2.9.8 YGP Area Water Quality Summary

With the exception of Round Lake, which has been influenced by tailings since the 1950s, the water quality of Nicholas, Eclipse, Brien, Narrow, and Winter lakes were found to be typical of natural background values reported for other lakes in the region that are influenced by the geology of the Precambrian Shield (Puznichi 1996; Pienitz et al. 1997; Ruhland et al 2003).

The chemical characteristics for the lakes sampled were typically low, and generally consistent with natural background values for the region. Water quality is slightly acidic and very soft with low electrical conductivity. Physical parameters such as pH, turbidity and electrical conductivity were within the typical norms of Canadian Shield lakes. Excursions of the CCME guidelines were limited and explainable.

Round, Winter and Narrow lakes flow into each other, with Round Lake on the upstream end of the chain. Round Lake has also been the recipient of historic untreated tailings from the former Discovery mine and remains the recipient of surface runoff from these tailings. This could be noted in the higher metal concentrations in Round Lake with a noticeable gradient in the metals as sampling proceeded downstream through Winter to Narrow lakes.

It should be noted that Round and Winter lakes were mesotrophic in trophic state, based on phosphorous concentrations, while Narrow Lake was on the verge of being mesotrophic. All other lakes sampled were oligotrophic. The impact of the historic tailings deposition on trophic state was limited; higher trophic state (i.e. mesotrophic) conditions were related to lake morphometric and vegetative characteristics. Details of the trophic state of these lakes can be found in Appendix C.

The dissolved oxygen profiles in Winter Lake confirm that the lake would not support a fish population over the winter period. All other lakes sampled had dissolved oxygen above the critical level (>6.5 mg/l) during the winter sampling.

2.10 HYDROGEOLOGY

2.10.1 General

An assessment of groundwater conditions in the vicinity of the proposed Ormsby Open Pit and Nicolas Lake underground mines was undertaken to:

- evaluate the potential influence groundwater discharge from the mine workings may have on surface water quality; and
- evaluate the potential dewatering requirements during mine operations.

Information for this assessment was obtained from:

- an understanding of permafrost distribution near the proposed mine workings based on information provided by Klohn-Leonoff in 1992;

- a site visit conducted in 2009 to identify topographic influences on local shallow groundwater conditions;
- several groundwater monitoring wells and piezometers installed in 2009 to obtain shallow and deep hydrogeologic characteristics, and shallow groundwater quality information;
- geologic data including maps of the distribution and structure of major rock types near the proposed mine areas, and geologic data obtained from rock cores; and
- downhole packer and instantaneous response (slug) test results that measured the shallow bedrock hydraulic conductivities.

Hydrogeologic data including groundwater occurrence and flow, shallow groundwater quality, and potential dewatering requirements are discussed below.

2.10.2 Topographic and Geologic Setting – Ormsby, Nicholas Lake

The regional terrain surrounding the project area is flat-lying with numerous shallow fresh water lakes. Elongate rounded rocky hills and ridges with abundant outcrop exposures are separated by numerous lakes, ponds, rivers, creeks and swamps. Cliffs and steep bluffs up to a few tens of metres in height commonly occur along the side or end of these hills. Strong linear features several kilometres long defined by depressions between ridges are common. Topographic relief ranges from about 265 masl at the surface of Giauque Lake to broad flat hills over 350 masl near Nicholas Lake.

Unconsolidated sediments occur as discontinuous veneers and blankets of hummocky to rolling, glacially-derived sandy morainal, fluvioglacial, and organic deposits with local eskers. A thin mantle of sediments derived from frost action and mechanical erosion of the exposed bedrock outcrops has resulted in coarse debris accumulating in the lower lying areas between the bedrock exposures.

Bedrock in the Ormsby project area primarily consists of Burwash Formation greywacke and Giauque Lake Formation amphibolite, bedrock in the Nicholas Lake area consists of Burwash Formation granite and granodiorite rocks.

The proposed open pit and underground mine at Ormsby will be located mainly within the northeast – southwest trending amphibolite ore body but the proposed pit will extend into adjacent greywacke rocks to maintain safe pit wall slopes. The underground workings at Nicolas Lake are expected to occur primarily within the mineralized granodiorite.

2.10.3 Groundwater Occurrence – Ormsby, Nicholas Lake

As previously discussed in Section 2.8, the Ormsby and Nicholas Lake study areas are located within the Yellowknife River drainage basin, a medium-sized catchment of approximately 15,000 km^2, which drains into Yellowknife Bay of Great Slave Lake, near the City of Yellowknife (Env. Can. 1990).

In the Ormsby area, flow out of Brien Lake north of the proposed Ormsby pit (el. 295 masl) enter Shona Lake (el. 291 masl), then generally flow southwest through a series of small unnamed lakes eventually reaching Barker Lake (el. 243 masl), Johnstone Lake (el. 232 masl), Clan Lake (el. 216 masl) and then to the Yellowknife River. Surface water in the Ormsby area also flows to the southwest from Round Lake, through Winter Lake and continues on to Narrow Lake. Flows from the Narrow Lake Basin including Round Lake, Winter Lake, and Narrow Lake flow to the southwest to Morris Lake (el. 278 masl), then Goodwin Lake (el.260 masl), Johnstone Lake (el. 232 masl), Clan Lake (el. 216 masl), and then to the Yellowknife River.

The Nicholas Lake project area is located within the Nicholas Lake drainage basin. Starting at Nicholas Lake (el. 325 masl) this small catchment flows west to Eclipse Lake (el. 311 masl) with eventual flow into the Yellowknife River via numerous small lakes, ponds and bogs.

Groundwater in the Ormsby and Nicholas Lake project areas occurs in both unconsolidated surficial sediments and in fractured bedrock.

2.10.4 Shallow Groundwater

Shallow groundwater is stored within unconsolidated sediments and near-surface bedrock fractures, with generally decreasing openness and density with depth. Flow directions generally follow surface topography, with generally radial flow from the topographic uplands down towards lower elevations. Regional shallow groundwater flow likely follows surface water flow patterns, with flow generally southward.

Shallow groundwater is likely hydraulically connected with adjacent surface water bodies, marshes, ponds and bogs, however insufficient information is presently available to characterize the hydraulic connections between surface water features and shallow and deep fractures

Shallow piezometers, consisting of slotted pvc pipe were installed at Nicholas Lake and Ormsby during the Fall 2009 field season

2.10.5 Deep Groundwater

The ore zone is located within a vertical trending fault zone known as the Ormsby Fault. Several other faults exist near the proposed YGP site. These fault zones will be associated with greater open porosity than the surrounding, undisturbed rock. The additional open porosity in these zones creates preferential conduits for groundwater movement. Observations have shown that groundwater flows into the historic mining area have not posed an operational problem

Data from a borehole drilled immediately east of the proposed location of the Ormsby pit indicate artesian conditions at 302 m above mean sea level (amsl). Data returned from the drilling indicate that the bedrock here dips at approximately 42º with a strike azimuth of 309º. It is likely that this borehole is supplied through flow parallel to strike, from higher ground to the northeast and possibly southwest. The degree of connectivity between the area drilled and the nearby Winter Lake is presently unknown, the artesian conditions suggest that the regional groundwater flow potentially extends beyond the surface water catchment areas as defined by the surface topography. Additional testing will be required to better define the regional flow system and the area of groundwater flow contributing to the Ormsby pit.

The bedrock dip and strike in and around the Ormsby area are such that any groundwater migration is most likely to occur along a southwest-northeast axis. The dip azimuth will be important in determining whether water is lost or gained from the surface water catchment on the northwestern side of the claim boundary. If the beds in this area dip to the southeast then additional water will be captured and will require consideration in the dewatering calculation; conversely a northwesterly dip will reduce the groundwater catchment area.

2.10.6 Recharge and Discharge Areas, Flow Direction – Ormsby, Nicholas Lake

The climate in the nearby City of Yellowknife is subarctic and semi-arid, with average precipitation of 152 mm per year. Average daily temperatures range from -31 to -23°C in January and 12 to 21°C in July (Environment Canada 2004). The YGP has an operational weather station, which recorded site meteorology data for 2006. Records indicate that typical wind speeds for the time period were in the range of 7 to 8 m/s. Air temperatures typically range from 10 to 25°C during the summer and from -30 to -5°C in the winter. Extreme daily averages of approximately +30ºC in summer and -48ºC in winter occur occasionally. Total precipitation recorded at the YGP for 2006 was 286.7 mm (EBA 2006).

The average annual runoff in the area is approximately 100 mm (Environment Canada 1969), and the estimated annual evaporation for the site is approximately 424 mm. This evaporation corresponds to that obtained at Giant Mine (Reid 2001). These low-lying areas can serve as conduits for the movement of groundwater.

Recharge to the shallow groundwater occurs due to direct precipitation on the ground surface or through runoff from the exposed bedrock. Groundwater flow direction typically follows the slope of the bedrock surface and essentially mimics the surface topography. Within the permafrost zone much of the free water is locked-in as ice. The debris may be coarse enough to have an open porosity and be able to support active shallow ground water flow in the warm season. This groundwater flow will in part replenish the water normally supplied to the lakes, streams and wetlands by overland flow.

2.10.7 Permafrost

Klohn Leonoff (1992) noted that permafrost extended to about the 38-metre level in the historic Discovery Mine and minimal water was observed flowing into the mine. Minimal evidence of groundwater problems in the historic Discovery mine suggests that there is little groundwater flow in the area.

Within the permafrost zone much of the free water is locked-in as ice. The natural debris may be coarse enough to have an open porosity and be able to support active shallow ground water flow in the warm season. This groundwater flow will in part replenish the water normally supplied to the lakes, streams and wetlands by overland flow and likewise may flow into the Ormsby open pit along its upper perimeter. The depth of permafrost reported in 1992 suggests that some seepage may be observed at depths along the pit face of 30 metres or more. However, recent testing by EBA suggests the depth of permafrost previously tested in 1992 may have changed and additional testing is needed to confirm the extent of the permafrost.

The term “permafrost” describes a ground condition where the soil or rock remains below 0ºC for at least two consecutive years (Ecosystem Classification Group 2008), irrespective of material type, ground ice distribution, or thermal stability. Permafrost does not usually form under large lakes and rivers that do not freeze to bottom during winter (GSC 2007).

The YGP occurs entirely within the discontinuous permafrost zone, which is characterized by permafrost that underlies 50-90% of the land area (GSC 2007). In the vicinity of the Historic Discovery Mine, permafrost is commonly found in organic soils (Klohn Leonoff 1992).

2.10.8 Conceptual Hydrogeologic Modelling

2.10.8.1 General

A preliminary hydrogeologic investigation of the proposed Ormsby and Nicholas Lake open pit and underground mine operations was conducted as part of each mine’s prefeasibility water balance assessment. This work was intended to develop estimates of approximate groundwater production and support estimates of produced water storage volume, and to support estimates of mine dewatering pipe and pump capacities with related cost estimates. The conceptual hydrogeologic model for the Ormsby and Nicholas Lake mine areas was developed using available geological data and groundwater elevation information and rock hydraulic conductivity data obtained from groundwater monitoring wells and piezometers and from hydraulic tests conducted in geotechnical and exploration boreholes installed at both areas.

Site hydrogeology in both mine areas can be conceptualized as a thin layer of unconsolidated glacially-derived overburden above fractured bedrock. In general, three hydrogeologic units are present at Ormsby: country rock consisting of greywacke, the ore body generally consisting of amphibolite, and a thin but potentially extensive fractured greywacke or fault zone situated along the ore body’s eastern boundary. The hydrogeologic units present at Nicholas Lake include meta-sedimentary country rocks and the ore body within mineralized granite/granodiorite. Groundwater at both areas is held in storage within the bedrock fractures. The Ormsby/Nicolas Lake areas are also known for discontinuous permafrost which has not been mapped to date.

Local recharge in the Nicolas Lake and Ormsby areas likely occurs via direct precipitation onto surficial unconsolidated sediments or from runoff from exposed bedrock and upgradient surface water bodies. Recharge to deep groundwater likely occurs via open fractures and faults as slow-moving regional-scale lateral flow and also as vertically downward migration from shallow sediments and fractured bedrock. This observation is supported by vertically downward gradients observed in most nested well pairs. However, indications of vertically upward gradients were observed at both Ormsby and Nicholas Lake, with artesian flow conditions observed at Ormsby.

Depths to groundwater in the fractured bedrock at Ormsby and Nicholas Lake were obtained from shallow monitoring wells installed into vertical geotechnical holes and in deep piezometers installed into inclined exploration boreholes. A vibrating wire piezometer was also installed into one exploration corehole at Ormsby. The monitoring wells are all approximately 20 m deep, while the piezometers range in depth from about 28.6 m to 211.7 m. Groundwater was found at generally shallow depths in all wells and piezometers, ranging from about 1.8 m to 24.8 m below ground surface (bgs). These DTW measurements are consistent with those expected for groundwater in hydraulic connection with unconsolidated sediments and near-surface fractured bedrock and adjacent surface water bodies. Well/piezometer construction details and depths to water are provided in Appendix I.

Bedrock hydraulic conductivities based on packer and slug testing at Ormsby ranged from 1.0 E-13 m/sec (essentially impermeable) to 9.5 E-07 m/sec in the greywacke and amphibolite, with K's ranging between 2.7 E-08 to 1.0 E-06 m/sec in the shattered argillite/fault zone. Conductivities in Nicholas Lake bedrock ranged between 4.5 E-09 to 3.9 E-08 m/sec, with conductivities as high as 8.2 E-06 in shallow bedrock. In general, the measured Ks in both areas do not appear to significantly decrease with depth, indicating relatively uniform fracture permeability. Packer test data and conductivities based on slug tests are included in Appendix I.

2.10.8.2 Model Description/Key Assumptions

Feflow version 5.2 was used to develop preliminary numerical models of the Ormsby and Nicolas Lake mine areas. Open pit and underground workings were simulated based on preliminary mine layouts and specifications. Mine specifications have changed since development of the model; however, results should still be applicable at a Pre-Feasibility level of study. Groundwater flows were estimated by modeling Ormsby and Nicholas Lake mine areas at full build-out conditions as this conservative scenario was assumed to predict the highest continuous groundwater flow.

Site plans showing the major features of Ormsby and Nicholas Lake sites are provided in Figures 2.10-1 and 2.10-3, respectively. Figures 2.10-2 and 2.10-4 show depth profiles of the mining areas for Ormsby and Nicholas lake sites, respectively.

Model super elements around the lakes, ore body, mining area and the rest of the surrounding rocks were established with refined meshes within the lakes, ore bodies, mining area and fault as compared to the surrounding rocks at both sites. The mining area in both models and the fault zone at the Ormsby site were further refined. The element type set was six nodded triangle prism. The total number of nodes and meshes at the Ormsby site were 50,420 and 74,925, respectively and 4,866 and 6,046 respectively at Nicholas Lake site.

The preliminary Ormbsy model was established as a three-dimensional, steady state, finite element numerical model containing with four slices and three layers. Available digital ground surface elevations were imported into the model as the first slice. The second, third and fourth slice depths were set at 5 m, 20 m and 450 m, respectively below the first slice, which in turn created three layers of 5 m, 15m and 430 m thickness. Figure 2.10-1 shows the dimensions of the Ormsby model domain and major features.

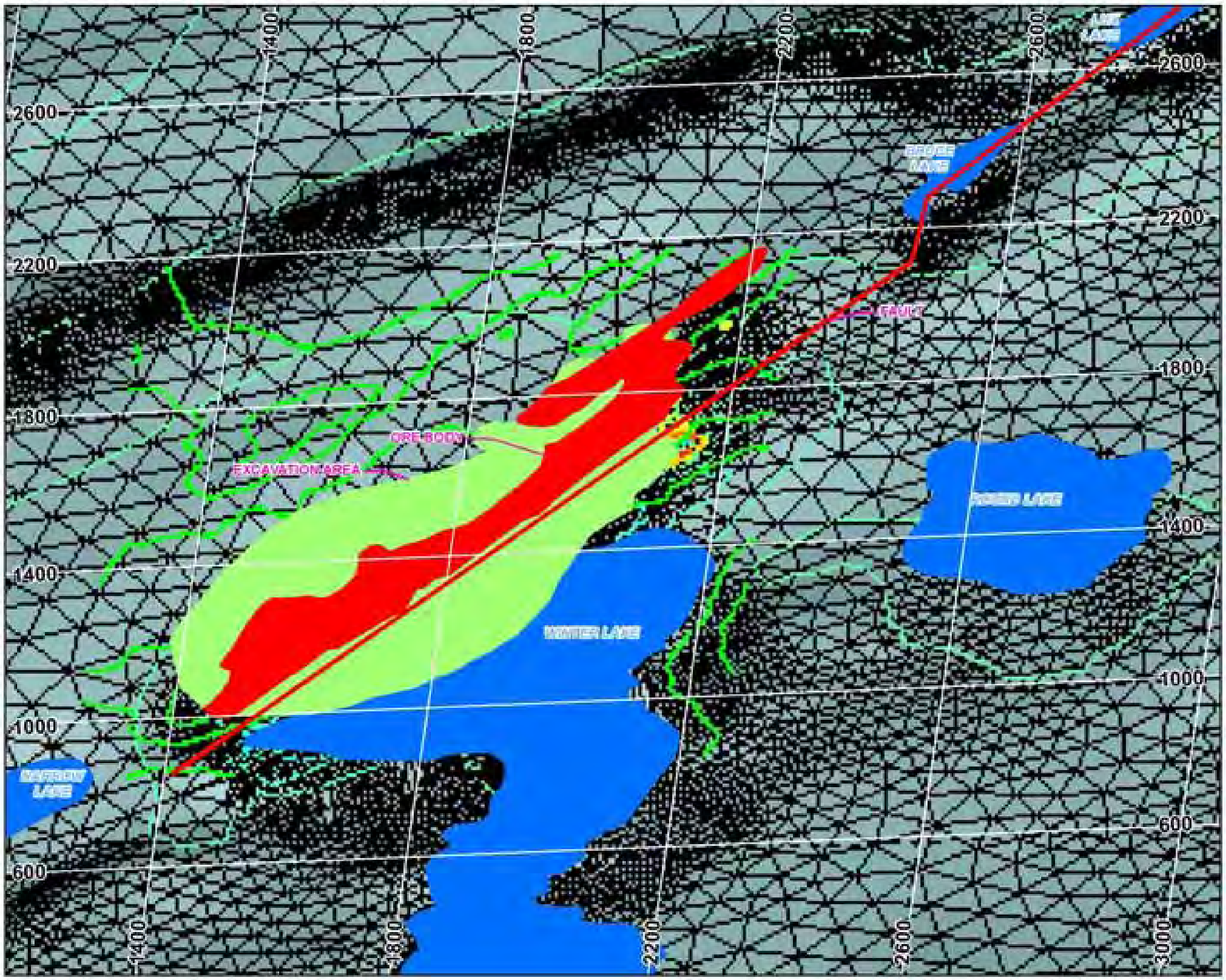
The preliminary Nicholas Lake model was set up a three-dimensional, steady state, finite element numerical model with three slices and two layers. Similar to the Ormsby model, surface elevations data was imported to the model as the first slice. The second and third slice was set at 5 m and 330 m respectively below the first slice, which in turn created two layers of 5 m, and 325 m thickness. Figure 2.10-3 shows the dimensions of the Nicholas Lake model domain and major features. Initial lake heads corresponded to topographic elevations while initial groundwater elevations within the remainder of the preliminary models were assigned as 10 m below the pre-mining ground elevations. The measured average hydraulic conductivities within surrounding rocks, the ore body and the fault were assigned and considered as homogenous and isotropic to the depth of the models. The inflow (constant head) groundwater boundary was assigned to the northwest model boundaries based on the overall topographical relief within the model areas.

Groundwater recharge at the lakes and mining areas was assigned as equal to the annual precipitation measured between the years 2004 to 2009 at the Tyhee meteorological station. Recharge in the remainder of the model areas was assigned as 10% of the annual precipitation.

The models were run for approximately 20 years until flow approximate steady state conditions appeared to have been reached, based on converging flow estimates. A detailed description of the preliminary groundwater model is provided in Appendix I.

2.10.8.3 Model Findings/Sensitivity Analyses

The low hydraulic conductivities of the ore body and surrounding country rock suggest that groundwater flow volume from these rocks will be limited. The most likely source of significant flows at Ormsby will be from the shattered greywacke/Ormsby Fault zone as the conductivity of this zone is at least one order of magnitude higher than the surrounding rocks and as continuous artesian flow of approximately 50 L/min was observed from this fault during drilling of one corehole. No sources of significant groundwater flow were observed during drilling at Nicholas Lake.



LEGEND

- Ore Body
- Excavation Area
- Road Network

NOTES

Figure source: Technical Report on the Pre-Feasibility Study of the Yellowknife Gold Project, Appendix P (Figure P1). July 2010.

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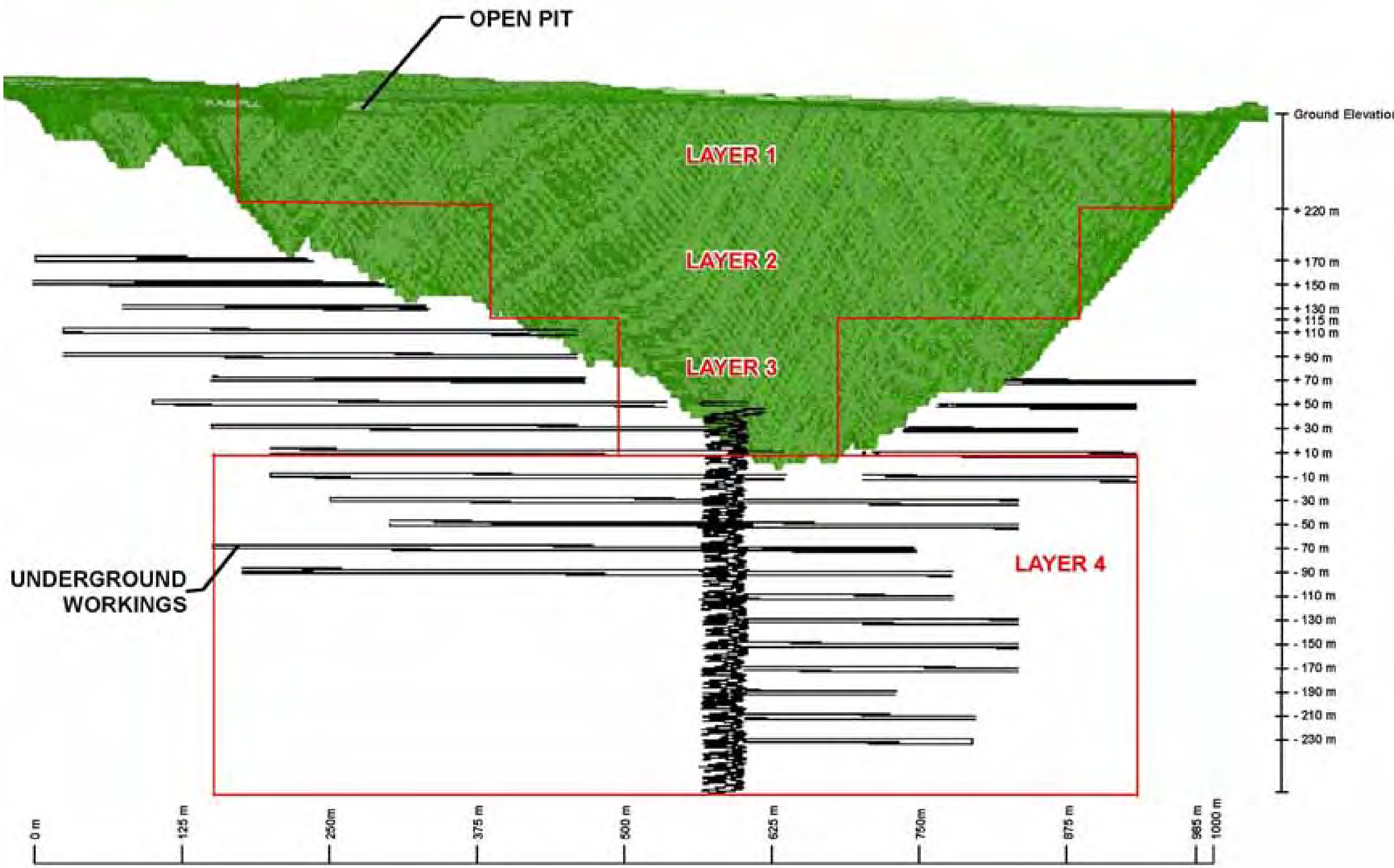
YELLOWKNIFE GOLD PROJECT

Groundwater Model Domain Showing Hydraulic Features and Mining Area of Ormsby

PROJECT NO.	DWN	CKD	REV
V23201097	KW	RH	0

OFFICE	DATE
EBA-VANC	April 14, 2011

Figure 2.10-1



NOTES
1. Ground elevations are variable at the proposed mining area. For this figure ground elevation was referenced as +325 m approximate at the center of the mining area.
2. Figure source: Technical Report on the Pre-Feasibility Study of the Yellowknife Gold Project, Appendix P (Figure P2). July 2010.

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Open Mine and Underground Mine Depths Ormsby

PROJECT NO.	DWN	CKD	REV
V23201097	SL	RH	0
OFFICE	DATE		
EBA-VANC	February 17, 2011		

Figure 2.10-2

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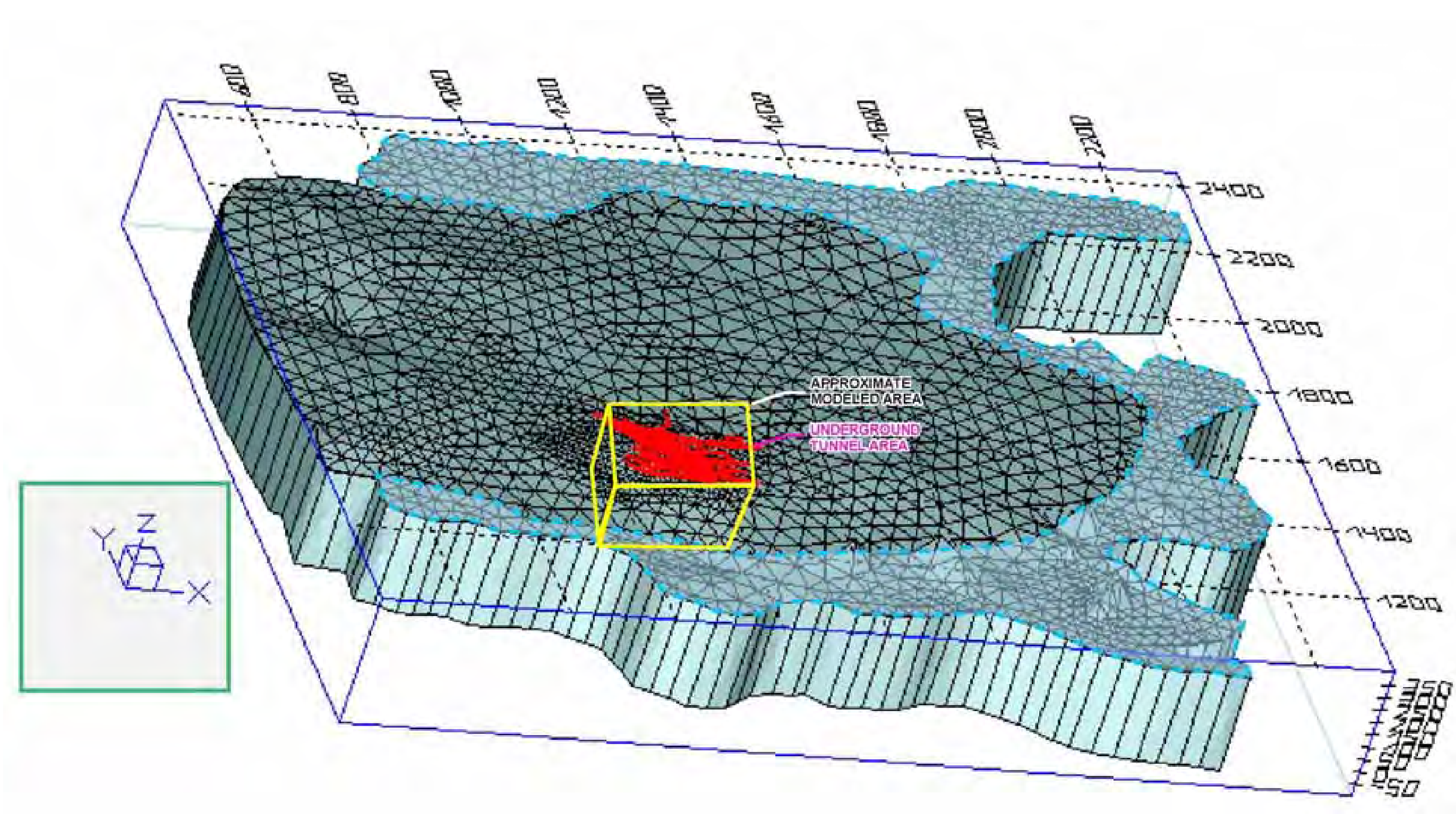

LEGEND

- Approximate Nicholas Lake Boundary
- Approximate Modeled Area

NOTES

Figure source: Technical Report on the Pre-Feasibility Study of the Yellowknife Gold Project, Appendix P (Figure P3). July 2010.

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Groundwater Model Domain Showing Hydraulic Features and Mining Area of Nicholas Lake

PROJECT NO.	DWN	CKD	REV
V23201097	SL	RH	0
OFFICE	DATE		
EBA-VANC	February 17, 2011		

Figure 2.10-3

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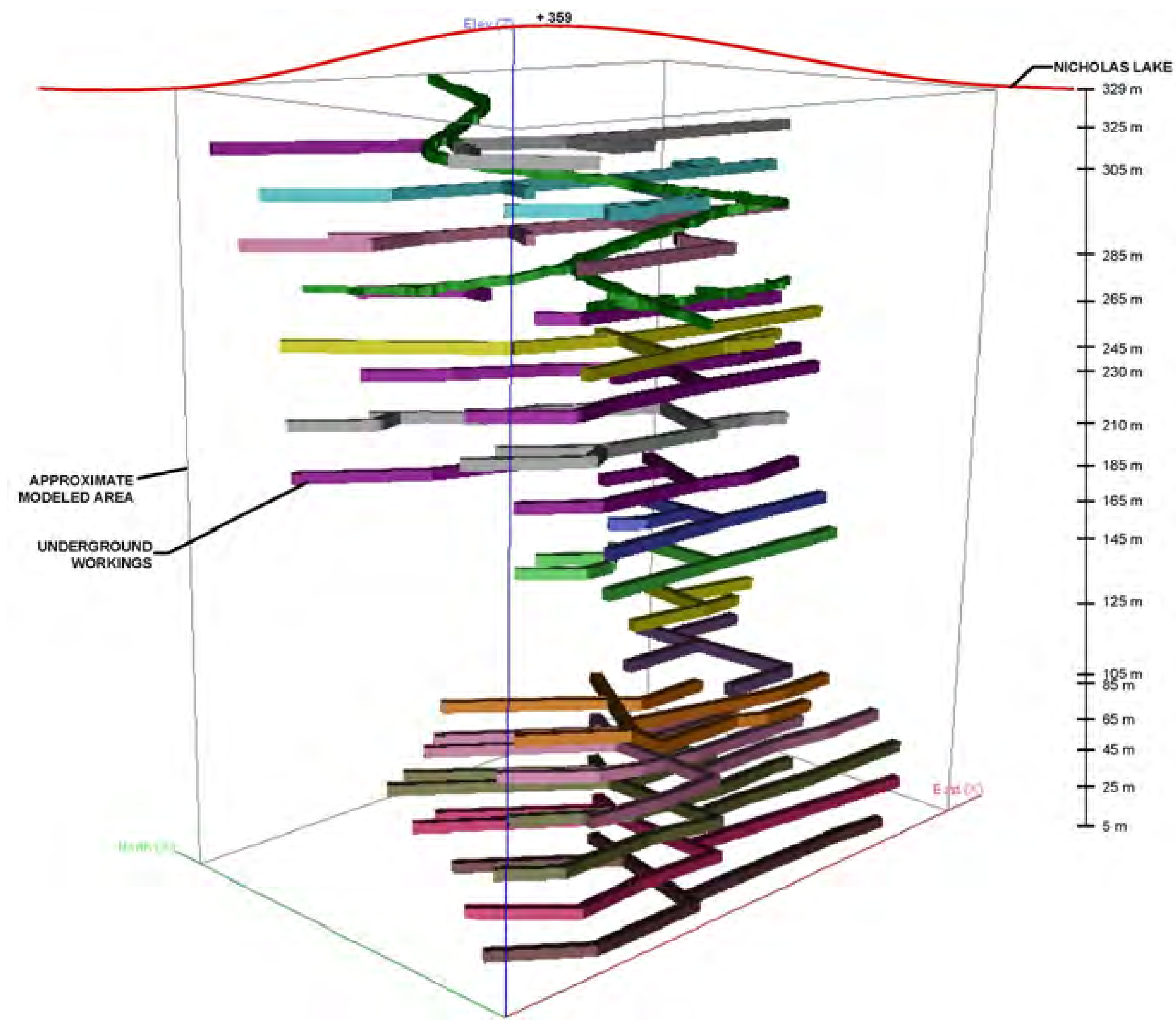

LEGEND

Approximate Ground Elevation

NOTES
1. Ground elevations are variable above the proposed underground mine workings. For this figure ground elevation was referenced as +359 m approximate at the center of the proposed mining area.
2. Elevations on the vertical scale were obtained as the bottom elevations of each underground workings from a digital file provided.
3. Figure source: Technical Report on the Pre-Feasibility Study of the Yellowknife Gold Project, Appendix P (Figure P4). July 2010.

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YELLOWKNIFE GOLD PROJECT

Underground Mine Depths Nicholas Lake

PROJECT NO.	DWN	CKD	REV
V23201097	SL	RH	0
OFFICE	DATE		
EBA-VANC	February 17, 2011		

Figure 2.10-4

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As shown in Table 2.10-1, groundwater flow into the Ormbsy open pit and underground mine, based on average measured bedrock conductivities is estimated at approximately 787 m^3/day. This flow does not appear to be sensitive to rock hydraulic conductivity, with flows only potentially increasing to about 987 m^3/day with increased greywacke conductivity and flows only increasing to about 1,155 m^3/day with increased fault conductivity.

Groundwater flows into the underground workings at Nicholas Lake appear to be more sensitive to bedrock conductivities. Flows using the measured conductivity are estimated at 86 m^3/day, with potentially lower flows of approximately 8 m^3/day using one order of magnitude lower rock conductivity and increased flows of approximately 1,300 m^3/day using one order of magnitude higher bedrock conductivity. Additional sensitivity checks of the regional groundwater regime at Nicholas Lake, run by assigning variable heads both with and without the hydraulic gradient, did not significantly change the simulation results.

Estimated monthly flows were determined by multiplying the estimated daily flows by the number of days in each month, subtracting the model's estimated daily precipitation recharge, and by adding the estimated monthly precipitation recharge.

Monthly flows for Ormsby, assuming average daily flows ranging between 500 and 1500 m^3/day, were estimated to range between 13,444 and 49,691 m^3/mo. Monthly flows for Nicholas Lake, assuming average daily flows between 100 and 1,200 m^3/day, were estimated to range between 2,800 and 42,336 m^3/mo. These values are similar to those observed at other comparable mine sites in NWT.

However, it is important to also note that zones of temporarily increased flow may be encountered during open pit and underground mining. These zones of increased flow may result from increased fracture density and/or openness, fault zone width or increased fault interconnectedness. The amount and duration of increased flow cannot be predicted with available data at this time.

Flows from the Ormsby pit and underground workings at full build-out are estimated to range between 500 and 1,500 m^3/day. Flows from Nicolas Lake are estimated to range between 100 and 1,200 m^3/day, depending upon bedrock conductivity. It is likely that scattered "pockets" or intervals of increased fracture density or bedrock permeability will be encountered during excavation and underground mining. Significantly increased but likely temporary flows may occur from these areas. It is also possible that increased flows may occur from the Ormsby fault, should the fault permeability be greater than the available data suggests. Model and key sensitivity analyses results are summarized in Appendix I.

TABLE 2.10-1: GROUNDWATER MODEL SENSITIVITY ANALYSES SUMMARY			
Varied Parameter			
Ormsby Rock Hydraulic Conductivity (m/sec)		**Rationale**	**Calculated Flows**
Graywacke	Ave 7.3 E-09 m/s	Based on K's measured by packer tests in core holes	787 m^3/day
Amphibolite	Ave 6.6 E-10 m/s		
Fault Zone	Ave 3.0 E-07 m/s		
Sensitivity Adjustments			
High Graywacke Flow	1.8 E-08 m/s	Based on ave high Ks measured in packer tests	987 m^3/day
High Flow for Fault Zone	1.0 E-06 m/s	Account for potential geologic variability and for potential high volume flow from fault zone	1155 m^3/day
Nicholas Lake Rock Conductivity (m/sec)		**Rationale**	**Calculated Flows**
Granite/Metasediments	Ave 2.5 E-08 m/s	Ave K based on packer test results	
Sensitivity Adjustments			
Low Flow both units	2.5 E-09 m/s	Account for potential lower permeability rocks	6 m^3/day
High Flow both units	2.5 E-07 m/s	Account for potential higher permeability rocks	1200 m^3/day

Notes:

Analytical models using available Ks indicate very low flows from mine areas, thus most flow will be from seasonal recharge and/or from productive fractures/faults.

Model insufficient to accept wide difference between fault K and country rock K, due narrow fault compared to size of pit, model.

Model also has difficulty with large head differences between top and bottom of excavated area.

Flow estimate based on constant head away from pit providing source of water, rock acting as slightly permeable porous media.

Likely flow on lower end of these scale due to generally impermeable nature of country rock and ore bodies, and presently known limited fault permeability at Ormsby.

Nicolas Lake model - no significant variations by changing constant/not constant heads at model boundary, location of constant head boundary, changing from flat to slight gradient.

2.10.9 Groundwater Quality

Limited groundwater quality information exists for the Ormsby and Nicholas Lake mine sites. As a result, in September and October, 2009, an initial groundwater sampling program was conducted at the two mine sites by EBA. The purpose of the program was to collect groundwater samples from several shallow (0 to ±20 m below ground surface (bgs)) and deep (> 90 m bgs) wells completed into fractured bedrock as part of the ongoing mineral exploration activity.

Groundwater monitoring wells were installed in inclined exploration and geotechnical investigation coreholes at both sites. The wells were generally constructed of 1-inch or 2-inch Schedule 80 PVC pipe, with slotted screen sections set at the corehole bottom. Several wells were completed with both 1-inch (shallow) and 2-inch (deep) casing in one corehole. Some exploration coreholes were drilled deeper than the planned well depth and were backfilled with cement/bentonite grout. A sand filter pack was installed around each screen, with the sand level nominally set at approximately 1 ft above the screen depth. The remainder of the coreholes were backfilled with cement/bentonite grout to the ground surface. A total of 6 wells were installed at Nicholas Lake and 2 wells at Ormsby.

The wells were purged before sampling to remove water affected by drilling and to ensure that representative groundwater samples were collected. Water quality parameters including pH, conductivity and temperature were monitored and purging continued until at least three well volumes were removed or until the well was dry.

Limited bedrock permeability and resulting slow water flow into several wells resulted in limited or no ability to flush grout or drilling fluid from the holes using any available pumping method – Grundfos pump, water tubing or bailing.

Good quality samples were only collected from Nicholas Lake wells N119 and N123, and from Ormsby well BH15. Analytical results from the remaining samples were considered to be skewed due to the high pH and unknown other affects from the drilling fluid and grout. The analytical results for the acceptable water quality samples successfully extracted from the wells are presented in Table 2.10-2.

TABLE 2.10-2: ANALYTICAL RESULTS FOR GROUNDWATER SAMPLING AT ORMSBY AND NICHOLAS LAKE – SEPTEMBER 2009

WQ Parameter	Units	Borehole W119 20 m Bg	Borehole W123 90 m Bg	Borehole BH15 20 m Bg
pH	pH	7.84	8.32	8.45
Conductivity (EC)	uS/cm	401	689	365
Bicarbonate (HCO3)	mg/l	161	189	147
Carbonate (CO3)	mg/l	<5.0	<5.0	<5.0
Hydroxide (OH)	mg/l	<5.0	<5.0	<5.0
Alkalinity, Total (as CaCO3)	mg/l	132	157	127
Hardness (as CaCO3)	mg/l	188	272	162
Nitrate (as N)	mg/l	<0.050	<0.050	<0.050
Nitrate as Nitrite as N	mg/l	<0.071	<0.071	<0.071
Nitrite (as N)	mg/l	<0.050	<0.050	<0.050
Sulphate (SO4)	mg/l	71.3	191	64.5
Ammonia-N	mg/l	0.249	1.13	0.130
Chemical Oxygen Demand	mg/l	65.8	48.7	235
Total Suspended Solids	mg/l	3.0	17.0	<3.0
Total Metals				
Aluminum (AL)	mg/l	0.504	1.47	<0.020
Antimony (Sb)	mg/l	<0.00040	<0.00040	0.00177
Arsenic (As)	mg/l	0.0392	0.761	0.0247
Barium (Ba)	mg/l	0.0718	0.0243	0.0119
Beryllium (Be)	mg/l	<0.0010	<0.0010	<0.0010
Bismuth (Bi)	mg/l	<0.00020	<0.00020	<0.00020
Boron (B)	mg/l	<0.020	0.095	0.042
Cadmium (Cd)	mg/l	<0.00020	<0.00020	<0.00020
Chromium (Cr)	mg/l	0.00419	0.00356	<0.00080
Cobalt (Co)	mg/l	0.00328	0.00199	0.00022
Copper (Cu)	mg/l	0.0015	0.0065	<0.0010
Lead (Pb)	mg/l	0.00058	0.00470	<0.00010
Molybdenum (Mo)	mg/l	0.00523	0.0325	0.00232
Nickel (Ni)	mg/l	0.0113	0.00575	0.00359
Selenium (Se)	mg/l	<0.00040	<0.00040	0.00047
Silver (Ag)	mg/l	<0.00040	<0.00040	<0.00040
Strontium (Sr)	mg/l	0.155	0.485	0.279
Thallium (Tl)	mg/l	<0.00010	<0.00010	<0.00010
Tin (Sn)	mg/l	<0.00040	<0.00040	<0.00040
Titanium (Ti)	mg/l	0.0186	0.0184	<0.0050
Uranium (U)	mg/l	0.0718	0.0139	0.00401
Vanadium (V)	mg/l	0.00615	0.00133	<0.00050
Zinc (Zn)	mg/l	0.0060	0.0333	<0.0040

2.11 AQUATIC RESOURCES

2.11.1 Background Studies

A number of studies have been conducted on the environmental condition of Giauque Lake and within the Nicholas Lake watershed. A report prepared by North Slave Métis Holdings and Gartner Lee (2002) for Public Works and Government Services Canada, provided a summary of environmental information for the area of interest. This comprehensive document was used as the basis for 2004 and 2005 field programs conducted on behalf of the Tyhee NWT Corporation (EBA 2005, 2006c, Appendix D). A comprehensive summary of the information available on the aquatic biological resources in the project area is presented in Table 2.11-1.

Moore *et al.* (1978) reported information on the benthic invertebrates, zooplankton and sediments of Giauque, Thistlethwaite, Wagenitz and Maguire lakes and represents the best historic information available for the 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. 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 that 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.

Fish from Giauque Lake regularly contained mercury levels in excess of the 0.5 ppm (wet weight) restrictive consumption level and the 1.5 ppm (wet weight) consumption warning level set by Health and Welfare Canada. However, some fish collected downstream of Thistlethwaite Lake, upstream of Control Lake and Wagenitz Lake, also contained mercury concentrations in excess of the restrictive level, suggesting that naturally elevated background levels of mercury occur in the environment of the study area (Moore *et al.* 1978). Based on available literature and the 2004 field program, fish species commonly found in the water bodies of the YGP study area, are listed in Table 2.11-2. Fish habitat suitability ratings for fish species recorded in each of the lakes surveyed are presented in Table 2.11-3a to Table 2.11-3e.

TABLE 2.11-1: SUMMARY OF AVAILABLE REPORTS ON THE AQUATIC RESOURCES OF GIAUQUE LAKE AREA

Author(s)	Study Title	Fisheries	Benthic Invertebrates	Lake Water Quality	Sediment Quality	Tailings	Water Associated w/ Tailings	Groundwater	Vegetation
Careau *et al.* 1992	State of Contamination of Northern Canada and Greenland	X							
Coedy 1994	The Effect of Abandoned Gold Mine Tailings of Discovery Mine on the Ecosystem of Giauque Lake	X			X	X	X		
Hall and Sutherland 1989	Assessment of Contaminant Leaching and Transport from Abandoned Mines in the Northwest Territories, Summary and Data Reports				X	X	X		
Klohn Leonoff 1992	Discovery Mine, Options for Tailings Reclamation								X
Lafontaine 1994	An Evaluation of the Metal Concentrations in the Tissues of Five Fish Species under the Influence of the Metal Contaminated Tailings of Discovery Mine, Giauque, NWT, 1992	X							
Lockhart *et al.* 1998	Depositional Trends – Lake and Marine Sediments				X				
Moore *et al.* 1978	The Effects of Abandoned Metal Mines on Aquatic Ecosystems in the Northwest Territories	X	X	X	X				
North Slave Métis Alliance 2000	Metal concentrations in Vegetation at Six Abandoned Mine Sites in the North								X
North Slave Métis Alliance 1998 [or NSMA 1998]	Discovery Mine Tailings Reclamation April 1998 Initial Reconnaissance Survey	X	X	X	X	X	X		
North Slave Métis Holdings Ltd. and Gartner Lee Limited 2001 [or NSMHL and GLL 2001]	Discovery Mine, Northwest Territories, 2000 Environmental Monitoring Program, Final Report		X	X	X		X	X	
North Slave Métis Holdings Ltd. *et al.* 2000 [or NSMHL *et al.* 2000]	Discovery Mine, Reclamation Environmental Monitoring Program for 1999/2000 Phase 2				X		X	X	X
North Slave Métis Holdings Ltd. *et al.* 1999 [or NSMHL *et al.* 1999]	Discovery Mine, Reclamation Environmental Monitoring Program 1998/1999 Phase 1	X	X	X		X		X	
Sergy 1978	Environmental Distribution of Cadmium in the Prairie Provinces and Northwest Territories	X							
Wedel *et al.* 1990	An Overview Study of the Yellowknife River Basin, N.W.T.			X					
North Slave Métis Holdings Ltd. and Gartner Lee Limited 2002 [or NSMHL and GLL 2002]	Discovery Mine, Northwest Territories, 2001 Environmental Monitoring Program			X			X	X	

TABLE 2.11-2: FISH SPECIES FOUND IN THE YGP STUDY AREA**	
Common Name	**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*

* Fish captured or observed in YGP study area in 2004 and 2005

** Based on literature and field studies

TABLE 2.11-3A: FISH HABITAT SUITABILITY FOR NORTHERN PIKE															
Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total	Habitat
	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	Score	Rating
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 2.11-3B: FISH HABITAT SUITABILITY FOR LAKE TROUT															
Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total	Habitat
	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	Score	Rating
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 2.11-3C: FISH HABITAT SUITABILITY FOR LAKE WHITEFISH															
Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total	Habitat
	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	Score	Rating
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 2.11-3D: FISH HABITAT SUITABILITY FOR LAKE CISCO															
Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total	Habitat
	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	Score	Rating
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 2.11-3E: FISH HABITAT SUITABILITY FOR ARCTIC GRAYLING

Sample Lakes	Spawning Habitat						Rearing Habitat					Overwintering Habitat		Total	Habitat
	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	Score	Rating
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).

2.11.2 YGP Studies

2.11.2.1 Study Area

A study of fisheries and aquatic resources within the YGP area was conducted during the period, July 17, 2004 to August 1, 2004, and May 24 to June 3, 2005 and August 4 to 13, 2005 (Appendix D). Studies included the assessment of baseline conditions for the six lakes in the YGP: Round Lake, Winter Lake, Eclipse Lake, Nicholas Lake, Brien Lake, and Narrow Lake (Figure 2.11-1). The lakes surveyed within the YGP fall within three drainage basins:

- the Brien Lake drainage basin (3.24 km^2), which flows out of Brien Lake (el. 295 masl), enters Shona Lake (el. 291 m), then generally flows to the southwest through a series of small unnamed lakes eventually reaching Barker Lake (el. 243 masl), Johnstone Lake (el. 232 masl), Clan Lake (el. 216 masl) 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 masl), then Goodwin Lake (el.260 masl), Johnstone Lake (el. 232 masl), Clan Lake (el. 216 masl), and then into the Yellowknife River; and,
- the Nicholas Lake drainage basin (6.28 km^2), in which the north part of the study area is located starts at Nicholas Lake (el. 325 masl) and flows west to Eclipse Lake (el. 311 masl), and eventually flows into the Yellowknife River via numerous small lakes, ponds and bogs.

2.11.2.2 Field Studies

The fisheries and aquatic resources program in 2004 included the following investigations:

- assessment of fish species composition, relative abundance, fish tissue metals, and biometrics within each lake and their primary inlet and outlet streams;
- assessment of lake shoreline habitat characteristics and bathymetry;
- assessment of zooplankton and benthic invertebrate community composition and abundance; and
- assessment of water and sediment quality.

Follow-up studies in the spring and summer of 2005 focussed on fish presence, fish habitat and bathymetry of Winter Lake and Narrow Lake, as well as fish presence and fish habitat at four locations along a proposed haul road between the Nicholas Lake property and the proposed process plant at the Ormsby property.

The studies were designed after discussions and input from DFO. This input was related to the future use of Winter Lake as a tailings containment area considering the possible use of Winter Lake by fish. Fisheries and aquatic resource investigations undertaken during the spring portion of the 2005 field study focused on potential fish migration between Winter and Narrow lakes. The study included sampling to determine: fish species presence, relative abundance, distribution and species composition (inlet and outlet trapping); fish biological characteristics (length, weight, age); fish habitat characterization in the stream connecting the lakes; and, fish tissue metals analyses. In addition, a habitat survey and electro-fishing for fish presence was conducted at four stream crossing locations along the proposed overland route to Nicholas Lake.

Investigations undertaken during the summer of the 2005 field study, focused on fish species presence, habitat characterization and utilization of Winter and Narrow lakes, and included: fish species relative abundance, distribution and species composition (gillnetting and minnow trapping); fish biological characteristics (length, weight, age); characterization of habitat attributes; fish tissue metals analysis; lake bathymetry; water quality analyses; and, an underwater survey (snorkel and video) in Winter Lake.

Lake shoreline and stream habitats surveys were carried out as part of the 2004 studies. The lakes surveyed are characteristic of northern Canadian Shield lakes. Most of the lakes surveyed were rocky, relatively deep and low in productivity. Bathymetric surveys were completed for Round, Winter and Narrow lakes over the 2004 and 2005 field seasons. The review of stream fish habitat and stream channel characteristics included: in-stream cover, bed material, riparian habitat, channel morphology, and water quality. At the time of the 2004 survey, lake and stream flow conditions were at low seasonal levels. A rating of stream habitat conditions for inlet and outlet streams was not completed for the summer 2004 survey.

The detailed report on the 2004 fisheries and aquatic resources is provided in Appendix D. A summary of the major findings from the summer 2004, and spring and summer 2005 fisheries and aquatic investigations is provided in the following sections, which are organized to provide relevant information for each of the waterbodies included in these investigations. Summary tables for the various aquatic resource parameters (Tables 2.11-3 to 2.11-10) can be found at the end of Section 2.12.

2.11.3 Round Lake

2.11.3.1 Lake Shoreline Habitat and Bathymetry

An assessment of shoreline and aquatic habitat features for Round Lake was completed from July 18 to 19, 2004.

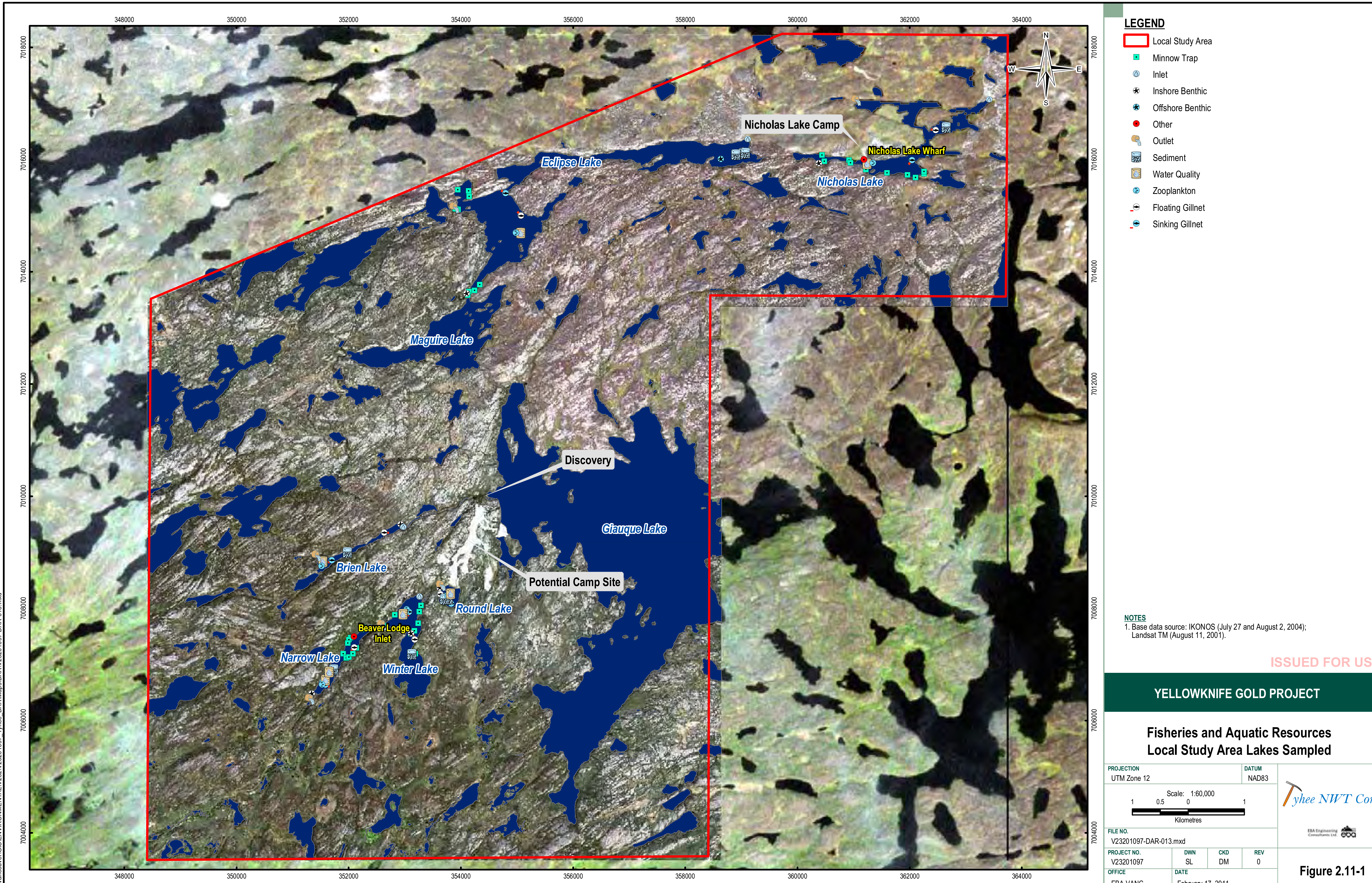
Round Lake is located approximately 0.5 km south of the historic Discovery Mine site and is a round shallow basin, about 450 m in length and 315 m wide, with a surface area of approximately 11.5 ha (Figure 2.11-1). Historically, Round Lake received runoff from the historic Discovery Mine and today continues to receive runoff from exposed tailings at Round Lake's north end. A cap of crushed rock fill and a small strip of uncapped tailings adjoin the north end of Round Lake.

A poorly defined inlet is located at the north end of the lake; however, there may be additional overland inflows not identified at the time of the field study. Water from Round Lake flows southwest through a vegetated, unconfined bog outlet into Winter Lake (approximately 400 m). The outlet was formerly used to lower Round Lake, during high lake levels. Winter Lake then flows into Narrow Lake.

The vegetation surrounding Round Lake consists of black spruce, dwarf birch, sweet gale and willow. Riparian ground cover also includes hummocks of sphagnum moss, Labrador tea, and cottongrass. Shoreline vegetation consists of marsh cinquefoil, and emergent stands of water sedge, and scouring rush. The lake supports a small community of submerged macrophytes consistent with wetland vegetation found in graminoid-dominated fens, shrub-dominated fens, treed fens and bogs, marshes, and areas dominated by floating aquatic vegetation, as described in Section 2.7.1.3.

As Round Lake is very shallow, the bathymetric survey of Round Lake was completed using a measuring rod. Depth measurements were taken at 15 locations around the lake. The lake was determined to have a maximum depth of 1.5 m, located within the lake's southern basin (Figure 2.11-2). The bottom substrate of Round Lake consisted primarily of organic material and silt.

An analysis of fish habitat attributes for Round Lake indicated an overall rating of Poor for all fish species evaluated (Table 2.11-3a to Table 2.11-3e). The lake provides emergent and submerged vegetation suitable for use by northern pike; however, the lake has no coarse substrates, deep water, shoals, boulder fields or a significant inlet and outlet suitable for use by other fish species (Figure 2.11-3). Round Lake has been impacted by tailings from the historic Discovery Mine and freezes to near bottom during winter. No fish were caught in Round Lake using gillnets and baited minnow traps. Based on the 2004 assessment, Round Lake is considered unsuitable for use by fish.



NOTES
1. Base data source: IKONOS (July 27 and August 2, 2004); Landsat TM (August 11, 2001).

ISSUED FOR USE

YELLOWKNIFE GOLD PROJECT

Fisheries and Aquatic Resources
Local Study Area Lakes Sampled

PROJECTION: UTM Zone 12	DATUM: NAD83		
Scale: 1:60,000 (1 0.5 0 1 Kilometres)			
FILE NO.: V23201097-DAR-013.mxd			
PROJECT NO.: V23201097	DWN: SL	CKD: DM	REV: 0
OFFICE: EBA-VANC	DATE: February 17, 2011		

Tyhee NWT Corp

Figure 2.11-1

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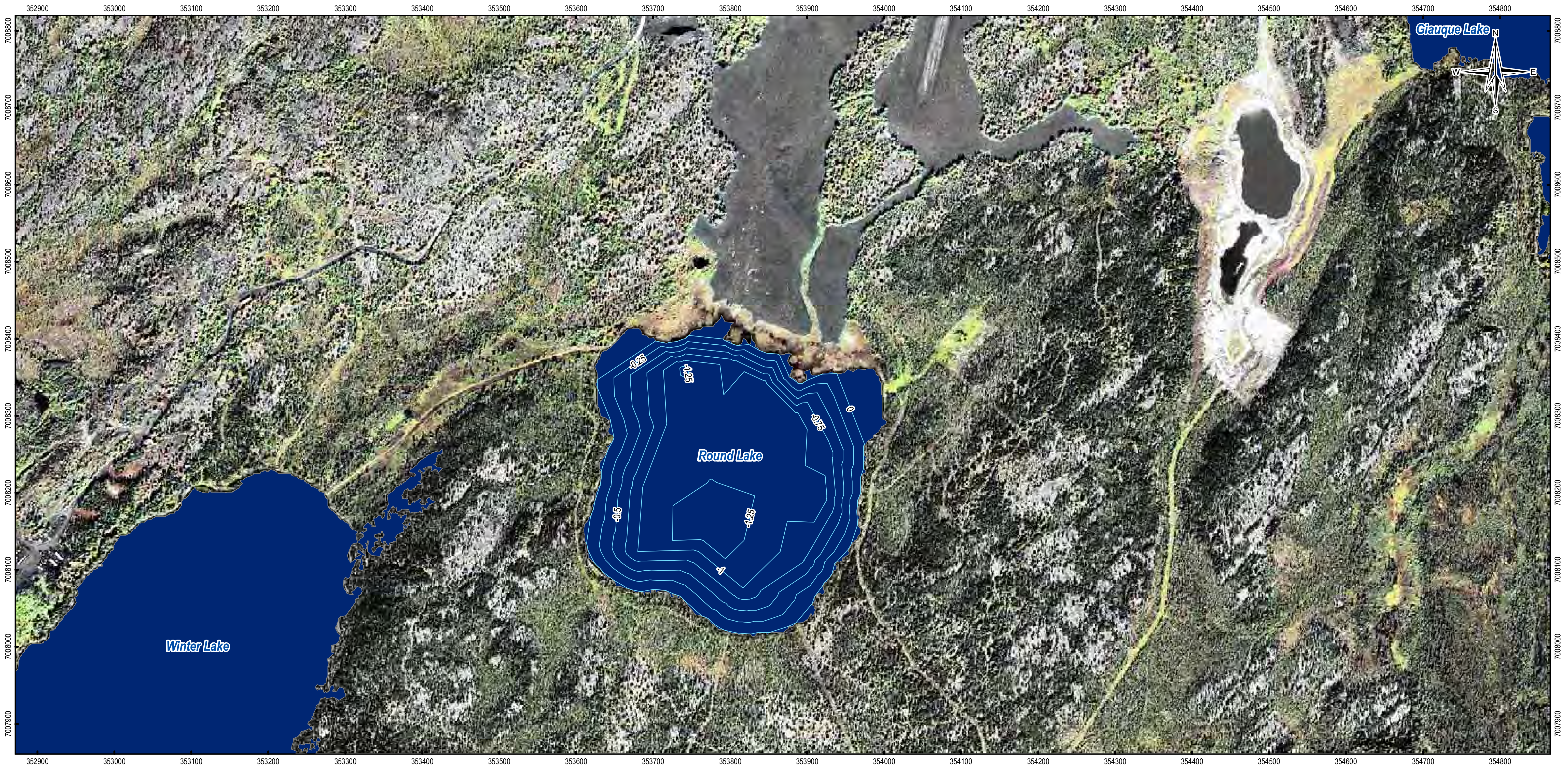

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LEGEND

Bathymetry (0.25m interval)

NOTES

Base data source: IKONOS (July 27 and August 2, 2004); Landsat TM (August 11, 2001).

ISSUED FOR USE

YELLOWKNIFE GOLD PROJECT

Round Lake Bathymetry

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:5,000

100 50 0 100

Metres

Tyhee NWT Corp

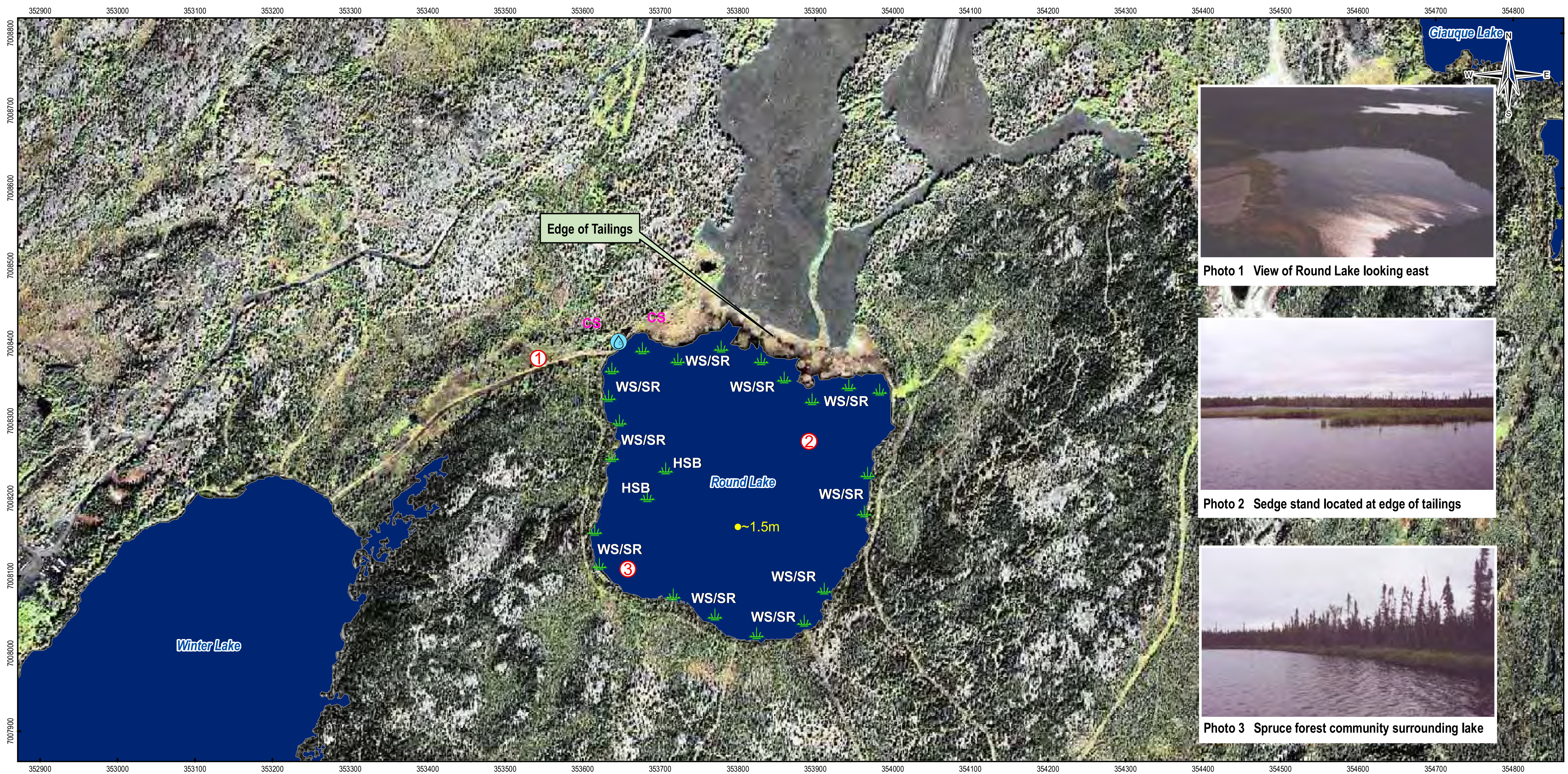
EBA Engineering Consultants Ltd.

FILE NO.
V23201097-DAR-014.mxd

PROJECT NO.	DWN	CKD	REV
V23201097	SL	DM	0

OFFICE	DATE
EBA-VANC	March 29, 2011

Figure 2.11-2



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

NOTES
Base data source: IKONOS (July 27 and August 2, 2004); Landsat TM (August 11, 2001).

ISSUED FOR USE

YELLOWKNIFE GOLD PROJECT

Round Lake Habitat Features

PROJECTION: UTM Zone 12
DATUM: NAD83
Scale: 1:5,000
100 50 0 100
Metres

Tyhee NWT Corp
EBA Engineering Consultants Ltd.

FILE NO.: V23201097-DAR-015.mxd
PROJECT NO.: V23201097
DWN: SL
CKD: DM
REV: 0
OFFICE: EBA-VANC
DATE: February 17, 2011

Figure 2.11-3

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2.11.3.2 Fish Population

No fish were collected in Round Lake using either gillnets or minnow traps. No defined inflows or outflows were observed during the survey of Round Lake, and hence no electro-fishing was conducted. As discussed in Section 2.8.1.4 there is only a diffuse flow through the muskeg leading to Winter Lake. An overnight floating and sinking gillnet set resulted in no captured fish. As well, no fish were caught in ten baited gee-type minnow traps that were set overnight and placed around the littoral area of the shoreline.

2.11.3.3 Zooplankton

Zooplankton are described in terms of mean abundance, mean density, distribution, and percent composition. Sampling locations are shown on Figure 2.11-1 and results are presented in Table 2.11-4. The Round Lake zooplankton survey involved the completion of three vertical tows from the lake bottom (1.5 m) to the surface. The majority (46.0%) of the zooplankton population sampled from Round Lake consisted of crustaceans of the Order Copepoda. Copepoda also recorded the highest mean density with 16.4 organisms/m^3. Rotifera comprised 38.0% of the sample with a mean density of 13.5 organisms/m^3. Cladocera (water fleas) comprised 12.0% with a mean density of 4.3 organisms/m^3. The Order Insecta comprised 4.5% of the population and Amphipoda (freshwater shrimp) were present in low numbers. The total mean density of zooplankton in Round Lake was 35.9 organisms/m^3.

2.11.3.4 Benthic Invertebrates

The benthic surveys involved the collection of three replicate Ponar dredge (0.023 m^2) samples in shallow water (littoral) and deep water at each of the lakes in the YGP study area. In Round Lake benthic samples, three groups of biota dominated the composition at both the inshore and offshore locations, due to the shallow (<2 m) nature of this lake. Chironomidae (midges) represented 54.4% of genera recorded in the deeper offshore area and 43.2% of the inshore genera. Amphipoda represented 8.8% of the offshore genera and 40.0% of the inshore genera. Bivalvia (clams) represented 28.4% of the offshore genera and 8.39% of the inshore genera.

Mean densities of Chironomidae, Amphipoda and Bivalvia were 971.0, 898.6 and 188.4 organisms/m^2, respectively in the nearshore, and 2,695.7, 434.8, and 1,405.1 organisms/m^2, respectively, in the offshore. The total mean density of benthic invertebrates in Round Lake littoral samples was 2,246.4 organisms/m^2. The total mean density of benthic invertebrates in Round Lake offshore samples was 4,956.5 organisms/m^2.

The data for mean abundance of aquatic invertebrate taxa are presented in Table 2.11-5. Taxonomic composition data for the major invertebrate groups are presented in Table 2.11-6. No benthic invertebrates were collected from the round lake inlet and outlet streams.

2.11.3.5 Lake Sediment Quality

The analysis of Round Lake sediment samples indicated that values for the metals: arsenic, copper, lead, mercury, nickel, and zinc, were higher in Round Lake than in any other YGP lakes sampled. Concentrations of mercury found in sediments were 0.844 mg/kg, six times higher than the next highest value reported from Brien Lake (0.133 mg/kg). Lead concentrations in Round Lake were 37 mg/kg. Round Lake sediments also had the lowest levels of available phosphorus of any of the lakes sampled. These results are attributed to the historic and ongoing discharges from the former Discovery Mine and surface runoff from the area into Round Lake. Particle size analysis was not possible due to the high organic content of the sediment samples.

Analytical data summarizing the percent moisture, pH, nutrients, total metals, organic carbon, and particle size composition in Round Lake sediments are presented in Table 2.11-7.

2.11.3.6 Stream Habitat

The Round Lake inlet and outlet streams are defined by a willow riparian and sedge fen habitat (Figure 2.11-3). At the time of the summer 2004 survey, no defined inflows to the lake or outflows from the lake were observed. Round Lake flows west into Winter Lake during periods of high water.

2.11.4 Winter Lake

2.11.4.1 Lake Shoreline Habitat and Bathymetry

An assessment of shoreline habitat features for Winter Lake was completed from July 20, 2004 to July 21, 2004. A follow-up assessment that included a snorkel survey was carried out in 2005.

Winter Lake (Figure 2.11-1) is located approximately 0.8 km southwest of the historic Discovery Mine site. Winter Lake is approximately 1.74 km long, 620 m wide and consists of two basins. The lake has a total surface area of 69.2 ha. The inlet to Winter Lake drains from Round Lake. The outlet from the lake flows west into Narrow Lake.

The vegetation surrounding Winter Lake consists of black spruce, dwarf birch and willow. Shoreline vegetation consists of buckbean, sweetgale, scouring rush and floating mats of water sedge and beaked sedge. Results of the 2005 snorkel survey confirmed that bottom substrates in the lake are dominated by organics and silt, with cobbles and boulders at sporadic locations along the shoreline. Winter Lake was observed to have a diverse community of aquatic macrophytes. The shallow littoral zone of the lake includes yellow water lily, large-leaved pondweed, water smartweed, and hard-stem bulrush. The deep littoral zone (>1.0 m) supports submerged stands of water milfoil, Richardson's pondweed, large-leaved pondweed, and muskgrass. Several small shrub wetlands connect the shoreline along the south basin. Of particular note, no fish, or any signs of fish, were observed on any of the twelve underwater transects surveyed in Winter Lake.

The bathymetric survey of Winter Lake determined that the maximum lake depth was 6.0 m, located in the north basin, and that the south basin was relatively shallow, not exceeding 2.0 m in depth (Figure 2.11-4). Bottom substrates in the north basin consisted of bedrock and course material along the shoreline, and fine organic sediments in the deeper areas 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 (Tables 2.11-3a to Table 2.11-3e). While the lake does provide shallow vegetated bays suitable for the spawning and rearing of northern pike, the lake is also relatively shallow and lacks the coarse substrates and deep-water habitat complexity suitable for other species, such as lake trout or whitefish (Figure 2.11-5). 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 potentially lethal oxygen levels. The lake also receives runoff from Round Lake. Overall, these factors indicate poor habitat conditions for aquatic life.

The 2005 investigations confirmed that Winter Lake provides poor habitat conditions for fish. This conclusion was reached based on the limited number of fish captures and the age of the fish captured; the lack of dissolved oxygen in the winter, precluding fish overwintering in the lake; and the limited overall depth of the lake, which only exceeds two meters in two small areas that become anoxic in the winter. The shallower areas of the lake were observed to freeze to near the bottom in winter.

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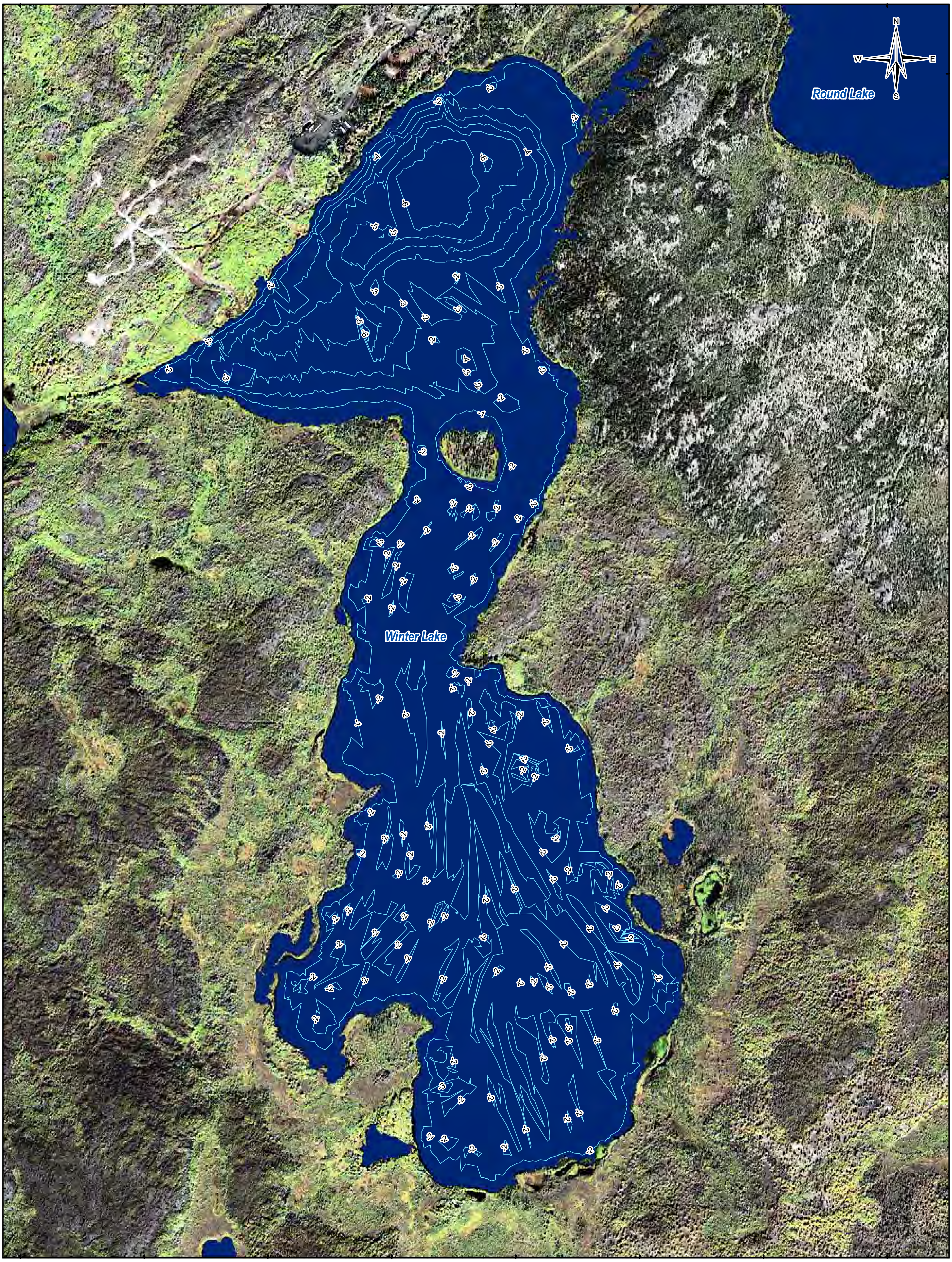

LEGEND

Bathymetry (1m interval)

NOTES

1. Bathymetry Features: data was collected using a Trimble Pathfinder Pro XRS TS-C1 GPS data logger and Trimble Pro XRS receiver and a MarineTek SEAMAX depth sounder. The data were formatted using ARC/INFO to produce maps.
2. Imagery Source: IKONOS (July 27 and August 2, 2004); Landsat TM (August 11, 2001).
3. Water Features: Extracted from IKONOS imagery.

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YELLOWKNIFE GOLD PROJECT

Winter Lake Bathymetry

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:6,000

50 25 0 50 100 150

Metres

Tyhee NWT Corp

EBA Engineering Consultants Ltd.

FILE NO.			
V23201097-DAR-016.mxd			
PROJECT NO.	DWN	CKD	REV
V23201097	SL	DM	0
OFFICE	DATE		
EBA-VANC	March 29, 2011		

Figure 2.11-4

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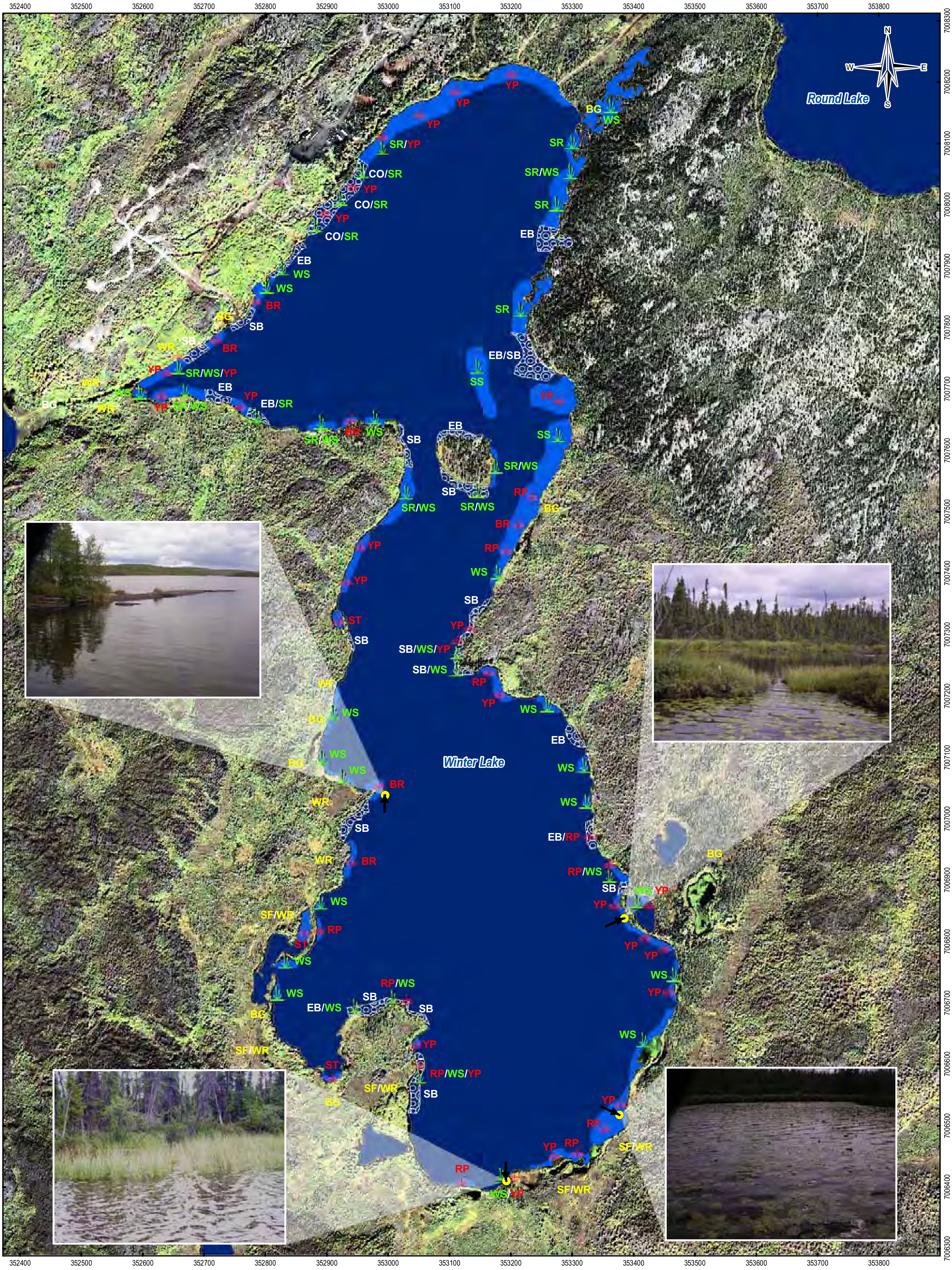


LEGEND

- Photo
- Rock Feature
- Emergent Vegetation
- Submergent Vegetation
- Picture Angle

Emergent Vegetation		Habitat Type	
BG	Bog Wetland	BG	Bog Wetland
SF	Sedge Fen	SF	Sedge Fen
SR	Scouring Rush	WR	Willow (Salix) Riparian
SS	Soft Stemmed		
WS	Water Sedge		
Submergent Vegetation		**Feature**	
BR	Burreed	CO	Cobbles
RP	Richardson's Pondweed	EB	Emergent Boulders
ST	Submerged Trees	SB	Shallow Boulders
YP	Yellow Water Lily		

NOTES

1. Imagery Source: IKONOS (July 27 and August 2, 2004); Landsat TM (August 11, 2001).
2. Water Features: Extracted from IKONOS imagery.
3. Habitat Features: from Spring/Summer 2005.

ISSUED FOR USE

YELLOWKNIFE GOLD PROJECT

Winter Lake Habitat Features

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:6,014

50 25 0 50 100 150

Metres

FILE NO.
V23201097-DAR-017.mxd

PROJECT NO.	DWN	CKD	REV
V23201097	SL	DM	0

OFFICE	DATE
EBA-VANC	February 15, 2011

Tyhee NWT Corp

EBA Engineering Consultants Ltd.

Figure 2.11-5

2.11.4.2 Fish Population

No fish were caught in Winter Lake using gillnets and baited minnow traps in 2004. During the spring 2005 fish migration survey, fish traps were installed in the Winter Lake outlet/Narrow Lake inlet stream, resulting in the collection of four juvenile northern pike and five slimy sculpin in the Narrow Lake inlet trap (fish migrating upstream from Narrow Lake) over seven days of fishing effort (see also Section 2.11.8.2). No fish were caught in the Winter Lake outlet trap; however, an incidental observation of an adult (~ 40 cm long) northern pike was made upstream near the entrance to the Winter Lake outlet trap.

During the summer 2005 lake survey, gillnet sets were successful in the collection of fish from both Winter and Narrow lakes. However, it should be noted that although the fishing effort undertaken in Winter Lake was more intensive (than in Narrow Lake), northern pike was the only species collected in Winter Lake, with a total of 10 juvenile pike being captured; two fish were captured in floating gill nets and the remaining eight in the sinking gill net sets. All of the pike from Winter Lake were determined to be less than three years of age. No fish were captured in the Winter Lake minnow traps. Detailed information on fish captures can be found in Appendix D.

2.11.4.3 Zooplankton

The Winter Lake zooplankton survey involved the completion of three vertical tows from the lake bottom (6.0 m) to the surface. Sample locations are shown on Figure 2.11-1 and results are presented in Table 2.11-4. Cladocera comprised 45% of the zooplankton population with a mean density of 19.0 organisms/m^3. Rotifera comprised 28.8% of the population with a mean density of 12.2 organisms/m^3. Copepods comprised 20.4% and had a mean density of 8.7 organisms/m^3. Insecta, Eubranchiopoda (fairy shrimp) and Amphipoda comprised 6.2%, 0.05% and 0.01% of the samples, respectively. The total mean density of zooplankton in Winter Lake was 42.5 organisms/m^3.

2.11.4.4 Benthic Invertebrates – Winter Lake

The benthic surveys involved the collection of three replicate Ponar dredge (0.023 m^2) samples in shallow water (littoral) and deep water at each of the lakes in the YGP study area. Data for mean abundance of aquatic invertebrate taxa are presented in Table 2.11-5. Taxonomic composition data (%) for the major invertebrate groups are presented in Table 2.11-6. In Winter Lake littoral benthic samples, Chironomidae represented the greatest portion of taxa collected and comprised 58.2% of all taxa collected, with a mean density of 1,289.9 organisms/m^2. Bivalvia and Amphipoda comprised 12.4% and 8.5% of all taxa collected, with mean densities of 275.4 and 188.4 organisms/m^2, respectively. Larval chironomids are particularly tolerant of low oxygen concentrations and under certain circumstances, may be the only insects present in benthic sediments at near anoxic conditions (Armitage et al. 1995).

The total mean density of benthic invertebrates in Winter Lake littoral samples was 2,217.4 organisms/m^2. Offshore samples were also dominated by Chironomidae, representing 84.7% of all taxa collected, with a mean density of 913.1 organisms/m^2.

Conchostraca (crustacea) comprised 6.9% of the taxa represented, with a mean density of 72.5 organisms/m^2. The total mean density of benthic invertebrates in Winter Lake offshore samples was 1,072.5 organisms/m^2.

2.11.4.5 Benthic Invertebrates – Winter Lake Inlet and Outlet Streams

In the Winter Lake inlet stream benthic samples, Chironomidae represented 50.0% of species collected, with a mean density of 478.3 organisms/m^2, while Ostracoda (crustacean) represented 28.79%, with a mean density of 275.4 organisms/m^2. Plecoptera (stoneflies) and Oligochaeta (segmented worms) each comprised 7.6% of genera collected, with mean densities of 72.5 organisms/m^2 each. The total mean density of benthic invertebrates in Winter Lake inlet stream samples was 956.5 organisms/m^2.

The Winter Lake outlet stream benthic samples exhibited a wider diversity of genera. Chironomidae represented 33.23% of genera collected, with a mean density of 1,536.2 organisms/m^2. Bivalvia represented 24.79%, with a mean density of 1,144.9 organisms/m^2. Gastropoda (snails) comprised 14.1%, with a mean density of 652.2 organisms/m^2. The total mean density of benthic invertebrates in Winter Lake outlet samples was 4,579.7 organisms/m^2.

2.11.4.6 Lake Sediment Quality

Analytical data summarizing the percent moisture, pH, nutrients, total metals, organic carbon, and particle size are presented in Table 2.11-7. Arsenic concentrations measured in Winter Lake sediments were the second lowest for all YGP lakes sampled. Copper concentrations were low but comparable to the other YGP lakes sampled. Lead concentrations were below detection limits. Mercury levels were the second lowest value recorded for the sampled lakes. Total organic carbon was relatively high (19.4 mg/kg) indicating the generally organic nature of the sediments in Winter Lake. Particle size analysis was not possible due to the high organic content of the sediment samples.

2.11.4.7 Stream Habitat

The inlet to Winter Lake is defined within a narrow stand of black spruce and willow shrub thicket (Figure 2.11-5). 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 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 (DO) concentration of 3.52 mg/L in July, 2004, which is below the DO concentrations of 5.5 to 9.5 mg/L deemed by CCME to be generally acceptable for aquatic life (Environment Canada 2002b). Water temperature was measured at 16.0°C.

The outlet from Winter Lake is defined within a sedge fen and willow and birch riparian vegetation community (Figure 2.11-5). 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, in July 2004, which is below the generally accepted criterion for aquatic life (Environment Canada 2002b). Since the Winter Lake dissolved oxygen level measured in July, 2004 was 10 mg/L, it is likely that the low oxygen concentration at the lake outlet is due to water stagnation combined with biological decomposition occurring in this shallow outlet area.

Measurements for pH and specific conductivity were 6.71 and 217 μS/cm, respectively. The CCME accepted criterion for pH in freshwater ranges from 6.5 to 9.0. No specific criterion for conductivity has been defined by CCME. The water temperature measurement at the outlet was 16.4°C.

2.11.5 Eclipse Lake

2.11.5.1 Lake Shoreline Habitat

An assessment of shoreline habitat features for Eclipse Lake was completed from July 22, 2004 to July 25, 2004.

Eclipse Lake (Figure 2.11-6) is located approximately 4.8 km north of the former Discovery Mine camp. Eclipse Lake has a surface area of approximately 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 about 4.5 km long and 400 m wide.

Eclipse Lake can be characterized as having a diverse habitat. Features include numerous rocky embayments, rocky islands, and submerged reefs (Figure 2.11-6). Inflowing streams connect small upland lakes and wetlands located north and south of Eclipse Lake. The embayments and islands support steep drop-offs, 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 lake shoreline drops off rapidly to form a rocky transitional fringe of mixed boulders, cobbles, gravels and sand.

The surrounding forest community consists of spruce, dwarf birch, and alder. Blackened vegetation observed along the hillside indicates evidence of a recent burn. Sections of low-lying shorelines support hummocks of sphagnum moss, Labrador tea, bog rosemary, marsh cinquefoil, mosses and lichens, and small patches of cottongrass. Emergent vegetation along the shoreline and in shallow basins consists primarily of water sedge, beaked sedge and scouring rush. Northern pike were observed during the field survey utilizing the stands of emergent vegetation.

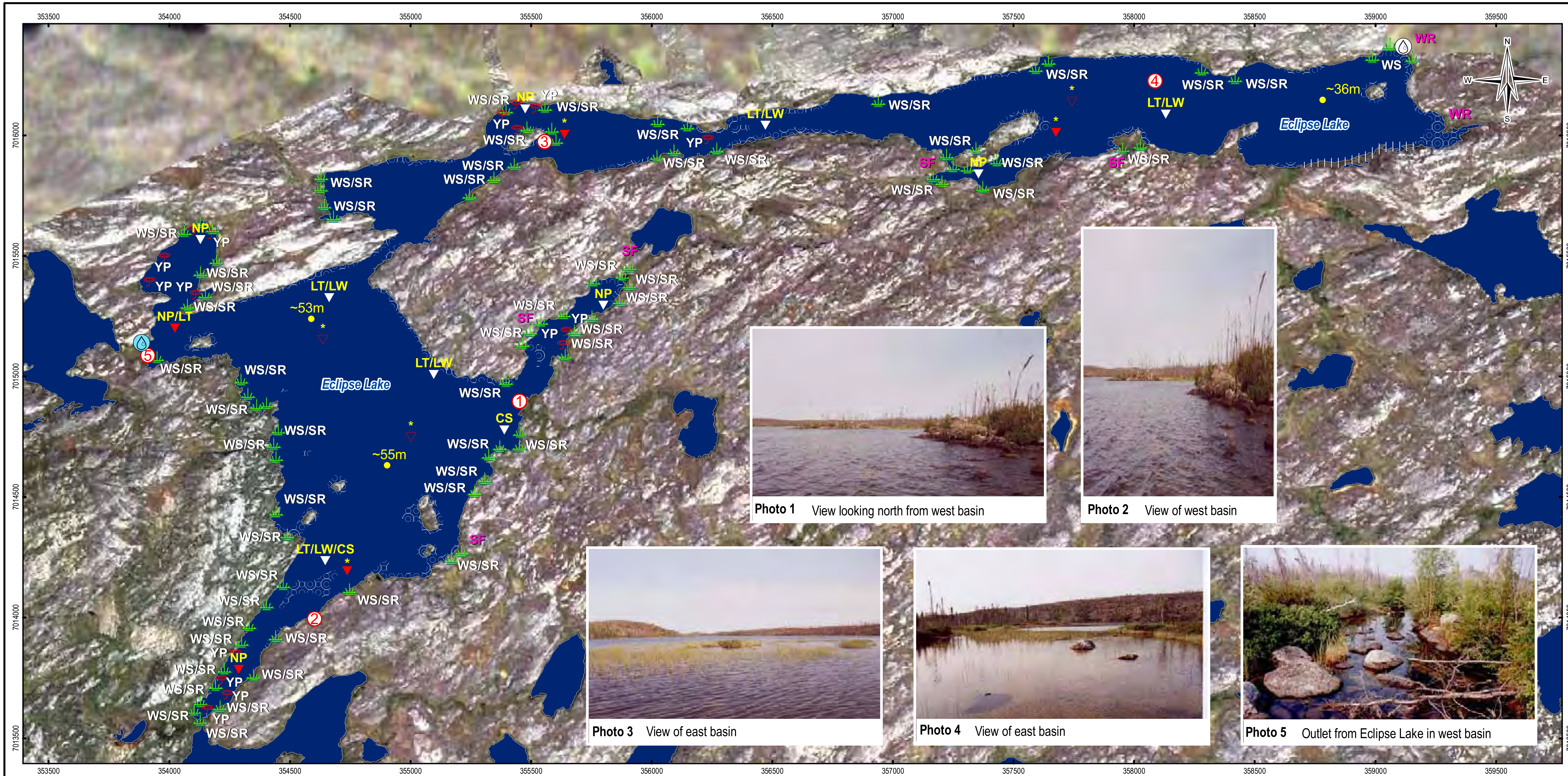
Depth soundings indicated the west and east basins of Eclipse Lake to be relatively deep. Soundings indicated the presence of a 55 m deep hole located near the middle of the west basin and a 53 m deep hole located near the inlet to the east basin. The east basin has a maximum depth of approximately 36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

The preliminary assessment of Eclipse Lake identified habitats that could be good for various life stages of 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 would 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 habitat quality for 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 (Tables 2.11-3a to Table 2.11-3e). Habitat features exhibited a diversity of habitat types that are known to be important for all life stages of northern pike, lake trout, lake whitefish, and lake cisco. Water depths exceeding 30 m were recorded at various locations throughout the lake. These deep-water areas maintain high water quality and cold temperatures for the seasonal foraging of cold water fish.

Steep drop-off areas along the shoreline and islands, and the abundance of rocky reefs and submerged boulder fields could provide optimal spawning and foraging for lake trout, whitefish and migrating schools of lake 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 would 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 lake's main inflow and outflow were observed to lack suitable spawning gravel for grayling use. No records of Arctic grayling populations for this lake are known.



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

NOTES
Base data source: IKONOS (July 27 and August 2, 2004); Landsat TM (August 11, 2001).

ISSUED FOR USE

YELLOWKNIFE GOLD PROJECT

Eclipse Lake Habitat Features

PROJECTION: UTM Zone 12	DATUM: NAD83
Scale: 1:16,000 (100 50 0 100 200 300 400 500 Metres)	
FILE NO.: V23201097-DAR-018.mxd	

PROJECT NO.	DWN	CKD	REV
V23201097	SL	DM	0

OFFICE	DATE
EBA-VANC	February 15, 2011

Tyhee NWT Corp

EBA Engineering Consultants Ltd.

Figure 2.11-6

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2.11.5.2 Fish Population

Fish species composition data and biological information are summarized in Table 2.11-8. 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 one incidental 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 collected from the mouth of a lake trout.

In total, the floating gillnets captured five lake trout, five lake whitefish and three northern pike. The sinking gillnets captured six lake trout and three cisco. The total catch was 23 fish. Ten baited minnow traps, placed along the shoreline and left overnight, did not capture any fish.

Electro-fishing was conducted along a standard 100 m section of the inlet stream for a total effort of 269 seconds. No fish were collected. The Eclipse Lake outlet was electro-fished along a 137 m section of stream for a total effort of 384 seconds. Two small fish, likely juvenile Arctic grayling, were observed in the outlet stream but were not captured.

2.11.5.3 Zooplankton

Zooplankton sampling results are presented in Table 2.11-4. Zooplankton are described in terms of mean abundance, mean density, distribution, and percent composition. In Eclipse Lake, three vertical zooplankton tows were completed from a depth of 23 m to the surface. Rotifera comprised 63.5% of zooplankton taxa with a mean density of 11.6 organisms/m^3. Copepods comprised 31.5% with a mean density of 5.8 organisms/m^3. Cladocera comprised 5% of the zooplankton community. No other orders of organisms were represented. The total mean density of zooplankton in Eclipse Lake was 18.2 organisms/m^3.

2.11.5.4 Benthic Invertebrates – Eclipse Lake

The benthic surveys in Eclipse Lake involved the collection of three replicate Ponar dredge (0.023 m^2) samples in shallow water (littoral) and deep water. Benthic invertebrate data for mean abundance of aquatic invertebrate taxa are presented in Table 2.11-5. Taxonomic composition data (%) for the major invertebrate groups are presented in Table 2.11-6.

Amphipoda were found at a density of 927.5 organisms/m^2, representing 55.2% of genera recorded. Hirudinea (leaches) were also relatively common, representing 22.4%, with a mean density of 376.8 organisms/m^2. Bivalvia, Gastropoda and Oligochaeta all represented 3.5%, with mean densities of 58.0 organisms/m^2 each. The total mean density of benthic invertebrates in Eclipse Lake littoral samples was 1,681.2 organisms/m^2. The benthic genera offshore were comprised principally of Amphipoda (62.0%) with a mean density of 2,318.9 organisms/m^2, and Bivalvia (23.6%) with a mean density of 884.1 organisms/m^2. The total mean density of benthic invertebrates in Eclipse Lake offshore samples was 3,739.1 organisms/m^2.

2.11.5.5 Benthic Invertebrates – Eclipse Lake Inlet and Outlet Streams

Conditions at Eclipse Lake also allowed for the sampling of the main inlet and outlet streams. Chironomidae accounted for the majority of benthic invertebrate genera found in the inlet stream, representing 91.8% of the community, with a mean density of 21,884.1 organisms/m^2. Bivalvia comprised 3.1% of the benthic population, with a mean density of 739.1 organisms/m^2, while Ostracoda comprised 2.3%, with a mean density of 550.73 organisms/m^2. The total mean density of benthic invertebrates in Eclipse Lake inlet stream samples was 869.6 organisms/m^2.

Benthic samples obtained from the outlet stream were more varied and were comprised of: 20.0% Chironomidae, with a mean density of 173.9 organisms/m^2, 35.0% Bivalvia with a mean density of 304.4 organisms/m^2, and 11.7% of both Hirudinea and Ostracoda, with mean densities of 101.4 organisms/m^2. The total mean density of benthic invertebrates in the Eclipse Lake outlet stream samples was 23,840.6 organisms/m^2.

2.11.5.6 Lake Sediment Quality

Analytical data summarizing the percent moisture, pH, nutrients, total metals, organic carbon, and particle size from Eclipse Lake sediments are presented in Table 2.11-7. The second highest value for available phosphorus (82.0 mg/kg) was measured in Eclipse Lake sediments. Copper concentrations in Eclipse Lake were the lowest of all YGP lakes sampled (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 lakes sampled at 2.74 mg/kg. Particle size analysis indicated that the Eclipse Lake sediments consisted primarily of clay (49.9%) and silt (47.8%).

2.11.5.7 Stream Habitat

An investigation of inlet streams at Eclipse Lake identified the presence of one flowing stream located at the end of the east arm of the lake (Figure 2.11-6). The primary inlet to Eclipse Lake is defined within a spruce peat bog at the end of the east arm of the lake. The creek flows through a low topographic depression and conifer forest. Streamside vegetation along both sides of the stream included conifers (black spruce, fir), dwarf birch and wetland plants including sedge, bur-reed and water plantain.

The wetted channel was meandering and unconfined, and had an 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 dominant cover along the creek channel consisted of in-stream vegetation. The inlet stream lacked deep pools, undercut banks and boulders. Stream substrates, as well as bank texture, consisted of fines and small patches of gravel.

A survey of water quality in the inlet stream to Eclipse Lake resulted in a measured DO concentration of 5.74 mg/L (below the generally accepted criterion for aquatic life), a pH of 6.58 and a specific conductivity of 51.5 μS/cm during sampling at the end of July, 2004. Water temperature was measured at 18.6°C.

The primary inlet to the lake is located northeast of the entrance to the east basin. However, due to the diffuse nature of inflowing water to the lake, the shoreline survey was not able to confirm the precise location of the main inlet flow.

The outlet from Eclipse Lake is defined within an open spruce forest community (Section 2.7.1) and a low topographic depression located between Eclipse Lake and another small lake located approximately 80 m to the west (Figure 2.11-6). 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, although 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 deep rocky pools. Stream substrates and bank texture consisted of cobbles and boulders. This outlet stream may provide spawning habitat for Arctic grayling, although this would be limited by the limited presence of gravel substrates.

A survey of water quality in the Eclipse Lake outlet stream resulted in a DO measurement of 8.03 mg/L, a pH of 6.82 and a specific conductivity of 52 μS/cm during sampling in the latter part of July, 2004. These measurements fall within the generally accepted criterion for aquatic life (Environment Canada 2002b). Water temperature was measured at 22°C.

As indicated in Section 2.11.5.2 above, no fish were captured during electrofishing in the inlet and outlet streams of Eclipse Lake. However, two small fish, likely juvenile Arctic grayling, were observed in the outlet stream, but were not captured.

2.11.6 Nicholas Lake

2.11.6.1 Lake Shoreline Habitat

Nicholas Lake is located approximately 9.6 km northeast of the former Discovery Mine camp (Figure 2.11-1). Nicholas Lake is the second largest lake of the six lakes surveyed during the summer 2004 study. Nicholas Lake has three main basins and can be characterized as having many small embayments, small rocky islands, submerged reefs, extensive beds of emergent vegetation, and wetlands (Figure 2.11-7). Nicholas Lake is approximately 3.74 km long and 450 m wide at its widest point, and has a surface area of approximately 96 ha.

An assessment of shoreline habitat features for Nicholas Lake was completed during the period July 26 to 28, 2004. At the time of the field study, the inlet to Nicholas Lake was ephemeral. Observed water in the outlet stream was limited to the first 40 m of creek exiting the lake. The following 100 m was mostly dry and the bottom boulder substrate was exposed and dry. Staff gauge readings at the outlet of Nicholas Lake indicated a water level of 0.3 m. Based on this reading, the lakes' water level was estimated to have lowered by approximately 20 cm from the spring water levels measured by the field crew.

The shoreline vegetation community surrounding Nicholas Lake consists of black spruce, paper birch, dwarf birch, willow and fireweed. The lake basins are typically associated with pockets of emergent sedges including: water sedge, scouring rush, 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 submerged beds of water smartweed, and slender pondweed. A further discussion of vegetation within the YGP project area is provided in Section 2.7.1 of this DAR.

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's 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 (Tables 2.11-3a to Table 2.11-3e). Habitat characteristics are similar to those documented for Eclipse Lake. The abundance of sedge grasses and rushes along the shoreline may provide spawning and rearing habitat for northern pike (Inskip 1982). Rocky bottom substrates and the diversity of steep shoreline drop-offs, islands, rocky reefs, and submerged boulder fields all provide optimal rearing and foraging habitat for such species as lake trout, whitefish and northern pike (Figure 2.11-7).

Nicholas Lake was observed to have a series of deep-water basins with good water quality and cold temperatures, which are important for seasonal foraging of cold 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 showed limited suitable spawning substrate for grayling.

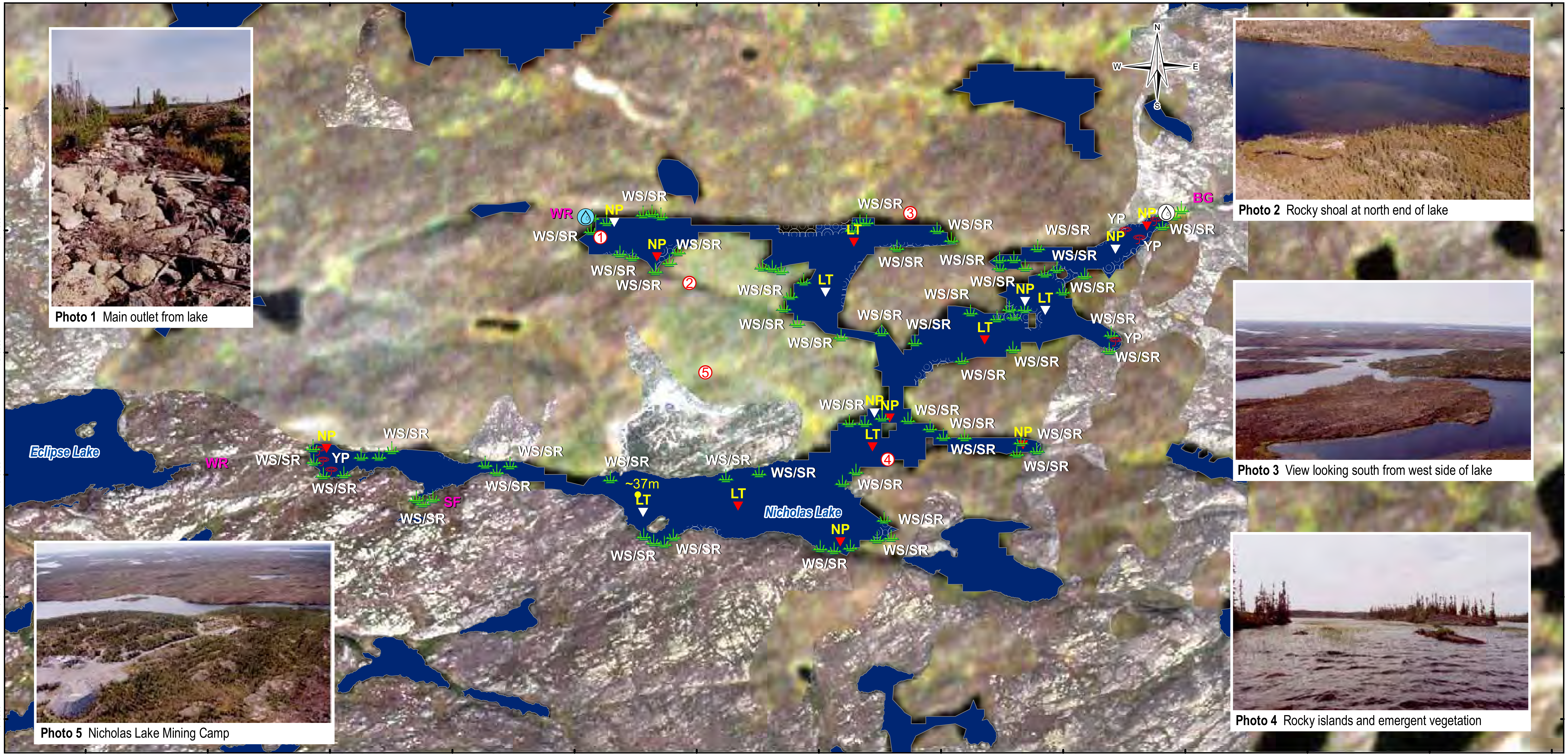

Photo 1 Main outlet from lake

Photo 2 Rocky shoal at north end of lake

Photo 3 View looking south from west side of lake

Photo 4 Rocky islands and emergent vegetation

Photo 5 Nicholas Lake Mining Camp

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
- Principle Inlet
- Principle 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

NOTES
Base data source: IKONOS (July 27 and August 2, 2004); Landsat TM (August 11, 2001).

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YELLOWKNIFE GOLD PROJECT

Nicholas Lake Habitat Features

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:16,000
200 100 0 200 400
Metres

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FILE NO.
V23201097-DAR-019.mxd

PROJECT NO.	DWN	CKD	REV
V23201097	SL	DM	0

OFFICE	DATE
EBA-VANC	February 15, 2011

Figure 2.11-7

2.11.6.2 Fish Population

Fish species composition data and biological information derived from gill net sampling in Nicholas Lake are summarized in Table 2.11-8. A total of 17 fish were caught in Nicholas Lake consisting of northern pike, lake trout, and burbot. No lake whitefish were captured despite the apparent availability of suitable habitat for this species. Lake trout accounted for 52.9% (nine fish) of the catch, while northern pike accounted for 41.2% (seven 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, thereby precluding electro-fishing. A 42 m section of the outlet stream was electro-fished, resulting in the collection of one 6.2 cm long juvenile northern pike. Other small fish observed in the stream were likely juvenile Arctic grayling.

2.11.6.3 Zooplankton

Zooplankton sampling results are presented in Table 2.11-4. Zooplankton are described in terms of mean abundance, mean density, distribution, and percent composition. The Nicholas Lake zooplankton survey involved the completion of three vertical tows from water depths of 19 m and 21 m to the surface. Copepoda, with a mean density of 5.7 organisms/m^3, comprised the majority (80%), of the zooplankton community in Nicholas Lake. Rotifera, with a mean density of 1.4 organisms/m^3, comprised 19.2% of the population. Amphipoda was the only other order represented with 0.1%. Nicholas Lake exhibited the lowest density of zooplankton of all the lakes sampled with a mean of 7.0 organisms/m^3.

2.11.6.4 Benthic Invertebrates

Benthic surveys in Nicholas Lake involved the collection of three replicate Ponar dredge (0.023 m^2) samples in shallow water (littoral) and deep water. The data for mean abundance of aquatic invertebrate taxa are presented in Table 2.11-5. Taxonomic composition data (%) for the major invertebrate groups are presented in Table 2.11-6.

Nicholas Lake littoral benthic samples were primarily represented by Hirudinea (43.95%), with a mean density of 1,000.0 organisms/m^2. Amphipoda comprised 27.4% of the community, with a mean density of 623.2 organisms/m^2, while Diptera (flies) comprised 7.6% of the benthic community, with a mean density of 173.9 organisms/m^2. Nematoda (round worms) comprised 5.1% of the community with a mean density of 115.9 organisms/m^2. The total mean density of benthic invertebrates in Nicholas Lake littoral samples was 2,275.4 organisms/m^2.

Deep water benthic samples consisted of Amphipoda, representing 54.7% of the community, with a mean density of 2,710.2 organisms/m^2. Bivalvia comprised 27.5%, with a mean density of 1,362.32 organisms/m^2 and Hirudinea comprised 8.2%, with a mean density of 405.8 organisms/m^2. The total mean density of benthic invertebrates in Nicholas Lake offshore samples was 4,956.5 organisms/m^2.

Benthic invertebrate samples were not collected from Nicholas Lake inlet and outlet streams during the 2004 and 2005 studies.

2.11.6.5 Lake Sediment Quality

Analytical data summarizing the percent moisture, pH, nutrients, total metals, organic carbon, and particle size in Nicholas Lake sediment samples are presented in Table 2.11-7.

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

2.11.6.6 Stream Habitat

The inlet to Nicholas Lake is poorly defined within a sedge and peat bog, (Figure 2.11-7), which is described in Section 2.7.1 of this DAR. 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 cottongrass. Streambed material consisted of fines. Several upland bogs and small lakes drain into Nicholas Lake.

The Nicholas Lake outlet stream was defined within an open spruce forest community and 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. The dominant cover type was boulders (>0.8 m in diameter). Stream substrates as well as bank texture, consisted of cobbles and boulders. This outlet stream may provide spawning habitat for Arctic grayling, although this could be limited by the small amount of suitable gravel substrate.

Measurements of water quality within the first 42 m of the outlet stream channel from Nicholas Lake occurred during the latter part of July, 2004. Results were similar to surface water quality from the lake. Measured DO concentration was 8.03 mg/L, pH was recorded at 7.04 and specific conductivity was 61 µS/cm. Water temperature at the outlet was measured at 20°C.

2.11.7 Brien Lake

2.11.7.1 Lake Shoreline Habitat

The field assessment of Brien Lake was completed during the period July 29, 2004 and July 30, 2004.

Brien Lake (Figure 2.11-1) is located approximately 1.5 km west of the former Discovery Mine Camp. Brien Lake is approximately 1.61 km long and 290 m wide, and has a surface area of about 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 2.11-8).

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, lodgepole pine, 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, milfoil, and muskgrass. A further description of vegetation in the YGP area is provided in Section 2.7.1 of this DAR.

The dense stands of emergent, submerged and floating aquatic vegetation along the south end of the basin and along the shoreline margins together with deep water, would provide optimal cover for the rearing and foraging of northern pike and small forage fish (Figure 2.11-8). Sedge fens observed along the margins of the lake would also provide an increase in available spawning substrate for northern pike when flooded during higher lake levels in spring. Small hummocks of sedge vegetation help keep the adhesive eggs suspended above sediments and in well-oxygenated water, thus avoiding anoxic conditions (Casselman, 1996). The long profile of the lake allows for wind action to continually mix and oxygenate the water column. Brien Lake provides suitable over-wintering conditions for both northern pike and forage fish species, such as slimy sculping.

Observed habitat attributes for fish indicate a habitat suitability rating of Moderate for northern pike and Poor for all other fish species (Tables 2.11-3a to Table 2.11-3e). Brien Lake was observed to be relatively shallow and to have only one deep section (approximately 11 m) near the centre of the lake. The results of the fish population assessment (presented in section 2.11.7.2) indicated that Brien Lake provides suitable habitat for northern pike (only northern pike were caught during the sampling program). Lake trout and whitefish were not captured, suggesting poor habitat conditions for these species. The lake was observed to have no steep shoreline gradients, rocky shoals or large coarse substrates. The Brien Lake inlet and outlet regulate water levels in the lake and also provide spawning area and rearing conditions for northern pike.

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

NOTES

Base data source: IKONOS (July 27 and August 2, 2004); Landsat TM (August 11, 2001).

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Brien Lake Habitat Features

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:10,000

100 50 0 100 200 300 Metres

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EBA Engineering Consultants Ltd.

FILE NO.			
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PROJECT NO.	DWN	CKD	REV
V23201097	SL	DM	0
OFFICE	DATE		
EBA-VANC	February 15, 2011		

Figure 2.11-8

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2.11.7.2 Fish Population

Fish species composition data and biological information for fish gillnetted in 2004 in Brien Lake are summarized in Table 2.11-8.

Six northern pike were caught during the sampling program. All of the pike were caught in a floating gillnet set. Minnow traps did not capture any fish. The main inlet and outlet channels of Brien Lake were defined by two sedge/willow wetlands. No visibly defined inlet or outlet channels were observed in the wetlands and therefore no electro-fishing was conducted.

2.11.7.3 Zooplankton

Zooplankton sampling locations are shown on Figure 2.11-1 and results are presented in Table 2.11-4. Zooplankton results are described in terms of mean abundance, mean density, distribution, and percent composition.

The Brien Lake zooplankton survey involved the completion of three vertical tows from a water depth of 10 m to the surface. The Brien Lake zooplankton community consisted primarily of Copepoda (48.7%), Rotifera (46.7%) and Cladocera (4.0%). The mean densities for Copepoda, Rotifera, and Cladocera were 17.8 organisms/m^3, 17.1 organisms/m^3 and 1.5 organisms/m^3, respectively. Zooplankton identified in low numbers included the orders Insecta, Amphipoda and Eubranchiopoda. The total mean density of zooplankton in Brien Lake was 36.6 organisms/m^3.

2.11.7.4 Benthic Invertebrates

The data for mean abundance of aquatic invertebrate taxa are presented in Table 2.11-5. Taxonomic composition data (%) for the major invertebrate groups are presented in Table 2.11-6. The benthic surveys involved the collection of three replicate Ponar dredge (0.023 m^2) samples in shallow water (littoral) and deep water at each of the lakes in the YGP study area.

Chironomidae comprised the largest group in Brien Lake littoral benthic samples, representing 55.9% of the community, with a mean density of 478.3 organisms/m^2. Amphipoda comprised 15.3% with a mean density of 130.4 organisms/m^2. Bivalvia comprised 11.9%, with a mean density of 101.5 organisms/m^2. The total mean density of benthic invertebrates in Brien Lake littoral samples was 884.1 organisms/m^2.

The deeper water samples consisted primarily of Bivalvia, representing 41.25% of genera. These samples had a mean density of 478.3 organisms/m^2. Chironomidae represented 40.0% of the community, with a mean density of 463.8 organisms/m^2. Copepoda comprised 11.3% of genera and had a mean density of 130.4 organisms/m^2. The total mean density of benthic invertebrates in Brien Lake offshore samples was 1,159.4 organisms/m^2.

Benthic invertebrate samples were not collected in the Brien Lake inflow and outflow streams.

2.11.7.5 Lake Sediment Quality

Analytical data summarizing the percent moisture, pH, nutrients, total metals, organic carbon, and particle size for Brien Lake sediment samples are presented in Table 2.11-7. Available phosphorus levels in these samples were the highest of all the other YGP lakes included in the study. Brien Lake samples also exhibited the highest concentrations of cadmium, beryllium and cobalt. 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, and mercury was the second highest recorded concentration (0.133 mg/kg) after Round Lake. Total organic carbon was high at 19.4 mg/kg. Particle size analysis was not possible due to the high organic content of the sediment samples.

2.11.7.6 Stream Habitat

A willow shrub forest and sedge fen located at the north end of Brien Lake characterizes the stream inlet to Brien Lake (Figure 2.11-8). The outlet from Brien Lake is located at the end of a triangular bay at the northwest side of the lake. An elevated section of shoreline 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, defined within a sedge fen located at the south end of the lake. At the time of the 2004 summer survey, the inlet and outlet were dry and poorly defined.

2.11.8 Narrow Lake

2.11.8.1 Lake Shoreline Habitat

An assessment of shoreline habitat features for Narrow Lake was completed July 30, 2004 through August 1, 2004.

Narrow Lake is located about 2.2 km southwest of the former Discovery Mine camp (Figure 2.11-1). The lake is characterized by a single long basin, approximately 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, flows south into a small lake located about 100 metres to the southwest (Figure 2.11-9).

The forest surrounding Narrow Lake consists of black spruce, paper birch, lodgepole pine, and willow. Shoreline vegetation includes dwarf birch, sweet gale, and willow. Several wetlands exist along the edge of Narrow Lake, as described in Section 2.7.1. The complexity of wetlands observed along the margins of the lake include: open fens dominated by water sedge, fen/swamps dominated by dead spruce, 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, while deep littoral plants include water smartweed and milfoil (Figure 2.11-9).

The bathymetric survey of Narrow Lake indicated a maximum depth of 13 m located in the southwest basin of the lake (Figure 2.11-10). This depth was recorded in a deep hole with a relatively steep gradient. Another deep hole of 10 m was identified in the northeast basin. While rocky bottom substrates were identified within the southern portion of the lake, the bottom substrate within the majority of Narrow Lake consists of fine organic material and silt.

An analysis of fish habitat suitability for Narrow Lake indicates a rating of Moderate for northern pike, lake trout, lake whitefish, and lake cisco, and a rating of Poor for Arctic grayling (Tables 2.11-3a to Table 2.11-3e). While the margins of the lake provide abundant emergent and submerged 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 either lake cisco or Arctic grayling.

2.11.8.2 Fish Population

Fish species composition data and biological information for Narrow Lake are summarized in Table 2.11-8. In Narrow Lake, lake whitefish were the most common fish species captured in 2004 by gillnets, representing 89.2% (74 individuals) of all fish collected. The floating gillnet set captured 24 lake whitefish, while the sinking gillnet set captured 50 lake whitefish. The remaining 10.8% of fish collected in Narrow Lake were six northern pike captured by floating gillnet and three northern pike captured by sinking gillnet. Baited minnow traps were effective in the capture of two juvenile northern pike. Electro-fishing of the inlet channel from Winter Lake was previously conducted and did not result in any fish being captured. No visible outlet channel was evident at the southwest end of the lake, and therefore no electro-fishing was conducted.

During the summer 2005 lake survey, gillnet sets were successful in the collection of fish from Narrow Lake. Lake whitefish was the most abundant species present in Narrow Lake with a total of 96 whitefish being captured; 32 fish were captured in floating gill nets and 64 in the sinking gillnet sets. A sub sample of the whitefish collected from Narrow Lake ranged in age from four to nineteen years. Ten northern pike were also captured and ranged in age from under four to twelve years. No fish were captured in the Narrow Lake minnow traps.

2.11.8.3 Zooplankton

Zooplankton sample results of the analysis are presented in Table 2.11-4. Zooplankton data are described in terms of mean abundance, mean density, distribution, and percent composition. .

The Narrow Lake zooplankton survey involved the completion of three vertical tows from a water depth of 11 m to the surface. The Narrow Lake zooplankton community consisted of Copepoda (54.3%), Cladocera (35.4%), and Rotifera (10.3%). Copepoda, Cladocera, and Rotifera recorded mean densities of 46.2, 30.1, and 8.7 organisms/m^3 respectively. No other zooplankton species were represented. Narrow Lake had the highest recorded zooplankton density of all the lakes in the YGP study area, with a mean of 85.1 organisms/m^3.

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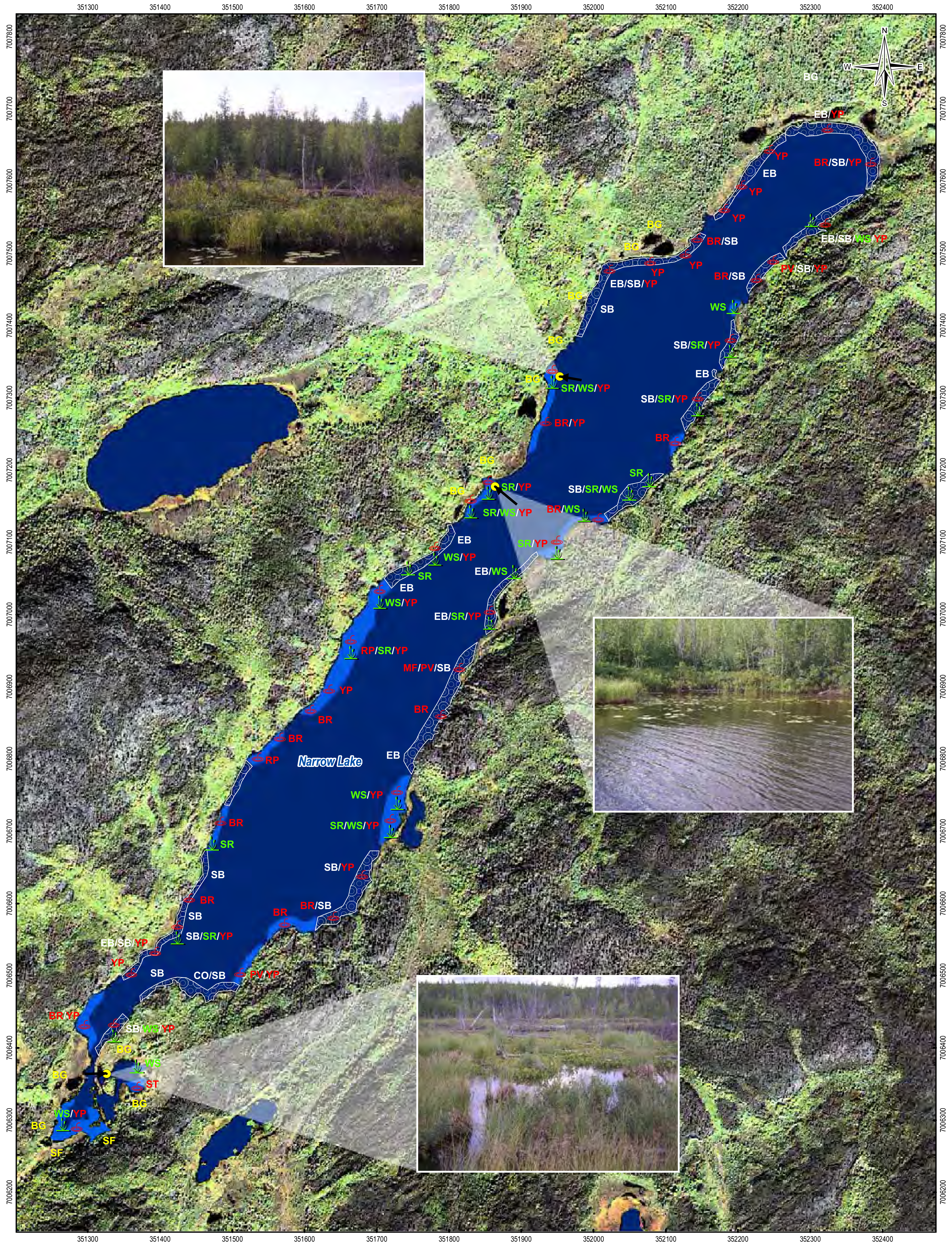

LEGEND

- Photo
- Rock Feature
- Emergent Vegetation
- Submergent Vegetation

Emergent Vegetation		Submergent Vegetation	
BG	Bog Wetland	BR	Burreed
SF	Sedge Fen	MF	Milfoil
SR	Scouring Rush	PV	Potangeton Vulgaris
SS	Soft Stemmed	RP	Richardson's Pondweed
WS	Water Sedge	ST	Submerged Trees
		YP	Yellow Water Lily
Habitat Type		**Feature**	
BG	Bog Wetland	CO	Cobbles
SF	Sedge Fen	EB	Emergent Boulders
WR	Willow (Salix) Riparian	SB	Shallow Boulders

NOTES
1. Imagery Source: IKONOS (July 27 and August 2, 2004); Landsat TM (August 11, 2001).
2. Water Features: Extracted from IKONOS imagery.
3. Habitat Features: from Spring/Summer 2005.

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Narrow Lake Habitat Features

PROJECTION: UTM Zone 12
DATUM: NAD83
Scale: 1:5,012
100 50 0 100
Metres

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EBA Engineering Consultants Ltd.

FILE NO.: V23201097-DAR-021.mxd

PROJECT NO.	DWN	CKD	REV
V23201097	SL	DM	0

OFFICE: EBA-VANC
DATE: February 15, 2011

Figure 2.11-9

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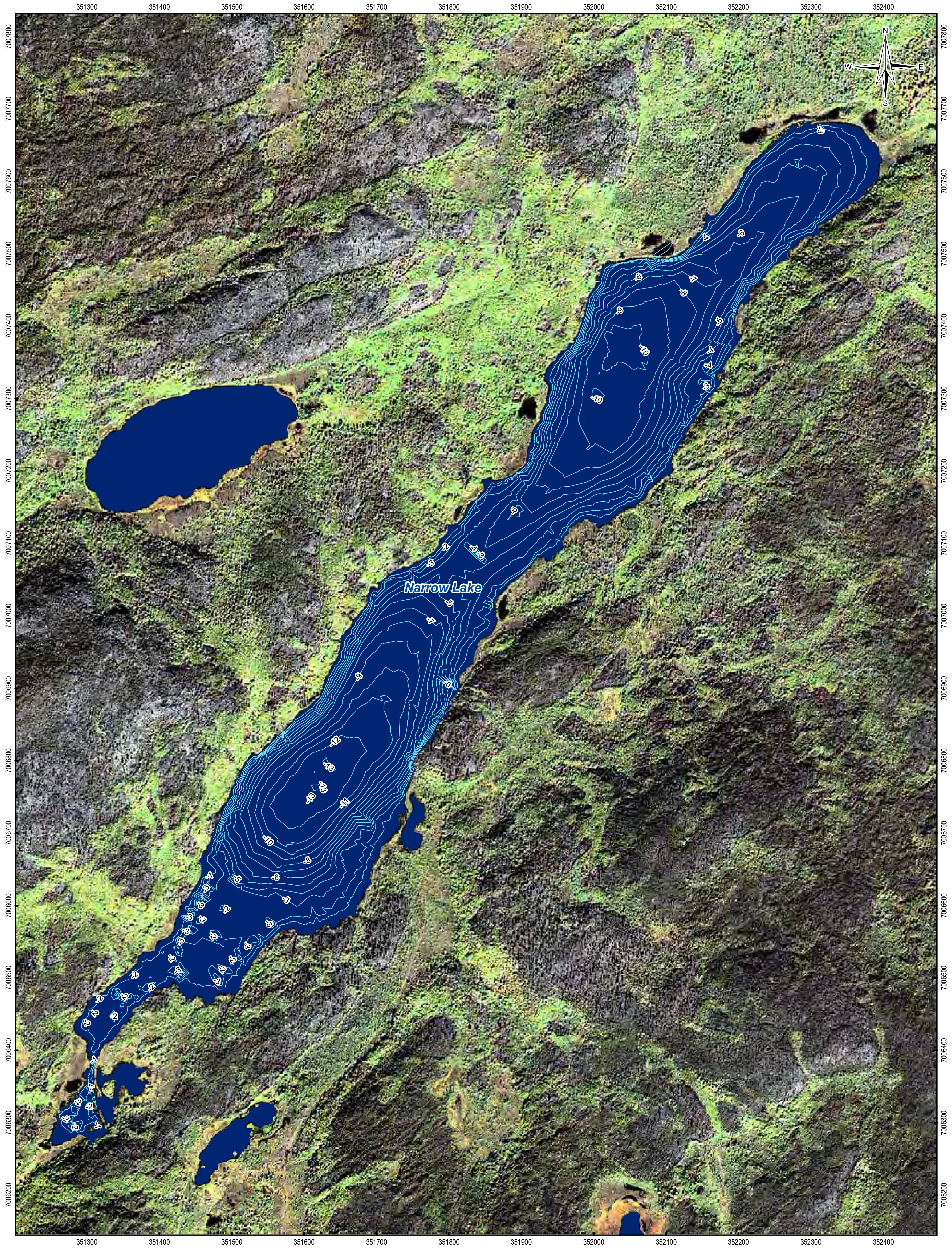

LEGEND

Bathymetry (1 m interval)

NOTES

1. Bathymetry Features: data was collected using a Trimble Pathfinder Pro XRS TS-C1 GPS data logger and Trimble Pro XRS receiver and a MarineTek SEAMAX depth sounder. The data were formatted using ARC/INFO to produce maps.
2. Imagery Source: IKONOS (July 27 and August 2, 2004); Landsat TM (August 11, 2001).
3. Water Features: Extracted from IKONOS imagery.
4. Source: 2005 Field Data Report.

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YELLOWKNIFE GOLD PROJECT

Narrow Lake Bathymetry

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:5,000

50 25 0 50 100 150

Metres

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FILE NO.
V23201097-DAR-026.mxd

PROJECT NO.	DWN	CKD	REV
V23201097	SL	DM	0

OFFICE	DATE
EBA-VANC	February 15, 2011

Figure 2.11-10

2.11.8.4 Benthic Invertebrates

The benthic surveys in Narrow Lake involved the collection of three replicate Ponar dredge (0.023 m^2) samples in shallow water (littoral) and deep water. The data for mean abundance of aquatic invertebrate taxa are presented in Table 2.11-5. Taxonomic composition data (%) for the major invertebrate groups are presented in Table 2.11-6.

In Narrow Lake littoral benthic samples, Amphipoda represented the largest group at 44.0%, with a mean density of 1,000.0 organisms/m^2. Bivalvia made up 12.7% of the genera with a mean density of 289.9 organisms/m^2. Chironomidae and Cladocera each comprised 9.6% of the genera, with mean densities of 217.4 organisms/m^2. The total mean density of benthic invertebrates in Narrow Lake littoral samples was 2,260.9 organisms/m^2. Deep-water samples were dominated by Hirudinea. This group represented 76.9% of the genera, with a mean density of 434.8 organisms/m^2. Chironomidae represented 15.4% of the genera, with a mean density of 87.0 organisms/m^2. The total mean density of benthic invertebrates in Narrow Lake offshore samples was 565.2 organisms/m^2.

2.11.8.5 Lake Sediment Quality

Analytical data summarizing the percent moisture, pH, nutrients, total metals, organic carbon, and particle size in Narrow Lake sediment samples are presented in Table 2.11-7. Narrow Lake sediments had the highest value of barium (224 mg/kg) compared to the other YGP lakes sampled. Chromium concentrations were also the highest (58.5 mg/kg) compared to the other lakes in the study area. Copper and mercury levels were comparable to the other lakes and the 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 Narrow Lake sediments consisted of clay (63.1%), silt (30.5%) and sand (6.4%).

2.11.8.6 Stream Habitat

The inlet to Narrow Lake is located within a willow shrub forest and sedge fen located at the north end of the lake (Figure 2.11-9). The inlet and outlet streams were dry during the survey and poorly defined.

2.11.9 Fish Biological Characteristics

This section discusses the biological characteristics of the fish collected in the YGP study area in 2004. Fish meristic data are presented in Table 2.11-8. Data and data analyses are provided in Appendix D.

2.11.9.1 Northern Pike

Length measurements obtained for northern pike collected from Eclipse, Nicholas, Brien and Narrow lakes, ranged from 165 mm to 745 mm, and from 15.5 to 55.4 cm in Winter Lake. Weights ranged between 40 g to 2,660 g in Eclipse, Nicholas, Brien and Narrow lakes, and 22 g to 1,293 g in Winter Lake. Ages ranged from two to seven years in all but Winter Lake where the age range of the 10 captured fish was one to three years.

The exponential relationship between fish length and weight for northern pike in Eclipse, Nicholas, Brien, and Narrow lakes resulted in a high degree of correlation (R^2) of 0.98, 0.82, 0.98, and 0.8, respectively.

The condition factor[2] calculated for gill netted northern pike among the sampled lakes was very consistent, ranging from 0.63 to 0.69. For all lakes, condition factor was less than one, perhaps indicating relatively poor feeding conditions.

2.11.9.2 Lake Trout

Lake trout were only collected in Eclipse and Nicholas lakes, and ranged in length from 191 mm to 755 mm. Weights ranged from 60 g to 6,803 g, and ages ranged from a 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 and Nicholas lakes were positioned in water approximately 20 m in depth.

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. Condition factor for lake trout was similar between these two lakes (1.05 vs. 1.01, respectively) despite the large variability in fish lengths and weights. A condition factor greater than one generally reflects good feeding conditions and energy conversion.

2.11.9.3 Lake Whitefish

Lake whitefish were captured only in Eclipse and Narrow lakes within the study area. Length measurements obtained for lake whitefish captured in these lakes ranged from 144 mm to 450 mm. Weights ranged between 40 g and 1,240 g, and ages ranged from a 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. Out of a total of 170 lake whitefish captured in Narrow Lake in 2004 and 2005, 56 fish were captured in surface waters and 114 fish were captured by sinking gillnets positioned in the deepest area of the lake at a water depth of 12 m.

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. The condition factor for lake whitefish for both Eclipse and Narrow lakes was 1.17 and 1.27, respectively, suggesting the availability of an adequate food supply in both lakes.

2.11.10 Fish Tissue – Metals Analysis

2.11.10.1 2004 Sampling

The following section presents the results of fish tissue analysis from samples collected in 2004. The tissue-sampling program was completed to document baseline levels of metals in fish tissues from lakes in the YGP study area (Appendix D). Samples for metal analysis were submitted as composite tissue samples (muscle and liver combined) for three northern pike,

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[2] Calculated as K=(Weight (gm) x 100) / Length (cm)^3

five lake trout, and five lake whitefish from Eclipse Lake, and for five northern pike and five lake trout from Nicholas Lake. Fish tissue samples were also submitted from Brien Lake (five northern pike) and Narrow Lake (five northern pike and five lake whitefish). Analytical results are presented in Table 2.11-9.

The levels of mercury and arsenic were recorded in tissues from a single large lake trout captured in Eclipse Lake. The lake trout, determined to be 34+ years of age, contained mercury levels at eight times the restrictive consumption level of 0.5 ppm (wet weight – Health and Welfare Canada, 2002). The same specimen also exhibited an elevated arsenic level that was below the restrictive consumption level of 3.5 ppm (wet weight – DFO 1985). One northern pike collected from Eclipse Lake showed slightly elevated levels of mercury and arsenic.

As previously noted in Section 2.11.1, laboratory analyses of fish tissues (muscle and liver) from Giauque Lake conducted in the late 1970s, determined that mercury levels were elevated at that time (Moore *et al*. 1978; Hale *et al*. 1979). 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 that 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.

Fish from Giauque Lake regularly contained mercury levels in excess of the 0.5 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 also contained mercury concentrations in excess of the restrictive level, suggesting that naturally elevated background levels of mercury occur in the environment of the study area.

Regarding other metals tested during the 2004 sampling program, high levels of selenium were found in lake trout from both Eclipse and Nicholas lakes. In addition, high levels of copper were found in northern pike tissues in Nicholas and Brien lakes, and particularly in one northern pike sample from Brien Lake, which had the highest level of copper found during the study (54.3 mg/kg). No elevated levels were reported for all other metal analyses including: cadmium, chromium, lead, nickel, silver or zinc.

2.11.10.2 2005 Sampling

During the 2005 summer survey, additional samples of liver and muscle tissue were collected from fish in Narrow and Winter lakes (Appendix D). Tables 2.11-10a and 2.11-10b provide analysis results for concentrations of metals in northern pike and lake whitefish muscle and liver tissues, respectively. Mercury levels recorded in Narrow Lake fish were higher than those found in Winter Lake fish, likely due to the greater size and age of the fish present in Narrow Lake (only 10 juvenile pike were captured in Winter Lake). In both liver and muscle tissue from northern pike and lake whitefish collected from Narrow Lake, mercury levels were measured above the Health and Welfare Canada restrictive consumption level of 0.5 ppm. Zinc was commonly present in muscle and liver tissue of fish tested from both lakes. No other metal of concern was present in any of the muscle tissue samples.

Copper, selenium and silver were commonly present in most liver samples. Arsenic, cadmium, chromium, lead, and nickel levels in fish livers from both lakes were generally found to be at values below detection limits. For whole fish samples taken from the Narrow Lake outlet stream during the spring survey, metals analysis indicates detectable levels of zinc, mercury and copper.

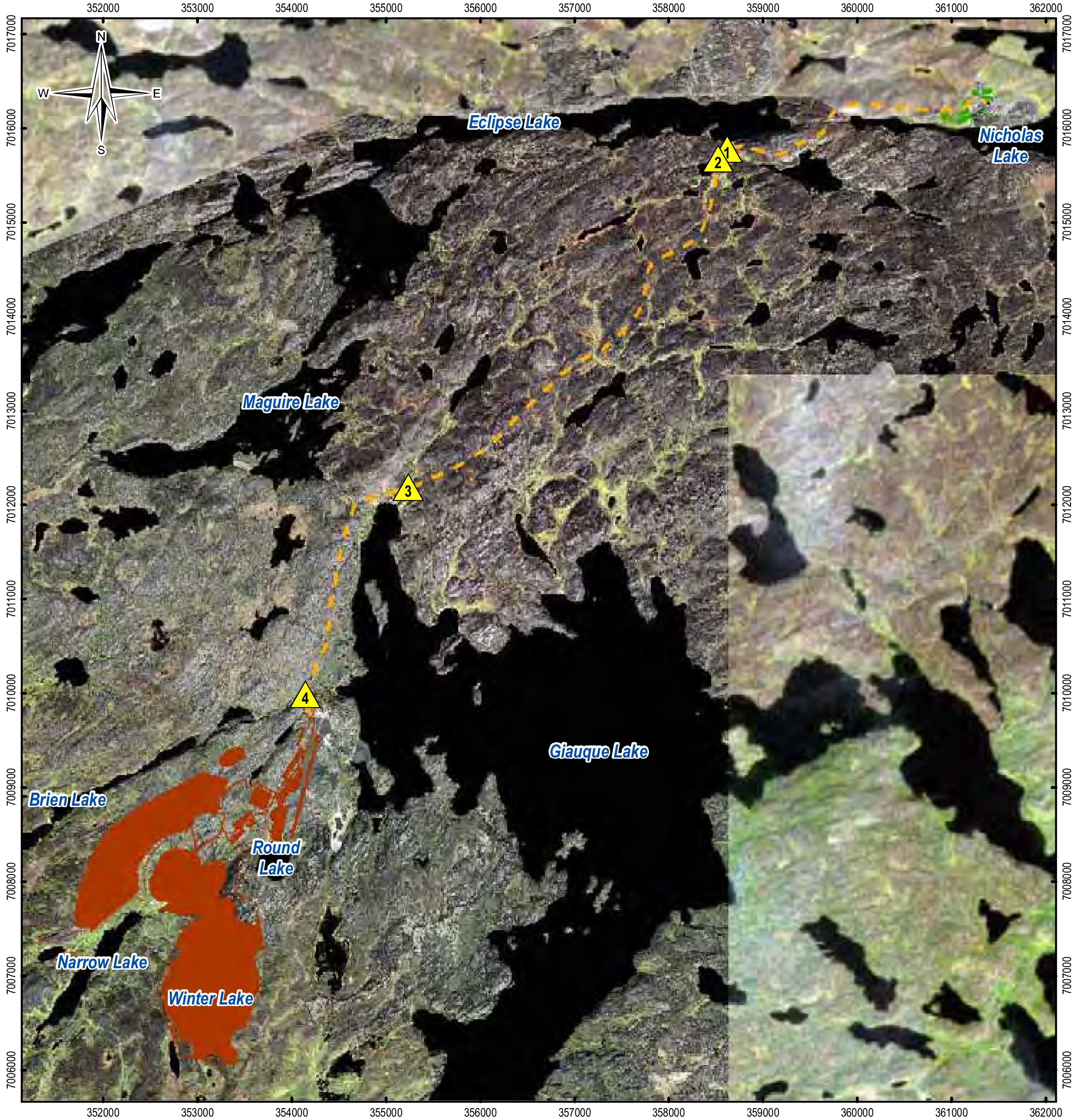
2.11.11 Proposed Haul Road – Ormsby to Nicholas Lake Stream Crossings

Figure 2.11-11 identifies the route of the proposed haul road between the Ormsby and Nicholas development areas. This route has changed somewhat since fish sampling was carried out at the potential stream crossing sites (June 3 and August 10, 2005). Sampling Sites 1, 2, and 4 (Figure 2.11-11) are located on the same streams, but not the exact positions, that will be crossed by the proposed haul road. Stream crossing Site 3 is now located on an outlet stream from a small lake, just upstream of the northwest arm of Giauque Lake, which differs from its previous location on a small drainage creek located elsewhere in this same drainage.

No fish were captured or observed at any of the stream crossings along the proposed haul road during fishing efforts in 2005. It was concluded that these small streams are unlikely to be fish-bearing. However, since sampling or observations have not been carried out at Site 3, reconnaissance fish and fish habitat surveys will be conducted at this location prior to road construction. Results of this investigation will permit adaptation of stream crossing design and methods to suit local conditions.

Potential fish habitat was variable at the stream crossing locations investigated in 2005. Sites 1 and 2 consist of defined, slow-flowing channels (with the exception of where the existing winter road has resulted in a segment of diffuse unconfined flow at Site 1. The stream at Site 4 consists of a wide, braided channel near its confluence with Giauque Lake. Overland flow within the riparian zone was observed during the spring survey. This flow had resulted from ice build- up within the channel in the lower portion of the stream. As indicated above, the Site 3 crossing is now in a different location and as such, results of the fish habitat investigations at the previous site are no longer relevant.

Water temperatures were measured at each of the stream crossings during spring fieldwork between May 29 and June 3, 2005. Consistent with previous sampling completed at the Winter Lake outlet stream and the Narrow Lake inlet stream, water temperatures increased rapidly at Sites 1 and 2, but only marginally at Site 4 during the short sampling period.



Q:\Vancouver\GIS\ENVIRONMENTAL\V232\V23201097_Tyhee_DAR\Maps\DAR\V23201097-DAR-027.mxd

LEGEND

- Stream Crossing
- Nicholas Lake Access Road
- Ormsby Footprint
- Nicholas Lake Footprint

NOTES

1. Imagery Source: IKONOS (July 27 and August 2, 2004); Landsat TM (August 11, 2001).
2. Source: 2005 Spring/Summer Data Report.

ISSUED FOR USE

YELLOWKNIFE GOLD PROJECT

Ormsby to Nicholas Lake Access Road Fisheries Survey Locations

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:60,000

1 0.5 0 1

Kilometres

Tyhee NWT Corp

EBA Engineering Consultants Ltd.

FILE NO.			
V23201097-DAR-027.mxd			
PROJECT NO.	**DWN**	**CKD**	**REV**
V23201097	SL	DM	0
OFFICE	**DATE**		
EBA-VANC	April 14, 2011		

Figure 2.11-11

TABLE 2.11-4: ZOOPLANKTON TOTAL ABUNDANCE AND PERCENT COMPOSITION														
Lake ID	Brien Lake		Narrow Lake		Winter Lake		Round Lake		Eclipse Lake		Nicholas Lake		TOTAL	
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	No of Organisms	% Total
Rotifera	7030	46.72	3950	10.26	3017	28.79	833	37.68	10945	63.48	1090	19.16	26865	30%
Eubranchiopoda	0	0.00	0	0.00	5	0.05	0	0.00	0	0.00	0	0.00	5	0%
Cladocera	600	3.99	13633	35.43	4680	44.64	265	11.99	862	5.00	13	0.23	20053	22%
Copepoda	7327	48.69	20898	54.31	2137	20.38	1012	45.77	5435	31.52	4585	80.61	41394	46%
Amphipoda	0	0.00	0	0.00	1	0.01	2	0.09	0	0.00	0	0.00	3	0%
Insecta	90	0.60	0	0.00	645	6.15	99	4.48	0	0.00	0	0.00	834	1%
Total	15047	100.00	38481	100.00	10485	100.00	2211	100.00	17242	100.00	5688	100.00	89154	100%

TABLE 2.11-5: 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	Mean 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)	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:

Inshore samples taken with Ekman sampler; approximate area of 0.023 m^2.

Offshore samples taken with Ponar sampler; approximate area of 0.023 m^2.

In all cases Mean Abundance is average of three samples

TABLE 2.11-5: 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	0.10	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	83.75	3641.31

Note:

Inshore samples taken with Ekman sampler; approximate area of 0.023 m^2.

Offshore samples taken with Ponar sampler; approximate area of 0.023 m^2.

In all cases Mean Abundance is average of three samples

TABLE 2.11-6: 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 2.11-6: BENTHIC INVERTEBRATE COMMUNITY COMPOSITION (CONT'D)

Lake ID	Round Lake				Eclipse Lake				Eclipse Lake (Stream Samples)				Nicholas Lake				Total	Total %
Sample Location	Inshore		Offshore		Inshore		Offshore		Inlet		Outlet		Inshore		Offshore		Species No.	Composition
	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	35	0.98
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	1	0.03
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	5	0.14
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	13	0.38
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	3	0.09
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	38	1.07
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	2167	61.48
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	9	0.25
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	2	0.06
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	1	0.03
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	6	0.18
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	6	0.17
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	388	11.01
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	5	0.14
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	39	1.11
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	32	0.91
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	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	1	0.03
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	62	1.75
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	44	1.25
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	493	13.99
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	83	2.35
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	34	0.96
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	59	1.67
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	3525	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 2.11-7: 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.

TABLE 2.11-8: 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
		Condition Factor**			0.67	0.63	0.69	0.66	
	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)			52.47	47.36			49.92
		Maximum Length (cm)			75.5	56.4			75.5
		Minimum Length (cm)			29.5	19.1			19.1
		Standard Deviation			11.46	11.61			11.48
	Weight Data	Number of fish sampled			11	9			20
		Mean Weight (g)			1859.30	1280.63			1569.96
		Maximum Weight (g)			6803	1820			6803
		Minimum Weight (g)			250	60			60
		Standard Deviation			1804.74	524.92			1387.57
		Condition Factor			1.05	1.01			
	Age Data	Number of fish sampled			7	5			12
		Mean Age			11.33	14			12.40
		Maximum Age			16	24			24
		Minimum Age			7	3			3
		Standard Deviation			3.33	8.68			5.76
Lake cisco	Length Data	Number of fish sampled			3				3
		Mean Length (cm)			12.60				12.60
		Maximum Length (cm)			12.8				12.8
		Minimum Length (cm)			12.6				12.6
		Standard Deviation			#DIV/0!				#DIV/0!
	Weight Data	Number of fish sampled			3				3
		Mean Weight (g)			18.00				18.00
		Maximum Weight (g)			19				19
		Minimum Weight (g)			18				18
		Standard Deviation			#DIV/0!				#DIV/0!
		Condition Factor			0.9				
	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							
		Condition Factor				0.7			
	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)			577.4			27.80	302.60
		Maximum Length (cm)			41.6			45.4	45.4
		Minimum Length (cm)			34.6			14.4	14.4
		Standard Deviation			378.93			5.57	155.30
	Weight Data	Number of fish sampled			5			68	73
		Mean Weight (g)			465			307.02	386.01
		Maximum Weight (g)			850			1240	1240
		Minimum Weight (g)			465			100	100
		Standard Deviation			#DIV/0!			191.10	190.59
		Condition Factor			1.17			1.27	
	Age Data	Number of fish sampled			5			6	11
		Mean Age			6			7.00	6.67
		Maximum Age			6			11	11
		Minimum Age			6			3	3
		Standard Deviation			#DIV/0!			5.66	4.04
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

**Condition factors were calculated from the raw data set as K=(Weight (gm) x 100)/Length (cm)^3

TABLE 2.11-9: METALS IN FISH TISSUES, 2004

				Metal Parameter									
				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											
Lake Trout (mus/liv)	LT1	76.30		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		0.406	0.0312	<0.10	6.300	<0.020	0.375	0.119	0.67	0.0312	18.7
	LT3	79.60		0.279	0.0217	<0.10	9.260	<0.020	0.250	0.116	0.44	0.0565	12.5
	LT4	79.40		0.390	0.0077	<0.10	1.710	<0.020	0.292	0.065	0.40	0.0130	9.9
	LT5	79.40		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		0.427	0.0099	<0.10	3.140	<0.020	0.134	0.121	0.69	0.0194	14.6
n=5	WF10	80.10		0.827	0.0085	<0.10	1.050	<0.020	0.081	0.086	0.54	<0.006	10.9
	WF11	76.70		0.731	0.0113	<0.10	3.320	<0.020	0.103	0.061	0.67	0.0125	18.8
	WF12	79.00		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		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		1.240	0.0324	<0.10	7.950	<0.020	0.747	0.125	0.45	0.1090	15.4
	NP8	79.10		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		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		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		0.271	0.1650	<0.1	12.100	<0.02	0.255	0.117	1.16	0.0834	18.0
	LT3	78.10		0.465	0.0364	<0.1	5.730	<0.02	0.344	0.118	1.40	0.0407	18.7
	LT4	76.50		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		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		0.217	0.0192	<0.10	10.500	<0.020	0.248	0.126	0.64	0.1130	26.1
	NP4	79.20		0.308	0.0180	<0.10	9.540	<0.020	0.305	0.300	0.60	0.1010	20.5
	NP5	78.40		0.365	0.0082	<0.10	21.600	<0.020	0.308	0.271	0.78	0.2390	23.2
	NP6	79.20		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		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		0.162	0.0085	<0.1	13.400	<0.02	0.367	0.137	0.35	0.1280	29.9
	NP3	75.60		0.152	0.0078	<0.1	15.700	<0.02	0.166	0.176	0.29	0.1030	11.9
	NP4	80.50		0.213	<0.0060	<0.1	3.290	<0.02	0.201	0.098	0.20	0.0288	8.9
	NP5	81.30		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		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		0.164	<0.0060	<0.1	1.170	<0.02	0.197	0.131	0.26	<0.006	10.0
	WF6	81.10		0.226	<0.0060	<0.1	0.959	<0.02	0.234	0.265	<0.2	0.0066	8.9
	WF7	80.80		0.193	<0.0060	<0.1	0.688	<0.02	0.253	0.304	<0.2	<0.006	9.6
	WF8	80.50		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		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		0.152	<0.0060	<0.1	5.130	<0.02	0.965	0.067	0.48	0.0271	23.8
	NP2	78.80		0.089	<0.0060	<0.1	4.820	<0.02	0.290	0.088	0.27	0.0141	13.1
	NP3	75.20		0.172	0.0152	<0.1	6.330	<0.02	0.967	0.114	0.86	0.0261	46.8
	NP1	81.10		0.178	0.0376	<0.1	4.470	<0.02	1.320	0.253	0.63	0.0357	47.4
			Mean	0.161	n/a	n/a	4.830	n/a	0.757	0.030	0.53	0.0209	25.8

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 2.11-10A: METALS IN FISH MUSCLE TISSUE - SUMMER 2005												
			Metal Parameter									
			Arsenic	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Selenium**	**Silver**	**Zinc**
	Detection Limit (DL)		0.20	0.05	1.00	0.50	0.10	0.05	0.80	0.50	0.05	1.00
Winter Lake	**Code**											
Northern Pike	Winter Lake - NP1		<	<	1.00	<	<	0.38	<	<	<	11.70
n=5	Winter Lake - NP2		<	<	1.00	<	<	0.39	<	<	<	10.60
	Winter Lake - NP3		<	<	<	<	<	0.14	<	<	<	10.40
	Winter Lake - NP6		<	<	1.00	<	<	0.39	<	<	<	9.00
	Winter Lake - NP9		<	<	1.00	<	<	0.42	<	<	<	12.30
		Mean	n/a	n/a	1.00	n/a	n/a	0.34	n/a	n/a	n/a	10.80
Narrow Lake	**Code**											
Northern Pike	N.L - NP1		0.20	<	<	1.10	0.20	1.28	<	<	<	7.00
n =5	N.L - NP3		<	<	<	<	<	0.82	<	<	<	10.50
	N.L - NP4		<	<	<	<	<	0.92	<	<	<	9.00
	N.L - NP5		0.30	<	<	<	0.10	1.51	<	<	<	11.20
	N.L - NP6		<	<	<	<	<	0.38	<	<	<	8.00
		Mean	0.25	n/a	n/a	1.10	0.15	0.98	n/a	n/a	n/a	9.14
Lake Whitefish	N.L - WF8		<	<	<	<	<	0.23	<	<	<	10.60
n =9	N.L - WF9		<	<	1.00	<	<	0.24	<	<	<	12.90
	N.L - WF46		<	<	1.00	<	<	1.18	<	<	<	7.00
	N.L - WF47		<	<	1.00	<	<	0.20	<	<	<	33.00
	N.L - WF48		<	<	<	<	<	0.37	<	<	<	15.60
	N.L - WF49		<	<	1.00	<	<	0.18	<	<	<	13.00
	N.L - WF50		<	<	<	<	<	0.22	<	<	<	10.70
	N.L - WF51		<	<	<	8.50	<	2.34	<	3.10	<	25.60
	N.L - WF52		<	<	1.00	<	<	0.36	<	<	<	8.00
		Mean	n/a	n/a	1.00	8.50	n/a	0.59	n/a	3.10	n/a	15.16

Note:

All concentrations in mg/kg (wet)

<= Less than the dectection limit indicated

Indicates individuals that exceed Health and Welfare Canada restrictive consumption levles for mercury (0.5 ppm or mg/kg)

TABLE 2.11-10B: METALS IN FISH LIVER TISSUE - SUMMER 2005

			Metal Parameter									
			Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
	Detection Limit (DL)		0.20	0.05	1.00	0.50	0.10	0.05	0.80	0.50	0.05	1.00
Winter Lake	**Code**											
Northern Pike	Winter Lake - NP1		<	<	<	37.40	<	0.13	<	1.10	0.09	39.20
n=5	Winter Lake - NP2		<	<	<	21.40	<	0.13	<	1.00	0.05	31.90
	Winter Lake - NP3		<	<	1.00	5.30	<	0.15	<	<	<	41.40
	Winter Lake - NP6		<	<	<	23.20	<	0.15	<	1.00	<	36.20
	Winter Lake - NP9		<	<	<	30.50	<	0.14	<	1.00	<	39.10
		Mean	n/a	n/a	1.00	23.56	n/a	0.14	n/a	1.03	0.07	37.56
Narrow Lake	**Code**											
Northern Pike	N.L - NP1		<	<	<	6.50	<	1.19	<	1.50	0.05	72.40
n =5	N.L - NP3		<	<	<	7.20	<	0.58	<	1.00	0.11	45.70
	N.L - NP4		<	<	<	8.70	<	0.62	<	1.10	0.05	66.70
	N.L - NP5		<	<	<	13.40	<	1.89	<	1.40	0.10	152.00
	N.L - NP6		<	<	<	10.20	<	0.30	<	0.90	0.18	70.70
		Mean	n/a	n/a	n/a	9.20	n/a	0.92	n/a	1.18	0.10	81.50
Lake Whitefish	N.L - WF8		<	<	1.00	4.50	<	0.50	<	1.50	<	31.00
n =9	N.L - WF9		<	<	1.00	7.40	<	0.50	<	1.70	0.08	29.20
	N.L - WF46		<	<	<	4.10	<	2.60	<	1.40	<	23.30
	N.L - WF47		<	<	<	6.20	<	0.78	<	1.70	0.06	22.30
	N.L - WF48		0.40	<	<	14.80	<	0.76	<	1.20	0.18	28.90
	N.L - WF49		<	0.05	<	8.80	<	0.57	<	1.90	<	27.40
	N.L - WF50		<	<	1.00	4.50	<	0.58	<	1.90	<	27.60
	N.L - WF51		0.30	<	<	<	<	0.39	<	<	<	7.00
	N.L - WF52		<	0.10	<	7.30	<	0.67	<	1.20	<	31.70
		Mean	0.35	0.08	1.00	7.20	n/a	0.82	n/a	1.56	0.11	25.38

Note:

All concentrations in mg/kg (wet)

<= Less than the dectection limit indicated

Indicates individuals that exceed Health and Welfare Canada restrictive consumption levles for mercury (0.5 ppm or mg/kg)

2.12 WILDLIFE

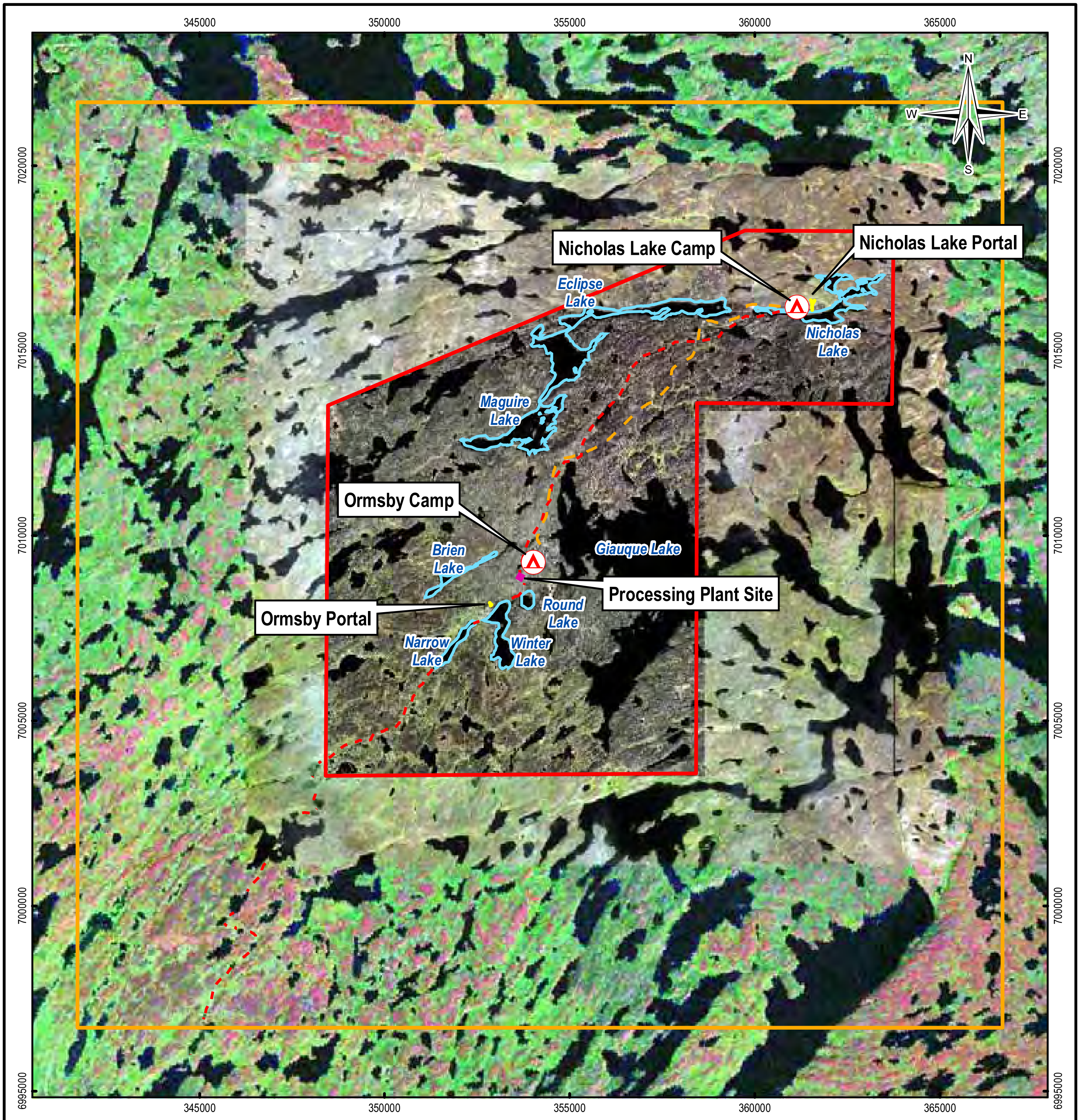
Baseline wildlife studies were conducted in 2004 and 2005 to document and characterize wildlife and wildlife habitats at and near the YGP. The baseline studies established baseline wildlife presence, distribution and relative abundance conditions, wherever possible. These initial baseline studies have been supplemented with literature reviews and more recent wildlife data and studies (aerial and ground-based) conducted by government agencies and third parties. Wildlife studies focused on species representative of the region, those important to local stakeholders (*i.e.* harvestable species), and species with special conservation status[3] or management concern.

Wildlife field programs conducted in 2004 and 2005 (Appendix E) included:

- a breeding bird survey;
- owl survey;
- waterfowl survey;
- aerial moose and caribou surveys;
- carnivore (esker) survey; and
- other incidental wildlife observations.

Two study areas were demarcated for the wildlife field programs: a regional study area (RSA) and a local study area (LSA) (Figure 2.12-1). The aerial ungulate surveys were completed in the 625 km^2 RSA centred on the existing YGP camp site. Additional ground based wildlife surveys were conducted within a smaller irregular shaped LSA approximately 144.75 km^2.

[3] Species with special conservation status include those listed under the Species At Risk Act (SARA), assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and ranked by the Government of Northwest Territories Environment and Natural Resources (ENR) division.



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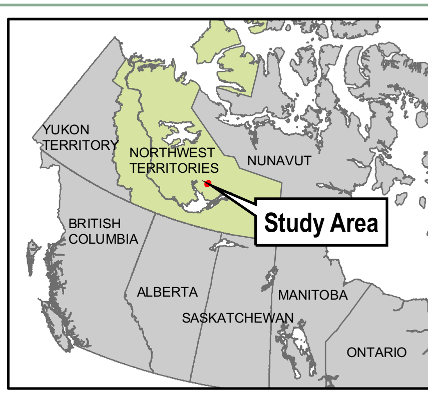
LEGEND

- Camps
- Local Study Area (LSA)
- Regional Study Area (RSA)
- 2004 Study Lakes
- Nicholas Lake Access Road
- Winter Road



NOTES

1. Imagery Source: IKONOS (July 27 and August 2, 2004); Landsat TM (August 11, 2001).
2. Figure from 2005 Wildlife Data Report.
3. Road routes are approximate.

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YGP Wildlife Study Areas

PROJECTION: UTM Zone 12	DATUM: NAD83

Scale: 1:150,000

1 0.5 0 1 2 3 4 5

Kilometres

Tyhee NWT Corp

EBA Engineering Consultants Ltd.

FILE NO.			
V23201097-DAR-042.mxd			
PROJECT NO.	DWN	CKD	REV
V23201097	SL	GC	0
OFFICE	DATE		
EBA-VANC	April 14, 2011		

Figure 2.12-1

2.12.1 Mammals

As indicated earlier, the YGP study area lies within the boreal forest of the Great Slave Upland High Boreal and Great Slave Upland Low Subarctic Ecoregions; however, both boreal and tundra animal species may occupy or frequent the area. Twenty six (26) species of mammals may occupy this region throughout the year (Table 2.12-1) Some species, such as barren-ground caribou (*Rangifer tarandus groenlandicus*) are found within this ecoregion during the winter months, spending the summers on the tundra. Other species, such as gray wolf (*Canis lupus*) and wolverine (*Gulo gulo*) are residents of both tundra and boreal forest, and frequent the transitional ecoregion to the north throughout the year. Boreal species such as mink (*Mustela vision*) and beaver (*Castor canadensis*) are reaching their northern limit at this latitude and are seldom found beyond the treeline.

TABLE 2.12-1: MAMMALS POTENTIALLY FOUND IN THE YGP STUDY AREA

Common Name	Scientific Name
Masked Shrew	*Sorex cinereus*
Pygmy Shrew	*Sorex hoyi*
Snowshoe Hare*	*Lepus americanus*
Red Squirrel*	*Tamiasciurus hudsonicus*
Beaver*	*Castor canadensis*
Deer Mouse	*Peromyscus maniculatus*
Northern Red-backed Vole	*Clethrionomys rutilus*
Brown Lemming	*Lemmus sibiricus*
Northern Bog Lemming	*Synaptomys borealis*
Muskrat*	*Ondatra zibethicus*
Meadow Vole*	*Microtus pennsylvanicus*
Chestnut cheeked Vole	*Microtus xanthognathus*
Common Porcupine*	*Erethizon dorsatum*
Gray Wolf*	*Canis lupus*
Red Fox*	*Vulpes vulpes*
Black Bear*	*Ursus americanus*
Grizzly Bear	*Ursus arctos*
American Marten*	*Martes americana*
Ermine	*Mustela erminea*
Least Weasel	*Mustela nivalis*
Mink	*Mustela vison*
Wolverine*	*Gulo gulo*
River Otter	*Lutra canadensis*
Lynx	*Lynx canadensis*
Barren-ground Caribou*	*Rangifer tarandus groenlandicus*
Moose*	*Alces alces*

* Mammal species observed during the 2004 and 2005 wildlife field program.

2.12.1.1 Barren-ground Caribou

On December 17, 2009, the Minister of Environment and Natural Resources, NWT, announced all barren-ground caribou hunting would be cancelled for an area covering approximately 70,000 square kilometres. The ban went into effect January 1, 2010. Based on the long-term satellite tracking data and site-specific aerial surveys, caribou occur in the vicinity of the YGP during the winter months and intermittently during the migration. Tyhee NWT Corp is therefore evaluating all aspects of these recent developments. Tyhee NWT Corp feels that with a cooperative approach involving First Nations and wildlife regulators, issues related to the protection of barren-ground caribou in the vicinity of the YGP can be effectively addressed for the YGP.

Barren-ground caribou are a significant resource for the people of the NWT and Nunavut, both socially and culturally. Caribou hunting is a vital component of Dene, Métis, and Inuit cultures and is the most important factor in a lifestyle largely dependent on natural resources (Case et al. 1996; Yellowknives Dene 1997; Nunavut Planning Commission 1998; North Slave Métis Alliance 1999). Caribou found in the YGP area are part of the Bathurst herd. Bathurst caribou are accessible to more people than any other herd (Case et al. 1996) and are ranked as "Sensitive[4]" under the general status program (GNWT ENR 2010b, but have not been assessed by COSEWIC (COSEWIC 2010).

The population size of the Bathurst herd has been estimated fairly regularly since 1970 by the GNWT (GNWT ENR 2010a) as summarized in Figure 2.12-1. The herd reached a peak size of 472,000 ± 72,900 in 1986, however, have declined at approximately 5% per year since peak size. Following completion of the most recent survey in 2010, the estimated size of the herd is considerably lower, at 31,900 ± 11,000 (GNWT ENR 2010a). The number of animals in a caribou herd naturally fluctuates over a 40 to 60 year cycle. The distribution and density varies from year to year, with the herd rarely using the same area for more than two or three years out of ten (Case et al. 1996).

Habitat, climate, and predation are key natural factors that can affect the size of a caribou herd (Lines 2009). Quality winter foraging habitat includes lichen dominated habitats including Jack Pine – Lichen and Spruce – Lichen woodlands. Barren-ground caribou utilize frozen lakes and ponds as travel corridors and resting sites. On the wintering grounds, deep snow and freeze thaw cycles (ice formation) reduce the amount of foraging habitat available, increases energy expended during foraging, and increases the risks of predation (Lines 2009; Mattson et al. 2009). Lichens favoured by caribou are associated with late-successional seral stage forests and are lost in the short-term following fire (Lewis et al. 2009). A total of 23% of the YGP study area has been previously burnt. Predictive climate change models indicate more frequent and larger-scale fires which can lead to a decline in lichen abundance (Lewis et al. 2009).

[4] Species ranked as "Sensitive" are not at risk of extinction, but require particular protection to prevent their populations from becoming at risk.

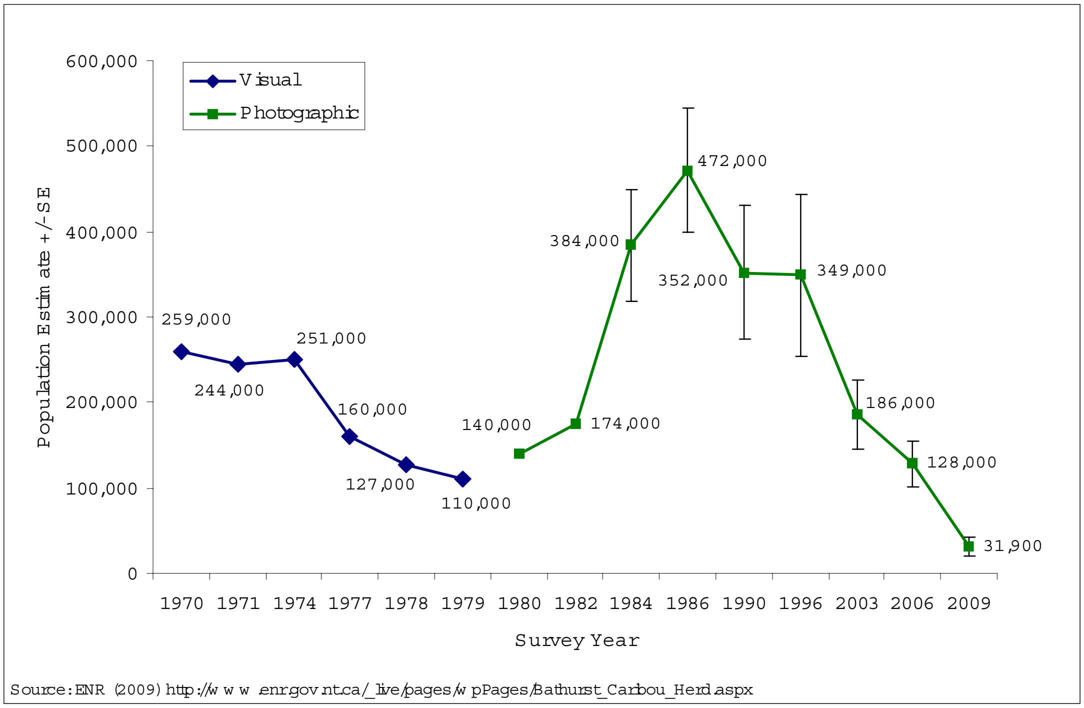

Figure 2.12-2
Bathurst Caribou Herd Population Estimates, 1970 – 2009

Hunting, a traditional part of the northern lifestyle, and predation significantly affect the Bathurst herd. Holders of a General Hunting License account for the bulk of the harvest, followed by Resident, Non-Resident and Non-Resident Alien hunters. The total annual harvest of Bathurst caribou is estimated to be between 14,500 and 18,500, representing about 5% of the 1996 Bathurst caribou population estimate (Case et al. 1996). More recent annual harvest estimates based on outfitter, resident hunter, check-station data, and model analysis suggests approximately 4,000 to 5,000 cows/year and about 2,000 bulls/year are harvested from the Bathurst herd (Adamczewski *et al.* 2009).

When caribou wintering grounds include the existing winter road corridors, a substantial proportion of the annual harvest occurs along the winter roads. In addition, wolves, the primary predators of caribou, kill tens of thousands of Bathurst caribou annually (Case et al. 1996). Estimates of wolf kill and natural mortality are unavailable for the YGP area; however, kill rates are largely dependent upon caribou winter densities.

The Bathurst caribou herd has an annual home range of approximately 354,000 km^2 (Gunn and Dragon 2000), which generally spans from the spring calving areas near Bathurst Inlet to wintering habitat within the boreal forest. All of the existing diamond mines, ongoing mineral exploration projects in the Slave Geological Province, and the existing Tibbitt to Contwoyto winter road, fall within this home range. Figures 2.12-3a to 2.12-3f illustrate the seasonal distribution of the Bathurst caribou herd within its home range. Studies on caribou habitat and migration patterns using radio telemetry and traditional ecological knowledge studies were initiated in 1996, and continue to provide information on caribou movements and behaviour (FSC et al. 1999; Whaèhdôö Nàowoò Kö Dogrib Treaty 11 Council 2001).

Caribou spring migration generally begins along broad corridors within forested winter ranges and becomes more directed as movements coalesce towards calving areas (Figure 2.12-3a). Frequently used migration corridors follow the drainages of major rivers such as the Hood and Burnside, funnelling animals toward Bathurst Inlet (Kelsall 1968; Calef 1981). The intensity of use of known corridors during spring migration depends largely on the late winter distribution of the herd in any given year. Major crossings include Lac de Gras, Point Lake, and Contwoyto Lake.

The specific area used for calving may vary from year to year, however cows from the Bathurst caribou herd always return to the same general area to calve. The calving grounds tend to overlap in any two consecutive years, but they do exhibit a gradual shift over time. Inuit traditional knowledge (KIA 2006) and early research (Kelsall 1968) show that the calving grounds used by the Bathurst caribou in the 1950s were west of Bathurst Inlet. For almost three decades, between 1960 and 1990, the Bathurst herd moved east of Bathurst Inlet to calve (Bathurst Caribou Management Planning Committee 2004). Beginning in the late 1980s, the cows gradually shifted west again and were calving back in the same areas used in the 1950s, west of the Bathurst Inlet (Bathurst Caribou Management Planning Committee 2004, Gunn et al. 1997; Figure 2.12-3b). Since then, the cows have been calving between the Hood and Burnside rivers west of Bathurst Inlet (Bathurst Caribou Management Planning Committee 2004).

After calving in June, the cows and calves travel south and west to their post-calving ranges. The routes followed depend on the calving area. From the late 1990s until 2003, movements generally followed the southeast side of Contwoyto Lake (GNWT ENR 2006; Figure 2.12-3c). As summer progresses, the cows join the bulls and the herd moves across the tundra. Between July and September, the caribou generally move south, then west and then northwest, almost in a counter clockwise direction (GNWT ENR 2006; Figure 2.12-3d). Fidelity to summer range is high, with the animals using the same general area year after year; the distribution within the range itself, however, may vary considerably (GNWT ENR 2006).

Summer aggregations and dispersals lead to a more leisurely drift into the tree line, which eventually becomes a more directed fall migration in October and November, and is often governed largely by the timing of snowfall (Figure 2.12-3e). Although migration corridors are not specifically predictable for a given year, corridors such as those previously mentioned are used regularly.

Satellite tracking of collared Bathurst caribou since 1997 has confirmed that wintering areas are variable and include areas south of the tree line, from the Coppermine River to Great Slave Lake, extending in some years as far south as the Saskatchewan border (Gunn and Dragon 2000; Kelsall 1968) According to Aboriginal Traditional Knowledge, some caribou have been observed at the north end of Contwoyto Lake during winter, but these individuals are few in number and may have migrated south from Victoria Island.

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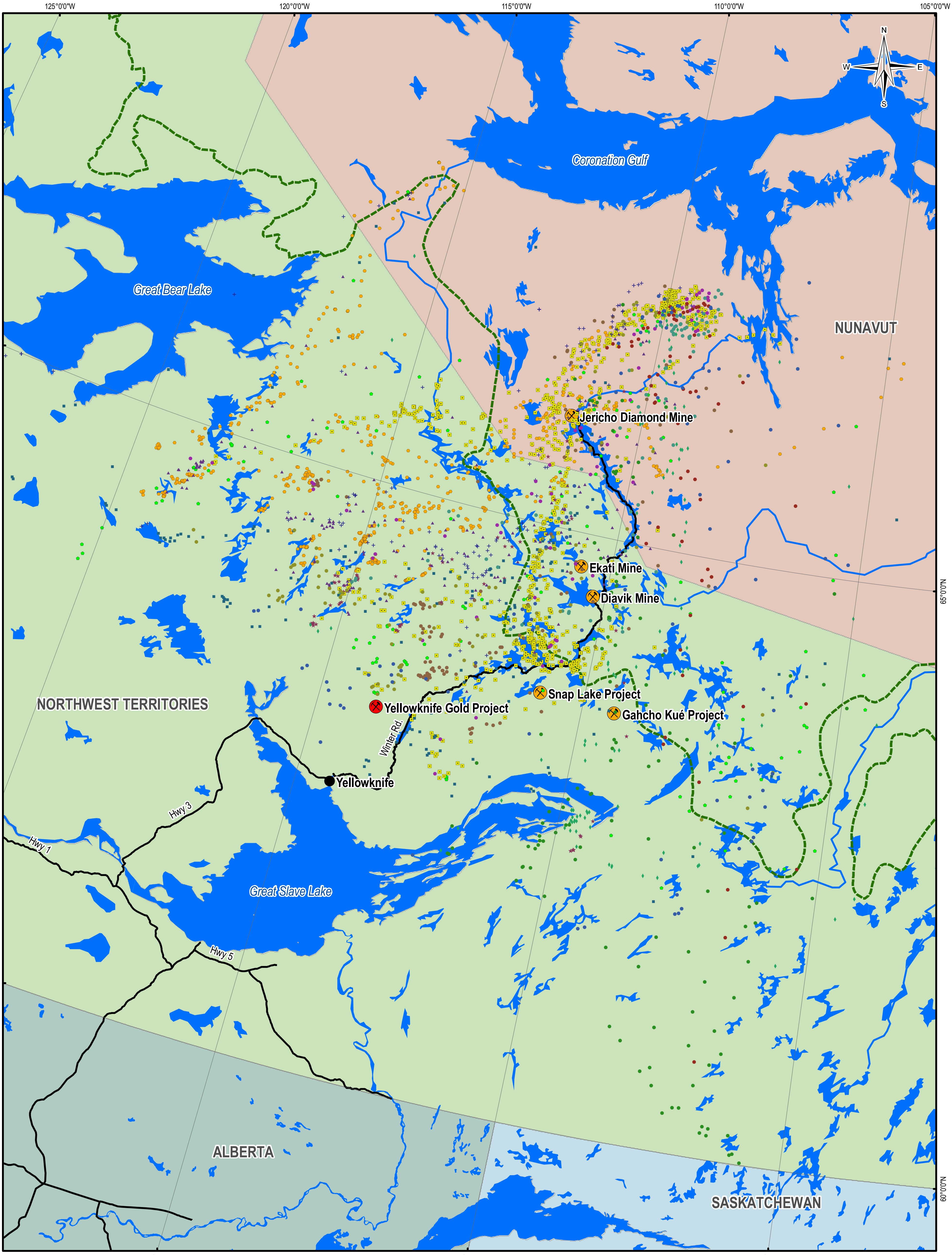

LEGEND

- Yellowknife
- Existing Mine/Project
- Yellowknife Gold Project
- Road
- Treeline
- Watercourse
- Waterbody

Bathurst Caribou Spring Migration by Year

1996	2002	2008
1997	2003	2009
1998	2004	2010
1999	2005	
2000	2006	
2001	2007	

NOTES
1. Some locations seen on the map may represent Caribou from other herds.
2. Base data sources: GNWT ENR (February, 2011), ESRI

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YELLOWKNIFE GOLD PROJECT

Distribution of Satellite- and GPS-Collared Bathurst Caribou: Annual Spring Migration (April 16 to May 31)

PROJECTION	DATUM
Canada Albers	NAD83

Scale: 1:3,500,000
40 20 0 40 80
Kilometres

Tyhee NWT Corp

EBA Engineering Consultants Ltd.

FILE NO.			
v23201097-DAR-034.mxd			
PROJECT NO.	**DWN**	**CKD**	**REV**
V23201097	SL	GC	0
OFFICE	**DATE**		
EBA-VANC	April 14, 2011		

Figure 2.12-3a

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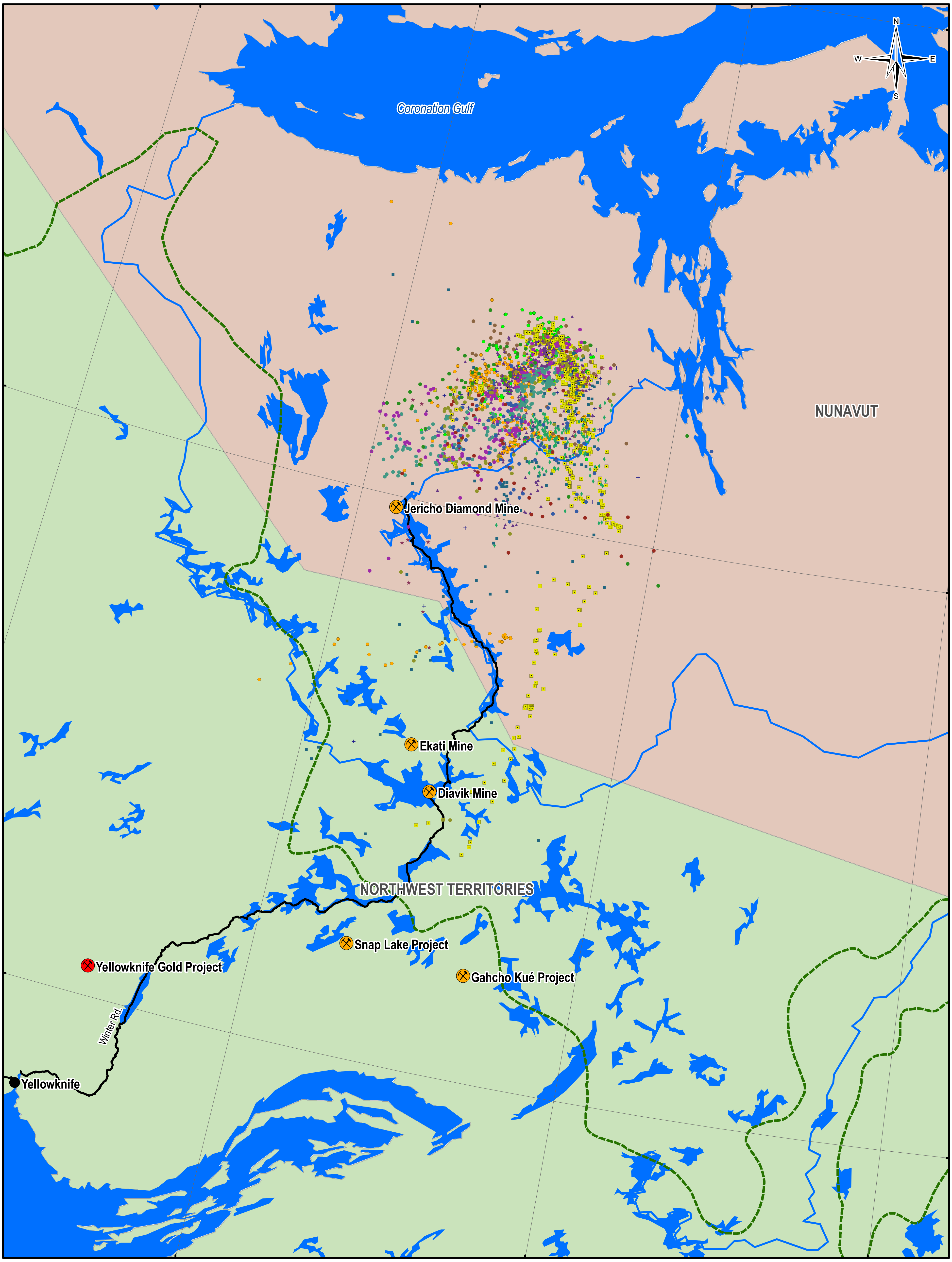

LEGEND

- Yellowknife
- Existing Mine/Project
- Yellowknife Gold Project
- Road
- Treeline
- Watercourse
- Waterbody

Bathurst Caribou Calving Period by Year

1996	2002	2008
1997	2003	2009
1998	2004	2010
1999	2005	
2000	2006	
2001	2007	

NOTES
1. Some locations seen on the map may represent Caribou from other herds.
2. Base data sources: GNWT ENR (February, 2011), ESRI

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YELLOWKNIFE GOLD PROJECT

Distribution of Satellite- and GPS-Collared Bathurst Caribou: Annual Calving Period (June 1 to June 25)

PROJECTION: Canada Albers
DATUM: NAD83

Scale: 1:2,250,000
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Kilometres

Tyhee NWT Corp

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FILE NO.: V23201097-DAR-035.mxd

PROJECT NO.	DWN	CKD	REV
V23201097	SL	GC	0

OFFICE: EBA-VANC
DATE: April 14, 2011

Figure 2.12-3b

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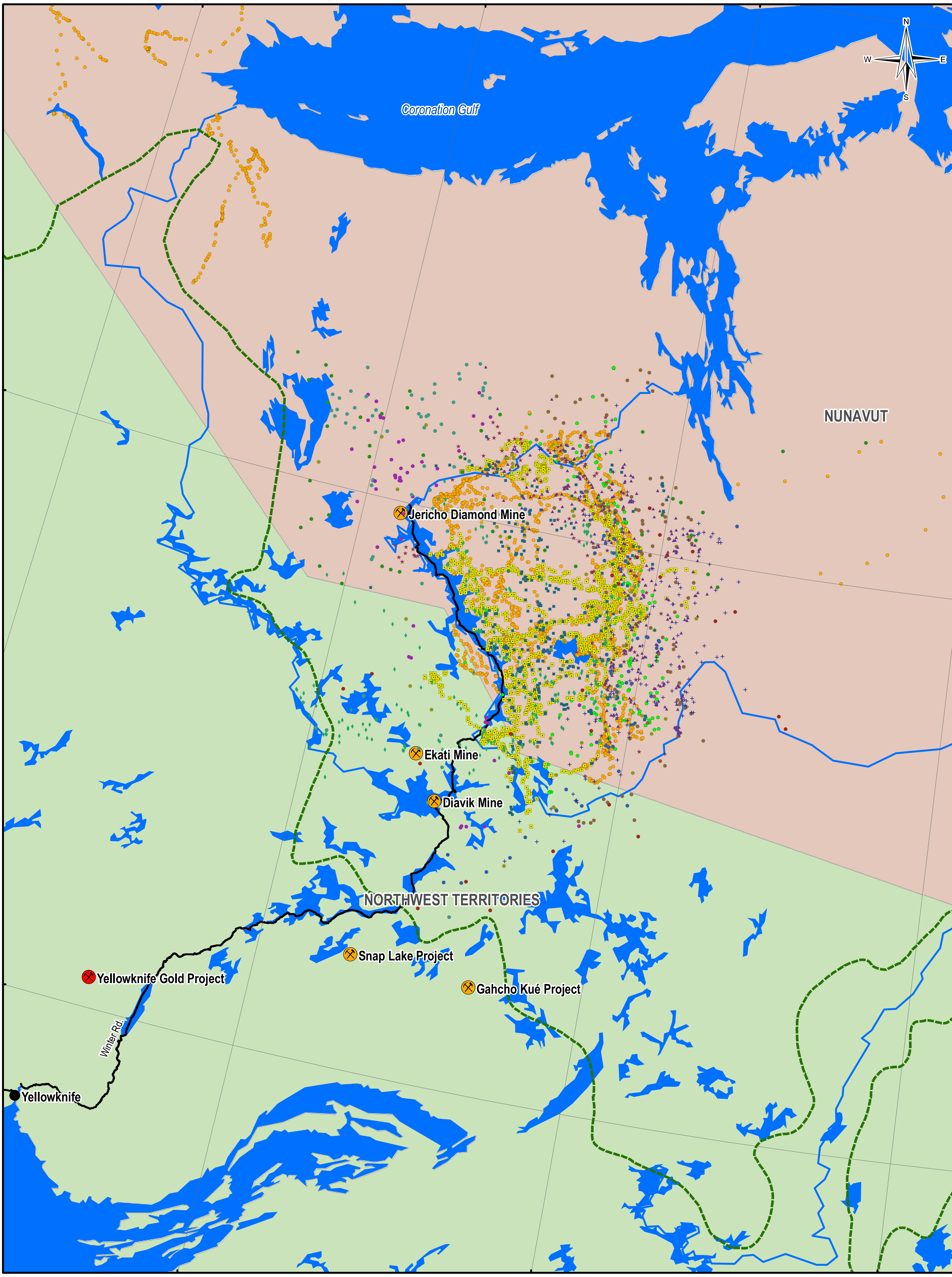

LEGEND

- Yellowknife
- Existing Mine/Project
- Yellowknife Gold Project
- Road
- Treeline
- Watercourse
- Waterbody

Bathurst Caribou Post Calving Movement by Year

1996	2002	2008
1997	2003	2009
1998	2004	2010
1999	2005	
2000	2006	
2001	2007	

NOTES
1. Some locations seen on the map may represent Caribou from other herds.
2. Base data sources: GNWT ENR (February, 2011), ESRI

ISSUED FOR USE

YELLOWKNIFE GOLD PROJECT

Distribution of Satellite- and GPS-Collared Bathurst Caribou: Annual Post-Calving Movement (June 26 to July 15)

PROJECTION: Canada Albers
DATUM: NAD83

Scale: 1:2,250,000
40 20 0 40
Kilometres

Tyhee NWT Corp

EBA Engineering Consultants Ltd.

FILE NO.: V23201097-DAR-036.mxd

PROJECT NO.	DWN	CKD	REV
V23201097	SL	GC	0

OFFICE	DATE
EBA-VANC	April 14, 2011

Figure 2.12-3c

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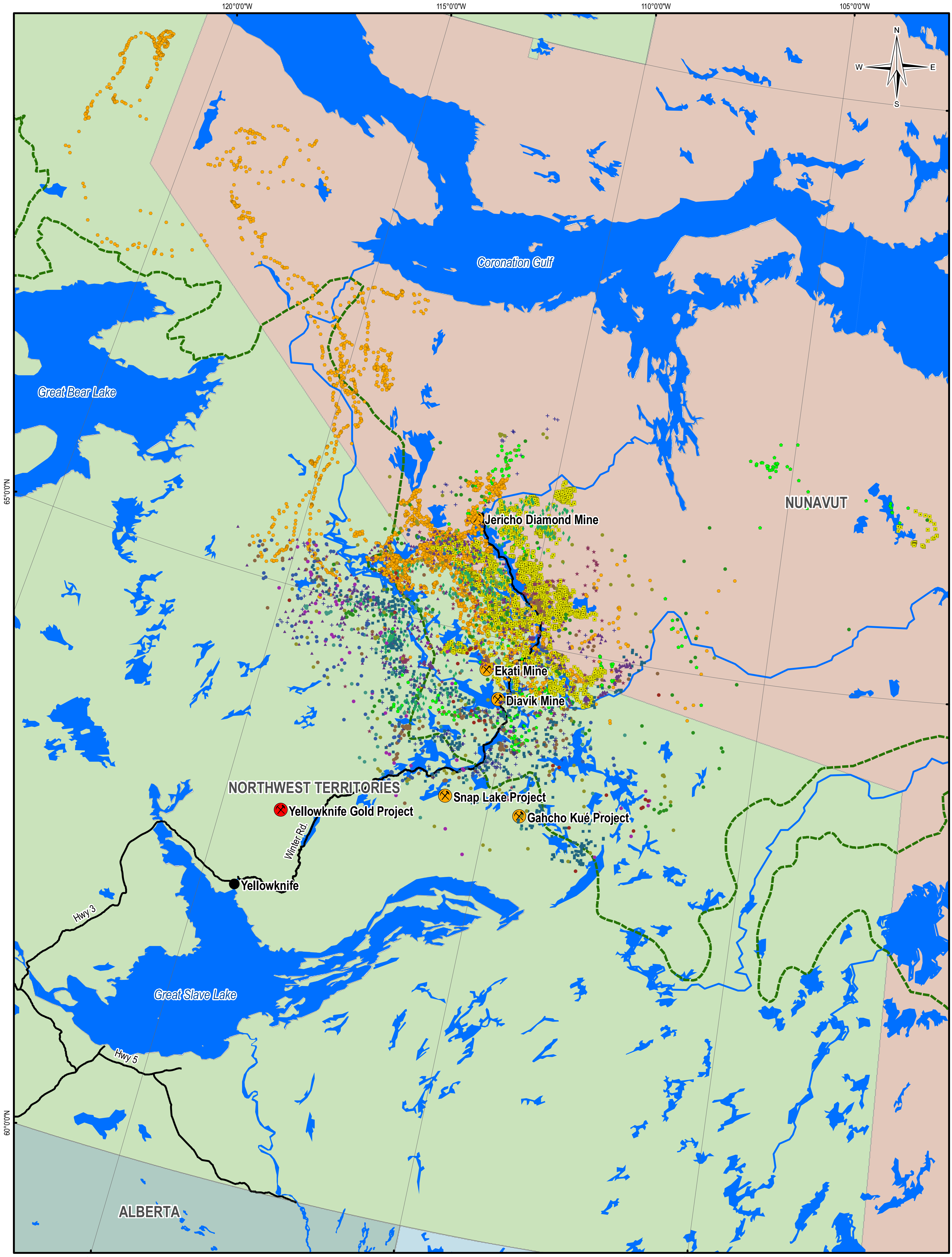

LEGEND

- Yellowknife
- Existing Mine/Project
- Yellowknife Gold Project
- Road
- Treeline
- Watercourse
- Waterbody

Bathurst Caribou Summer Range by Year

1996	2002	2008
1997	2003	2009
1998	2004	2010
1999	2005	
2000	2006	
2001	2007	

NOTES

1. Some locations seen on the map may represent Caribou from other herds.
2. Base data sources: GNWT ENR (February, 2011), ESRI

ISSUED FOR USE

YELLOWKNIFE GOLD PROJECT

Distribution of Satellite- and GPS-Collared Bathurst Caribou: Annual Summer Range (July 16 to September 10)

PROJECTION	DATUM
Canada Albers	NAD83

Scale: 1:3,500,000

40 20 0 40 80

Kilometres

Tyhee NWT Corp

EBA Engineering Consultants Ltd.

FILE NO.			
V23201097-DAR-037.mxd			
PROJECT NO.	**DWN**	**CKD**	**REV**
V23201097	SL	GC	0
OFFICE	**DATE**		
EBA-VANC	February 21, 2011		

Figure 2.12-3d

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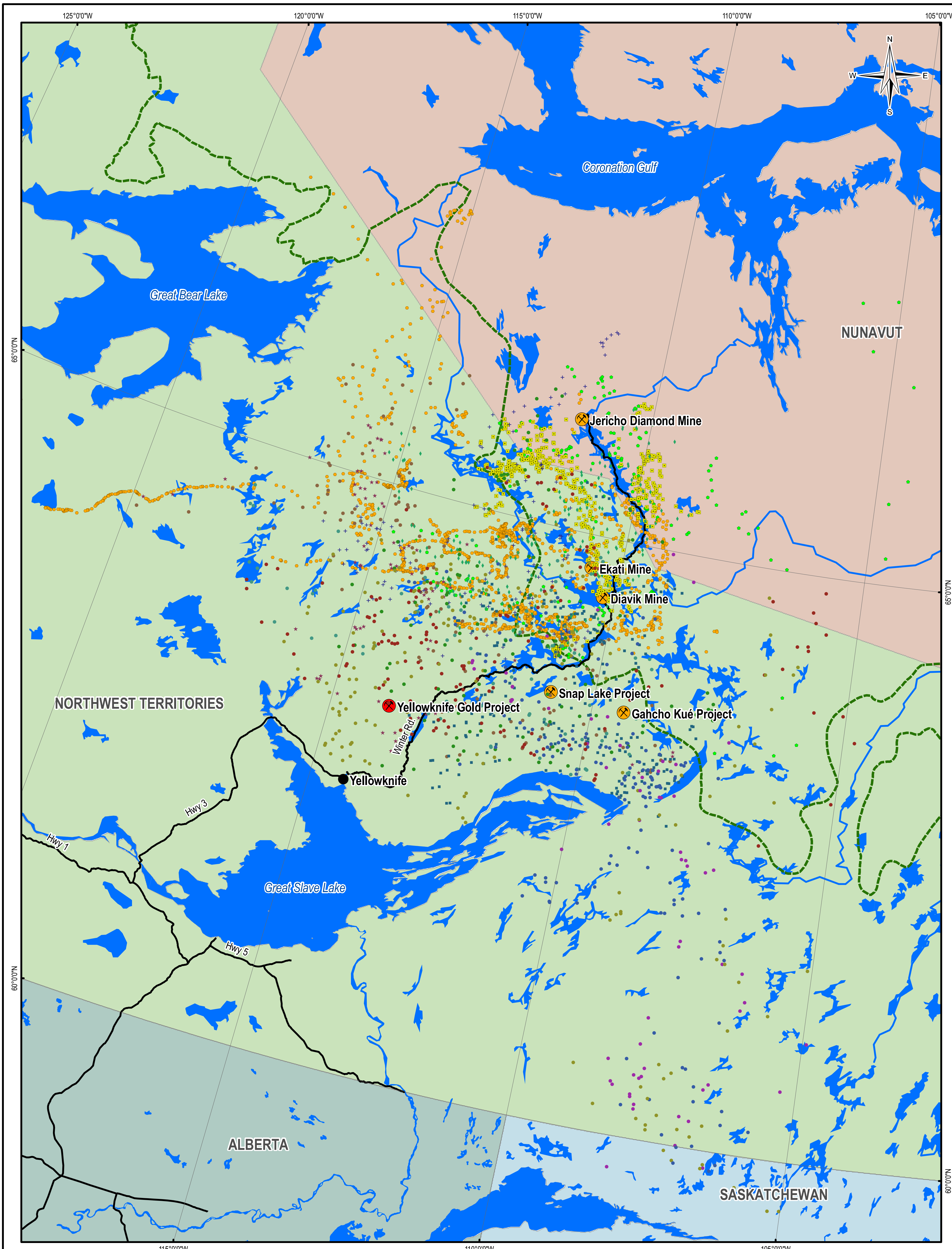

LEGEND

- Yellowknife
- Existing Mine/Project
- Yellowknife Gold Project
- Road
- Treeline
- Watercourse
- Waterbody

Bathurst Caribou Fall Migration by Year

1996	2002	2008
1997	2003	2009
1998	2004	2010
1999	2005	
2000	2006	
2001	2007	

NOTES

1. Some locations seen on the map may represent Caribou from other herds.
2. Base data sources: GNWT ENR (February, 2011), ESRI

ISSUED FOR USE

YELLOWKNIFE GOLD PROJECT

Distribution of Satellite- and GPS-Collared Bathurst Caribou: Annual Fall Migration (September 11 to November 20)

PROJECTION	DATUM
Canada Albers	NAD83

Scale: 1:3,500,000

40 20 0 40 80

Kilometres

Tyhee NWT Corp

EBA Engineering Consultants Ltd.

FILE NO.			
V23201097-DAR-038.mxd			
PROJECT NO.	**DWN**	**CKD**	**REV**
V23201097	SL	GC	0
OFFICE	**DATE**		
EBA-VANC	April 14, 2011		

Figure 2.12-3e

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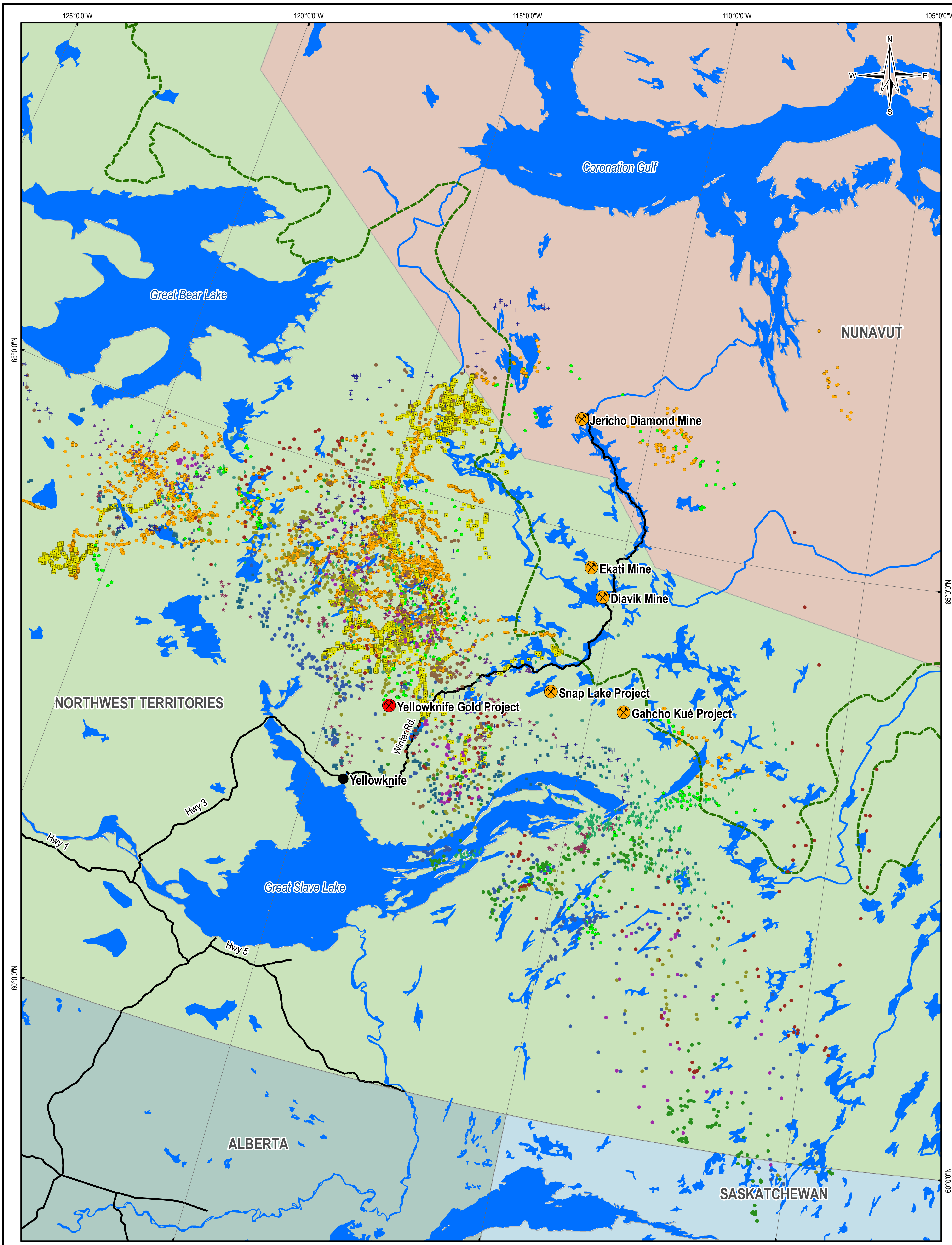

LEGEND

- Yellowknife
- Existing Mine/Project
- Yellowknife Gold Project
- Road
- Treeline
- Watercourse
- Waterbody

Bathurst Caribou Winter Range by Year

1996	2002	2008
1997	2003	2009
1998	2004	2010
1999	2005	
2000	2006	
2001	2007	

NOTES

1. Some locations seen on the map may represent Caribou from other herds.
2. Base data sources: GNWT ENR (February, 2011), ESRI

ISSUED FOR USE

YELLOWKNIFE GOLD PROJECT

Distribution of Satellite- and GPS-Collared Bathurst Caribou: Annual Winter Range (November 21 to April 15)

PROJECTION	DATUM
Canada Albers	NAD83

Scale: 1:3,500,000

40 20 0 40 80

Kilometres

Tyhee NWT Corp

EBA Engineering Consultants Ltd.

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Figure 2.12-3f

Caribou spring migration generally begins along broad corridors within forested winter ranges and becomes more directed as movements coalesce towards calving areas (Figure 2.12-3a). Frequently used migration corridors follow the drainages of major rivers such as the Hood and Burnside, funnelling animals toward Bathurst Inlet (Kelsall 1968; Calef 1981). The intensity of use of known corridors during spring migration depends largely on the late winter distribution of the herd in any given year. Major crossings include Lac de Gras, Point Lake, and Contwoyto Lake.

The specific area used for calving may vary from year to year, however cows from the Bathurst caribou herd always return to the same general area to calve. The calving grounds tend to overlap in any two consecutive years, but they do exhibit a gradual shift over time. Inuit traditional knowledge (KIA 2006) and early research (Kelsall 1968) show that the calving grounds used by the Bathurst caribou in the 1950s were west of Bathurst Inlet. For almost three decades, between 1960 and 1990, the Bathurst herd moved east of Bathurst Inlet to calve (Bathurst Caribou Management Planning Committee 2004). Beginning in the late 1980s, the cows gradually shifted west again and were calving back in the same areas used in the 1950s, west of the Bathurst Inlet (Bathurst Caribou Management Planning Committee 2004, Gunn et al. 1997; Figure 2.12-3b). Since then, the cows have been calving between the Hood and Burnside rivers west of Bathurst Inlet (Bathurst Caribou Management Planning Committee 2004).

After calving in June, the cows and calves travel south and west to their post-calving ranges. The routes followed depend on the calving area. From the late 1990s until 2003, movements generally followed the southeast side of Contwoyto Lake (GNWT ENR 2006; Figure 2.12-3c). As summer progresses, the cows join the bulls and the herd moves across the tundra. Between July and September, the caribou generally move south, then west and then northwest, almost in a counter clockwise direction (GNWT ENR 2006; Figure 2.12-3d). Fidelity to summer range is high, with the animals using the same general area year after year; the distribution within the range itself, however, may vary considerably (GNWT ENR 2006).

Summer aggregations and dispersals lead to a more leisurely drift into the tree line, which eventually becomes a more directed fall migration in October and November, and is often governed largely by the timing of snowfall (Figure 2.12-3e). Although migration corridors are not specifically predictable for a given year, corridors such as those previously mentioned are used regularly.

Satellite tracking of collared Bathurst caribou since 1997 has confirmed that wintering areas are variable and include areas south of the tree line, from the Coppermine River to Great Slave Lake, extending in some years as far south as the Saskatchewan border (Gunn and Dragon 2000; Kelsall 1968) According to Aboriginal Traditional Knowledge, some caribou have been observed at the north end of Contwoyto Lake during winter, but these individuals are few in number and may have migrated south from Victoria Island.

In the winters of 1996 to 1997, 1998 to 1999, and 1999 to 2000, limited numbers of Bathurst caribou over-wintered in the area around the YGP (Gunn and Dragon 2000; Figure 2.12-3f). The winter period is the only time of year when Bathurst caribou may be present in the YGP area. During 1999 to 2000, the winter distribution of the collared cows was split northwest and southeast of Great Slave Lake, similar to the winter of 1998 to 1999. In contrast, all collared cows were located southeast of Great Slave Lake in 1997 to 1998, and northwest of Great Slave Lake in 1996 to1997.

During the 2005 survey season, aerial ungulate surveys were conducted on February 4, March 7 and April 18, within a 25 km by 25 km study area centred on the Property (Figure 2.12-4. Each survey consisted of six transects 25 km long and spaced 5 km apart. The effective observation width was 1 km giving a total survey area of 150 km^2 or 24% of the study area.

During the February 4, 2005 aerial survey, 22 caribou were observed on transect in five separate groups, yielding a density estimate of 92 ± 40 caribou (using Jolly's Method 2) for the entire survey area. The majority of caribou were observed occupying frozen lakes at the time of the aerial survey. Other wildlife observations included 22 caribou off-transect, four moose, and several wolf tracks.

During the March 7 survey, 122 caribou were observed on transect in four separate groups, yielding a density estimate of 492 ± 340 caribou in the entire survey area. Other wildlife observations included 30 caribou off-transect, common raven, wolf, moose and wolverine, numerous tracks, trails, kill sites, feeding areas and beds.

During the April 18 survey, 48 caribou were observed on transect in four separate groups, yielding a density estimate of 196 ± 90 caribou for the entire survey area. One group of four caribou was also observed off-transect. The majority of caribou were observed on frozen lakes and large ponds. One moose was observed, along with numerous caribou trails, tracks and beds. A further 238 caribou were observed en-route to the Project area from Yellowknife.

Based on the long-term satellite tracking data and site-specific aerial surveys, caribou occur in the vicinity of the YGP during the winter months and intermittently during the migration.

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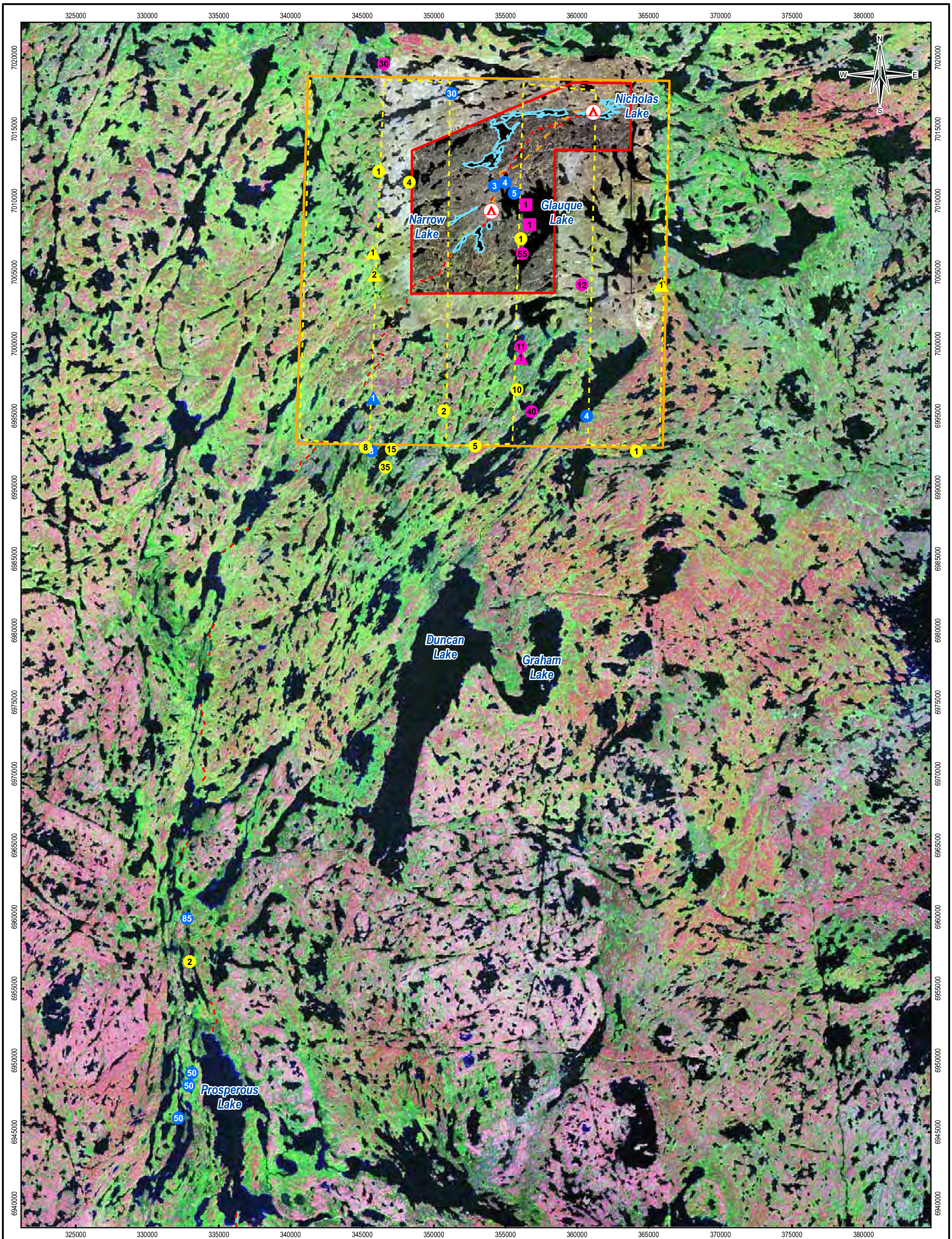

LEGEND

- Camps
- Survey Transects
- Local Study Area (LSA)
- Ungulate Study Area
- 2004 Study Lakes
- Nicholas Lake Access Road
- Winter Road

Aerial Observations (February 4, 2005)	Aerial Observations (March 7, 2005)	Aerial Observations (April 18, 2005)
Caribou	Caribou	Caribou
Moose	Moose	Moose
Wolverine	Wolverine	Wolverine

NOTES
1. Imagery Source: IKONOS (July 27 and August 2, 2004); Landsat TM (August 11, 2001).
2. Road routes are approximate.

ISSUED FOR USE

YELLOWKNIFE GOLD PROJECT

Aerial Wildlife Transects and Observations February 4, March 7, & April 18, 2005

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:250,000

5 2.5 0 5

Kilometres

Tyhee NWT Corp

EBA Engineering Consultants Ltd.

FILE NO.
V23201097-DAR-041.mxd

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OFFICE	DATE
EBA-VANC	February 15, 2011

Figure 2.12-4