PROJECT # 1009-002-17 GIS # HB-15-038 February 1, 2011

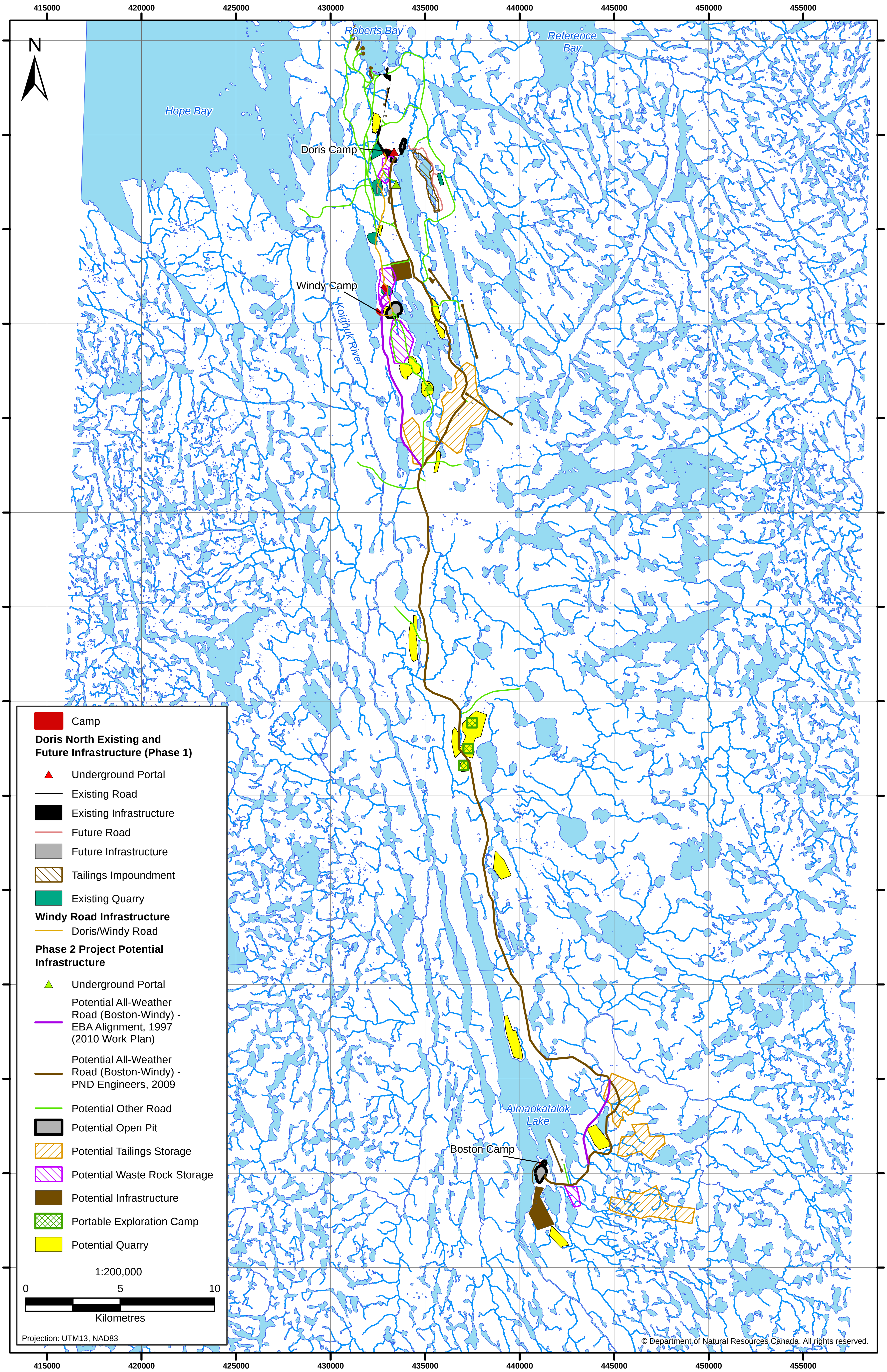


Figure 1-2

# Site Layout Options Considered for Phase 2 Baseline Program, 2010

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- 2010 Hydrology Compliance Report, Doris North Project
- 2010 Wildlife Monitoring and Mitigation Report, Doris North Project
- 2010 Wildlife DNA Study, Doris North Project
- 2010 Aquatic Effects Monitoring Program Report, Doris North Project
- 2010 Air Quality Compliance Reports, Doris North Project

Archaeology work was also conducted in 2010 and is being reported separately.

This report presents the results from the Freshwater Fish and Fish Habitat portion of the 2010 Phase 2 environmental baseline program.

The primary objective of the 2010 freshwater fish and fish habitat baseline work was to characterize fish habitat and fish communities in the Project area. Specific objectives of the 2010 program were to:

1. Characterize fish habitat and fish communities in lakes, ponds, rivers and streams of the Phase 2 Project area, including those water bodies potentially affected by mine development and reference areas outside the Project area.
2. Describe the type of lake habitat (i.e., substrate or bottom type) near the proposed Ore Deposit site and a reference site in Aimaokatalok Lake.
3. Estimate the population number (with 95% confidence intervals) and spatial distributions of lake trout in the Ore Deposit and reference sites in Aimaokatalok Lake.
4. Determine the type, quantity and rating of stream habitat found along road alignments and within proposed waste rock and tailings management areas in the Phase 2 Project area.

Fish habitat was defined as those environmental components that are required either directly or indirectly by fish to carry out their life processes, including spawning and rearing areas, food production areas, migration routes and over-wintering areas. These areas included lakes, ponds, rivers and streams. The fish communities were defined in terms of total number and number-by-species at each sampling location, total catch-per-unit-effort (CPUE) and species-specific CPUE for each type of assessment gear. Biological features of fish such as length, weight, condition, age and diet were also measured. Lake trout (*Salvelinus namaycush*) tissue metal concentrations were evaluated at Aimaokatalok Lake and at Reference Lake D. Ninespine stickleback (*Pungitius pungitius*) tissue metal concentrations were evaluated at five streams within the Project Area. Hydroacoustic methods were also used to estimate absolute fish abundance and evaluate fish habitat in Aimaokatalok Lake. Sensitive Habitat Inventory Mapping (SHIM) was conducted at proposed waste rock and tailings management areas.

# 2. Materials and Methods

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## 2.1 FISH HABITAT

### 2.1.1 Shoreline Lake Habitat

Fish habitat surveys were conducted at Aimaokatalok Lake in 2010. The lake was assessed using similar methods in previous studies conducted in 2005 to 2007 and 2009. Surveys were conducted by walking or slowly boating along the shoreline and delineating habitat units based on the substrate composition of the littoral zone. The substrate types were classified as bedrock, boulder, cobble, gravel, sand, silt and organic material. Substrate size classes followed the modified Wentworth scale for particle size (<2 mm = fins, 2 to 64 mm = gravel, 64 to 256 mm = cobble, >256 mm = boulder). Substrate composition was recorded as a percent coverage (e.g., 70% cobble and 30% boulder) within delineated zones. Patches of emergent and submergent vegetation were noted and recorded on a field map. Photographs were taken to illustrate various habitat types.

### 2.1.2 Substrate Classification using Hydroacoustics and Underwater Video

#### *2.1.2.1 Data Collection*

Hydroacoustic methods were used to quantify fish habitat at Aimaokatalok Lake in order to obtain information on lake productive capacity and habitat quality for future fish habitat compensation purposes. Due to the size of Aimaokatalok Lake, only two areas were surveyed using hydroacoustic methods to describe substrate composition. These areas included the Ore Deposit area and the Reference area (Figure 2.1-1). The Reference area was selected due to the similar depth profile to the Ore Deposit area. Hydroacoustics and underwater video methods were used for habitat classification (i.e., substrate or bottom type) surveys from August 4 to 6, 2010.

Data were collected from a 4.9 m-long aluminum boat with a low-horsepower outboard motor (Plate 2.1-1). The echo sounding system consisted of a dual-transducer, 200 kHz, BioSonics DT-X digital split-beam echo sounder linked to a Garmin model 18 differential GPS. Full beam angles of the transducers (at the half power point) were 6.7° (down-looking) and 6.8° (side-looking). The transducers were mounted on a metal pole that was attached to the port side of the boat, with one transducer aimed downward (down-looking) and the other aimed sideways (side-looking) perpendicular to the direction of travel, tilted slightly downward. The down-looking transducer was aimed 1° to 3° sternward to aid in the identification of bubbles. The side-looking transducer was tilted 5° down from horizontal to reduce echoes from the lake surface as described by Yule (2000). Only data from the down-looking transducer was used for bottom typing. In the study area, depths sampled ranged from < 1 m to approximately 28 m. The system was controlled by a laptop computer running Visual Acquisition 6 software used to display electronic echograms for monitoring sounder performance during data collection. Hydroacoustic data merged with geographic coordinates from the GPS were logged to the computer hard drive. Only data from the down-looking transducer was used for bottom typing. Other system specifications are shown in Table 2.1-1.

Sampling was performed by piloting the boat with the hydroacoustics system along parallel cross-lake transects at an average speed of 1.1 to 1.8 m/s. Transects were spaced approximately 200 m apart, perpendicular to the long axis of the lake. The number of transects was 13 in the Ore Deposit area and 10 in the Reference area.

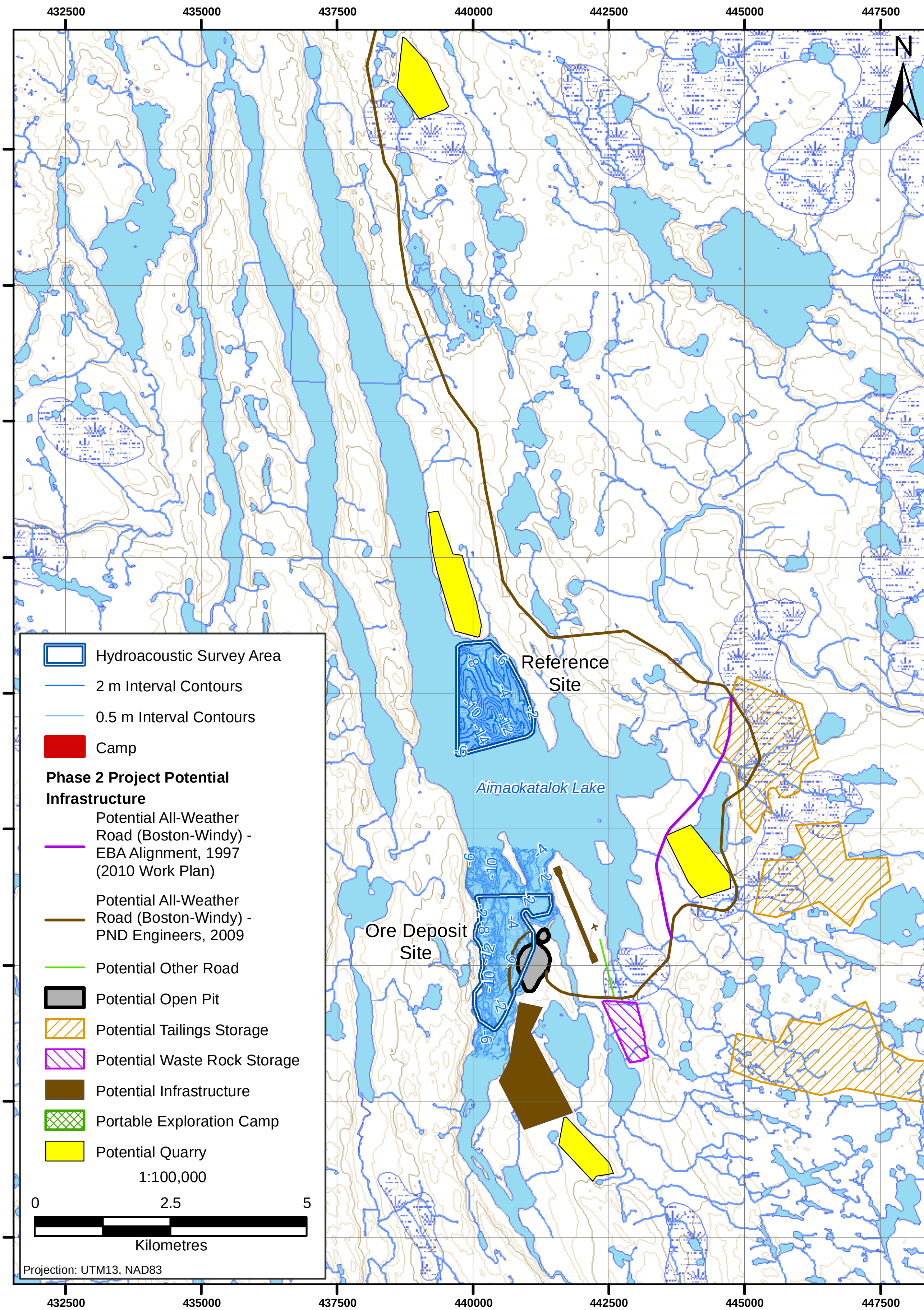


Figure 2.1-1

**Ore Deposit and Reference Sites at Aimaokatalok Lake, Hope Bay Belt Project, 2010**

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*Plate 2.1-1. Boat set-up used to conduct hydroacoustics surveys of Ore Deposit and reference areas at Aimaokatalok Lake, Hope Bay Belt Project, 2010.*

**Table 2.1-1. Hydroacoustic System Specifications for Surveys of Aimaokatalok Lake, Hope Bay Belt Project, 2010**

| Project Phase | Category | Variable | Value |
|---|---|---|---|
| Data Collection | Transducers | Type | Split-beam[1] |
| | | Sound frequency | 201 kHz down-looking |
| | | | 199 kHz side-looking |
| | | Nominal beam angle | 6.7° down-looking |
| | | | 6.8° side-looking |
| | | Depth of transducer face | 0.4 m |
| | Settings (both transducers) | Pulse width | 0.4 msec |
| | | Transmit power level | low (-10.3 dB) |
| | | Data collection threshold | -80 dB |
| | | Minimum data range[2] | 0.75 m |
| | | Time varied threshold | 40 log R |
| | | Ping rate | 5.5 pps/transducer |
| | DGPS | Type | WAAS-differential[3] |
| | | Datum | NAD83 |
| | Other | Transecting speed | 1.1 - 1.8 m/sec |

*(continued)*

**Table 2.1-1. Hydroacoustic System Specifications for Surveys of Aimaokatalok Lake, Hope Bay Belt Project, 2010 (completed)**

| Project Phase | Category | Variable | Value |
|---|---|---|---|
| Data Analysis | General | Calibration offset | -0.5 dB down-looking<br>1.6 dB side-looking |
| | | Time varied gain | 40 log R |
| | | Minimum threshold[4] | -60 dB |
| | | Maximum threshold[4] | none |
| | | Beam pattern threshold | -6 dB |
| | | Beam full angle | 6.7° down-looking<br>6.8° side-looking |
| | | Single target filters | 0.5-1.5 @ -6 dB |
| | | Range processed[2] | 2-30 m down-looking<br>10-30 m side-looking |
| | Fish tracking, per fish | Minimum no. echoes | 1 down-looking<br>2 side-looking |
| | | Maximum range change | 0.2 m |
| | | Maximum ping gap | 1 |

[1] *BioSonics DT-X split-beam digital echo sounder.*
[2] *Range from transducer.*
[3] *A WAAS satellite signal was received during sampling with typical nominal position accuracy 2 to 3 m.*
[4] *Processing threshold after application of calibration offset.*

Portions of these transects were also surveyed using underwater video to examine substrate types and to verify hydroacoustic classification of bottom type at the same locations. Video recordings of each lake bottom were conducted after the hydroacoustics transects were completed. Video recordings of the lake bottom were made at 22 locations in the Ore Deposit area. The depth at video sampling sites ranged from 2 to 11 m. No images were obtained at the Reference area due to unsafe, inclement weather at the time of video sampling.

Images were collected with a Splashcam Deltavision underwater video camera recording to a Sony VRD-MC6 DVD recorder. The camera was suspended from the side of a 5 m power boat with the lens aimed straight down about 50-100 cm above bottom. At each location the recording covered several meters or more of linear distance as the boat drifted. A 3.5 cm diameter lead ball on a 50 cm string served as a size reference, sediment probe, and gauge of proximity to the bottom. Parallel lasers 10 cm apart provided a secondary size reference. Time and boat position (latitude and longitude) from a Garmin GPS map 182 differential GPS were recorded continuously to the video image by way of a video overlay device. Nominal position accuracy of the GPS (indicated by the instrument) was 2-3 m during the survey.

#### *2.1.2.2 Data Processing and Analysis*

Substrate composition was determined from hydroacoustic data using the RoxAnn method (Chivers et. al. 1990), which was implemented through BioSonics Visual Bottom Typing (VBT) version 1.12 software (Burczynski 2007). This method uses the ratio of first and second bottom echo energy levels to distinguish bottom types. Energy from the first echo (E1) represents substrate roughness, while energy from the second echo (E2) represents hardness. Scatter plots (not shown) of these variables are used to characterize substrate types through a form of cluster analysis. Because E1 and E2 can vary from ping to ping, even at a single location with a homogeneous bottom type, VBT estimates bottom type by averaging values from groups of contiguous pings (or reports). In this study, VBT reports were 14 pings long (4-5 m along transect at our transecting speed). Other processing settings for VBT appear in Table 2.1-2. This technique was not applicable at depths < 1 m or slopes > 20% (J. Burczynski, BioSonics, personal communication), so shallow and steep areas were excluded from analysis where necessary.

**Table 2.1-2. Visual Bottom Typing (VBT) Processing Settings Used to Distinguish Bottom Types of Aimaokatalok Lake, Hope Bay Belt Project, 2010**

| Item | Setting |
|---|---|
| Data processing threshold | -80 dB |
| TVG | 30 log R |
| ***Bottom Sampling Windows*** | |
| First bottom, first part | 16 samples |
| First bottom, second part | 40 samples |
| Second bottom | 100 samples |
| Sediment layer | 16 samples |
| ***Bottom Tracker Settings*** | |
| Peak threshold | -45 to -30 dB (typically -40 dB) |
| Peak width | 5 samples |
| Bottom detection threshold | -60 dB |
| Above bottom blanking | 1 samples |
| Alarm limit | 8 samples |
| Tracking window | 25 samples |
| Tracking domain | 20 log R |
| Bottom typing method | B2 (E1/FD) |
| Depth normalization | none |
| Pings per report | 14 |
| Energy filter | 75% |

The substrate classification scheme used for Aimaokatalok Lake in 2010 was modified from one developed for the same echo sounder in 2009 using acoustic and video data from Patch Lake (Rescan 2010). The 2009 scheme classified sediments as very soft fines, mud, or gravel-cobble-boulder. Following analysis of additional reference samples in 2010, part of the gravel-cobble-boulder category was taken for a sand-gravel category, resulting in four sediment categories in 2010: very soft fines, mud, sand-gravel, and cobble-boulder. Even with four classes, this scheme is a simplification of the actual bottom-type, because a continuum of substrates from soft fines to bedrock undoubtedly occurred throughout the many and varied habitats within the study areas.

Video recordings were analyzed in the field and the lab by playing them back on a computer using Windows Media Player, and visually observing the substrate type and degree of aquatic plant coverage. Substrate size classes followed the modified Wentworth scale for particle size: <2 mm = fines, 2 to 64 mm = gravel, 64 to 256 mm = cobble, >256 mm = boulder (Orth 1983). Plant coverage was classed as sparse (0 to 25% of the bottom coverage), intermediate (25 to 50% coverage), or extensive (75 to 100% coverage). A screen-capture that included sampling time and geographic coordinates was taken at the end of each segment.

### 2.1.3 Stream Habitat

A total of 57 stream sites were surveyed in the Project area, 34 in the Boston area and 23 in the Doris/mid-belt area (Table 2.1-3 and Figures 2.1-2a to 2.1-2c). The inflows (I/F) and outflows (O/F) of the lakes and ponds sampled in the Project area were surveyed to identify which streams provided fish habitat and allowed fish passage between lakes. Streams that had clearly defined channels were split into units defined by habitat type and underwent an assessment that followed the protocol originally developed by Johnston and Slaney (1996) for the BC Watershed Restoration Program. A field data sheet template is shown in Appendix 2.1-1. The following habitat types were identified: pool, glide, riffle, and cascade. Pools are defined as areas of low turbulence, low velocity, low gradient and relatively deep water. Glides are moderately shallow reaches of low turbulence, moderate velocity and low gradient. Riffles are shallower areas of higher velocity and turbulence and gradient < 4%. Cascades are reaches in which water flows down steep gradients (from 4% to vertical) with high velocity and high turbulence. Cascades usually involve a series of small steps of alternating waterfalls and pools. Within each habitat unit, the physical features (e.g., gradient, mean depth, mean width, substrate composition, water velocity, availability of cover for fish, potential barriers, bank stability and bank height) were measured. Data were collected with a measuring tape, meter stick, clinometer (for gradient), and by visual inspection.

Some streams in the Project area had no clearly defined channel, with water flowing among boulder gardens and tundra vegetation. In these circumstances, a description of the flow characteristics and potential fish habitat was provided, but a detailed breakdown into different habitat types was not conducted.

Data collected on the habitat variables listed above were used to evaluate the overall quality of fish habitat at sites within the Project area. Fish habitat quality was evaluated for all fish life-stages (e.g., spawning, rearing, adult feeding, and overwintering) and categorized as none, poor, fair or good. These observations of fish habitat and fish catch data were used to determine if a stream site is fish bearing, and to classify fish habitat as none, marginal, important or critical on a watershed scale. Based on the fish-bearing status of each site and the streams wetted width, streams were classified as shown in Table 2.1-4.

### 2.1.4 Sensitive Fish Habitat Inventory

All streams and wetlands located within the proposed tailings, waste rock and infrastructure footprints were ground-truthed, mapped and habitat was assessed through the implementation of the Sensitive Habitat Inventory Mapping (SHIM) protocol (Figure 2.1-3). The SHIM method is used as a standard for watercourse and fish habitat mapping in British Columbia (Mason and Knight 2001). These methods were tailored and adapted for streams encountered in Nunavut. This method attempts to ensure the collection and mapping of reliable, high quality, current and spatially accurate information about fish habitats and watercourses.

Streams and wetlands were located in the field and their locations were mapped with a differential GPS unit (+/- 1 m accuracy). Moving in an upstream direction, streams were mapped, barriers were identified and habitat assessments were conducted. The presence of falls greater than 2 m high, steep cascades, channel gradients greater than 30% and where habitat becomes discontinuous or insufficient to support fish were determined as the point of “end of fish use”. The “end of fish use” for each stream was further validated with fish sampling.

Detailed fish habitat data was collected in the field as streams and wetlands were mapped. The spatial data was tied to fish habitat data collected in the field. Habitat data collected followed a combination of the *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures* (Resource Inventory Standards Committee 2001) and *BC Watershed Restoration Protocol* (Johnston and Slaney 1996) data, revised for use in Nunavut by removing data fields specific to forested and montane areas.

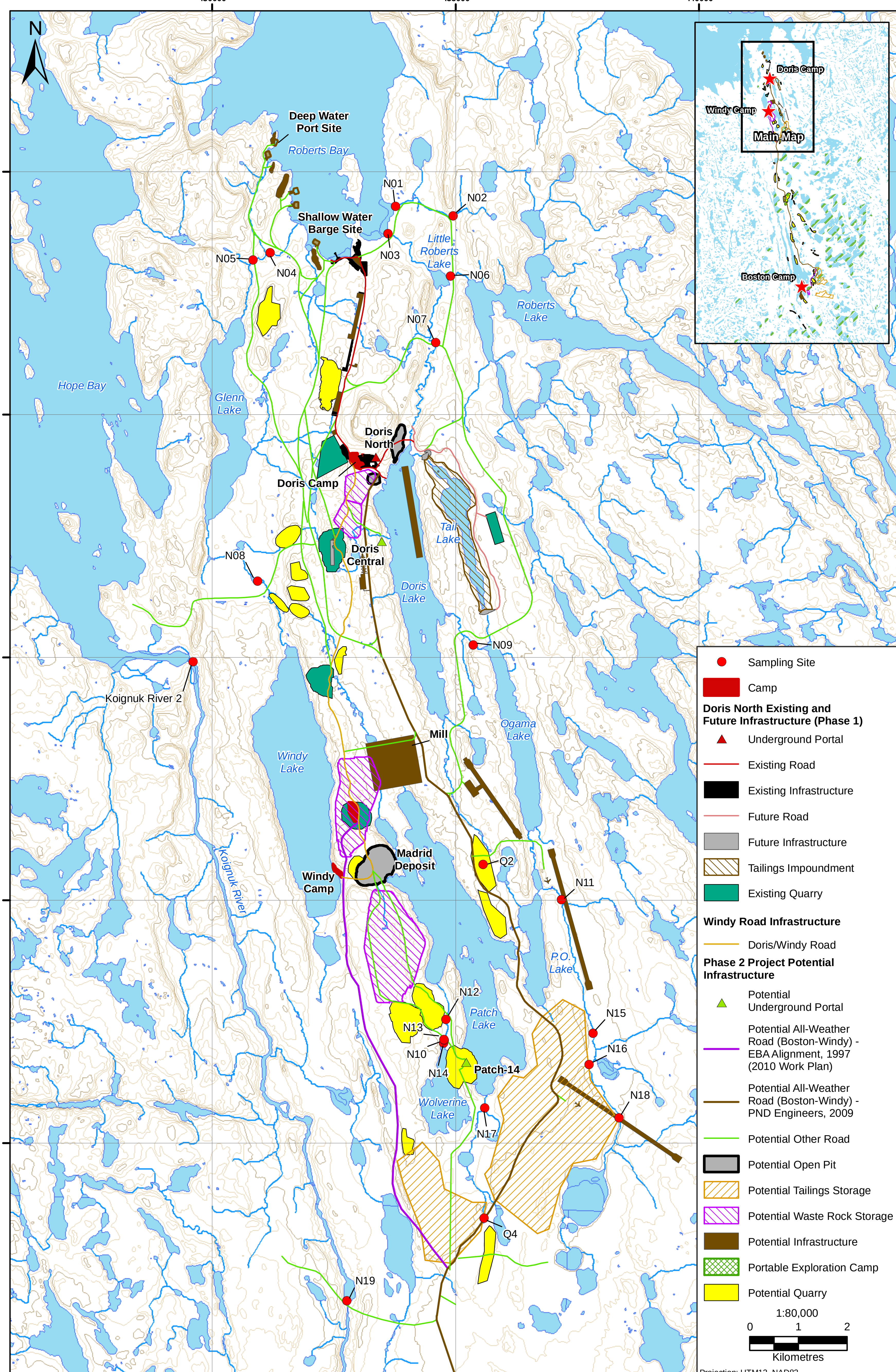


Figure 2.1-2a

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## Stream and Pond Fish Habitat and Fish Community Assessment Locations, Hope Bay Belt North, 2010

Figure 2.1-2a

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