Tyhee NWT Corp

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APPENDIX D

APPENDIX D FISHERIES

YELLOWKNIFE GOLD PROJECT

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FISHERIES AND AQUATIC RESOURCES REPORT

February, 2005

Tyhee NWT Corp

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FISHERIES AND AQUATIC RESOURCES REPORT

TYHEE NWT CORP

YELLOWKNIFE GOLD PROJECT

Prepared For

TYHEE NWT CORP

Prepared by:

EBA ENGINEERING CONSULTANTS LTD.
Yellowknife, Northwest Territories

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EXECUTIVE SUMMARY

INTRODUCTION AND BACKGROUND

EBA Engineering Consultants Ltd (EBA) completed a comprehensive baseline investigation of six lakes surrounding the former Discovery Mine and Nicholas Lake area that included Round Lake, Winter Lake, Narrow Lake, Brien Lake, Eclipse Lake and Nicholas Lake to document fisheries and aquatic resource parameters. The objectives of the summer 2004 Fisheries and Aquatic Resources baseline study were as follows:

- to document existing fish and fish habitat conditions within lakes in the Yellowknife Gold Project (YGP) and Nicholas Lake areas;
- to provide information for evaluating and mitigating potential impacts due to the project; and
- to provide a benchmark for possible future monitoring during construction, operations and site decommissioning.

The Fisheries and Aquatic Resources investigations undertaken during the summer 2004 field study included: Fish Species Relative Abundance, Distribution and Species Composition (Gillnetting and Minnow Trapping), Fish Biological Characteristics (length, weight, age), Fish Habitat (characterization of habitat attributes), Fish Tissue Metals Analysis, Lake Bathymetry, Benthic Invertebrate and Zooplankton Populations, Water Quality, and Sediment Quality Analysis in Lakes. In streams, Fish Species Populations Relative Abundance, Distribution and Species Composition (Electro-fishing, Minnow Trapping and Gillnetting), Fish Biological Characteristics (length, weight, age), Fish Habitat (characterization of habitat attributes), and Benthic Invertebrate Populations. A summary of results in presented below.

<u>Fish Species Composition, Relative Abundance and Distribution</u>

Lakes

Gillnet sets were successful in the collection of fish from Eclipse Lake, Nicholas Lake, Brien Lake and Narrow Lake. No fish were collected in Round Lake or Winter Lake. Northern pike was the most widely distributed species in the study area, with the collection of 25 individuals. Lake whitefish was the most abundant species with the collection of 5 fish from Eclipse Lake and 74 fish from Narrow Lake. The collection of lake trout was limited to Eclipse Lake (11 fish) and Nicholas Lake (9 fish). Other species collected in nets included three lake cisco in Eclipse Lake and two burbot, one from both Eclipse and Nicholas lakes. No Arctic grayling were collected from lakes or streams from the study area. Fish collected by minnow traps was limited to two juvenile pike captured in Narrow Lake near shore.

Streams

At the time of the summer survey, water levels in the lakes and streams surveyed were at seasonal low levels. Most inlet and outlets streams within the study area were found to be ephemeral or not visibly evident within the riparian vegetation. The main outlet streams for Eclipse Lake and Nicholas Lake were at seasonally low water levels, which resulted in the isolation of pools. Some of these pools were observed to contain rearing fish.

Fish Biological Characteristics

Northern pike ranged in length from 160 mm to 745 mm and in weight from 40 g to 2,660 g. Ages observed were between 0+ (including juveniles captured in minnow traps) to 7+ years. Lake trout ranged in length from 191 mm to 755 mm and weights ranged from 60 g to 6,803 g. Ages observed ranged from age 3+ to age 34+. Length and weight measurements for whitefish ranged from 144 mm to 454 mm and 100 g to 1240 g, respectively. Ages ranged from 3+ to 17+ years.

Lake Habitat Characteristics

The six lakes surveyed within the YGP study area ranged in size from 11.5 ha to 258 ha and had a bathymetric depth ranging between 1.5 (Winter Lake) to 55 m (Eclipse Lake) in depth. Round Lake and Winter Lake were shallow and have large sections of the lakes, which freeze to the bottom during winter. Eclipse Lake and Nicholas Lake were observed to support a complex diversity of habitat types, including steep and vegetated shorelines, rocky shoals and islands, deep water, boulder fields and multiple embayments. Both lakes provided important habitat attributes for the spawning, rearing and over-wintering of northern pike, lake trout and lake whitefish. Brien Lake and Narrow Lake were limited in their habitat availability for fish and were primarily comprised of a single elongated basin supporting a single deep lake section and extensive shed wetland vegetation, at both ends of each of the lakes. Both Brien and Narrow lakes support a small population of northern pike. Narrow Lake was also found to support a large population of lake whitefish.

A habitat suitability rating for individual fish species based on ideal lake habitat characteristics was conducted for all lakes surveyed. The rating resulted in fish habitat ratings of "Poor" for all fish species for Round and Winter Lakes. Eclipse and Nicholas lakes were given a rating of "Good" for all fish species including northern pike, lake trout, lake whitefish, lake cisco and Arctic grayling. Brien Lake was rated as having "Moderate" habitat for northern pike, only. Narrow Lake was rated as having "Moderate" habitat for both northern pike and lake whitefish.

Fish Tissue Metals

Samples of composite tissue collected from fish within the YGP study area, resulted in the highest values of mercury and arsenic observed in tissue from a large trout captured in Eclipse Lake. The trout (age 34+ years) was observed to contain mercury levels (4.0 ppm), eight times the Health and Welfare Canada restrictive consumption level of 0.5 ppm. The highest mean levels of arsenic occurred in fish captured in Eclipse Lake. High levels of selenium were observed from lake trout in Nicholas Lake. Northern pike from Brien Lake showed the highest mean concentrations of copper of all fish collected, within the YGP study area. Levels for cadmium, chromium, lead, nickel, silver and zinc were all found in fish tissue samples at levels below detection limits.

Zooplankton Community

Zooplankton sampled from lakes within the YGP study area comprised a total of six species, including Rotifera, Eubranchipoda, Cladocera, Copepoda, amphipoda, and Insecta. Copepoda were found in the greatest numbers of all species collected at 46.4% (41,394 individuals) and the greatest mean density at 3,146.78 organisms/m^3. Followed in order of decreasing abundance was Rotifera at 30.1% (26,865 individuals) and Cladocera at 22.5% (20,053 individuals) and a mean density of animals at 2,018.87 and 1,746.75 organisms/m^3. The other zooplankton communities made up the remainder (~ 2%).

Benthic Invertebrate Community

Lakes

An assessment of benthic invertebrate communities for lakes included the collection of benthic samples from both inshore and offshore. The Chironomidae were observed to have the greatest overall abundance from both inshore and offshore lake samples. They represented 61.81% all taxa collected, followed in order of decreasing abundance and composition, by the Bivalvia (13.15%) and Amphipoda (12.56%). All taxa found in significant numbers in inshore and offshore sediment samples were facultative organisms. Orders "sensitive" to environmental conditions (i.e., Ephemeroptera) were found in only moderate numbers at the sites, as were pollution tolerant orders, such as Oligochaeta.

Streams

The benthic invertebrate group, with the greatest overall abundance, was the Chironomidea followed by the Bivalvia, and Ostracoda. These groups are known to be “facultative” with respect to changes in environmental conditions. Plecoptera, identified as “sensitive” were observed in small numbers within the inlet to Winter Lake only.

Lake Water Quality

High summer water temperatures in Round and Winter lakes' limit suitable rearing conditions for cool water fish. The shallow morphology of both Round and Winter lakes suggests that these lakes freeze to the bottom during winter. Eclipse and Nicholas lakes were observed to have significant depth (55 m and 36 m, respectively) providing cool seasonal temperatures optimal for most fish species. The exposure of the shoreline features (rocky islands and elongated embayments to wind and waves allow for optimal water circulation and vertical oxygenation of the water column. Brien Lake and Narrow Lake were comprised of a single elongated basin supporting a deep section. The morphology of the lakes would result in summer and winter stratification of water temperatures and available oxygen in deeper water. The morphology also limits the availability of suitable rearing and over-wintering conditions for fish. The pH measurements for all lakes ranged between 6.91 and 7.43. Conductivity levels range for most lakes was between 51.1 µs/cm to 206.9 µs/cm at the surface.

Lake Sediment Quality

Sediments within Round Lake were shown to have higher values for arsenic, copper, nickel, zinc and phosphorus, in comparison to all other lakes sampled. Brien Lake showed the highest concentration of mercury in sediments, followed by the second highest concentrations of copper and arsenic. Sediment samples collected from Narrow Lake indicated the highest concentrations of chromium of all lakes and supported the second highest concentrations of mercury, nickel, zinc and phosphorus. Levels for chromium were found elevated within all lake sampled in the study area. Winter Lake was found to have the lowest concentrations of arsenic and phosphorus, and the second lowest concentrations of chromium, mercury and zinc. Eclipse Lake was observed to support and lowest concentrations of mercury and copper in sediments, while Nicholas Lake supported the lowest concentrations of nickel and zinc.

Metals in lake sediments were compared to the CCME Sediment Quality Guidelines (Environment Canada, 2002) (Table 10). Arsenic, chromium, cooper exceeded Interim Sediment Quality Guidelines (ISQG) in all lakes sampled. Round Lake also exceeded ISQG for lead and mercury. Zinc concentrations exceeded ISQG in all lakes, except Winter and Nicholas lakes.

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1.0 INTRODUCTION

Tyhee NWT Corp (Tyhee) retained EBA Engineering Consultants Ltd. (EBA) to complete a baseline study of aquatic resources at the Yellowknife Gold Project (YGP) area, Northwest Territories (NWT). The baseline study included an assessment of six lakes surrounding the historical Discovery Mine and Nicholas Lake area. The six lakes; Round Lake, Winter Lake, Narrow Lake, Brien Lake, Eclipse Lake and Nicholas Lake were surveyed for fisheries and aquatic resource parameters. The baseline Fisheries and Aquatic Resources data collection took place in the summer of 2004 between July 18 and August 1. The exact locations of the sampling sites are shown on the attached map showing the YGP area (See Figure 1).

2.0 BACKGROUND AND ENVIRONMENTAL SETTING

Tyhee owns two advanced exploration projects located in the Canadian Shield approximately 80 km north of Yellowknife, Northwest Territories. The Ormsby Deposit, includes the area of the historic Discovery Mine and the Nicholas Lake Gold Deposit. The exploration and development of these mineral properties requires the completion of a baseline assessment of environmental resources of the area, in order to support the preparation of a detailed Environmental Assessment for the YGP.

Historically, the primary focus for an environmental study in the area of interest has been related to impacts of the Discovery Mine. This site has a known history of contamination and has been identified as a contributor to the acid mine drainage reported in the area, as well as elevated mercury and metal levels in Giauque Lake sediments and fish (Moore et al., 1978). Indian Affairs and Northern Affairs Canada (INAC), through their Yellowknife Contaminated Sites Office, have put considerable effort into the remediation of these issues and continue to monitor the area.

Over the years, a number of fisheries studies have been conducted on Giauque Lake and the surrounding Discovery Mine area. Laboratory analyses of fish tissues (muscle and liver) from Giauque Lake conducted by Moore et al., (1978) and Hale et al., (1979) determined that mercury levels were elevated at that time. However, the results of recent fish sampling and analysis conducted on lakes in the Giauque and Nicholas lakes area by the North Slave Métis Alliance (1998) indicate the mercury levels in Giauque Lake fish tissues have declined. More recently, North Slave Métis Holdings and Gartner Lee (2002) reported that an analysis of variance (ANOVA) of mean mercury concentration (not considering age) indicated there have been no changes in the mercury concentration, average size or the weight of fish in Giauque or Thistlethwaite lakes from 1978 to 1998.

The report by Moore et al. (1978) also provided information on benthic invertebrates and zooplankton populations and sediment quality for Giauque, Thistlethwaite, Wagenitz and Maguire lakes. This report represents the best historic information available for the area.

Fish from Giauque Lake have often contained mercury levels in excess of the 0.5 parts per million (ppm) (wet weight) restrictive consumption level and the 1.5 ppm (wet weight) consumption warning level set by Health and Welfare Canada (2002). However, some fish collected downstream of Thistlethwaite Lake, upstream of Control Lake and Wagenitz Lake have also been shown to contain mercury in excess of the restrictive level, indicating the potential for naturally elevated background levels of mercury in the environment of the study area (North Slave Métis Holdings Ltd. and Gartner Lee (2002)**.**

Fish species that could found in water bodies in the Giauque and Nicholas lakes region are listed in Table 1. Northern pike (*Esox lucius)*, and lake trout (*Salvelinus namaycush)* are the largest and most common fish species found in the study area.

Table 1
Fish Species of the YGP Study Area

Common Name	Scientific/ Latin Name
Arctic grayling	*Thymallus arcticus*
Burbot	*Lota lota*
Emerald shiner	*Notropis atherinoides*
Lake chub	*Couesius plumbeus*
Lake cisco	*Coregounus artedi*
Lake trout	*Salvelinus namaycush*
Lake whitefish	*Coregonus clupeaformis*
Longnose sucker	*Catostomus catostomus*
Ninespine sticklebacks	*Pungitius pungitius*
Northern pike	*Esox lucius*
Round whitefish	*Prosopium cylindraceum*
Slimy sculpin	*Cottus cognatus*
Spoonhead sculpin	*Cottus ricei*
Spottail shiner	*Notropis hudsonius*
Trout-perch	*Percopsis omiscomaycus*
Walleye	*Stizostedion vitreum*
White sucker	*Catostomus commersoni*

3.0 STUDY SCOPE AND OBJECTIVES

The objective of the summer 2004 Fisheries and Aquatic Resources environmental baseline study was to evaluate the existing fish and fish habitat conditions within the YGP study area. The intent of this report is to provide a comprehensive documentation of the existing summer conditions, which may be used as a benchmark for future investigations.

The Fisheries and Aquatic Resources program comprised the following elements:

Fish Populations – Lakes and Streams (Lake Inlets and Outlets):

- Fish Populations and/or Relative Abundance, Distribution and Species Composition;
- Fish Biological Characteristics; and
- Fish Tissue Metals.

Fish Habitat – Lakes and Streams (Lake Inlets and Outlets):

- Fish Habitat Characteristics and Values (spawning, rearing, foraging, over-wintering)
-
- Bathymetry (Lakes only)

Zooplankton – Lakes:

- Relative Abundance, Distribution and Species Composition

Benthic Invertebrate - Lakes and Streams:

- Relative Abundance, Distribution and Species Composition

Water Quality - Lakes and Streams:

- Temperature
- Dissolved Oxygen
- Conductivity
- pH
- Turbidity

Sediment Quality (Lakes):

- Total Metals
- Grain Size Analysis

4.0 SAMPLING METHODOLOGY

The following section discusses the methodology used for the assessment of fisheries and aquatic resources, during the summer 2004 field studies.

4.1 Fish Habitat

4.1.1 Lakes

Fish habitat characteristics and values observed at each lake were accomplished as per standards and procedures recognized within the *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Standards and Procedures (Lake Survey's)* (RIC, 1998). Fish habitat characteristics, as well as survey sampling points were recorded directly onto field maps. Field data was formatted using ARC/INFO to produce habitat feature maps as shown in Figures 2 to 7. Photographs compiled in Appendix A, document shoreline attributes, aquatic vegetation types, wildlife features, and fish collection specimens.

EBA completed a rating of fish habitat suitability for all lakes sampled. The rating of fish habitat is based on a relative scoring scheme developed to evaluate fish habitat attributes required to sustain all stages of life for individual fish species, including habitat requirements for spawning, rearing and over-wintering.

Each individual fish species has a maximum possible score based on the ideal habitat attributes. The rating given to each lake for a particular species is based on the presence or absence of these species-specific habitat attributes. A rating of "Poor" represents a lake providing none to only a limited number of attributes necessary to sustain all life stages; a rating of "Moderate", indicates a lake providing a minimum number of attributes necessary to sustain all life stages; and a rating of "Good" represents a lake providing a maximum and diverse number of attributes to sustain all life stages for that fish species.

Fish species considered (not necessarily present) included northern pike, lake trout, lake whitefish, lake cisco and Arctic grayling. Individual fish species' tables were produced for individual fish species to identify the potential for those species to be present in the lakes studied (See Figures 4a - 4e).

4.1.2 Streams

Fish habitat characterization for streams was carried out as per the *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Standards and Procedures (Stream Survey's)* (RIC, 1998). Basic habitat unit types such as pool, riffle, run, cascade, etc., were identified and noted within each stream study site. Stream channel morphology was defined using percent habitat within each sampling site; measurements or estimates of wetted width, depth, slope and substrate composition were assessed. In addition, the composition of cover provided by overstream vegetation (OSV), undercut banks (UCB), instream large woody debris (LWD), pools and boulders were visually estimated.

4.1.3 Bathymetry

Bathymetric mapping was completed on lakes using a Trimble Pathfinder Pro XRS TS-C1 Global Positional System (GPS) data logger and Trimble Pro XRS receiver. Lake depths were recorded using a MarineTek SEAMAX depth sounder in combination with the Trimble data logger. An aluminum boat was used to map the perimeter of the lakes, embayments, stands of emergent vegetation, and any wildlife features (i.e., beaver houses, nest sites etc.). Data gathered was then formatted using ARC/INFO to produce hard copies of lake bathymetric maps shown in Figures 8 and 9. GPS positions of sampling locations were taken in the field with a Trimble Pathfinder Pro XRS TS-C1 data logger and Pro XRS receiver. ARC/INFO was used to format the data and create maps depicting locations of gillnet sets, water sample, benthic sample, sediment sample, and zooplankton sample locations as shown in Figures 10-15.

4.2 Fish Populations

4.2.1 Lakes

Large size-classes of fish were collected from each lake using two experimental monofilament gillnet gangs. A floating gillnet was positioned nearshore at the surface (floating) and the sinking gillnet, was positioned offshore on the bottom. Gillnet deployment locations within each lake are shown in Figures 10 to 15. Each net was comprised of six gillnet panels with mesh sizes of 25 mm, 76 mm, 51 mm, 89 mm, 38 mm and 64 mm stretched. Gillnets were deployed using a 4.2 m (14') aluminum boat with 9.9 horsepower, Mercury outboard engine. Boats were transported to sample lakes by truck or by slinging using a helicopter. Nets were strategically placed on each lake by considering the lakes morphology and shoreline habitat characteristics. Once deployed, gillnets were left to fish overnight.

Catch rates were calculated using a fishing effort of 12 hrs/net/unit catch area of 100 m^2 (i.e., 12 x 100 m^2 = Catch per Unit Effort or CPUE). Additional data recorded at each net site included the set and pull date and time, orientation, water depth, weather and GPS location using a Trimble Pathfinder Pro XRS TS-C1 data logger and Pro XRS receiver.

Gee-type minnow traps were used to collect smaller-class fish within littoral areas and small shallow embayments. Ten minnow traps baited with sardines were used in each lake. Traps were placed in dense emergent reed beds, undercut shorelines and adjacent to fallen trees, and left over night. Dimensions of the Gee-traps used were 0.4 m length by 0.2 m diameter with an aperture of 0.02 m. Data recorded included date, set/haul times, location and contents. Figures 10-15 identify sampling locations.

All fish species collected were identified and counted using Scott and Crossman (1973). Where fish could not be identified in the field, voucher specimens were collected and forwarded to North-South Consultants Inc., in Winnipeg, Manitoba for verification. Relative abundance, distribution and species composition of fish populations were analyzed for each lake.

4.2.2 Streams

The fish sampling methods of inlet and outlet streams included the use a backpack electrofisher and minnow-trapping where appropriate. Fish collection focused on the presence or absence of fish species and incorporated the use of British Columbia Resource Inventory Committee (RIC) Standards for stream surveys as defined in the *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Standards and Procedures* (RIC, 1998).

Electrofishing was conducted using a battery-powered Smith-Root POW-15B backpack unit along a 100 m section of stream, starting at the inlet or outlet of each lake. This method was used to assess species distribution and population size at sample sites. In order to estimate population size, electrofishing was performed using consistent levels of effort proceeding from the lake and moving upstream or downstream. Specimens collected were placed in a half-filled bucket of water. After electrofishing, the unit was turned off, electrofisher settings and effort (in seconds) was recorded, and the captured fish were processed and released. The total length and width of the surveyed area was measured, in addition to stream channel widths and wetted widths. Where fish presence was recorded within the sample streams, the data was then used to determine relative abundance, distribution and species composition of fish populations as well as catch per unit effort (calculated as number of fish per species caught per minute).

4.2.3 Biological Characteristics

Fish data collection included fork length (measured between the tip of the head to the fork of the tail fin (mm), weight (g), sex, maturity, visible parasites and lesions. A sub-sample representing existing fish population age classes from lakes within the study area was determined by submitting pectoral fin clips from cyprinids and large coarse fish and cleithra (jaw bone) from northern pike, all of which were dried. Aging structures were removed from a subsample of approximately ten individual specimens per species.

A total of 41 fin age structures (pectoral fins and cleithra) samples were submitted for analysis.

4.2.4 Tissue Metals

Selected fish specimens from sample sites were retained for the determination of dorsal muscle and liver metals content. Dorsal muscle tissue and liver tissue were removed and preserved by freezing in labeled sample containers. These tissues were submitted as composite samples from individual fish specimens. Occasionally a whole fish or a composite of like whole fish was submitted for analysis, due either to the small size of fish specimens or the lack of sufficient tissue mass for individual tissue analysis. After dissection, tissue samples were then placed into Ziploc bags, labelled and put into a cooler and kept frozen in the camp freezer until shipment to ALS Environnmental Canada (ALS) Vancouver, British Columbia, for analysis. ALS analyzed tissue samples, using procedures consistent with the requirements of the appropriate regulatory agencies (i.e., CAEAL certified). A brief outline of the method follows:

Prior to analysis, fish tissues were prepared in a clean environment dedicated to the project. Analysis was carried out as soon as possible after sample submission.

The analysis of moisture in tissue was carried out gravimetrically, by drying the sample at 103 °C for a minimum of six hours. For tissue metals analysis, samples were homogenized either mechanically or manually prior to digestion.

The hotplate digestion involves the use of nitric acid followed by repeated additions of hydrogen peroxide. Metal analysis was by atomic absorption spectrophotometry (EPA Method 7000 series), inductively coupled plasma – mass spectrometry (EPA Method 6020), and /or inductively coupled plasma – optical emission spectrophotometry (EPA Method 6010B). The digested portion was analyzed by atomic emission mass spectrophotometry (ICPMS), to meet the required detection limit for each element (arsenic, cadmium, copper, lead, zinc, silver, tellurium and mercury). Table 2 shows various metals and their detection limits.

Table 2
Detection Limits for Metals Tested in Fish Tissues

Metals		μg/g wet weight
Aluminum	A	0.01
Copper	Cu	0.01
Chromium	Cr	0.01
Cadmium	Cd	0.0001
Mercury	Hg	0.0001
Lead	Pb	0.0001
Nickel	Ni	0.01
Selenium	Se	0.01
Zinc	Zn	0.01

4.3 Zooplankton

Zooplankton was sampled in the deepest sections of each lake (Figures 10-15). Three replicated vertical tows were conducted at varying depths, depending on lake morphology. A 153 μm mesh plankton net with a 12 inch diameter opening, 36 inches in total length, fitted with a cod-end was used for zooplankton collection. The total volume is calculated by the length of the zooplankton tow, multiplied by the area of the net opening, which is 0.07296587 m^2. Zooplankton samples were placed into labeled containers and preserved with 10% phosphate-buffered formalin. Samples were subsequently submitted to Applied Technical Services in Victoria, British Columbia, for identification and enumeration.

In the laboratory, samples were washed through a 65 μm sieve, mixed and poured into a 100 ml container, and then subsampled to 10 ml and placed into a grid-marked Petri dish. Each species or group was identified and counted as a 10 ml subsample. The remaining 100 ml sample was analyzed for additional species not present in the 10 ml subsample. With the raw data, relative abundance, distribution and species composition of zooplankton was determined.

4.4 Benthic Invertebrates

4.4.1 Lakes

In-situ benthic invertebrate sampling within lakes was conducted using a Ponar dredge sampler. Figures 10-15 show the locations of benthic invertebrate sample sites for each lake. Three replicate samples were collected within deep water and three samples in shallow water. The surface sampling area of the dredge is approximately 0.023 m^2.

The dredge was lowered down to the lake bottom, raised approximately 1.0 m above the sediment, and then allowed to fall and penetrate the substrate layer to a depth of approximately 10 cm. The dredge was then brought to the surface and emptied of its contents into a sieve bucket with 583 µm steel mesh on the bottom. Grab samples were collected following strict criteria: samples contained overlying water, sediments were relatively flat, the entire surface of the sample was included and a penetration depth of a least 10 cm was achieved. When a sample did not meet the above criteria, it was rejected and another was taken in its place.

Samples were then washed and sieved with remaining faunal organisms and organic material placed into labeled 500 ml plastic sample containers. Samples were then preserved with a 10% phosphate-buffered formalin solution. Additional data collected at the time of sampling included a qualitative description of the bottom sediments collected in the sampler, the sample location and water depth. With the data, relative abundance, distribution and the species composition of lake benthic invertebrates was determined.

4.4.2 Streams

In-situ benthic invertebrate sampling was also conducted at all lake inlets and outlets, to determine the taxonomic composition and density at each site. Invertebrates were sampled using an Ekman dredge sampler with a surface area of 0.023 m^2. Where possible, a total of three replicate samples, representative of the habitat type, were collected for each lake inlet and outlet.

The use of the Ekman dredge included pushing the sampler down into the streambed by hand, in order to reach a minimum sample depth of 6 to 10 cm, and then triggering the sampler to close and retain the contents. Samples were rejected if the Ekman did not fully close. The sample contents were emptied, washed and sieved through a 583 µm steel mesh sieve bucket. The remaining faunal organisms together with organic material, were placed into labeled 500 ml plastic sample containers. Larger gravels and small woody material collected were washed by hand in the sieve bucket, and examined to ensure no organisms were attached before discarding. Samples were then preserved with 10% phosphate-buffered formalin. Substrate composition within the sample area was also recorded.

All benthic invertebrate samples collected were shipped to Dr. Charles Low of Victoria, British Columbia, for analysis. Invertebrate identification and enumeration of taxa was completed referencing Pennak (1978) and Merritt and Cummins (1989). Laboratory procedures followed the Pulp and Paper Environmental Effects Monitoring (EEM) Technical Guidance Document (Environment Canada, 1998), due to the established protocols followed for benthic invertebrate sampling. With the data, relative abundance, distribution and species composition of stream benthic invertebrates was determined.

4.4.3 Community Analysis

A community analysis of benthic and zooplankton populations was conducted using the Shannon-Wiener biotic index (H'), which measures species diversity. Shannon-Wiener is a widely used index and incorporates relative abundance of different taxa and total numbers of taxa. H' increases with the number of evenly distributed species in the community and represents the quality of the site's environmental conditions as a relation to increased abundance and species richness. The index uses a rating from one to three, with three representing highest diversity of taxa. Tables 8c and 9c report community analysis using the Shannon-Wiener Index, of zooplankton and benthic invertebrate taxa, respectively.

4.5 Water Quality

Water quality parameters measured in lakes and streams were: water temperature, dissolved oxygen, specific conductivity, pH and turbidity. The locations of water quality sample sites within each lake are indicated in Figures 10-15. Water temperature, dissolved oxygen and specific conductance were measured using a YSI Multi-Function Meter (+/-1.0% saturation). The pH was measured using a Hanna HI 991300 Portable pH meter. Values were measured at (0-1990 (µS/cm) and (+/- 0.1 pH units). Water transparency was measured to the nearest 0.1 m using a 20 cm diameter Secchi disk. Water quality profiles were taken at deep point within each lake, and at 1.0 m depth intervals. Water temperature, dissolved oxygen, and specific conductance, were taken at a deep point in each lake and recorded at the surface and at 1.0 m depth intervals to the bottom. The pH was recorded at one depth approximately 30 cm below the water surface.

4.6 Sediment Quality

Lake sediment sampling was conducted using a Ponar dredge sampler. The locations of sediment sample sites within each lake are illustrated in Figure 10 to Figure 15. The dredge was lowered down to the lake bottom, raised approximately 1.0 m above the sediment, and then allowed to fall and penetrate the substrate layer to a depth of approximately 10 cm. The dredge was then brought to the surface and emptied of its contents into a bucket. Three replicate Ponar grab samples were collected in deep water and three samples in shallow water. Sediments were transferred into labeled 250 ml glass sample jars. Samples collected were analyzed for total metals and grain size analysis. Additional data collected at the time of sampling included a qualitative description of the sampled sediments, and the location and depth of the spot where the samples were collected.

ALS analyzed the sediment samples, using procedures consistent with the requirements of the appropriate regulatory agencies (i.e., CAEAL certified). The samples were analyzed by atomic emission mass spectrophotometry (ICPMS), to meet the required detection limit for each element. Metals tested included antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, phosphorus, selenium, silver, thallium, tin, vanadium, and zinc. Table 3 presents the detection limits for various metals and other parameters tested in lakes sediments.

Table 3
Detection Limits for Parameters Tested in Lake Sediments

Parameter		Unit	Detection Limit
Physical Tests			
Moisture		%	0.10
pH		pH	0.010
Nutrients			
Available Phosphorus	P	mg/kg	1.0
Total Nitrogen	N	%	0.010
Total Metals			
Antimony	T-Sb	mg/kg	10
Arsenic	T-As	mg/kg	5.0
Barium	T-Ba	mg/kg	1.0
Beryllium	T-Be	mg/kg	0.50
Cadmium	T-Cd	mg/kg	0.50
Chromium	T-Cr	mg/kg	2.0
Cobalt	T-Co	mg/kg	2.0
Copper	T-Cu	mg/kg	1.0
Lead	T-Pb	mg/kg	30
Mercury	T-Hg	mg/kg	0.0050
Molybdenum	T-Mo	mg/kg	4.0
Nickel	T-Ni	mg/kg	5.0
PhosphorusT-P		mg/kg	50
Selenium	T-Se	mg/kg	2.0
Silver	T-Ag	mg/kg	2.0
Thallium	T-Tl	mg/kg	1.0
Tin	T-Sn	mg/kg	5.0
Vanadium	T-V	mg/kg	2.0
Zinc	T-Zn	mg/kg	1.0
Organic Parameters			
Total Organic Carbon	C	%	0.050
Particle Size			
Gravel	(>2.00 mm)	%	0.10
Sand	(2.00 mm to 0.063 mm)	%	0.10
Silt	(0.063 mm to 4 um)	%	0.10
Clay	(<4 um)	%	0.10

4.7 Quality Assurance and Quality Control (QA/QC)

Strict QA/QC procedures were followed during field sampling. Sampling methodology followed accepted professional practice and QA/QC procedures were monitored by the field biologist on a daily basis. The field QA/QC procedures are detailed in the following list:

4.7.1 Field Procedures

QA/QC procedures for the field components of the aquatic biota baseline study are necessary to maintain a high degree of data quality. The following is a list of the main procedures adapted from Environment Canada (1993).

- all personnel involved in field procedures are qualified for the tasks undertaken and all work will be supervised by a qualified Professional Biologist (R.P. Bio.);
- all sampling is consistent throughout the baseline study;
- all samples are collected following the most appropriate method and sample quality will be maintained to the highest standard;
- sampling equipment is the most appropriate for the particular habitat, and should be in good working condition;
- all samples are labeled appropriately with the site reference, date collected, and sample type;
- all samples are preserved with the appropriate preservative;
- field personnel maintain detailed field notes for project reference; and
- field personnel follow appropriate safety guidelines for conducting fieldwork and will ensure all samples will be shipped in the appropriate containers following the appropriate shipping guideline.

Quality assurance measures for fish tissue analysis include analysis of digest blanks and certified reference tissues. In addition, a duplicate tissue analysis will be conducted for every ten samples, randomly chosen.

4.8 Emergency Response Capabilities

All personnel operating equipment such as boats, electrofishers, deploying nets, dissecting fish, etc., have a considerable amount of academic and professional experience, with the use of such equipment in the practice of their discipline of fisheries science. All crew working in the field program have a minimum of a valid Level 1 Emergency First Aid ticket. During field studies, the fisheries team was equipped with a radio for contact with other survey teams and the YGP camp. All crew members kept bear repellent in their possessions at all times and were familiar with other local natural hazards in the project area.

5.0 RESULTS

5.1 Lake Shoreline Habitat

The following section presents the results of the 2004 fish habitat surveys conducted on lakes within the YGP study area. The lakes surveyed are characteristic of northern Canadian Shield lakes. Lakes are rocky, relatively deep and are low in productively (oligotrophic). A summary of lake biophysical features including morphology, shoreline characteristics, fish habitat, vegetation, bathymetry and substrate is presented below (also see Figure 2 to Figure 9). Bathymetric surveys were completed for Round Lake and Winter Lake only.

A rating of fish habitat suitability, which includes spawning, rearing and over-wintering habitat for different fish species in the lakes sampled is presented in Table 4a to Table 4e. A complete set of photographs illustrating lake shoreline habitat is presented in Appendix A. A complete list of shoreline plant species observed in lakes and adjacent wetlands is presented in Appendix B.

5.1.1 Round Lake

An assessment of shoreline habitat features for Round Lake was completed between July 18, 2004 and July 19, 2004. Round Lake habitat photos are shown in Photo 1 to Photo 4; Appendix A.

Round Lake is located 0.5 km south of the YGP Camp and is characterized by a round shallow basin approximately 450 m in length, 315 m in width with a surface area of 11.5 ha (Figure 1). The north end of Round Lake receives runoff (over historical tailings) from the Discovery mine site. A cap of crushed rock fill and a small strip of uncapped tailings adjoin the north end of Round Lake (Figure 2). The outlet flows southwest through a bog into Winter Lake (approximately 400 m away). The outlet has been used to drain Round Lake during high lake levels. Round Lake is considered the headwaters to Winter and Narrow lakes.

Shoreline vegetation consists of marsh cinquefoil (*Potentillia palustris*), and emergent stands of water sedge (*Carex aqualtilis*), and scouring rush (*Equisetum hyemale*). The lake supports a small community of submergent macrophytes consisting only of slender-leaved pondweed (*Potemegon pusillus*).

Due to the shallowness of the lake, a bathymetric survey of Round Lake was completed using a measuring rod. Depth measurements were taken at 15 locations on the lake. The lake was found to have a maximum depth of 1.5 m located within the southern portion of the lake (Figure 8). Bottom sediments were visually observed to be comprised of organic materials and silts.

An analysis of fish habitat parameters for Round Lake indicated an overall rating of Poor for all fish species (See Table 4a to 4e). The lake did provide emergent and submergent vegetation suitable for use by northern pike; however, the lake was absent of course substrates, deep water, shoals, boulder fields and a significant inlet and outlet suitable for use by other fish species (Figure 2). Round Lake has been impacted by tailings from the historical Discovery Mine and is known to freeze to the bottom during winters.

A fish population assessment of Round Lake using gillnets and baited minnow traps resulted in no fish being collected.

5.1.2 Winter Lake

An assessment of shoreline habitat features for Winter Lake was completed between July 20 and 21, 2004 (see Photos 5 - 10; Appendix A).

Winter Lake is located approximately 0.8 km southwest of the historic Discovery Mine site (Figure 1). Winter Lake is approximately 1.74 km long and 620 m wide and is characterized by two basins. The lake has a total surface area of 69.2 ha. The inlet to Winter Lake drains from Round Lake, while the outlet from the lake drains to the west into Narrow Lake (Figure 3).

Shoreline vegetation consists of buckbean, (*Menyanthes trifoliata*), sweetgale, scouring rush (*Equisetum hyemale*) and floating mats of water sedge and beaked sedge. Winter Lake was observed to have a diverse community of aquatic macrophytes. The shallow littoral zone of the lake includes yellow water lily (*Nuphar lutea*), large-leaved pondweed (*Potamogeton epihydrus)*, water smartweed (*Polygonum amphibium*) and hard-stem bulrush (*Scirpus validus*). The deep littoral zone (>1.0 m) supports submergent stands of water milfoil (*Myriophyllum* spp.), Richardson's pondweed (*Potamogeton richardsonii),* and muskgrass (*Chara* spp.). Several small shrub wetlands connect the shoreline along the south basin.

A bathymetric survey of Winter Lake indicated a maximum lake depth of 6.0 m located in the north basin. Bathymetric data indicated that the south basin was relatively shallow and did not exceed 2.0 m in depth (Figure 9). Bottom substrates in the north basin consisted of bedrock and course material along the shoreline, and fine organic sediments in the deeper profundal zone of the lake. Substrate in the southern basin consisted predominantly of fine organic material and silt.

An analysis of fish habitat attributes for Winter Lake indicated a rating of Poor for all fish species (See Table 4a to 4e). While the lake did provide shallow vegetated bays suitable for the spawning and rearing of northern pike, the lake was also relatively shallow and lacked the presence of course substrates and deep-water habitat complexity suitable for other species, such as lake trout or whitefish (See Figure 3). Due to the shallow depth, the south basin of Winter Lake could be expected to freeze to the bottom during most winters, resulting in low and lethal oxygen levels. The lake also receives tailings runoff from Round Lake. Overall, these factors indicate poor habitat conditions for aquatic life. A fish population assessment of Winter Lake using gillnets and baited minnow traps resulted in no fish specimens being collected.

5.1.3 Eclipse Lake

An assessment of shoreline habitat features for Eclipse Lake was completed between July 22, 2004 and July 25, 2004. Habitat features are depicted in Photo 11 to Photo 23; Appendix A.

Eclipse Lake is located approximately 4.8 km north of the Discovery Mine camp (Figure 1). Eclipse Lake has a surface area of 258.0 ha and is the largest of the six lakes surveyed within the YGP study area. Two principal basins divide the lake. The west basin is approximately 2.5 km long and 2.0 km wide, while the east basin is ~4.5 km long and ~400 m wide.

Eclipse Lake is characterized by a wide diversity of complex habitat features, including numerous rocky embayments, rocky islands, and submerged reefs (Figure 4). Inflowing streams connect small upland lakes and wetlands located north and south of Eclipse Lake. The embayments and islands support steep dropoffs, shallow rocky flats, and exposed and submerged boulder fields. The boulder fields protect sedge and bog wetlands along the shoreline and at the inflow of tributary creeks. The lakes' shoreline was observed to drop off rapidly, and to form a rocky transitional fringe of mixed boulders, cobbles, gravels, and sand.

Sections of low-lying shorelines support hummocks of sphagnum moss, Labrador tea, bog rosemary (*Andromeda polifolia*), marsh cinquefoil, mosses and lichens and small patches of cotton grass. Emergent vegetation along the shoreline and in shallow basins consists primarily of water sedge, beaked sedge (*Carex rostrata*) and scouring rush. Northern pike were observed during the field survey utilizing the stands of emergent vegetation.

Soundings indicated a 55 m deep hole located near the middle of the west basin and a 53 m deep hole located near the inlet to the east basin. The east basin has a maximum depth of approximately 36 m located near the east end of the basin. Soundings also indicated several submerged reef features within both the west and east basin.

A preliminary assessment of Eclipse Lake identified a complexity of habitats ideal for various life stages for northern pike, lake trout and lake whitefish. Small wetland fens and sedge stands located at the end of the embayments and along the shorelines provide suitable spawning and rearing habitat for northern pike. During spring freshet, higher lake levels and flooded shoreline vegetation further enhance the availability of spawning habitat for northern pike. The abundant shoals and submerged boulder fields, with stands of sedge all provide good foraging and rearing habitat for northern pike. The abundance of shoals, and rocky reefs and the close proximity of the shoreline to deep water indicated high quality spawning and foraging habitat for lake trout and lake whitefish.

Observed habitat features in Eclipse Lake indicate a habitat suitability rating of Good for all species (See Table 4a to 4e). Habitat features exhibited a diversity of habitat types t known to be important for all life stages of northern pike, lake trout, lake whitefish, lake cisco and Arctic grayling. Water depths exceeding 30 m were recorded at various locations throughout the lake. These deep-water areas maintain high water quality and cool temperatures for the seasonal foraging of cool water fish. Steep dropoff areas along the shoreline and islands, and the abundance of rocky reefs and submerged boulder fields provide optimal spawning and foraging for lake trout, whitefish and migrating schools of cisco. The exposure of the shoreline features to wind and waves is expected to allow for optimal water circulation for well-oxygenated and clean spawning substrates. The abundance of sedge grasses and rushes along the shoreline provide important spawning and rearing habitat for northern pike (Inskip, 1982).

Although Eclipse Lake supports several attributes important for the rearing and overwintering of Arctic grayling, the lakes main inflow and outflow were observed to lack suitable spawning gravel for grayling use. No records of Arctic grayling for this lake are known. A spring survey of the lakes main inlet(s) and outlet may confirm the presence of spawning grayling.

5.1.4 Nicholas Lake

An assessment of shoreline habitat features for Eclipse Lake was completed between July 26, 2004 and July 28, 2004. Habitat features are illustrated in Photo 24 to Photo 34; Appendix A.

Nicholas Lake is located 9.6 km northeast of the YGP camp (Figure 1). Nicholas Lake is the second largest lake of the six lakes surveyed. Three basins comprise Nicholas Lake and are characterized by a complex array of small embayments, small rocky islands, submerged reefs, extensive beds of emergent vegetation and wetlands (Figure 5). Nicholas Lake is ~3.74 km long, ~450 m wide at its widest point, and has a surface area of ~96.3 ha.

At the time of the field study, the inlet to Nicholas Lake was ephemeral. In the outlet, water was limited to the first 40 m of creek exiting the lake. The following 100 m was mostly dry, with the substrate exposed. The lake basins are typically associated with pockets of emergent sedges including water sedge, scouring rush, and small shrub and willow-dominated wetlands. Wetlands define the boundary between summer and spring water levels. Soft-bottom littoral sections of the embayments support yellow water lily and submergent beds of water smartweed, and slender-leaved pondweed.

Depth soundings of Nicholas Lake indicate a maximum depth of approximately 37 m located just east of the old Nicholas Lake camp. Much of the lake shoreline consists of exposed bedrock. Where shoreline gradients were reduced, bottom substrates also consist of large gravels and cobbles.

Fish habitat attributes documented for Nicholas Lake indicate a habitat suitability rating of Good for all species (Table 4a to Table 4e). Habitat characteristics were similar to those documented for Eclipse Lake. The abundance of sedge grasses and rushes along the shoreline likely provide important spawning, and rearing habitat for northern pike (Inskip, 1982). Rocky bottom substrates and the diversity of steep shoreline dropoffs, islands, rocky reefs and submerged boulder fields all provide optimal rearing and foraging for lake trout, whitefish and northern pike (See Figure 5). Nicholas Lake was observed to have a series of deep-water basins supporting high water quality and cool temperatures, which are important for seasonal foraging of cool water fish. The convergence of basins and the exposure to wind and waves allows for optimal water circulation and clean, well-oxygenated spawning substrates. Previous under-ice water quality sampling (Norecol, 1990) indicated that stratification of the lake did not occur during winter conditions. The main inflow and outflow to this lake was also found to be limited in suitable spawning substrate for grayling. A survey of fish populations was limited to the capture of northern pike, lake trout, and burbot.

5.1.5 Brien Lake

The field assessment of Brien Lake was completed on July 29, 2004 and July 30, 2004. Habitat features are presented in Photos 35 - 41; Appendix A.

Brien Lake is located approximately 1.5 km west of the Discovery Mine Camp (Figure 1). Brien Lake is approximately 1.61 km long and 290 m wide and has a surface area of ~24.2 ha. The lake is partially separated into two basins by a sedge peninsula. The inlet to the lake flows through a sedge wetland located at the northeast end of the lake. A section of raised shoreline separates Brien Lake from a secondary outlet at the southwest end of the lake. The Brien Lake outlet is located at the end of a bay toward the south end of the lake (Figure 6).

Depth soundings of Brien Lake indicate a maximum lake depth of 11 m located in the basin near the lake outlet. Substrate in the lake was observed to consist primarily of fine organic material and silt. A bedrock cliff forms much of the southeast shore of the lake.

The forest community surrounding Brien Lake consists of black spruce, paper birch, and jack pine (*Pinus banksiana*), and willow. Shoreline vegetation consists of dwarf birch, sweetgale, and willow. Floating mats of water sedge and sphagnum moss along the northeast shoreline form a sedge wetland. Shallow littoral plants include yellow water lily, scouring rush, and water smartweed. Deep littoral plants include, Richardson's pondweed, slender leaved pondweed, bladderwort (*Utricularia* spp.), water milfoil and muskgrass.

Observed habitat attributes for fish indicate a habitat suitability rating of Moderate for northern pike and Poor for all other fish species (Table 4a to Table 4e). Brien Lake was observed to be shallow and to have only one deep section (approximately 11 m) near the centre. The lake is absent of steep shoreline gradients, rocky shoals or large course substrates. The Brien Lake inlet and outlet regulate water levels in the lake and also enhance spawning area and rearing conditions for northern pike. Fish caught in Brien Lake were limited to northern pike, which indicates the lake provides habitat suitable only for northern pike.

5.1.6 Narrow Lake

An assessment of shoreline habitat features for Narrow Lake was completed July 30 through August 1, 2004. Habitat features are shown on Photo 42 to Photo 47; Appendix A.

Narrow Lake is located 2.2 km southwest of the YGP Camp (Figure 1). A single, long basin characterizes the lake ~1.4 km long and 200 m wide. Narrow Lake has a surface area of ~24.9 ha. The inlet to Narrow Lake is connected to Winter Lake. The principal outlet, located at the southeast end of the lake, drains south into a small lake approximately 100 m to the southwest (Figure 7).

Several wetlands exist along the edge of Narrow Lake. The complexity of wetlands observed along the margins of the lake include open fens dominated by water sedge, fen/swamps dominated by dead spruce and birch and water plantain, and fen/bogs dominated by dwarf birch, sphagnum moss and Labrador tea. Shallow littoral plants include yellow water lily, scouring rush, and bur-reed (*Sparganium* spp.), while deep littoral plants include water smartweed and water milfoil.

Depth sounding in Narrow Lake indicated a maximum depth of 12 m located in the southwest portion of the lake. This depth was recorded in a deep hole with a relatively steep gradient. While rocky bottom substrates were identified within the southern portion of the lake, much of the bottom substrate within Narrow Lake consists of fine organic material and silt (Refer to Appendix J).

An analysis of fish habitat suitability for Narrow Lake indicates a rating of Moderate for northern pike, lake trout, lake whitefish, and lake (see Table 4a to Table 4). While the margins of the lake provide abundant emergent and submergent vegetation suitable for pike, the lake was observed to be limited in rocky shoals and submerged reefs that would provide sufficient spawning habitat for lake trout and whitefish. The lake lacks suitable spawning, or rearing habitat to support both lake cisco and grayling. An assessment of fish populations resulted in the capture of 89 lake whitefish and 12 northern pike (Table 6b).

5.2 Inlet and Outlet Stream Habitat

This section presents the results of the primary inlet and outlet streams of lakes surveyed within the YGP study area in 2004. A discussion of fish habitat and stream channel characteristics includes instream cover, bed material, riparian habitat, channel morphology, and water quality. A list of plants observed within the nearshore areas of the study area is included in Appendix B. At the time of the survey, lake and stream flow conditions were at low seasonal levels.

The lakes surveyed within the YGP study area fall within three drainage basins. The Brien Lake (el. 295 m) with a drainage basin ~3.24 km^2, flows to Shona Lake (el. 291 m), then to the southwest through a series of small unnamed lakes eventually reaching Barker Lake (el. 243 m), Johnstone Lake (el. 232 m), Clan Lake (el. 216 m) and then into the Yellowknife River.

The Narrow Lake drainage basin – (~9.19 km^2) flows from Narrow Lake to the southwest to Morris Lake (el. 278 m), then Goodwin Lake (el. 260 m), Johnstone Lake (el. 232 m), Clan Lake (el. 216 m), and then into the Yellowknife River.

The north part of the YGP study area is located within the Nicholas Lake drainage basin ~6.28 km^2). Water flows from Nicholas Lake (el. 325 m) west to Eclipse Lake (el. 311 m) and continues to the Yellowknife River via numerous small lakes, ponds and bogs.

5.2.1 Round Lake

The primary inlet and outlets from Round Lake were defined by dense stands of willow riparian and sedge fen habitat (Figure 2). At the time of summer 2004 survey, no flowing drainages were observed to indicate the location of the creeks. Round Lake flows west into Winter Lake during higher water periods.

5.2.2 Winter Lake

The primary inlet to Winter Lake is defined within a narrow stand of black spruce and a willow shrub thicket (Figure 3). The wetted channel of the stream was unconfined at its confluence with the lake and partially confined further upstream. The mean estimated wetted width and channel width (at low summer flows) was 5.8 m. The mean maximum pool depth was 10 cm. No riffles were present. Average stream gradient at the site was 0.2%. Dominant cover type was in-stream vegetation and over-stream vegetation. The stream had no deep pools, no undercut banks, and no boulders. Stream substrates, as well as bank texture consisted of fines.

A survey of water quality resulted in a measured dissolved oxygen concentration of 3.52 mg/l, which is below the approved dissolved oxygen concentrations of 5.5 mg/l to 9.5 mg/l for aquatic life (Environment Canada, 2002). Water temperature was measured at 16.0 °C. The pH and specific conductivity were not measured.

The outlet from Winter Lake is defined within a sedge fen and willow and birch riparian vegetation community (Figure 3). The outlet channel was unconfined at its margins with the lake and confined further downstream within the willow and birch community. The mean estimated channel and wetted width (at low summer flows) was 1.1 m. The mean maximum pool depth was 29 cm. No riffles were present. Average stream gradient at the site was 0.2%. Dominant cover consisted of over-stream vegetation followed by in-stream vegetation. The outlet stream had no deep pools, no undercut banks, and no boulders. In-stream substrates, as well as bank texture consisted of fines and small cobbles. A survey of water quality resulted in a measured DO concentration of 3.50 mg/l, and below standard for aquatic life (Environment Canada, 2002). Measurements for pH and specific conductivity were 6.71 and 217 µS/cm, respectively. Approved Environment Canada standards for pH in freshwater ranges from 6.5 to 9.0. No standards for conductivity have been defined by Environment Canada. The water temperature at the outlet was 16.4 °C.

5.2.3 Eclipse Lake

An investigation of inlet streams at Eclipse Lake identified the presence of one flowing stream located at the only end of the east arm of the lake (Figure 12). The creek flowed through a low topographic depression and conifer forest. The wetted channel was meandering and unconfined and had estimated mean channel and wetted width of 3.2 m. The mean maximum pool depth was 0.23 m. No riffles were present. The average stream gradient at the site was 0.2 %. The stream lacked deep pools, undercut banks and boulders. Stream substrates, as well as bank texture, consisted of fines, and small patches of gravel.

Water quality measurements showed a dissolved oxygen concentration of 5.74 mg/l, (5.0 mg/l to 9.5 mg/l, CCME FAL 2003), a pH of 6.58 and a specific conductivity of 51.5 µS/cm. Water temperature was measured at 18.6°C.

The inlet to the lake is located at the most northeast point of the east basin. A survey along the shoreline did not identify the exact location of the inlet creek.

The outlet creek from Eclipse Lake is defined within an open spruce forest community and a low topographic depression located between Eclipse Lake and another small lake, approximately 80 m to the west (Figure 4). The wetted channel is confined by bedrock. The mean estimated channel width was 6.8 m and the mean wetted width was 6.7 m. The mean maximum pool depth was 0.48 m, however, one pool was measured at a depth of 0.78 m. The average stream gradient at the site was 0.2%. No riffles were present, although the creek is expected to have adequate flow during high spring water levels. Stream channel cover consisted of angular boulders and secondly by deep rocky pools. Stream substrates, as well as bank texture consisted of cobbles and boulders. This outlet stream may provide important spawning habitat for Arctic grayling. The use of the creek by grayling would require a further site visit during spring ice breakup between May and June.

A survey of water quality resulted in a measurement for DO of 8.03 mg/l, a pH of 6.82 and a specific conductivity of 52 µS/cm. These measurements fall within approved water quality guidelines for aquatic life (Environment Canada, 2002). Water temperature was measured at 22°C.

5.2.4 Nicholas Lake

The primary inlet to Nicholas Lake is poorly defined within a sedge and peat bog (Figure 5). At the time of the survey the inlet stream was dry. Bog vegetation consisted primarily of small hummocks of sphagnum moss, Labrador tea and small stands of cotton grass. Streambed material consisted of fines. Several upland bogs and small lakes drain into Nicholas Lake. No water quality measurements were collected.

The Nicholas Lake outlet stream was defined within an open spruce forest community and a low topographic depression confined by bedrock. At the time of the survey, water was present in the outlet for a total distance of 42 m downstream from the lake. The remaining length of stream was dewatered. The mean estimated channel width was 5.3 m and the mean wetted width was 2.4 m. The mean maximum pool depth was 0.54 m. The average stream gradient was 0.5%. No riffles were present, although riffles are expected during high spring water levels. Boulders are the dominant cover type (0.8 m + in diameter). Stream substrates, as well as bank texture consisted of cobbles and boulders. This outlet stream may provide important spawning habitat for Arctic grayling.

Measurements for water quality within the first 42 m of stream channel were similar to surface water quality from the lake. The dissolved oxygen concentration was 8.03 mg/l, pH was 7.04 and specific conductivity was 61 µS/cm. Water temperature at the outlet was 20°C.

5.2.5 Brien Lake

A willow shrub forest and sedge fen located at the north end of Brien Lake characterizes the stream inlet to Brien Lake (Figure 6). The outlet from Brien Lake is located at the end of a triangular bay located at the northwest side of the lake. A high section of shoreline predominantly separates the confluence of this creek with the lake during low lake levels. The outlet creek meanders northwest through a spruce fen and into Shona Lake. At the time of the 2004 summer survey, the inlet and outlet were ephemeral and poorly defined. As such, an assessment of fish stream fish habitat was not conducted.

5.2.6 Narrow Lake

The inlet to Narrow Lake is located within a willow shrub forest and sedge fen located at the north end of the lake (Figure 7). The outlet from Brien Lake is defined within a sedge fen located at the south end of the lake. The inlet and outlet streams were ephemeral during the survey and poorly defined. An assessment of stream fish habitat was not conducted.

5.3 Fish Habitat Requirements

The following section summarizes the habitat requirements for common fish in the YGP study area. The information presented here is primarily derived from Scott and Crossman (1973) and the review of habitat suitability reports produced by the U.S. Department of the Interior, fish and Wildlife Service for Northern Pike (1982), Lake Trout (1984) and Arctic Grayling (1985).

5.3.1 Lake Trout

The spawning period of lake trout occurs in October and November in northern Canadian lakes. Spawning normally occurs at water depths between 2 m and 10.0 m in shoal substrates consisting of boulders and large cobbles (6 cm to 30 cm), with large interstitial spaces mixed with small cobbles and gravels. The size and depth of spaces (5 cm to 10 cm) must be large enough to allow for optimal water circulation and oxygen supply for fish embryos, as well as sufficient protection from predation. Optimal gradients of lake trout shoals surveyed in lakes north of Great Slave Lake, NWT were found between 30º to 50º (EBA, 2001; Golder, 1997). Lake trout prefer clean substrate and shoal areas exposed to direct current and wave action and at depths where eggs are not susceptible to freezing. Spawning is triggered by both water temperature and light. Spawning generally occurs when lake temperatures fall below 7°C and during periods just after dark, with spawning activity increasing during moonless nights. Egg deposition ranges from 400 eggs to 1,200 eggs per pound of female.

The diet of lake trout consists of a broad range of prey including freshwater sponges, large invertebrates (chironomids, small clams and crayfish), small fish (i.e., sculpins, chub, whitefish and burbot) and small mammals including mice and goslings. Foraging activity occurs primarily in open water along rocky shorelines near dropoffs.

5.3.2 Lake Whitefish

Lake whitefish are bottom feeders, preying largely on mayfly larvae, chironomids, mollusks, small fish, and the eggs of other fish such as lake trout. Foraging activity is concentrated along rocky substrates at the base of prominent dropoffs. Predators of lake whitefish include lake trout and northern pike, while the eggs are commonly foraged upon by burbot and sculpins.

Lake whitefish spawn in the fall between late September and October. During spawning, eggs are distributed over small cobble/gravel lake shoals or at river mouths. Preferred shoals have depth ranges from 3.5 m to 10 m, and are located in areas exposed to good water circulation. Ideal spawning locations will not be influenced by lake water fluctuations in which eggs may become exposed to the air or freeze over winter. Optimal shoal gradients required for the cleaning of substrate and aeration of eggs is approximately 10ºC to 25 ºC (EBA, 2001, Golder, 1997). Spawning occurs when water temperatures reach 4.5ºC. The dispersal of eggs varies in number from 2,400 to 10,000 and is dependent on the size of the fish. The development of the embryos occurs over a period of 140 days.

5.3.3 Northern Pike

In northern lakes, northern pike spawn shortly after breakup in May and June (EBA, 2001). Preferred water temperatures during spawning range from 4.4ºC to 11.1ºC with eggs hatching in 12 days to 14 days after fertilization. For spawning pike migrate into tributaries of flooded marshes and wetlands or along sedge dominated shorelines in water depths less than 0.18 m. The eggs are highly adhesive and are laid within stands of sedges and between hummocks of vegetation.

Northern pike are opportunistic carnivores, primarily preying upon other fish, however they are also known to feed on amphibians, aquatic birds, muskrats and mice. Pike prefer clear, warm, slow, meandering rivers or quiet lakes with dense vegetation cover. Favorable foraging and rearing habitat of young pike are areas dominated by submergent and emergent plants with 40% to 90% cover (Casselman and Lewis, 1996).

5.3.4 Arctic Grayling

Arctic grayling spawning normally occurs during the spring, immediately after ice break. Spawning takes place in small streams when water temperatures reach 7ºC to 10ºC. Adults migrate from ice-covered lakes and larger streams and rivers to spawn on small gravel stream sections. The number of eggs deposited on averages 4,000 to 7,000, but is dependent on the size of spawning females. Embryo development is rapid occurring over a period of 8 days to 14 days. Once hatched, juveniles will stay within their natal streams or frequent close to the mouth of the stream.

Young Artic grayling principally feed on zooplankton, while mature fish feed on mayflies, caddis flies, terrestrial insects (bees and wasps) and fish eggs. When foraging in lakes, adults will swim along rocky shorelines and along the top of steep rocky shoals. Northern pike and lake trout are predators of grayling throughout the year.

5.3.5 Lake Cisco

Lake cisco spawn in September and October. Spawning takes place in shallow waters of lakes and streams, 1 m to 5 m below the ice. Spawning substrates can vary, but small clean gravels are preferred. The number of eggs produced is positively correlated with the size of females and can range from 6,000 eggs to 20,000 eggs. Lake cisco travel in large schools and are principally plankton feeders but consume a wide variety of foods including larval cisco, caddisflies, mayflies and whitefish eggs and fry. Cisco is an important food source for lake trout, northern pike, and burbot.

5.4 Fish Population Relative Abundance, Distribution and Species Composition

This section discusses fish species composition, abundance, and distribution within lakes sampled during the 2004 summer survey. Fish species composition data and biological information are summarized in Table 5. Fish species abundance and fish species composition by collection method is presented in Tables 6a and 6b. Meristics for fish collected by gillnet in Eclipse Lake, Nicholas Lake, Brien Lake and Narrow Lake are included in Appendix C. Fish catch-per-unit-effort (CPUE) is quantified in Appendix D. Fish collected by gillnet include lake trout (*Salvelinus namaycush*), northern pike *(Esox lucius)*, burbot (*Lota, lota*), lake whitefish (*Coregonus clupeaformis*), and lake cisco (*Coregounus artedi*).

5.4.1 Round Lake

No fish were collected in Round Lake by either gillnets or minnow traps. No defined inflows or outflows were identified during the survey, therefore; no electrofishing was conducted. Ten baited gee-type minnow traps were set overnight and placed around the littoral area of the shoreline. No fish were captured.

5.4.2 Winter Lake

No fish were collected at Winter Lake by either gillnet or minnow traps. The main inlet and outlet streams were also surveyed. Electrofishing of the inlet stream was conducted over a length of 100 m length for a total effort of 150 seconds. No fish were collected or observed. Electrofishing in the outlet stream was completed over a distance of 100 m and did not result in any fish being collected.

5.4.3 Eclipse Lake

Eclipse Lake exhibited the greatest diversity of fish species of all lakes surveyed. Species captured included northern pike, lake trout, lake whitefish, lake cisco and burbot. Lake trout comprised the largest portion of the Eclipse Lake catch with 47.8% of all fish collected. Northern pike accounted for 13.0% of the total catch, while lake whitefish accounted for 21.7%. Lake cisco accounted for 4.3% of the total catch. One burbot (half digested) was also removed from the mouth of a large lake trout. In total, the floating gillnet captured five lake trout, five lake whitefish and three northern pike. The sinking gillnet captured six lake trout, and three lake cisco, resulting in a total catch of 23 fish. Ten baited minnow traps, placed along the shoreline and left to fish overnight, did not result in any fish being captured.

Electrofishing was conducted along a 100 m section of the inlet stream for a total effort of 269 seconds. No fish were collected. The Eclipse Lake outlet was electrofished along a 137 m section of stream for a total effort of 384 seconds. Two small fish were observed but not captured.

5.4.4 Nicholas Lake

A total of 17 fish were caught in Nicholas Lake. Fish species captured included northern pike, lake trout, and burbot. Lake trout accounted for 52.9% (9 fish) of fish caught, while northern pike accounted for 41.2% (7 fish). One burbot was also caught. All of the fish collected at Nicholas Lake were caught by gillnet. The Nicholas Lake inlet was ephemeral at the time of the survey and electrofishing was not conducted. A 42 m section of the outlet stream was electrofished and resulted in the collection of one juvenile northern pike, 6.2 cm in length. Other small fish were observed.

5.4.5 Brien Lake

In Brien Lake, six fish were caught, all northern pike (100%). All of the fish collected at Brien Lake were caught by in a floating gillnet set. Minnow traps did not capture any fish. The inlet and outlet channels of Brien Lake were in two sedge/willow wetlands. No defined inlet or outlet channel was observed and therefore electrofishing was not conducted.

5.4.6 Narrow Lake

In Narrow Lake, lake whitefish were captured by gillnet more than any other fish species. Lake whitefish represented 89.2% (71 individuals) of all fish collected. The floating gillnet set captured 24 lake whitefish, while the sinking gillnet set captured 47 fish. The remaining 10.8% of fish collected in Narrow Lake was comprised of six northern pike captured by floating gillnet and three northern pike by sinking gillnet. Baited minnow traps were effective in the capture of two juvenile northern pike. No visible outlet channel was evident at the southwest end of the lake, and therefore electrofishing was not conducted.

5.5 Fish Biological Characteristics

This section discusses the biological characteristics of fish collected in surveyed lakes during the summer of 2004. Meristics for fish collected by gillnet in Eclipse Lake, Nicholas Lake, Brien Lake and Narrow Lake are included in Appendix C-1. Length-at-Age Regression plots for northern pike, lake trout, and lake whitefish for all lakes surveyed and Length-Weight Regression plots for principal species within individual lakes are presented in Appendix F (F1 to F9). The following section discusses the biological characteristics by species.

5.5.1 Northern Pike

Length measurements obtained for northern pike collected from Eclipse, Nicholas, Brien and Narrow lakes, ranged from 165 mm to 745 mm. Weights ranged between 40 g to 2660 g, and ages ranged from a –two+ to seven+. Of 24 individual fish captured, 21 northern pike were captured in floating gillnets aligned perpendicular from the shoreline and into deep water. Length-at-Age regression for northern pike indicates a logarithmic relationship with a high degree of correlation ($R^2 = 0.93$; Appendix F1). The exponential relationship between fish length and weight for northern pike in Eclipse, Nicholas and Brien Lakes resulted in a high degree of correlation (R^2) of 0.98, 0.82, and 0.98 respectively (Appendix F4 to F6).

5.5.2 Lake Trout

Lake trout were captured from Eclipse and Nicholas lakes only, and ranged in length from 191 mm to 755 mm. Weights ranged from 60 g to 6,803 g, and ages ranged from age-3 year class to age 34. Of 21 lake trout captured, 12 were captured in sinking gillnets positioned in deep water areas of the lakes. Sinking gillnets placed in Eclipse Lake and Nicholas Lake were positioned in water approximately 20 m in depth. Length-at-Age regression for lake trout indicates a logarithmic relationship with a relatively high degree of correlation ($R^2 = 0.83$; Appendix F2). The exponential relationship between fish length and weight for lake trout in Eclipse and Nicholas lakes resulted in a high degree of correlation (R^2) of 0.98 and 0.91 respectively (Appendix F7 and F8).

5.5.3 Lake Whitefish

Length measurements obtained for lake whitefish captured in Eclipse and Narrow lakes, ranged from 144 mm to 450 mm. Weights ranged between 40 g and 1,240 g, and ages ranged from age-3 year class to age 17. All five whitefish collected in Eclipse Lake were captured in a floating gillnet set aligned at the entrance to the east basin. Of 66 lake whitefish collected in Narrow Lake, 47 fish were captured by a sinking gillnets positioned in the deepest area of the lake at a water depth of 12 m. Length-at-Age regression for lake whitefish indicates a logarithmic relationship with a relatively low degree of correlation (R^2 = 0.53; Appendix F3). The exponential relationship between fish length and weight for lake whitefish in Narrow Lake resulted in a high degree of correlation (R^2) of 0.92 (Appendix F3).

5.5.4 Incidental Captures

Incidental fish captured in gillnets included three lake cisco and one burbot. Cisco collected from Nicholas Lake measured between 126 and 128 mm in length and weighed from 18 g to 19 g. A single burbot collected from a floating gillnet in Nicholas Lake was measured at 634 mm with a weight of 1,790 g. Aging structures were not collected from these fish.

5.6 Fish Tissue Metals

The following section presents the results of analysis for tissue samples collected from fish species in 2004. Tissue metal levels for all fish species in lakes sampled are presented in Table **7**. Appendix I presents the lab analysis data of metals in fish tissues.

Generally, older fish were observed to have higher levels of metals than younger specimens. In all lakes sampled, levels for all other metals including cadmium, chromium, lead, nickel, silver and zinc were not elevated, and in many cases, were below detection limits.

5.6.1 Eclipse Lake

From Eclipse Lake, three northern pike, five lake trout, and four lake whitefish were analyzed for concentrations of metals in tissues. The highest mean levels of arsenic occurred in fish from Eclipse Lake.

The highest observed levels of mercury and arsenic were observed in tissues from a large lake trout captured in Eclipse Lake. The lake trout, determined to be 34+ years contained a mercury level of 4.09 mg/kg or eight times the restrictive consumption level of 0.5 ppm (wet weight) (Health and Welfare Canada, 2002). The same specimen was also observed to have an elevated level of arsenic. One northern pike collected from Eclipse Lake showed slightly elevated levels of mercury and arsenic. High levels of selenium occurred in lake trout from Eclipse Lake.

5.6.2 Nicholas Lake

From Nicholas Lake, five northern pike and five lake trout were analyzed for concentrations of metals in tissues. Elevated levels of selenium were recorded in lake trout from Nicholas Lake.

5.6.3 Brien Lake

Five northern pike were analyzed for concentrations of metals in tissues from Brien Lake. Northern pike had the highest mean concentrations of copper than any other fish from all other lakes sampled. Zinc levels in these fish were also higher than average.

5.6.4 Narrow Lake

Five northern pike and five lake whitefish were sampled from Narrow Lake. Mercury levels in four of the five northern pike sampled were above the Health Canada guidelines.

5.7 Zooplankton

Zooplankton populations for individual lakes sampled during the Summer 2004 investigations are summarized in the following section. Analysis of results for zooplankton populations include mean abundance, mean density, distribution and percent composition, which are presented in Table 8a and 8b. The sample locations are depicted in Figure 10 to Figure 15. Results of the zooplankton community analysis (Table 8c) resulted in an index measure between 1 and 2 for all samples/stations collected or a low to moderate diversity of taxa. Appendix G presents lab analysis and species identification data for collected zooplankton samples.

5.7.1 Round Lake

A survey of zooplankton within Round Lake was conducted in three vertical tows from the lake bottom at a depth of 1.5 m. The majority, (46.0%) of the zooplankton population sampled from Round Lake was comprised of the order Copepoda. Copepoda also recorded the highest mean density, with 16.41 organisms/m^3. Rotifera comprised of 38.0% of the sample and had a mean density of 2,536.99 organisms/m^3. Cladocera comprised of 12.0% and had a mean density of 4.30 organisms/m^3. The order Insecta comprised 4.5% of the population and Amphipoda was present in negligible quantities. The total mean density of zooplankton in Round Lake was 6,733.74 organisms/m^3.

5.7.2 Winter Lake

A survey of zooplankton within Winter Lake was conducted by collecting three vertical tows from a water depth of 6.0 m. An analysis of the zooplankton samples indicated that Cladocera comprised of 45% of the population with a mean density of 3,563.31 organisms/m^3. Rotifera had a percent composition of 28.8% and a mean density of 2297.12 organisms/m^3. Copepods comprised 20.4% and had a mean density of 1,627.08 organisms/m^3. Insecta, Eubranchiopoda, and Amphipoda comprised 6.2%, 0.05% and 0.01% of the sample, respectively. The total mean density of zooplankton was 7,983.18 organisms/m^3.

5.7.3 Eclipse Lake

In Eclipse Lake, vertical zooplankton tows were made from a depth of 23 m. An analysis of the zooplankton samples resulted in the order Rotifera comprising 63.5% of zooplankton taxa with a mean density of 2,173.93 organisms/m^3. Copepods were found to comprise 31.5 % with a mean density of 1,079.52 organisms/m^3. Cladocera comprised 5% of the zooplankton community. No other order of taxa was present. The total mean density of zooplankton from Eclipse Lake was 3,424.67 organisms/m^3.

5.7.4 Nicholas Lake

The sampling of zooplankton in Nicholas Lake was completed from water depths of 19 m and 21 m. Copepoda (80.6%), with a mean density of 1,065.04 organisms/m^3, were found to comprise the majority of the of zooplankton community in Nicholas Lake. Rotifera, which accounted for a mean density of 253.19 organisms/m^3, comprised the remaining 19.16%. Amphipoda was the only other order present with a minor 0.09 %. Nicholas Lake had the lowest mean density of zooplankton of all the sampled lakes with 1,321.25 organisms/m^3.

5.7.5 Brien Lake

Zooplankton tows from Brien Lake were collected from a water depth of 10 m. An analysis of the samples collected indicated the zooplankton community primarily consisted of Copepoda (48.7%), Rotifera (46.7%), and Cladocera (4.0%). The mean densities for Copepoda, Rotifera, and Cladocera were 3,347.91 organisms/m^3, 3,211.54 organisms/m^3, and 274.10 organisms/m^3, respectively. Zooplankton identified in negligible quantities, included the orders Insecta, Amphipoda, and Eubranchiopoda. The total mean density of zooplankton from Brien Lake was 6874.67 organisms/m^3.

5.7.6 Narrow Lake

A survey of the zooplankton population within Narrow Lake was conducted by vertical tows from a water depth of 11 m. The Narrow Lake zooplankton community comprised of Copepoda (54.3%), Cladocera (35.4%), and Rotifera (10.3%). Copepoda, Cladocera, and Rotifera respectively recorded mean densities of 8,679.03, 5,661.84, and 1,640.46 organisms/m^3. No other orders or groups were present. Narrow Lake had the greatest zooplankton mean density of all the lakes sampled with 15,981.32 organisms/m^3.

5.8 Summary of Zooplankton Community

Zooplankton sampled from lakes within the study area comprised a total of six major taxonomic groups, including Rotifera, Eubranchipoda, Cladocera, Copepoda, Amphipoda, and the Insecta. Copepoda were found in the greatest numbers of all taxa collected at 46.4% (41,394 individuals) and the greatest mean density at 3,146.78 organisms/m^3. Followed in order of decreasing abundance was Rotifera at 30.1% (26,865 individuals) and Cladocera at 22.5 % (20,053 individuals) and a mean density of animals at 2,018.87 organisms/m^3 and 1,746.75 organisms/m^3, respectively (Table 8a and Table 8b).

5.9 Benthic Invertebrates

The following section presents the results of benthic invertebrate surveys completed during the 2004 field program. The sample locations are shown on Figure 10 to Figure 15. Relative abundance, density and the analysis of benthic communities are discussed for all lakes and streams. The mean abundance and density for benthic invertebrate taxa for each sample lake is presented in Table 9a. Benthic invertebrate community composition of major invertebrate groups is presented in Table 9b. The community analysis of benthic invertebrates produced Shannon-Weiner indices values ranging from one to two for all samples/stations. These indices are presented in Table 9c. Appendix H presents the lab analysis and species identification data for benthic invertebrate samples collected.

5.9.1 Round Lake

Round Lake benthic samples indicated that the same three groups dominated the composition in both the inshore and offshore. Chironomidae represented 54.39% of genera offshore and 43.23% of genera inshore. Amphipoda represented 8.77% of genera offshore and 40.00% of genera inshore. Bivalvia represented 28.36% of genera offshore and 8.39% of genera inshore. Mean densities of Chironomidae, Amphipoda and Bivalvia were 971.02, 898.55 and 188.41 organisms/m^2 respectively in the nearshore, and 2695.66, 434.78, and 1405.08 organisms/m^2 respectively in the offshore. The total mean density of benthic invertebrates in Round Lake littoral samples was 2246.38 organisms/m^2. The total mean density of benthic invertebrates in Round Lake offshore samples was 4956.53 organisms/m^2. A Shannon-Weiner index value of two for Round Lake benthic samples indicates moderate diversity for both inshore and offshore benthic communities (Table 9c).

5.9.2 Winter Lake

Chironomidae represented the greatest portion of genera collected for Winter Lake and represented 58.17% of all taxa collected with a mean density of 1,289.86 organisms/m^2 individuals per square meter. Bivalia and Amphipoda comprised 12.4% and 8.5% of all taxa collected, respectively with mean densities of 275.36 and 188.41 organisms/m^2, respectively. The total mean density of benthic invertebrates in Winter Lake littoral samples was 2,217.40 organisms/m^2. Offshore samples were largely comprised of Chironomidae genera, representing 84.72% of all taxa collected, with a mean density of 913.05 organisms/m^2. Conchostraca represented 6.94% of genera present with a mean density of 72.46 organisms/m^2. The total mean density of benthic invertebrates in Winter Lake offshore samples was 1072.47 organisms/m^2. The Shannon-Weiner index of applied to Winter Lake benthic samples resulted in an index value of two or moderate diversity for inshore and a value of one for offshore benthic communities (Table 9c).

Conditions at Winter Lake also allowed for the benthic sampling of the principle inlet and outlet. In the outlet, benthic samples exhibited a wide diversity of genera. Chironomidae represented 33.23% of taxa collected, which correlates to a mean density of 1,536.24 organisms/m^2. Bivalvia represented 24.79%, with a mean density of 1,144.93 organisms/m^2. Gastropoda comprised 14.11%, with a mean density of 652.18 organisms/m^2. The total mean density of benthic invertebrates in Winter Lake outlet samples was 4,579.72 organisms/m^2. In the inlet, Chironomidae represented 50.0% of species collected, with a mean density of 478.26 organisms/m^2, while Ostracoda represented 28.79%, with a mean density of 275.36 organisms/m^2. Plecoptera and Oligochaeta each comprised of 7.58% of genera collected, with mean densities of 72.46 organisms/m^2 each. The total mean density of benthic invertebrates in Winter Lake inlet samples was 956.52 organisms/m^2. Community analysis indicated a Shannon-Wiener diversity index value of two or moderate for both inlet and outlet benthic invertebrate populations.

5.9.3 Eclipse Lake

In Eclipse Lake littoral samples, Amphipoda comprised the largest order, representing 55.17% of genera. This correlates to a mean density of 927.54 organisms/m^2. Hirudinea was also significant, representing 22.41%, with a mean density of 376.81 organisms/m^2. Bivalvia, Gastropoda and Oligochaeta all represented 3.5% with mean densities of 57.97 organisms/m^2 each. The total mean density of benthic invertebrates in Eclipse Lake littoral samples was 1681.16 organisms/m^2. The benthic genera offshore were comprised principally of Amphipoda (62.02%) with a mean density of 2,318.85 organisms/m^2, and Bivalvia (23.64%) with a mean density of 884.06 organisms/m^2. The total mean density of benthic invertebrates in Eclipse Lake offshore samples was 3,739.14 organisms/m^2. The Shannon-Weiner index applied to Eclipse Lake benthic invertebrate samples yielded an index value of two or moderate for inshore samples, while analysis of offshore populations yielded an index value of one.

Conditions at Eclipse Lake allowed for the sampling of the principal inlet and outlet streams. Chironomidae accounted for the majority of benthic invertebrate genera in the inlet. This represented 91.79% of the community, with a mean density of 21,884.11 organisms/m^2. Bivalvia, comprising 3.10 %, had a mean density of 739.13 organisms/m^2, while Ostracoda comprised of 2.31%, and had a mean density of 550.73 organisms/m^2. The total mean density of benthic invertebrates in Eclipse Lake inlet samples was 869.57 organisms/m^2, and resulted in a moderate Shannon-Weiner index number of 2. Benthic samples obtained from the outlet were more varied and comprised of 20.0% Chironomidae, with a mean density of 173.91 organisms/m^2, 35.0% Bivalvia with a mean density of 304.35 organisms/m^2, and 11.67% of both Hirudinea and Ostracoda with mean densities of 101.42 organisms/m^2. The total mean density of benthic invertebrates in the Eclipse Lake outlet samples was 23,840.63 organisms/m^2. Shannon-Weiner indices for the stream benthic invertebrate community yielded values of one for the outlet stream and two for the inlet stream.

5.9.4 Nicholas Lake

Nicholas Lake littoral benthic samples were largely comprised of Hirudinea (43.95%), with a mean density of 1,000.00 organisms/m^2. Amphipoda comprised 27.39% of the community with a mean density of 623.19 organisms/m^2, while Diptera comprised 7.64% of the benthic community with a mean density of 173.91 organisms/m^2. Nematoda comprised 5.10% of the community with a mean density of 115.94 organisms/m^2. The total mean density of benthic invertebrates in Nicholas Lake littoral samples was 2,275.37 organisms/m^2. Offshore, benthic samples were comprised of Amphipoda, representing 54.68% of the community with a mean density of 2710.15 organisms/m^2. The Bivalvia comprised of 27.49.6% with a mean density of 1,362.32 organisms/m^2 and Hirudinea comprised 8.19% with a mean density of 405.8 organisms/m^2. The total mean density of benthic invertebrates in Nicholas Lake offshore samples was 4,956.53 organisms/m^2. Shannon-Weiner indices for the inshore and offshore benthic communities yielded values of two and one, respectively.

5.9.5 Brien Lake

Chironomidae comprised the largest group in Brien Lake littoral benthic samples, representing 55.93% of the community with a mean density of 478.26 organisms/m^2. Amphipoda comprised of 15.25% with a mean density of 130.44 organisms/m^2. Bivalia made up 11.86% with a mean density of 101.45 organisms/m^2. The total mean density of benthic invertebrates in Brien Lake littoral samples was 884.06 organisms/m^2. The deeper water samples were largely comprised of Bivalvia, representing 41.25% of genera. These samples had a mean density of 478.26 organisms/m^2. The Chironomidae represented 40.00% of the community, with a mean density of 463.77 organisms/m^2. Copepoda comprised of 11.25% of genera and had a mean density of 130.44 organisms/m^2. The total mean density of benthic invertebrates in Brien Lake offshore samples was 1,159.42 organisms/m^2. Both inshore and offshore benthic invertebrate community analyses yielded moderate Shannon-Weiner diversity index values of two.

5.9.6 Narrow Lake

In Narrow Lake littoral benthic samples the Amphipoda represented the largest group at 43.95% with a mean density of 1,000.00 organisms/m^2. Bivalia made up 12.74% of the genera with a mean density of 289.86 organisms/m^2. Chironomidae and Cladocera each comprised of 9.55% of the genera and had mean densities of 217.39 organisms/m^2. The total mean density of benthic invertebrates in Narrow Lake littoral samples was 2,260.87 organisms/m^2. Deep-water samples were comprised largely of Hirudinea. This group represented 76.9% of the genera with a mean density of 434.78 organisms/m^2. Chironomidae represented 15.38% of the genera and had a mean density of 86.96 organisms/m^2. The total mean density of benthic invertebrates in Narrow Lake offshore samples was 565.22 organisms/m^2. The Shannon-Weiner diversity index determined for inshore benthic populations within Narrow Lake was moderate at a value of two, while the index determined for offshore populations yielded a low value of one.

5.9.7 Streams

Benthic sampling for streams was limited to the inlets and outlets from Winter Lake and Eclipse Lake. Benthic samples collected at the inlet stream to Winter Lake were largely comprised of Chironomidea at 50.0%, Ostracoda at 28.8% and Plecoptera and Oligochaeta, each representing 7.6% of the genera. The total mean density for each group was 478.26, 275.36, and 72.46 organisms/m^2, respectively. The outlet stream from Winter Lake comprised a benthic community consisting of Chironomidea at 33.2%, Bivalvia at 24.76%, Gastropoda at 14.1% and Hirudinea representing 12.5% of the genera. The four groups exhibited total mean densities of 1,536.24, 1,144.93, 652.18 and 579.71 organisms/m^2, respectively.

Benthic samples collected at an inlet stream to Eclipse Lake primarily consisted of four major groups, the Bivalvia at 35.0%, the Chironomidea at 20.0%, and the Ostracoda and Gastropoda, each comprising 11.67% of the genera. These stream organisms resulted in mean densities of 304.35, 173.91, and 101.45 organisms/m^2, respectively. The outlet stream supported a similar community composition to the inlet stream. Chironomidea comprised the greatest number of organisms at 91.79%, followed by the Bivalvia at 3.1%, and the Ostracoda at 2.31%. The mean densities were 21,884.1, 739.13, and 550.73 organisms/m^2, respectively.

5.9.8 Summary of Benthic Community

Order Chironomidae was found with the greatest overall abundance from lake samples and streams representing 61.81 % all species collected followed in order of decreasing abundance and composition, by the orders Bivalvia (13.15%) and Amphipoda (12.56%). All species found in significant numbers in inshore and offshore sediment samples were facultative organisms. Orders "sensitive" to environmental conditions (i.e., Ephemeroptera) were found in only moderate numbers at the sites, as were pollution tolerant orders such as Oligochaeta.

Chironomidae were observed to be the dominant benthic taxonomic group in both inshore and offshore samples. While it cannot be said for this data set, generally, benthic community structures commonly observed in lakes consist of a rich heterogeneity of species in the littoral zone and a less diverse and a more homogeneous community in the profundal zone. The change in community composition is primarily due to greater oxygen mixing and substrate diversity in the upper littoral zone than in the deeper profundal zone (Wetzel, 2001).

5.9.9 Community Analysis

The lake with the greatest mean species richness for inshore samples collected was Nicholas Lake with 17 different taxa, followed by Narrow Lake with 16 different taxa and Winter Lake with 14 different taxa. Brien Lake benthic samples exhibited the least number of different taxa with ten (See Table 9c). Round Lake supported the greatest mean species richness for offshore samples collected with 15 different taxa, followed by Nicholas Lake with 11 different taxa and Eclipse Lake with 8 different taxa. The mean species richness value for the Winter Lake inlet was determined to be eight, while the value for the outlet was determined to be 22 different taxa. The mean species richness value for Eclipse Lake inlet was determined to be 11 different taxa, while the value for the outlet was determined to be 18 different taxa. The observed increase in species richness within the littoral zone is presumably due to greater substrate diversity and organic food availability.

5.10 Lake Water Quality

Water quality for lakes sampled during the Fisheries 2004 field studies are summarized in the following section, and include measurements for water temperature, dissolved oxygen, specific conductivity and pH. The sample locations are depicted in Figures 10-15. Water quality measurement profiles collected for individual lakes are presented in Appendix K.

5.10.1 Round Lake

At the time of sampling, water temperature in Round Lake was 17.4°C, dissolved oxygen was 7.52 mg/L and specific conductivity was 55.2 µS/cm. The pH was recorded at 7.43. These measurements were taken at the water surface only, due to insufficient depth. Secchi depth was not recorded due to a visible bottom recorded at a depth of 1.5 m.

5.10.2 Winter Lake

Water temperature in Winter Lake ranged from 19.6°C at the surface to 14.6°C at a depth of 5 m. Dissolved oxygen measurements ranged from a high of 7.37 mg/L at a depth of 1 m to 5.2 mg/L at a depth of 5 m. Specific conductivity was recorded at 206.9 µS/cm at the surface and 187 µS/cm at 5 m. The pH at the surface was recorded at 7.03. Secchi depth was recorded at 3.0 m.

5.10.3 Eclipse Lake

Water quality measurements recorded within the main body of Eclipse Lake resulted in water temperatures ranging from 20.1°C at the surface to 4.4°C at a depth of 28 m. Dissolved oxygen measurements ranged from 8.52 mg/L at the surface to a high of

12.62 mg/L at 6 m depth, while most values were around 9 mg/L. Specific conductivity was recorded at 51.1 µS/cm at the surface and declined to 9.22 µS/cm at 28 m depth. The pH at the surface was recorded at 7.03. Water quality measurements were also taken in the east channel of the lake (Appendix K). Secchi depth was recorded at 7.07 m. Dramatic changes in the water temperatures and oxygen levels indicated a visible thermocline in the lake's main body at 6 m and between 5 and 6m in the east channel.

5.10.4 Nicholas Lake

Water temperature in Nicholas Lake ranged from 19.5°C at the surface to 4.4°C at a depth of 28 m. Dissolved oxygen ranged from 8.46 mg/L at the surface to 5.46 mg/L at 28 m depth with a high of 11.54 mg/L recorded at 8 m. Specific conductivity ranged from 61.9 µS/cm at the surface to 60.7 µS/cm at 28 m depth. The pH at the surface was recorded at 7.04 and secchi depth was recorded at 5.94 m. Vertical changes in water temperatures and oxygen at depth indicated a summer thermocline level at 7 m.

5.10.5 Brien Lake

Water temperature in Brien Lake ranged from 18.6°C at the surface to 6.8°C at a depth of 9 m. Dissolved oxygen ranged from 8.12 mg/L at the surface to 0.02 mg/L at 9 m depth. Specific conductivity was recorded at 75.4 µS/cm at the surface and 0 µS/cm at 9 m depth. The pH at the surface was recorded at 7.03 and secchi depth was recorded at 3.67 m. The lake's thermocline was measured at 5.0 m.

5.10.6 Narrow Lake

Water temperature in Narrow Lake ranged from 16.2°C at the surface to 5.8°C at a depth of 12 m. Dissolved oxygen ranged from 8.54 mg/L at the surface to 0.07 mg/L at 12 m depth. Conductivity was recorded at 133.3 µS/cm at the surface and 107.2 µS/cm at 12 m depth. The pH at the surface was recorded at 7.03. Secchi depth was recorded at 3.1 m. The lake's thermocline level at the time of the study was at a depth of 5 m.

5.11 Lake Sediment Quality

A summary of sediment quality for samples obtained from the six lakes, from July 18 to August 1, 2004, and is provided in the following section. Analytical data summarizing the percent moisture, pH, nutrients, total metals, organic carbon and particle size analysis are presented in Table 10. Metals in sediments were compared to CCME Interim Sediment Quality Guidelines (Environment Canada, 2002) (Table 10). Appendix J presents the lab analysis data for lake sediment samples collected.

5.11.1 Round Lake

An analysis of sediment samples indicated that values for the metals arsenic, copper, lead, mercury, nickel, and zinc were higher in Round Lake than in any other lake sampled. Concentrations of mercury found in sediments were 0.844 mg/kg, six times higher than the next highest value at Brien Lake (0.133 mg/kg). Round Lake contained the highest levels of copper (184 mg/kg) and lead (37 mg/kg) of all the lake samples. Round Lake sediments also had the lowest levels of available phosphorus of any of the lakes sampled. Particle size evaluation of Round Lake sediments was not possible due to the high organic content.

5.11.2 Winter Lake

The arsenic concentrations in Winter Lake sediments were the second lowest of the lakes sampled. Copper concentrations were lower than those found in Round Lake but still exceeded acceptable levels at 54.3 mg/kg. Lead concentrations for Winter Lake were below detection limits. Winter Lake had the second lowest concentration of mercury for the sampled lakes. Total organic carbon was quite high (19.4 mg/kg). Particle size analysis was not conducted.

5.11.3 Eclipse Lake

The second highest value for available phosphorus (82.0 mg/kg) was observed in Eclipse Lake sediments. Copper concentrations were the lowest of all the lakes sampled at 47.9 mg/kg. Lead concentrations were below detection limits and mercury levels were below all other lakes sampled (0.0154 mg/kg). Total organic carbon was the lowest of all other lakes sampled at 2.74 mg/kg. Particle size analysis indicated that 49.9% of the sediment sample was clay and 47.8 % was silt.

5.11.4 Nicholas Lake

Nicholas Lake sediment samples recorded the second lowest copper levels (53.9 mg/kg) of all the lakes sampled. Lead concentrations were below the detection limits. Nicholas Lake had the lowest concentration of arsenic, barium, cobalt, nickel, vanadium and zinc. Total organic carbon was in the middle range at 13.4 mg/kg, when compared to other lakes sampled. Particle size analysis was not possible due to the high organic content of the sediment sample.

5.11.5 Brien Lake

Brien Lake sediment samples recorded the highest value for available phosphorus, with mercury being the second highest recorded level after Round Lake. Brien Lake samples also exhibited the highest levels of mercury (0.133 mg/kg), cadmium (0.55 mg/kg), beryllium (1.10 mg/kg) and cobalt (45.6 mg/kg). Copper in Brien Lake (84.6 mg/kg) sediment was the second highest compared to the other lakes sampled. Lead was below the detection limit. Total organic carbon was high at 19.4 mg/kg. Due to the high organic content of the sample particles size analysis was not possible.

5.11.6 Narrow Lake

Narrow Lake sediments had the highest levels of barium (224 mg/kg) and chromium (58.5 mg/kg) compared to other lakes sampled. Copper levels were comparable to the other lakes, while mercury levels were the third highest of all lakes. Lead concentration was below the detection limit. Vanadium levels in Narrow Lake were higher than those recorded for the other lakes. Total organic carbon was 9.36 mg/kg. The particle size analysis indicated that 63.1% of Narrow Lake sediments consisted of clay while 30.5% comprised of silt and 6.4% was sand.

6.0 CONCLUSIONS AND DISCUSSION

A comprehensive Fisheries and Aquatic Resource baseline investigation of Round Lake, Winter Lake, Narrow Lake, Brien Lake, Eclipse Lake and Nicholas Lake was completed within the YGP area. Discussions, conclusions are addressed below.

6.1 Fish Populations

A total of 188 hours (including floating and sinking net sets) of gillnetting effort was undertaken to determine the presence of fish populations for the six lakes surveyed within the study area. In total gillnets captured 129 fish. Floating and sinking gillnets resulted in the capture of 60 and 69 fish, respectively. The placement of 60 minnow trap sets along lake shorelines resulted in the capture of two juvenile pike both within Narrow Lake. The electrofishing of fish habitat within inlet and outlet streams resulted in the capture of one juvenile northern pike.

6.2 Lake Habitat Characteristics

The six lakes surveyed within the YGP study area range in size from 11.5 ha to 258 ha and have a bathymetric depth ranging between 1.5 (Winter Lake) to 55 m (Eclipse Lake) in depth. Round Lake and Winter Lake are shallow and prone to freezing to the bottom during winter. Eclipse Lake and Nicholas Lake support a complex diversity of habitat types including steep and vegetated shorelines, rocky shoals and islands, deep water, boulder fields and multiple embayments. Both lakes provide important habitat attributes for the spawning, rearing and overwintering of northern pike, lake trout and lake whitefish. Brien Lake and Narrow Lake are limited in their habitat availability for fish primarily due to a single elongated basin supporting a single deep lake section and extensive shed wetland vegetation at both ends of each of the lakes. Both Brien and Narrow lakes support a small population of northern pike. Narrow Lake is also found to support a large population of lake whitefish.

A habitat suitability rating for individual fish species based on lake habitat characteristics resulted in an overall fish habitat rating of "Poor" for Round and Winter lakes. Eclipse and Nicholas lakes were given a rating of "Good" for all fish species including northern pike, lake trout, lake whitefish, lake cisco and Arctic grayling. Brien Lake was found to provide "Moderate" habitat for northern pike, only. A "Moderate" habitat suitability rating for both northern pike and lake whitefish was determined for Narrow Lake.

6.3 Metals in YGP Study Area

An investigation of metals within lake sediments and fish tissues was completed. EBA sampled water within the YGP study area lakes and conducted analysis for dissolved metals in the water (EBA, 2005). An investigation of fish tissues resulted in high concentrations of mercury and arsenic observed in the tissues sampled from a large lake trout captured in Eclipse Lake. One particular trout, aged 34+ years captured in Eclipse Lake was observed to contain mercury levels of 4.09 mg/kg. In the water quality analysis, mercury was found to exceed the CCME water quality guidelines (Environment Canada, 2002) for most lakes but levels also varied between sampling periods (EBA, 2005).

6.3.1 Metals in Sediment

Northern pike from Brien Lake were observed to have the highest mean concentrations of copper of all fish collected within the study area. Copper was found in elevated levels in all lake sediments sampled and ranged from 47.9 mg/kg in Eclipse Lake to 184 mg/kg in Round Lake.

Mercury values ranged from a low of 0.0154 mg/kg in Eclipse Lake to a high of 0.844 mg/kg in Round Lake. Sediments within Round Lake had the highest levels for arsenic, copper, nickel, zinc and phosphorus of all lakes sampled. As a former tailings pond, Round Lake was expected to have higher sediment metal concentrations.

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Table 4a
Fish Habitat Suitability for Northern Pike

Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total Score	Habitat Rating
	Shallow Bays	Rocky Shoals	Creek In/Outlets	EV/SV	Gravel	Cobble	Creek In/Outlets	Vegetated Bays	Deep Water	Rocky Shoals	Boulder Fields	Deep Water	*Dissolved Oxygen		
Round Lake	0	-	-	1	-	-	0	0	-	0	0	0	0	1	P
Winter Lake	1	-	-	1	-	-	0	1	-	0	0	0	0	3	P
Eclipse Lake	1	-	-	1	-	-	1	1	-	1	1	1	2	9	G
Nicholas Lake	1	-	-	1	-	-	1	1	-	1	1	1	2	9	G
Brien Lake	1	-	-	1	-	-	0	1	-	0	0	1	1	5	M
Narrow Lake	1	-	-	1	-	-	0	1	-	0	0	1	1	5	M

Habitat Characteristics:

1) Spawning Habitat
Shallow Bays =1
Rocky Shoals =1
Creek Inlets/Outlets =1
Emergent/Submergent Vegetation (EV/SV) = 1
Gravel (>0.2 to 6.5 cm) =1
Cobble (>6.5 to 25 cm) =1
Characteristic Not Present = 0
Not Applicable "-"

2) Rearing Habitat
Creek Inlets/Outlets =1
Vegetated Bays =1
Deep Water (>10 m) =1
Rocky Shoals =1
Boulder Fields =1
Characteristic Not Present = 0
Not Applicable "-"

3) Overwintering Habitat
Deep Water (>10 m) =1
*Adequate Oxygen
0 = Ice freezes to lake bottom
1 = Low winter oxygen levels
2 = High winter oxygen levels
Characteristic Not Present = 0
Not Applicable "-"

Rating:
Maximum Score = 9 Points
Point Score and Habitat Rating:
0 to 3 = Poor (P)
4 to 6 = Moderate (M)
7 to 9 = Good (G)

Habitat Requirement:
Northern Pike (Lake Spawner)
Spawning = Shallow Bays; Submerged Vegetation
Rearing = Creeks; Vegetated Bays; Submerged Vegetation; Rocky Shoals; Boulder Fields
Overwintering = Deep Water; Suitable Oxygen

Notes:
• The rating of fish habitat suitability is based on a relative scoring scheme used to evaluate habitat attributes required to sustain all life stages of fish
• The scheme assigns a single point (1) for the presense of fish habitat attributes, including spawning, rearing and overwintering habitat present within lakes sampled.
• Different fish species may require different attributes to sustain all life stages and will thus result in different maximum scores which cannot be compared to other species
Poor = Provides none to limited habitat attributes to sustain all life stages
Moderate = Provides a minimum number of habitat attributes necessary to sustain all life stages
Good = Provides a maximum and diverse number of habitat attributes to sustain all life stages
• The presence fish habitat attributes does not necessarily indicate the presence of fish
*Adequate dissolved oxygen levels range from 5.5 to 9.5 mg/l, as per Environment Canada (2003)

References:
Habitat suitability requirements are based upon documentation presented in Scott and Crossman (1973)
and Fish and Wildlife Service - U.S. Department of the Interior - Habitat Suitability Index Models (1982).

Table 4b
Fish Habitat Suitability for Lake Trout

Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total Score	Habitat Rating
	Shallow Bays	Rocky Shoals	Creek In/Outlets	EV/SV	Gravel	Cobble	Creek In/Outlets	Vegetated Bays	Deep Water	Rocky Shoals	Boulder Fields	Deep Water	*Dissolved Oxygen		
Round Lake	-	0	-	-	0	0	-	-	0	0	-	0	0	0	P
Winter Lake	-	0	-	-	0	0	-	-	0	0	-	0	0	0	P
Eclipse Lake	-	1	-	-	1	1	-	-	1	1	-	1	2	8	G
Nicholas Lake	-	1	-	-	1	1	-	-	1	1	-	1	2	8	G
Brien Lake	-	0	-	-	0	0	-	-	0	0	-	1	1	2	P
Narrow Lake	-	0	-	-	1	0	-	-	0	0	-	1	1	3	M

Habitat Characteristics:

1) Spawning Habitat
Shallow Bays =1
Rocky Shoals =1
Creek Inlets/Outlets =1
Emergent/Submergent Vegetation (EV/SV) = 1
Gravel (>0.2 to 6.5 cm) =1
Cobble (>6.5 to 25 cm) =1
Characteristic Not Present = 0
Not Applicable "-"

2) Rearing Habitat
Creek Inlets/Outlets =1
Vegetated Bays =1
Deep Water (>10 m) =1
Rocky Shoals =1
Boulder Fields =1
Characteristic Not Present = 0
Not Applicable "-"

3) Overwintering Habitat
Deep Water (>10 m) =1
*Adequate Oxygen
0 = Ice freezes to lake bottom
1 = Low winter oxygen levels
2 = High winter oxygen levels
Characteristic Not Present = 0
Not Applicable "-"

Rating:
Maximum Score = 8 Points
Point Score and Habitat Rating:
0 to 2 = Poor (P)
3 to 5 = Moderate (M)
6 to 8 = Good (G)

Habitat Requirement:
Lake Trout (Lake Spawner)
Spawning = Rocky Shoals; Cobble/Gravel
Rearing = Deep Water; Rocky Shoals;
Overwintering = Deep Water; Suitable Oxygen

Notes:
• The rating of fish habitat suitability is based on a relative scoring scheme used to evaluate habitat attributes required to sustain all life stages of fish
• The scheme assigns a single point (1) for the presense of fish habitat attributes, including spawning, rearing and overwintering habitat present within lakes sampled.
• Different fish species may require different attributes to sustain all life stages and will thus result in different maximum scores which cannot be compared to other species
Poor = Provides none to limited habitat attributes to sustain all life stages
Moderate = Provides a minimum number of habitat attributes necessary to sustain all life stages
Good = Provides a maximum and diverse number of habitat attributes to sustain all life stages
• The presence fish habitat attributes does not necessarily indicate the presence of fish
*Adequate dissolved oxygen levels range from 5.5 to 9.5 mg/l, as per Environment Canada (2003)

References:
Habitat suitability requirements are based upon documentation presented in Scott and Crossman (1973)
and Fish and Wildlife Service - U.S. Department of the Interior - Habitat Suitability Index Models (1984).

Table 4c
Fish Habitat Suitability for Lake Whitefish

Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total Score	Habitat Rating
	Shallow Bays	Rocky Shoals	Creek In/Outlets	EV/SV	Gravel	Cobble	Creek In/Outlets	Vegetated Bays	Deep Water	Rocky Shoals	Boulder Fields	Deep Water	*Dissolved Oxygen		
Round Lake	-	0	-	-	0	0	-	-	0	0	-	0	0	0	P
Winter Lake	-	0	-	-	0	0	-	-	0	0	-	0	0	0	P
Eclipse Lake	-	1	-	-	1	1	-	-	1	1	-	1	2	8	G
Nicholas Lake	-	1	-	-	1	1	-	-	1	1	-	1	2	8	G
Brien Lake	-	0	-	-	0	0	-	-	0	0	-	1	1	2	P
Narrow Lake	-	0	-	-	1	0	-	-	0	0	-	1	1	3	M

Habitat Characteristics:

1) Spawning Habitat
Shallow Bays =1
Rocky Shoals =1
Creek Inlets/Outlets =1
Emergent/Submergent Vegetation (EV/SV) = 1
Gravel (>0.2 to 6.5 cm) =1
Cobble (>6.5 to 25 cm) =1
Characteristic Not Present = 0
Not Applicable "-"

2) Rearing Habitat
Creek Inlets/Outlets =1
Vegetated Bays =1
Deep Water (>10 m) =1
Rocky Shoals =1
Boulder Fields =1
Characteristic Not Present = 0
Not Applicable "-"

3) Overwintering Habitat
Deep Water (>10 m) =1
*Adequate Oxygen
0 = Ice freezes to lake bottom
1 = Low winter oxygen levels
2 = High winter oxygen levels
Characteristic Not Present = 0
Not Applicable "-"

Rating:
Maximum Score = 8 Points
Point Score and Habitat Rating:
0 to 2 = Poor (P)
3 to 5 = Moderate (M)
6 to 8 = Good (G)

Habitat Requirement:
Lake Whitefish (Lake Spawner)
Spawning = Rocky Shoals; Gravel
Rearing = Deep Water; Rocky Shoals;
Overwintering = Deep Water; Suitable Oxygen

Notes:
• The rating of fish habitat suitability is based on a relative scoring scheme used to evaluate habitat attributes required to sustain all life stages of fish
• The scheme assigns a single point (1) for the presense of fish habitat attributes, including spawning, rearing and overwintering habitat present within lakes sampled.
• Different fish species may require different attributes to sustain all life stages and will thus result in different maximum scores which cannot be compared to other species
Poor = Provides none to limited habitat attributes to sustain all life stages
Moderate = Provides a minimum number of habitat attributes necessary to sustain all life stages
Good = Provides a maximum and diverse number of habitat attributes to sustain all life stages
• The presence fish habitat attributes does not necessarily indicate the presence of fish
*Adequate dissolved oxygen levels range from 5.5 to 9.5 mg/l, as per Environment Canada (2003)

References:
Habitat suitability requirements are based upon documentation presented in Scott and Crossman (1973).

Table 4d
Habitat Suitability for Lake Cisco

Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total Score	Habitat Rating
	Shallow Bays	Rocky Shoals	Creek In/Outlets	EV/SV	Gravel	Cobble	Creek In/Outlets	Vegetated Bays	Deep Water	Rocky Shoals	Boulder Fields	Deep Water	*Dissolved Oxygen		
Round Lake	-	0	-	-	0	-	-	-	0	0	-	0	0	0	P
Winter Lake	-	0	-	-	0	-	-	-	0	0	-	0	0	0	P
Eclipse Lake	-	1	-	-	1	-	-	-	1	1	-	1	2	7	G
Nicholas Lake	-	1	-	-	1	-	-	-	1	1	-	1	2	7	G
Brien Lake	-	0	-	-	0	-	-	-	0	0	-	1	1	2	P
Narrow Lake	-	0	-	-	1	-	-	-	0	0	-	1	1	3	M

Habitat Characteristics:

1) Spawning Habitat
Shallow Bays =1
Rocky Shoals =1
Creek Inlets/Outlets =1
Emergent/Submergent Vegetation (EV/SV) = 1
Gravel (>0.2 to 6.5 cm) =1
Cobble (>6.5 to 25 cm) =1
Characteristic Not Present = 0
Not Applicable "-"

2) Rearing Habitat
Creek Inlets/Outlets =1
Vegetated Bays =1
Deep Water (>20 m) =1
Rocky Shoals =1
Boulder Fields =1
Characteristic Not Present = 0
Not Applicable "-"

3) Overwintering Habitat
Deep Water (>10 m) =1
*Adequate Oxygen
0 = Ice freezes to lake bottom
1 = Low winter oxygen levels
2 = High winter oxygen levels
Characteristic Not Present = 0
Not Applicable "-"

Rating:
Maximum Score = 7 Points
Point Score and Habitat Rating:
0 to 2 = Poor (P)
3 to 5 = Moderate (M)
6 to 7 = Good (G)

Habitat Requirement:
Lake Cisco (Lake Spawner)
Spawning = Rocky Shoals; Gravel/Cobble
Rearing = Deep Water; Rocky Shoals
Overwintering = Deep Water; Suitable Oxygen

Notes:
• The rating of fish habitat suitability is based on a relative scoring scheme used to evaluate habitat attributes required to sustain all life stages of fish
• The scheme assigns a single point (1) for the presense of fish habitat attributes, including spawning, rearing and overwintering habitat present within lakes sampled.
• Different fish species may require different attributes to sustain all life stages and will thus result in different maximum scores which cannot be compared to other species
Poor = Provides none to limited habitat attributes to sustain all life stages
Moderate = Provides a minimum number of habitat attributes necessary to sustain all life stages
Good = Provides a maximum and diverse number of habitat attributes to sustain all life stages
*Adequate dissolved oxygen levels range from 5.5 to 9.5 mg/l, as per Environment Canada (2003)
• The presence fish habitat attributes does not necessarily indicate the presence of fish

References:
Habitat suitability requirements are based upon documentation presented in Scott and Crossman (1973).

Table 4e
Habitat Suitability for Arctic Grayling

Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total Score	Habitat Rating
	Shallow Bays	Rocky Shoals	Creek In/Outlets	EV/SV	Gravel	Cobble	Creek In/Outlets	Vegetated Bays	Deep Water	Rocky Shoals	Boulder Fields	Deep Water	*Dissolved Oxygen		
Round Lake	-	-	0	-	0	-	0	-	0	0	-	0	0	0	P
Winter Lake	-	-	0	-	0	-	0	-	0	0	-	0	0	0	P
Eclipse Lake	-	-	1	-	0	-	1	-	1	1	-	1	2	7	G
Nicholas Lake	-	-	1	-	0	-	1	-	1	1	-	1	2	7	G
Brien Lake	-	-	0	-	0	-	0	-	0	0	-	1	1	2	P
Narrow Lake	-	-	0	-	0	-	0	-	0	0	-	1	1	2	P

Habitat Characteristics:

1) Spawning Habitat
Shallow Bays =1
Rocky Shoals =1
Creek Inlets/Outlets =1
Emergent/Submergent Vegetation (EV/SV) = 1
**Gravel (>0.2 to 6.5 cm) =1
Cobble (>6.5 to 25 cm) =1
Characteristic Not Present = 0
Not Applicable "-"

2) Rearing Habitat
Creek Inlets/Outlets =1
Vegetated Bays =1
Deep Water (>10 m) =1
Rocky Shoals =1
Boulder Fields =1
Characteristic Not Present = 0
Not Applicable "-"

3) Overwintering Habitat
Deep Water (>10 m) =1
*Adequate Oxygen
0 = Ice freezes to lake bottom
1 = Low winter oxygen levels
2 = High winter oxygen levels
Characteristic Not Present = 0
Not Applicable "-"

Rating:
Maximum Score = 8 Points
Point Score and Habitat Rating:
0 to 2 = Poor (P)
3 to 5 = Moderate (M)
6 to 8 = Good (G)

Habitat Requirement:
Arctic Grayling (Creek Spawner)
Spawning = Creeks, Gravel
Rearing = Creeks; Deep Water; Rocky Shoals
Overwintering = Deep Water; Suitable Oxygen

Notes:
• The rating of fish habitat suitability is based on a relative scoring scheme used to evaluate habitat attributes required to sustain all life stages of fish
• The scheme assigns a single point (1) for the presense of fish habitat attributes, including spawning, rearing and overwintering habitat present within lakes sampled.
• Different fish species may require different attributes to sustain all life stages and will thus result in different maximum scores which cannot be compared to other species
Poor = Provides none to limited habitat attributes to sustain all life stages
Moderate = Provides a minimum number of habitat attributes necessary to sustain all life stages
Good = Provides a maximum and diverse number of habitat attributes to sustain all life stages
• The presence fish habitat attributes does not necessarily indicate the presence of fish
*Adequate dissolved oxygen levels range from 5.5 to 9.5 mg/l, as per Environment Canada (2003)
** Refers to gravel in creeks

References:
Habitat suitability requirements are based upon documentation presented in Scott and Crossman (1973)
and Fish and Wildlife Service - U.S. Department of the Interior - Habitat Suitability Index Models (1995).

TABLES

Table 4a
Fish Habitat Suitability for Northern Pike

Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total Score	Habitat Rating
	Shallow Bays	Rocky Shoals	Creek In/Outlets	EV/SV	Gravel	Cobble	Creek In/Outlets	Vegetated Bays	Deep Water	Rocky Shoals	Boulder Fields	Deep Water	*Dissolved Oxygen		
Round Lake	0	-	-	1	-	-	0	0	-	0	0	0	0	1	P
Winter Lake	1	-	-	1	-	-	0	1	-	0	0	0	0	3	P
Eclipse Lake	1	-	-	1	-	-	1	1	-	1	1	1	2	9	G
Nicholas Lake	1	-	-	1	-	-	1	1	-	1	1	1	2	9	G
Brien Lake	1	-	-	1	-	-	0	1	-	0	0	1	1	5	M
Narrow Lake	1	-	-	1	-	-	0	1	-	0	0	1	1	5	M

Habitat Characteristics:

1) Spawning Habitat
Shallow Bays =1
Rocky Shoals =1
Creek Inlets/Outlets =1
Emergent/Submergent Vegetation (EV/SV) = 1
Gravel (>0.2 to 6.5 cm) =1
Cobble (>6.5 to 25 cm) =1
Characteristic Not Present = 0
Not Applicable "-"

2) Rearing Habitat
Creek Inlets/Outlets =1
Vegetated Bays =1
Deep Water (>10 m) =1
Rocky Shoals =1
Boulder Fields =1
Characteristic Not Present = 0
Not Applicable "-"

3) Overwintering Habitat
Deep Water (>10 m) =1
*Adequate Oxygen
0 = Ice freezes to lake bottom
1 = Low winter oxygen levels
2 = High winter oxygen levels
Characteristic Not Present = 0
Not Applicable "-"

Rating:
Maximum Score = 9 Points
Point Score and Habitat Rating:
0 to 3 = Poor (P)
4 to 6 = Moderate (M)
7 to 9 = Good (G)

Habitat Requirement:
Northern Pike (Lake Spawner)
Spawning = Shallow Bays; Submerged Vegetation
Rearing = Creeks; Vegetated Bays; Submerged Vegetation; Rocky Shoals; Boulder Fields
Overwintering = Deep Water; Suitable Oxygen

Notes:
• The rating of fish habitat suitability is based on a relative scoring scheme used to evaluate habitat attributes required to sustain all life stages of fish
• The scheme assigns a single point (1) for the presense of fish habitat attributes, including spawning, rearing and overwintering habitat present within lakes sampled.
• Different fish species may require different attributes to sustain all life stages and will thus result in different maximum scores which cannot be compared to other species
Poor = Provides none to limited habitat attributes to sustain all life stages
Moderate = Provides a minimum number of habitat attributes necessary to sustain all life stages
Good = Provides a maximum and diverse number of habitat attributes to sustain all life stages
• The presence fish habitat attributes does not necessarily indicate the presence of fish
*Adequate dissolved oxygen levels range from 5.5 to 9.5 mg/l, as per Environment Canada (2003)

References:
Habitat suitability requirements are based upon documentation presented in Scott and Crossman (1973)
and Fish and Wildlife Service - U.S. Department of the Interior - Habitat Suitability Index Models (1982).

Table 4b
Fish Habitat Suitability for Lake Trout

Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total Score	Habitat Rating
	Shallow Bays	Rocky Shoals	Creek In/Outlets	EV/SV	Gravel	Cobble	Creek In/Outlets	Vegetated Bays	Deep Water	Rocky Shoals	Boulder Fields	Deep Water	*Dissolved Oxygen		
Round Lake	-	0	-	-	0	0	-	-	0	0	-	0	0	0	P
Winter Lake	-	0	-	-	0	0	-	-	0	0	-	0	0	0	P
Eclipse Lake	-	1	-	-	1	1	-	-	1	1	-	1	2	8	G
Nicholas Lake	-	1	-	-	1	1	-	-	1	1	-	1	2	8	G
Brien Lake	-	0	-	-	0	0	-	-	0	0	-	1	1	2	P
Narrow Lake	-	0	-	-	1	0	-	-	0	0	-	1	1	3	M

Habitat Characteristics:

1) Spawning Habitat
Shallow Bays =1
Rocky Shoals =1
Creek Inlets/Outlets =1
Emergent/Submergent Vegetation (EV/SV) = 1
Gravel (>0.2 to 6.5 cm) =1
Cobble (>6.5 to 25 cm) =1
Characteristic Not Present = 0
Not Applicable "-"

2) Rearing Habitat
Creek Inlets/Outlets =1
Vegetated Bays =1
Deep Water (>10 m) =1
Rocky Shoals =1
Boulder Fields =1
Characteristic Not Present = 0
Not Applicable "-"

3) Overwintering Habitat
Deep Water (>10 m) =1
*Adequate Oxygen
0 = Ice freezes to lake bottom
1 = Low winter oxygen levels
2 = High winter oxygen levels
Characteristic Not Present = 0
Not Applicable "-"

Rating:
Maximum Score = 8 Points
Point Score and Habitat Rating:
0 to 2 = Poor (P)
3 to 5 = Moderate (M)
6 to 8 = Good (G)

Habitat Requirement:
Lake Trout (Lake Spawner)
Spawning = Rocky Shoals; Cobble/Gravel
Rearing = Deep Water; Rocky Shoals;
Overwintering = Deep Water; Suitable Oxygen

Notes:
• The rating of fish habitat suitability is based on a relative scoring scheme used to evaluate habitat attributes required to sustain all life stages of fish
• The scheme assigns a single point (1) for the presense of fish habitat attributes, including spawning, rearing and overwintering habitat present within lakes sampled.
• Different fish species may require different attributes to sustain all life stages and will thus result in different maximum scores which cannot be compared to other species
Poor = Provides none to limited habitat attributes to sustain all life stages
Moderate = Provides a minimum number of habitat attributes necessary to sustain all life stages
Good = Provides a maximum and diverse number of habitat attributes to sustain all life stages
• The presence fish habitat attributes does not necessarily indicate the presence of fish
*Adequate dissolved oxygen levels range from 5.5 to 9.5 mg/l, as per Environment Canada (2003)

References:
Habitat suitability requirements are based upon documentation presented in Scott and Crossman (1973)
and Fish and Wildlife Service - U.S. Department of the Interior - Habitat Suitability Index Models (1984).

Table 4c
Fish Habitat Suitability for Lake Whitefish

Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total Score	Habitat Rating
	Shallow Bays	Rocky Shoals	Creek In/Outlets	EV/SV	Gravel	Cobble	Creek In/Outlets	Vegetated Bays	Deep Water	Rocky Shoals	Boulder Fields	Deep Water	*Dissolved Oxygen		
Round Lake	-	0	-	-	0	0	-	-	0	0	-	0	0	0	P
Winter Lake	-	0	-	-	0	0	-	-	0	0	-	0	0	0	P
Eclipse Lake	-	1	-	-	1	1	-	-	1	1	-	1	2	8	G
Nicholas Lake	-	1	-	-	1	1	-	-	1	1	-	1	2	8	G
Brien Lake	-	0	-	-	0	0	-	-	0	0	-	1	1	2	P
Narrow Lake	-	0	-	-	1	0	-	-	0	0	-	1	1	3	M

Habitat Characteristics:

1) Spawning Habitat
Shallow Bays =1
Rocky Shoals =1
Creek Inlets/Outlets =1
Emergent/Submergent Vegetation (EV/SV) = 1
Gravel (>0.2 to 6.5 cm) =1
Cobble (>6.5 to 25 cm) =1
Characteristic Not Present = 0
Not Applicable "-"

2) Rearing Habitat
Creek Inlets/Outlets =1
Vegetated Bays =1
Deep Water (>10 m) =1
Rocky Shoals =1
Boulder Fields =1
Characteristic Not Present = 0
Not Applicable "-"

3) Overwintering Habitat
Deep Water (>10 m) =1
*Adequate Oxygen
0 = Ice freezes to lake bottom
1 = Low winter oxygen levels
2 = High winter oxygen levels
Characteristic Not Present = 0
Not Applicable "-"

Rating:
Maximum Score = 8 Points
Point Score and Habitat Rating:
0 to 2 = Poor (P)
3 to 5 = Moderate (M)
6 to 8 = Good (G)

Habitat Requirement:
Lake Whitefish (Lake Spawner)
Spawning = Rocky Shoals; Gravel
Rearing = Deep Water; Rocky Shoals;
Overwintering = Deep Water; Suitable Oxygen

Notes:
• The rating of fish habitat suitability is based on a relative scoring scheme used to evaluate habitat attributes required to sustain all life stages of fish
• The scheme assigns a single point (1) for the presense of fish habitat attributes, including spawning, rearing and overwintering habitat present within lakes sampled.
• Different fish species may require different attributes to sustain all life stages and will thus result in different maximum scores which cannot be compared to other species
Poor = Provides none to limited habitat attributes to sustain all life stages
Moderate = Provides a minimum number of habitat attributes necessary to sustain all life stages
Good = Provides a maximum and diverse number of habitat attributes to sustain all life stages
• The presence fish habitat attributes does not necessarily indicate the presence of fish
*Adequate dissolved oxygen levels range from 5.5 to 9.5 mg/l, as per Environment Canada (2003)

References:
Habitat suitability requirements are based upon documentation presented in Scott and Crossman (1973).

Table 4d
Habitat Suitability for Lake Cisco

Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total Score	Habitat Rating
	Shallow Bays	Rocky Shoals	Creek In/Outlets	EV/SV	Gravel	Cobble	Creek In/Outlets	Vegetated Bays	Deep Water	Rocky Shoals	Boulder Fields	Deep Water	*Dissolved Oxygen		
Round Lake	-	0	-	-	0	-	-	-	0	0	-	0	0	0	P
Winter Lake	-	0	-	-	0	-	-	-	0	0	-	0	0	0	P
Eclipse Lake	-	1	-	-	1	-	-	-	1	1	-	1	2	7	G
Nicholas Lake	-	1	-	-	1	-	-	-	1	1	-	1	2	7	G
Brien Lake	-	0	-	-	0	-	-	-	0	0	-	1	1	2	P
Narrow Lake	-	0	-	-	1	-	-	-	0	0	-	1	1	3	M

Habitat Characteristics:

1) Spawning Habitat
Shallow Bays =1
Rocky Shoals =1
Creek Inlets/Outlets =1
Emergent/Submergent Vegetation (EV/SV) = 1
Gravel (>0.2 to 6.5 cm) =1
Cobble (>6.5 to 25 cm) =1
Characteristic Not Present = 0
Not Applicable "-"

2) Rearing Habitat
Creek Inlets/Outlets =1
Vegetated Bays =1
Deep Water (>20 m) =1
Rocky Shoals =1
Boulder Fields =1
Characteristic Not Present = 0
Not Applicable "-"

3) Overwintering Habitat
Deep Water (>10 m) =1
*Adequate Oxygen
0 = Ice freezes to lake bottom
1 = Low winter oxygen levels
2 = High winter oxygen levels
Characteristic Not Present = 0
Not Applicable "-"

Rating:
Maximum Score = 7 Points
Point Score and Habitat Rating:
0 to 2 = Poor (P)
3 to 5 = Moderate (M)
6 to 7 = Good (G)

Habitat Requirement:
Lake Cisco (Lake Spawner)
Spawning = Rocky Shoals; Gravel/Cobble
Rearing = Deep Water; Rocky Shoals
Overwintering = Deep Water; Suitable Oxygen

Notes:
• The rating of fish habitat suitability is based on a relative scoring scheme used to evaluate habitat attributes required to sustain all life stages of fish
• The scheme assigns a single point (1) for the presense of fish habitat attributes, including spawning, rearing and overwintering habitat present within lakes sampled.
• Different fish species may require different attributes to sustain all life stages and will thus result in different maximum scores which cannot be compared to other species
Poor = Provides none to limited habitat attributes to sustain all life stages
Moderate = Provides a minimum number of habitat attributes necessary to sustain all life stages
Good = Provides a maximum and diverse number of habitat attributes to sustain all life stages
*Adequate dissolved oxygen levels range from 5.5 to 9.5 mg/l, as per Environment Canada (2003)
• The presence fish habitat attributes does not necessarily indicate the presence of fish

References:
Habitat suitability requirements are based upon documentation presented in Scott and Crossman (1973).

Table 4e
Habitat Suitability for Arctic Grayling

Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total Score	Habitat Rating
	Shallow Bays	Rocky Shoals	Creek In/Outlets	EV/SV	Gravel	Cobble	Creek In/Outlets	Vegetated Bays	Deep Water	Rocky Shoals	Boulder Fields	Deep Water	*Dissolved Oxygen		
Round Lake	-	-	0	-	0	-	0	-	0	0	-	0	0	0	P
Winter Lake	-	-	0	-	0	-	0	-	0	0	-	0	0	0	P
Eclipse Lake	-	-	1	-	0	-	1	-	1	1	-	1	2	7	G
Nicholas Lake	-	-	1	-	0	-	1	-	1	1	-	1	2	7	G
Brien Lake	-	-	0	-	0	-	0	-	0	0	-	1	1	2	P
Narrow Lake	-	-	0	-	0	-	0	-	0	0	-	1	1	2	P

Habitat Characteristics:

1) Spawning Habitat
Shallow Bays =1
Rocky Shoals =1
Creek Inlets/Outlets =1
Emergent/Submergent Vegetation (EV/SV) = 1
**Gravel (>0.2 to 6.5 cm) =1
Cobble (>6.5 to 25 cm) =1
Characteristic Not Present = 0
Not Applicable "-"

2) Rearing Habitat
Creek Inlets/Outlets =1
Vegetated Bays =1
Deep Water (>10 m) =1
Rocky Shoals =1
Boulder Fields =1
Characteristic Not Present = 0
Not Applicable "-"

3) Overwintering Habitat
Deep Water (>10 m) =1
*Adequate Oxygen
0 = Ice freezes to lake bottom
1 = Low winter oxygen levels
2 = High winter oxygen levels
Characteristic Not Present = 0
Not Applicable "-"

Rating:
Maximum Score = 8 Points
Point Score and Habitat Rating:
0 to 2 = Poor (P)
3 to 5 = Moderate (M)
6 to 8 = Good (G)

Habitat Requirement:
Arctic Grayling (Creek Spawner)
Spawning = Creeks, Gravel
Rearing = Creeks; Deep Water; Rocky Shoals
Overwintering = Deep Water; Suitable Oxygen

Notes:
• The rating of fish habitat suitability is based on a relative scoring scheme used to evaluate habitat attributes required to sustain all life stages of fish
• The scheme assigns a single point (1) for the presense of fish habitat attributes, including spawning, rearing and overwintering habitat present within lakes sampled.
• Different fish species may require different attributes to sustain all life stages and will thus result in different maximum scores which cannot be compared to other species
Poor = Provides none to limited habitat attributes to sustain all life stages
Moderate = Provides a minimum number of habitat attributes necessary to sustain all life stages
Good = Provides a maximum and diverse number of habitat attributes to sustain all life stages
• The presence fish habitat attributes does not necessarily indicate the presence of fish
*Adequate dissolved oxygen levels range from 5.5 to 9.5 mg/l, as per Environment Canada (2003)
** Refers to gravel in creeks

References:
Habitat suitability requirements are based upon documentation presented in Scott and Crossman (1973)
and Fish and Wildlife Service - U.S. Department of the Interior - Habitat Suitability Index Models (1995).

Table 5
Fish Species Composition and Biological Data

Species	Data		Lake						All lakes
			Round	Winter	Eclipse	Nicholas	Brien	Narrow	
Northern pike	Length Data	Number of fish sampled			3	7	6	9	25
		Mean Length (cm)			64.8	55.33	33.33	56.48	52.48
		Maximum Length (cm)			74.5	59.2	49.1	69.5	74.5
		Minimum Length (cm)			52.7	50.2	16.5	16.8	16.5
		Standard Deviation			11.10	3.47	12.39	12.24	14.61
	Weight Data	Number of fish sampled			3	7	6	8	24
		Mean Weight (g)			1636	1062.14	326.67	1459.38	1121.05
		Maximum Weight (g)			2660	1125	725	2440	2660
		Minimum Weight (g)			980	840	40	175	40
		Standard Deviation			861.34	185.60	306.46	755.65	747.36
	Age Data	Number of fish sampled			3	5	5	5	18
		Mean Age			5.67	4.2	2.6	4.2	4
		Maximum Age			7.0	5	4	5	7
		Minimum Age			4	4	2	2	2
		Standard Deviation			1.53	0.45	0.89	1.30	1.41
Lake trout	Length Data	Number of fish sampled			11	9			20
		Mean Length (cm)			52.68	47.97			50.32
		Maximum Length (cm)			75.5	56.4			75.5
		Minimum Length (cm)			29.5	19.1			19.1
		Standard Deviation			10.89	11.01			10.92
	Weight Data	Number of fish sampled			11	9			20
		Mean Weight (g)			1853.91	1340.56			1597.23
		Maximum Weight (g)			6803	1820			6803
		Minimum Weight (g)			250	60			60
		Standard Deviation			1712.22	522.90			1314.07
	Age Data	Number of fish sampled			7	5			12
		Mean Age			14.57	15.2			14.83
		Maximum Age			34	24			34
		Minimum Age			7	3			3
		Standard Deviation			9.09	7.98			8.27
Lake cisco	Length Data	Number of fish sampled			3				3
		Mean Length (cm)			12.67				12.67
		Maximum Length (cm)			12.8				12.8
		Minimum Length (cm)			12.6				12.6
		Standard Deviation			0.12				0.12
	Weight Data	Number of fish sampled			3				3
		Mean Weight (g)			18.33				18.33
		Maximum Weight (g)			19				19
		Minimum Weight (g)			18				18
		Standard Deviation			0.58				0.58
	Age Data	Number of fish sampled							
		Mean Age							
		Maximum Age							
		Minimum Age							
		Standard Deviation							
Burbot	Length Data	Number of fish sampled			1	1			2
		Mean Length (cm)			41.4	63.4			52.4
		Maximum Length (cm)			41.4	63.4			63.4
		Minimum Length (cm)			41.4	63.4			41.4
		Standard Deviation							
	Weight Data	Number of fish sampled				1			1
		Mean Weight (g)				1790			1790
		Maximum Weight (g)				1790			1790
		Minimum Weight (g)				1790			1790
		Standard Deviation							
	Age Data	Number of fish sampled							
		Mean Age							
		Maximum Age							
		Minimum Age							
		Standard Deviation							
Lake whitefish	Length Data	Number of fish sampled			5			66	71
		Mean Length (cm)			37.98			28.17	33.08
		Maximum Length (cm)			41.6			45.4	45.4
		Minimum Length (cm)			34.6			14.4	14.4
		Standard Deviation			2.91			5.90	6.26
	Weight Data	Number of fish sampled			5			68	73
		Mean Weight (g)			656			324.32	490.16
		Maximum Weight (g)			850			1240	1240
		Minimum Weight (g)			465			100	100
		Standard Deviation			172.68			219.43	231.77
	Age Data	Number of fish sampled			5			6	11
		Mean Age			6.2			9.17	7.82
		Maximum Age			7			17	17
		Minimum Age			5			3	3
		Standard Deviation			0.84			5.00	3.89
Total Number of Fish sampled for Length (Per Site)			0	0	23	17	6	75	121
Total Number of Fish sampled for Weight (Per Site)			0	0	22	17	6	76	121
Total Number of Fish sampled for Age (Per Site)			0	0	15	10	5	11	41

Note:
No fish were captured at Round Lake or Winter Lake

Table 6a
Fish Species Abundance by Collection Method

Species	Sample Lakes and Gear Type												Total Catch	
	Round		Winter		Eclipse		Nicholas		Brien		Narrow			
	Gillnet	Minnow Trap	Gillnet	Minnow Trap	Gillnet	Minnow Trap	Gillnet	Minnow Trap	Gillnet	Minnow Trap	Gillnet	Minnow Trap	Gillnet	Minnow Trap
Northern Pike	0	0	0	0	3	0	7	0	6	0	9	2	25	2
Lake Trout	0	0	0	0	11	0	9	0	0	0	0	0	20	0
Lake Whitefish	0	0	0	0	5	0	0	0	0	0	74	0	79	0
Lake Cisco	0	0	0	0	3	0	0	0	0	0	0	0	3	0
Burbot	0	0	0	0	1	0	1	0	0	0	0	0	2	0
Fish Total	0	0	0	0	23	0	17	0	6	0	83	2	129	2

Note:

Gillnets used were 100 m^2 in surface area and were comprised of 6 panels with mesh sizes 25 mm, 76 mm, 51mm, 89 mm, 38 mm and 64 mm stretched.
Ten Gee-Type minnow traps were set each lake to collect small fish. Size was 0.4 m length x 1.2 m diameter and with an aperature of 0.02 m

Table 6b
Fish Species Composition by Collection Method

Species	Sample Lakes and Gear Type												Percent (%) Composition	
	Round		Winter		Eclipse		Nicholas		Brien		Narrow			
	Gillnet	Minnow Trap	Gillnet	Minnow Trap	Gillnet	Minnow Trap	Gillnet	Minnow Trap	Gillnet	Minnow Trap	Gillnet	Minnow Trap	Gillnet	Minnow Trap
Northern Pike	0.0	0.0	0.0	0.0	13.0	0.0	41.2	0.0	100.0	0.0	10.8	2.0	19.4	100
Lake Trout	0.0	0.0	0.0	0.0	47.8	0.0	52.9	0.0	0.0	0.0	0.0	0.0	15.5	0
Lake Whitefish	0.0	0.0	0.0	0.0	21.7	0.0	0.0	0.0	0.0	0.0	89.2	0.0	61.2	0
Lake Cisco	0.0	0.0	0.0	0.0	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0
Burbot	0.0	0.0	0.0	0.0	4.3	0.0	5.9	0.0	0.0	0.0	0.0	0.0	1.5	0
												Total (%)	100	100

Note:

Gillnets used were 100 m^2 in surface area and were comprised of 6 panels with mesh sizes 25 mm, 76 mm, 51mm, 89 mm, 38 mm and 64 mm stretched.
Ten Gee-Type minnow traps were set each lake to collect small fish. Size was 0.4 m length x 1.2 m diameter and with an aperature of 0.02 m

Table 7
Metals in Fish Tissues

				Metal Parameters									
				Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
	Detection Limit (DL)			0.010	0.0060	0.10	0.010	0.020	0.020	0.020	0.20	0.0060	0.1
Eclipse Lake	**Code**	**% Moisture**	**Weight/g**										
Lake Trout (mus/liv)	LT1	76.30	6803	2.020	0.0169	<0.10	0.876	0.188	4.090	0.085	1.20	<0.006	12.0
n =5	LT2	80.50	1425	0.406	0.0312	<0.10	6.300	<0.020	0.375	0.119	0.67	0.0312	18.7
	LT3	79.60	1650	0.279	0.0217	<0.10	9.260	<0.020	0.250	0.116	0.44	0.0565	12.5
	LT4	79.40	1225	0.390	0.0077	<0.10	1.710	<0.020	0.292	0.065	0.40	0.0130	9.9
	LT5	79.40	920	0.436	0.0124	<0.10	3.240	<0.020	0.186	0.063	0.52	0.0161	11.6
			Mean	0.706	0.0180	n/a	4.277	0.188	1.039	0.090	0.65	0.0292	12.9
Lake Whitefish (mus/liv)	WF9	78.80	850	0.427	0.0099	<0.10	3.140	<0.020	0.134	0.121	0.69	0.0194	14.6
n=4	WF10	80.10	600	0.827	0.0085	<0.10	1.050	<0.020	0.081	0.086	0.54	<0.006	10.9
	WF11	76.70	825	0.731	0.0113	<0.10	3.320	<0.020	0.103	0.061	0.67	0.0125	18.8
	WF12	79.00	540	0.811	0.0885	<0.10	2.290	<0.020	0.089	0.065	0.56	<0.006	13.9
			Mean	0.700	0.0272	n/a	2.815	n/a	0.289	0.085	0.62	0.0204	14.2
Northern Pike (mus/liv)	NP3	78.00	2150	0.673	0.0130	<0.10	8.750	<0.020	0.568	0.069	0.67	0.0840	20.1
n=3	NP5	80.10	2660	1.240	0.0324	<0.10	7.950	<0.020	0.747	0.125	0.45	0.1090	15.4
	NP8	79.10	980	0.337	0.0102	<0.10	5.1100	<0.020	0.216	0.096	0.64	0.0398	21.7
			Mean	0.752	0.0343	n/a	5.383	n/a	0.382	0.088	0.59	0.0633	17.1
Cisco (mus/liv)	C5	81.30	N/A	0.218	0.0071	<0.10	0.6310	0.026	0.063	0.030	0.29	<0.006	50.2
n=1													
			Mean	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Nicholas Lake													
Lake Trout (mus/liv)	LT1	77.90	1820	0.449	0.0398	<0.1	6.570	<0.02	0.352	0.287	0.82	0.0506	16.5
n =5	LT2	77.60	1260	0.271	0.1650	<0.1	12.100	<0.02	0.255	0.117	1.16	0.0834	18.0
	LT3	78.10	1425	0.465	0.0364	<0.1	5.730	<0.02	0.344	0.118	1.40	0.0407	18.7
	LT4	76.50	1530	0.440	0.0262	<0.1	4.970	<0.02	0.262	0.276	0.53	0.0620	14.5
	LT5	80.90		0.473	0.0074	<0.1	1.360	<0.02	0.138	0.107	0.27	0.0118	9.8
			Mean	0.420	<0.006	n/a	6.146	n/a	0.270	<0.02	<0.2	0.0497	15.5
Northern Pike (mus/liv)	NP2	79.60	920	0.354	0.0297	<0.10	33.500	<0.020	0.445	0.084	0.84	0.3190	25.7
n=5	NP3	78.60	1020	0.217	0.0192	<0.10	10.500	<0.020	0.248	0.126	0.64	0.1130	26.1
	NP4	79.20	930	0.308	0.0180	<0.10	9.540	<0.020	0.305	0.300	0.60	0.1010	20.5
	NP5	78.40	1320	0.365	0.0082	<0.10	21.600	<0.020	0.308	0.271	0.78	0.2390	23.2
	NP6	79.20	840	0.350	0.0280	<0.10	14.100	<0.020	0.354	0.824	0.60	0.1980	21.7
			Mean	0.356	0.0165	n/a	13.774	n/a	0.286	0.178	0.63	0.1389	20.1
Brien Lake													
Northern Pike (mus/liv)	NP1	79.50	725	0.115	0.0132	<0.1	54.300	<0.02	0.272	0.139	0.57	0.2140	38.8
n =5	NP2	81.30	710	0.162	0.0085	<0.1	13.400	<0.02	0.367	0.137	0.35	0.1280	29.9
	NP3	75.60	170	0.152	0.0078	<0.1	15.700	<0.02	0.166	0.176	0.29	0.1030	11.9
	NP4	80.50	155	0.213	<0.0060	<0.1	3.290	<0.02	0.201	0.098	0.20	0.0288	8.9
	NP5	81.30	160	0.070	<0.0060	<0.1	0.290	<0.02	0.035	<0.04	<0.4	0.0200	11.3
			Mean	0.161	n/a	n/a	21.673	n/a	0.252	0.030	0.35	0.1185	22.4
Narrow Lake													
Lake Whitefish (mus/liv)	WF4	78.70	1240	0.265	<0.0060	<0.1	1.690	<0.02	0.300	0.141	0.47	<0.006	10.7
n =5	WF5	78.90	360	0.164	<0.0060	<0.1	1.170	<0.02	0.197	0.131	0.26	<0.006	10.0
	WF6	81.10	520	0.226	<0.0060	<0.1	0.959	<0.02	0.234	0.265	<0.2	0.0066	8.9
	WF7	80.80	250	0.193	<0.0060	<0.1	0.688	<0.02	0.253	0.304	<0.2	<0.006	9.6
	WF8	80.50	700	0.215	<0.0060	<0.1	2.260	<0.02	0.439	0.229	0.38	0.0098	10.3
			Mean	0.204	n/a	n/a	1.474	n/a	0.346	0.267	0.37	n/a	9.9
Northern Pike (mus/liv)	NP1	75.80	2440	0.230	<0.0060	<0.1	3.040	<0.02	0.804	0.041	0.50	0.0161	19.4
n =5	NP2	79.00	175	0.152	<0.0060	<0.1	5.130	<0.02	0.965	0.067	0.48	0.0271	23.8
	NP1	81.10	1140	0.178	0.0376	<0.1	4.470	<0.02	1.320	0.253	0.63	0.0357	47.4
	NP2	78.80	1200	0.089	<0.0060	<0.1	4.820	<0.02	0.290	0.088	0.27	0.0141	13.1
	NP3	75.20	1810	0.172	0.0152	<0.1	6.330	<0.02	0.967	0.114	0.86	0.0261	46.8
			Mean	0.164	n/a	n/a	4.758	n/a	0.869	0.030	0.55	0.0238	30.1

Note:
All concentrations in mg/kg (wet)
<= Less than the dectection limit indicated
All samples are composite samples of liver and muscle tissues combined
Indicates individuals that exceed Health and Welfare Canada restrictive consumption levles for mercury (0.5 ppm or mg/kg)

Table 8a
Zooplankton Mean Abundance and Density

Lake ID	Brien Lake		Narrow Lake		Winter Lake		Round Lake		Eclipse Lake		Nicholas Lake		Total (All Samples)	
Depth Sampled (m)	10		11		6		1.5		23		19			
Volume Sampled (m^3)	0.73		0.80		0.44		0.11		1.68		1.39			
Major Group	Mean Abundance	Mean Density (per m^3)	Mean Abundance	Mean Density (per m^3)	Mean Abundance	Mean Density (per m^3)	Mean Abundance	Mean Density (per m^3)	Mean Abundance	Mean Density (per m^3)	Mean Abundance	Mean Density (per m^3)	Mean Abundance	Mean Density (per m^3)
Rotifera	2343.33	3211.54	1316.67	1640.46	1005.67	2297.12	277.67	2536.99	3648.33	2173.93	363.33	253.19	1492.50	2018.87
Eubranchiopoda	0.00	0.00	0.00	0.00	1.67	3.81	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.64
Cladocera	200.00	274.10	4544.33	5661.84	1560.00	3563.31	88.33	807.04	287.33	171.21	4.33	3.02	1114.05	1746.75
Copepoda	2442.83	3347.91	6966.00	8679.03	712.33	1627.08	337.33	3082.08	1811.67	1079.52	1528.33	1065.04	2299.75	3146.78
Amphipoda	0.00	0.00	0.00	0.00	0.33	0.75	0.67	6.12	0.00	0.00	0.00	0.00	0.17	1.15
Insecta	30.00	41.12	0.00	0.00	215.00	491.10	33.00	301.51	0.00	0.00	0.00	0.00	46.33	138.95
Total	5016.16	6874.67	12827.00	15981.32	3495.00	7983.18	737.00	6733.74	5747.33	3424.67	1895.99	1321.25	4953.08	7053.14

Note: Zooplankton samples collected by vertical haul using 153 micron plankton net with 12 inch diameter opening

Table 8b
Zooplankton Total Abundance and Percent Composition

Lake ID	Brien Lake		Narrow Lake		Winter Lake		Round Lake		Eclipse Lake		Nicholas Lake	
Major Group	No. of Organisms	% Total	No. of Organisms	% Total	No. of Organisms	% Total	No of Organisms	% Total	No. of Organisms	% Total	No. of Organisms	% Total
Rotifera	7030	46.72	3950	10.26	3017	28.79	833	37.68	10945	63.48	1090	19.16
Eubranchiopoda	0	0.00	0	0.00	5	0.05	0	0.00	0	0.00	0	0.00
Cladocera	600	3.99	13633	35.43	4680	44.64	265	11.99	862	5.00	13	0.23
Copepoda	7327	48.69	20898	54.31	2137	20.38	1012	45.77	5435	31.52	4585	80.61
Amphipoda	0	0.00	0	0.00	1	0.01	2	0.09	0	0.00	0	0.00
Insecta	90	0.60	0	0.00	645	6.15	99	4.48	0	0.00	0	0.00
Total Number of Individuals (Abundance)	15047	100.00	38481	100.00	10485	100.00	2211	100.00	17242	100.00	5688	100.00
Total Number of Taxa (Richness)	14		14.0		20.0		19.0		22.0		9.0	

Table 8c
Zooplankton Community Analysis

Location	Brien Lake		Narrow Lake		Winter Lake		Round Lake		Eclipse Lake		Nicholas Lake	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Rotifera	2343	545	1317	510	1006	700	278	235	3648	430	363	206
Eubranchipoda	0	0	0	0	2	1	0	0	0	0	0	0
Cladocera	200	50	4544	2050	1560	1076	88	27	287	116	4	1
Copepoda	2442	785	6966	2188	712	605	337	210	1812	687	1528	529
Amphipoda	0	0	0	0	0	1	1	1	0	0	0	0
Insecta	30	9	0	0	215	278	33	11	0	0	0	0
Total Number of Individuals (Abundance)	10031	1340	25654	7715	6990	3057	1474	911	11495	2424	3792	1427
Total Number of Taxa (Species Richness)	14	2	14	2	20	1	19	2	22	0	9	1
Shannon-Wiener Index (H')	1	0	1	0	1	0	1	0	1	0	1	0
Number of equally common species needed for the same H' (N_1)	4	1	4	0	3	1	4	0	3	0	3	0

Note:
Shannon-Wiener (H') incorporates total abundance of taxa and total number of taxa (within a collected samples) to assess the quality of the benthic community
H ' increases with the number of evenly distributed species in the community in relation to increased species abundance and species richness
The index uses a rating between 1(low) and 3 (high) with 3 representing the highest diverity of taxa.

Table 9a
Benthic Invertebrate Mean Abundance and Density

Lake ID	Brien Lake				Narrow Lake				Winter Lake							
Sample Location	Inshore		Offshore		Inshore		Offshore		Inshore		Offshore		Inlet		Outlet	
	Mean Abundance	Density (per/ m^2)	Mean Abundance	Density (per/ m^2)	Mean Abundance	Density (per/ m^2)	Mean Abundance	Density (per/ m^2)	Mean Abundance	Mean Density (per/ m^2)	Mean Abundance	Mean Density (per/ m^2)	Mean Abundance	Mean Density (per/ m^2)	Mean Abundance	Mean Density (per/ m^2)
Sensitive Organisms																
Ephemeroptera	0.67	28.99	0	0.00	0.33	14.49	0	0.00	0.33	14.49	0	0.00	0	0.00	0.67	28.99
Plecoptera	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.33	14.49	1.67	72.46	0	0.00
Odonata	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.33	14.49
Trichoptera P	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.33	14.49
Faculative Organisms																
Coleoptera	0.33	14.49	0	0.00	0	0.00	0	0.00	0	0.00	0.33	14.49	0	0.00	0.33	14.49
Diptera Unid L	1.00	43.48	0.33	14.49	0.67	28.99	0.33	14.49	1.67	72.46	0	0.00	0.33	14.49	1.00	43.48
Chironomidae	11.00	478.26	10.67	463.77	5.00	217.39	2.00	86.96	29.67	1289.86	21.00	913.05	11.00	478.26	35.33	1536.24
Culicidae A	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.33	14.49	1.00	43.48
Hemiptera	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Homoptera Unid (terr)	0	0.00	0	0.00	0.33	14.49	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Aranaea	0	0.00	0	0.00	0	0.00	0.33	14.49	0	0.00	0	0.00	0	0.00	0	0.00
Hydracarina Unid J/D	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1.33	57.97
Amphipoda	3.00	130.44	0	0.00	23.00	1000.00	0	0.00	4.33	188.41	0	0.00	0.33	14.49	8.00	347.83
Conchostraca	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1.67	72.46	0	0.00	0	0.00
Copepoda	0	0.00	3.00	130.44	2.67	115.94	0	0.00	0	0.00	0	0.00	0	0.00	0.67	28.99
Cladocera	0	0.00	1.67	72.46	5.00	217.39	0.33	14.49	0.33	14.49	0.33	14.49	0	0.00	0	0.00
Isopoda	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.33	14.49	0	0.00
Mysidaceae, dam	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Ostracoda	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1.00	43.48	6.33	275.36	0	0.00
Hirudinea Unid J	0	0.00	0	0.00	0.33	14.49	0	0.00	0.67	28.99	0	0.00	0	0.00	13.33	579.71
Bivalvia	2.33	101.45	11.00	478.26	6.67	289.86	10.00	434.78	6.33	275.36	0	0.00	0	0.00	26.33	1144.93
Gastropoda	0.67	28.99	0	0.00	2.00	86.96	0	0.00	1.00	43.48	0	0.00	0	0.00	15.00	652.18
Nematoda	0.33	14.49	0	0.00	0	0.00	0	0.00	2.33	101.45	0	0.00	0	0.00	0	0.00
Tolerant Organisms																
Oligochaeta	1.00	43.48	0	0.00	6.00	260.87	0	0.00	4.33	188.41	0	0.00	1.67	72.46	1.67	72.46
Total	20.33	884.06	26.67	1159.42	52.00	2260.87	13.00	565.22	51.00	2217.40	24.67	1072.47	22.00	956.52	105.33	4579.72

Note:

Inlets and outlets were sampled with an Ekman sampler; area of 0.023 m^2.

Inshore and offshore samples were taken with a Ponar sampler; area of 0.023 m^2.

In all cases Mean Abundance is average of three samples

Table 9a
Benthic Invertebrate Mean Abundance and Density (cont'd)

Lake ID	Round Lake				Eclipse Lake								Nicholas Lake				TOTAL	
Sample Location	**Inshore**		**Offshore**		**Inshore**		**Offshore**		**Inlet**		**Outlet**		**Inshore**		**Offshore**			
	Mean Abundance	**Mean Density (per/ m^2)**	**Mean Abundance**	**Mean Density (per/ m^2)**	**Mean Abundance**	**Mean Density (per/ m^2)**	**Mean Abundance**	**Mean Density (per/ m^2)**	**Mean Abundance**	**Mean Density (per/ m^2)**	**Mean Abundance**	**Mean Density (per/ m^2)**	**Mean Abundance**	**Mean Density (per/ m^2)**	**Mean Abundance**	**Mean Density (per/ m^2)**	**Mean Abundance**	**Mean Density (per/ m^2)**
Sensitive Organisms																		
Ephemeroptera	1.33	57.97	6.33	275.36	0	0.00	0	0.00	0.33	14.49	0.33	14.49	0.67	28.99	1.33	57.97	0.77	33.51
Plecoptera	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.13	5.43
Odonata	0	0.00	1	43.48	0	0.00	0	0.00	0	0.00	0	0.00	0.33	14.49	0	0.00	80.00	4.53
Trichoptera P	0.67	28.99	0	0.00	0	0.00	0	0.00	0.67	28.99	1.67	72.46	0.67	28.99	0	0.00	0.25	10.87
Faculative Organisms																		
Coleoptera	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.06	2.72
Diptera Unid L	0	0.00	0	0.00	2.67	115.94	0	0.00	1.33	57.97	0	0.00	4.00	173.91	0	0.00	0.83	36.23
Chironomidae	22.33	971.02	62.00	2695.66	8.67	376.81	4.00	173.91	4.00	173.91	503.33	21884.11	23.00	1000.00	9.33	405.80	47.65	2071.56
Culicidae A	0	0.00	0	0.00	0	0.00	0	0.00	0.33	14.49	1.00	43.48	0	0.00	0	0.00	0.17	7.25
Hemiptera	0	0.00	0.67	28.99	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.04	1.81
Homoptera Unid (terr)	0	0.00	0	0.00	0	0.00	0.33	14.49	0	0.00	0	0.00	0	0.00	0	0.00	0.04	1.81
Aranaea	0	0.00	0	0.00	0	0.00	0	0.00	0.67	28.99	0	0.00	0	0.00	0	0.00	0.06	2.72
Hydracarina Unid J/D	0	0.00	0.33	14.49	0.33	14.49	0	0.00	0	0.00	0.33	14.49	0	0.00	0	0.00	0.15	6.34
Amphipoda	20.67	898.55	10.00	434.78	21.33	927.54	53.33	2318.85	0	0.00	4.33	188.41	14.33	623.19	62.33	2710.15	14.06	611.41
Conchostraca	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.10	4.53
Copepoda	0.67	28.99	0	0.00	0.67	28.99	3.67	159.42	0	0.00	0	0.00	0.67	28.99	6.00	260.87	1.13	48.91
Cladocera	0.67	28.99	0.33	14.49	1.00	43.48	1.67	72.46	0	0.00	2.00	86.96	0.67	28.99	0	0.00	0.88	38.04
Isopoda	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.02	0.91
Mysidaceae, dam	0	0.00	0	0.00	0	0.00	1.00	43.48	0	0.00	0	0.00	0	0.00	0.33	14.49	0.08	3.62
Ostracoda	0	0.00	0.33	14.49	0	0.00	0	0.00	2.33	101.45	12.67	550.73	0.33	14.49	0	0.00	1.44	62.50
Hirudinea Unid J	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.33	14.49	0	0.00	0	0.00	0.92	39.86
Bivalvia	4.33	188.41	32.33	1405.80	1.33	57.97	20.33	884.06	7.00	304.35	17.00	739.13	2.33	101.45	31.33	1362.32	11.17	485.51
Gastropoda	0.33	14.49	0.67	28.99	1.33	57.97	0	0.00	2.33	101.45	0.33	14.49	1.67	72.46	0	0.00	1.58	68.84
Nematoda	0	0.00	0	0.00	0	0.00	1.00	43.48	1.00	43.48	0.67	28.99	2.67	115.94	1.33	57.97	0.58	25.36
Tolerant Organisms																		
Oligochaeta	0.67	28.99	0	0.00	1.33	57.97	0.67	28.99	0	0.00	4.33	188.41	1.00	43.48	2.00	86.96	1.54	67.03
Total	51.67	2246.38	114.00	4956.53	38.67	1681.16	86.00	3739.14	20.00	869.57	548.33	23840.63	52.33	2275.37	114.00	4956.53	163.65	7115.05

Note:

Inlets and outlets were sampled with an Ekman sampler; area of 0.023 m^2.

Inshore and offshore samples were taken with a Ponar sampler; area of 0.023 m^2.

In all cases Mean Abundance is average of three samples

Table 9b
Benthic Invertebrate Community Composition

Lake ID	Brien Lake				Narrow Lake				Winter Lake				Winter Lake (Stream Samples)			
Sample Location	Inshore		Offshore		Inshore		Offshore		Inshore		Offshore		Inlet		Outlet	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Sensitive Organisms																
Ephemeroptera	2	3.39	0	0.00	1	0.64	0	0.00	1	0.65	0	0.00	0	0.00	2	0.63
Plecoptera	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.39	5	7.58	0	0.00
Odonata	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.31
Trichoptera P	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.31
Faculative Organisms																
Coleoptera	1	1.69	0	0.00	0	0.00	0	0.00	0	0.00	1	1.39	0	0.00	1	0.31
Diptera Unid L	3	5.08	1	1.25	2	1.27	1	2.56	5	3.27	0	0.00	1	1.52	3	0.94
Chironomidae	33	55.93	32	40.00	15	9.55	6	15.38	89	58.17	61	84.72	33	50.00	106	33.23
Culicidae A	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.52	3	0.94
Hemiptera	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Homoptera Unid (terr)	0	0.00	0	0.00	1	0.64	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Aranaea	0	0.00	0	0.00	0	0.00	1	2.56	0	0.00	0	0.00	0	0.00	0	0.00
Hydracarina Unid J/D	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	4	1.25
Amphipoda	9	15.25	0	0.00	69	43.95	0	0.00	13	8.50	0	0.00	1	1.52	24	7.52
Conchostraca	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	5	6.94	0	0.00	0	0.00
Copepoda	0	0.00	9	11.25	8	5.10	0	0.00	0	0.00	0	0.00	0	0.00	2	0.63
Cladocera	0	0.00	5	6.25	15	9.55	1	2.56	1	0.65	1	1.39	0	0.00	0	0.00
Isopoda	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.52	0	0.00
Mysidaceae, dam	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Ostracoda	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	4.17	19	28.79	0	0.00
Hirudinea Unid J	0	0.00	0	0.00	1	0.64	0	0.00	2	1.31	0	0.00	0	0.00	40	12.54
Bivalvia	7	11.86	33	41.25	20	12.74	30	76.92	19	12.42	0	0.00	0	0.00	79	24.76
Gastropoda	2	3.39	0	0.00	6	3.82	0	0.00	3	1.96	0	0.00	0	0.00	45	14.11
Nematoda	1	1.69	0	0.00	1	0.64	0	0.00	7	4.58	0	0.00	0	0.00	3	0.94
Tolerant Organisms																
Oligochaeta	1	1.69	0	0.00	18	11.46	0	0.00	13	8.50	0	0.00	5	7.58	5	1.57
Total Number of Individuals (Abundance)	59	100.00	80	100.00	157	100.00	39	100.00	153	100.00	72	100.00	66	100.00	319	100.00
Total Number of Taxa (Species Richness)*	19		9		28		8		18		9		15		36	

Notes:
*See Fisheries and Aquatic Resources (2004) Appendix H for individual counts per taxa
n = 3 samples

Table 9b
Benthic Invertebrate Community Composition (cont'd)

Lake ID	**Round Lake**				**Eclipse Lake**				**Eclipse Lake (Stream Samples)**				**Nicholas Lake**			
Sample Location	**Inshore**		**Offshore**		**Inshore**		**Offshore**		**Inlet**		**Outlet**		**Inshore**		**Offshore**	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Sensitive Organisms																
Ephemeroptera	4	2.58	19	5.56	0	0.00	0	0.00	1	1.67	1	0.06	2	1.27	4	1.17
Plecoptera	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Odonata	0	0.00	3	0.88	0	0.00	0	0.00	0	0.00	0	0.00	1	0.64	0	0.00
Trichoptera P	2	1.29	0	0.00	0	0.00	0	0.00	2	3.33	5	0.30	2	1.27	0	0.00
Faculative Organisms																
Coleoptera	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Diptera Unid L	0	0.00	0	0.00	8	6.90	0	0.00	4	6.67	0	0.00	12	7.64	0	0.00
Chironomidae	67	43.23	186	54.39	26	22.41	12	4.65	12	20.00	1510	91.79	69	43.95	28	8.19
Culicidae A	0	0.00	0	0.00	0	0.00	0	0.00	1	1.67	3	0.18	0	0.00	0	0.00
Hemiptera	0	0.00	2	0.58	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Homoptera Unid (terr)	0	0.00	0	0.00	0	0.00	1	0.39	0	0.00	0	0.00	0	0.00	0	0.00
Aranaea	0	0.00	0	0.00	0	0.00	0	0.00	2	3.33	0	0.00	0	0.00	0	0.00
Hydracarina Unid J/D	0	0.00	1	0.29	1	0.86	0	0.00	0	0.00	1	0.06	0	0.00	0	0.00
Amphipoda	62	40.00	30	8.77	64	55.17	160	62.02	0	0.00	13	0.79	43	27.39	187	54.68
Conchostraca	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Copepoda	2	1.29	0	0.00	2	1.72	11	4.26	0	0.00	0	0.00	2	1.27	18	5.26
Cladocera	2	1.29	1	0.29	3	2.59	5	1.94	0	0.00	6	0.36	2	1.27	0	0.00
Isopoda	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Mysidaceae, dam	0	0.00	0	0.00	0	0.00	3	1.16	0	0.00	0	0.00	0	0.00	1	0.29
Ostracoda	0	0.00	1	0.29	0	0.00	0	0.00	7	11.67	38	2.31	1	0.64	0	0.00
Hirudinea Unid J	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.06	0	0.00	0	0.00
Bivalvia	13	8.39	97	28.36	4	3.45	61	23.64	21	35.00	51	3.10	7	4.46	94	27.49
Gastropoda	1	0.65	2	0.58	4	3.45	0	0.00	7	11.67	1	0.06	5	3.18	0	0.00
Nematoda	0	0.00	0	0.00	0	0.00	3	1.16	3	5.00	2	0.12	8	5.10	4	1.17
Tolerant Organisms																
Oligochaeta	2	1.29	0	0.00	4	3.45	2	0.78	0	0.00	13	0.79	3	1.91	6	1.75
Total Number of Individuals (Abundance)	155	100.00	342	100.00	116	100.00	258	100.00	60	100.00	1645	100.00	157	100.00	342	100.00
Total Number of Taxa (Species Richness)	17		21		20		15		18		29		29		21	

Notes:
*See Fisheries and Aquatic Resources (2004) Appendix H for individual counts per taxa
n = 3 samples

Table 9c
Benthic Invertebrate Community Analysis - Shannon-Wiener Biotic Function Index

Lake ID	Brien Lake		Brien Lake		Narrow Lake		Narrow Lake		Winter Lake		Winter Lake		Winter Lake (Stream Samples)		Winter Lake (Stream Samples)	
Sample Location	Inshore		Offshore		Inshore		Offshore		Inshore		Offshore		Inlet		Outlet	
Sample Identification Number	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Total #of taxa (Species Richness)	10	4	7	5	16	2	4	2	14	3	5	2	8	6	22	10
Total # of individuals (Abundance)	20	7	27	10	52	7	13	10	51	10	24	18	22	17	107	59
Shannon-Wiener Index (H')	2	0	2	1	2	0	1	0	2	0	1	0	2	1	2	0
Number of equally common species needed for the same H' (N1)	8	3	5	4	8	1	2	0	10	1	3	0	6	4	11	3

Note: Shannon-Wiener (H') incorporates total abundance of taxa and total number of taxa (within collected samples) to assess the quality of the benthic community
H ' increases with the number of evenly distributed species in the community in relation to increased species abundance and species richness
The index uses a rating between 1(low) and 3 (high) with 3 representing the highest diverity of taxa.

Table 9c
Benthic Invertebrate Community Analysis - Shannon-Wiener Biotic Function Index (con't)

Lake ID	Round Lake		Round Lake		Eclipse Lake		Eclipse Lake		Eclipse Lake (Stream Samples)		Eclipse Lake (Stream Samples)		Nicholas Lake		Nicholas Lake	
Sample Location	Inshore		Offshore		Inshore		Offshore		Inlet		Outlet		Inshore		Offshore	
Sample Identification Number	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Total #of taxa (Species Richness)	12	2	15	1	10	3	8	4	11	2	18	4	17	3	11	6
Total # of individuals (Abundance)	52	11	114	26	39	12	86	34	20	4	548	82	52	19	114	46
Shannon-Wiener Index (H')	2	0	2	0	2	0	1	0	2	0	1	0	2	0	1	0
Number of equally commom species needed for the same H' (N1)	7	0	4	1	5	2	3	0	8	2	3	0	11	0	4	1

Note: Shannon-Wiener (H') incorporates total abundance of taxa and total number of taxa (within a collected samples) to assess the quality of the benthic community
H ' increases with the number of evenly distributed species in the community in relation to increased species abundance and species richness
The index uses a rating between 1(low) and 3 (high) with 3 representing the highest diverity of taxa.

Table 10
Lake Sediment Quality

Lake	Round Lake	Winter Lake	Eclipse Lake	Nicholas Lake	Brien Lake	Narrow Lake	CCME - Freshwater Sediment*	
Date Sampled	7/17/04	7/20/04	7/24/04	7/26/04	7/30/04	7/31/04	****ISQG (mg/kg)**	*****PEL (mg/kg)**
Depth Sampled (m)	1.3	1.5	10	19	9	12		
Physical Tests								
Moisture %	93.4	93.0	68.7	91.7	92.9	89.4		
pH	8.04	7.51	7.02	6.60	6.51	7.34		
Nutrients								
Available Phosphorus P	6.8	7.6	82.0	53.0	111	50.0		
Total Nitrogen N	1.42	1.42	0.180	2.09	1.35	1.26		
Total Metals								
Antimony T-Sb	<10	<10	<10	<10	<10	<10		
Arsenic T-As	33.8	9.2	14.9	8.8	28.5	18.0	5.9	17
Barium T-Ba	81.7	126	120	78.8	160	224		
Beryllium T-Be	0.60	0.57	0.87	0.72	1.10	1.03		
Cadmium T-Cd	0.52	<0.50	<0.50	<0.50	0.55	<0.50	0.6	3.5
Chromium T-Cr	38.6	38.9	54.8	41.3	51.8	58.5	37.3	90
Cobalt T-Co	40.3	19.8	23.9	5.6	45.6	34.2		
Copper T-Cu	184	54.3	47.9	53.9	84.6	63.4	35.7	197
Lead T-Pb	37	<30	<30	<30	<30	<30	35	91.3
Mercury T-Hg	0.844	0.0659	0.0154	0.0810	0.133	0.102	0.17	0.486
Molybdenum T-Mo	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0		
Nickel T-Ni	210	89.2	73.7	35.2	81.5	116		
Phosphorus T-P	563	437	1370	1270	3580	1380		
Selenium T-Se	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0		
Silver T-Ag	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0		
Thallium T-Tl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0		
Tin T-Sn	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0		
Vanadium T-V	32.1	33.4	49.1	25.9	53.9	58.3		
Zinc T-Zn	251	97.4	122	86.0	157	174	123	315
Organic Parameters								
Total Organic Carbon C	21.9	19.4	2.74	13.4	19.4	9.36		
Particle Size								
Gravel (>2.00mm) (%)	N/A	N/A	<0.10	N/A	N/A	<0.10		
Sand (2.00mm - 0.063mm) (%	N/A	N/A	2.30	N/A	N/A	6.40		
Silt (0.063mm - 4um) (%)	N/A	N/A	47.8	N/A	N/A	30.5		
Clay (<4um) (%)	N/A	N/A	49.9	N/A	N/A	63.1		

Note:

Analysis completed by ALS Laboratories - Vancouver, BC

Results are expressed as mg/kg except where noted.

< = Less than the detection limit indicated.

N/A = Data was not available due to the high organic content of the sample.

*Canadian Environmental Quality Guidelines, December 2003

**Interm Sediment Quality Guidelines

***Probable effects levels

Level exceeds the CCME Interim Sediment Quality Guideline

DETECTION LIMITS

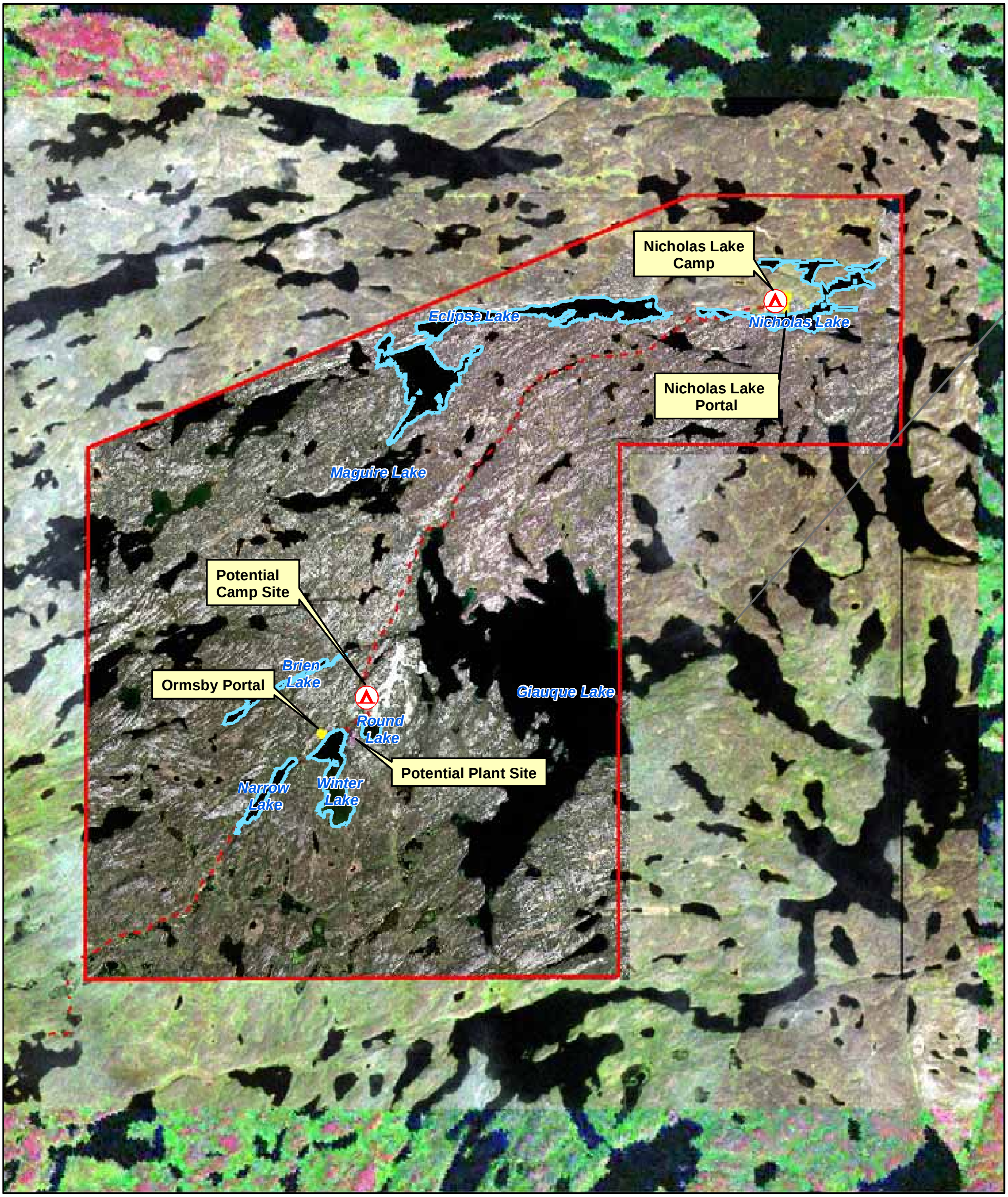
Sample ID	Round Lake	Winter Lake	Eclipse Lake	Nicholas Lake	Brien Lake	Narrow Lake
Date Sampled						
Time Sampled						
Nature	Sediment/Soil	Sediment/Soil	Sediment/Soil	Sediment/Soil	Sediment/Soil	Sediment/Soil
Physical Tests						
Moisture %	0.10	0.10	0.10	0.10	0.10	0.10
pH	0.010	0.010	0.010	0.010	0.010	0.010
Nutrients						
Available Phosphorus P	1.0	1.0	1.0	1.0	1.0	1.0
Total Nitrogen N	0.010	0.010	0.010	0.010	0.010	0.010
Total Metals						
Antimony T-Sb	10	10	10	10	10	10
Arsenic T-As	5.0	5.0	5.0	5.0	5.0	5.0
Barium T-Ba	1.0	1.0	1.0	1.0	1.0	1.0
Beryllium T-Be	0.50	0.50	0.50	0.50	0.50	0.50
Cadmium T-Cd	0.50	0.50	0.50	0.50	0.50	0.50
Chromium T-Cr	2.0	2.0	2.0	2.0	2.0	2.0
Cobalt T-Co	2.0	2.0	2.0	2.0	2.0	2.0
Copper T-Cu	1.0	1.0	1.0	1.0	1.0	1.0
Lead T-Pb	30	30	30	30	30	30
Mercury T-Hg	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
Molybdenum T-Mo	4.0	4.0	4.0	4.0	4.0	4.0
Nickel T-Ni	5.0	5.0	5.0	5.0	5.0	5.0
Phosphorus T-P	50	50	50	50	50	50
Selenium T-Se	2.0	2.0	2.0	2.0	2.0	2.0
Silver T-Ag	2.0	2.0	2.0	2.0	2.0	2.0
Thallium T-Tl	1.0	1.0	1.0	1.0	1.0	1.0
Tin T-Sn	5.0	5.0	5.0	5.0	5.0	5.0
Vanadium T-V	2.0	2.0	2.0	2.0	2.0	2.0
Zinc T-Zn	1.0	1.0	1.0	1.0	1.0	1.0
Organic Parameters						
Total Organic Carbon C	0.050	0.050	0.050	0.050	0.050	0.050
Particle Size						
Gravel (>2.00mm) (%)	0.10	0.10	0.10	0.10	0.10	0.10
Sand (2.00mm - 0.063mm) (%)	0.10	0.10	0.10	0.10	0.10	0.10
Silt (0.063mm - 4um) (%)	0.10	0.10	0.10	0.10	0.10	0.10
Clay (<4um) (%)	0.10	0.10	0.10	0.10	0.10	0.10

UNITS						
Sample ID	Round Lake	Winter Lake	Eclipse Lake	Nicholas Lake	Brien Lake	Narrow Lake
Date Sampled						
Time Sampled						
Nature	Sediment/Soil	Sediment/Soil	Sediment/Soil	Sediment/Soil	Sediment/Soil	Sediment/Soil
Physical Tests						
Moisture %	%	%	%	%	%	%
pH	pH	pH	pH	pH	pH	pH
Nutrients						
Available Phosphorus P	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Total Nitrogen N	%	%	%	%	%	%
Total Metals						
Antimony T-Sb	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Arsenic T-As	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Barium T-Ba	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Beryllium T-Be	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Cadmium T-Cd	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Chromium T-Cr	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Cobalt T-Co	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Copper T-Cu	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Lead T-Pb	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Mercury T-Hg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Molybdenum T-Mo	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Nickel T-Ni	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Phosphorus T-P	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Selenium T-Se	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Silver T-Ag	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Thallium T-Tl	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Tin T-Sn	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Vanadium T-V	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Zinc T-Zn	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Organic Parameters						
Total Organic Carbon C	%	%	%	%	%	%
Particle Size						
Gravel (>2.00mm) (%)	%	%	%	%	%	%
Sand (2.00mm - 0.063mm) (%)	%	%	%	%	%	%
Silt (0.063mm - 4um) (%)	%	%	%	%	%	%
Clay (<4um) (%)	%	%	%	%	%	%

Duplicate Results

Sample ID	Eclipse Lake	Eclipse Lake	RPD %
Date Sampled		QC# 404754	
Time Sampled			
Nature	Sediment/Soil		
Physical Tests			
Moisture %	68.7	67.5	1.76
Organic Parameters			
Total Organic Carbon C	2.74	2.46	10.8

FIGURES



Legend

- Local Study Area
- Winter Road
- Lakes Sampled Summer 2004

Note: Road Route is Approximate

Scale 1:100,000

0 0.35 0.7 1.4 2.1 2.8 3.5 km

UTM Z12 NAD83

Yellowknife Gold Project

Fisheries and Aquatic Resources (2004)

Study Area and Site Location

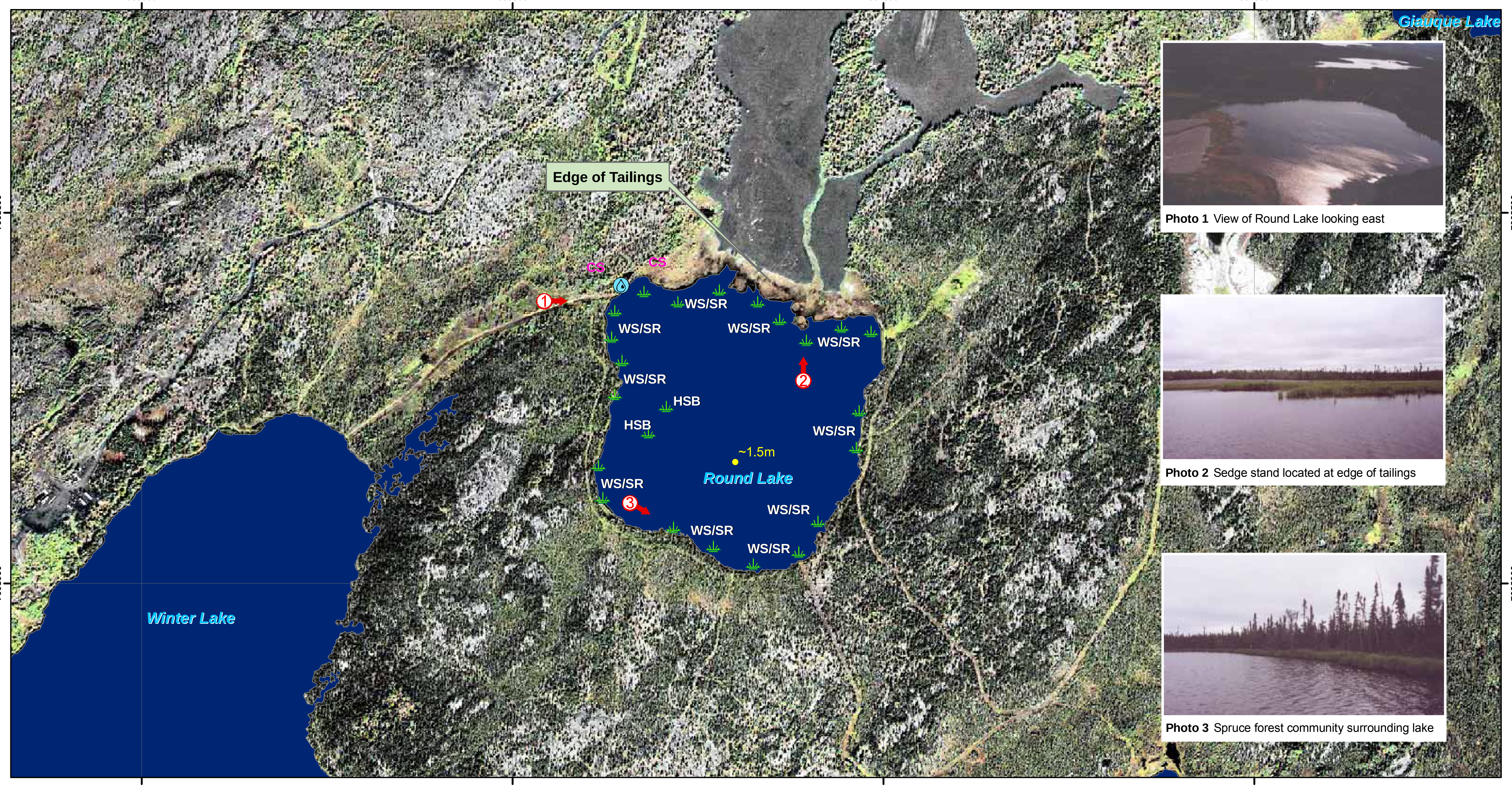
Tyhee NWT Corp

EBA Engineering Consultants Ltd.

February, 2005

Figure 1

Figure5-6-1_StudyArea.mxd



Legend

- Depth Measurement
- Photo Number and Orientation

Habitat Type/Vegetation Community

BG	Bog Wetland
CS	Cotton Grass/Sphagnum
SF	Sedge Fen
WR	Willow (*Salix*) Riparian

Habitat Feature

- Cliff
- Shallow Boulders
- Beaver Dam
- Principal Inlet
- Principal Outlet

Fish Species/Use

CS	Cisco
LT	Lake Trout
LW	Lake Whitefish
NP	Northern Pike
*	Most Fish Species
	Fish Rearing / Foraging
	Fish Spawning
	Fish Winter Holding

Emergent Vegetation

HSB	Hardstem bulrush
SR	Scouring rush
WS	Water sedge

1:5,000

0 25 50 100 150 200 250 Meters

Imagery Source: IKONOS (July 27 and August 2 2004) and Landsat TM (August 11 2001)
Water Features : Extracted from IKONOS imagery

Yellowknife Gold Project
Fisheries and Aquatic Resources (2004)

Round Lake Habitat Features

Tyhee NWT Corp | EBA Engineering Consultants Ltd.

February, 2005 | Figure 2

Project No. 1740082

Legend

Depth Measurement
Photo Number and Orientation

Habitat Type/Vegetation Community

BG	Bog Wetland
CS	Cotton Grass/Sphagnum
SF	Sedge Fen
WR	Willow (*Salix*) Riparian

Habitat Feature

- Cliff
- Shallow Boulders
- Beaver Dam
- Principal Inlet
- Principal Outlet

Fish Species/Use

CS	Cisco
LT	Lake Trout
LW	Lake Whitefish
NP	Northern Pike
*	Most Fish Species
	Fish Rearing / Foraging
	Fish Spawning
	Fish Winter Holding

Emergent Vegetation

HSB	Hardstem bulrush
SR	Scouring rush
WS	Water sedge

Submergent Vegetation

BR	Burreed
RP	Richardson's pondweed
SLP	Slender leafed pondweed
YP	Yellow water lily

Scale 1:10,000

0 50 100 200 300 400 500 Meters

Imagery Source: IKONOS (July 27 and August 2 2004) and Landsat TM (August 11 2001)

Water Features : Extracted from IKONOS imagery

Yellowknife Gold Project

Fisheries and Aquatic Resources (2004)

Winter Lake Habitat Features

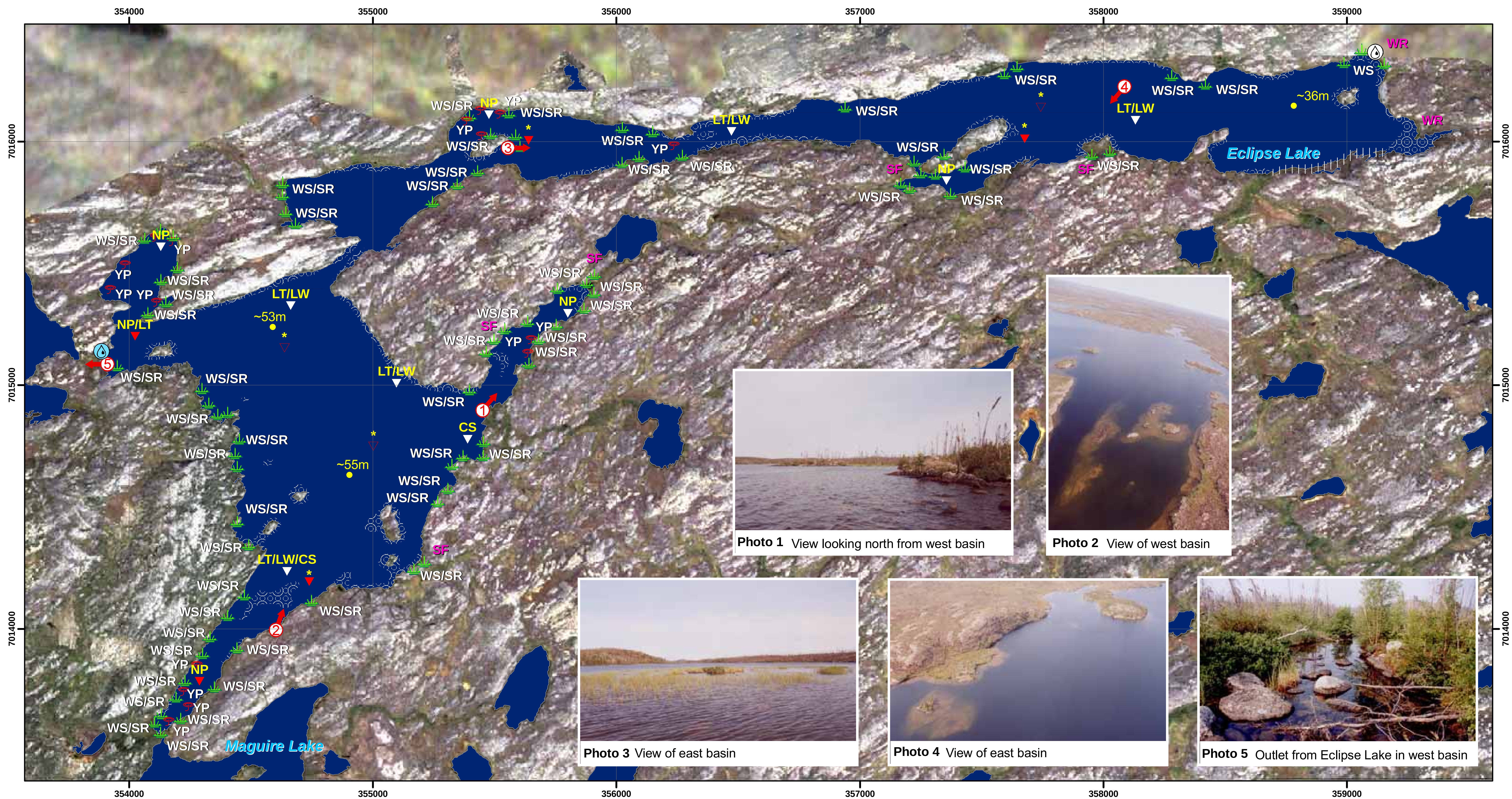
Tyhee NWT Corp

EBA Engineering Consultants Ltd.

February, 2005

Figure 3

Project No. 1740082



Legend

Depth Measurement

Photo Number and Orientation

Habitat Type/Vegetation Community

- BG Bog Wetland
- CS Cotton Grass/Sphagnum
- SF Sedge Fen
- WR Willow (*Salix*) Riparian

Habitat Feature

- Cliff
- Shallow Boulders
- Beaver Dam
- Principal Inlet
- Principal Outlet

Fish Species/Use

- CS Cisco
- LT Lake Trout
- LW Lake Whitefish
- NP Northern Pike
- * Most Fish Species
- Fish Rearing / Foraging
- Fish Spawning
- Fish Winter Holding

Emergent Vegetation

- SR Scouring rush
- WS Water sedge

Submergent Vegetation

- YP Yellow water lily

Scale 1:15,000

0 75 150 300 450 600 750 Meters

Imagery Source: IKONOS (July 27 and August 2 2004) and Landsat TM (August 11 2001)

Water Features : Extracted from IKONOS imagery

Yellowknife Gold Project

Fisheries and Aquatic Resources (2004)

Eclipse Lake Habitat Features

Tyhee NWT Corp

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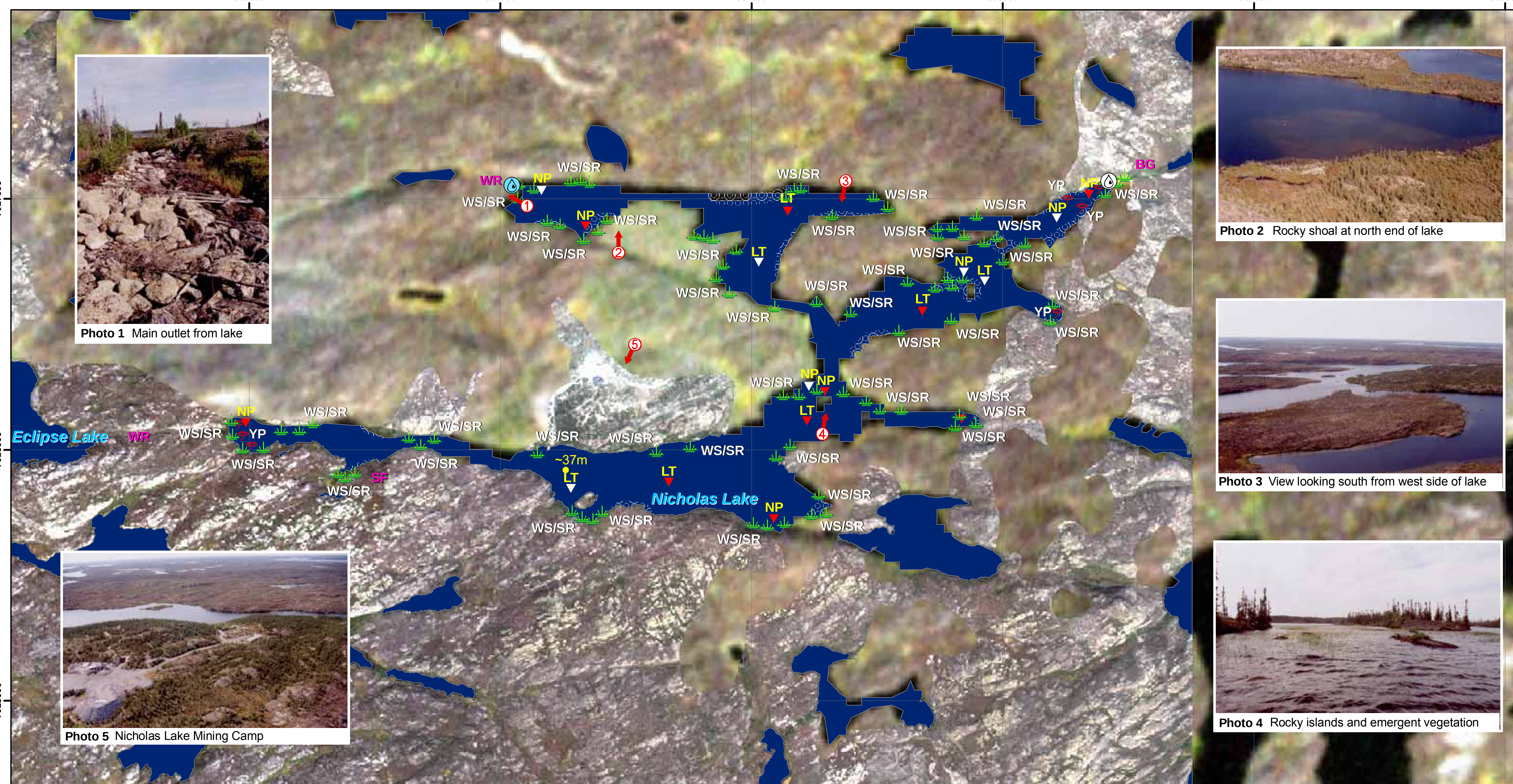
Figure 4

Project No. 1740082



Legend

Depth Measurement

Photo Number and Orientation

Habitat Type/Vegetation Community

- BG Bog Wetland
- CS Cotton Grass/Sphagnum
- SF Sedge Fen
- WR Willow (*Salix*) Riparian

Habitat Feature

- Cliff
- Shallow Boulders
- Beaver Dam
- Principal Inlet
- Principal Outlet

Fish Species/Use

- CS Cisco
- LT Lake Trout
- LW Lake Whitefish
- NP Northern Pike
- * Most Fish Species
- Fish Rearing / Foraging
- Fish Spawning
- Fish Winter Holding

Emergent Vegetation

- SR Scouring rush
- WS Water sedge

Submergent Vegetation

- YP Yellow water lily

1:15,000

0 75 150 300 450 600 750 Meters

Imagery Source: IKONOS (July 27 and August 2 2004) and Landsat TM (August 11 2001)

Water Features : Extracted from IKONOS imagery

Yellowknife Gold Project

Fisheries and Aquatic Resources (2004)

Nicholas Lake Habitat Features

Tyhee NWT Corp

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Figure 5

Project No. 1740082

Legend

Depth Measurement
Photo Number and Orientation

Habitat Type/Vegetation Community

BG	Bog Wetland
CS	Cotton Grass/Sphagnum
SF	Sedge Fen
WR	Willow (*Salix*) Riparian

Habitat Feature

Cliff
Shallow Boulders
Beaver Dam
Principal Inlet
Principal Outlet

Fish Species/Use

CS	Cisco
LT	Lake Trout
LW	Lake Whitefish
NP	Northern Pike
*	Most Fish Species
	Fish Rearing / Foraging
	Fish Spawning
	Fish Winter Holding

Emergent Vegetation

SR	Scouring rush
WS	Water sedge

Submergent Vegetation

BW	Bladder wort
CH	Chara
RP	Richardson's pondweed
SW	Smartweed
YP	Yellow water lily

Scale 1:10,000

0 62.5 125 250 375 500 Meters

Imagery Source: IKONOS (July 27 and August 2 2004) and Landsat TM (August 11 2001)

Water Features : Extracted from IKONOS imagery

Yellowknife Gold Project
Fisheries and Aquatic Resources (2004)

Brien Lake - Fish Habitat Features

Tyhee NWT Corp

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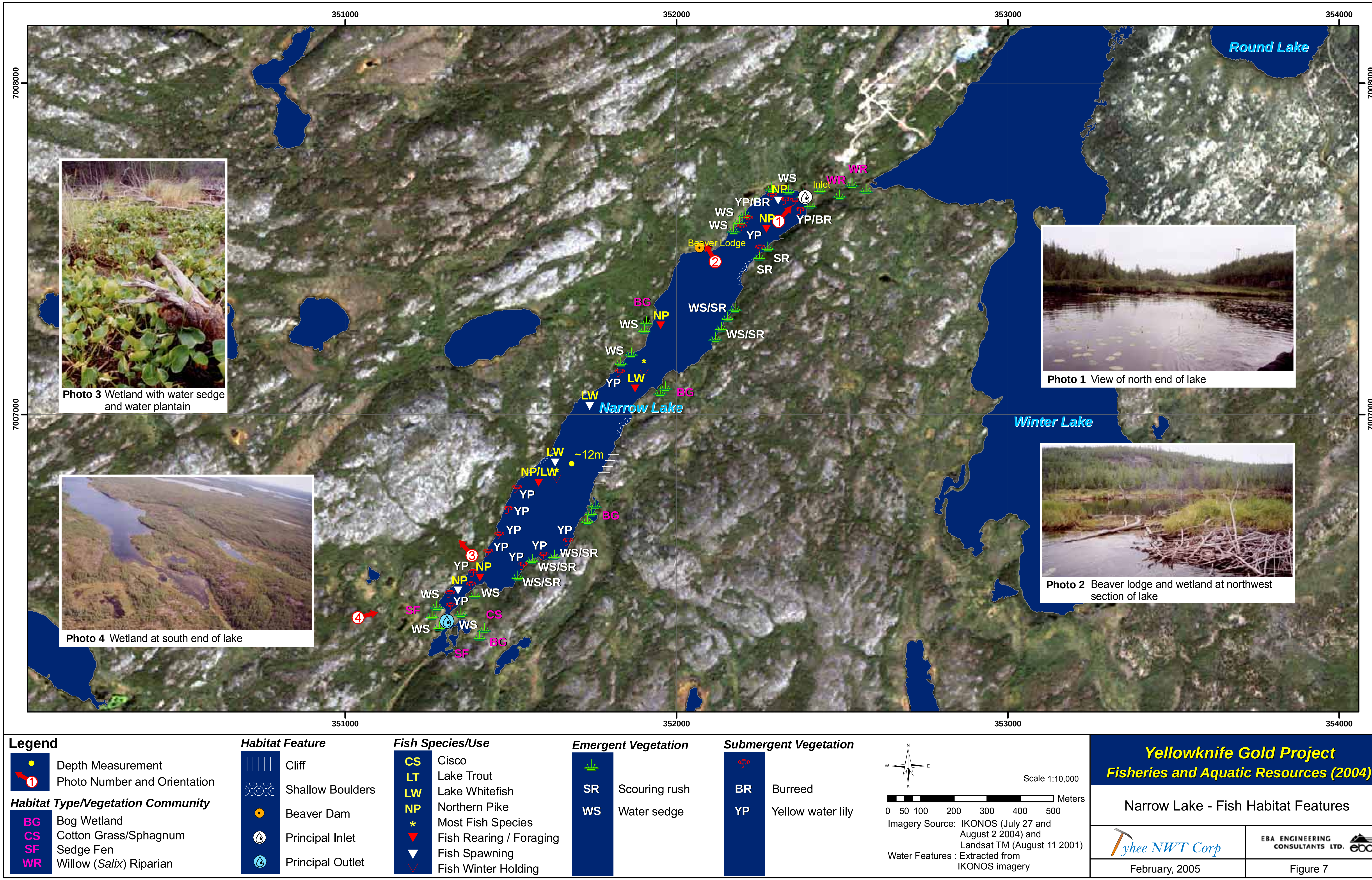
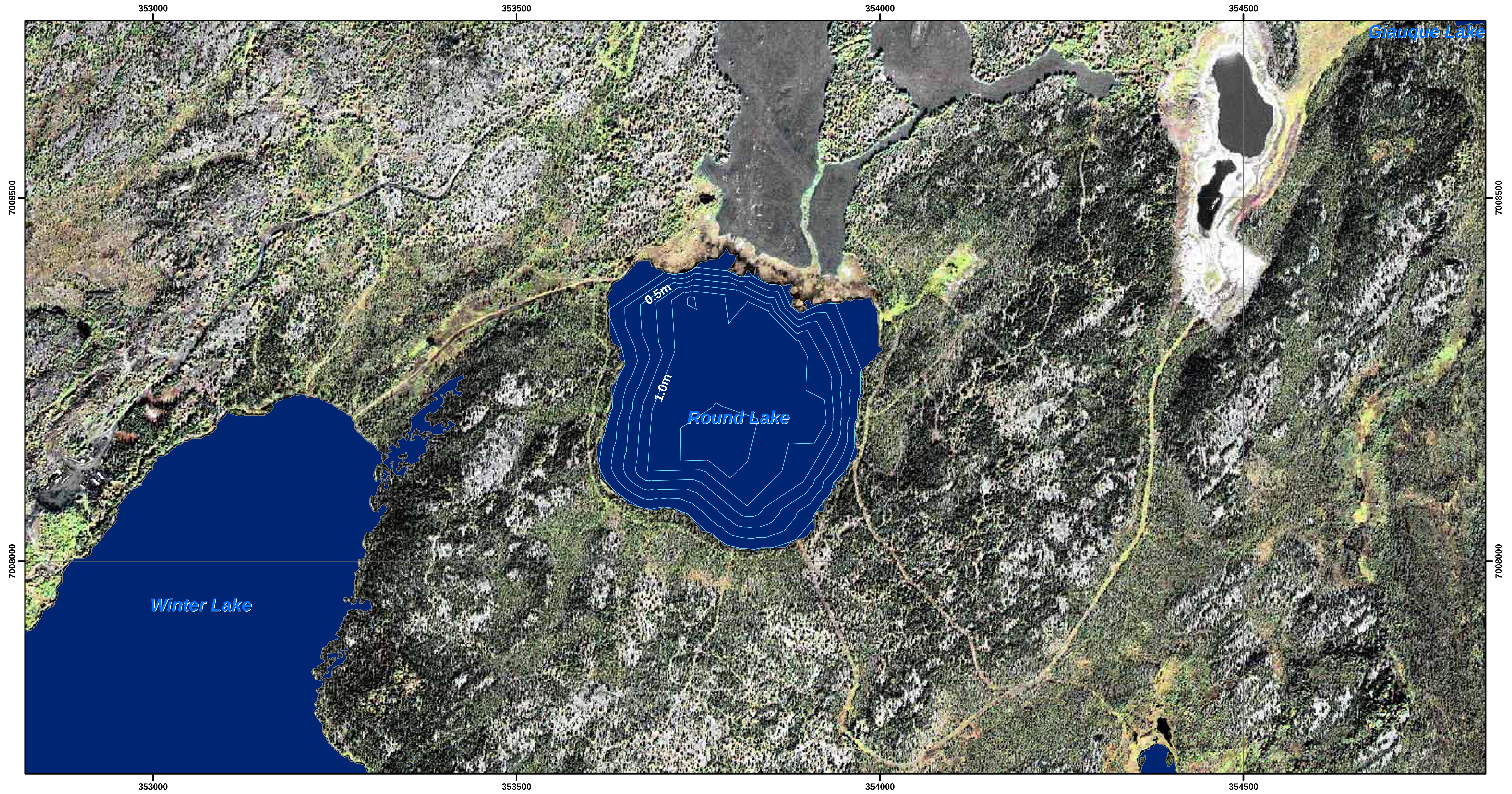
February, 2005

Figure 6

Project No. 1740082


351000
352000
353000
354000
7008000
7007000
Round Lake
Narrow Lake
Winter Lake
Inlet
Beaver Lodge
~12m
WS
NP
YP/BR
NP
YP/BR
YP
SR
SR
BG
WS/SR
WS/SR
LW
WR
WR
CS
SF
BG
Photo 1 View of north end of lake
Photo 2 Beaver lodge and wetland at northwest section of lake
Photo 3 Wetland with water sedge and water plantain
Photo 4 Wetland at south end of lake
Legend
Depth Measurement
Photo Number and Orientation
Habitat Type/Vegetation Community
BG Bog Wetland
CS Cotton Grass/Sphagnum
SF Sedge Fen
WR Willow (Salix) Riparian
Habitat Feature
Cliff
Shallow Boulders
Beaver Dam
Principal Inlet
Principal Outlet
Fish Species/Use
CS Cisco
LT Lake Trout
LW Lake Whitefish
NP Northern Pike
* Most Fish Species
Fish Rearing / Foraging
Fish Spawning
Fish Winter Holding
Emergent Vegetation
SR Scouring rush
WS Water sedge
Submergent Vegetation
BR Burreed
YP Yellow water lily
Scale 1:10,000
0 50 100 200 300 400 500 Meters
Imagery Source: IKONOS (July 27 and August 2 2004) and Landsat TM (August 11 2001)
Water Features : Extracted from IKONOS imagery
Yellowknife Gold Project
Fisheries and Aquatic Resources (2004)
Narrow Lake - Fish Habitat Features
Tyhee NWT Corp
EBA ENGINEERING CONSULTANTS LTD.
February, 2005
Figure 7
Project No. 1740082



Legend

Bathymetry (0.25m Interval)

<u>Round Lake</u>

Volume: 84,016 m^3
Perimeter: 1,762 m
Max Depth: 1.5 m
Elevation: 262 MSL
Surface Area: 11.5 ha

N
W E
S

Scale 1:5,000

0 25 50 100 150 200 250 Meters

Imagery Source: IKONOS (July 27 and August 2 2004)
Landsat TM (August 11 2001)
Water Features : Extracted from IKONOS imagery

Yellowknife Gold Project
Fisheries and Aquatic Resources (2004)

Round Lake Bathymetry

Tyhee NWT Corp

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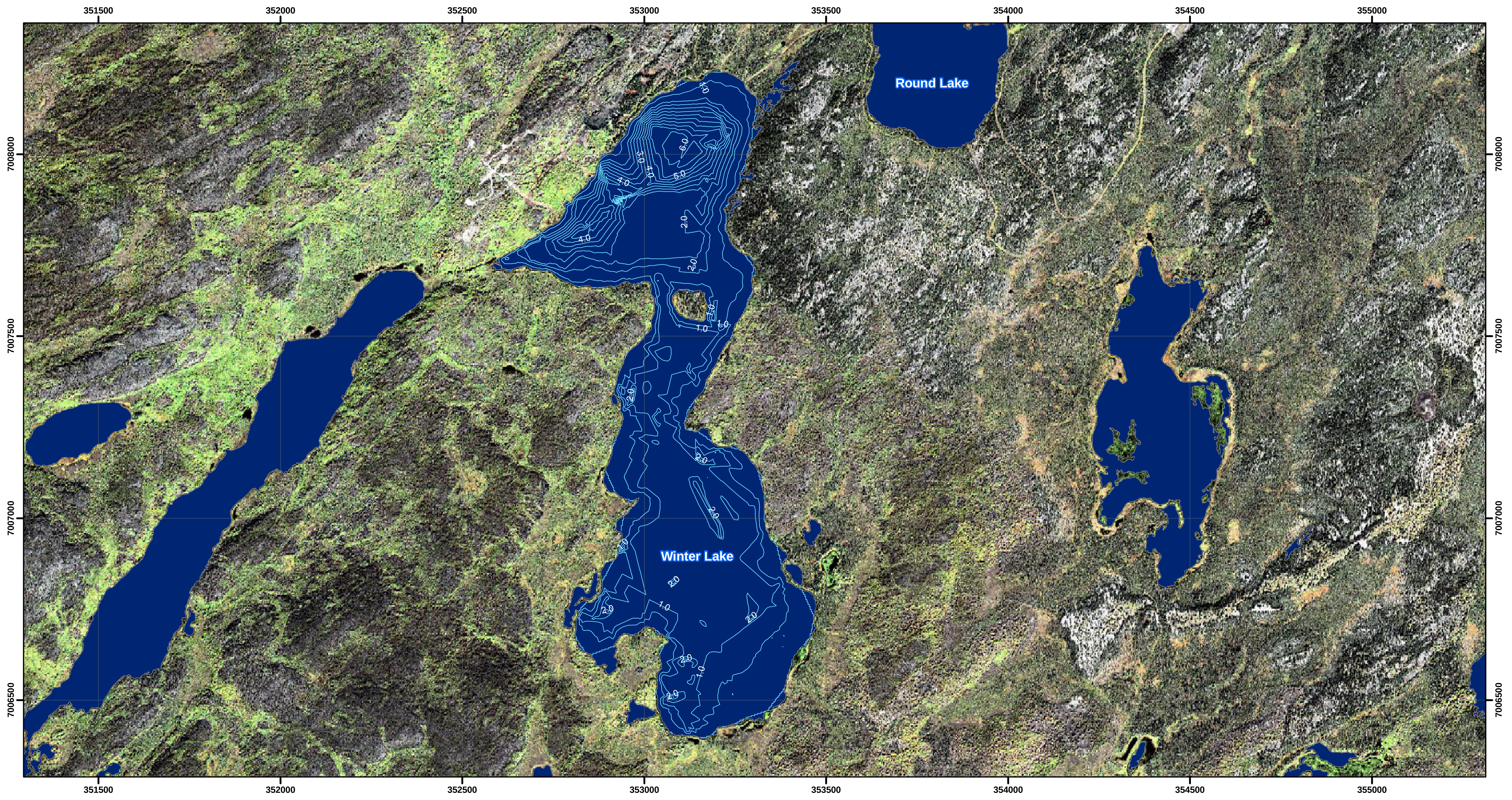
February, 2005

Figure 8

Project No. 1740082



Legend

Bathymetry (0.50m Interval)

Winter Lake

Volume: 891,595 m^3
Perimeter: 8,650 m
Max Depth: 6.2 m
Elevation: 252 MSL
Surface Area: 69.2 ha

N
W E
S

Scale 1:10,000

0 50 100 200 300 400 500 Meters

Imagery Source: IKONOS (July 27 and August 2 2004)
Landsat TM (August 11 2001)
Water Features : Extracted from IKONOS imagery

Yellowknife Gold Project
Fisheries and Aquatic Resources (2004)

Winter Lake Bathymetry

Tyhee NWT Corp

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Figure 9

Project No. 1740082