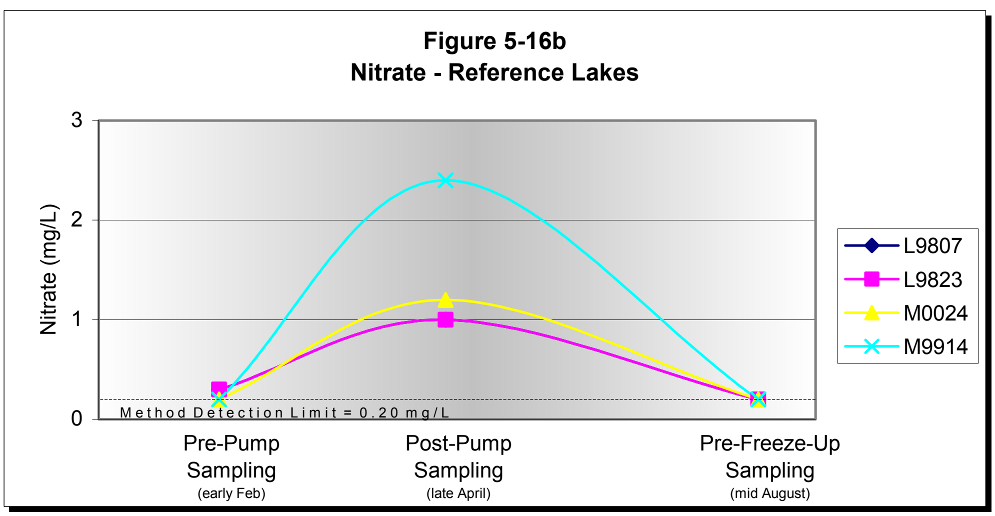


Nitrate

Changes in nitrate concentration, all of which were 2.2 mg/L or less, were small. Both pump and reference lakes followed similar trends.

Figure 5-16 Nitrate Comparison





5.3.3 Biochemical Oxygen Demand

With the exception of low-level post-pump sampling detections at pump lake M9922 and reference lake L9807, biochemical oxygen demand (BOD) results were non-detect at all lakes over the course of the investigation (Appendix C).

Meeting the 48-hour holding time was an issue with BOD analyses. During the planning stages of the investigation the issue of holding times was discussed with the contract analytical laboratory, CT&E Environmental Services, Inc. (CTE). Because of the remote nature of the lakes in NPR-A, and because flights out of Alpine are often affected by inclement weather, there was a concern that the BOD holding time might be difficult to meet.

CTE chemists stated that the validity of a given BOD sample should not be considered compromised, even though the holding time is exceeded, as long as the sample remains properly chilled throughout the collection, storage, and transport phases of the sampling process.

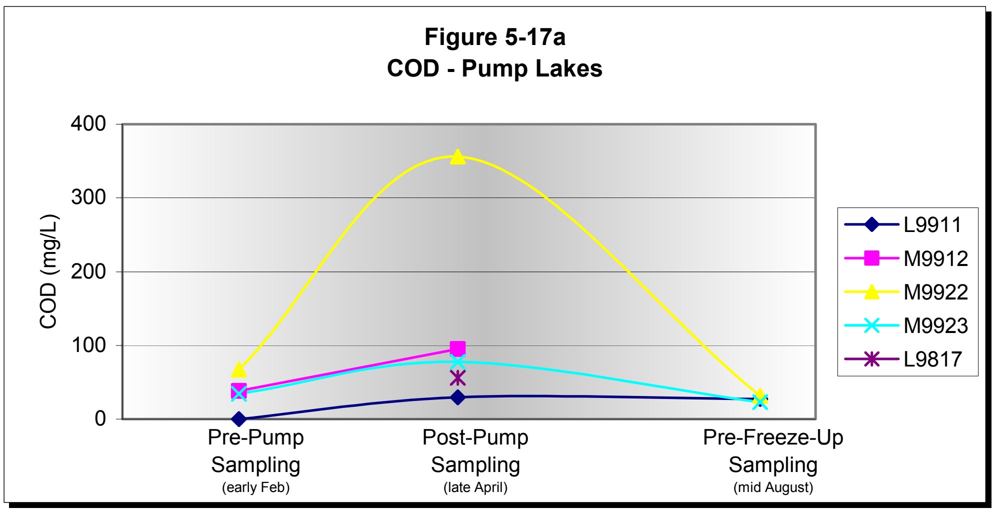
The holding time for BOD was exceeded on a number of samples during the mid-winter stages of the investigation. During the pre-pump and post-pump sampling events, BOD holding time was exceeded on six and nine samples, respectively. During the pre-freeze-up sampling event, however, BOD holding time was met on all samples. During all sampling events, samples were collected, stored, and transported under strict chain-of-custody procedures and were properly cooled at all times. Upon delivery, laboratory personnel confirmed by temperature blank that sample temperatures were within the range specified for optimum sample preservation.

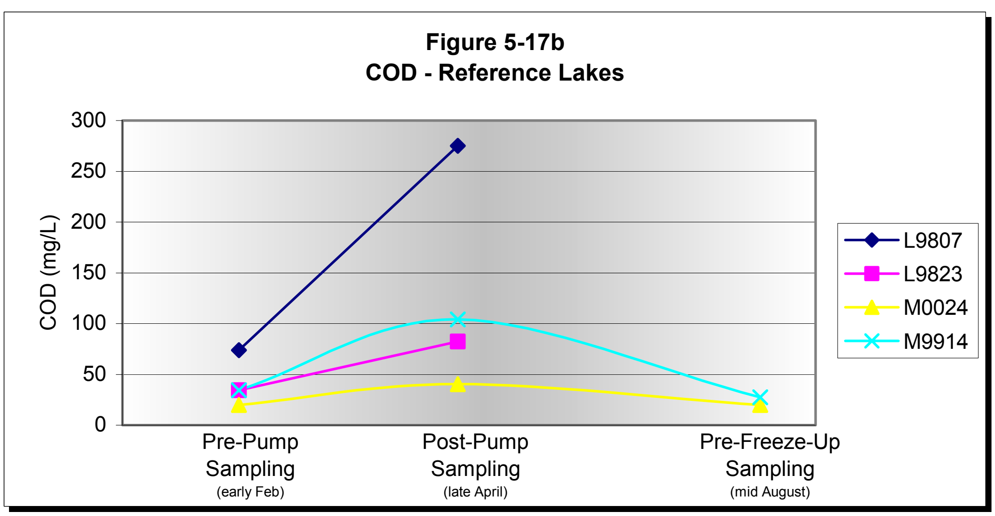
5.3.4 Chemical Oxygen Demand

Graphical representations of chemical oxygen demand (COD) measurements over the course of the investigation are shown in Figure 5-17, a and b. Measured COD values are presented in tabular format in Appendix C.

Pre-freeze-up COD concentrations for two pump and two reference lakes are not shown on Figure 5-17, a and b. The data are unavailable since analyses of COD were inadvertently not requested at those lakes.

Figure 5-17 Chemical Oxygen Demand (COD) Comparison

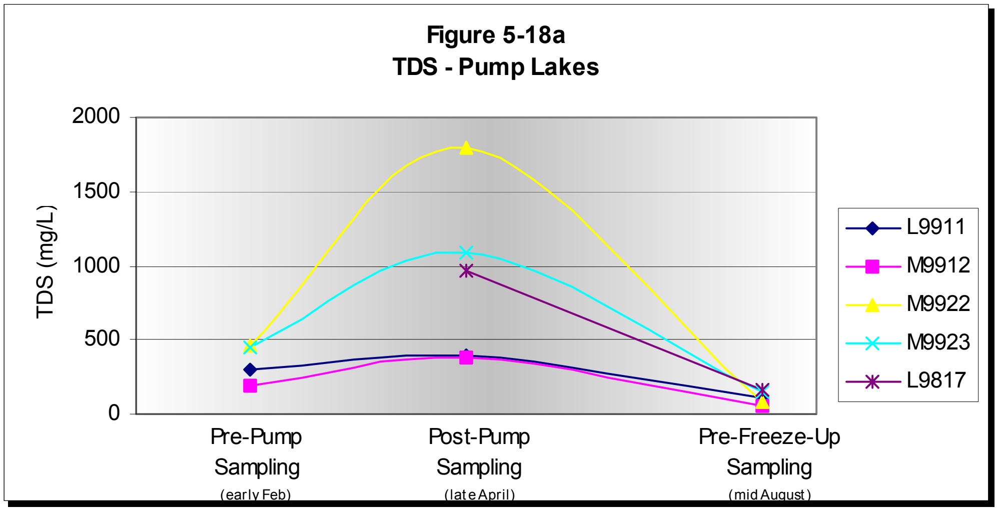


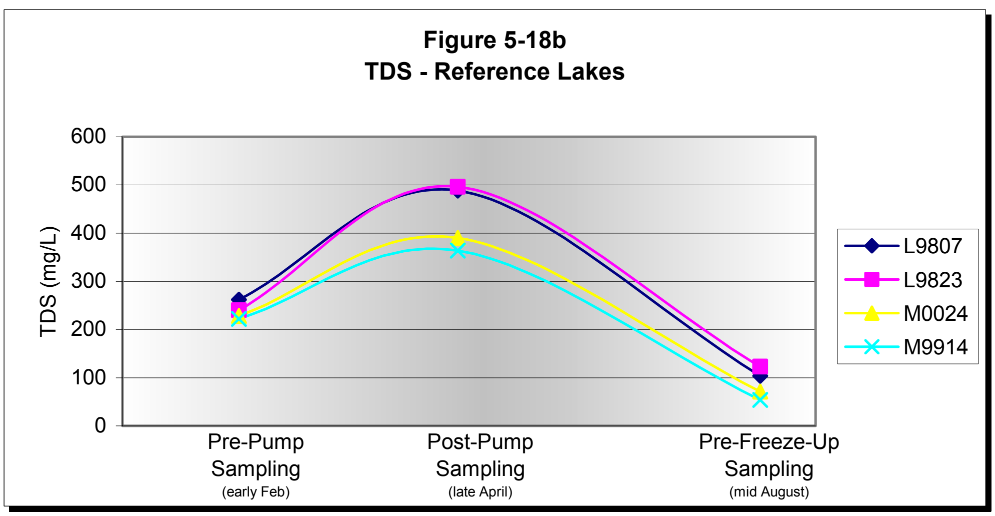


5.3.5 Total Dissolved Solids

Graphical representations of total dissolved solids (TDS) measurements over the course of the investigation are shown in Figure 5-18, a and b. Measured TDS values are presented in tabular format in Appendix C.

Figure 5-18 Total Dissolved Solids (TDS) Comparison



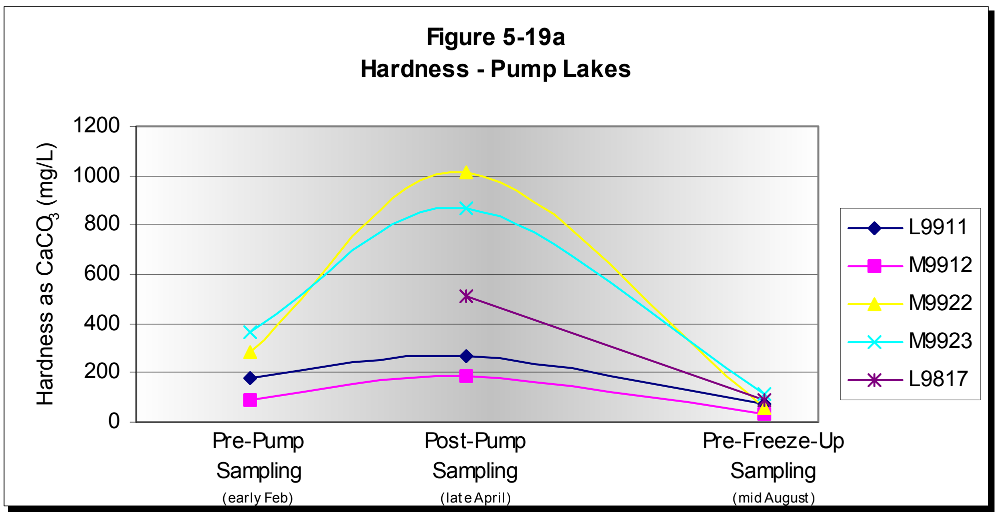


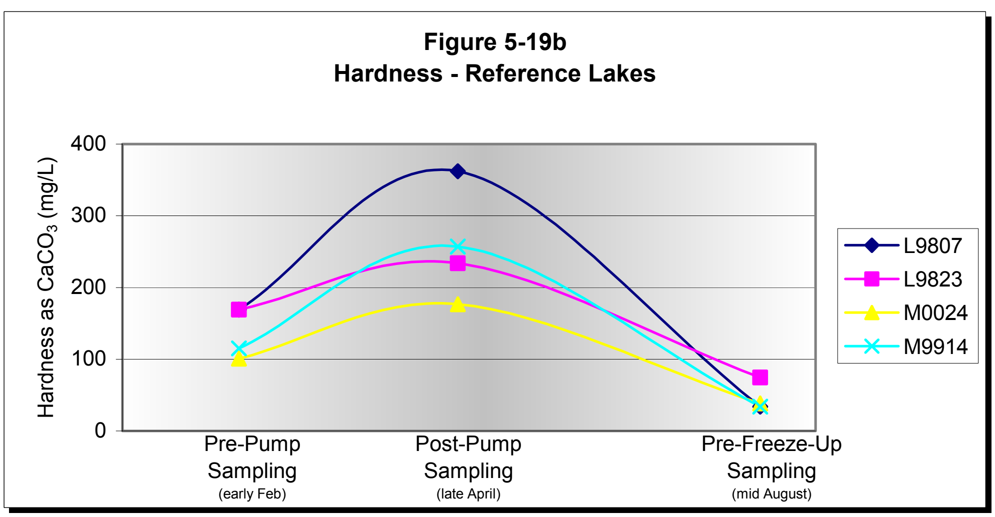
With two exceptions, pre-pump TDS concentrations in pump lakes were similar to those in reference lakes. The exceptions were at the two shallowest pump lakes, M9922 and M9923, where TDS concentrations were roughly double those in other pump and reference lakes. TDS increases between pre-pump and post-pump sampling events were noted at all lakes, with the average increase at pump lakes nearly three times that seen in reference lakes. The shallowest pump lakes represented locations of highest increase. Pump lakes M9922 and M9923 showed increases of 1330 and 640 mg/L, respectively. Increases at the two other measured pump lakes, L9911 and M9912, were 96 and 183 mg/L, respectively. TDS concentration increases over the same period at reference lakes were comparable with the deeper pump lakes, ranging from 142 to 256 mg/L. By August, TDS concentrations at all lakes had decreased to below pre-pump levels.

5.3.6 Hardness

Hardness of natural water is measured as the total concentration of calcium and magnesium ions expressed as calcium carbonate. Graphical representations of hardness over the course of the investigation are shown in Figure 5-19, a and b. Measured hardness values are presented in tabular format in Appendix C.

Figure 5-19 Hardness Comparison





With two exceptions, pre-pump hardness values in pump lakes were comparable to those in reference lakes. The exceptions were at the two shallowest pump lakes, M9922 and M9923, where hardness was roughly twice those in other pump and reference lakes. Increases in hardness between the pre-pump and post-pump sampling events were noted at all lakes. Increases were comparable to increases previously discussed with respect to calcium and magnesium. Changes in hardness values at the two shallowest pump lakes, M9922 and M9923, represented the largest magnitude of increase. By August, hardness values at all lakes had decreased to below pre-pump levels.

6.0 Comparison of Results with Other Studies

The following section compares the results of the 2002 NPR-A Lake Monitoring and Recharge Study with data and results from other relevant lake studies. These other studies include lake investigations carried out in the Alpine and Kuparuk development areas in 2002, as well as previous studies conducted in the NPR-A. An overview of previous NPR-A lake studies was provided in Section 1.3.

6.1 2000 PAI and ARCO Eastern NPR-A Lakes Fish Utilization Studies

Studies of fish utilization of lakes in the eastern NPR-A were produced for PAI and ARCO in 2000 (MJM Research, 2000a, b). The studies include a limited amount of analytical water quality data collected in the mid-summer at most of the 2002 NPR-A study lakes. The data measured included concentrations of chloride, sodium, calcium, magnesium, hardness, and total dissolved solids. A review of these mid-summer data shows very close comparison, on a lake-by-lake basis, with values measured in mid-August 2002.

6.2 2001 BPX NPR-A Winter Water Withdrawal Effects Study

The BPX 2001 winter water withdrawal study attempted to compare changes in physical, in situ, and analytical parameters between pump lakes and reference lakes. Methodological and sampling difficulties associated with the study made it difficult to clearly quantify changes occurring in pump lakes versus those occurring in reference lakes. Some general comparisons can be made, however, of trends in certain parameters that were measured between the pre-pump and post-pump sampling events in both the 2001 BPX study and the 2002 NPR-A study.

Parameters in which differences were noted between the two studies include pH and temperature. Gradual increases in pH values were noted at all lakes in the 2002 NPR-A study, but little discernable change was noted in the 2001 BPX study. Gradual decreases in temperatures that were noted during the winter at all lakes in the 2002 NPR-A study were not noted in the 2001 BPX study.

Parameter trends in which clear similarities exist between the two studies include increases between the pre-pump and post-pump sampling events in conductivity and turbidity, and in concentrations of calcium, magnesium, sodium, chloride, and total dissolved solids. Decreases in dissolved oxygen concentrations during the winter were also noted in both studies.

6.3 2001 PAI NPR-A Lake Monitoring Study

The PAI lake monitoring study in 2001 was similar in scope to the 2001 BPX study but included a much smaller number of lakes. Because of the small sample size, it was difficult to draw firm conclusions about differences between pump and reference lakes throughout the course of the study. The study reported general trends in hardness, chloride, total dissolved solids, and selected metals concentrations that showed increases as ice thicknesses increased, and then general decreases in the summer season after the ice cover of the lakes had melted. Dissolved oxygen was noted to follow the opposite trend, decreasing throughout the winter and then increasing in the summer months. These trends match those in the 2002 NPR-A lakes study.

6.4 2002 Alpine and Kuparuk Lakes Monitoring and Recharge Studies

Sections 6.4.1 and 6.4.2 present an introduction to lake monitoring and recharge studies that were conducted at the Alpine and Kuparuk development areas concurrently with the 2002 NPR-A lakes study. Reports for both the Alpine and Kuparuk studies were submitted under separate cover. Section 6.4.3 presents discussions comparing the NPR-A findings with these two other studies.

The Alpine and Kuparuk lake monitoring and recharge studies were stand-alone investigations, and each was structured and scoped somewhat differently than the NPR-A study. Core components of each of the programs were similar, however, and the results of the various programs can be compared on a limited basis. Vicinity figures and summary data tables for the Alpine study lakes are provided in Appendix E while those for the Kuparuk study lakes are provided in Appendix F.

6.4.1 2002 Alpine Lakes Monitoring and Recharge Study Overview

The scope of the 2002 Alpine lakes monitoring and recharge study consisted of winter water quality and lake level measurements at Alpine's two permanent drinking water source lakes (L9312 and L9313) and five other lakes, four of which were permitted for temporary water withdrawal. Three of the seven lakes had water withdrawn over the winter, with two of these being the permanent water source lakes. The Alpine lakes included in the study are shown in Table 6-1. The locations of the Alpine study lakes are shown on Figure E-1 in Appendix E.

Table 6-1 2002 Alpine Study Lakes

Lake Number	Estimated Volume	Area	Max. Depth	Fish Presence
L9312	300 million gallons	100 acres	14 feet	Yes
L9313	160 million gallons	69 acres	12 feet	Yes
L9310 (Reference)	211 million gallons	61 acres	24 feet	Yes
L9282	1,800 million gallons	480 acres	28 feet	Yes
L9342	65 million gallons	25 acres	12 feet	Yes
L9283	76 million gallons	74 acres	10 feet	Yes
L9275 (Reference)	730 million gallons	376 acres	18 feet	Yes

Note: Lake data provided by ConocoPhillips

The Alpine sampling program was similar to the NPR-A program in that it consisted of measurement of the same physical parameters (ice and water surface elevation, water depth, ice thickness, and freeboard), and the same in situ parameters (temperature, pH, conductivity, salinity, DO, and turbidity). Analytical sampling at Alpine was an abbreviated version of the NPR-A program with BOD and COD being the only analytical parameters measured.

The Alpine program was different from the NPR-A program in several ways. The NPR-A sampling program was event-driven. Sampling events were scheduled to evaluate the lakes during different phases of winter water withdrawal. In contrast, lakes at Alpine were sampled at regular intervals regardless of water withdrawal. Five monthly sampling events were scheduled for a period of five months beginning in January. Additionally, in situ measurements at NPR-A lakes were taken at a single depth that represented one-half the distance between the bottom of the ice (or in summer months, the water surface) and the lake bottom. At Alpine, in situ measurements were taken at multiple discrete depths located at approximately three-foot intervals between the bottom of the ice (or in summer months, the water surface) and the bottom of the lake.

The Alpine program was also different in that pump lake and reference lake distinctions were fundamentally different than those at NPR-A. According to the PAI water use website, of the five Alpine lakes designated as pump lakes, only three (L9312, L9313, and L9282) were used for water withdrawal (PAI, 2002). The method and frequency of water withdrawal at Alpine was also different. Lakes L9312 and L9313 are drinking water lakes that serve the Alpine facility. Water withdrawal from these lakes, which is ongoing and occurs year-round, is not readily comparable with lakes where water is removed during a brief period during the winter.

6.4.2 2002 Kuparuk Lakes Monitoring and Recharge Study Overview

The purpose of the 2002 Kuparuk lakes monitoring and recharge study was to conduct winter water quality and lake level measurements at two lakes permitted for the winter water withdrawal program associated with the construction of Drill Site 3S. Two reference lakes were also included in the program. The Kuparuk lakes and background information included in the study are shown in Table 6-2 . The locations of the Kuparuk study lakes are shown on Figure F-1 in Appendix F.

Table 6-2 2002 Kuparuk Study Lakes

Lake Number	Estimated Volume	Area	Max. Depth	Fish Presence
PUMP LAKES				
K309	41.7 million gallons	48 acres	4 feet	No
K214	708.4 million gallons	518 acres	7 feet	No
REFERENCE LAKES				
K203	273.7 million gallons	210 acres	6 feet	No
K204	204.0 million gallons	143 acres	7 feet	No

Note: Lake data provided ConocoPhillips.

The Kuparuk sampling program was similar to the NPR-A program in that it consisted of the measurement of the same physical parameters (ice and water surface elevation, water depth, ice thickness, and freeboard), and the same in situ parameters (temperature, pH, conductivity, salinity, DO, and turbidity). In situ measurements at both NPR-A and Kuparuk lakes were taken at a single depth that represented one-half the distance between the bottom of the ice (or in summer months, the water surface) and the lake bottom. Both the NPR-A and Kuparuk lakes programs were also event-driven. Sampling events were scheduled to evaluate the lakes during different phases of winter water withdrawal. A minor difference between the two programs was that the Kuparuk program lacked an analytical sampling component.

Fire Suppression System Effects on Kuparuk Pump Lakes. The presence of fire suppression system intake structures in the two Kuparuk pump lakes makes it difficult to directly compare Kuparuk pump lake data with data from pump lakes in the NPR-A and Alpine programs. The possible effects from these structures on the physical and in situ parameters measured on the lakes were unfortunately not identified until after the field portion of the program had been completed.

At Kuparuk, both pump lakes were situated adjacent to Central Processing Facilities (CPFs). Lake K309 was located adjacent to CPF 3, and Lake K214 was located adjacent to CPF 2. During the lake selection phase of the program, it was known that both pump lakes were designated sources of emergency fire suppression water for their respective CPFs. As such, each lake was equipped with pump intake structures. During the final lake selection process, contact was made with control room personnel at both CPF 2 and CPF 3 regarding water removal from the lakes. Personnel in both control rooms stated that water was not withdrawn from their respective lakes unless there was a fire that required additional volume. Personnel in both control rooms also stated that, to their knowledge, there had never been a fire in their respective CPFs, and that water had never been withdrawn from the lakes for fire fighting purposes. Based on these conversations, it was concluded that the fire suppression system intakes would have no effect on the lake sampling efforts.

During post-field data reduction, inconsistencies in the results from pump lake K309 prompted a reexamination of the background conditions at the lakes. It was discovered that the fire suppression system at both lakes was kept from freezing during the winter months by a recirculation system that regularly returned water to lakes K309 and K214. Water that was returned to the lakes was presumably warmer than ambient conditions. Also, while it is unlikely that sufficient volumes were removed to result in water surface elevation changes, it is a distinct possibility that residence time in the fire suppression system may have had some effect on dissolved oxygen concentrations, pH, conductance, salinity, and the turbidity of the water.

Potential effects from the recirculation of fire suppression system water are possible in both Lake K309 and Lake K214 but it is likely that effects would be greatest at or near the pump intake structure. Because the sampling location at Lake K309 was less than 100 feet from the fire suppression system intake structure, it is therefore more likely that the sampling results from that lake were affected by recirculated waters than those at Lake K214 where the sampling location was approximately three-quarters of a mile from the pump intake structure. Additionally, the pump intake structure at Lake K214 was located within a man-made lagoon that did not appear to be hydraulically connected to the main body of the lake during the winter months. Effects of the fire suppression systems to physical and in situ parameters at lakes K214 and K309 are discussed in the following section.

6.4.3 Comparison of 2002 Lake Monitoring and Recharge Studies

The following sections compare the results of the 2002 lake monitoring and recharge studies performed at Alpine, Kuparuk, and in the NPR-A.

1. Physical Parameters

Water Surface Elevations

Water surface elevation trends over the winter and as a result of spring recharge were comparable between the lakes in the NPR-A and Kuparuk studies. In the NPR-A and Kuparuk lakes, water surface elevations generally decreased between the pre-pump and post-pump sampling events, increased between the post-pump and breakup site visits, and declined gradually after spring recharge between the breakup and pre-freeze-up site visits.

Water surface elevation changes for lakes in the Alpine study did not exhibit the pattern noted in the other studies. Five of the seven lakes in this study saw slight increases in water surface elevations over the period between January and April. Reasons for the increases are not known. While survey techniques and field conditions may be partly responsible, these are not thought to be solely responsible for the variations. The two lakes with water surface elevation decreases were the permanent water source lakes for the Alpine facility. All Alpine study lakes showed water surface elevation increases in the spring as recharge occurred, but the magnitude and timing of the peak water surface elevation varied considerably among study lakes. Rates of decline in water surface elevations after June were similar among all the Alpine lakes and were similar to those rates observed in the NPR-A.

Ice Thickness

Mid-winter ice thicknesses at NPR-A tended to be slightly less than those measured at the Alpine and Kuparuk study lakes. The average mid-winter ice thickness in the NPR-A was 3.4 feet in early February, while ice thicknesses were 4.6 feet at Alpine and 4.3 feet at Kuparuk.

Average ice growth between the pre-pump and post-pump sampling events at NPR-A was 1.5 feet and at Alpine was 2.1 feet over this same period. The average ice growth rate for the Kuparuk study lakes was 1.0 feet; however, the average is skewed by an anomalous measurement at pump lake K309 which exhibited an increase of only 0.11 feet during the 3-1/2 months since the previous measurement had been made. As previously discussed, the sampling location at Lake K309 was less than 100 feet from the pump intake structure of the fire suppression system for CPF 3. The anomalous rate of ice growth was presumably a result of the close proximity of the sampling location to this structure, the source of warm return water from the fire suppression system. If the measurement at K309 is discounted, average ice growth at Kuparuk was 1.5 feet, which is comparable to the ice growth at NPR-A. With the exception of the anomalous ice growth measurement for Lake K309, it appears that pumping had little or no effect on ice growth.

2. In Situ Parameters

In situ parameters at all Alpine lakes were measured monthly and at discrete depths within the water column at a given sample location. For comparison purposes, the date of the Alpine sampling that most closely matched the NPR-A sampling date was chosen. Then, on that date, the value closest to the depth that represented the point midway between the bottom of the ice (or in summer months, the water surface) and the lake bottom was selected.

In situ parameters at all Kuparuk lakes were measured at the depth that represented the point midway between the bottom of the ice (or in summer months, the water surface) and the lake bottom.

Water Temperature

Water temperatures and trends in water temperatures were comparable among all three groups of study lakes. As would be expected, temperatures were noted to gradually decrease throughout the winter and then increase to roughly similar values during the summer. Early winter water temperatures in NPR-A, Alpine, and Kuparuk lakes averaged 1.4^{o}C, 1.6^{o}C, and 1.8^{o}C, respectively. The average late winter water temperatures NPR-A were again slightly cooler than those measured at the Kuparuk and Alpine lakes. NPR-A lakes were also slightly cooler than the Alpine and Kuparuk study lakes during the late summer. Late summer water temperatures in NPR-A, Alpine, and Kuparuk lakes averaged 8.2^{o}C, 9.0^{o}C, and 8.6^{o}C, respectively. Water temperatures in Kuparuk lake K309 were consistently warmer by as much as 3^{o}C, almost certainly a reflection of the sampling location's close proximity to the fire suppression system intake structure at that lake. Water temperatures at Lake K214 do not appear to have been affected by the intake structure in that lake.

pH

Over the course of the investigation, variations in the magnitudes and trends of pH values were noted among the three groups of study lakes. The range of pH values measured in NPR-A lakes was 6.2 to 8.8 in pump lakes and from 6.4 to 8.6 in reference lakes. For the Alpine lakes, pH values exhibited a much narrower range, from 7.3 to 8.5. Kuparuk lakes, on the other hand, exhibited a fairly broad variation in pH values, ranging from 5.1 to 9.0. Trends in pH values over the course of the study period were not the same for all groups of lakes. The NPR-A and Kuparuk lakes exhibited gradual increases in pH throughout the course of the study. At Alpine lakes, however, mid- and late-winter decreases in pH were noted at all lakes. These winter decreases in pH values at Alpine lakes were followed by increases through the end of the study period. It does not appear that the presence of the fire suppression system intake structures at Kuparuk lakes K309 and K214 had any measurable effect on the pH of those lakes.

In Situ Conductivity

As was observed at NPR-A lakes, in situ conductivity at Alpine lakes generally tended to increase over the winter as the thickening of ice presumably increased dissolved constituent concentrations in the free water. Conductivity concentrations and the magnitude of concentration increases at all Alpine lakes, including L9312 and L9313, were comparable to increases noted at NPR-A reference lakes. Winter increases in conductivities at three of five NPR-A pump lakes, however, were generally about an order of magnitude higher than those observed at Alpine lakes. Conductivity values were noted to decline to similar levels by the end of the summer at both NPR-A and Alpine lakes.

The in situ conductivity increases noted over the course of the winter in the NPR-A and at Alpine were not generally noted at the Kuparuk lakes. Only one of the Kuparuk pump lakes, Lake K214, followed this pattern. The remaining three lakes exhibited consistent decreases in conductivity over the course of the investigation. The reason for these declining conductivities is unknown. It does not appear that the presence of the fire suppression system intake structures at lakes K309 and K214 had any measurable effect on the conductivities of those lakes.

Salinity

All Alpine lakes, and all NPR-A lakes except one, saw increases in salinity as the ice thickened that were proportional to increases in conductance over the same time period. Winter salinity concentration trends at Kuparuk, however, behaved somewhat differently from those noted in the other two studies. Salinity at Kuparuk pump lake K214 and reference lake K203 generally followed the pattern seen at Alpine and NPR-A. Pump lake K214 had the highest salinity concentration (0.2 mg/L) of any lake in the study. Of the remaining two lakes, pump lake K309 showed a steady decrease in salinity over the course of the study, similar to the decrease seen there in conductivity values. Reference lake K204 had salinity concentrations of 0.0 mg/L both times it was sampled (Lake K204 was frozen to the bottom during the post-pump sampling event and therefore was not sampled). It does not appear that the presence of the fire suppression system intake structure at Lake K309 had any measurable effect on the salinity of that lake. It’s possible, but unlikely given the distance between the structure and the sampling location, that the fire suppression system structure at Lake K214 was in some way related to the relatively high salinity measured in that lake during the post-pump sampling event.

Dissolved Oxygen

The nature of the changes measured in dissolved oxygen concentrations was comparable between lakes at Alpine and in the NPR-A. In both groups of lakes, DO was seen to decrease during the winter as ice thicknesses increased, and then rebound again by the end of the study period. NPR-A pump lakes appeared to have remained more oxygenated through the mid-winter period with the average late-April DO concentration in pump lakes (2.9 mg/L) nearly three times that of reference lakes (1.0 mg/L).

Alpine lakes generally remained more oxygenated than even NPR-A pump lakes, with an average late-April DO concentration of 5.5 mg/L. Additionally, in contrast to NPR-A lakes where pump lakes remained more oxygenated through the winter, the most heavily pumped lake at Alpine, Lake L9313, had the most significant mid-winter DO decrease. That lake, however, was pumped using an underwater intake rather than a temporary pumphouse, as was the case with all NPR-A pump lakes.

No reasonable comparisons to the Kuparuk lakes could be made regarding dissolved oxygen due to suspected contamination of the samples from ice auger effects. It does not appear that the presence of the fire suppression system intake structures at lakes K309 and K214 had any measurable effect on dissolved oxygen levels in those lakes.

Turbidity

Turbidity trends in the NPR-A followed a common pattern in all lakes. Turbidity values in the NPR-A study lakes increased between the early-February and late-April sampling events, and then dropped again by mid-August. With one exception, the magnitude of turbidity increases between pump and reference lakes were comparable. Trends in turbidity concentrations at Alpine lakes were more complex. Three of the lakes followed the pattern seen at NPR-A. The four remaining lakes, however, including the two permanent water source lakes, experienced decreases in turbidity between the early-February and late-April sampling events. Of those four, three showed increased turbidity between late-April and mid-August, and the fourth continued to decrease.

Turbidity values at the three Kuparuk study lakes that did not freeze to the bottom during the late winter followed the pattern of changes seen in the NPR-A lakes. The magnitude of turbidity increases at NPR-A lakes were comparable to those at Kuparuk lakes with increases at pump lakes typically an order of magnitude higher than increases at reference lakes. It does not appear that the presence of the fire suppression system intake structures at lakes K309 and K214 had any measurable effect on the turbidity of those lakes.

3. Analytical Parameters

As mentioned above, no analytical sampling was performed for the 2002 Kuparuk lakes monitoring and recharge study. The following discussion compares and contrasts the analytical parameters sampled in the NPR-A and at Alpine studies.

Unlike in situ sampling, which was carried out at approximately three-foot intervals through the water column, analytical samples in the NPR-A were collected at a single discrete depth that represented the point midway between the bottom of the ice (or in summer months, the water surface) and the lake bottom.

Biochemical Oxygen Demand (BOD)

Without exception, BOD results were non-detect at all Alpine lakes over the course of the investigation (Appendix E). With the exception of low-level post-pump sampling detections at pump lake M9922 and reference lake L9807, BOD results were non-detect at all NPR-A lakes over the course of the investigation as well (Appendix C).

Chemical Oxygen Demand (COD)

COD concentrations in Alpine lakes over the course of the investigation behaved much differently than those in the NPR-A lakes. At all NPR-A lakes, COD concentrations typically increased between the early-February and late-April sampling events, and decreased to approximately the level measured in February between the April and mid-August sampling events. The magnitude of this increase, and the accompanying decrease in NPR-A lakes as a whole, averaged about 80 to 100 mg/L. At Alpine lakes, however, COD concentrations between the early-February and late-April sampling events decreased an average of about 15 mg/L. Average concentrations decreased again or stayed the same between the late-April and mid-August sampling events at all Alpine lakes.

7.0 Use of Fresh Water Lakes in North Slope Communities

The withdrawal of water from fresh water lakes on the North Slope is a common practice. Fresh water users include not only the oil industry, but most North Slope Borough communities as well, which use fresh water lakes to provide potable water for residents. Anaktuvuk Pass, which gets its water supply from a groundwater source, is the one exception.

In general, the periods of water withdrawal differ between the oil industry and North Slope communities. The bulk of exploration-related fresh water withdrawals occur during the winter when ice roads are being constructed. For North Slope communities, however (and with the exception of Barrow, which has a year-round water supply), water is normally withdrawn each summer to fill community water supply tanks. Brief discussions of the lake-based water supply systems in North Slope communities are provided below. In all the communities discussed, it is noted that annual recharge to water supply lakes occurs in excess of community water withdrawals.

7.1 Barrow

Isatkoak Reservoir is the source of potable water for the City of Barrow. The reservoir was created by the construction of an earthen dam to increase the volume of water available to the community, and to prevent seawater intrusion from Isatkoak Lagoon. The reservoir is part of the 2.5- to 3-square mile Isatkoak drainage basin that includes Isatkoak Creek (BUECI 2002).

LCMF Incorporated completed a bathymetric survey of the lake during April 1998. The estimated volume of water in the reservoir was 493 million gallons of which approximately 249 million gallons were unfrozen. The measured ice thickness was 5 feet.

Recharge to the reservoir occurs from spring melting of winter snow accumulations within the lake's drainage basin, and from precipitation during the summer months. Snow fences have been installed to minimize snow drifting within the developed portions of the community and these also enhance snow deposition within the drainage basin.

According to Rob Taylor, City of Barrow utility plant foreman, water withdrawal from the reservoir over the past three years has averaged approximately 100 million gallons per year

(Taylor, 2002). This includes water for community use, freeze protection for the water and sewer system piping, and excess waste from the treatment process. No visual changes to the lake's water surface elevations have been noted by local operators, even during the winter months. Water quality is noted to progressively degrade over the winter and then improve significantly in the spring when recharge takes place (Taylor, 2002). Water is withdrawn from the reservoir on a year-round basis, unlike the other North Slope community systems, which withdraw water only during the summer.

7.2 Wainwright

There are two fresh water lakes that serve as the water supply for Wainwright. Both lakes are located approximately two miles to the north of the village. The larger lake is the main supply source. It has a surface area of approximately 134 acres, a depth of 3.3 to 3.5 feet, and a calculated volume of 113 million gallons (Shiltec, 1994). The second lake is approximately one-third the size of the larger and is located adjacent to it. Depths for each lake are similar. The second lake was developed as an alternate water source because water quality in the larger lake can become compromised during certain wind conditions due to the shallow depths. This causes problems with the water treatment system. The intake on the larger lake is located at its southern end while the intake for the smaller lake is located at its northern end. Wind direction will usually determine which lake is used.

The anticipated annual water needs of the community are 10.3 million gallons. All water is pumped during the summer months to heated storage tanks. No withdrawal from these lakes occurs during the winter months.

An evaluation of the annual recharge to the larger lake was performed during the design of the village's piped water and sewer system to determine the adequacy of this lake as a water source (Shiltec, 1994). The drainage basin for the larger lake is approximately 660 acres. The recharge evaluation indicated that the annual drawdown from pumping and evaporation would be 6.8 inches while recharge would be 9.1 inches. It was therefore concluded that the lake could provide an adequate supply of water.

Observations indicate that the lakes at Wainwright are drawn down during the summer pumping season. According to J.W. Graves, a Project Engineer with ASCG Incorporated who has worked on this system (Graves, 2002), the smaller lake was actually used more frequently than originally anticipated during the first year of operation. The lake was drawn down 4-6 inches before pumping was halted. It was only a matter of days, however, before the lake level began to rise towards its pre-pump level, suggesting that hydraulic connections to other nearby lakes exist. Graves also commented that regardless of the summer drawdown, the lakes are completely recharged each spring.

7.3 Point Lay

A fresh water lake located approximately one and a half miles east of the village of Point Lay serves as the community's water source. The lake is approximately 300 acres in size and is estimated to have a volume of over 500 million gallons (Shiltec, 1993). The annual water requirement of the village is approximately 2.6 million gallons, which correlates to a drawdown of only 0.03 feet during the open water season.

There has been little concern about the ability of this lake to provide the village with an adequate supply of water. In addition to recharge from summer precipitation and spring recharge from snowmelt within the lake's drainage basin, the lake also receives recharge from overflow from the Kokolik River through a narrow connection during some breakup events.

7.4 Point Hope

The raw water source for Point Hope is located approximately six miles to the east of the village. The source is a small fresh water lake that is approximately 13 feet deep. Although the lake itself is small in size, it is located within a broad, wet lowland area. The drainage around the lake is generally a vegetative mat that appears to be floating over saturated ground.

With the completion of water and sewer system improvements in the late 1990s, the approximate storage capacity of the village is 11 million gallons. Water is pumped from the water source during the summer months and stored in insulated steel tanks. A hydrologic investigation to verify the capacity of the supply source was completed by G.N. McDonald & Associates (G.N. McDonald, 1996). The analysis compared the expected volume to be pumped on an annual basis (complete recharge of the storage tanks) to the precipitation expected to fall within the lake drainage basin. Historical data from Point Hope as well as Kotzebue, Cape Lisburne, and Barrow were used. It was concluded that snowfall sufficient to recharge the lake during spring breakup could be expected to occur in 99 out of every 100 years.

According to Dave Welsh, Point Hope Water Plant Operator (Welsh, 2002), drawdown to the fresh water lake does occur during summer pumping, but the lake recharges to capacity every spring. In 2000, the lake was drawn down 3-4 feet and turbidity increased significantly. Concerns that the lake might not become fully recharged the following spring, however, turned out to be unfounded. There are no noticeable differences in lake water surface elevations from spring to spring (Welsh, 2002).

7.5 Atqasak

The existing water source in the community of Atqasak is Lake Immagruaq. The lake is located to the northwest of the village. The annual water requirement of the village is predicted to eventually reach 4.2 million gallons, and the lake is more than adequate to provide this supply (Shiltec, 1993). The surface area of the lake is approximately 2,300 acres, and a water drawdown associated with withdrawals for village use is less than 0.01 feet. Snowmelt and precipitation into the lake's drainage basin provides annual recharge in excess of the village's water demands.

7.6 Nuiqsut

The water source in the village of Nuiqsut is a fresh water lake located approximately one mile from the community. The lake has an area of approximately 178 acres, a maximum depth of 12 feet, and an estimated volume of 687 million gallons (Shiltec, 1993). The water storage capacity of the village is approximately 8 million gallons. An annual water drawdown based on the village's storage capacity is estimated to be 0.15 feet. The drainage basin for this lake is relatively large as it includes numerous other lakes connected by small streams. Snowmelt and precipitation into the lake's drainage basin provide annual recharge in excess of the village's water demands.

7.7 Kaktovik

The water source of the village of Kaktovik is a fresh water lake located to the southeast of the community. The lake has an approximate depth of 9 feet and an estimated volume of over 200 million gallons (Shiltec, 1993). The water storage capacity of the village is approximately 4 million gallons. An annual water drawdown based on the village storage capacity is estimated to be 0.10 feet. Snowmelt and precipitation into the lake's drainage basin provides annual recharge in excess of the community's water demands.

8.0 Conclusions

Conclusions, subdivided with respect to physical, in situ, and analytical results, are program-specific and therefore should be considered to apply only to the NPR-A lakes study. General conclusions are broad-based and are founded on comparisons of results from other 2002 lake monitoring and recharge studies as well as other information regarding the North Slope.

8.1 Physical Parameters

- Water surface elevations decreased in most lakes between the pre-pump and post-pump sampling events with the exception of two reference lakes where very slight increases were noted. Water surface elevations in the majority of pump lakes were lowered more than in reference lakes. These water level changes in pump lakes were almost certainly the result of winter water withdrawal.

- Water surface elevations in all lakes increased to well above pre-pump levels as the lakes were recharged in the spring. Without exception, pump lake recharge volumes were sufficient to compensate for winter water withdrawals.

- The primary mechanism for recharge in 2002 was snowmelt and snowmelt runoff for all of the study lakes.

- Water surface elevations in all lakes declined over the summer to levels below those measured during the Pre-Pump sampling event. Summer declines in water surface elevations were the result of lake outflow and/or evaporation.

- Pumping appears to have had no effect on ice growth.

8.2 In Situ and Analytical Water Quality Parameters

- General trends for in situ and analytical water quality parameters for both pump and reference lakes were similar over the study period.

  Three of the pump lakes however, had notable increases in most parameter levels over the pumping period when compared to reference lakes. It should be noted that two of those three pump lakes were the shallowest in the study and presumably had the greatest proportional decreases in under-ice water volumes. It should also be noted that two of these three lakes were the most heavily pumped, based on water withdrawal as a percentage of estimated lake volume. The expectation is that the highest increases in concentrations would occur in lakes with the greatest proportional decrease in under-ice water volumes. Pumping of shallow lakes may magnify this effect depending on the timing and magnitude of water withdrawal.

  While it is probable that winter water withdrawal contributed to measured increases in concentrations, the extent to which this effect was caused by pumping could not be determined based on the available data. The following exceptions were noted:

  - Temperature, pH, turbidity, sulfate, and nitrate levels do not appear to have been affected by pumping.

  - Dissolved oxygen concentrations decreased in all lakes between pre-pump and post-pump sampling events; however, pump lakes appear to have remained more oxygenated through the mid-winter period. Average post-pump dissolved oxygen concentrations in pump lakes were higher than average post-pump concentrations measured in reference lakes. Higher levels of oxygenation in pump lakes may be a result of pumping methods used by the ice road subcontractor.

- Concentrations of in situ parameters for both pump and reference lakes were at comparable levels in August.

8.3 General Conclusions

- The results of a number of studies have confirmed that naturally occurring seasonal changes in water chemistry are a characteristic of North Slope coastal plain lakes. Water chemistry changes appear to be influenced by ice growth, changes in under ice-water volumes, and recharge.

- 2002 data indicate that water chemistry and naturally occurring seasonal changes in water chemistry differ not only among geographic regions but among individual lakes within the same geographic region. This suggests that broad regional generalizations about baseline water chemistry, trends of season water chemistry variation, or changes in water chemistry due to winter water withdrawals should be avoided.

- The majority of annual recharge to North Slope lakes occurs each year during spring breakup. Data from 2001 and 2002 lakes studies, and anecdotal information provided by seven North Slope communities indicates that the magnitude of spring recharge has always been sufficient to replace previously withdrawn water volumes.

- Chemical changes in water quality between the open water season and winter are likely influenced by the proportion of under-ice water volume to open water lake volume. Pumping from shallow lakes is likely to have a greater effect on water quality than pumping a comparable volume from deeper lakes, providing the lakes are similar in size.

9.0 References

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Appendix A 2002 Water Use

Table A-1
January 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons): Ice Roads/Pads: Peak	Ice Roads/Pads: Catco	Ice Roads/Pads: Nanuq	Alpine Pad	Drilling	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										339,670,000
A2001-21	R0056	1/1		0					0	339,670,000
A2001-21	R0056	1/2		0					0	339,670,000
A2001-21	R0056	1/3		0					0	339,670,000
A2001-21	R0056	1/4		12,000					12,000	339,658,000
A2001-21	R0056	1/5		60,000					60,000	339,598,000
A2001-21	R0056	1/6		0					0	339,598,000
A2001-21	R0056	1/7		24,000					24,000	339,574,000
A2001-21	R0056	1/8		90,000					90,000	339,484,000
A2001-21	R0056	1/9		0					0	339,484,000
A2001-21	R0056	1/10	283,500	123,480					406,980	339,077,020
A2001-21	R0056	1/11	1,039,374	299,880					1,339,254	337,737,766
A2001-21	R0056	1/12	157,500	0					157,500	337,580,266
A2001-21	R0056	1/13	245,700	0					245,700	337,334,566
A2001-21	R0056	1/14	220,500	0					220,500	337,114,066
A2001-21	R0056	1/15	163,800	0					163,800	336,950,266
A2001-21	R0056	1/16	340,200	0					340,200	336,610,066
A2001-21	R0056	1/17	207,900	0					207,900	336,402,166
A2001-21	R0056	1/18	113,400	0				3,000	116,400	336,285,766
A2001-21	R0056	1/19	30,240	0					30,240	336,255,526
A2001-21	R0056	1/20	0	0					0	336,255,526
A2001-21	R0056	1/21	0	0					0	336,255,526
A2001-21	R0056	1/22	0	0					0	336,255,526
A2001-21	R0056	1/23	0	0					0	336,255,526
A2001-21	R0056	1/24	0	0					0	336,255,526
A2001-21	R0056	1/25	0	0					0	336,255,526
A2001-21	R0056	1/26	0	0					0	336,255,526
A2001-21	R0056	1/27	0	0					0	336,255,526
A2001-21	R0056	1/28	0	0					0	336,255,526
A2001-21	R0056	1/29	0	0					0	336,255,526
A2001-21	R0056	1/30	0	0					0	336,255,526
A2001-21	R0056	1/31	0	0				12,000	12,000	336,243,526
A2001-21	R0056	January Total	2,802,114	609,360	0	0	0	15,000	3,426,474	336,243,526
										23,690,000
A2001-21	R0054	1/10	0						0	23,690,000
A2001-21	R0054	1/11	0						0	23,690,000
A2001-21	R0054	1/12	252,000						252,000	23,438,000
A2001-21	R0054	1/13	229,824						229,824	23,208,176
A2001-21	R0054	1/14	94,080						94,080	23,114,096
A2001-21	R0054	1/15	85,680						85,680	23,028,416
A2001-21	R0054	1/16	183,456						183,456	22,844,960
A2001-21	R0054	1/17	120,960						120,960	22,724,000
A2001-21	R0054	1/18	24,192						24,192	22,699,808
A2001-21	R0054	1/19							0	22,699,808
A2001-21	R0054	1/20							0	22,699,808
A2001-21	R0054	1/21							0	22,699,808
A2001-21	R0054	1/22							0	22,699,808
A2001-21	R0054	1/23							0	22,699,808
A2001-21	R0054	1/24							0	22,699,808
A2001-21	R0054	1/25							0	22,699,808
A2001-21	R0054	1/26							0	22,699,808
A2001-21	R0054	1/27							0	22,699,808
A2001-21	R0054	1/28							0	22,699,808
A2001-21	R0054	1/29							0	22,699,808
A2001-21	R0054	1/30							0	22,699,808
A2001-21	R0054	1/31							0	22,699,808
		January Total	990,192	0	0	0	0	0	990,192	22,699,808

January 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons)						Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
			Ice Roads/Pads			Alpine Pad	Drilling	Camp Water (Catco)		
			Peak	Catco	Nanuq					
										1,520,000
A2001-21	R0052	1/10		0					0	1,520,000
A2001-21	R0052	1/11		58,800					58,800	1,461,200
A2001-21	R0052	1/12		172,520					172,520	1,288,680
A2001-21	R0052	1/13		135,240					135,240	1,153,440
A2001-21	R0052	1/14		120,540					120,540	1,032,900
A2001-21	R0052	1/15		141,120					141,120	891,780
A2001-21	R0052	1/16		0					0	891,780
A2001-21	R0052	1/17		0					0	891,780
A2001-21	R0052	1/18		0					0	891,780
A2001-21	R0052	1/19		0					0	891,780
A2001-21	R0052	1/25							0	891,780
A2001-21	R0052	1/26							0	891,780
A2001-21	R0052	1/27							0	891,780
A2001-21	R0052	1/28							0	891,780
A2001-21	R0052	1/29							0	891,780
A2001-21	R0052	1/30							0	891,780
A2001-21	R0052	1/31							0	891,780
		January Total	0	628,220	0	0	0	0	628,220	263,560
										262,980,000
A2001-21	L9806	1/9			0				0	262,980,000
A2001-21	L9806	1/10			169,050				169,050	262,810,950
A2001-21	L9806	1/11			154,560				154,560	262,656,390
A2001-21	L9806	1/12			233,310				233,310	262,423,080
A2001-21	L9806	1/13			217,770				217,770	262,205,310
A2001-21	L9806	1/14			227,010				227,010	261,978,300
A2001-21	L9806	1/15			357,210				357,210	261,621,090
A2001-21	L9806	1/16			470,610				470,610	261,150,480
A2001-21	L9806	1/17			317,520				317,520	260,832,960
A2001-21	L9806	1/18			39,690				39,690	260,793,270
A2001-21	L9806	1/19			232,470				232,470	260,560,800
A2001-21	L9806	1/20			561,330				561,330	259,999,470
A2001-21	L9806	1/21			340,200				340,200	259,659,270
A2001-21	L9806	1/22			436,590				436,590	259,222,680
A2001-21	L9806	1/23			453,600				453,600	258,769,080
A2001-21	L9806	1/24			306,180				306,180	258,462,900
A2001-21	L9806	1/25			147,420				147,420	258,315,480
A2001-21	L9806	1/26							0	258,315,480
A2001-21	L9806	1/27	443,940						443,940	257,871,540
A2001-21	L9806	1/28	805,560						805,560	257,065,980
A2001-21	L9806	1/29	988,134						988,134	256,077,846
A2001-21	L9806	1/30	887,628						887,628	255,190,218
A2001-21	L9806	1/31	487,746						487,746	254,702,472
		January Total	3,613,008	0	4,664,520	0	0	0	8,277,528	254,702,472

January 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons) – Ice Roads/Pads – Peak	Ice Roads/Pads – Catco	Ice Roads/Pads – Nanuq	Alpine Pad	Drilling	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										415,900,000
A2001-21	M9602	1/9							0	415,900,000
A2001-21	M9602	1/10							0	415,900,000
A2001-21	M9602	1/11							0	415,900,000
A2001-21	M9602	1/12		35,280					35,280	415,864,720
A2001-21	M9602	1/13							0	415,864,720
A2001-21	M9602	1/14							0	415,864,720
A2001-21	M9602	1/15							0	415,864,720
A2001-21	M9602	1/16							0	415,864,720
A2001-21	M9602	1/16							0	415,864,720
A2001-21	M9602	1/17							0	415,864,720
A2001-21	M9602	1/18							0	415,864,720
A2001-21	M9602	1/19							0	415,864,720
A2001-21	M9602	1/20							0	415,864,720
A2001-21	M9602	1/21							0	415,864,720
A2001-21	M9602	1/22							0	415,864,720
A2001-21	M9602	1/23	446,418						446,418	415,418,302
A2001-21	M9602	1/24	907,872						907,872	414,510,430
A2001-21	M9602	1/25	743,652						743,652	413,766,778
A2001-21	M9602	1/26	258,006						258,006	413,508,772
A2001-21	M9602	1/27	88,200						88,200	413,420,572
A2001-21	M9602	1/28							0	413,420,572
A2001-21	M9602	1/29							0	413,420,572
A2001-21	M9602	1/30							0	413,420,572
A2001-21	M9602	1/31							0	413,420,572
		January Total	2,444,148	35,280	0	0	0	0	2,479,428	413,420,572
										238,300,000
A2001-21	M9605	1/9	0		0				0	238,300,000
A2001-21	M9605	1/10	0		0				0	238,300,000
A2001-21	M9605	1/11	0		0				0	238,300,000
A2001-21	M9605	1/12	0		0				0	238,300,000
A2001-21	M9605	1/13	0						0	238,300,000
A2001-21	M9605	1/14	581,658						581,658	237,718,342
A2001-21	M9605	1/15	791,196						791,196	236,927,146
A2001-21	M9605	1/16	893,424						893,424	236,033,722
A2001-21	M9605	1/22	835,926						835,926	235,197,796
A2001-21	M9605	1/23	116,424						116,424	235,081,372
A2001-21	M9605	1/24							0	235,081,372
A2001-21	M9605	1/25							0	235,081,372
A2001-21	M9605	1/26	117,600						117,600	234,963,772
A2001-21	M9605	1/27							0	234,963,772
A2001-21	M9605	1/28							0	234,963,772
A2001-21	M9605	1/29							0	234,963,772
A2001-21	M9605	1/30							0	234,963,772
A2001-21	M9605	1/31							0	234,963,772
		January Total	3,336,228	0	0	0	0	0	3,336,228	231,627,544

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Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons): Ice Roads/Pads: Peak	Ice Roads/Pads: Catco	Ice Roads/Pads: Nanuq	Alpine Pad	Drilling	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										3,900,000
A2001-21	M9606	1/9	0		0				0	3,900,000
A2001-21	M9606	1/10	0		0				0	3,900,000
A2001-21	M9606	1/11	0		0				0	3,900,000
A2001-21	M9606	1/12	0		0				0	3,900,000
A2001-21	M9606	1/13	0		0				0	3,900,000
A2001-21	M9606	1/14	0		0				0	3,900,000
A2001-21	M9606	1/15	0		0				0	3,900,000
A2001-21	M9606	1/16	0		0				0	3,900,000
A2001-21	M9606	1/17	0		34,020				34,020	3,865,980
A2001-21	M9606	1/18			0				0	3,865,980
A2001-21	M9606	1/19			0				0	3,865,980
A2001-21	M9606	1/20			0				0	3,865,980
A2001-21	M9606	1/21			136,122				136,122	3,729,858
A2001-21	M9606	1/22			187,110				187,110	3,542,748
A2001-21	M9606	1/23			119,070				119,070	3,423,678
A2001-21	M9606	1/24							0	3,423,678
A2001-21	M9606	1/25							0	3,423,678
A2001-21	M9606	1/26							0	3,423,678
A2001-21	M9606	1/27							0	3,423,678
A2001-21	M9606	1/28							0	3,423,678
A2001-21	M9606	1/29							0	3,423,678
A2001-21	M9606	1/30							0	3,423,678
A2001-21	M9606	1/31							0	3,423,678
		January Total	0	0	476,322	0	0	0	476,322	3,423,678
										72,150,000
A2001-21	L9817	1/9	0		0				0	72,150,000
A2001-21	L9817	1/10	0		0				0	72,150,000
A2001-21	L9817	1/11	0		0				0	72,150,000
A2001-21	L9817	1/12	0		0				0	72,150,000
A2001-21	L9817	1/13	0		0				0	72,150,000
A2001-21	L9817	1/14	0		0				0	72,150,000
A2001-21	L9817	1/15	0		0				0	72,150,000
A2001-21	L9817	1/16	0		0				0	72,150,000
A2001-21	L9817	1/17	0	90,000	0				90,000	72,060,000
A2001-21	L9817	1/18	0						0	72,060,000
A2001-21	L9817	1/19	0						0	72,060,000
A2001-21	L9817	1/20		70,560					70,560	71,989,440
A2001-21	L9817	1/21		54,000					54,000	71,935,440
A2001-21	L9817	1/22		42,000					42,000	71,893,440
A2001-21	L9817	1/23		24,000					24,000	71,869,440
A2001-21	L9817	1/24		84,000					84,000	71,785,440
A2001-21	L9817	1/25		84,000					84,000	71,701,440
A2001-21	L9817	1/26		42,000					42,000	71,659,440
A2001-21	L9817	1/27		78,000					78,000	71,581,440
A2001-21	L9817	1/28		132,000					132,000	71,449,440
A2001-21	L9817	1/29	144,900	186,000					330,900	71,118,540
A2001-21	L9817	1/30	270,900	252,000					522,900	70,595,640
A2001-21	L9817	1/31	672,336	174,000					846,336	69,749,304
		January Total	1,088,136	1,312,560	0	0	0	0	2,400,696	69,749,304

January 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons): Ice Roads/Pads: Peak	Ice Roads/Pads: Catco	Ice Roads/Pads: Nanuq	Alpine Pad	Drilling	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										24,000,000
A2001-21	R00053	1/9							0	24,000,000
A2001-21	R00053	1/10							0	24,000,000
A2001-21	R00053	1/11							0	24,000,000
A2001-21	R00053	1/12							0	24,000,000
A2001-21	R00053	1/13							0	24,000,000
A2001-21	R00053	1/14							0	24,000,000
A2001-21	R00053	1/20							0	24,000,000
A2001-21	R00053	1/21							0	24,000,000
A2001-21	R00053	1/22							0	24,000,000
A2001-21	R00053	1/23							0	24,000,000
A2001-21	R00053	1/24							0	24,000,000
A2001-21	R00053	1/25							0	24,000,000
A2001-21	R00053	1/26							0	24,000,000
A2001-21	R00053	1/27							0	24,000,000
A2001-21	R00053	1/28						3000	3,000	23,997,000
A2001-21	R00053	1/29							0	23,997,000
A2001-21	R00053	1/30						6000	6,000	23,991,000
A2001-21	R00053	1/31							0	23,991,000
		January Total	0	0	0	0	0	9,000	9,000	23,982,000
										106,860,000
A2001-21	L9804	1/9	0		0				0	106,860,000
A2001-21	L9804	1/10	0		0				0	106,860,000
A2001-21	L9804	1/11	0		0				0	106,860,000
A2001-21	L9804	1/12	0		0				0	106,860,000
A2001-21	L9804	1/13	0		0				0	106,860,000
A2001-21	L9804	1/14	0		0				0	106,860,000
A2001-21	L9804	1/15	0		0				0	106,860,000
A2001-21	L9804	1/16	0		0				0	106,860,000
A2001-21	L9804	1/17	0		0				0	106,860,000
A2001-21	L9804	1/18	0						0	106,860,000
A2001-21	L9804	1/19	0						0	106,860,000
A2001-21	L9804	1/20							0	106,860,000
A2001-21	L9804	1/21							0	106,860,000
A2001-21	L9804	1/22							0	106,860,000
A2001-21	L9804	1/23							0	106,860,000
A2001-21	L9804	1/24							0	106,860,000
A2001-21	L9804	1/25							0	106,860,000
A2001-21	L9804	1/26							0	106,860,000
A2001-21	L9804	1/27							0	106,860,000
A2001-21	L9804	1/28							0	106,860,000
A2001-21	L9804	1/29							0	106,860,000
A2001-21	L9804	1/30							0	106,860,000
A2001-21	L9804	1/31	87,990						87,990	106,772,010
		January Total	87,990	0	0	0	0	0	87,990	106,772,010

Table A-2
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Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons): Ice Roads/Pads: Peak	Ice Roads/Pads: Catco	Ice Roads/Pads: Nanuq	Camp (Catco)	Drilling (Catco)	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										336,243,526
A2001-21	R0056	2/1		0		6,000			6,000	336,237,526
A2001-21	R0056	2/2		0					0	336,237,526
A2001-21	R0056	2/3		0					0	336,237,526
A2001-21	R0056	2/4		0					0	336,237,526
A2001-21	R0056	2/5		0					0	336,237,526
A2001-21	R0056	2/6		0		6,000			6,000	336,231,526
A2001-21	R0056	2/7		0		6,000			6,000	336,225,526
A2001-21	R0056	2/8		0		6,000			6,000	336,219,526
A2001-21	R0056	2/9		0		9,000			9,000	336,210,526
A2001-21	R0056	2/10		0		3,000			3,000	336,207,526
A2001-21	R0056	2/11		0		9,000			9,000	336,198,526
A2001-21	R0056	2/12		18,000		6,000			24,000	336,174,526
A2001-21	R0056	2/13		0		9,000			9,000	336,165,526
A2001-21	R0056	2/14		0		18,000			18,000	336,147,526
A2001-21	R0056	2/15		48,000		6,000			54,000	336,093,526
A2001-21	R0056	2/16		48,000		18,000			66,000	336,027,526
A2001-21	R0056	2/17				48,000			48,000	335,979,526
A2001-21	R0056	2/18				3,000			3,000	335,976,526
A2001-21	R0056	2/19							0	335,976,526
A2001-21	R0056	2/20							0	335,976,526
A2001-21	R0056	2/21							0	335,976,526
A2001-21	R0056	2/22		30,000					30,000	335,946,526
A2001-21	R0056	2/23		30,000					30,000	335,916,526
A2001-21	R0056	2/24		30,000					30,000	335,886,526
A2001-21	R0056	2/25		30,000					30,000	335,856,526
A2001-21	R0056	2/26		33,000					33,000	335,823,526
A2001-21	R0056	2/27		15,000					15,000	335,808,526
A2001-21	R0056	2/28		9,000					9,000	335,799,526
		February Total	0	291,000	0	153,000	0	0	444,000	335,799,526
										69,839,304
A2001-21	L9817	2/1		174,000					174,000	69,665,304
A2001-21	L9817	2/2	1,212,960	210,000					1,422,960	68,242,344
A2001-21	L9817	2/3	251,244						251,244	67,991,100
A2001-21	L9817	2/4	0						0	67,991,100
A2001-21	L9817	2/5	0						0	67,991,100
A2001-21	L9817	2/6	1,462,914						1,462,914	66,528,186
A2001-21	L9817	2/7	1,101,996						1,101,996	65,426,190
A2001-21	L9817	2/8	998,634						998,634	64,427,556
A2001-21	L9817	2/9	853,650						853,650	63,573,906
A2001-21	L9817	2/10	905,142						905,142	62,668,764
A2001-21	L9817	2/11	1,002,540						1,002,540	61,666,224
A2001-21	L9817	2/12	913,080						913,080	60,753,144
A2001-21	L9817	2/13	307,230						307,230	60,445,914
A2001-21	L9817	2/14	37,800						37,800	60,408,114
A2001-21	L9817	2/15	0						0	60,408,114
A2001-21	L9817	2/16	0						0	60,408,114
A2001-21	L9817	2/17	37,800		34,020				71,820	60,336,294
A2001-21	L9817	2/18	18,900						18,900	60,317,394
A2001-21	L9817	2/19							0	60,317,394
A2001-21	L9817	2/20	176,400						176,400	60,140,994
A2001-21	L9817	2/21	113,400						113,400	60,027,594
A2001-21	L9817	2/22							0	60,027,594
A2001-21	L9817	2/23	75,600						75,600	59,951,994
A2001-21	L9817	2/24	25,200						25,200	59,926,794
A2001-21	L9817	2/25	37,800						37,800	59,888,994
A2001-21	L9817	2/26	184,800						184,800	59,704,194
A2001-21	L9817	2/27	88,200						88,200	59,615,994
A2001-21	L9817	2/28	107,100						107,100	59,508,894
		February Total	9,912,390	384,000	34,020	0	0	0	10,330,410	59,508,894

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Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons) — Ice Roads/Pads — Peak	Ice Roads/Pads — Catco	Ice Roads/Pads — Nanuq	Camp (Catco)	Drilling (Catco)	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										106,772,010
A2001-21	L9804	2/1	1120140						1,120,140	105,651,870
A2001-21	L9804	2/2	723,240						723,240	106,048,770
A2001-21	L9804	2/3	148,680						148,680	105,900,090
A2001-21	L9804	2/4	0						0	105,900,090
A2001-21	L9804	2/5	0						0	105,900,090
A2001-21	L9804	2/6	132,300						132,300	105,767,790
A2001-21	L9804	2/7	178,416						178,416	105,589,374
A2001-21	L9804	2/8	110,880						110,880	105,478,494
A2001-21	L9804	2/9	27,720						27,720	105,450,774
A2001-21	L9804	2/10							0	105,450,774
A2001-21	L9804	2/11							0	105,450,774
A2001-21	L9804	2/12							0	105,450,774
A2001-21	L9804	2/13							0	105,450,774
A2001-21	L9804	2/14							0	105,450,774
A2001-21	L9804	2/15							0	105,450,774
A2001-21	L9804	2/16							0	105,450,774
A2001-21	L9804	2/17							0	105,450,774
A2001-21	L9804	2/18							0	105,450,774
A2001-21	L9804	2/19							0	105,450,774
A2001-21	L9804	2/20							0	105,450,774
A2001-21	L9804	2/21							0	105,450,774
A2001-21	L9804	2/22							0	105,450,774
A2001-21	L9804	2/23							0	105,450,774
		February Total	2,441,376	0	0	0	0	0	2,441,376	105,450,774
										3,423,678
A2001-21	M9606	2/1	0						0	3,423,678
A2001-21	M9606	2/2	0						0	3,423,678
A2001-21	M9606	2/3	0						0	3,423,678
A2001-21	M9606	2/4	0						0	3,423,678
A2001-21	M9606	2/5	0						0	3,423,678
A2001-21	M9606	2/6	0						0	3,423,678
A2001-21	M9606	2/7	0						0	3,423,678
A2001-21	M9606	2/8	79,380						79,380	3,344,298
A2001-21	M9606	2/9	0						0	3,344,298
A2001-21	M9606	2/10	0						0	3,344,298
A2001-21	M9606	2/11	403,452						403,452	2,940,846
A2001-21	M9606	2/12	113,400						113,400	2,827,446
A2001-21	M9606	2/13							0	2,827,446
A2001-21	M9606	2/14							0	2,827,446
A2001-21	M9606	2/15							0	2,827,446
A2001-21	M9606	2/16							0	2,827,446
A2001-21	M9606	2/17							0	2,827,446
A2001-21	M9606	2/18							0	2,827,446
A2001-21	M9606	2/19							0	2,827,446
A2001-21	M9606	2/20							0	2,827,446
A2001-21	M9606	2/21							0	2,827,446
A2001-21	M9606	2/22							0	2,827,446
A2001-21	M9606	2/23							0	2,827,446
		February Total	596,232	0	0	0	0	0	596,232	2,827,446

February 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons) – Ice Roads/Pads – Peak	Ice Roads/Pads – Catco	Ice Roads/Pads – Nanuq	Camp (Catco)	Drilling (Catco)	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										175,890,000
A2001-21	M9923	2/1	0						0	175,890,000
A2001-21	M9923	2/2	0						0	175,890,000
A2001-21	M9923	2/3	0						0	175,890,000
A2001-21	M9923	2/4	0						0	175,890,000
A2001-21	M9923	2/5	0						0	175,890,000
A2001-21	M9923	2/6	0						0	175,890,000
A2001-21	M9923	2/7	0						0	175,890,000
A2001-21	M9923	2/8	0						0	175,890,000
A2001-21	M9923	2/9	0						0	175,890,000
A2001-21	M9923	2/10	316,512						316,512	175,573,488
A2001-21	M9923	2/11	274,176						274,176	175,299,312
A2001-21	M9923	2/12	404,208						404,208	174,895,104
A2001-21	M9923	2/13	200,088						200,088	174,695,016
A2001-21	M9923	2/14	0						0	174,695,016
A2001-21	M9923	2/15	81,648						81,648	174,613,368
A2001-21	M9923	2/16	221,256						221,256	174,392,112
A2001-21	M9923	2/17	210,672						210,672	174,181,440
A2001-21	M9923	2/18	167,328						167,328	174,014,112
A2001-21	M9923	2/19	208,656						208,656	173,805,456
A2001-21	M9923	2/20	180,423						180,423	173,625,033
A2001-21	M9923	2/21							0	173,625,033
A2001-21	M9923	2/22	112,392						112,392	173,512,641
A2001-21	M9923	2/23	200,592						200,592	173,312,049
A2001-21	M9923	2/24	182,448						182,448	173,129,601
A2001-21	M9923	2/25	76,104						76,104	173,053,497
A2001-21	M9923	2/26	248,472						248,472	172,805,025
A2001-21	M9923	2/27	41,832						41,832	172,763,193
A2001-21	M9923	2/28							0	172,763,193
		February Total	3,126,807	0	0	0	0	0	3,126,807	173,312,049
										254,702,472
A2001-21	L9806	2/1	0						0	254,702,472
A2001-21	L9806	2/2	0						0	254,702,472
A2001-21	L9806	2/3	0						0	254,702,472
A2001-21	L9806	2/4	0						0	254,702,472
A2001-21	L9806	2/5	0						0	254,702,472
A2001-21	L9806	2/6	0						0	254,702,472
A2001-21	L9806	2/7	0						0	254,702,472
A2001-21	L9806	2/8	0						0	254,702,472
A2001-21	L9806	2/9	0						0	254,702,472
A2001-21	L9806	2/10	0						0	254,702,472
A2001-21	L9806	2/11	0						0	254,702,472
A2001-21	L9806	2/12	0						0	254,702,472
A2001-21	L9806	2/13	0						0	254,702,472
A2001-21	L9806	2/14	0		216,695				216,695	254,485,777
A2001-21	L9806	2/15	0		252,252				252,252	254,233,525
A2001-21	L9806	2/16	0		0				0	254,233,525
A2001-21	L9806	2/17	0		45,360				45,360	254,188,165
A2001-21	L9806	2/18	12,600						12,600	254,175,565
A2001-21	L9806	2/19							0	254,175,565
A2001-21	L9806	2/20							0	254,175,565
A2001-21	L9806	2/21							0	254,175,565
A2001-21	L9806	2/22							0	254,175,565
A2001-21	L9806	2/23							0	254,175,565
		February Total	12,600	0	514,307	0	0	0	526,907	254,175,565

February 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons) Ice Roads/Pads Peak	Catco	Nanuq	Camp (Catco)	Drilling (Catco)	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										27,610,000
A2001-21	M9912	2/1	0						0	27,610,000
A2001-21	M9912	2/2	0						0	27,610,000
A2001-21	M9912	2/3	0						0	27,610,000
A2001-21	M9912	2/4	0						0	27,610,000
A2001-21	M9912	2/5	0						0	27,610,000
A2001-21	M9912	2/6	0						0	27,610,000
A2001-21	M9912	2/7	0						0	27,610,000
A2001-21	M9912	2/8	0						0	27,610,000
A2001-21	M9912	2/9	0						0	27,610,000
A2001-21	M9912	2/10	0						0	27,610,000
A2001-21	M9912	2/11	0						0	27,610,000
A2001-21	M9912	2/12	0						0	27,610,000
A2001-21	M9912	2/13	413,910						413,910	27,196,090
A2001-21	M9912	2/14	595,560						595,560	26,600,530
A2001-21	M9912	2/15	546,840						546,840	26,053,690
A2001-21	M9912	2/16	764,316						764,316	25,289,374
A2001-21	M9912	2/17	622,860						622,860	24,666,514
A2001-21	M9912	2/18	615,300						615,300	24,051,214
A2001-21	M9912	2/19	760,830						760,830	23,290,384
A2001-21	M9912	2/20	643,440						643,440	22,646,944
A2001-21	M9912	2/21	574,140						574,140	22,072,804
A2001-21	M9912	2/22	654,780						654,780	21,418,024
A2001-21	M9912	2/23	527,730						527,730	20,890,294
A2001-21	M9912	2/24	435,900						435,900	20,454,394
A2001-21	M9912	2/25	379,680						379,680	20,074,714
A2001-21	M9912	2/26	912,030						912,030	19,162,684
A2001-21	M9912	2/27	474,180						474,180	18,688,504
A2001-21	M9912	2/28	190,680						190,680	18,497,824
		February Total	9,112,176	0	0	0	0	0	9,112,176	18,497,824
										413,420,572
A2001-21	M9602	2/1			0				0	413,420,572
A2001-21	M9602	2/2			0				0	413,420,572
A2001-21	M9602	2/3			0				0	413,420,572
A2001-21	M9602	2/4			0				0	413,420,572
A2001-21	M9602	2/5			0				0	413,420,572
A2001-21	M9602	2/6			0				0	413,420,572
A2001-21	M9602	2/7			0				0	413,420,572
A2001-21	M9602	2/8			0				0	413,420,572
A2001-21	M9602	2/9			0				0	413,420,572
A2001-21	M9602	2/10			0				0	413,420,572
A2001-21	M9602	2/11			0				0	413,420,572
A2001-21	M9602	2/12			0				0	413,420,572
A2001-21	M9602	2/13			261,954				261,954	413,158,618
A2001-21	M9602	2/14			97,020				97,020	413,061,598
A2001-21	M9602	2/15							0	413,061,598
A2001-21	M9602	2/16							0	413,061,598
A2001-21	M9602	2/17							0	413,061,598
A2001-21	M9602	2/18							0	413,061,598
A2001-21	M9602	2/19							0	413,061,598
A2001-21	M9602	2/20							0	413,061,598
A2001-21	M9602	2/21							0	413,061,598
A2001-21	M9602	2/22							0	413,061,598
A2001-21	M9602	2/23							0	413,061,598
		February Total	0	0	358,974	0	0	0	358,974	413,061,598

February 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons)						Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
			Ice Roads/Pads			Camp	Drilling	Camp Water		
			Peak	Catco	Nanuq	(Catco)	(Catco)	(Catco)		
A2001-21										870,780
A2001-21	R0052	2/1							0	870,780
A2001-21	R0052	2/2							0	870,780
A2001-21	R0052	2/3							0	870,780
A2001-21	R0052	2/4							0	870,780
A2001-21	R0052	2/5							0	870,780
A2001-21	R0052	2/6							0	870,780
A2001-21	R0052	2/7							0	870,780
A2001-21	R0052	2/8							0	870,780
A2001-21	R0052	2/9							0	870,780
A2001-21	R0052	2/10							0	870,780
A2001-21	R0052	2/11							0	870,780
A2001-21	R0052	2/12							0	870,780
A2001-21	R0052	2/13							0	870,780
A2001-21	R0052	2/14							0	870,780
A2001-21	R0052	2/15							0	870,780
A2001-21	R0052	2/16							0	870,780
A2001-21	R0052	2/17							0	870,780
A2001-21	R0052	2/18		24,000					24,000	846,780
A2001-21	R0052	2/19		30,000		12000			42,000	804,780
A2001-21	R0052	2/20		48,000					48,000	756,780
A2001-21	R0052	2/21		54,000					54,000	702,780
A2001-21	R0052	2/22		18,000		18000			36,000	666,780
A2001-21	R0052	2/23				18000			18,000	648,780
		February Total	0	174,000	0	48,000	0	0	222,000	648,780
										108,650,000
A2001-21	M9922	2/1	0						0	108,650,000
A2001-21	M9922	2/2	0						0	108,650,000
A2001-21	M9922	2/3	0						0	108,650,000
A2001-21	M9922	2/4	0						0	108,650,000
A2001-21	M9922	2/5	0						0	108,650,000
A2001-21	M9922	2/6	0						0	108,650,000
A2001-21	M9922	2/7	0						0	108,650,000
A2001-21	M9922	2/8	0						0	108,650,000
A2001-21	M9922	2/9	0						0	108,650,000
A2001-21	M9922	2/10	0						0	108,650,000
A2001-21	M9922	2/11	0						0	108,650,000
A2001-21	M9922	2/12	0						0	108,650,000
A2001-21	M9922	2/13	0						0	108,650,000
A2001-21	M9922	2/14	0						0	108,650,000
A2001-21	M9922	2/15	0						0	108,650,000
A2001-21	M9922	2/16	0						0	108,650,000
A2001-21	M9922	2/17	0						0	108,650,000
A2001-21	M9922	2/18	0						0	108,650,000
A2001-21	M9922	2/19	0						0	108,650,000
A2001-21	M9922	2/20	34,776						34,776	108,615,224
A2001-21	M9922	2/21	308,448						308,448	108,306,776
A2001-21	M9922	2/22	211,680						211,680	108,095,096
A2001-21	M9922	2/23	0						0	108,095,096
A2001-21	M9922	2/24	0						0	108,095,096
A2001-21	M9922	2/25	0						0	108,095,096
A2001-21	M9922	2/26	0						0	108,095,096
A2001-21	M9922	2/27	113,904						113,904	107,981,192
A2001-21	M9922	2/28	205,632						205,632	107,775,560
		February Total	874,440	0	0	0	0	0	874,440	107,775,560

February 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons) — Ice Roads/Pads — Peak	Ice Roads/Pads — Catco	Ice Roads/Pads — Nanuq	Camp (Catco)	Drilling (Catco)	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										232,124,992
A2001-19	M9605	2/4							0	232,124,992
A2001-19	M9605	2/5							0	232,124,992
A2001-19	M9605	2/6							0	232,124,992
A2001-19	M9605	2/7							0	232,124,992
A2001-19	M9605	2/8							0	232,124,992
A2001-19	M9605	2/9							0	232,124,992
A2001-19	M9605	2/10							0	232,124,992
A2001-19	M9605	2/11							0	232,124,992
A2001-19	M9605	2/12							0	232,124,992
A2001-19	M9605	2/13							0	232,124,992
A2001-19	M9605	2/14							0	232,124,992
A2001-19	M9605	2/15							0	232,124,992
A2001-19	M9605	2/16							0	232,124,992
A2001-19	M9605	2/17							0	232,124,992
A2001-19	M9605	2/18							0	232,124,992
A2001-19	M9605	2/19							0	232,124,992
A2001-19	M9605	2/20							0	232,124,992
A2001-19	M9605	2/21	75,600						75,600	232,049,392
A2001-19	M9605	2/22	176,400						176,400	231,872,992
A2001-19	M9605	2/23							0	231,872,992
A2001-19	M9605	2/24							0	231,872,992
A2001-19	M9605	2/25							0	231,872,992
A2001-19	M9605	2/26							0	231,872,992
A2001-19	M9605	2/27	51,450						51,450	231,821,542
A2001-19	M9605	2/28							0	231,821,542
		February Total	303,450	0	0	0	0	0	303,450	231,821,542
										23,360,000
A2001-19	M9915	2/4							0	23,360,000
A2001-19	M9915	2/5							0	23,360,000
A2001-19	M9915	2/6							0	23,360,000
A2001-19	M9915	2/7							0	23,360,000
A2001-19	M9915	2/8							0	23,360,000
A2001-19	M9915	2/9							0	23,360,000
A2001-19	M9915	2/10							0	23,360,000
A2001-19	M9915	2/11							0	23,360,000
A2001-19	M9915	2/12							0	23,360,000
A2001-19	M9915	2/13							0	23,360,000
A2001-19	M9915	2/14							0	23,360,000
A2001-19	M9915	2/15							0	23,360,000
A2001-19	M9915	2/16							0	23,360,000
A2001-19	M9915	2/17							0	23,360,000
A2001-19	M9915	2/18							0	23,360,000
A2001-19	M9915	2/19							0	23,360,000
A2001-19	M9915	2/20							0	23,360,000
A2001-19	M9915	2/21							0	23,360,000
A2001-19	M9915	2/22							0	23,360,000
A2001-19	M9915	2/23							0	23,360,000
A2001-19	M9915	2/24							0	23,360,000
A2001-19	M9915	2/25							0	23,360,000
A2001-19	M9915	2/26							0	23,360,000
A2001-19	M9915	2/27							0	23,360,000
A2001-19	M9915	2/28	297,360						297,360	23,062,640
		February Total	297,360	0	0	0	0	0	297,360	23,062,640

February 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons): Ice Roads/Pads: Peak	Ice Roads/Pads: Catco	Ice Roads/Pads: Nanuq	Camp (Catco)	Drilling (Catco)	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
Lake Use Only by Anadarko										463,590,000
A2001-19	R0061/L9911	2/4							0	463,590,000
A2001-19	R0061/L9911	2/5							0	463,590,000
A2001-19	R0061/L9911	2/6							0	463,590,000
A2001-19	R0061/L9911	2/7							0	463,590,000
A2001-19	R0061/L9911	2/8							0	463,590,000
A2001-19	R0061/L9911	2/9							0	463,590,000
A2001-19	R0061/L9911	2/10							0	463,590,000
A2001-19	R0061/L9911	2/11							0	463,590,000
A2001-19	R0061/L9911	2/12							0	463,590,000
A2001-19	R0061/L9911	2/13							0	463,590,000
A2001-19	R0061/L9911	2/14							0	463,590,000
A2001-19	R0061/L9911	2/15							0	463,590,000
A2001-19	R0061/L9911	2/16							0	463,590,000
A2001-19	R0061/L9911	2/17							0	463,590,000
A2001-19	R0061/L9911	2/18							0	463,590,000
A2001-19	R0061/L9911	2/19		70,900					70,900	463,519,100
A2001-19	R0061/L9911	2/20		174,000					174,000	463,345,100
A2001-19	R0061/L9911	2/21		192,000					192,000	463,153,100
A2001-19	R0061/L9911	2/22	174,300	36,000					210,300	462,942,800
A2001-19	R0061/L9911	2/23	390,600						390,600	462,552,200
A2001-19	R0061/L9911	2/24	27,790						27,790	462,524,410
A2001-19	R0061/L9911	2/25	161,154						161,154	462,363,256
A2001-19	R0061/L9911	2/26							0	462,363,256
A2001-19	R0061/L9911	2/27							0	462,363,256
A2001-19	R0061/L9911	2/28							0	462,363,256
		February Total	753,844	472,900	0	0	0	0	1,226,744	462,363,256

Table A-3
March 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons): Ice Roads/Pads: Peak	Ice Roads/Pads: Catco	Ice Roads/Pads: Nanuq	Camp (Catco)	Drilling (Catco)	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										23,062,640
A2001-19	M9915	3/1	475440						475,440	22,587,200
A2001-19	M9915	3/2	443,940						443,940	22,143,260
A2001-19	M9915	3/3	239,400						239,400	21,903,860
A2001-19	M9915	3/4							0	21,903,860
A2001-19	M9915	3/5							0	21,903,860
A2001-19	M9915	3/6							0	21,903,860
A2001-19	M9915	3/7							0	21,903,860
A2001-19	M9915	3/8							0	21,903,860
A2001-19	M9915	3/9							0	21,903,860
A2001-19	M9915	3/10							0	21,903,860
A2001-19	M9915	3/11							0	21,903,860
A2001-19	M9915	3/12							0	21,903,860
A2001-19	M9915	3/13							0	21,903,860
A2001-19	M9915	3/14							0	21,903,860
A2001-19	M9915	3/15							0	21,903,860
A2001-19	M9915	3/16							0	21,903,860
A2001-19	M9915	3/17							0	21,903,860
A2001-19	M9915	3/18							0	21,903,860
A2001-19	M9915	3/19							0	21,903,860
A2001-19	M9915	3/20							0	21,903,860
A2001-19	M9915	3/21							0	21,903,860
A2001-19	M9915	3/22							0	21,903,860
A2001-19	M9915	3/23							0	21,903,860
A2001-19	M9915	3/24							0	21,903,860
A2001-19	M9915	3/25							0	21,903,860
		March Total	1,158,780	0	0	0	0	0	1,158,780	21,903,860
										107,775,560
A2001-21	M9922	37316	204120						204,120	107,571,440
A2001-21	M9922	37317	162,792						162,792	107,408,648
A2001-21	M9922	3/3	197,568						197,568	107,211,080
A2001-21	M9922	3/4	0						0	107,211,080
A2001-21	M9922	3/5	177,408						177,408	107,033,672
A2001-21	M9922	3/6	22,176						22,176	107,011,496
A2001-21	M9922	3/7							0	107,011,496
A2001-21	M9922	3/8							0	107,011,496
A2001-21	M9922	3/9							0	107,011,496
A2001-21	M9922	3/10							0	107,011,496
A2001-21	M9922	3/11							0	107,011,496
A2001-21	M9922	3/12							0	107,011,496
A2001-21	M9922	3/13							0	107,011,496
A2001-21	M9922	3/14							0	107,011,496
A2001-21	M9922	3/15							0	107,011,496
A2001-21	M9922	3/16							0	107,011,496
A2001-21	M9922	3/17							0	107,011,496
A2001-21	M9922	3/18							0	107,011,496
A2001-21	M9922	3/19							0	107,011,496
A2001-21	M9922	3/20							0	107,011,496
A2001-21	M9922	3/21							0	107,011,496
A2001-21	M9922	3/22							0	107,011,496
A2001-21	M9922	3/23							0	107,011,496
A2001-21	M9922	3/24							0	107,011,496
A2001-21	M9922	3/25							0	107,011,496
A2001-21	M9922	3/26							0	107,011,496
A2001-21	M9922	3/27							0	107,011,496
A2001-21	M9922	3/28							0	107,011,496
		March Total	764,064	0	0	0	0	0	764,064	107,011,496

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Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons)						Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
			Ice Roads/Pads			Camp (Catco)	Drilling (Catco)	Camp Water (Catco)		
			Peak	Catco	Nanuq					
										172,763,193
A2001-21	M9923	3/1							0	172,763,193
A2001-21	M9923	3/2							0	172,763,193
A2001-21	M9923	3/3							0	172,763,193
A2001-21	M9923	3/4	148,680						148,680	172,614,513
A2001-21	M9923	3/5	69,048						69,048	172,545,465
A2001-21	M9923	3/6							0	172,545,465
A2001-21	M9923	3/7							0	172,545,465
A2001-21	M9923	3/8							0	172,545,465
A2001-21	M9923	3/9							0	172,545,465
A2001-21	M9923	3/10							0	172,545,465
A2001-21	M9923	3/11							0	172,545,465
A2001-21	M9923	3/12							0	172,545,465
A2001-21	M9923	3/13							0	172,545,465
A2001-21	M9923	3/14							0	172,545,465
A2001-21	M9923	3/15							0	172,545,465
A2001-21	M9923	3/16							0	172,545,465
A2001-21	M9923	3/17							0	172,545,465
A2001-21	M9923	3/18							0	172,545,465
A2001-21	M9923	3/19							0	172,545,465
A2001-21	M9923	3/20							0	172,545,465
A2001-21	M9923	3/21							0	172,545,465
A2001-21	M9923	3/22							0	172,545,465
A2001-21	M9923	3/23							0	172,545,465
A2001-21	M9923	3/24							0	172,545,465
A2001-21	M9923	3/25							0	172,545,465
A2001-21	M9923	3/26							0	172,545,465
A2001-21	M9923	3/27							0	172,545,465
A2001-21	M9923	3/28							0	172,545,465
		March Total	217,728	0	0	0	0	0	217,728	172,545,465
										59,508,894
A2001-21	L9817	3/1	0					42,000	42,000	59,466,894
A2001-21	L9817	3/2	138,600					16,800	155,400	59,311,494
A2001-21	L9817	37318	100,800					12,600	113,400	59,198,094
A2001-21	L9817	37319	63,060					16,800	79,860	59,118,234
A2001-21	L9817	37320	75,600					16,800	92,400	59,025,834
A2001-21	L9817	3/6	63,000					16,800	79,800	58,946,034
A2001-21	L9817	3/7	163,800					25,200	189,000	58,757,034
A2001-21	L9817	3/8	27,300					25,200	52,500	58,704,534
A2001-21	L9817	3/9	50,400					25,200	75,600	58,628,934
A2001-21	L9817	3/10	0					16,800	16,800	58,612,134
A2001-21	L9817	3/11	107,100					33,600	140,700	58,471,434
A2001-21	L9817	3/12	113,400					16,800	130,200	58,341,234
A2001-21	L9817	3/13	56,700					12,600	69,300	58,271,934
A2001-21	L9817	3/14	56,700					25,200	81,900	58,190,034
A2001-21	L9817	3/15	50,400					16,800	67,200	58,122,834
A2001-21	L9817	3/16	126,000					16,800	142,800	57,980,034
A2001-21	L9817	3/17	195,300					16,800	212,100	57,767,934
A2001-21	L9817	3/18	233,100					16,800	249,900	57,518,034
A2001-21	L9817	3/19	302,400					16,800	319,200	57,198,834
A2001-21	L9817	3/20	207,900					16,800	224,700	56,974,134
A2001-21	L9817	3/21	12,600					16,800	29,400	56,944,734
A2001-21	L9817	3/22	189,000					25,200	214,200	56,730,534
A2001-21	L9817	3/23	226,800					16,800	243,600	56,486,934
A2001-21	L9817	3/24	81,900					25,200	107,100	56,379,834
A2001-21	L9817	3/25	0					16,800	16,800	56,363,034
A2001-21	L9817	3/26	12,600					16,800	29,400	56,333,634
A2001-21	L9817	3/27	6,300					16,800	23,100	56,310,534
A2001-21	L9817	3/28	25,200						25,200	56,285,334
A2001-21	L9817	3/29	69,300						69,300	56,216,034
A2001-21	L9817	3/30	50,400						50,400	56,165,634
A2001-21	L9817	3/31	100,800						100,800	56,064,834
		March Total	2,906,460	0	0	0	0	537,600	3,444,060	56,064,834

March 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons)						Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
			Ice Roads/Pads			Camp (Catco)	Drilling (Catco)	Camp Water (Catco)		
			Peak	Catco	Nanuq					
										335,799,526
A2001-21	R0056	37316					12,000		12,000	335,787,526
A2001-21	R0056	37317					12,000		12,000	335,775,526
A2001-21	R0056	37318					0		0	335,775,526
A2001-21	R0056	37319					0		0	335,775,526
A2001-21	R0056	37320					12,000		12,000	335,763,526
A2001-21	R0056	37321					24,000		24,000	335,739,526
A2001-21	R0056	37322					18,000		18,000	335,721,526
A2001-21	R0056	37323					24,000		24,000	335,697,526
A2001-21	R0056	37324					15,000		15,000	335,682,526
A2001-21	R0056	37325					24,000		24,000	335,658,526
A2001-21	R0056	37326					27,000		27,000	335,631,526
A2001-21	R0056	37327					6,000		6,000	335,625,526
A2001-21	R0056	37328					15,000		15,000	335,610,526
A2001-21	R0056	37329					18,000		18,000	335,592,526
A2001-21	R0056	37330					15,000		15,000	335,577,526
A2001-21	R0056	37331					9,000		9,000	335,568,526
A2001-21	R0056	37332					9,000		9,000	335,559,526
A2001-21	R0056	37333					12,000		12,000	335,547,526
A2001-21	R0056	37334					6,000		6,000	335,541,526
A2001-21	R0056	37335					6,000		6,000	335,535,526
A2001-21	R0056	37336					3,000		3,000	335,532,526
A2001-21	R0056	37337					9,000		9,000	335,523,526
A2001-21	R0056	37338					18,000		18,000	335,505,526
A2001-21	R0056	37339					12,000		12,000	335,493,526
A2001-21	R0056	37340					12,000		12,000	335,481,526
A2001-21	R0056	37341					3,000		3,000	335,478,526
A2001-21	R0056	37342							0	335,478,526
A2001-21	R0056	37343					9,000		9,000	335,469,526
		March Total	0	0	0	0	330,000	0	330,000	335,469,526
										648,780
A2001-21	R0052	37316					12,000		12,000	636,780
A2001-21	R0052	37317					12,000		12,000	624,780
A2001-21	R0052	37318					30,000		30,000	594,780
A2001-21	R0052	37319					18,000		18,000	576,780
A2001-21	R0052	37320					6,000		6,000	570,780
A2001-21	R0052	37321					9,000		9,000	561,780
A2001-21	R0052	37322					15,000		15,000	546,780
A2001-21	R0052	37323					9,000		9,000	537,780
A2001-21	R0052	37324					9,000		9,000	528,780
A2001-21	R0052	37325					12,000		12,000	516,780
A2001-21	R0052	37326					9,000		9,000	507,780
A2001-21	R0052	37327					6,000		6,000	501,780
A2001-21	R0052	37328					9,000		9,000	492,780
A2001-21	R0052	37329					12,000		12,000	480,780
A2001-21	R0052	37330					12,000		12,000	468,780
A2001-21	R0052	37331					15,000		15,000	453,780
A2001-21	R0052	37332					6,000		6,000	447,780
A2001-21	R0052	37333					6,000		6,000	441,780
A2001-21	R0052	37334					12,000		12,000	429,780
A2001-21	R0052	37335					15,000		15,000	414,780
A2001-21	R0052	37336					3,000		3,000	411,780
A2001-21	R0052	37337					15,000		15,000	396,780
A2001-21	R0052	37338					6,000		6,000	390,780
A2001-21	R0052	37339					12,000		12,000	378,780
A2001-21	R0052	37340					12,000		12,000	366,780
A2001-21	R0052	37341					9,000		9,000	357,780
A2001-21	R0052	37342					9,000		9,000	348,780
A2001-21	R0052	37343					6,000		6,000	342,780
A2001-21	R0052	37344					6,000		6,000	336,780
A2001-21	R0052	37345					3,000		3,000	333,780
A2001-21	R0052	37346					0		0	333,780
		March Total	0	0	0	0	315,000	0	315,000	333,780

March 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons) — Ice Roads/Pads: Peak	Ice Roads/Pads: Catco	Ice Roads/Pads: Nanuq	Camp (Catco)	Drilling (Catco)	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										231,821,542
A2001-19	M9605	37316	63000						63,000	231,758,542
A2001-19	M9605	37317	0						0	231,758,542
A2001-19	M9605	37318	88,200						88,200	231,670,342
A2001-19	M9605	37319	0						0	231,670,342
A2001-19	M9605	37320	0						0	231,670,342
A2001-19	M9605	37321	0						0	231,670,342
A2001-19	M9605	37322	0						0	231,670,342
A2001-19	M9605	37323	0						0	231,670,342
A2001-19	M9605	37324	100,800						100,800	231,569,542
A2001-19	M9605	37325	75,600						75,600	231,493,942
A2001-19	M9605	37326	0						0	231,493,942
A2001-19	M9605	37327	44,100						44,100	231,449,842
A2001-19	M9605	37328	63,000						63,000	231,386,842
A2001-19	M9605	37329	0						0	231,386,842
A2001-19	M9605	37330	75,600						75,600	231,311,242
A2001-19	M9605	37331	37,800						37,800	231,273,442
A2001-19	M9605	37332	75,600						75,600	231,197,842
A2001-19	M9605	37333							0	231,197,842
A2001-19	M9605	37334							0	231,197,842
A2001-19	M9605	37335	81,900						81,900	231,115,942
A2001-19	M9605	37336	244,650						244,650	230,871,292
A2001-19	M9605	37337	567,000						567,000	230,304,292
A2001-19	M9605	37338							0	230,304,292
A2001-19	M9605	37339							0	230,304,292
A2001-19	M9605	37340							0	230,304,292
A2001-19	M9605	37341							0	230,304,292
A2001-19	M9605	37342							0	230,304,292
A2001-19	M9605	37343							0	230,304,292
A2001-19	M9605	37344	25,200						25,200	230,279,092
A2001-19	M9605	37345	100,800						100,800	230,178,292
A2001-19	M9605	37346	44,100						44,100	230,134,192
		March Total	1,687,350	0	0	0	0	0	1,687,350	230,134,192
										18,497,824
A2001-21	M9912	37316	0						0	18,497,824
A2001-21	M9912	37317	50,400						50,400	18,447,424
A2001-21	M9912	37318	214,200						214,200	18,233,224
A2001-21	M9912	37319	277,200						277,200	17,956,024
A2001-21	M9912	37320	352,800						352,800	17,603,224
A2001-21	M9912	37321	25,200						25,200	17,578,024
A2001-21	M9912	37322							0	17,578,024
A2001-21	M9912	37323							0	17,578,024
A2001-21	M9912	37324							0	17,578,024
A2001-21	M9912	37325							0	17,578,024
A2001-21	M9912	37326							0	17,578,024
A2001-21	M9912	37327							0	17,578,024
A2001-21	M9912	37328							0	17,578,024
A2001-21	M9912	37329							0	17,578,024
A2001-21	M9912	37330							0	17,578,024
A2001-21	M9912	37331							0	17,578,024
A2001-21	M9912	37332							0	17,578,024
A2001-21	M9912	37333							0	17,578,024
A2001-21	M9912	37334							0	17,578,024
A2001-21	M9912	37335							0	17,578,024
A2001-21	M9912	37336							0	17,578,024
A2001-21	M9912	37337							0	17,578,024
A2001-21	M9912	37338							0	17,578,024
A2001-21	M9912	37339							0	17,578,024
A2001-21	M9912	37340							0	17,578,024
A2001-21	M9912	37341							0	17,578,024
A2001-21	M9912	37342							0	17,578,024
A2001-21	M9912	37343							0	17,578,024
		March Total	919,800	0	0	0	0	0	919,800	17,578,024

March 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons) Ice Roads/Pads Peak	Catco	Nanuq	Camp (Catco)	Drilling (Catco)	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										254,175,565
A2001-21	L9806	37316							0	254,175,565
A2001-21	L9806	37317							0	254,175,565
A2001-21	L9806	37318							0	254,175,565
A2001-21	L9806	37319							0	254,175,565
A2001-21	L9806	37320							0	254,175,565
A2001-21	L9806	37321							0	254,175,565
A2001-21	L9806	37322							0	254,175,565
A2001-21	L9806	37323							0	254,175,565
A2001-21	L9806	37324							0	254,175,565
A2001-21	L9806	37325	88,200						88,200	254,087,365
A2001-21	L9806	37326							0	254,087,365
A2001-21	L9806	37327							0	254,087,365
A2001-21	L9806	37328							0	254,087,365
A2001-21	L9806	37329							0	254,087,365
A2001-21	L9806	37330							0	254,087,365
A2001-21	L9806	37331							0	254,087,365
A2001-21	L9806	37332							0	254,087,365
A2001-21	L9806	37333							0	254,087,365
A2001-21	L9806	37334							0	254,087,365
A2001-21	L9806	37335							0	254,087,365
A2001-21	L9806	37336							0	254,087,365
A2001-21	L9806	37337							0	254,087,365
A2001-21	L9806	37338							0	254,087,365
A2001-21	L9806	37339							0	254,087,365
A2001-21	L9806	37340							0	254,087,365
A2001-21	L9806	37341							0	254,087,365
A2001-21	L9806	37342							0	254,087,365
A2001-21	L9806	37343							0	254,087,365
A2001-21	L9806	37344	25,200						25,200	254,062,165
A2001-21	L9806	37345							0	254,062,165
A2001-21	L9806	37346							0	254,062,165
		March Total	113,400	0	0	0	0	0	113,400	254,062,165

Table A-4
April 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons): Ice Roads/Pads Peak	Ice Roads/Pads Catco	Ice Roads/Pads Nnnuq	Camp (Catco)	Drilling (Catco)	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										230,134,192
A2001-19	M9605	4/1	25200						25,200	230,108,992
A2001-19	M9605	4/2	0						0	230,108,992
A2001-19	M9605	4/3	75,600						75,600	230,033,392
A2001-19	M9605	4/4	63,000						63,000	229,970,392
A2001-19	M9605	4/5	50,400						50,400	229,919,992
A2001-19	M9605	4/6	50,400						50,400	229,869,592
A2001-19	M9605	4/7	88,200						88,200	229,781,392
A2001-19	M9605	4/8	50,400						50,400	229,730,992
A2001-19	M9605	4/9	81,900						81,900	229,649,092
A2001-19	M9605	4/10	50,400						50,400	229,598,692
A2001-19	M9605	4/11	100,800						100,800	229,497,892
A2001-19	M9605	4/12	12,600						12,600	229,485,292
A2001-19	M9605	4/13	0						0	229,485,292
A2001-19	M9605	4/14	0						0	229,485,292
A2001-19	M9605	4/15	138,600						138,600	229,346,692
A2001-19	M9605	4/16	81,900						81,900	229,264,792
A2001-19	M9605	4/17							0	229,264,792
A2001-19	M9605	4/18	56,700						56,700	229,208,092
A2001-19	M9605	4/19							0	229,208,092
A2001-19	M9605	4/20	75,600						75,600	229,132,492
A2001-19	M9605	4/21							0	229,132,492
A2001-19	M9605	4/22							0	229,132,492
A2001-19	M9605	4/23							0	229,132,492
A2001-19	M9605	4/24							0	229,132,492
A2001-19	M9605	4/25							0	229,132,492
A2001-19	M9605	4/26							0	229,132,492
A2001-19	M9605	4/27							0	229,132,492
A2001-19	M9605	4/28							0	229,132,492
A2001-19	M9605	4/29							0	229,132,492
A2001-19	M9605	4/30							0	229,132,492
		April Total	1,001,700	0	0	0	0	0	1,001,700	229,132,492
										333,780
A2001-21	R0052	4/1					9,000		9,000	324,780
A2001-21	R0052	4/2					6,000		6,000	318,780
A2001-21	R0052	4/3					6,000		6,000	312,780
A2001-21	R0052	4/4					3,000		3,000	309,780
A2001-21	R0052	4/5					3,000		3,000	306,780
A2001-21	R0052	4/6					9,000		9,000	297,780
A2001-21	R0052	4/7					3,000		3,000	294,780
A2001-21	R0052	4/8					3,000		3,000	291,780
A2001-21	R0052	4/9					6,000		6,000	285,780
A2001-21	R0052	4/10					6,000		6,000	279,780
A2001-21	R0052	4/11					6,000		6,000	273,780
A2001-21	R0052	4/12					3,000		3,000	270,780
A2001-21	R0052	4/13					3,000		3,000	267,780
A2001-21	R0052	4/14					3,000		3,000	264,780
A2001-21	R0052	4/15					6,000		6,000	258,780
A2001-21	R0052	4/16					3,000		3,000	255,780
A2001-21	R0052	4/17					3,000		3,000	252,780
A2001-21	R0052	4/18					3,000		3,000	249,780
A2001-21	R0052	4/19					3,000		3,000	246,780
A2001-21	R0052	4/20					3,000		3,000	243,780
A2001-21	R0052	4/21					3,000		3,000	240,780
A2001-21	R0052	4/22					3,000		3,000	237,780
A2001-21	R0052	4/23					3,000		3,000	234,780
A2001-21	R0052	4/24					3,000		3,000	231,780
A2001-21	R0052	4/25					3,000		3,000	228,780
A2001-21	R0052	4/26					3,000		3,000	225,780
A2001-21	R0052	4/27					3,000		3,000	222,780
A2001-21	R0052	4/28					3,000		3,000	219,780
A2001-21	R0052	4/29					3,000		3,000	216,780
A2001-21	R0052	4/30					0		0	216,780
		April Total	0	0	0	0	117,000	0	117,000	216,780

April 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons): Ice Roads/Pads: Peak	Ice Roads/Pads: Catco	Ice Roads/Pads: Nnnuq	Camp (Catco)	Drilling (Catco)	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										56,064,834
A2001-21	L9817	4/1	75606						75,606	55,989,228
A2001-21	L9817	4/2	50,400						50,400	55,938,828
A2001-21	L9817	4/3	75,600						75,600	55,863,228
A2001-21	L9817	4/4	75,600					113,400	189,000	55,674,228
A2001-21	L9817	4/5	50,400						50,400	55,623,828
A2001-21	L9817	4/6	69,300						69,300	55,554,528
A2001-21	L9817	4/7	37,800						37,800	55,516,728
A2001-21	L9817	4/8	0						0	55,516,728
A2001-21	L9817	4/9	0						0	55,516,728
A2001-21	L9817	4/10	31,500						31,500	55,485,228
A2001-21	L9817	4/11	0						0	55,485,228
A2001-21	L9817	4/12	75,600						75,600	55,409,628
A2001-21	L9817	4/13	0						0	55,409,628
A2001-21	L9817	4/14	0						0	55,409,628
A2001-21	L9817	4/15	0						0	55,409,628
A2001-21	L9817	4/16	88,200						88,200	55,321,428
A2001-21	L9817	4/17	88,200						88,200	55,233,228
A2001-21	L9817	4/18	25,200						25,200	55,208,028
A2001-21	L9817	4/19	132,300						132,300	55,075,728
A2001-21	L9817	4/20							0	55,075,728
A2001-21	L9817	4/21	100,800						100,800	54,974,928
A2001-21	L9817	4/22	25,200						25,200	54,949,728
A2001-21	L9817	4/23							0	54,949,728
A2001-21	L9817	4/24							0	54,949,728
A2001-21	L9817	4/25							0	54,949,728
A2001-21	L9817	4/26							0	54,949,728
A2001-21	L9817	4/27							0	54,949,728
A2001-21	L9817	4/28							0	54,949,728
A2001-21	L9817	4/29							0	54,949,728
A2001-21	L9817	4/30							0	54,949,728
		April Total	1,001,706	0	0	0	0	113,400	1,115,106	54,949,728
										2 M gallons Shared w/M0184
A2002-16	M0183	4/1							0	#VALUE!
A2002-16	M0183	4/2		36,000					36,000	#VALUE!
A2002-16	M0183	4/3		36,000					36,000	#VALUE!
A2002-16	M0183	4/4		0					0	#VALUE!
A2002-16	M0183	4/5		0					0	#VALUE!
A2002-16	M0183	4/6		24,000					24,000	#VALUE!
A2002-16	M0183	4/7		0					0	#VALUE!
A2002-16	M0183	4/8		0					0	#VALUE!
A2002-16	M0183	4/9		48,000					48,000	#VALUE!
A2002-16	M0183	4/10		12,000					12,000	#VALUE!
A2002-16	M0183	4/11		132,000					132,000	#VALUE!
A2002-16	M0183	4/12		126,000					126,000	#VALUE!
A2002-16	M0183	4/13		96,000					96,000	#VALUE!
A2002-16	M0183	4/14		87,000					87,000	#VALUE!
A2002-16	M0183	4/15		138,000					138,000	#VALUE!
A2002-16	M0183	4/16		150,000					150,000	#VALUE!
A2002-16	M0183	4/17		13,800					13,800	#VALUE!
A2002-16	M0183	4/18		114,000					114,000	#VALUE!
A2002-16	M0183	4/19		126,000					126,000	#VALUE!
A2002-16	M0183	4/20		102,000					102,000	#VALUE!
A2002-16	M0183	4/21		84,000					84,000	#VALUE!
A2002-16	M0183	4/22		66,000					66,000	#VALUE!
A2002-16	M0183	4/23		3,000					3,000	#VALUE!
A2002-16	M0183	4/24		3,000					3,000	#VALUE!
A2002-16	M0183	4/25		3,000					3,000	#VALUE!
A2002-16	M0183	4/26		3,000					3,000	#VALUE!
A2002-16	M0183	4/27		0					0	#VALUE!
A2002-16	M0183	4/28		3,000					3,000	#VALUE!
A2002-16	M0183	4/29		3,000					3,000	#VALUE!
A2002-16	M0183	4/30		0					0	#VALUE!
		April Total	0	1,408,800	0	0	0	0	1,408,800	#VALUE!

Table A-5
May 2002 NPR-A Lake Water Use

Permit Number(s)	Common Name	Date	Type and Volume of Water Use (Gallons): Ice Roads/Pads: Peak	Ice Roads/Pads: Catco	Ice Roads/Pads: Nnnuq	Camp (Catco)	Drilling (Catco)	Camp Water (Catco)	Daily/ Cumulative Total (Gallons)	Regulatory Limit & Remaining Volume (Gallons)
										229,132,492
A2001-19	M9605	5/1							0	229,132,492
A2001-19	M9605	5/2							0	229,132,492
A2001-19	M9605	5/3			34,020				34,020	229,098,472
A2001-19	M9605	5/4			22,680				22,680	229,075,792
A2001-19	M9605	5/5							0	229,075,792
A2001-19	M9605	5/6							0	229,075,792
A2001-19	M9605	5/7							0	229,075,792
A2001-19	M9605	5/8							0	229,075,792
A2001-19	M9605	5/9							0	229,075,792
A2001-19	M9605	5/10							0	229,075,792
A2001-19	M9605	5/11							0	229,075,792
A2001-19	M9605	5/12							0	229,075,792
A2001-19	M9605	5/13							0	229,075,792
A2001-19	M9605	5/14							0	229,075,792
A2001-19	M9605	5/15							0	229,075,792
		May Total	0	0	56,700	0	0	0	56,700	229,075,792
										216,780
A2001-21	R0052	5/1					3,000		3,000	213,780
A2001-21	R0052	5/2					3,000		3,000	210,780
A2001-21	R0052	5/3					3,000		3,000	207,780
A2001-21	R0052	5/4					3,000		3,000	204,780
A2001-21	R0052	5/5					3,000		3,000	201,780
A2001-21	R0052	5/6					3,000		3,000	198,780
A2001-21	R0052	5/7							0	198,780
A2001-21	R0052	5/8							0	198,780
A2001-21	R0052	5/9							0	198,780
A2001-21	R0052	5/10							0	198,780
A2001-21	R0052	5/11							0	198,780
A2001-21	R0052	5/12							0	198,780
A2001-21	R0052	5/13							0	198,780
A2001-21	R0052	5/14							0	198,780
A2001-21	R0052	5/15							0	198,780
		May Total	0	0	0	0	18,000	0	18,000	198,780
										1,405,800
A2002-16	M0183	5/1					3,000		3,000	1,402,800
A2002-16	M0183	5/2					3,000		3,000	1,399,800
A2002-16	M0183	5/3					3,000		3,000	1,396,800
A2002-16	M0183	5/4					6,000		6,000	1,390,800
A2002-16	M0183	5/5					0		0	1,390,800
A2002-16	M0183	5/6					12,000		12,000	1,378,800
A2002-16	M0183	5/7							0	1,378,800
A2002-16	M0183	5/8							0	1,378,800
A2002-16	M0183	5/9							0	1,378,800
A2002-16	M0183	5/10							0	1,378,800
A2002-16	M0183	5/11							0	1,378,800
A2002-16	M0183	5/2							0	1,378,800
A2002-16	M0183	5/13							0	1,378,800
A2002-16	M0183	5/14							0	1,378,800
A2002-16	M0183	5/15							0	1,378,800
		May Total	0	0	0	0	27,000	0	27,000	1,378,800

Appendix B   NPR-A Lake Photographs

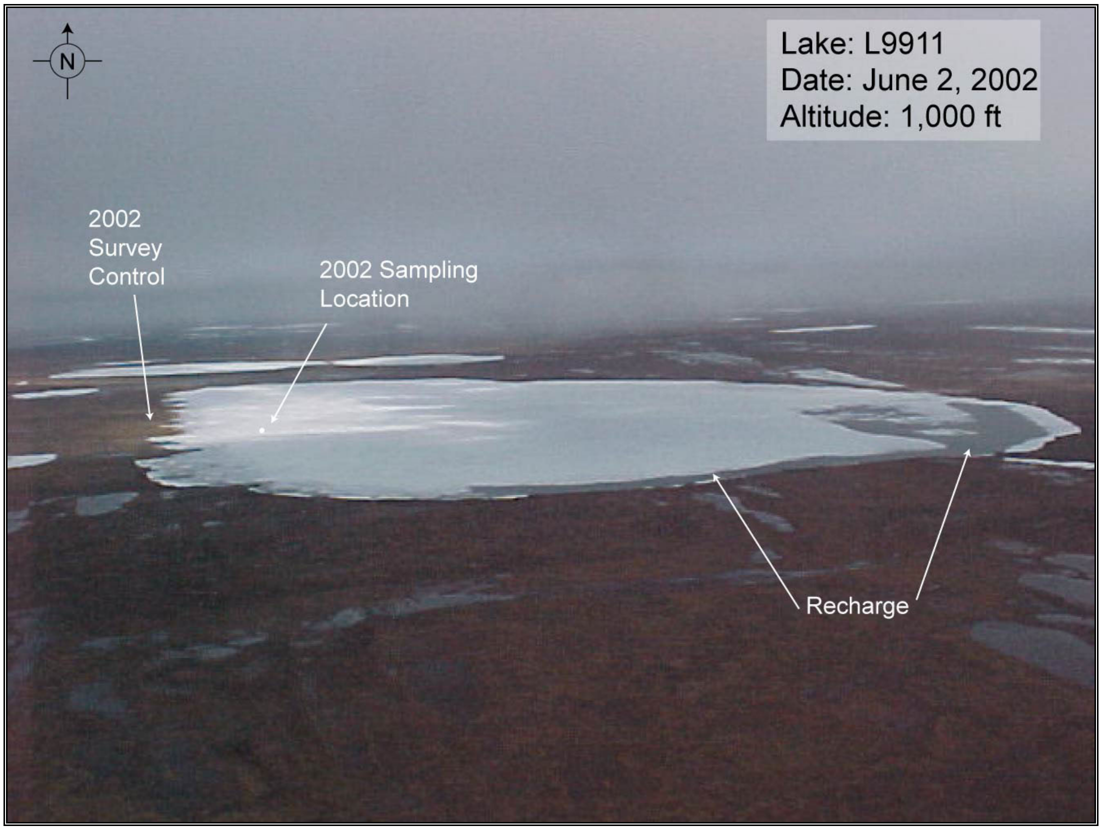

Photo B-1-a Recharge from local melt/runoff is evident on the south and east sides of lake.

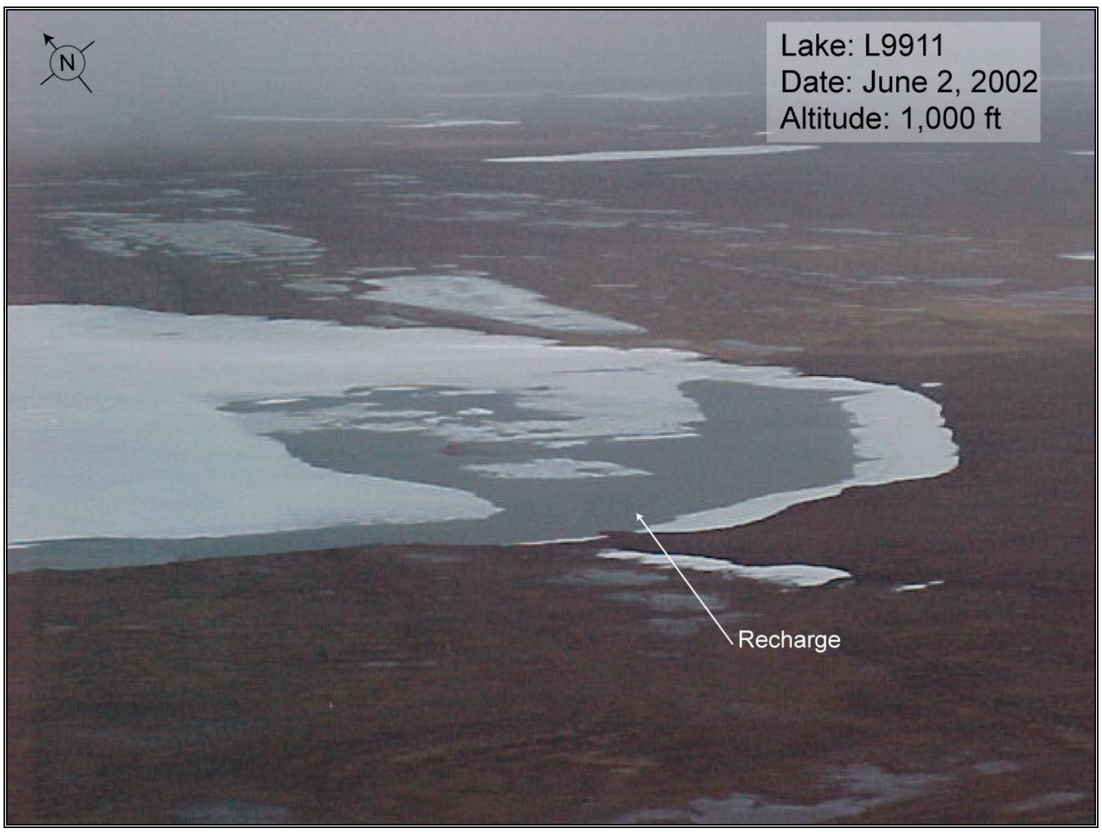

Photo B-1-b Local melt-generated recharge on southeast end of lake.

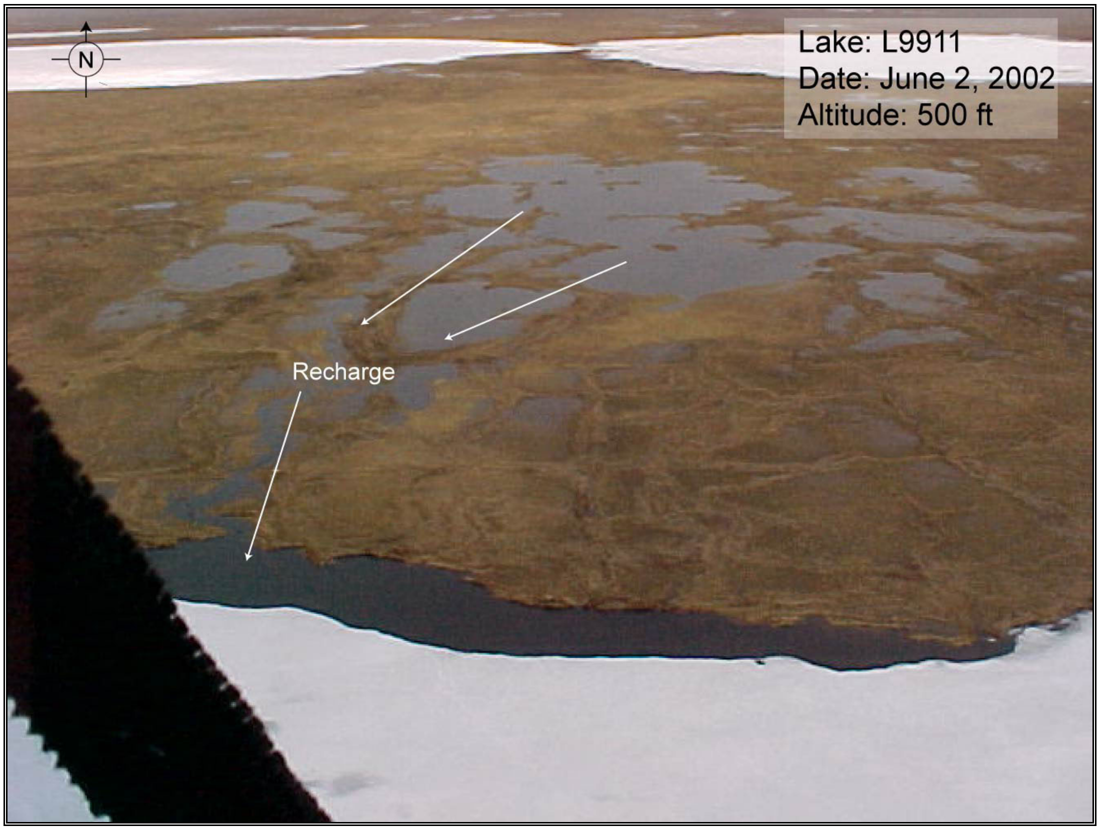

Photo B-1-c Local melt/recharge on north end of lake. Note defined flow path.

Photo B-1-d North end of lake.

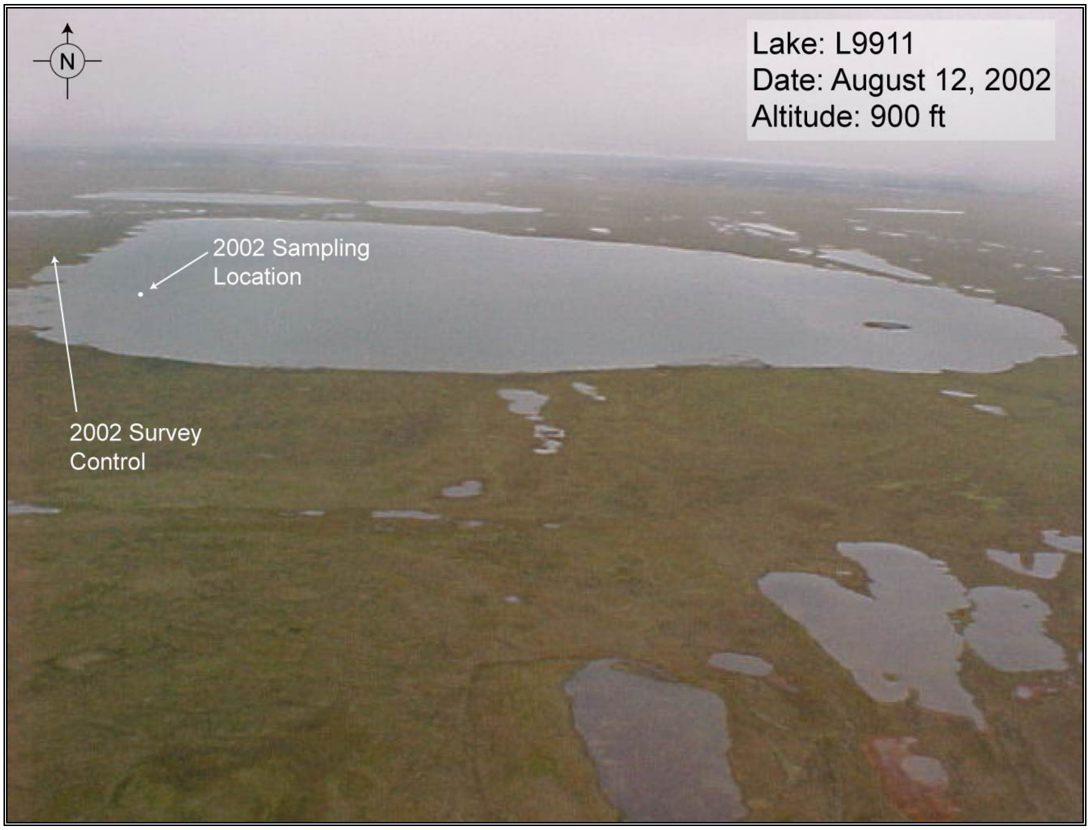

Photo B-1-e Overview of lake.

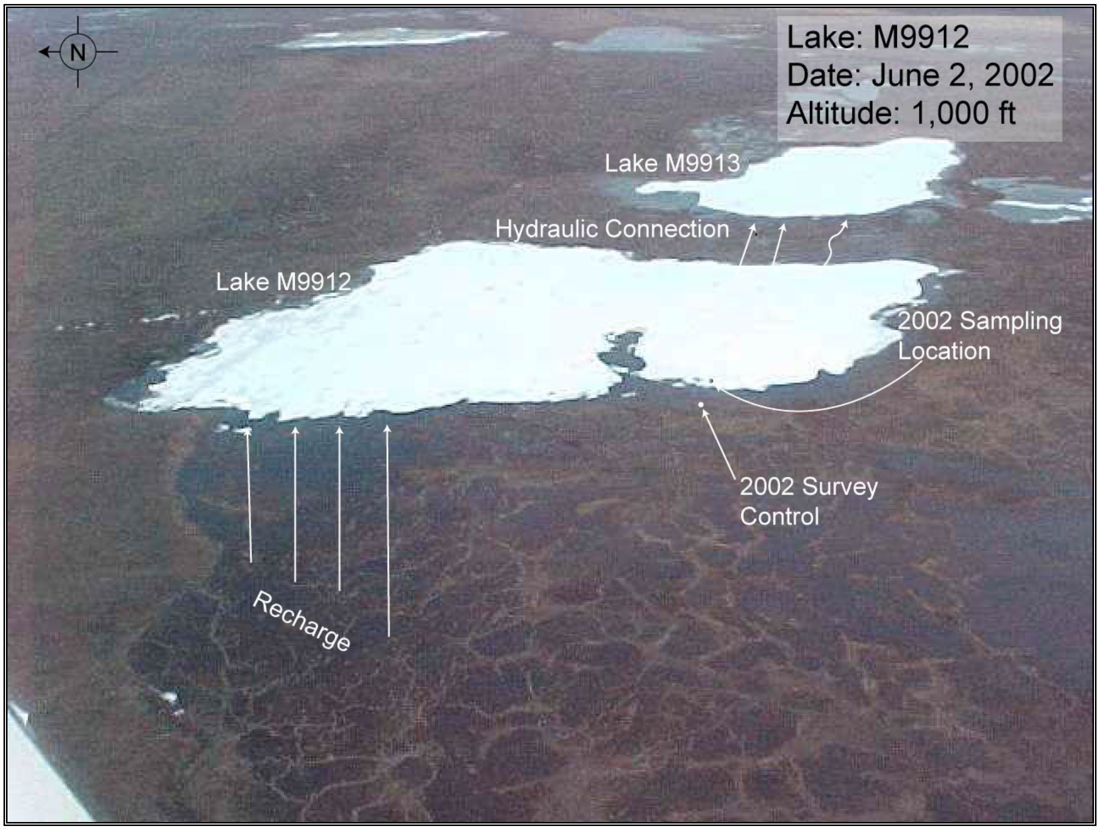

Photo B-2-a Recharge from local melt/runoff noted along northwest end of Lake M9912. Hydraulic connection noted between Lakes M9912 and M9913 in the form of shallow sheet flow.

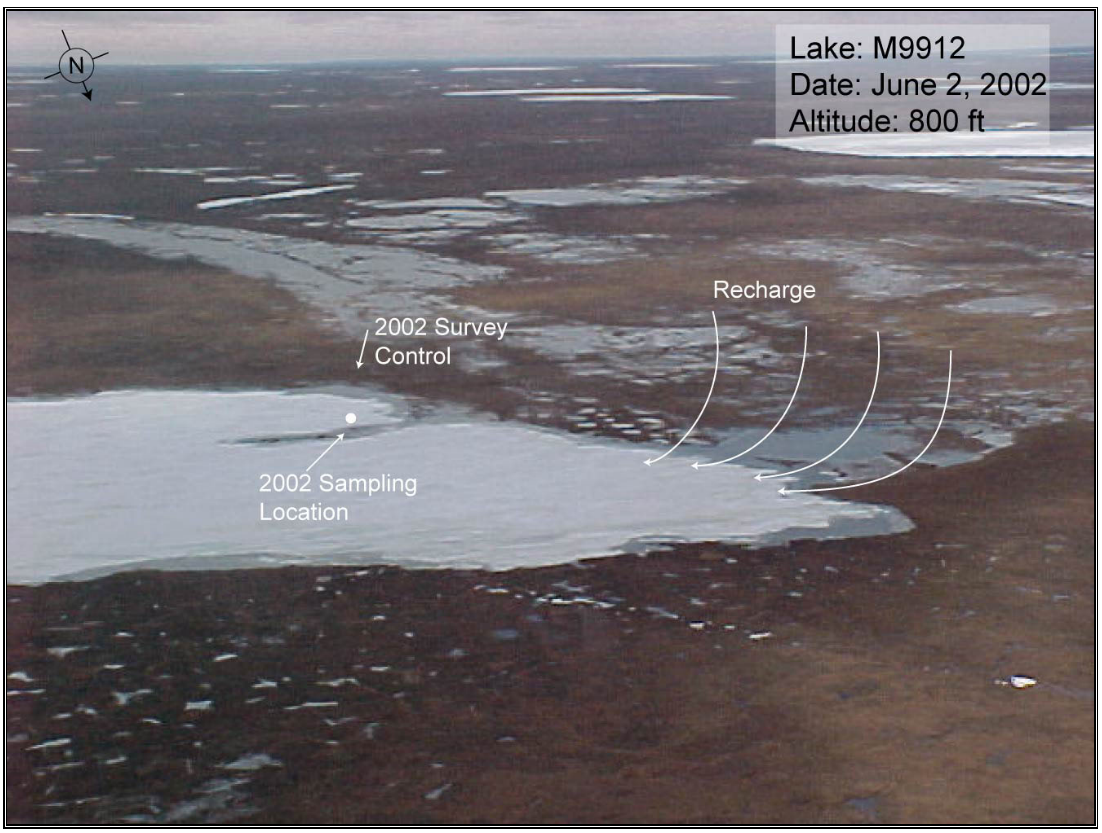

Photo B-2-b Northwest portion of lake and source of local melt/runoff recharge. Flow was observed into lake from this source on June 2.

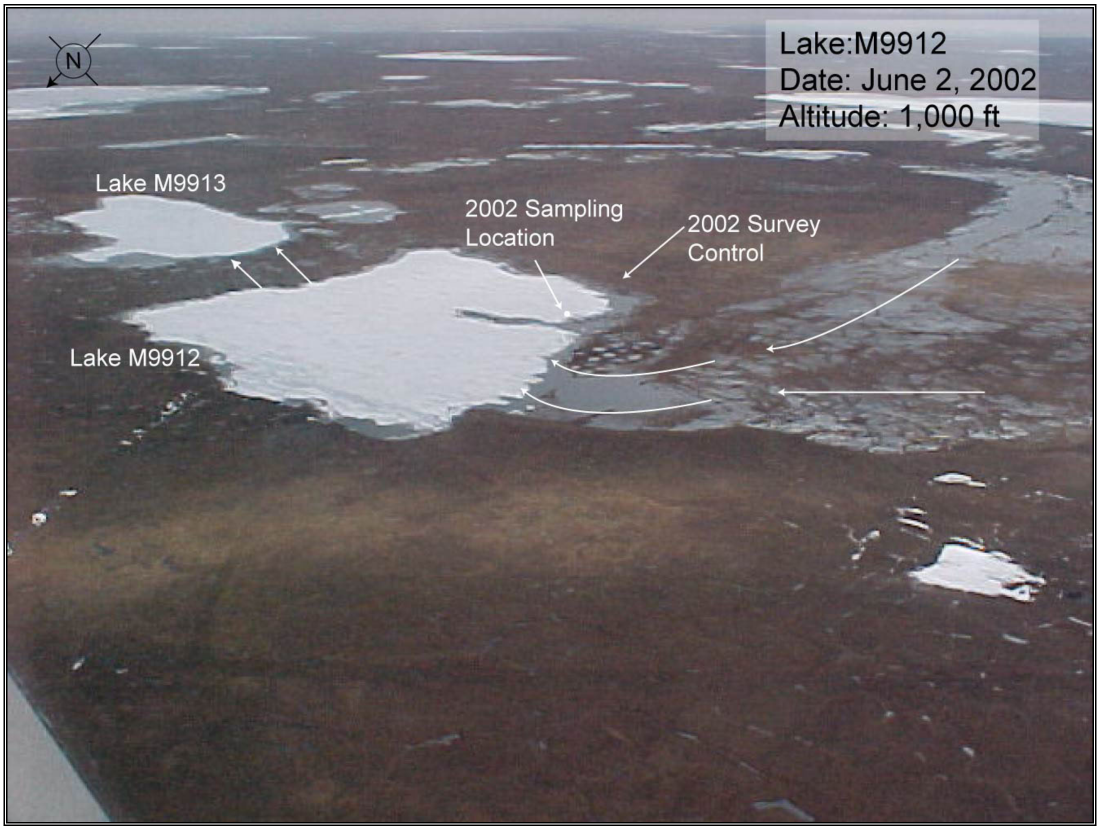

Photo B-2-c Wide-angle view showing extent of local melt/runoff and recharge to the lake. Photo shows hydraulic connection between Lakes M9912 and M9913.

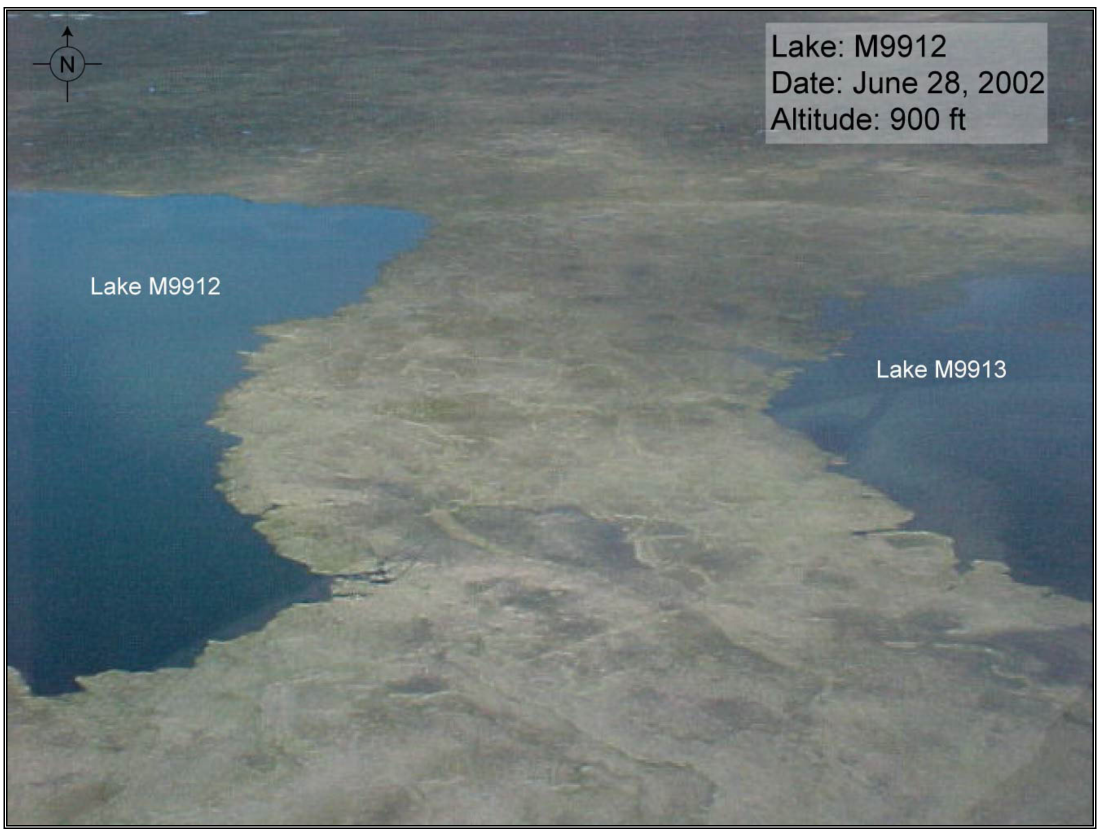

Photo B-2-d Area between Lakes M9912 and M9913. Sheet flow between lakes is no longer apparent. Some suggestion of channel formation between lakes is evident.

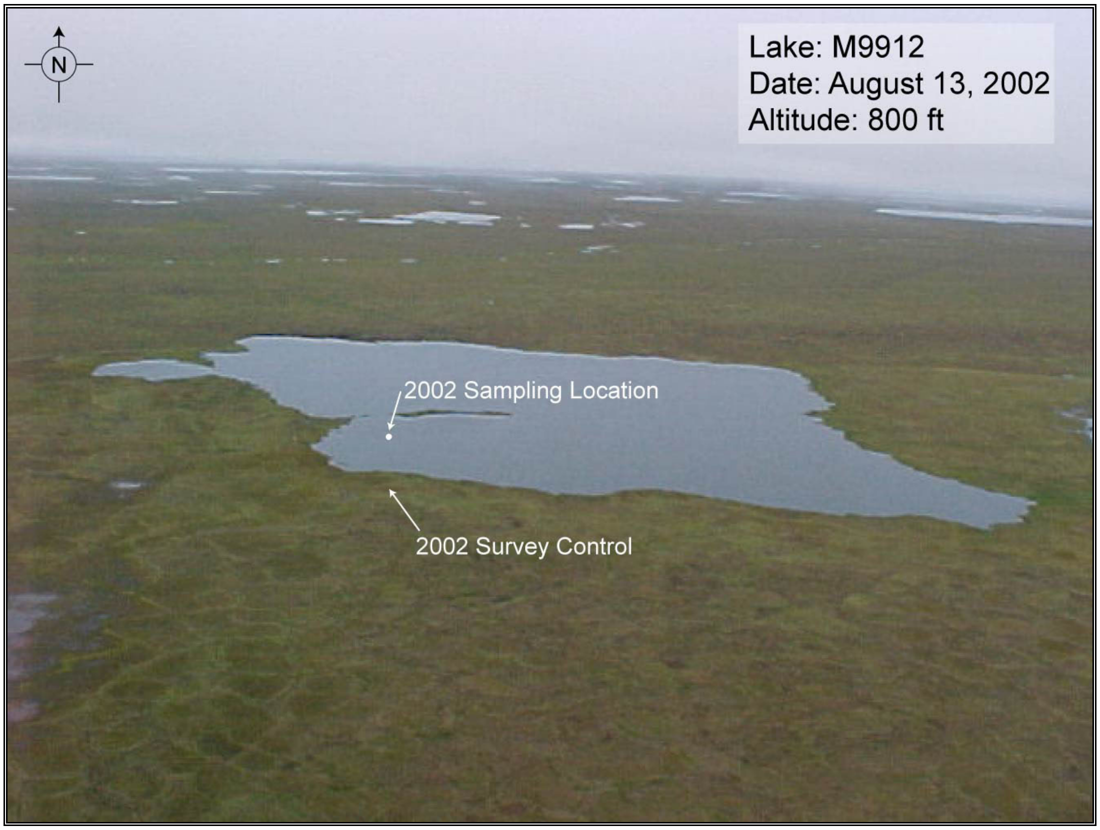

Photo B-2-e Overview of lake.

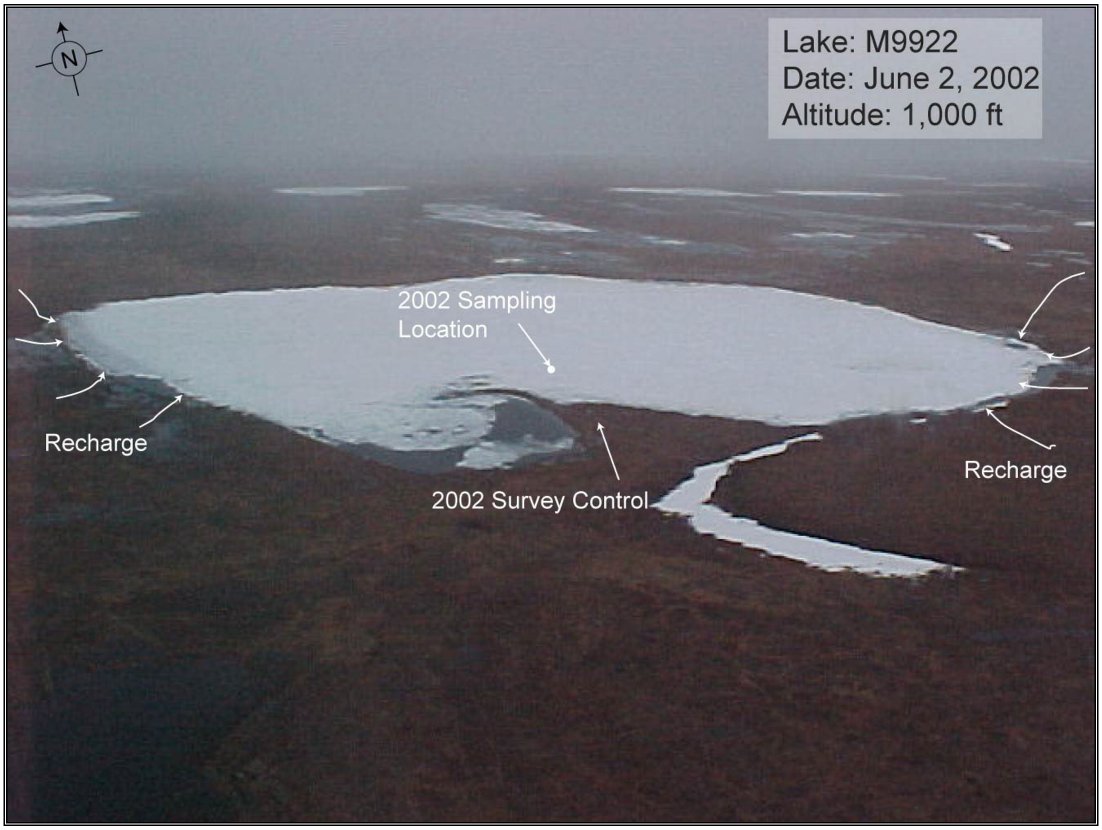

Photo B-3-a Recharge from local melt is evident on the east and west ends of the lake.

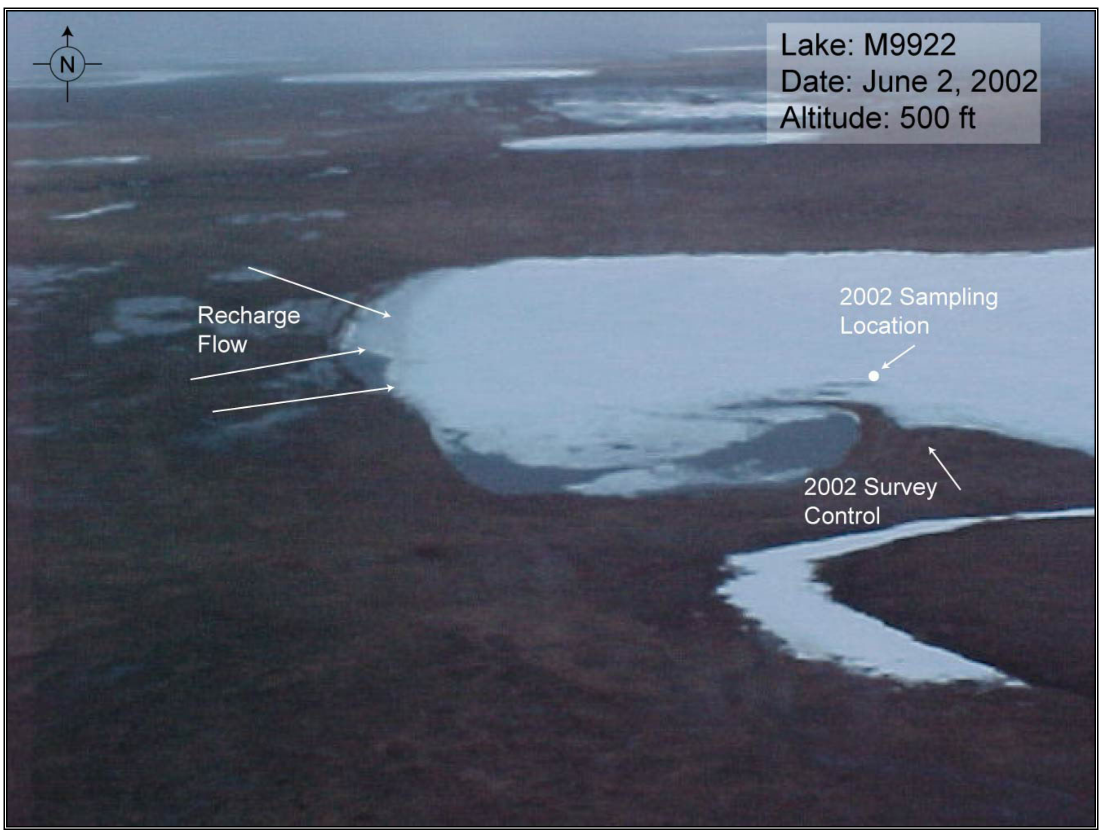

Photo B-3-b Local melt/recharge at west end of the lake.

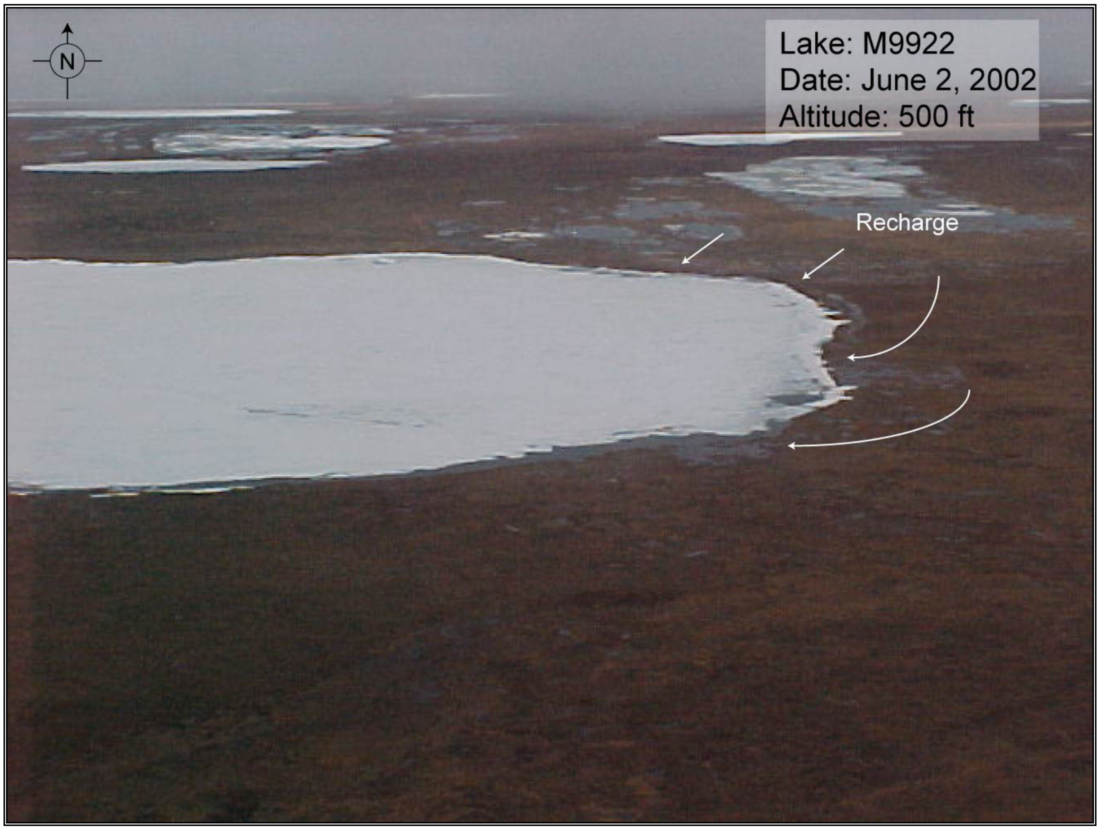

Photo B-3-c Local melt/recharge at east end of the lake.

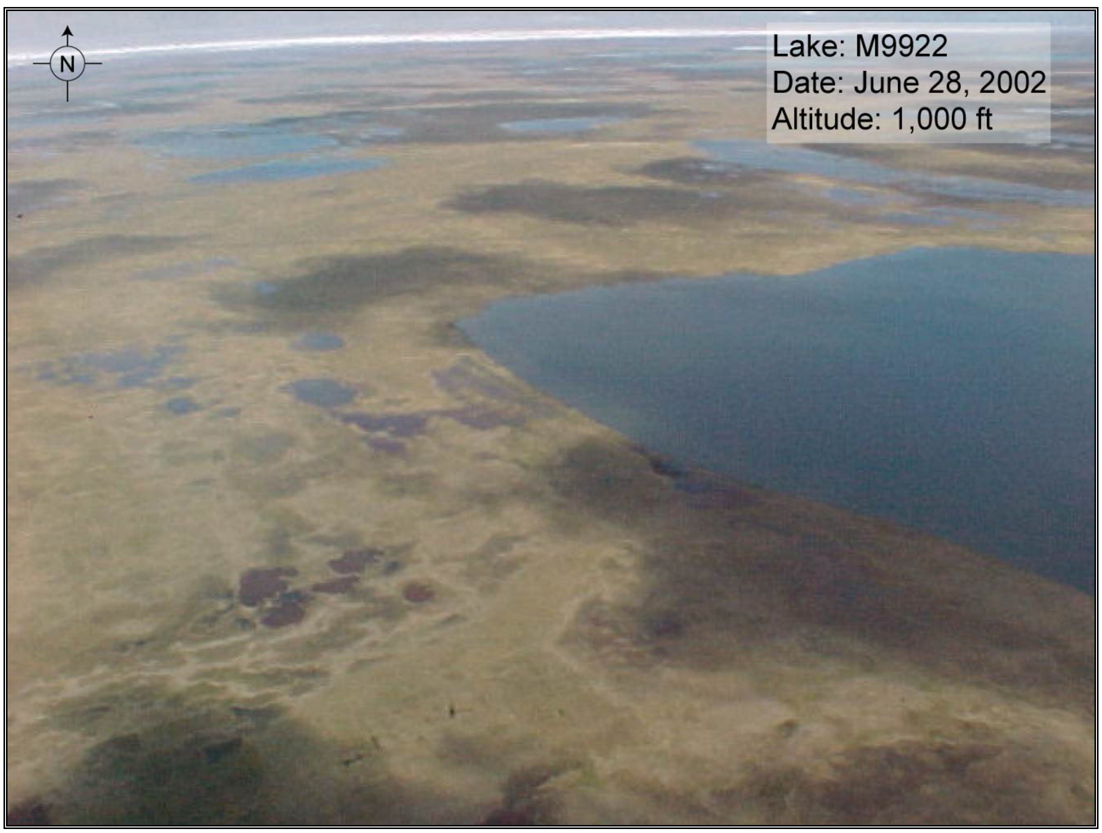

Photo B-3-d West end of lake.

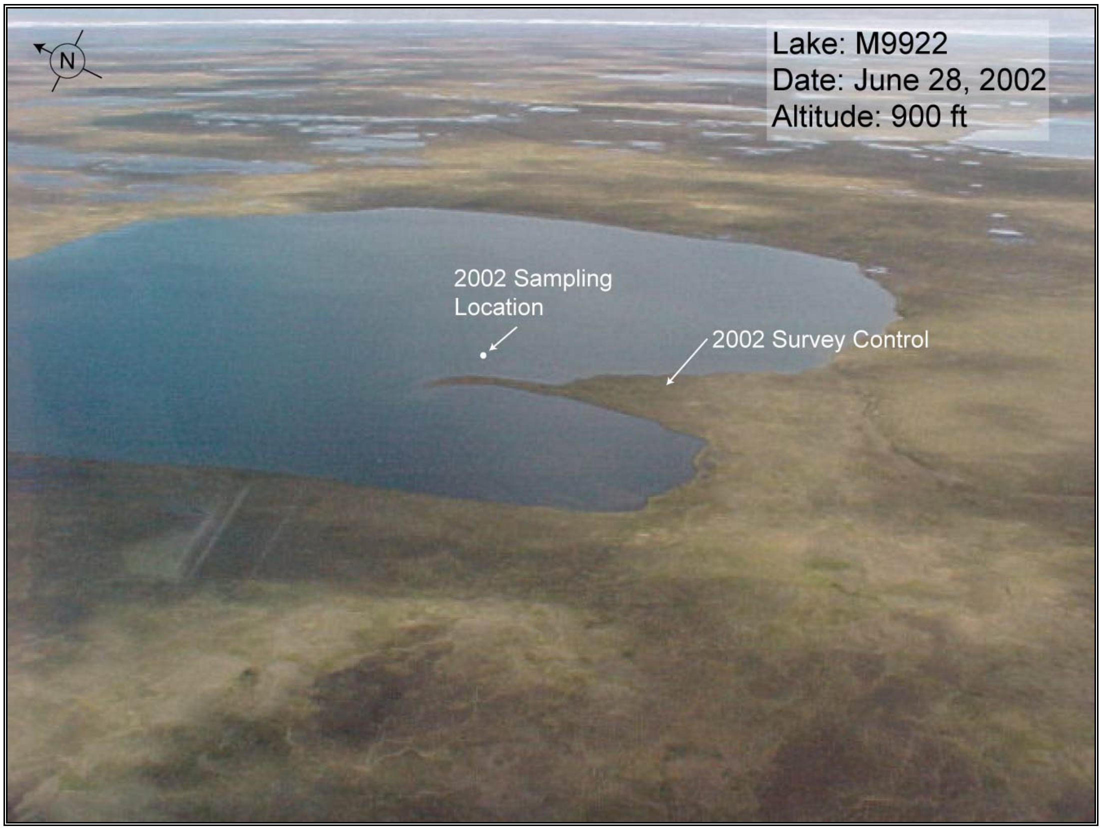

Photo B-3-e East end of lake.

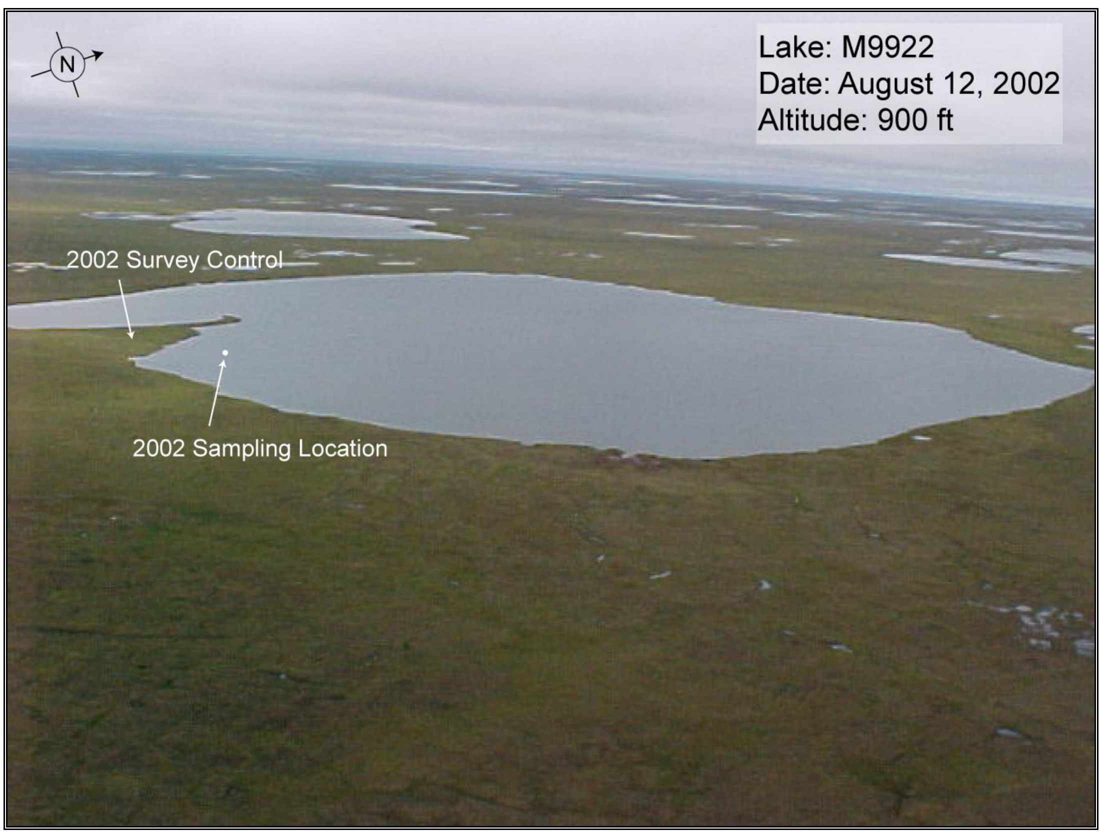

Photo B-3-f Overview of lake.

Photo B-4-a No visible connections to other water sources noted on June 2. Recharge from local melt/runoff only.

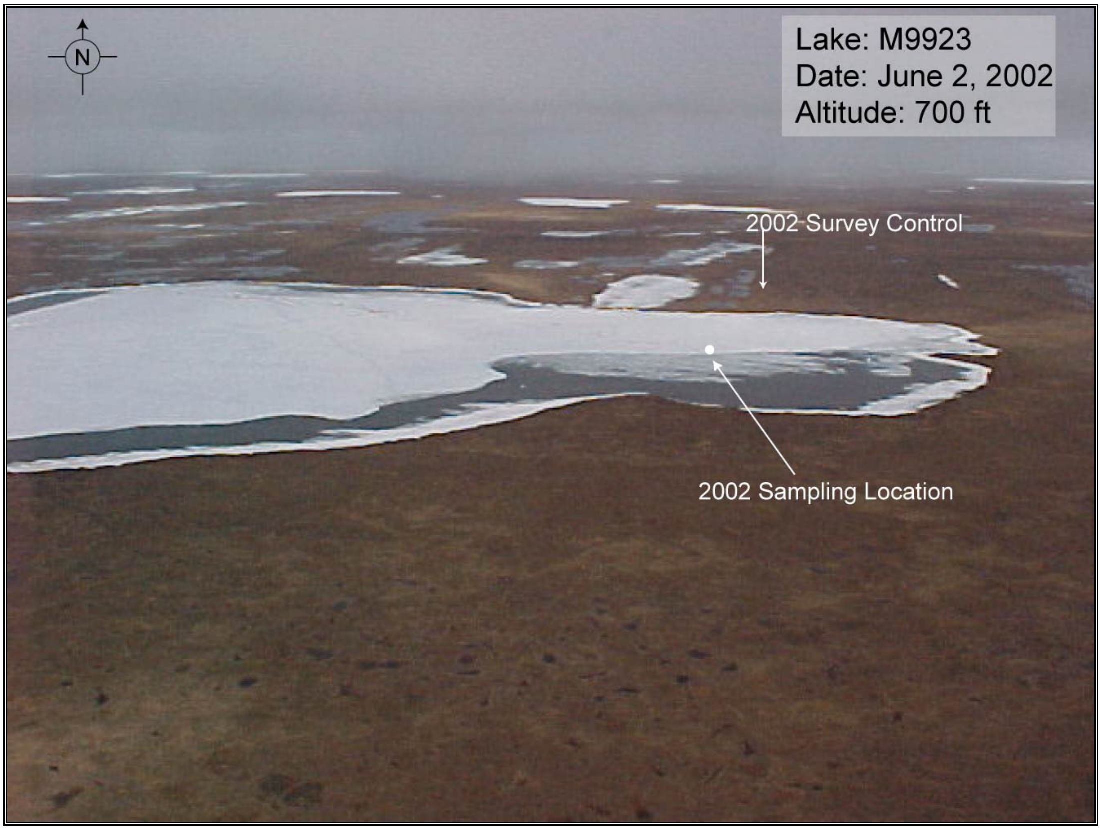

Photo B-4-b East end of lake, 2002 survey control, and sampling location.

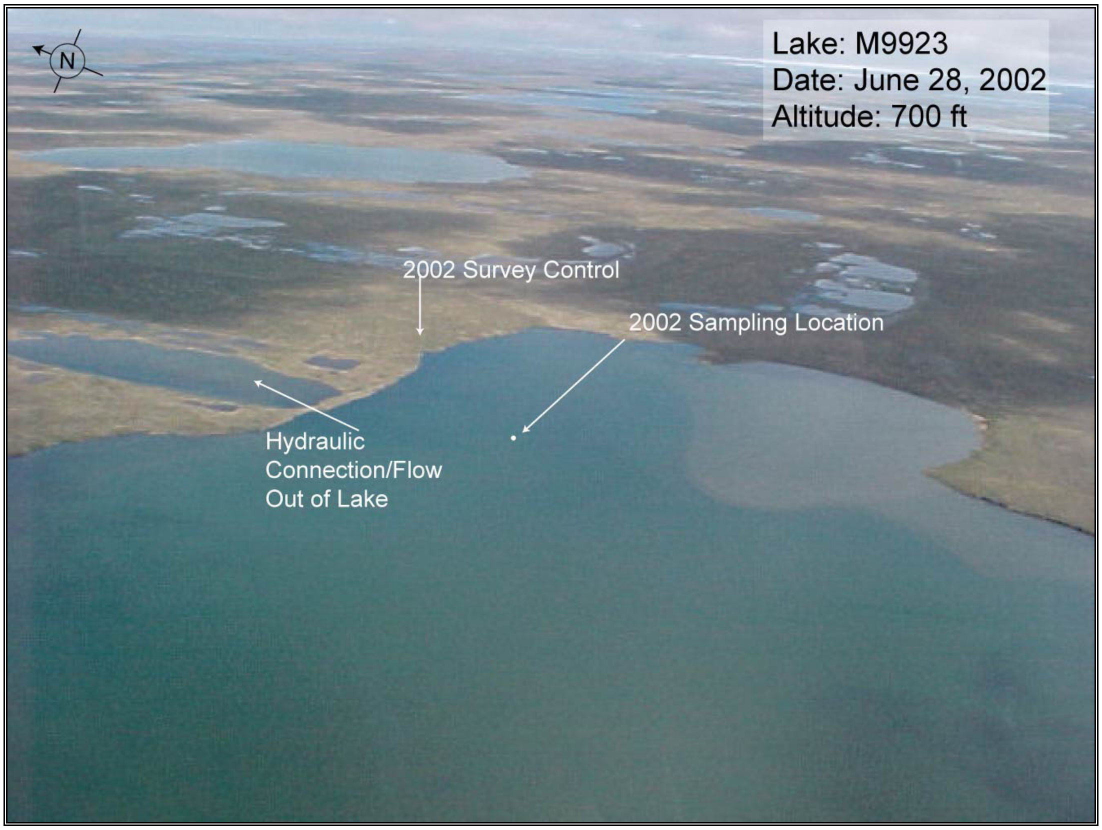

Photo B-4-c Northeast portion of lake. Flow out of Lake M9923 into small lake to the north was observed on June 28. Hydraulic connection was approximately 2 feet wide and ranged from 0.6 to 1.1 feet deep. Flow volume was steady.

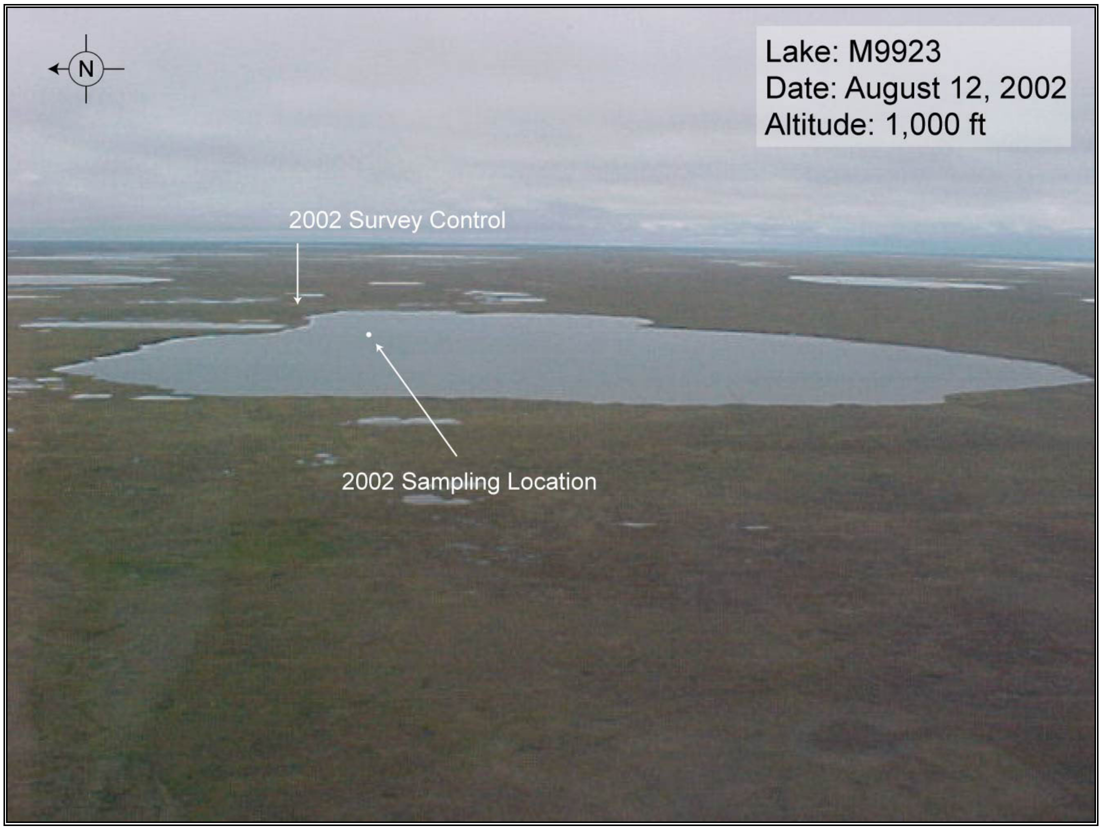

Photo B-4-d Overview of lake.

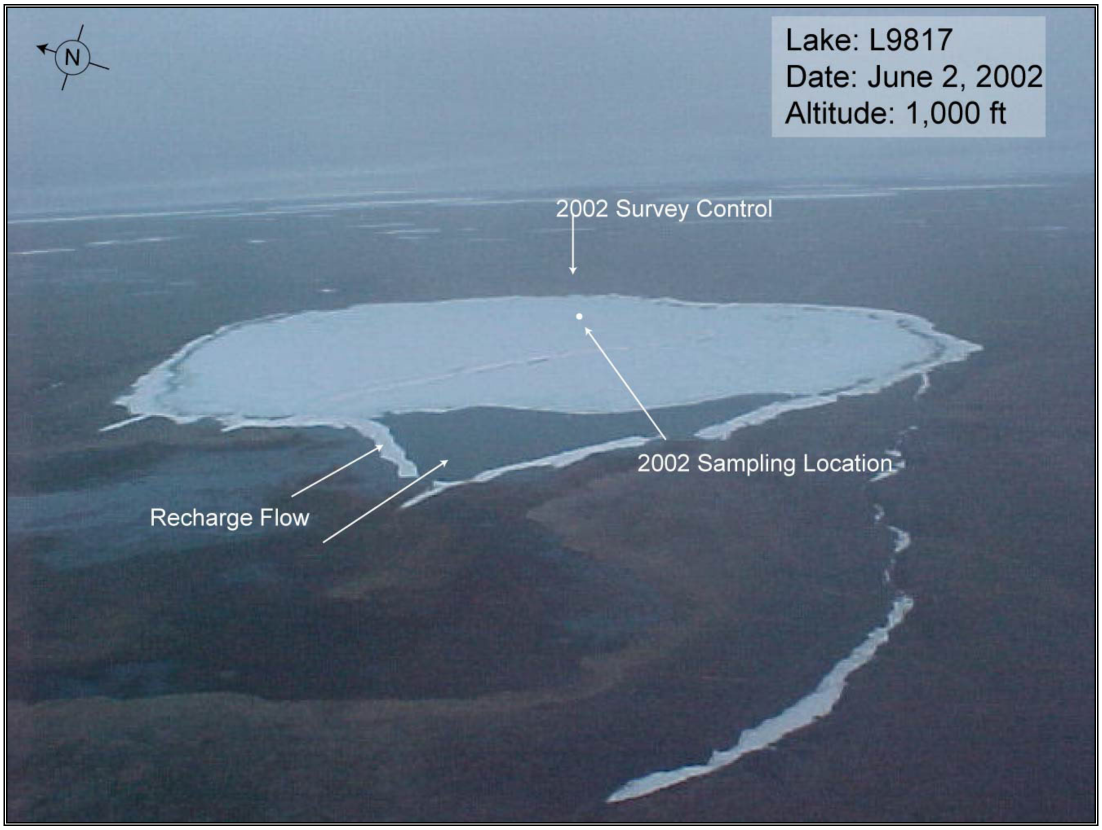

Photo B-5-a Recharge source is local melt/runoff with major contributions from area immediately southwest of Lake L9817. No hydraulic connections with other lakes observed.

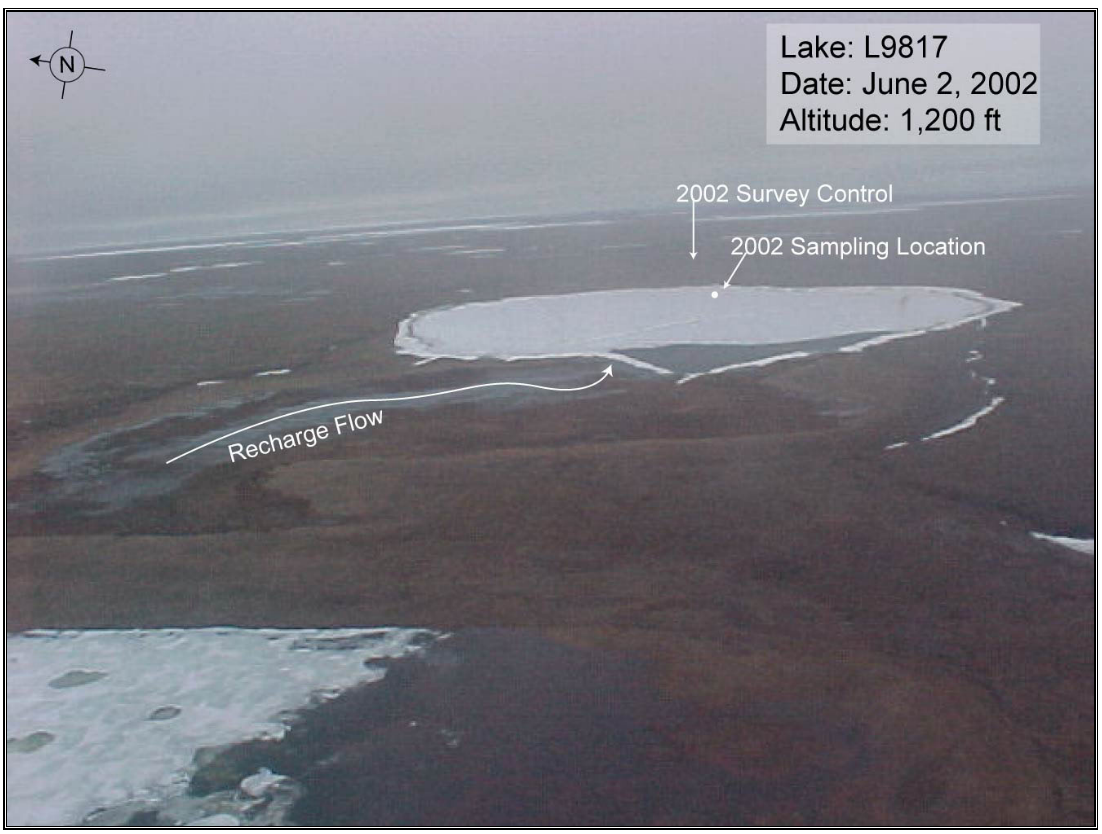

Photo B-5-b Wide-angle view showing extent of local melt/runoff into Lake L9817 from the southwest.

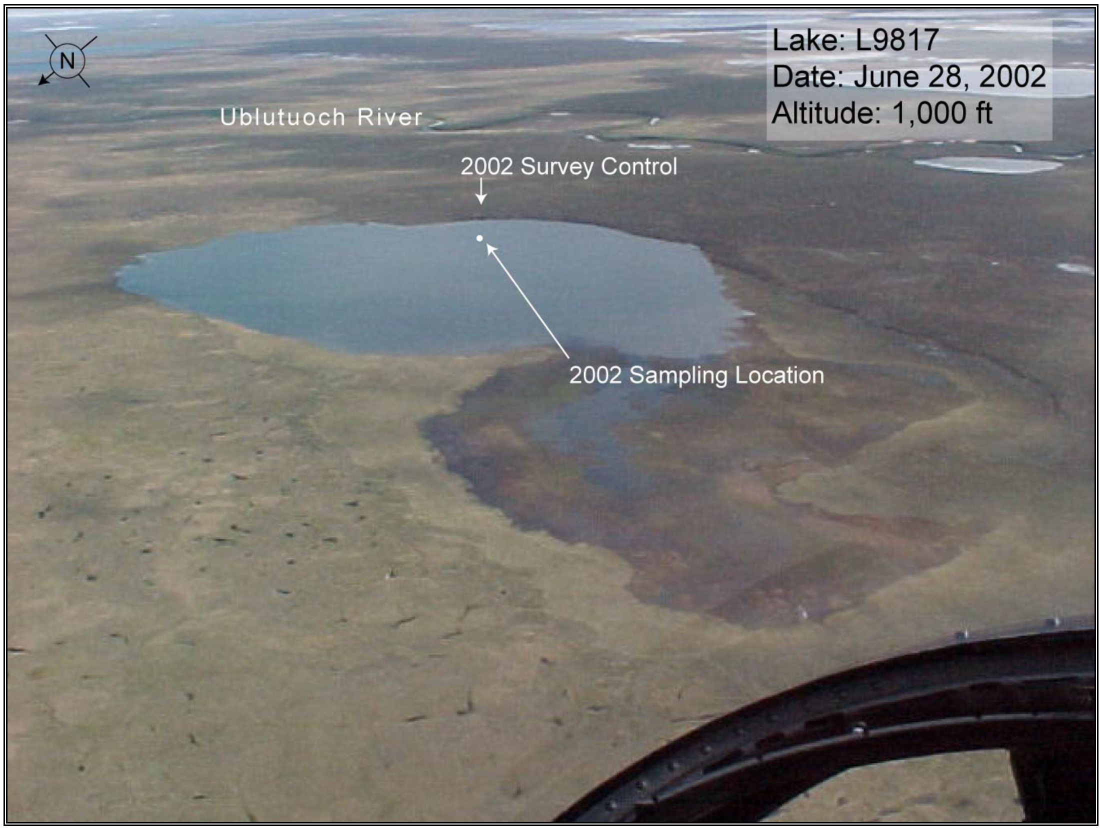

Photo B-5-c Recharge to Lake L9817 appears to still be occurring, from low lying area to the southwest. No outlet noted.

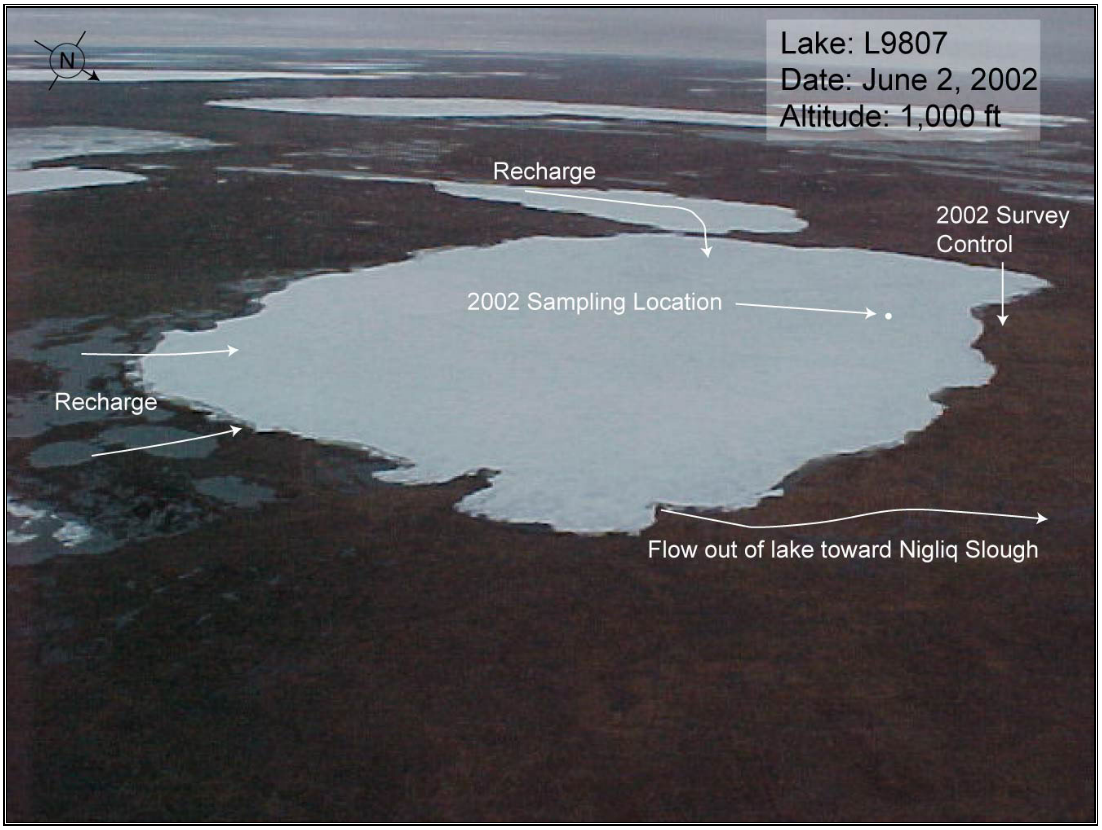

Photo B-6-a Hydraulic connections with the lake to the southwest and with the Nigliq Slough were noted.

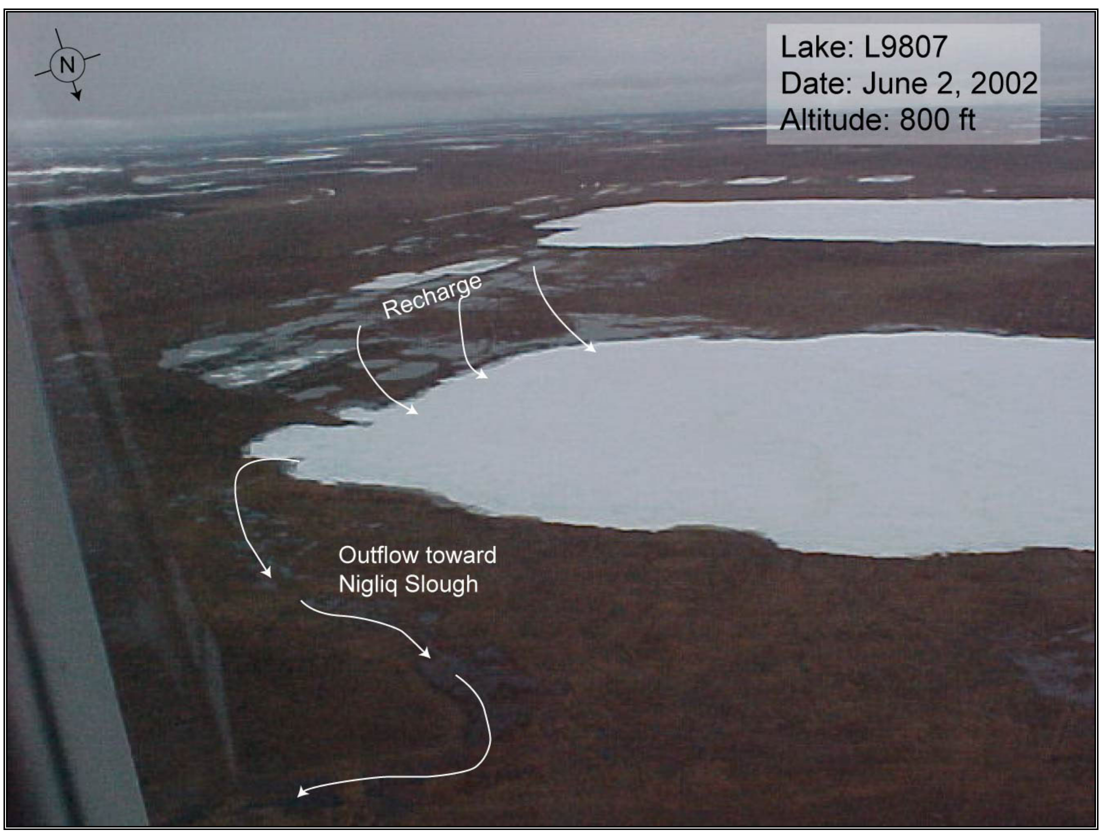

Photo B-6-b Northeast portion of lake. Photo shows recharge inflow due to local melt and outflow toward the Nigliq Slough.

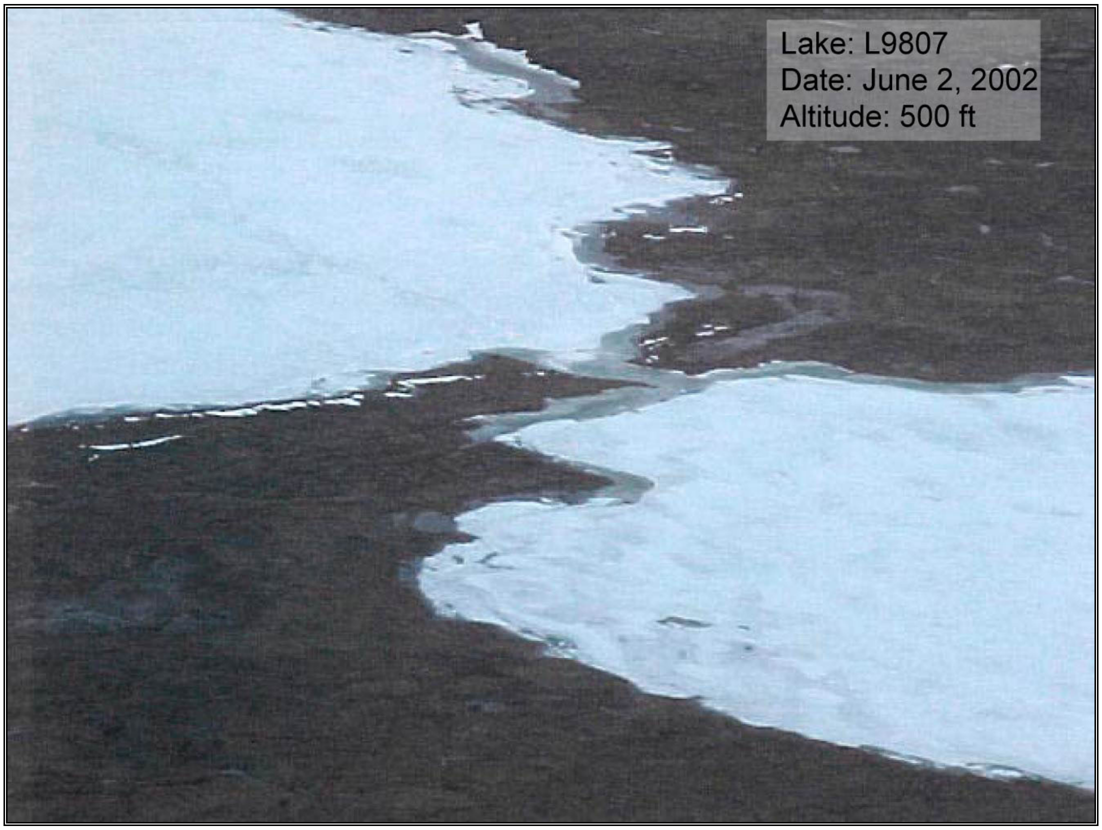

Photo B-6-c Hydraulic connection between Lake L9807 and small lake to the southwest.

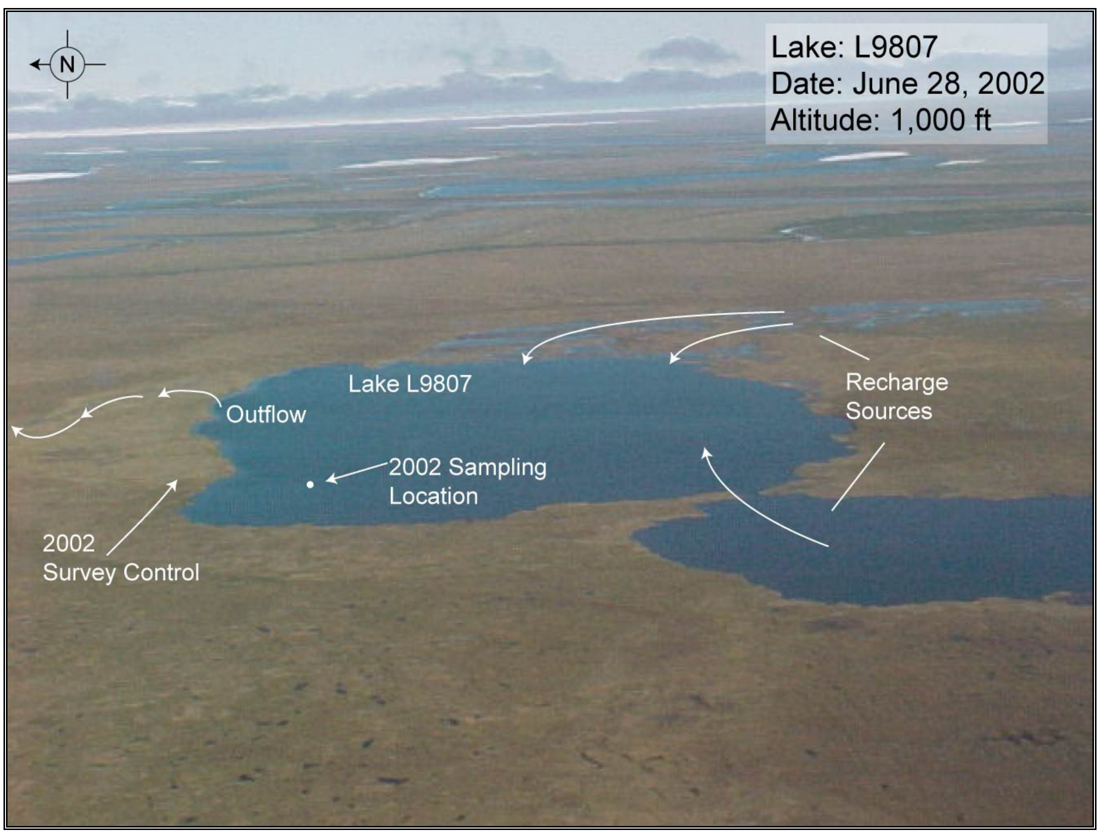

Photo B-6-d Overview of lake showing hydraulic connection between lakes.

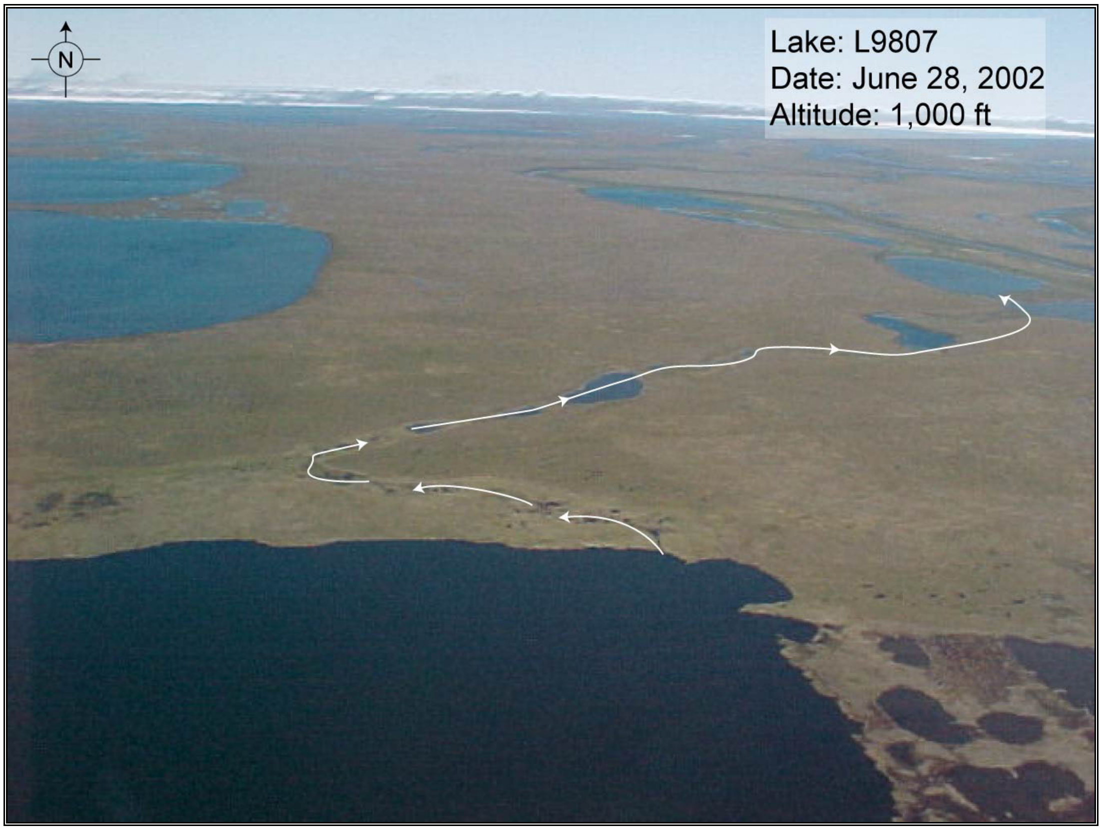

Photo B-6-e Northeast portion of lake showing hydraulic connection with the Nigliq Slough.

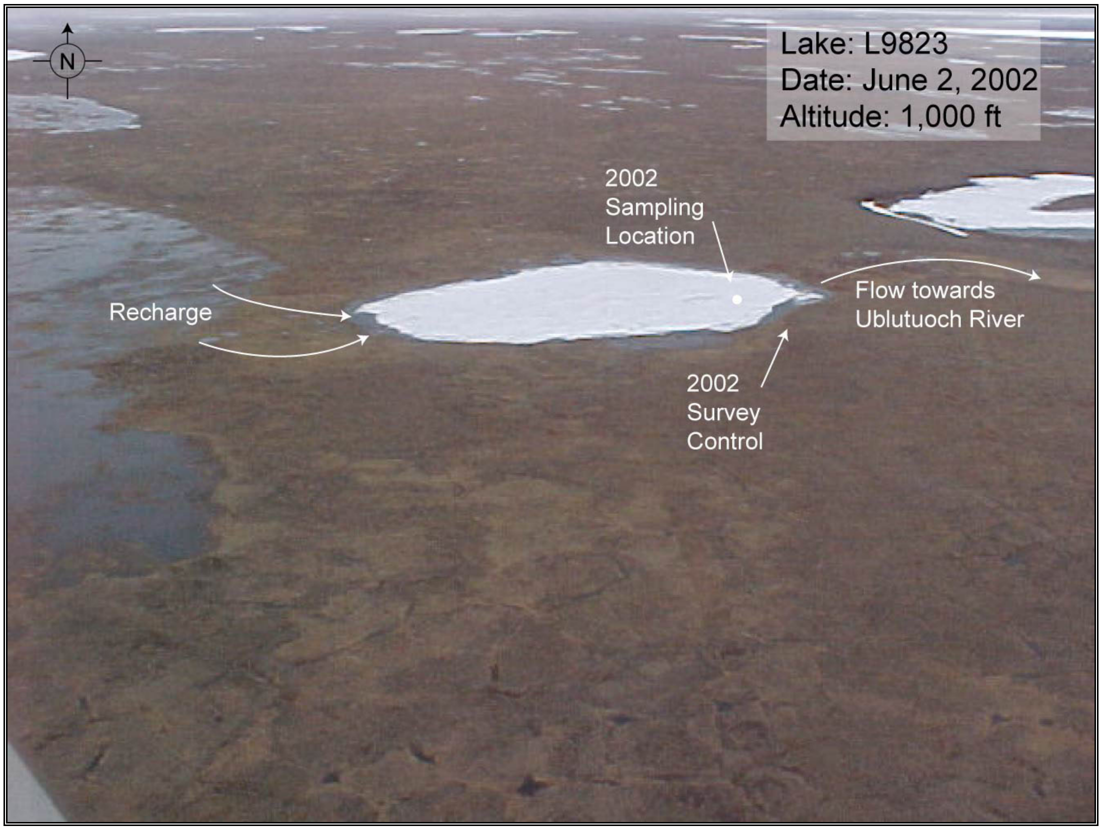

Photo B-7-a Hydraulic connection from lake to Ublutuoch River was noted. Flow was observed from the lake towards the river. Recharge to lake from local melt/runoff, was observed from the west.

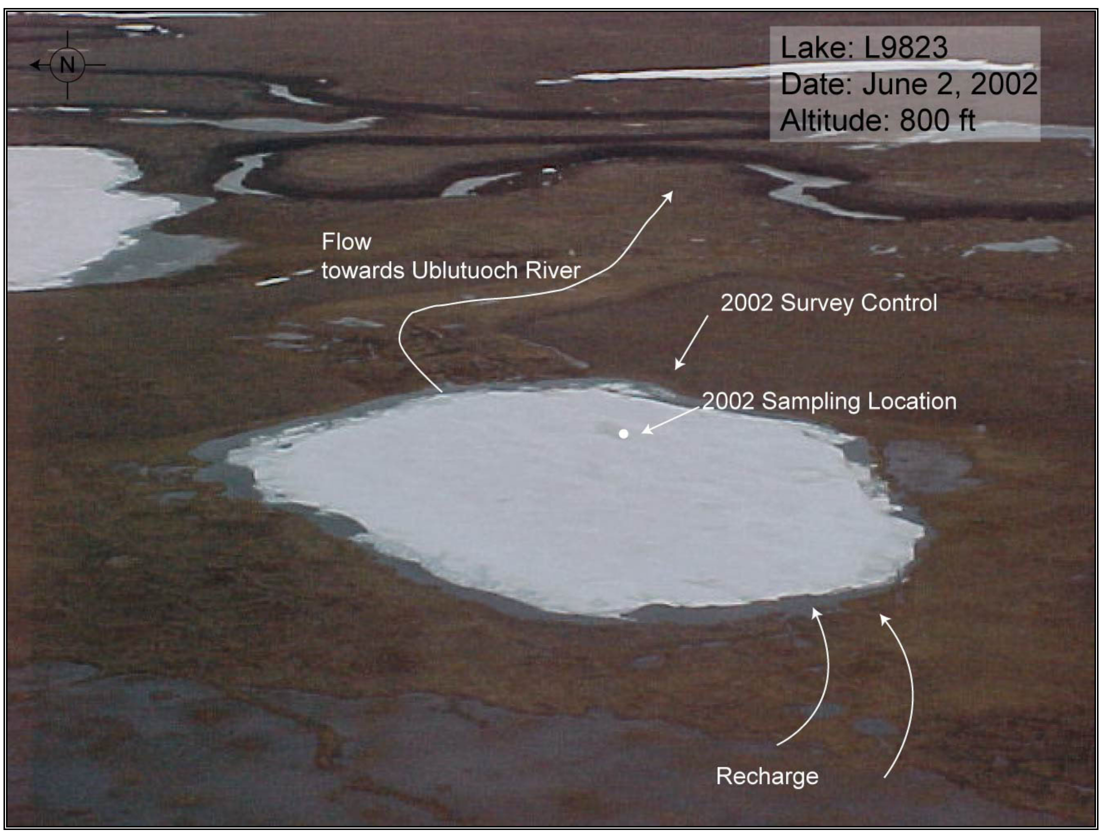

Photo B-7-b Flow path from lake toward Ublutuoch River, and from recharge source to the west.

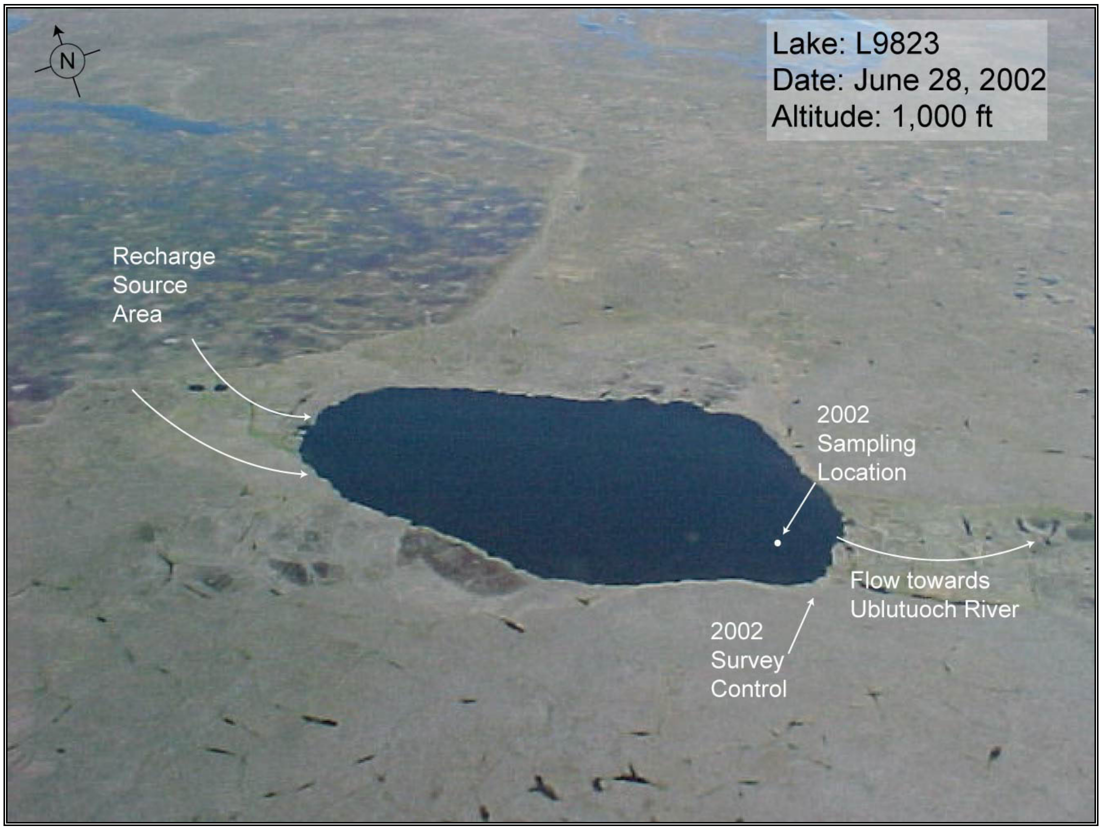

Photo B-7-c Primary recharge source and flow path into lake.

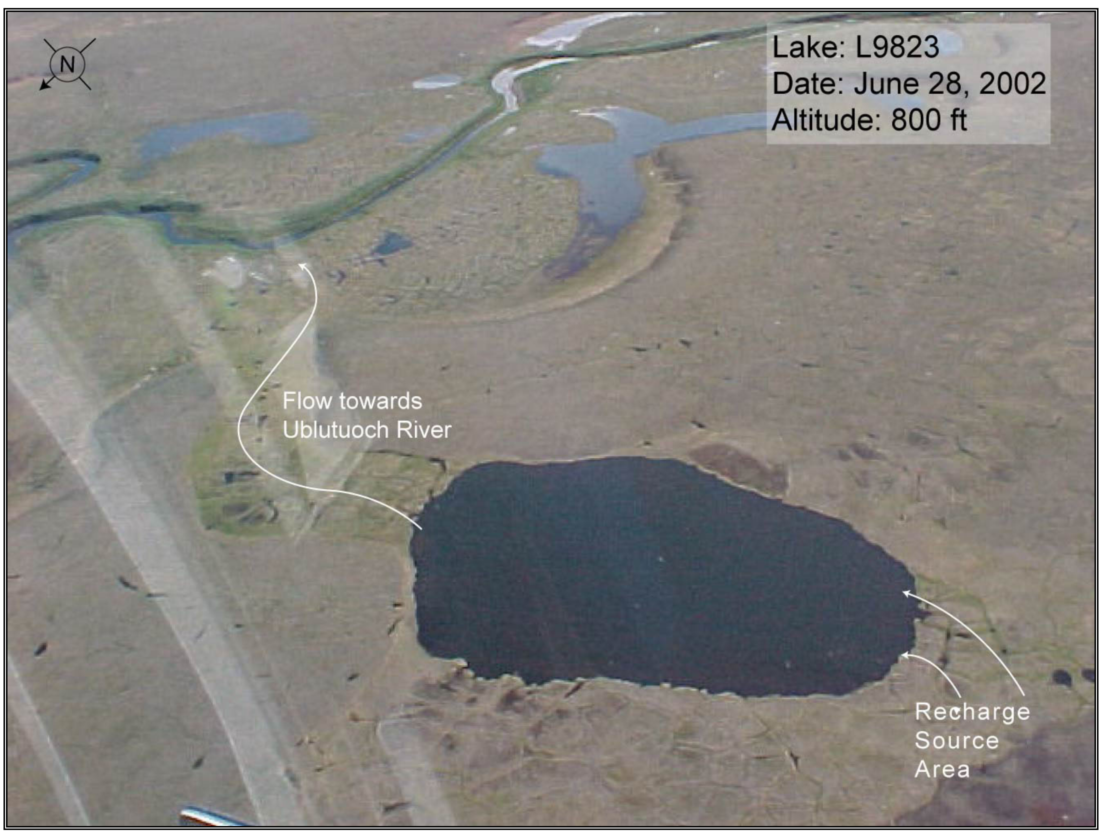

Photo B-7-d Flow between Lake L9823 and the Ublutuoch River was observed.

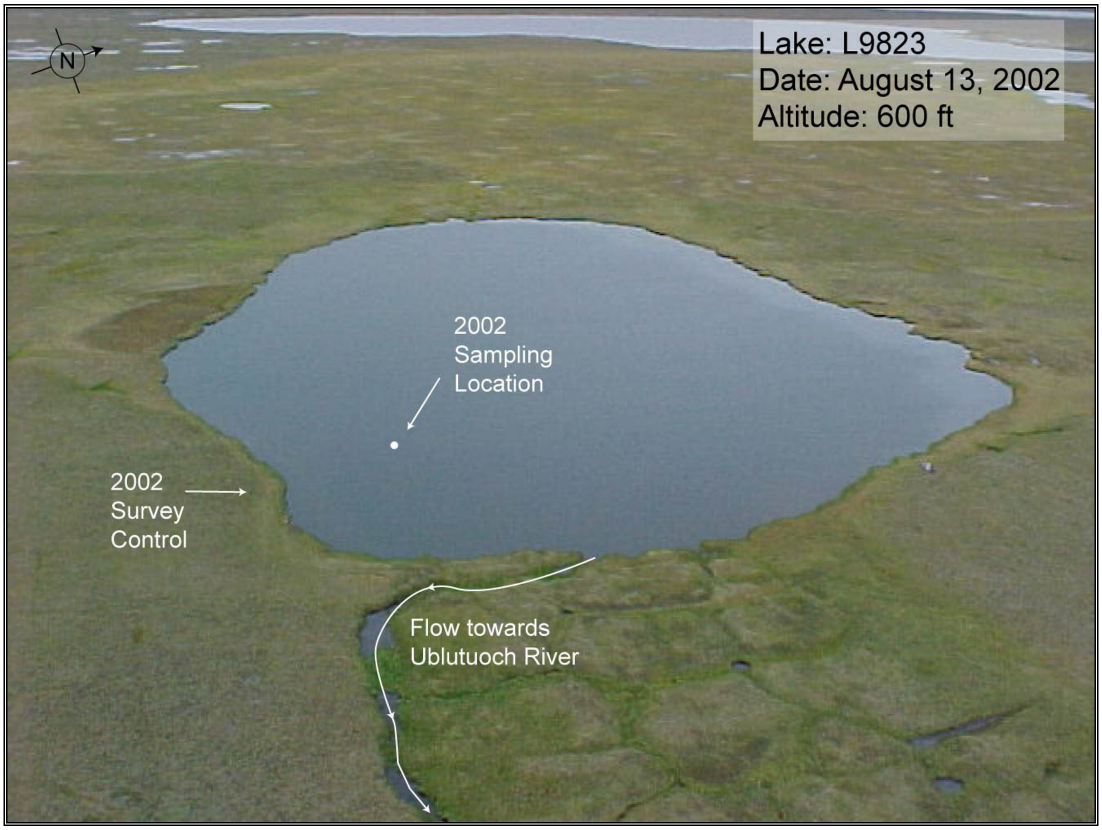

Photo B-7-e	Overview of lake.

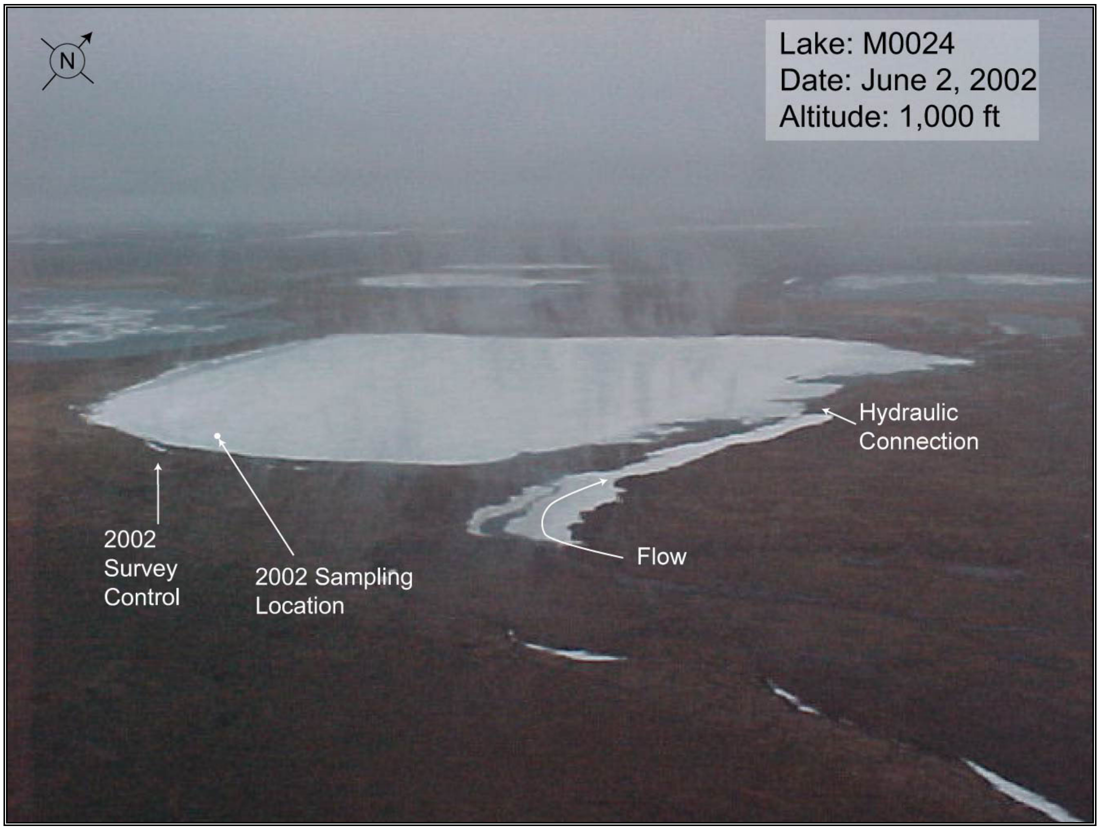

Photo B-8-a A connection to small lake to the southeast is visible in the foreground. Flowing water was not observed on date of photo.

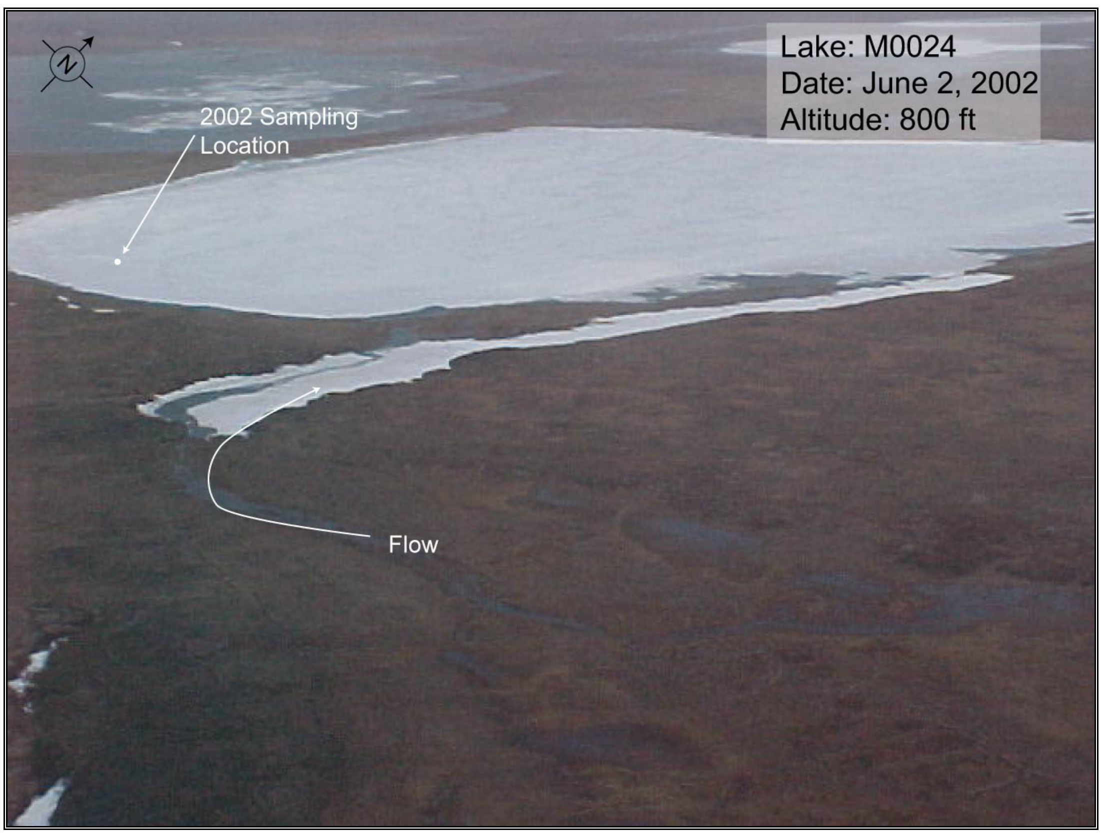

Photo B-8-b Hydraulic connection at southeast end of lake.

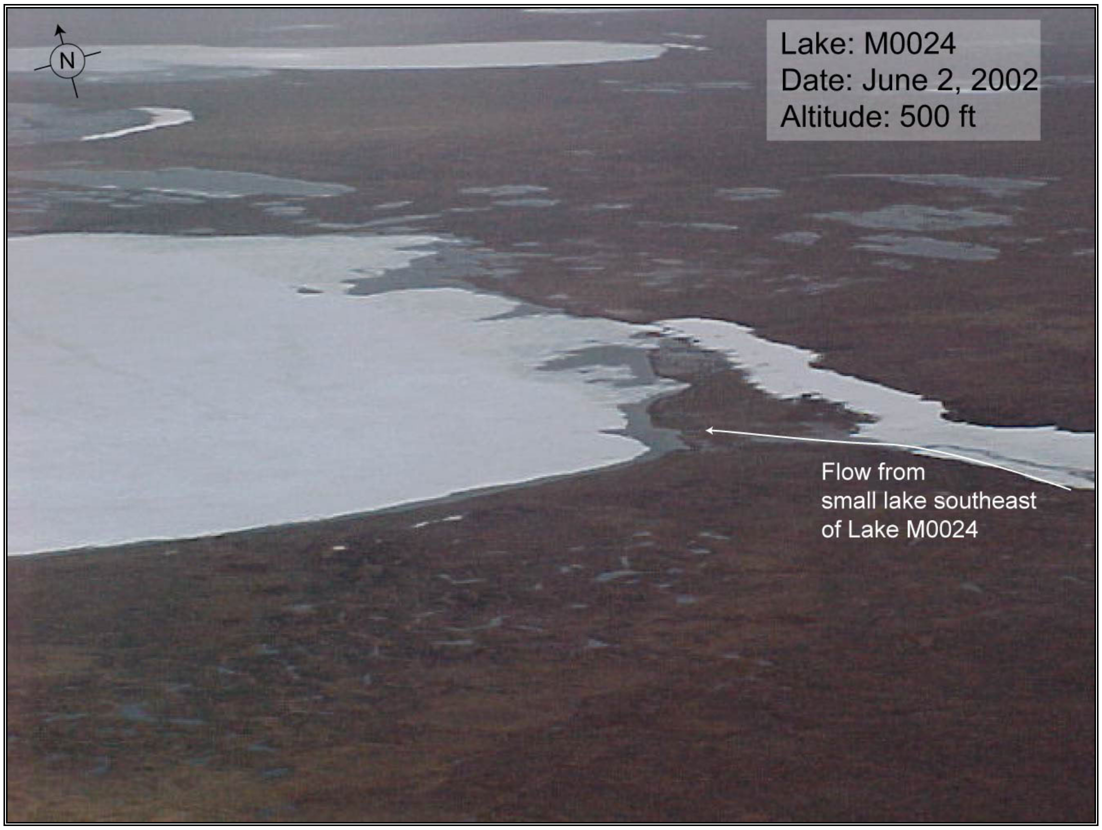

Photo B-8-c Recharge from local melt/runoff at southeast end of lake. Note the flow from small lake to the southeast has nearly reached Lake M0024.

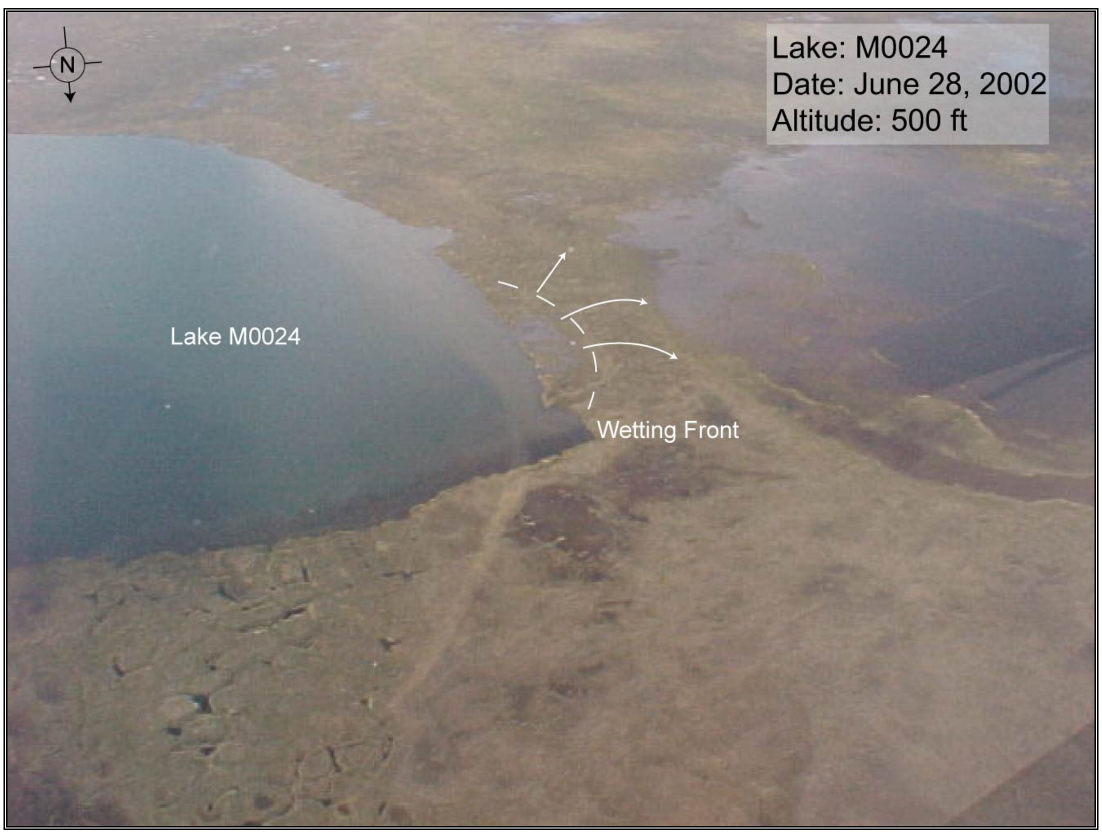

Photo B-8-d West side of lake. Detail shows the beginning of overflow from Lake M0024 into the lake immediately to the west; however, flow was not noted until the September site visit.

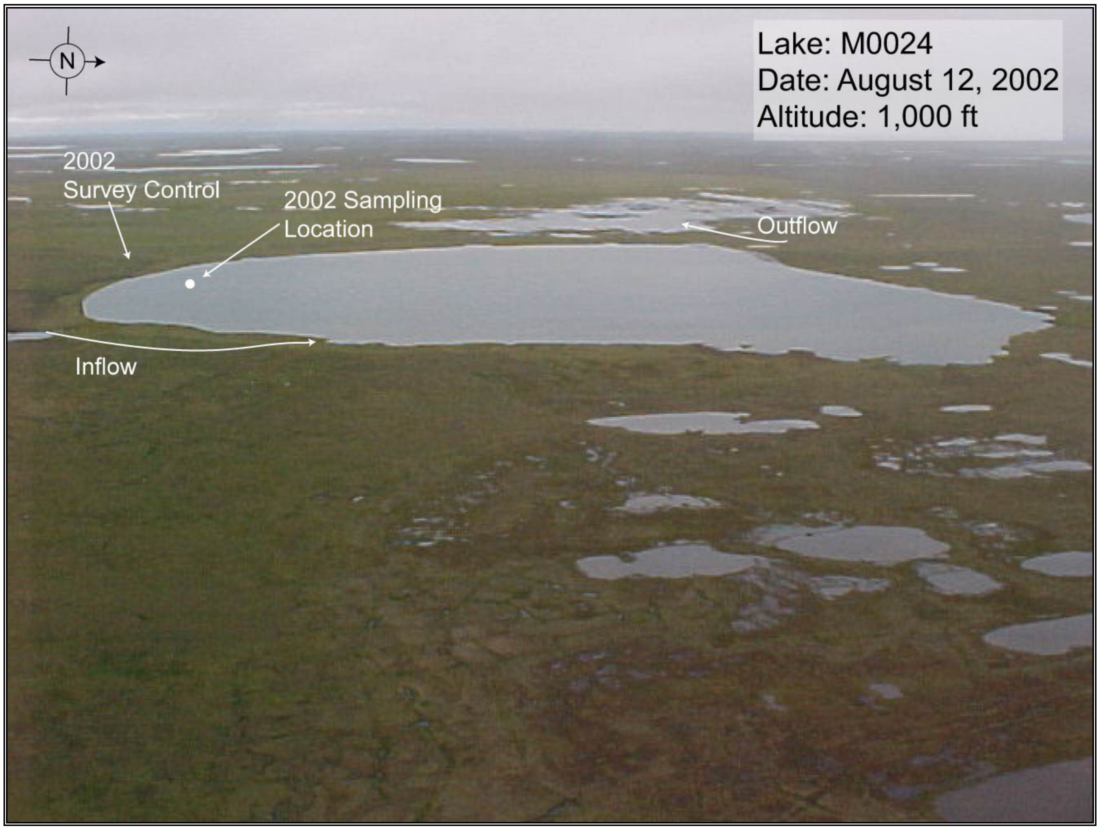

Photo B-8-e Overview of lake.

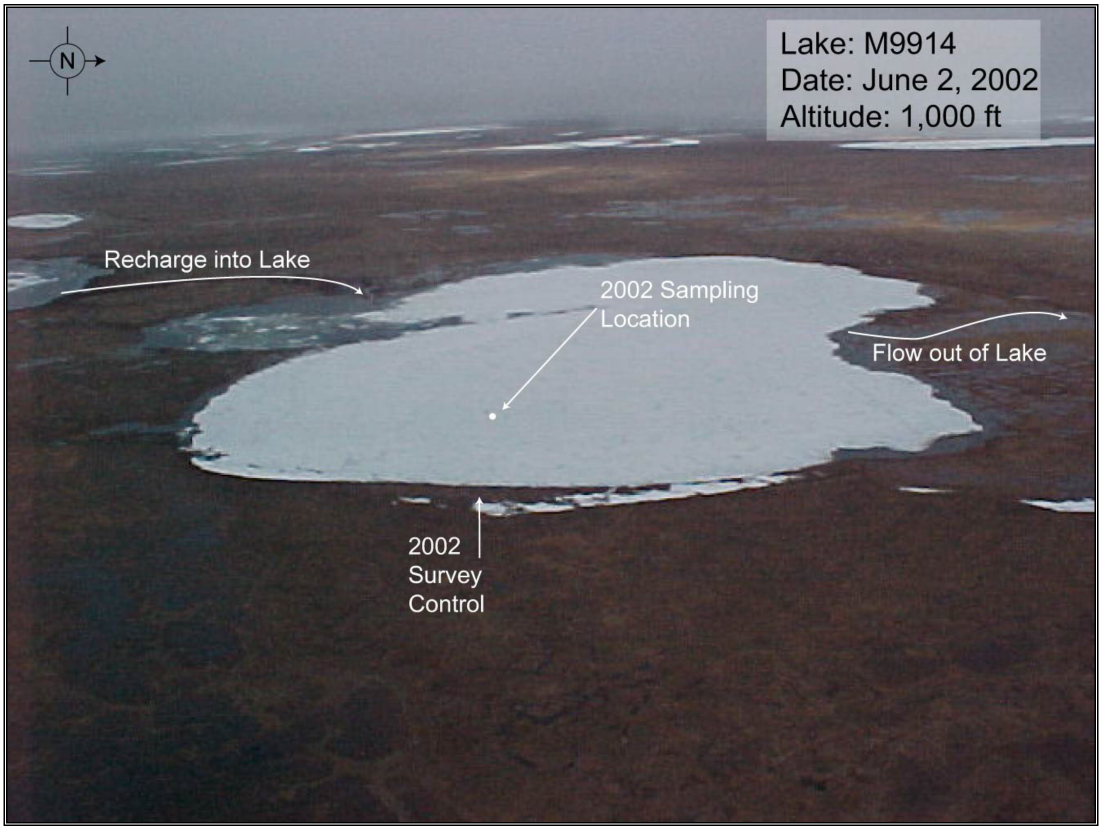

Photo B-9-a Hydraulic connections to lakes north and south of Lake M9914 are noted. Flow was observed into Lake M9914 from lake to the south (Lake R0071) and out of Lake M9914 toward lake to the northeast. Source of flow is local melt only.

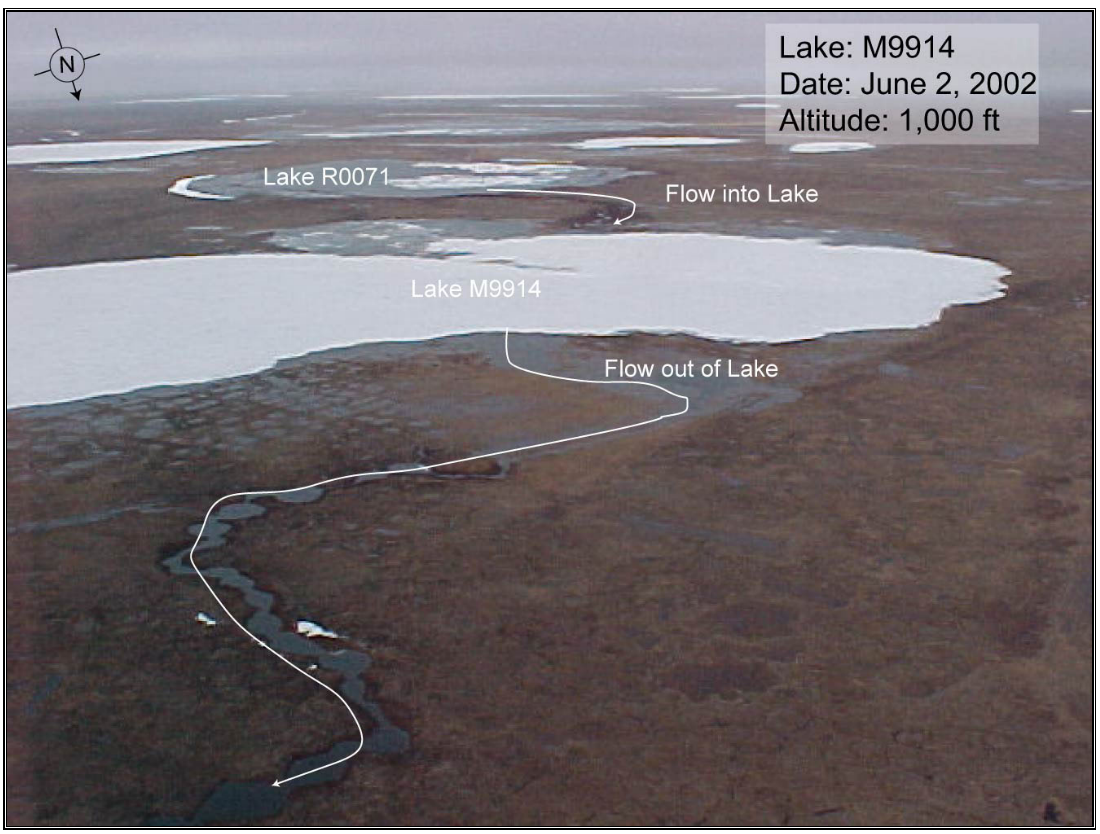

Photo B-9-b Hydraulic connections and flow into and out of Lake M9914.

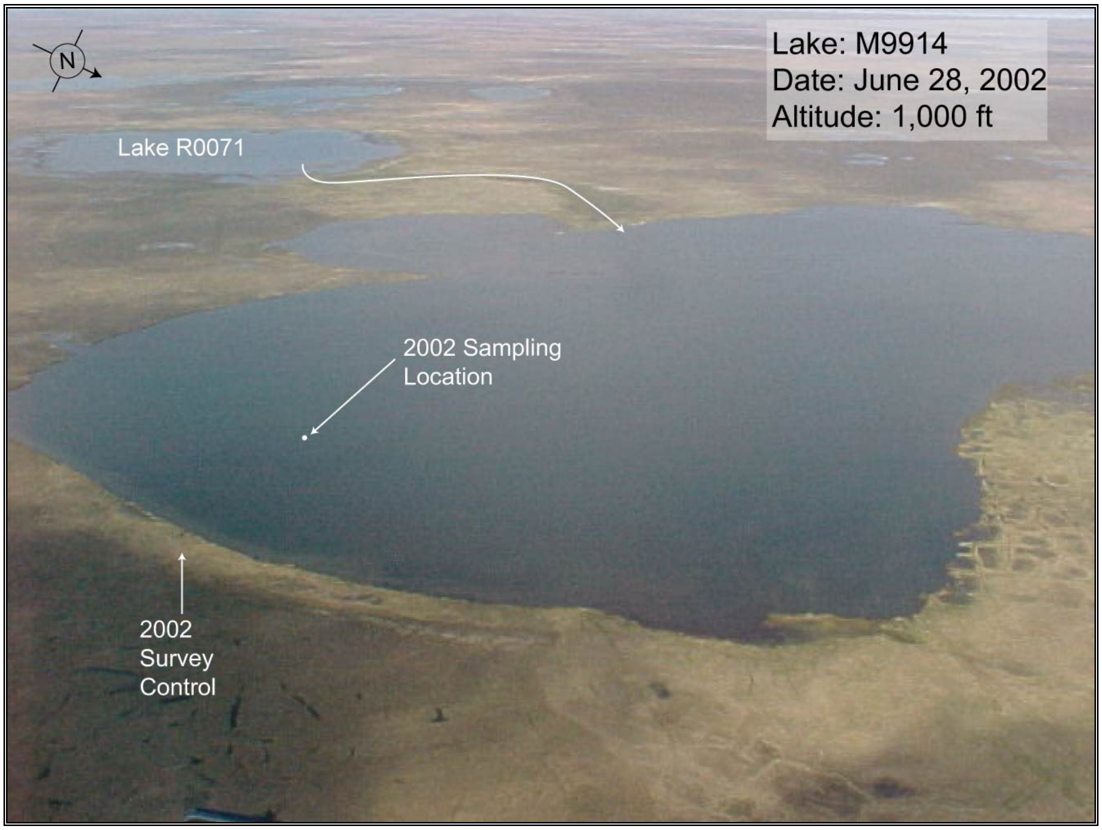

Photo B-9-c Flow path from Lake R0071 to Lake M9914. Flow into Lake M9914 was not observed on June 28.

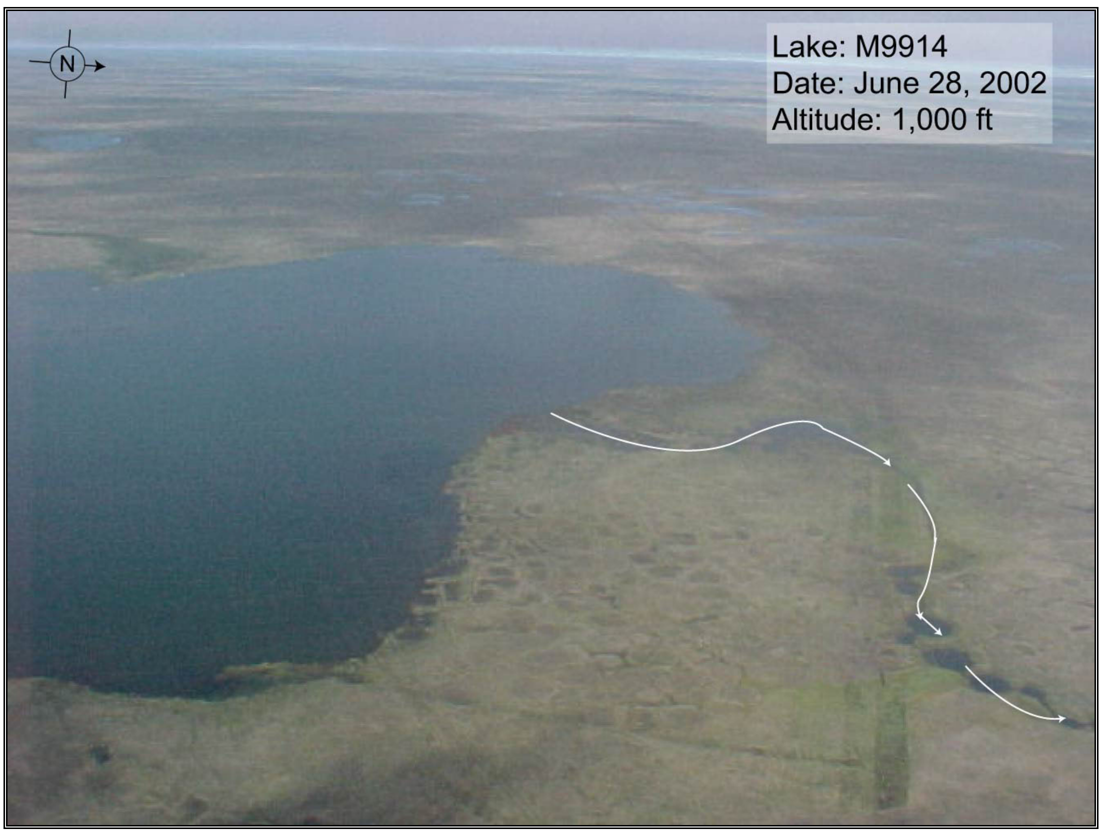

Photo B-9-d Flow path out of Lake M9914. Water was observed flowing out of Lake M9914 on June 28.

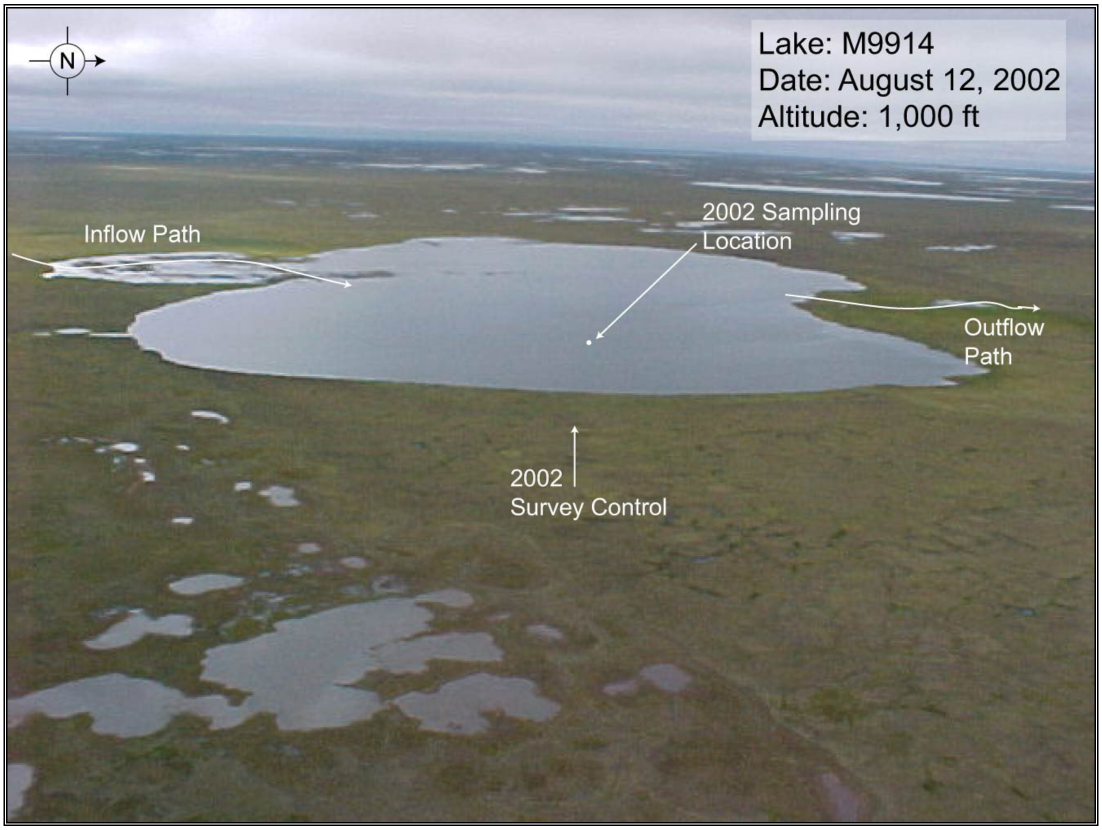

Photo B-9-e Overview of lake.

Appendix C Summary Tables

Table C-1

Physical and In Situ Water Quality Parameters — **2002 Summary (January through August)**

Lake Number	Sample Date & Time	Sample Location Coordinates (NAD27)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	In Situ Parameters: Sample Depth[2] (ft)	Temp. (°C)	pH	Conductivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
PUMP LAKES												
L9911	2/3/02, 10:00	N70°10'05.3" W151°47'44.0"	68.38	6.9	3.10	5.0	1.0	7.0	0.3	0.0	13.9	1.2
	4/23/02, 14:00		68.35	7.0	4.50	5.7	0.7	7.6	0.5	0.0	3.1	1.9
	6/2/02, 09:20		68.67	Not Sampled								
	6/28/02, 10:15		68.51	Not Sampled								
	8/12/02, 10:30		68.13	6.8	-	5.3	8.2	8.7	0.1	0.0	11.4	1.3
M9912	2/6/02, 12:15	N70°15'02.5" W151°33'14.5"	41.41	5.7	3.05	4.4	1.0	6.6	0.2	0.0	5.4	3.9
	4/24/02, 11:45		40.64	5.1	4.35	4.7	0.6	6.8	0.2	0.0	0.1	30.3
	6/2/02, 12:50		41.63	Not Sampled								
	6/28/02, 13:40		41.45	Not Sampled								
	8/13/02, 09:30		41.11	5.5	-	4.5	8.1	7.0	0.1	0.0	10.9	1.2
M9922	2/2/02, 13:15	N70°13'35.7" W151°35'10.2"	50.30	5.7	3.95	4.8	1.0	7.2	0.6	0.0	13.3	2.7
	4/24/02, 13:20		49.88	5.6	5.15	5.4	0.3	7.4	2.6	0.1	0.0	403.0
	6/2/02, 11:17		50.83	Not Sampled								
	6/28/02, 12:30		50.49	Not Sampled								
	8/12/02, 15:30		50.15	5.4	-	5.0	7.8	8.2	0.1	0.0	11.6	1.6

Notes:

1 - Total depth during the winter is measured from the top of ice to the lake bottom.

2 - Sampling depth in the winter equals one half the distance between the bottom of ice and the bottom of the lake.
Sampling depth in the summer is approximately the average of the February and April sampling depths.

Baker

Table C-1 (continued)

Physical and In Situ Water Quality Parameters **2002 Summary (January through August)**

Lake Number	Sample Date & Time	Sample Location Coordinates (NAD27)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	In Situ Parameters: Sample Depth[2] (ft)	Temp. (°C)	pH	Conduc-tivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
PUMP LAKES (continued)												
M9923	2/2/02, 09:10	N70°13'50.8" W151°30'50.7"	57.76	6.4	3.65	5.0	1.0	6.2	0.6	0.0	14.1	2.7
	4/24/02, 15:05		57.44	6.6	5.35	6.0	1.3	7.4	1.8	0.1	9.1	5.6
	6/2/02		N/A [3]	Not Sampled								
	6/28/02, 13:00		57.96	Not Sampled								
	8/12/02, 18:05		57.58	6.0	-	5.1	8.3	8.8	0.2	0.0	11.6	1.6
ADD-ON PUMP LAKE [4]												
L9817	4/25/02, 10:00	N70°14'02.7" W151°19'58.3"	53.98	6.3	4.85	5.6	0.7	6.6	1.5	0.1	2.3	14.1
	6/2/02		N/A [5]	Not Sampled								
	6/28/02, 14:20		54.96	Not Sampled								
	8/13/02, 11:40		54.79	7.0	-	5.5	8.1	8.2	0.2	0.0	11.2	1.6

Notes:

1 - Total depth during the winter is measured from the top of ice to the lake bottom.

2 - Sampling depth in the winter equals one half the distance between the bottom of ice and the bottom of the lake. Sampling depth in the summer is approximately the average of the February and April sampling depths.

3 - Lake was inaccesible due to unsafe ice/wading conditions.

4 - Add-on lake was sampled for the first time during the post-pump sampling event. No pre-pump data are available.

5 - Lake water elevation measurement was not possible due to ponding on submerged ice.

Baker

Table C-1 (continued)

Physical and In Situ Water Quality Parameters **2002 Summary (January through August)**

Lake Number	Sample Date & Time	Sample Location Coordinates (NAD27)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	In Situ Parameters: Sample Depth[2] (ft)	Temp. (°C)	pH	Conductivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
REFERENCE LAKES												
L9807	2/1/02, 08:55	N70°15'43.4" W151°06'41.9"	28.39	6.8	2.90	4.9	1.0	7.0	0.3	0.0	7.3	4.9
L9807	4/23/02, 9:45	N70°15'43.4" W151°06'41.9"	28.40	7.0	4.55	5.8	0.6	7.6	0.7	0.0	0.1	77.1
L9807	6/2/02, 14:15	N70°15'43.4" W151°06'41.9"	28.65	Not Sampled								
L9807	6/28/02, 15:25	N70°15'43.4" W151°06'41.9"	28.56	Not Sampled								
L9807	8/13/02, 15:45	N70°15'43.4" W151°06'41.9"	28.21	6.5	-	5.0	8.0	8.6	0.1	0.0	11.1	1.2
L9823	2/1/02, 15:00	N70°15'04.5" W151°17'49.0"	24.95	11.6	4.20	7.9	1.0	6.4	0.4	0.0	5.7	3.0
L9823	4/25/02, 11:30	N70°15'04.5" W151°17'49.0"	24.88	11.2	6.05	8.6	0.9	6.6	0.6	0.0	0.0	8.6
L9823	6/2/02, 13:35	N70°15'04.5" W151°17'49.0"	25.31	Not Sampled								
L9823	6/28/02, 14:55	N70°15'04.5" W151°17'49.0"	25.09	Not Sampled								
L9823	8/13/02, 13:45	N70°15'04.5" W151°17'49.0"	24.76	11.5	-	9.0	8.5	8.3	0.2	0.0	11.0	1.0

Notes:

1 - Total depth during the winter is measured from the top of ice to the lake bottom.

2 - Sampling depth in the winter equals one half the distance between the bottom of ice and the bottom of the lake.
Sampling depth in the summer is approximately the average of the February and April sampling depths.

Baker

Table C-1 (continued)

Physical and In Situ Water Quality Parameters **2002 Summary (January through August)**

Lake Number	Sample Date & Time	Sample Location Coordinates (NAD27)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	In Situ Parameters: Sample Depth[2] (ft)	Temp. (°C)	pH	Conductivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
REFERENCE LAKES (continued)												
M0024	2/6/02, 09:30	N70°12'27.5" W151°38'54.3"	57.09	6.5	3.30	4.9	2.0	6.6	0.2	0.0	16.9[3]	1.3
	4/24/02, 9:45		56.95	6.7	4.57	5.6	0.6	6.9	0.4	0.0	3.9	5.8
	6/2/02, 10:05		57.26	Not Sampled								
	6/28/02, 10:50		57.09	Not Sampled								
	8/12/02, 13:30		56.80	5.9	-	5.0	8.2	8.2	0.1	0.0	11.6	1.4
M9914	2/2/02, 14:30	N70°13'57.4" W151°37'20.9"	47.07	6.8	3.20	5.0	3.0	7.1	0.2	0.0	4.6	9.5
	4/23/02, 16:00		47.16	7.1	4.55	5.8	0.8	7.4	0.6	0.0	0.0	27.2
	6/2/02, 10:30		47.56	Not Sampled								
	6/28/02, 11:20		47.27	Not Sampled								
	8/12/02, 17:05		46.91	6.2	-	5.3	8.5	8.1	0.1	0.0	11.3	1.4

Notes:

1 - Total depth during the winter is measured from the top of ice to the lake bottom.

2 - Sampling depth in the winter equals one half the distance between the bottom of ice and the bottom of the lake.
Sampling depth in the summer is approximately the average of the February and April sampling depths.

3 - DO concentration shown exceeds 100% saturation.

Baker

Table C-2

Analytical Water Quality Parameters — **2002 Summary (January through August)**

Lake Number	Sample		Total Metals by EPA 200.8					Anions by EPA 300			BOD by EPA 405.1 (mg/L)	COD by EPA 410.4 (mg/L)	TDS by SM 2540C (mg/L)	Hardness as $CaCO_3$ (mg/L)	Conductivity (mS/cm)
	Date/ Time	Depth [1] (ft)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Iron (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)					
PUMP LAKES															
L9911	2/3/02, 10:00	5.0	62.2	8.9	12.1	1.7	U (0.25)	23.4	0.6	0.3	U (2.0)[2]	U (20.0)	296	182	Not Analyzed
	4/23/02, 14:00	5.7	87.3	11.5	15.3	1.9	U (0.25)	24.2	1.0	1.3	U (2.0)[2]	29.6	392	265	0.7
	8/12/02, 10:30	5.3	25.3	3.3	4.6	0.6	U (0.25)	13.3	0.2	U (0.2)	U (2.0)	27.4	106	76.9	Not Analyzed
L9911 Dup	4/23/02	5.7	92.6	13.0	17.7	2.2	U (0.25)	45.7	0.9	6.9	U (2.0)[2]	29.6	368	285	0.7
L9911 Dup	8/12/02	5.3	25.9	3.3	4.5	0.6	U (0.25)	12.9	0.2	U (0.2)	U (2.0)	27.4	109	78.4	Not Analyzed
M9912	2/6/02, 12:15	4.4	25.6	7.4	14.8	1.9	1.09	38.6	U (0.2)	0.2	U (2.0)	38.4	192	91.7	Not Analyzed
	4/24/02, 11:45	4.7	52.5	14.4	27.9	3.1	8.92	95.6	0.3	U (1.0)	U (2.0)[2]	95.3	375	190	6.0
	8/13/02, 09:30	4.5	9.7	2.5	5.0	0.7	U (0.25)	16.4	U (0.2)	0.2	U (2.0)	Not Analyzed[5]	60.0	34.6	Not Analyzed
M9922	2/2/02, 13:15	4.8	86.4	21.0	35.3	5.1	0.54	119	1.9	0.3	U (2.0)[2]	67.5	460	283	Not Analyzed
	4/24/02, 13:20	5.4	285	72.3	109	10.6	77.40	403	3.1[3]	U (1.0)	4.4[2]	356	1,790	1,010	2.4
	8/12/02, 15:30	5.0	16.4	3.7	6.0	0.9	U (0.25)	21.2	0.4	U (0.2)	U (2.0)	31.8	80.0	56.4	Not Analyzed

Notes:

1 - Total depth during the winter is measured from the top of ice to the lake bottom.

2 - Sample holding time had expired upon delivery to lab.

3 - Detectable amount of sulfate in the calibration blank; sulfate value may be bias high.

4 - Add-on lake was sampled for the first time during the post-pump sampling event. No pre-pump data are available.

5 - COD analysis inadvertantly not requested on the chain of custody form

BOD = Biochemical oxygen demand

COD = Chemical oxygen demand

TDS = Total dissolved solids

U = Analyte was not detected at detection limit indicated in parenthesis.

Table C-2 (continued)

Analytical Water Quality Parameters — **2002 Summary (January through August)**

Lake Number	Sample		Total Metals by EPA 200.8					Anions by EPA 300			BOD by EPA 405.1 (mg/L)	COD by EPA 410.4 (mg/L)	TDS by SM 2540C (mg/L)	Hardness as $CaCO_3$ (mg/L)	Conductivity (mS/cm)
	Date/ Time	Depth [1] (ft)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Iron (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)					
REFERENCE LAKES															
L9807	2/1/02, 08:55	4.9	56.0	11.2	16.6	3.6	0.68	27.0	0.4	0.3	U (2.0)[2]	73.8	262	169	Not Analyzed
	4/23/02, 09:45	5.8	109	21.5	31.3	5.5	14.60	57.2	0.6	U (1.0)	4.9 [2]	275	488	362	0.8
	8/13/02, 15:45	5.0	10.4	1.9	3.0	0.6	U (0.125)	13.1	U (0.2)	U (0.2)	U (2.0)[2]	Not Analyzed[5]	104	33.8	Not Analyzed
L9823	2/1/02, 15:00	7.9	46.4	15.0	24.3	2.6	0.88	78.0	U (0.2)	0.3	U (2.0)[2]	34.3	240	169	Not Analyzed
	4/25/02, 11:30	8.6	60.8	19.9	33.7	3.2	2.32	130	U (0.2)	U (1.0)	U (2.0)[2]	82.2	496	234	0.7
	8/13/02, 13:45	9.0	19.9	6.0	10.1	1.0	U (0.25)	33.9	U (0.2)	U (0.2)	U (2.0)	Not Analyzed[5]	123	74.6	Not Analyzed
M0024	2/6/02, 09:30	4.9	31.2	8.3	14.4	2.1	U (0.25)	32.9	0.3	U (0.2)	U (2.0)	U (20.0)	228	101	Not Analyzed
	4/24/02, 09:45	5.6	49.4	13.0	23.2	2.9	0.59	45.4	0.5	1.2	U (2.0) [2]	40.5	390	177	0.5
	8/12/02, 13:30	5.0	11.0	2.7	4.7	0.6	0.26	16.2	U (0.2)	U (0.2)	U (2.0)	U (20.0)	71.3	38.6	Not Analyzed
M9914	2/2/02, 14:30	5.0	34.1	8.2	14.1	2.9	2.72	28.9	0.4	U (0.2)	U (2.0)[2]	34.3	222	115	Not Analyzed
	4/23/02, 16:00	5.8	73.4	17.8	31.0	5.0	6.99	62.4	1.0	2.4	U (2.0) [2]	104	364	257	0.7
	8/12/02, 17:05	5.3	9.8	2.3	4.1	0.8	U (0.25)	12.0	U (0.2)	U (0.2)	U (2.0)	27.4	53.8	33.9	Not Analyzed

Notes:

1 - Total depth during the winter is measured from the top of ice to the lake bottom.
2 - Sample holding time had expired upon delivery to lab.
3 - Detectable amount of sulfate in the calibration blank; sulfate value may be bias high.
4 - Add-on lake was sampled for the first time during the post-pump sampling event. No pre-pump data are available.
5 - COD analysis inadvertantly not requested on the chain of custody form

BOD = Biochemical oxygen demand
COD = Chemical oxygen demand
TDS = Total dissolved solids
U = Analyte was not detected at detection limit indicated in parenthesis.

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Table C-2 (continued)
Analytical Water Quality Parameters

Lake Number	Sample		Total Metals by EPA 200.8					Anions by EPA 300			BOD by EPA 405.1 (mg/L)	COD by EPA 410.4 (mg/L)	TDS by SM 2540C (mg/L)	Hardness as $CaCO_3$ (mg/L)	Conductivity (mS/cm)
	Date/ Time	Depth [1] (ft)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Iron (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)					
PUMP LAKES (continued)															
M9923	2/2/02, 09:10	5.0	125	20.4	24.5	3.3	U (0.25)	70.3	2.4	0.2	U (2.0)[2]	34.3	450	367	Not Analyzed
	4/24/02, 15:05	6.0	274	44.7	51.6	5.2	0.41	197	4.2 [3]	U (1.0)	U (2.0)[2]	77.8	1,090	867	1.7
	8/12/02, 18:05	5.1	35.7	5.3	6.1	0.8	U (0.25)	19.3	0.6	U (0.2)	U (2.0)	23.0	150	111	Not Analyzed
M9923 Dup	2/2/02	5.0	132	21.0	24.6	3.5	U (0.25)	68.5	2.3	0.2	U (2.0)[2]	30.1	446	381	Not Analyzed
ADD-ON PUMP LAKE [4]															
L9817	4/25/02, 10:00	5.6	126	48	56.6	4.5	0.94	256	0.6	1.2	U (2.0)[2]	55.9	964	513	1.4
	8/13/02, 11:40	5.5	22.9	8.1	9.5	1.0	U (0.25)	43.5	U (0.2)	U (0.2)	U (2.0)	Not Analyzed[5]	163	90.4	Not Analyzed

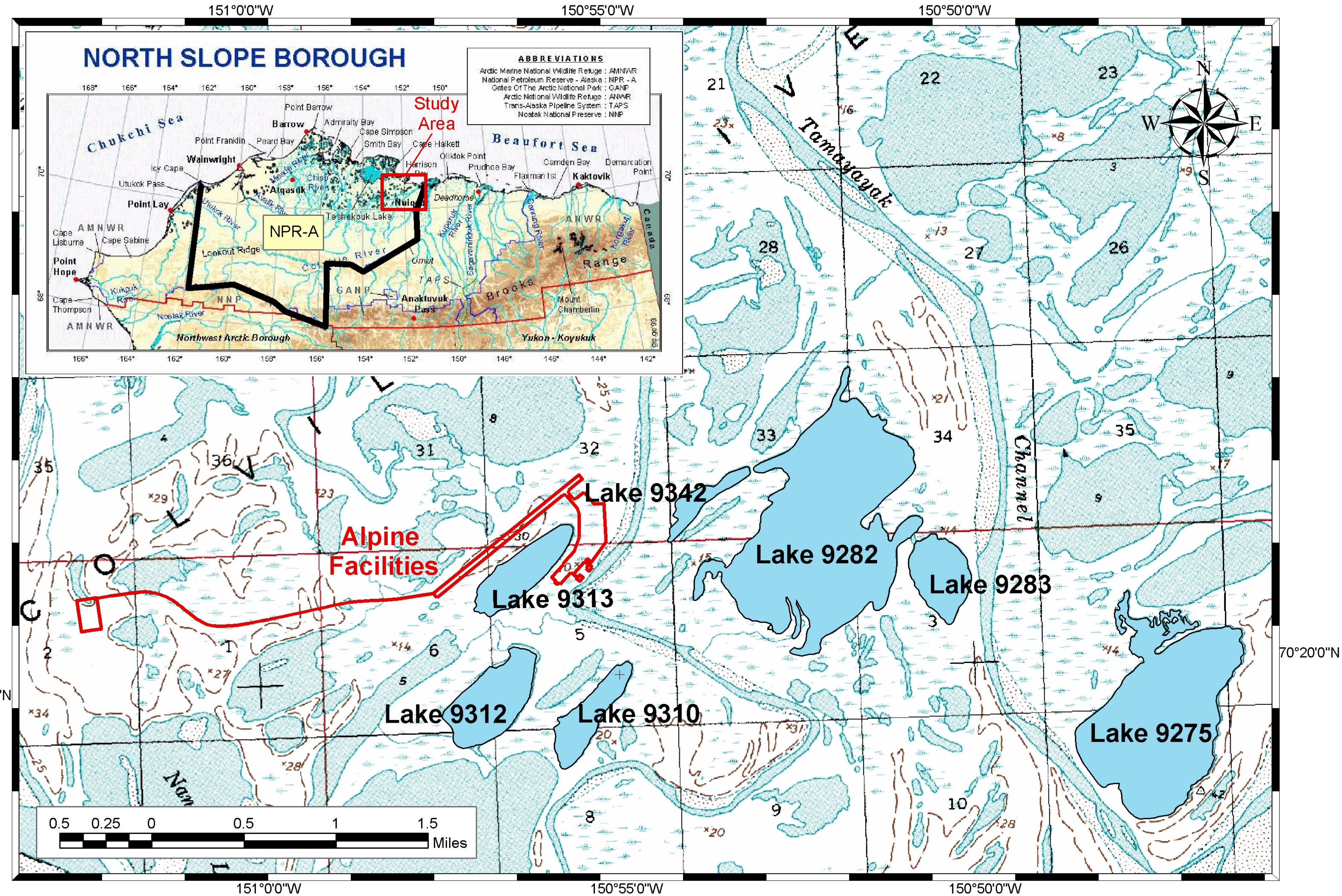
Notes:
1 - Total depth during the winter is measured from the top of ice to the lake bottom.
2 - Sample holding time had expired upon delivery to lab.
3 - Detectable amount of sulfate in the calibration blank; sulfate value may be bias high.
4 - Add-on lake was sampled for the first time during the post-pump sampling event. No pre-pump data are available.
5 - COD analysis inadvertantly not requested on the chain of custody form

BOD = Biochemical oxygen demand
COD = Chemical oxygen demand
TDS = Total dissolved solids
U = Analyte was not detected at detection limit indicated in parenthesis.

Appendix D Lab Data

Appendix E Alpine Lakes Summary Tables

Figure E-1 Alpine Lakes Study Vicinity



Baker

Table E-1
Alpine Lakes Monitoring Program
Physical and In-Situ Water Quality Parameters — **2002 Summary (January through August)**

Lake Number	Sample Date	Sample Time	Sample Location Coordinates (NAD27)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	In-Situ Parameters: Sample Depth[2] (ft)	Temp. (°C)	pH	Conduc-tivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
PERMANENT USE LAKE													
L9312	1/16/02	14:50	N70°19'53.4" W150°56'48.6"	7.34	11.40	3.10	4.0	0.4	7.6	0.08	0.00	15.99	0.29
							7.0	1.5	7.6	0.07	0.00	14.16	0.45
							10.0	2.5	7.5	0.07	0.00	9.75	0.39
	2/9/02	11:05		7.36	11.4	3.85	5.0	0.6	7.5	0.08	0.00	15.94	1.22
							8.0	1.6	7.3	0.08	0.00	15.52	1.46
							10.0	2.3	7.2	0.08	0.00	13.68	2.08
	3/11/02	18:00		7.32	11.53	4.67	5.0	1.3	7.3	0.10	0.00	15.44	2.00
							8.0	2.1	7.3	0.10	0.00	14.30	1.62
							10.0	2.6	7.2	0.09	0.00	10.00	1.79
	4/6/02	17:20		7.31	11.68	5.4	6.5	2.0	6.9	0.089	0.00	9.74	0.55
							9.5	2.9	7.1	0.088	0.00	9.31	0.64
	5/11/02			-	Not Sampled[3]								
	5/31/02	18:35		8.05	No Sampling Planned								
	6/29/02	11:00		7.98	No Sampling Planned								
	8/14/02	16:25		7.74	11.9	-	4.0	9.4	8.2	0.048	0.00	11.31	0.50
							7.0	9.3	8.0	0.049	0.00	11.30	0.46
							10.0	9.3	7.8	0.05	0.00	11.22	0.57

Notes:
1 - Total depth during the winter is measured from the top of ice to the lake bottom.
2 - Sample depth is measured from the top of ice in winter, from water surface in summer.
3 - Lake was not sampled as tundra travel restrictions did not permit access.

Baker

Table E-1 (continued)
Alpine Lakes Monitoring Program
Physical and In-Situ Water Quality Parameters **2002 Summary (January through August)**

Lake Number	Sample Date	Sample Time	Sample Location Coordinates (NAD27)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	In-Situ Parameters: Sample Depth[2] (ft)	Temp. (°C)	pH	Conduc-tivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
PERMANENT USE LAKE													
L9313	1/16/02	17:10	N70°20'29.3" W150°56'20.2"	6.04	9.40	3.70	4.7	0.6	8.2	0.3	0.0	10.8	0.6
							7.7	1.9	7.5	0.3	0.0	9.5	0.6
	2/9/02	13:01		5.98	9.45	4.35	5.3	1.1	7.1	0.4	0.0	7.1	1.1
							8.3	2.1	7.1	0.4	0.0	6.0	1.1
	3/12/02	7:40		5.97	9.5	5.43	6.0	1.7	6.3	0.4	0.0	3.8	1.1
							9.0	2.2	6.3	0.5	0.0	2.8	1.2
	4/7/02	7:55		5.95	9.38	5.8	6.8	1.4	6.9	0.5	0.0	0.1	0.9
							8.0	2.1	6.9	0.6	0.0	0.0	0.9
	5/11/02	14:50		5.96	9.50	5.9	7.0	3.1	7.3	0.5	0.0	4.0	13.9
	5/31/02	13:50		6.55	No Sampling Planned								
	6/29/02	11:00		7.98	No Sampling Planned								
	8/14/02	18:45		5.87	9.5	-	4.7	9.5	8.2	0.2	0.0	11.4	1.0
							7.7	9.4	8.4	0.2	0.0	11.4	1.6

Notes:

1 - Total depth during the winter is measured from the top of ice to the lake bottom.

2 - Sample depth is measured from the top of ice in winter, from water surface in summer.

Table E-1 (continued)
Alpine Lakes Monitoring Program
Physical and In-Situ Water Quality Parameters **2002 Summary (January through August)**

Lake Number	Sample Date	Sample Time	Sample Location Coordinates (NAD27)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	In-Situ Parameters: Sample Depth[2] (ft)	Temp. (°C)	pH	Conductivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
REFERENCE LAKE													
L9310	1/16/02	13:50	N70°19'46.6" W150°55'24.9"	8.78	20.90	4.00	5.0	0.4	7.7	0.2	0.0	11.3	0.5
							8.0	0.8	7.6	0.2	0.0	10.7	0.5
							11.0	1.6	7.6	0.2	0.0	9.5	0.5
							14.0	1.8	7.5	0.2	0.0	8.1	0.6
							17.0	2.0	7.5	0.2	0.0	6.1	0.9
							19.0	2.1	7.4	0.2	0.0	4.8	1.1
	2/9/02	9:55		8.87	21.35	5.0	6.0	0.5	7.6	0.2	0.0	10.2	0.7
							9.0	1.2	7.5	0.2	0.0	9.1	0.7
							12.0	1.6	7.4	0.2	0.0	8.5	0.8
							15.0	1.9	7.3	0.2	0.0	7.5	1.4
							18.0	2.0	7.2	0.2	0.0	5.4	1.8
							20.0	2.1	7.1	0.2	0.0	1.0	1.9
	03/11/02	15:45		8.76	18.46[3]	5.59	6.5	2.5	7.2	0.2	0.0	9.1	0.8
							9.5	2.6	7.2	0.2	0.0	8.1	0.8
							12.5	2.4	7.1	0.2	0.0	7.1	0.8
							15.5	2.5	7.2	0.2	0.0	6.5	1.4
	4/6/02	16:07		8.8	21.09	6.3	7.5	1.3	7.8	0.4	0.0	7.9	0.7
							10.5	1.6	7.7	0.4	0.0	7.3	0.8
							13.5	1.9	7.6	0.4	0.0	6.4	0.9
							16.5	2.3	7.6	0.4	0.0	5.8	0.7
							19.5	2.3	7.6	0.4	0.0	5.3	0.8
	5/11/02			-	Not Sampled[4]								
	6/1/02	12:20		8.83	No Sampling Planned								
	6/29/02	10:30		8.89	No Sampling Planned								
	8/14/02	15:00		8.61	20.2	-	5.0	9.6	8.4	0.1	0.0	10.7	0.4
							8.0	9.4	8.6	0.1	0.0	11.1	0.5
							11.0	9.4	8.7	0.1	0.0	11.0	0.6
							14.0	9.4	8.7	0.1	0.0	10.9	0.5
							17.0	9.3	8.6	0.1	0.0	10.9	1.4
							19.0	9.3	8.7	0.1	0.0	10.8	0.5

Notes:
1 - Total depth during the winter is measured from the top of ice to the lake bottom.
2 - Sample depth is measured from the top of ice in winter, from water surface in summer.
3 - March total depth is 2.89 feet shallower than February total depth, likely a function of sampling location, but could be a monitoring error.
4 - Lake was not sampled as tundra travel restrictions did not permit access.

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Table E-1 (continued)
Alpine Lakes Monitoring Program
Physical and In-Situ Water Quality Parameters **2002 Summary (January through August)**

Lake Number	Sample Date	Sample Time	Sample Location Coordinates (NAD27)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	In-Situ Parameters: Sample Depth[2] (ft)	Temp. (°C)	pH	Conductivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
TEMPORARY USE LAKES													
L9275	1/15/02	16:00	N70°19'37.5" W150°47'38.9"	10.4	12.50	3.80	4.8	1.0	8.4	0.2	0.0	14.4	0.8
							7.8	1.4	8.7	0.2	0.0	14.4	0.6
							10.8	1.9	8.8	0.2	0.0	13.6	0.4
	2/8/02	12:29		10.48	12.5	4.2	5.2	1.0	7.6	0.3	0.0	12.6	0.6
							8.2	2.0	7.4	0.3	0.0	12.4	0.6
							11.2	2.0	7.5	0.3	0.0	12.0	0.6
	3/11/02	9:00		10.38	12.84	5.00	5.0	0.6	7.2	0.3	0.0	11.6	1.3
							8.0	1.3	7.6	0.3	0.0	11.6	0.9
							11.0	1.9	7.8	0.3	0.0	11.4	0.9
	4/6/02	8:15		10.48	12.65	5.4	6.5	1.3	6.9	0.3	0.0	9.5	0.7
							9.5	1.9	7.0	0.3	0.0	8.4	0.6
							11.0	2.2	7.2	0.3	0.0	8.5	0.6
	5/11/02			-	Not Sampled 3								
	6/1/02			-	No Sampling Planned								
	6/29/02	10:50		10.56	No Sampling Planned								
	8/13/02	17:00		10.28	12.5	-	5.0	8.9	9.0	0.2	0.0	11.3	0.6
							8.5	8.9	9.0	0.2	0.0	11.4	0.5
							11.0	8.9	8.9	0.2	0.0	11.4	0.5

Notes:

1 - Total depth during the winter is measured from the top of ice to the lake bottom.

2 - Sample depth is measured from the top of ice in winter, from water surface in summer.

3 - Lakes L9312, L9310 and L9275 were not sampled as tundra travel restrictions did not permit access to these sites.

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Table E-1 (continued)
Alpine Lakes Monitoring Program
Physical and In-Situ Water Quality Parameters **2002 Summary (January through August)**

Lake Number	Sample Date	Sample Time	Sample Location Coordinates (NAD27)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	In-Situ Parameters: Sample Depth[2] (ft)	Temp. (°C)	pH	Conduc-tivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
TEMPORARY USE LAKES													
L9282	1/16/02	11:05	N70°20'53.3" W150°51'00.2"	8.69	21.00	3.80	4.8	0.5	7.9	0.2	0.0	9.1	1.4
							7.8	1.0	7.8	0.2	0.0	8.2	0.7
							10.8	1.2	7.8	0.3	0.0	10.0	0.5
							13.8	1.8	7.7	0.3	0.0	10.4	0.4
							16.8	2.0	7.6	0.3	0.0	9.0	0.6
							19.8	2.3	7.8	0.3	0.0	7.3	0.6
	2/8/02	15:42		8.77	21.0	4.9	5.0	1.0	7.7	0.4	0.0	11.8	0.5
							8.0	1.0	7.6	0.4	0.0	10.8	0.5
							11.0	2.0	7.6	0.4	0.0	10.6	0.5
							14.0	2.0	7.6	0.4	0.0	10.7	0.7
							17.0	2.0	7.6	0.4	0.0	10.8	0.9
							20.0	2.0	7.7	0.4	0.0	10.1	0.8
	3/11/02	13:25		8.71	21.1	5.41	6.0	1.0	7.4	0.4	0.0	9.4	1.4
							9.0	1.1	7.3	0.4	0.0	9.1	1.9
							12.0	1.5	7.3	0.4	0.0	8.8	0.9
							15.0	1.7	7.3	0.4	0.0	8.3	1.0
							18.0	1.9	7.2	0.4	0.0	8.2	1.0
	4/6/02	13:05		8.74	21.0	5.8	7.0	1.3	7.8	0.4	0.0	7.9	0.7
							10.0	1.6	7.7	0.4	0.0	7.3	0.8
							13.0	1.9	7.6	0.4	0.0	6.4	0.9
							16.0	2.3	7.6	0.4	0.0	5.8	0.7
							19.0	2.3	7.6	0.4	0.0	5.3	0.8
	5/11/02	9:40		8.74	20.8	6.0	7.0	2.0	6.9	0.3	0.0	10.4	3.5
							10.0	2.6	7.1	0.4	0.0	9.1	1.2
							13.0	2.8	7.1	0.4	0.0	7.4	0.7
							16.0	2.9	7.1	0.4	0.0	6.6	0.6
							19.0	2.7	7.2	0.4	0.0	5.7	1.1
	6/1/02	10:20		8.85	No Sampling Planned								
	6/29/02	10:50		8.83	No Sampling Planned								
	8/14/02	10:25		8.62	13.00	-	5	8.9	8.68	0.2	0.0	10.7	0.6
							8	8.9	8.84	0.2	0.0	10.6	0.8
							11.0	8.8	8.8	0.2	0.0	10.6	0.7
							14.0	8.8	8.8	0.2	0.0	10.6	0.6
							17.0	8.8	8.9	0.2	0.0	10.6	0.9
							20.0	8.8	8.9	0.2	0.0	10.5	0.6

Notes:
1 - Total depth during the winter is measured from the top of ice to the lake bottom.
2 - Sample depth is measured from the top of ice in winter, from water surface in summer.

Baker

Table E-1 (continued)
Alpine Lakes Monitoring Program
Physical and In-Situ Water Quality Parameters **2002 Summary (January through August)**

Lake Number	Sample Date	Sample Time	Sample Location Coordinates (NAD27)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	In-Situ Parameters: Sample Depth[2] (ft)	Temp. (°C)	pH	Conductivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
TEMPORARY USE LAKES													
L9283	1/16/02	9:00	N70°20'29.8" W150°50'15.0"	8.71	9.00	4.00	5.0	0.5	6.9	0.4	0.0	12.9	1.2
							8.0	0.9	7.2	0.5	0.0	12.1	0.8
	2/8/02	15:02		8.72	8.7	5.1	6.0	1.0	7.5	0.5	0.0	7.9	0.8
							7.0	1.0	7.5	0.4	0.0	8.7	1.0
	3/11/02	12:15		8.74	9.0	6.1	7.0	1.0	7.7	0.5	0.0	9.8	3.4
							8.0	2.0	7.5	0.5	0.0	10.2	6.0
	4/6/02	11:50		8.74	9.0	6.3	7.3	0.6	7.4	0.6	0.0	2.2	1.4
	5/11/02	12:20		8.77	9.1	6.7	7.7	2.3	7.2	0.7	0.0	1.7	2.1
	6/1/02	11:00		8.85	No Sampling Planned								
	6/29/02	10:04		8.86	No Sampling Planned								
	8/14/02	8:15		8.62	8.9	-	5	8.1	8.47	0.2	0.0	11.1	0.8
							8.0	8.0	8.5	0.2	0.0	11.0	0.9

Notes:
1 - Total depth during the winter is measured from the top of ice to the lake bottom.
2 - Sample depth is measured from the top of ice in winter, from water surface in summer.

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Table E-1 (continued)
Alpine Lakes Monitoring Program
Physical and In-Situ Water Quality Parameters **2002 Summary (January through August)**

Lake Number	Sample Date	Sample Time	Sample Location Coordinates (NAD27)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	In-Situ Parameters: Sample Depth[2] (ft)	Temp. (°C)	pH	Conductivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
TEMPORARY USE LAKES													
L9342	1/16/02	12:20	N70°20'50.1" W150°53'43.7"	8.71	11.30	4.00	5.0	0.6	7.7	0.1	0.0	10.0	0.4
							8.0	1.4	7.5	0.1	0.0	9.6	0.3
							10.0	1.9	7.2	0.2	0.0	8.1	0.4
	2/9/02	8:54		8.81	11.3	4.7	5.7	1.3	6.5	0.2	0.0	10.0	0.7
							8.7	1.9	6.7	0.2	0.0	9.3	0.6
							10.0	2.4	6.8	0.2	0.0	7.2	0.9
	3/11/02	14:45		8.77	10.78	5.5	6.5	1.1	6.2	0.2	0.0	8.5	1.4
							9.5	2.1	6.4	0.2	0.0	8.1	1.6
	4/6/02	14:05		8.85	11.17	6.0	7.0	1.8	7.6	0.2	0.0	5.7	0.5
							10.0	2.4	7.4	0.2	0.0	4.5	0.4
	5/11/02	8:20		8.79	11.23	6.2	7.2	2.4	6.3	0.2	0.0	6.8	5.0
							10.2	3.2	6.3	0.2	0.0	6.3	1.6
	6/1/02	9:40		8.88	No Sampling Planned								
	6/29/02	8:45		8.86	No Sampling Planned								
	8/14/02	13:00		8.63	11.80	-	5.0	8.9	8.34	0.1	0.0	11.0	0.8
							8.0	8.8	8.32	0.1	0.0	10.9	0.5
							10.0	8.8	8.4	0.1	0.0	10.8	0.4

Notes:
1 - Total depth during the winter is measured from the top of ice to the lake bottom.
2 - Sample depth is measured from the top of ice in winter, from water surface in summer.

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Table E-2
Alpine Lakes Monitoring Program
Analytical Water Quality Parameters

2002 Summary (January through August)

Lake Number	Sample Date	Sample Time	Analytical Sample Depth[1] (ft)	Biochemical Oxygen Demand by EPA Method 405.1 (mg/L)	Chemical Oxygen Demand by EPA Method 410.4 (mg/L)	Total Dissolved Solids by SM 2540C (mg/L)
PERMANENT USE LAKES						
L9312	1/16/02	14:50	7.3	U (2.0)	38.4	56
	2/9/02	11:05	7.3	U (2.0) [2]	28.0	Not Analyzed
	3/11/02	18:00	8.1	U (2.0) [2]	U (20.0)	Not Analyzed
	4/6/02	17:20	8.5	U (2.0) [2]	U (20.0)	Not Analyzed
	05/11/02	Not Sampled [3]				
	8/14/02	16:45	7.5	U (2.0)	U (20.0)	Not Analyzed
L9313	1/16/02	17:10	6.5	U (2.0)	46.7	218
	2/9/02	13:01	6.8	U (2.0) [2]	U (20.0)	Not Analyzed
	3/12/02	7:40	7.4	U (2.0)	U (20.0)	Not Analyzed
	4/7/02	7:55	7.6	U (2.0)	U (20.0)	Not Analyzed
	5/11/02	14:50	8.2	U (2.0)	23.0	Not Analyzed
	8/14/02	18:45	7.5	U (2.0)	U (20.0)	Not Analyzed
REFERENCE LAKE						
L9310	1/16/02	13:50	12.5	U (2.0)	34.3	106
	2/9/02	9:55	13.0	U (2.0) [2]	U (20.0)	Not Analyzed
	3/11/02	15:45	12.0	U (2.0) [2]	U (20.0)	Not Analyzed
	4/7/02	16:07	13.7	U (2.0) [2]	U (20.0)	Not Analyzed
	5/11/2002	Not Sampled [3]				
	8/14/02	15:00	13.0	U (2.0)	U (20.0)	Not Analyzed
TEMPORARY USE LAKES						
L9275	1/15/02	16:00	8.1	U (2.0)	U (20.0)	146
	2/8/02	12:29	8.3	U (2.0) [2]	44.7	Not Analyzed
	3/11/02	9:00	8.9	U (2.0) [2]	U (20.0)	Not Analyzed
	4/6/02	8:15	9.0	U (2.0) [2]	U (20.0)	Not Analyzed
	5/11/2002	Not Sampled [3]				
	8/13/02	18:15	8.5	U (2.0)	U (20.0)	
L9275 Dup	3/11/02	-	8.9	U (2.0) [2]	U (20.0)	Not Analyzed

Notes:

1 - Sample depth is equal to one-half the distance between the bottom of ice (in summer the water surface) and the bottom of the lake.

2 - Sample holding time had expired upon delivery to lab.

3 - Lakes L9312, L9310 and L9275 were not sampled in May 2002, as tundra travel restrictions did not permit access to these sites.

U = Analyte was not detected at detection limit indicated in parenthesis.

Baker

Table E-2 (continued)
Alpine Lakes Monitoring Program
Analytical Water Quality Parameters

2002 Summary (January through August)

Lake Number	Sample Date	Sample Time	Analytical Sample Depth[1] (ft)	Biochemical Oxygen Demand by EPA Method 405.1 (mg/L)	Chemical Oxygen Demand by EPA Method 410.4 (mg/L)	Total Dissolved Solids by SM 2540C (mg/L)
TEMPORARY USE LAKES						
L9282	1/16/02	11:05	12.5	U (2.0)	38.4	210
	2/8/02	15:42	13.0	U (2.0) [2]	38.4	Not Analyzed
	3/11/02	13:25	13.3	U (2.0) [2]	23.0	Not Analyzed
	4/6/02	13:05	13.4	U (2.0) [2]	20.8	Not Analyzed
	5/11/02	9:40	13.4	U (2.0) [2]	U (20.0)	Not Analyzed
	8/14/02	11:00	13.0	U (2.0)	U (20.0)	Not Analyzed
L9283	1/16/02	9:00	6.5	U (2.0)	U (20.0)	279
	2/8/2002	15:02	6.0	U (2.0) [2]	48.8	Not Analyzed
	3/11/02	12:15	7.6	U (2.0) [2]	27.4	Not Analyzed
	4/6/02	11:50	7.5	U (2.0) [2]	25.2	Not Analyzed
	5/11/02	12:20	7.9	U (2.0) [2]	25.2	Not Analyzed
	8/14/02	9:15	7.0	U (2.0)	U (20.0)	Not Analyzed
L9283 Dup	1/16/02	-	6.5	U (2.0)	48.8	289
	4/6/02	-	7.5	U (2.0) [2]	34.0	Not Analyzed
	8/14/02	-	7.0	U (2.0)	U (20.0)	Not Analyzed
L9342	1/16/02	12:20	7.5	U (2.0)	44.7	104
	2/9/02	8:54	8.0	U (2.0) [2]	53.0	Not Analyzed
	3/11/02	14:45	8.1	U (2.0) [2]	U (20.0)	Not Analyzed
	4/6/02	14:05	8.6	U (2.0) [2]	U (20.00)	Not Analyzed
	5/11/02	8:20	8.7	U (2.0) [2]	U (20.00)	Not Analyzed
	8/14/02	13:20	8.0	U (2.0)	U (20.0)	Not Analyzed
L9342 Dup	2/9/02	-	8.0	U (2.0) [2]	U (20.0)	Not Analyzed
	5/11/02	-	8.7	U (2.0) [2]	U (20.0)	Not Collected

Notes:
1 - Sample depth is equal to one-half the distance between the bottom of ice (in summer the water surface) and the bottom of the lake.
2 - Sample holding time had expired upon delivery to lab.
U = Analyte was not detected at detection limit indicated in parenthesis.

Appendix F Kuparuk Lakes Summary Tables

Figure F-1 Kuparuk Lakes Study Vicinity

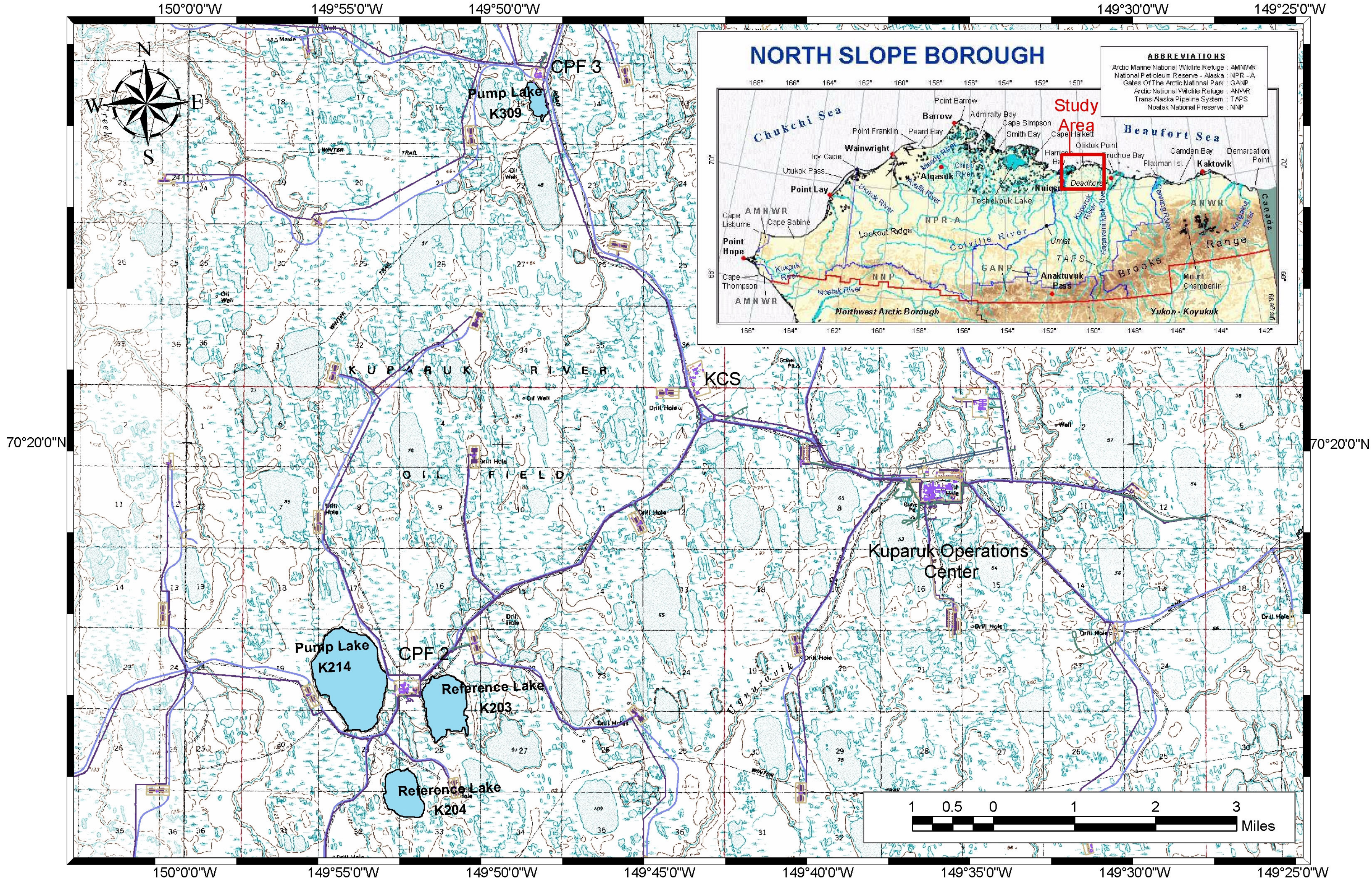

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Table F-1
Kuparuk Lakes Monitoring Program
Physical Parameters — **Summary (January - August 2002)**

Lake Number	Sample Date	Sample Time	Sample Location Coordinates (NAD27)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)
PUMP LAKES						
K309 [2]	1/29/02	9:20	N70°23'51.4" W149°48'59.4"	88.90	7.70	3.60
	5/14/02	8:15		89.31	6.81	3.71
	6/27/02	18:45		89.07	NM	No Ice Present
	8/15/02	15:00		89.02	10.00	
K214	1/29/02	15:30	N70°17'28.8" W149°55'02.8"	81.41	6.00	4.50
	5/14/02	10:15		81.31	5.91	5.64
	6/27/02	15:15		81.58	NM	No Ice Present
	8/15/02	16:20		81.45	6.00	
REFERENCE LAKES						
K203	1/30/02	11:30	N70°17'07.6" W149°51'39.5"	82.90	6.50	4.40
	5/14/02	11:40		82.76	5.92	5.31
	6/27/02	16:00		83.14	NM	No Ice Present
	8/15/02	18:15		83.12	5.50	
K204	1/30/02	11:15	N70°16'28.2" W149°52'57.5"	89.78	6.40	4.80
	5/14/02	11:40		89.77	6.43	6.43
	6/27/02	18:00		89.85	NM	No Ice Present
	8/15/02	17:50		89.77	6.50	

Notes:

1 - Total depth during the winter is measured from the top of ice to the lake bottom.

2 - Sampling completed in frozen overflow conditions in May 2002.. All measurements are referenced to the top of the overflow ice. Overall water surface elevation may be artificially elevated by overflow water. Top of overflow ice to top of lake ice proper = 0.45 feet. Overflow ice thickness = 0.75 feet.

NM - Not Measured

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Table F-2
Kuparuk Lakes Monitoring Program
In-Situ Parameters **Summary (January - August 2002)**

Lake Number	Sample		In-Situ Parameters						
	Date	Time	Sample Depth[1] (ft)	Temperature (°C)	pH	Conductivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
P U M P L A K E S									
K309 [2]	1/29/02	9:20	5.7	4.0	6.5	1.4	0.1	1.3	4.0
	5/14/02	8:15	5.3	2.9	7.3	1.2	0.1	3.9	36.4
	8/15/02	15:00	5.5	8.8	8.7	0.3	0.0	10.7	9.7 [4]
K214	1/29/02	15:30	5.3	1.0	5.1	1.0	0.0	2.4	2.6
	5/14/02	10:15	5.8	0.7	7.2	3.7	0.2	14.4	186
	8/15/02	16:20	5.0	8.6	9.0	0.2	0.0	10.8	24.3
R E F E R E N C E L A K E S									
K203	1/30/02	11:30	5.5	1.0	7.0	0.7	0.0	9.6	2.8
	5/14/02	11:40	5.6	0.5	7.5	0.4	0.0	11.2	36.1
	8/15/02	18:15	4.5	8.5	8.9	0.2	0.0	10.7	23.0
K204	1/30/02	11:15	5.6	1.0	5.7	0.6	0.0	6.9	2.7
	5/14/02	11:40	Not Sampled[3]						
	8/15/02	17:50	5.5	8.5	8.8	0.2	0.0	10.6	13.2

Notes:

1 - Sample depth in the winter equals one-half the distance between the bottom of ice and the bottom of the lake.
Sample depth in the summer was conducted at depths similar to those conducted in the winter.

2 - Sampling completed in frozen overflow conditions in May 2002. All measurements are referenced to the top of the overflow ice.
Overall water surface elevation may be artificially elevated by overflow water. Top of overflow ice to top of lake
ice proper = 0.45 feet. Overflow ice thickness = 0.75 feet.

3 - Water column at sampling location was frozen top to bottom. In situ monitoring was not conducted.

4 - Particulate matter in the sample had settled prior to performing Hach Meter field test. Sample result may be biased low.

Attachment I   Lake Depth Data (MJM Research)

NPR-A 2002 Lake Monitoring and Recharge Study
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