PHASE 2
Draft Environmental Impact Statement

Table of Contents

List of Figures

List of Tables

List of Appendices

Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

AEMP	Aquatic Effects Monitoring Program
CPUE	Catch per unit effort
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CRA	Commercial, Recreational, and Aboriginal fisheries
EIS	Environmental Impact Statement
DELT	Deformities, Erosion, Lesions, or tumors
DFO	Fisheries and Oceans Canada
EEM	Environmental Effects Monitoring
ERM	Environmental Resource Management
DGPS	Differential Global Positioning System
GPS	Global Positioning System
FHAP	Fish Habitat Assessment Procedure
HBML	Hope Bay Mining Ltd.
ICPMS	Inductively Coupled Plasma – Mass Spectroscopy
IIAB	Inuit Impacts and Benefits Agreement
LSA	Local Study Area

KIA	Kitikmeot Inuit Association
MAD	Mean Annual Discharge
MDL	Method Detection Limit
MMER	Metal Mining Effluent Regulations
n	Sample size
NIRB	Nunavut Impact Review Board
NWB	Nunavut Water Board
PAD	Permanent alteration to, or destruction
PIT	Passive Integrated Transponder
PoP	Pathway of Effect
QA/QC	Quality Assurance and Quality Control
RPD	Relative Percent Difference
RIC	Resource Inventory Committee
RSA	Regional Study Area
SARA	*Species at Risk Act*
SE	Standard Error
SHIM	Sensitive Habitat Inventory Mapping
TIA	Tailings Impoundment Area
TK	Traditional Knowledge
TP	Total Phosphorus
NTKP	Naonaiyaotit Traditional Knowledge Project
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VEC	Valued Ecosystem Component

6. Freshwater Fish

The Phase 2 Project may interact with freshwater fish and fish habitat through the development of Phase 2 Project infrastructure such as roads, water intakes and discharge pipelines, and quarry sites, as well as through water use or groundwater loss to mine development. This chapter provides an overview of the available freshwater fish habitat and the freshwater fish communities in the areas surrounding the Phase 2 Project, and identifies and evaluates the potential Project-related effects and cumulative effects on freshwater fish habitat and fish communities in a local and regional context.

Fish habitat is defined in the federal *Fisheries Act* (1985) as “spawning grounds and any other areas, including nursery, rearing, food supply, and migration areas, on which fish depend directly or indirectly in order to carry out their life processes.” Fish habitat thereby includes lower trophic levels: primary and secondary producers (i.e., biological resources) and forage fish. Fish habitat within the Phase 2 Project area is provided by numerous lakes, rivers, streams, ponds, and marine areas.

The term “fish” in the *Fisheries Act* includes “parts of fish; shellfish, crustaceans, marine animals, and any parts of shellfish, crustaceans, or marine animals; and the eggs, sperm, larvae, spat, and juvenile stages of fish, shellfish, crustaceans, and marine animals”. The freshwater fish communities within the Phase 2 Project area are representative of Arctic freshwater ecosystems. Many of these fish species serve an important role in the ecological, economic, and cultural health of the region.

6.1 INCORPORATION OF TRADITIONAL KNOWLEDGE

Traditional Knowledge (TK) information was gathered by the Kitikmeot Inuit Association (KIA) in a report titled *Inuit Traditional Knowledge for TMAC Resources Inc., Hope Bay Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report . This report provides recorded and georeferenced TK pertaining to the Hope Bay Project by means of interviews conducted between 1997 and 2000, regional and site-specific studies, the *Inuit Land Use Occupancy Study* , focused workshops in Kugluktuk and Cambridge Bay in 2013, and studies of anadromous Lake Trout from Roberts Lake by Dr. Heidi Swanson of the University of Waterloo.

6.1.1 Incorporation of Traditional Knowledge for Existing Environment and Baseline Information

The NTKP report was reviewed for existing environment and baseline information on freshwater fish and fish habitat. Fish were, and continue to be, an important component of the Inuit seasonal diet. They were essential during times of food shortage, particularly when caribou did not arrive because of a change in migration route or calving area. They were also important for feeding dog teams during winter trapping.

Inuit fishing places in the Project area were identified along the coastline of Roberts Bay and the southern coastline of Melville Sound, including Hope Bay and the Lower Koignuk River. A smaller number of fishing places were on the shores of lakes and rivers further inland. Areas of general fishing effort in the Project area included Roberts Lake and Roberts Creek, Windy and Patch lakes, and an elongated area encompassing Aimaokatalok Lake, the Upper Koignuk River, and surrounding lakes and ponds.

> *Inuit fished the rivers when fish were going down river and up river, when they needed food. We fished at Hakvatok, (south coast of Melville Sound), Naoyak and Etibliakyok, Kolgayok*

> *(Tingmeak River), Kunayok (Ellice River) … and all along the coast of Victoria Island. These areas have charr and trout … and cisco whitefish ...*

In general, Inuit fished wherever they were on the land, in conjunction with other harvesting activities. Fishing was not only a harvesting activity but included an element of recreation.

> *In the fall we used gill nets to catch a lot of fish for the dogs, and for dry fish too. All these places where we had our nets have inokhok or rock pile markers … On our traplines too we fished. We did a lot of fishing especially on the days that were stormy. We did a lot of fishing to pass the time …*

In the past, Inuit fished by jigging, spearing, trapping, and sometimes with nets. Fishing is now most commonly conducted using nets. Inuit fished primarily in the spring and fall. The spring fishing period coincided with migrations of spring spawners such as hulukpaugan (Arctic Grayling; *Thymallus arcticus*), from overwintering lake habitat to stream and river spawning habitat. The fall fishing period focused on migrations of fall-spawners such as ekalukpik (Arctic Char; *Salvelinus alpinus*) and ehok (Lake Trout; *Salvelinus namaycush*) from the sea to lake spawning habitat. TK of the dominant fish species of the Phase 2 Project area is summarized in the following sub-sections.

6.1.1.1 Ekalukpik (Arctic Char)

Anadromous Arctic Char (*Salvelinus alpinus*) was the main target species identified in the NTKP report because it is present in many of the coastal lakes and rivers and along the coastline, where Inuit focus most of their fishing effort, and because it is a prized food fish. This is particularly true of Arctic Char that are returning to their natal lakes in a fattened condition after spending a summer feeding in the ocean. The Inuit targeted ekalukpik at the mouths of rivers with weirs, fish traps, spears, and baskets. More recently, nets are also used.

> *Some lakes that have rivers to the ocean contain Arctic charr. There are many lakes with Arctic charr; so many that I can't name them all. Some of these lakes are further inland. In the spring the charr that have been in the lakes in the winter return back to the ocean while others are going to the lakes …*
>
> *When the fish went up the river (Arctic charr fall migration) at Hiukkittat, Havaktok (chain of lakes at coast) and Kangihoakyok (Daniel Moore Bay), Inuit speared them or scooped them up in baskets … The fish look (healthy) when going up the river (from the ocean to the lakes). At Ekalokakok and Kilanaktovik there are lots of cracks in the rocks. Some of these fish get stuck trying to go up or down the rivers, and the fish may become injured.*
>
> *These fish found inland are very good to eat, The Arctic charr where I lived long ago (Tahikyoak and Kiligiktokmik (Bathurst Inlet)) and from some of the areas around here (Killinik (Victoria Island)) are very good to eat, just before the fall migration.*
>
> *We fished for charr at Ekalolialok (lake on island of the same name) … They must be sea run. They migrate to the lake in the fall and return to the sea in the spring.*

6.1.1.2 Ehok (Lake Trout)

Lake Trout (*Salvelinus namaycush*) are also a common food fish because they are found in many lakes and ponds. They are also known to be anadromous with Inuit catching them in lakes and along the marine shoreline and close to the mouths of rivers.

You could wait around for lake trout. Anywhere there is an outlet on the lake, where the ice is thin … That's where people go fish. These areas you don't have to chop through two or three feet of ice. Most year-round these rivers, any outlet on a lake or inlet, you find fish, charr, year-round.

Ehok, they go to the ocean but mostly they stay around the river mouth or stream. In the ocean they mostly stick around the river mouth.

… Some rivers, and even the ocean, have fish that are usually found in the lakes. They got caught in our nets. Inuit sometimes caught lake trout in the rivers and sometimes in the ocean. If there are fish around you can really catch a lot when you are using nets.

Any lake, any little pond there too, you wouldn't think there would be ehok there too, but depending how deep there are, there is always ehok in there. It could be a small little lake. You'd never think there are fish in there but ehok are common in those areas too.

6.1.1.3 Kapihillik (Arctic Cisco) and Anakheek (Broad Whitefish)

Arctic cisco (*Coregonus autumnalis*) and whitefish were harvested for food by Inuit. Arctic Cisco resides in large rivers and is anadromous, being caught along the marine shoreline. The NTKP report refers specifically to Arctic Cisco, although there are at least two other species of cisco in the Phase 2 Project area: Cisco (*Coregonus artedi*) and Least Cisco (*Coregonus sardinella*). Cisco and Least Cisco are largely lake-resident but some populations are anadromous.

Consultants did not have a different name for Lake Whitefish (*Coregonus clupeaformis*) and Broad Whitefish (*Coregonus nasus*), and called them all anakheek. Broad Whitefish are bottom-feeders and larger in body size than the ciscoes. Both Broad Whitefish and Lake Whitefish are mainly lake dwellers, although they have been caught in estuaries. The NTKP report states that Arctic Cisco and whitefish are not found in lakes with high copper content.

… There are different kinds of whitefish. Some are small and some are big. The broad whitefish are always really fat and the cisco whitefish are lean. Cisco whitefish only have white flesh. Towards fall, before spawning the cisco whitefish from around Kugluktuk get fat and then they are really tasty. The two whitefish taste different.

Anywhere, there are lots and lots (of Arctic cisco).

There will be whitefish here (Bathurst Inlet). In summertime, they will be at the coast. Then they will go back to the lakes and the river systems... (In the oceans) they mostly will stick around the coasts.

The cisco whitefish also have fat and eggs and are very tasty but not the broad whitefish. The broad whitefish does not have many eggs. These are different types of whitefish that are much bigger than the cisco whitefish.

Whitefish are found around the shorelines. They are seldom seen out in the ocean.

All these little streams and rivers that drain into the lakes have whitefish. There is more concentration in some parts of the lakes.

The larger lake whitefish, you can find them just about anywhere you find lake trout, in rivers, where there are fresh water rivers. Kogluk (meaning fast rapids) has lots and lots of

> *anakheek (broad whitefish), especially at the mouth of the rivers. Every river has kogluks. So if you fish any river with rapids, you will likely catch anakheek and kapihillik (Arctic cisco)…*

6.1.1.4 Hulukpaugan (Arctic Grayling)

Arctic Grayling (*Thymallus arcticus*) are fished to a lesser degree than Arctic Char, Lake Trout, and whitefish and fewer locations with Arctic Grayling were mapped in the NTKP report study area. Arctic Grayling are an exclusively freshwater species that reside in lakes or large rivers and spawn in rivers and tributary streams. They are largely insectivores that feed in the upper water layer. In the Project area they are present in the Aimaokatalok Watershed and the Koignuk River.

> *Grayling are found in the rivers further inland. Long ago when I was a young boy I caught grayling at the rivers leading to lakes. There were so many grayling in some lakes.*

> *It is the same for grayling. If there is copper content in those lakes, there will be no lake whitefish or grayling. There is none of those where there is lots of copper content in the water.*

6.1.1.5 Tiktalik (Burbot)

Burbot (*Lota lota*) are another freshwater species that was identified as a food fish in the NTKP report.

> *Burbot stay in freshwater systems.*

> *First time I caught it, a really big one, I was really young. I told my dad I caught a really, really ugly fish.*

> *First time my wife see tiktalik, she asked 'what kind of fish is this?" It's a really good fish but it looks funny. They're good, they're really good, that tiktalik.*

> *They are something like barracuda but they're small. They are silver.*

6.1.2 Incorporation of Traditional Knowledge for Freshwater Fish VEC Selection

The NTKP report was reviewed to refine the potential Valued Ecosystem Component (VEC) list for freshwater fish. The freshwater and anadromous fish species identified in the NTKP report and other commercial and recreational fish and their habitats were considered as potential VECs for the effects assessment. In addition, Inuit traditional fishing places and known fish distribution/locations identified in the NTKP report were considered as potential VECs for the effects assessment. Traditional knowledge was combined with data from public consultation and baseline surveys to determine which valued components would potentially interact with the proposed Project, and should therefore be evaluated for inclusion in the candidate VEC list.

As a result of this process, and in consideration of the EIS guidelines (NIRB 2012a), Lake Trout, Arctic Grayling, Arctic Char, Cisco (Cisco and Least Cisco), and Whitefish (Lake Whitefish and Broad Whitefish) were selected as candidate VECs for the EIS (Volume 2, Section 4; Effects Assessment Methodology). While available TK information specifically identified Arctic Cisco as a fish species used by Inuit in the NTKP report study area, Arctic Cisco have not been confirmed to be present and critical freshwater habitats used by Arctic Cisco are very limited in the smaller, freshwater fish baseline study area boundaries (see Section 6.2.1) for the Phase 2 Project, based on baseline information collected since 1993. Thus, Arctic Cisco was not considered as part of the Cisco candidate VEC. Burbot was not considered as a candidate VEC because it is rare in the Phase 2 Project area, having been captured only in the Koignuk River and Trout Outflow of the Aimaokatalok Watershed.

6.1.3 Incorporation of Traditional Knowledge for Spatial and Temporal Boundaries

The results of the NTKP report were considered when developing the spatial and temporal boundaries for the Project. The NTKP report showed that specific and general fishing locations extend along both shores of Melville Sound, but are concentrated along the southern shore extending both east and west of Roberts Bay. General fishing areas also extend inland along the entire length of the Hope Bay Greenstone Belt. Therefore, the entire Hope Bay Project area was included within the spatial boundaries of the assessment. The temporal boundaries of the assessment extend into the future, aligned with the post-closure phase, as preservation of the productive capacity of the freshwater aquatic ecosystem, particularly the capacity to produce food fish and fishing opportunities, is a key value of Inuit culture.

6.1.4 Incorporation of Traditional Knowledge for Project Effects Assessment

Inuit value a suite of fish species as food fish and as key attributes of freshwater aquatic systems. The potential effects considered in the effects assessment focus on the habitat requirements of these fish species. The effects assessment considers the spatial and temporal overlap of the Phase 2 Project with these fish species, specifically considering critical habitats and life history periodicity. Four of the main food fish species – Lake Trout, Arctic Char, cisco and whitefish – are anadromous species thus their rearing lakes, outlet streams and rivers, and the estuarine and coastal habitat immediately adjacent to those stream and river mouths are equally essential for preservation of productive populations. Productive lake ecosystems in addition to continued access to the sea are key requirements for both species. Arctic Grayling require accesses to good quality rearing and spawning habitat in streams and overwintering habitat in lakes.

6.1.5 Incorporation of Traditional Knowledge for Mitigation and Adaptive Management

As summarized within Land Use (Volume 6, Section 4), focus group sessions revealed Inuit concerns about the potential for freshwater fish or fish habitat quality to be affected by the Phase 2 Project. The Phase 2 Project infrastructure has been designed, where possible to avoid the habitats of fish species identified as important in TK information and best management practices will be applied to avoid and/or mitigate the loss or alteration to fish habitats and harm to fish. Additional mitigation of Phase 2 Project effects on freshwater fish and fish habitat may be achieved though fisheries offsetting (as deemed necessary and approved by DFO). Where appropriate, offsetting options and monitoring programs may be developed though engagement with the local Hunters and Trappers Organization and TMAC's Inuit Environmental Advisory Committee.

6.2 EXISTING ENVIRONMENT AND BASELINE INFORMATION

6.2.1 Regional Overview and Past Activities

The Phase 2 Project and the overall Hope Bay Project are situated within the Queen Maud Gulf Lowlands, approximately 125 km southwest of Cambridge Bay on the southern shore of Melville Sound in the West Kitikmeot region of Nunavut. The Phase 2 Project is within the Hope Bay Greenstone Belt, running 80 km in a north-south direction that varies in width between 7 km and 20 km. The Phase 2 Project consists of the existing Doris Project as well as the proposed Phase 2 Project, which includes mining of three deposit areas: Madrid North, Madrid South, and Boston (Figure 6.2-1).

Baseline freshwater aquatic information has been collected within the Hope Bay Greenstone Belt since 1993. The proposed Phase 2 Project infrastructure lies within a single defined Local Study Area (LSA) that is bounded by a larger Regional Study Area (RSA; see Section 6.4; Figure 6.2-1). Regionally, the Hope Bay Project lies entirely within the Southern Arctic Ecozone and is situated in an area of continuous permafrost. Generally, the northern portion of the belt (Doris area) has more variable relief, with exposed igneous extrusions to 160 m, and a greater marine influence than Madrid or Boston. Madrid and Boston are characterized by flat rolling bedrock covered by thin layers of moraine, lacustrine, and fluvial deposits.

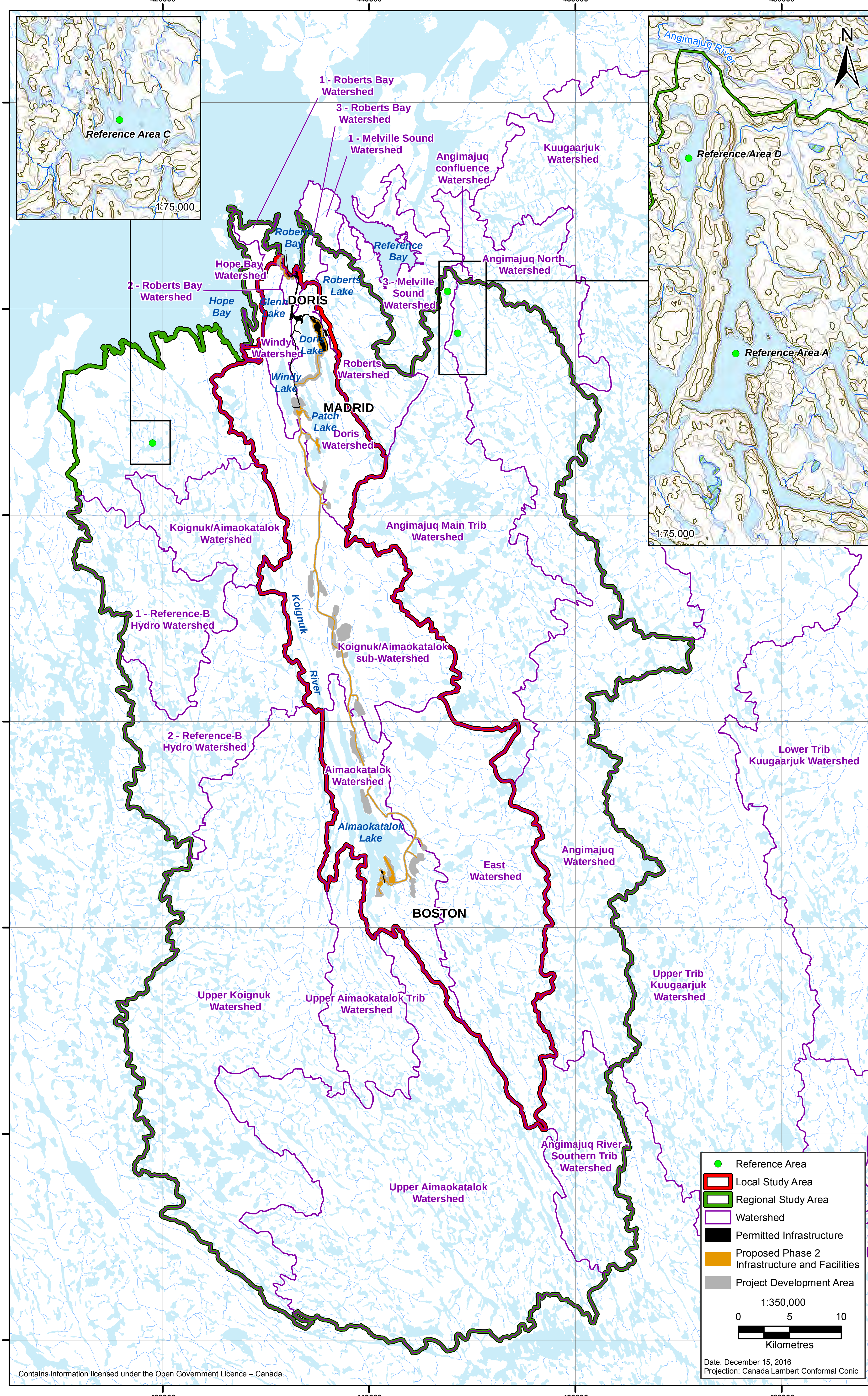
Winter is characterized by extreme cold, with mean monthly temperatures ranging from -33.4ºC to -3.1ºC. The coldest temperatures occur in January and February. There is a short snow-free season from mid-June through September with mean monthly temperatures ranging from -2.5ºC to 13.9ºC. The warmest temperatures are typically recorded in July. The Doris meteorological station reports total summer rainfall (June to September) ranging from 47.8 mm in 2012 to 97.8 mm in 2011 (see Volume 4, Section 1). The region's vegetation is characterized by shrub tundra vegetation such as dwarf birch (*Betula nana*), willow (*Salix* sp.), Labrador tea (*Ledum decumbens*), avens (*Dryas* sp.), and blueberries (*Vaccinium* sp.).

The freshwater LSA includes the Doris, Windy, and Koignuk sub-watersheds in the north, and the Aimaokatalok and East sub-watersheds in the south (Figure 6.2-1). Doris and Windy Watersheds flow northward into Roberts Bay via Little Roberts Outflow and Glenn Outflow, respectively, while watersheds around Boston flow into Hope Bay exclusively via the large Koignuk River system. The largest lakes in the north belt include Doris, Windy, Patch, Glenn, and Ogama. Aimaokatalok Lake is the largest lake in the south belt.

The hydrology of the Phase 2 Project area is dominated by snowmelt, with peak flows in most watersheds occurring in June. The lakes are typically frozen from November to June with ice thickness ranging between 1.5 and 2.0 m (Appendices V5-1C and V5-1D). Winter flow is largely absent because of negligible groundwater reserves outside of the permafrost and the lack of unfrozen surface water. Due to the influences of climate and permafrost, there is one major flood period (freshet) in June that quickly recedes into summer, with the hydrograph being punctuated with occasional high–flow events from storms during the open-water season.

Past mining activities associated with the Hope Bay Project include the previously permitted Doris North Gold Mine (Doris; see Volume 3, Project Description and Alternatives). The Doris deposit is located in the northernmost portion of the Belt, approximately 5 km inland from the coast. Doris was permitted in 2006 and construction commenced in 2007. The Doris mine is currently completing construction and entering the operations phase, and has an expected 6 year mine life. Doris infrastructure includes a jetty and associated infrastructure in Roberts Bay, all weather roads connecting Roberts Bay to the Doris mine, the Tailings Impoundment Area (TIA), as well as an all-weather airstrip, waste management facilities, accommodations, and water withdrawal from Doris and Windy lakes. The Phase 2 gold deposits, the subject of this EIS, are located south of Doris but will make use of existing Doris infrastructure where possible.

Figure 6.2-1
Local and Regional Study Areas for Freshwater Fish



6.2.2 Proximity to Designated Environmental Areas

There are currently no existing or proposed parks or conservation areas near the proposed Phase 2 Project. The nearest conservation area is the Queen Maud Gulf Migratory Bird Sanctuary approximately 50 km east of the Project area by air and over 300 km by water (because Melville Sound is isolated from the Queen Maud Gulf by the Kent Peninsula).

The Draft Nunavut Land Use Plan (Nunavut Planning Commission 2016) has designated the Project area as having high mineral potential and being within an area of Arctic Char abundance. The proposed Hiukkitak River Cultural Area on the eastern shore of northern Bathurst Inlet is approximately 100 km beyond the Project freshwater RSA boundary. Past, current, and potential future activities near the Project are outlined in the Effects Assessment Methodology (Volume 2, Section 4).

6.2.3 Regulatory Framework

Several federal regulations guide development where it pertains to fish and fish habitat protection. These include:

- *Fisheries Act* (1985);
- Metal Mining Effluent Regulations (MMER; SOR/2002-222); and
- *Species at Risk Act* (2002).

The following sections describe these acts, regulations, and guidelines and how they apply to the protection of fish and fish habitat.

6.2.3.1 Fisheries Act

Fish and fish habitat are protected under the *Fisheries Act*. In 2012, the *Fisheries Act* was amended to focus efforts on protecting the productivity of commercial, recreational, and Aboriginal fisheries (i.e., CRA fisheries); to institute enhanced compliance and protection tools that are more easily enforceable; to provide clarity, certainty, and consistency of regulatory requirements; and to enable enhanced partnerships with stakeholders.

The *Fisheries Act* includes a prohibition against causing serious harm to fish that are part of or support a CRA fishery (Section 35), provisions for flow and passage (Sections 20 and 21), and a framework for regulatory decision-making (Sections 6 and 6.1). The fisheries protection provisions of the *Fisheries Act* aim to provide for the sustainability and ongoing productivity of CRA fisheries (DFO 2013a).

The four factors in Section 6 and 6.1 to be taken into account by the Minister in decision-making (e.g., issuing authorizations) or making regulations are:

- the contribution of the relevant fish to the ongoing productivity of commercial, recreational, or Aboriginal fisheries;
- fisheries management objectives;
- whether there are measures and standards to avoid, mitigate, or offset serious harm to fish that are part of a commercial, recreational, or Aboriginal fishery; and
- the public interest.

For the purposes of the *Fisheries Act* (1985), "serious harm to fish" includes the death of fish or any permanent alteration to, or destruction (PAD) of fish habitat. The *Fisheries Act* defines fish habitat as "spawning grounds and any other areas, including nursery, rearing, food supply, and migration areas, on which fish depend directly or indirectly in order to carry out their life processes." The term "fish" includes parts of fish; shellfish, crustaceans, marine animals, and any parts of shellfish, crustaceans, or marine animals; and the eggs, sperm, larvae, spat, and juvenile stages of fish, shellfish, crustaceans, and marine animals. An alteration of fish habitat is considered a permanent alteration if it is "of a spatial scale, duration or intensity that limits or diminishes the ability of fish to use such habitats… in order to carry out one or more of their life processes". A alteration of fish habitat is considered the destruction of fish habitat if it is "of a spatial scale, duration, or intensity that fish can no longer rely upon such habitats…in order to carry out one or more of their life processes".

Any project or activity that causes a serious harm to fish that are part of, or support, a commercial, recreational, or Aboriginal fishery requires an authorization from DFO. Regulations have been developed to guide the application for this authorization: Applications for Authorization under Paragraph 35(2)(b) of the *Fisheries Act* Regulations. DFO has issued additional guidance in *The Fisheries Protection Program Operational Approach* (DFO 2013e).

Under the *Fisheries Act* a factor that must be considered for the issuance of an authorization for a project is whether there are measures and standards to avoid, mitigate, or offset serious harm to fish. According to the *Fisheries Protection Policy Statement* (DFO 2013b), efforts should be made to first prevent (avoid) impacts, then, when avoidance is not possible, to minimize (mitigate) impacts. After avoidance and mitigation actions are applied, any remaining impacts would normally require an authorization and should then be addressed by offsetting. Offsetting measures are intended to produce tangible conservation outcomes for fish and fish habitat to counterbalance the loss of fish habitat and fisheries productivity resulting from project impacts. Examples of offsetting measures include localized improvements in fish habitat and measures that address limitations on fisheries productivity. When applying for an authorization, proponents are required to submit an offsetting plan that demonstrates avoidance, mitigation, and offsetting measures and demonstrates how offsetting measures will maintain or improve the productivity of fisheries (DFO 2013a).

The *Fisheries Protection Policy Statement* (DFO 2013d) was issued on November 1, 2013 and replaced the earlier *Policy for the Management of Fish Habitat* (DFO 1986). Although the new policy statement does not include the "no net loss" principle, as outlined in the earlier policy, application of this principle provides some useful guidance when considering "serious harm to fish". Additional information is also available through scientific guidance documents developed by DFO (Koops et al. 2013; Randall et al. 2013).

6.2.3.2 Metal Mining Effluent Regulations

In 1996, Environment Canada undertook an assessment of the aquatic effects of mining in Canada. This assessment provided recommendations regarding the review and amendments of the Metal Mining Liquid Effluent Regulations, currently titled the Metal Mining Effluent Regulations (MMER; SOR/2002-222), and the design of a national Environmental Effects Monitoring (EEM) program for metal mining. The MMER, under the *Fisheries Act*, instructs metal mines to conduct EEM as a condition governing the authority to deposit effluent (MMER, Part 2, section 7).

The MMER (SOR/2002-222) permit the deposition of mine effluent into water containing fish if the effluent pH is within a defined range, if the concentrations of the MMER deleterious substances in the effluent do not exceed authorized limits, and if the effluent is demonstrated to be not acutely lethal to fish. These discharge limits were established to be minimum national standards based on the best available technology that is economically achievable at the time that the MMER were promulgated. To assess the adequacy of the effluent regulations for protecting the aquatic environment, the MMER include EEM requirements to evaluate the potential effects of effluents on fish, fish habitat, and the use of fisheries resources.

Regulations Amending the MMER were published in the Canada Gazette, Part II, in October 2006 (Canada Gazette 2006). The purpose of these amendments was to clarify the regulatory requirements by addressing matters related to the interpretation and clarity of the regulatory text that had emerged from the implementation of the Regulations.

Additional amendments to the MMER were published in the Canada Gazette, Part II, in March 2012 (Canada Gazette 2012). The following changes were made to expand EEM provisions of the MMER:

- modifications to the definition of an "effect on fish tissue" in order to be consistent with the Health Canada fish consumption guidelines and to clarify that the concentration of total mercury in tissue of fish from the exposure area must be statistically different from and higher than its concentration in fish tissue from the reference area;
- addition of selenium and electrical conductivity to the list of parameters required for effluent characterization and water quality monitoring;
- exemption for mines, other than uranium mines, from monitoring radium 226 as part of the water quality monitoring, if 10 consecutive test results showed that radium 226 levels are less than 10% of the authorized monthly mean concentration (subsection 13(2) of the Regulations; SOR/2002-222);
- change to the time frame for the submission of interpretative reports for mines with effects on the fish population, fish tissue, and benthic invertebrate community from 24 to 36 months;
- change to the time frame for the submission of interpretative reports for magnitude and geographic extent of effects, and for investigation of cause of effects, from 24 to 36 months; and
- minor changes to the wording for consistency within Schedule 5.

6.2.3.3 Species at Risk Act

The federal *Species at Risk Act* (2002) is designed to prevent Canadian indigenous species, subspecies, and distinct populations from becoming extirpated or extinct. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses and identifies species at risk. COSEWIC is designated under SARA to assess species according to their level of conservation concern: *extinct*, *extirpated*, *endangered*, *threatened*, *special concern*, *not at risk* or *data deficient*. Only those species listed in Schedule 1 of the *Act* qualify for legal protection and recovery under SARA. The *Act* prohibits the killing, harming, harassing, capturing or taking of an individual of a species that is listed in Schedule 1 as *extirpated*, *endangered* or *threatened* by SARA (section 32(1)). SARA also protects the residence of species listed as *extirpated*, *endangered* or *threatened* from being damaged and destroyed as specified in Section 33. No fish species listed under SARA were captured in freshwater habitats in baseline studies.

6.2.4 Data Sources

From 1993 to 1998, freshwater aquatic studies were conducted throughout the entire Hope Bay Greenstone Belt for BHP Minerals Canada Ltd., focusing mainly on the Boston and Doris areas.

Environmental studies continued under BHP Diamonds Inc. in 1998 and 1999, mainly focusing on the Boston area.

Miramar Hope Bay Ltd./Hope Bay Joint Venture (Miramar) acquired the property in 1999, and continued environmental studies in the belt, ultimately focusing on the Doris area. The Doris property went through the environmental permitting process, and was issued a Project Certificate by the Nunavut Impact Review Board (NIRB), a Type A water licence by the Nunavut Water Board (NWB), and a Schedule 2 amendment to the MMER for Tail Lake, now the Doris Tailings Impoundment Area (TIA). Other regulatory approvals such as a Fisheries Authorization and Fish Habitat Compensation Agreement for the Roberts Bay Jetty, a Navigable Waters Authorization, a Water Compensation Agreement with the Kitikmeot Inuit Association (KIA), and an Inuit Impacts and Benefits Agreement (IIBA) with KIA, were also obtained. As a result of permitting the Doris Project, most of the freshwater aquatic studies between approximately 2002 and 2006 focused on the Doris area. However, some baseline work in the Boston and Madrid areas was initiated in 2006, and continued in 2007 and 2008.

Newmont Mining Corporation acquired the property in March 2008, and formed Hope Bay Mining Ltd. (HBML) and continued exploration activities, and evaluated various options for long-term development of the belt. HBML also worked through the compliance commitments from the Doris Project, and determined how best to proceed given the objective of permitting additional deposits in the belt. That work included preparing a review of baseline studies and a data gap analysis (Rescan 2009) and undertaking subsequent additional baseline studies for the Phase 2 Project. In 2012, TMAC acquired the property and continued freshwater aquatic studies including baseline studies, annual compliance reports, and reports of the Doris Aquatic Effects Monitoring Program (AEMP).

6.2.4.1 Freshwater Fish Habitat - Biological Resources

Freshwater biological resources are those communities of plants and animals that form the basis of aquatic food webs and which support fish: phytoplankton, periphyton, zooplankton, and benthic invertebrates. Forage fish – small-bodied fish species that are prey for larger fish – can be considered biological resources because of their positions in the food webs, but are described in the fish sections of this document.

Biological resources data were compiled from site-specific surveys in the LSA and RSA that were conducted from 1993 to 2014. The primary sources of biological resource information used in the EIS were the baseline studies conducted from 1993 to 2010 (Rescan 1993, 1994, 1995, 1997, 1998, 1999b, 2001; RL&L Environmental Services Ltd./Golder Associates Ltd. 2003b; Golder Associates Ltd. 2008b, 2009; Rescan 2010c, 2011c) and the AEMP sampling for the Doris Project (Rescan 2011a, 2012a, 2013a; ERM Rescan 2014a; ERM 2015b). All reports can be found in associated appendices, except the Doris Project AEMP reports (Rescan 2011a, 2012a, 2013a; ERM Rescan 2014a; ERM 2015a, 2016b), which are available on the Nunavut Water Board (NWB) FTP site (ftp://ftp.nwb-oen.ca). Titles and associated appendix numbers of the baseline studies are the following:

- Boston Property N.W.T.: Environmental Data Report (Rescan 1993; Appendix V5-3B);
- Boston Property N.W.T.: Environmental Data Report (Rescan 1994; Appendix V5-3C);
- Boston Property N.W.T.: Environmental Data Report 1995 (Rescan 1995; Appendix V5-4B);
- Hope Bay Belt Project: Environmental Baseline Studies Report 1996 (Rescan 1997; Appendix V5-4C);
- Hope Bay Belt Project: 1997 Environmental Data Report (Rescan 1998; Appendix V5-4D);
- Hope Bay Belt Project: 1998 Environmental Data Report (Rescan 1999b; Appendix V5-4E);

- 2000 Supplemental Environmental Baseline Data Report, Hope Bay Belt Project (Rescan 2001; Appendix V5-3C);
- Doris North Project: Aquatic Studies 2003 (RL&L Environmental Services Ltd./Golder Associates Ltd. 2003b; Appendix V5-3E);
- Boston and Madrid Project Areas: 2006-2007 Aquatic Studies (Golder Associates Ltd. 2008b; Appendix V5-3G);
- Hope Bay Project: Aquatic Studies 2008 (Golder Associates Ltd. 2009; Appendix V5-3H);
- 2009 Freshwater Baseline Report, Hope Bay Belt Project (Rescan 2010c; Appendix V5-4A); and
- Hope Bay Belt Project: 2010 Freshwater Baseline Report (Rescan 2011c; Appendix V5-4B).

6.2.4.2 Freshwater Fish Habitat - Physical Characteristics and Fish Community

Surveys of fish and fish habitat in streams and lakes of the Hope Bay Belt began in 1993 and continued to 2015. Surveys were conducted in 22 of those 24 years; no surveys were conducted in the years 1999 and 2001. Sampling covered the North Belt (i.e., Doris area) and the South Belt (i.e., Madrid and Boston areas) of the LSA and selected lakes and streams within the RSA. Comprehensive baseline aquatic studies for the Phase 2 EIS were conducted in 2009 and 2010. Additional studies in support of the Doris AEMP and other environmental compliance programs were conducted from 2010 to 2015. Full details of the fish and fish habitat surveys from 1993 to 2015, including studies conducted in support of the Phase 2 EIS in 2009, 2010, 2014, and 2015, are described in the reports listed in Section 6.2.3.1 and the following 27 additional reports (associated appendix numbers included):

- Doris Lake Project, Northwest Territories 1995 Environmental Study (Klohn-Crippen Consultants Ltd. 1995; Appendix V5-4A);
- Hope Bay Belt Project, Metal Concentrations in Fish Tissues from Five Lakes in the Hope Bay Belt, Nunavut (Rescan 1999a; Appendix V5-6A);
- Aquatic Baseline Studies: Doris Hinge Project Data Compilation Report 1995-2000 (RL&L/Golder 2002; Appendix V5-3D) ;
- Doris North Project Aquatic Studies 2002 (RL&L Environmental Services Ltd./Golder Associates Ltd. 2003a; Appendix V5-5A);
- Doris North Project Aquatic Studies 2004 (Golder 2005; Appendix V5-4G);
- Bathymetric Surveys: Hope Bay Project, Hope Bay, Nunavut (Golder 2006a; Appendix V5-3F);
- Doris North Project Aquatic Studies 2005 (Golder 2006b; Appendix V5-4H);
- Doris North Project Aquatic Studies 2006 (Golder 2007a; Appendix V5-4I);
- Doris North Project “No Net Loss” Plan (Golder 2007b; Appendix V5-6B);
- Doris North Project Aquatic Studies 2007 (Golder 2008; Appendix V5-4J);
- Aquatic Baseline Studies Boston Project Data Compilation Report 1992 – 2000 (Golder Associates Ltd. 2008a; Appendix V5-6C);
- 2009 Freshwater Fish and Fish Habitat Baseline Report, Hope Bay Belt Project (Rescan 2010b; Appendix V5-6D);
- Hope Bay Belt Project: 2010 Freshwater Fish and Fish Habitat Baseline Report (Rescan 2011d; Appendix V5-6E);

- Doris North Gold Mine Project: Doris Mine Site Fisheries Authorization Monitoring Report 2010 (Rescan 2011b; Appendix V5-6F);
- Doris North Gold Mine Project: Doris Mine Site Fisheries Authorization Monitoring Report 2011 (Rescan 2012c; Appendix V5-6G);
- Doris North Gold Mine Project: 2011 Tail Lake Fish-out Report (Rescan 2012b; Appendix V5-6H);
- Doris North Gold Mine Project: Windy Lake Shoal Monitoring, 2012 (Rescan 2012e; Appendix V5-6I);
- Doris North Gold Mine Project: Roberts Outflow and E09 Fish Habitat Enhancement Report (Rescan 2012d; Appendix V5-6J);
- Doris North Gold Mine Project: 2012 Roberts Lake and Outflow Fish Monitoring Report (Rescan 2013b; Appendix V5-6K);
- Doris North Project: 2013 Windy Lake Shoal Compliance Monitoring Report (ERM Rescan 2014c; Appendix V5-6L);
- Doris North Project: 2013 Roberts Lake and Outflow Fish Compliance Monitoring Program Report (ERM Rescan 2014b; Appendix V5-6M);
- Doris North Project: 2014 Windy Lake Shoal Compliance Monitoring Report (ERM 2014; Appendix V5-6N);
- Doris North Project: 2014 Roberts Lake and Outflow Fish Compliance Monitoring Program Report (ERM 2015c; Appendix V5-6O);
- Imniagut Lake Fisheries Assessment, Doris North Project, 2014 (ERM 2015d; Appendix V5-6P);
- Proposed Access Road Fisheries Assessments, Doris North Project 2015 (ERM 2015e; Appendix V5-6Q);
- Doris Lake, Doris Creek, and Little Roberts Outflow Fisheries Assessment (ERM 2016a; Appendix V5-6R); and
- Doris North Project: 2015 Roberts Lake Fish Enhancement Monitoring Program (ERM 2016c; Appendix V5-6S).

6.2.5 Methods

6.2.5.1 Freshwater Fish Habitat – Biological Resources

The methods used to collect biological resources data are described below.

<u>Phytoplankton and Periphyton</u>

Phytoplankton and periphyton are photosynthetic microorganisms that use inorganic nutrients and sunlight to produce organic matter. Phytoplankton are free-floating while periphyton are attached to submerged surfaces such as rocks. These primary producers play a key ecological role in freshwater systems as the basis of aquatic food webs. Phytoplankton are important primary producers in lentic (still water) ecosystems such as lakes, while periphyton are important primary producers in the littoral habitat lakes and in lotic (flowing water) ecosystems such as streams and rivers.

Phytoplankton samples were collected from 12 lakes within the LSA and 9 lakes within the RSA from 1993 to 2015, with periphyton samples being collected from 16 streams within the LSA and 9 streams within the RSA. Tables 6.2-1 and 6.2-2 provide an overview of the phytoplankton and periphyton biomass and taxonomy sampling sites in the LSA and RSA. Figures 6.2-2 and 6.2-3 show the baseline phytoplankton and periphyton sampling sites.

Table 6.2-1. Lake Phytoplankton Biomass (as Chlorophyll *a*) and Taxonomy Sampling Sites, 1993 to 2015

	1993	1994	1995	1996	1997	1998	2000	2003	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
LSA - North Belt																		
Doris Lake	-	-	-	T	BT	-	BT	B	-	-	B	BT	B	B	B	B	B	B
Glenn Lake	-	-	-	-	-	-	-	-	-	B	B	BT	-	-	-	-	-	-
Imniagut Lake	-	-	-	-	-	-	-	-	-	-	-	BT	-	-	-	-	-	-
Nakhaktok Lake	-	-	-	-	-	-	-	-	-	-	-	BT	-	-	-	-	-	-
Ogama Lake	-	-	-	T	BT	-	-	-	B	B	B	BT	-	-	-	-	-	-
P.O. Lake	-	-	-	-	-	-	-	-	B	B	B	BT	-	-	-	-	-	-
Patch Lake	-	-	-	T	BT	-	-	-	B	B	B	BT	-	-	-	-	-	-
Windy Lake	-	-	-	T	BT	-	-	-	B	B	B	BT	BT	-	-	-	-	-
Wolverine Lake	-	-	-	-	BT	-	-	-	B	B	B	BT	-	-	-	-	-	-
LSA - South Belt																		
Aimaokatalok Lake	T	BT	T	BT	BT	BT	-	-	B	B	B	-	BT	-	-	-	-	-
Stickleback Lake	-	BT	T	BT	BT	BT	-	-	B	B	B	-	BT	-	-	-	-	-
Trout Lake	-	-	T	BT	BT	BT	-	-	B	B	B	-	BT	-	-	-	-	-
RSA																		
Boston Reference Lake	-	-	-	-	BT	BT	-	-	B	B	B	-	-	-	-	-	-	-
Little Roberts Lake	-	-	-	T	BT	-	-	B	-	-	B	BT	B	B	B	B	B	B
Naiqunnguut Lake	-	-	-	-	-	-	-	-	-	-	-	BT	-	-	-	-	-	-
Pelvic Lake	-	-	-	-	BT	-	BT	-	B	B	B	-	-	-	-	-	-	-
Reference A Lake (2003)	-	-	-	-	-	-	-	B	-	-	-	-	-	-	-	-	-	-
Reference Lake A	-	-	-	-	-	-	-	-	-	-	-	BT	-	-	-	-	-	-
Reference Lake B	-	-	-	-	-	-	-	-	-	-	-	BT	BT	B	B	B	B	B
Reference Lake D	-	-	-	-	-	-	-	-	-	-	-	-	BT	B	B	B	B	B
Roberts Lake	-	-	-	-	-	-	-	B	-	-	B	-	-	B	B	-	-	-

Notes:
Dashes indicate no samples were collected.
"B" indicates that biomass samples were collected.
"T" indicates that taxonomy samples were collected.
"BT" indicates that both biomass and taxonomy samples were collected.

Table 6.2-2. Stream Periphyton Biomass (as Chlorophyll *a*) and Taxonomy Sampling Sites, 1997 to 2015

LSA - North Belt	1997	1998	2000	2009	2010	2011	2012	2013	2014	2015
AWRa	-	-	-	-	BT	-	-	-	-	-
AWRb	-	-	-	-	BT	-	-	-	-	-
Doris Outflow	BT	-	BT	BT	B	B	B	B	B	B
Glenn Outflow Downstream	-	-	-	BT	-	-	-	-	-	-

LSA - North Belt	1997	1998	2000	2009	2010	2011	2012	2013	2014	2015
Koignuk River (Upstream, Midstream, Downstream)	-	-	-	BT	BT	-	-	-	-	-
Ogama Outflow	BT	-	-	BT	-	-	-	-	-	-
P.O. Outflow	-	-	-	BT	-	-	-	-	-	-
Patch Outflow	BT	-	-	BT	-	-	-	-	-	-
Windy Outflow	BT	-	-	BT	-	-	-	-	-	-
LSA - South Belt										
Aimaokatalok NE Inflow	BT	BT	-	-	BT	-	-	-	-	-
Aimaokatalok Outflow	-	-	-	-	BT	-	-	-	-	-
AWRc	-	-	-	-	BT	-	-	-	-	-
AWRd	-	-	-	-	BT	-	-	-	-	-
Koignuk River	-	-	-	-	BT	-	-	-	-	-
Stickleback Outflow	BT	BT	-	-	BT	-	-	-	-	-
Trout Outflow	BT	BT	-	-	BT	-	-	-	-	-
RSA										
Aimaokatalok River	BT	BT	-	-	BT	-	-	-	-	-
Angimajuq River Reference	-	-	-	BT	-	-	-	-	-	-
Boston Reference Outflow	BT	BT	-	-	-	-	-	-	-	-
Little Roberts Outflow	BT	-	-	BT	B	B	B	B	B	B
Pelvic Outflow	BT	-	BT	-	-	-	-	-	-	-
Reference A Outflow	-	-	-	BT	-	-	-	-	-	-
Reference B Outflow	-	-	-	BT	BT	B	B	B	B	B
Reference D Outflow	-	-	-	-	BT	B	B	B	B	B
Roberts Outflow	-	-	-	-	B	B	B	B	B	B

Notes:
Dashes indicate no samples were collected.
"B" indicates that biomass samples were collected.
"T" indicates that taxonomy samples were collected.
"BT" indicates that both biomass and taxonomy samples were collected.
Phytoplankton biomass (as chlorophyll a*) and taxonomy samples were typically collected using Niskin sampling bottles during the ice-covered season (October to June) and GO-FLO or Kemmerer sampling bottles during the open-water season (July to September).*

Periphyton samples were usually collected using Plexiglas artificial substrate samplers installed in streams for a set period of time. Upon retrieval, known surface areas of the plates were scraped and rinsed into a bottle for analysis of biomass as chlorophyll *a* and/or taxonomy. Periphyton samples collected as instantaneous rock scrapings were not included in this data compilation as this method is not comparable to periphyton collected using artificial substrate samplers.

Phytoplankton and periphyton biomass samples were filtered onto 0.45 µm filters that were wrapped in aluminum foil and stored frozen. Biomass samples were sent either to the University of British Columbia, the Alberta Research Council, or ALS Environmental (Burnaby or Vancouver, BC) for analysis of chlorophyll *a*.

Figure 6.2-2
Freshwater Phytoplankton and Periphyton Sampling Sites, North Belt, 1996-2015

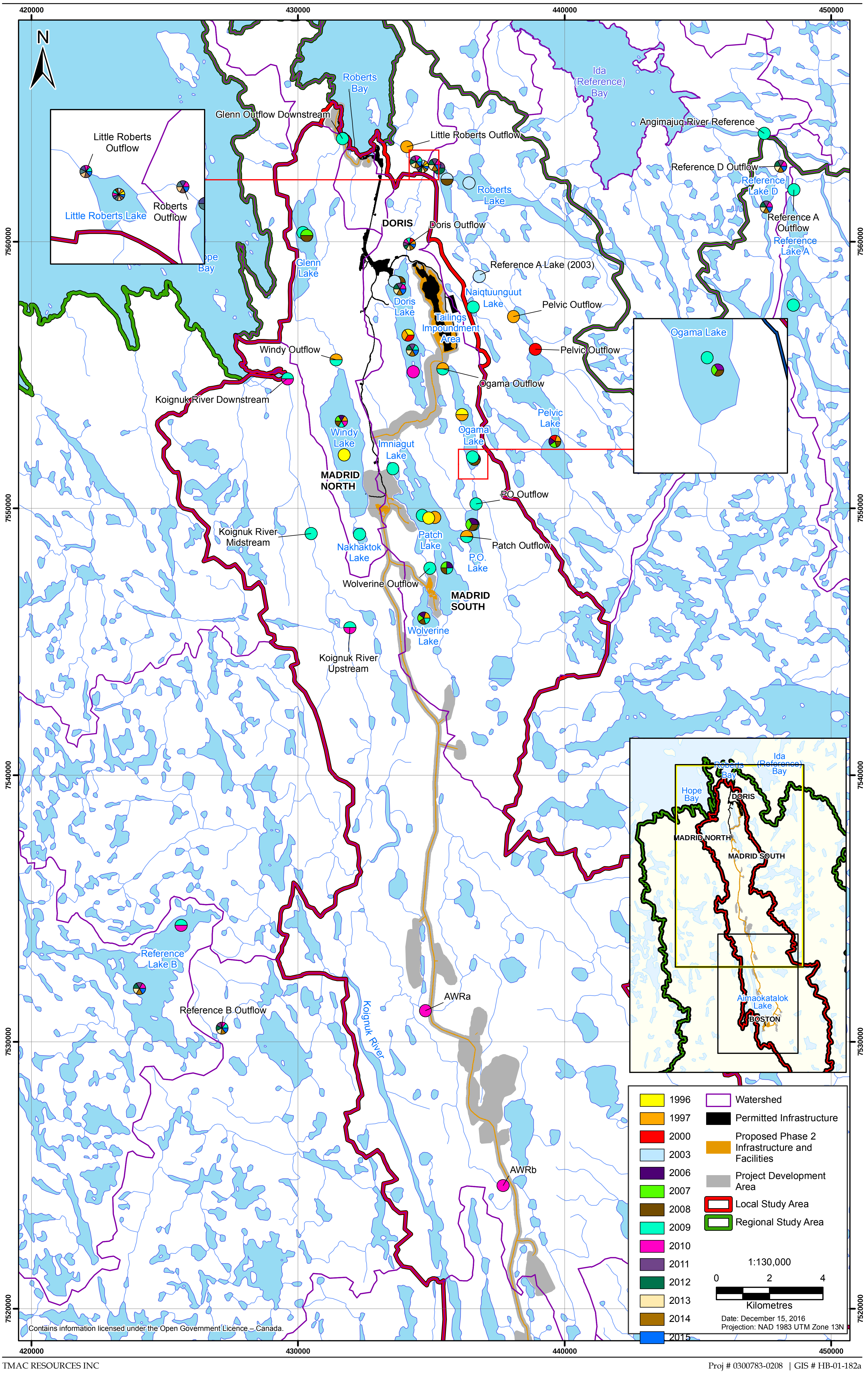
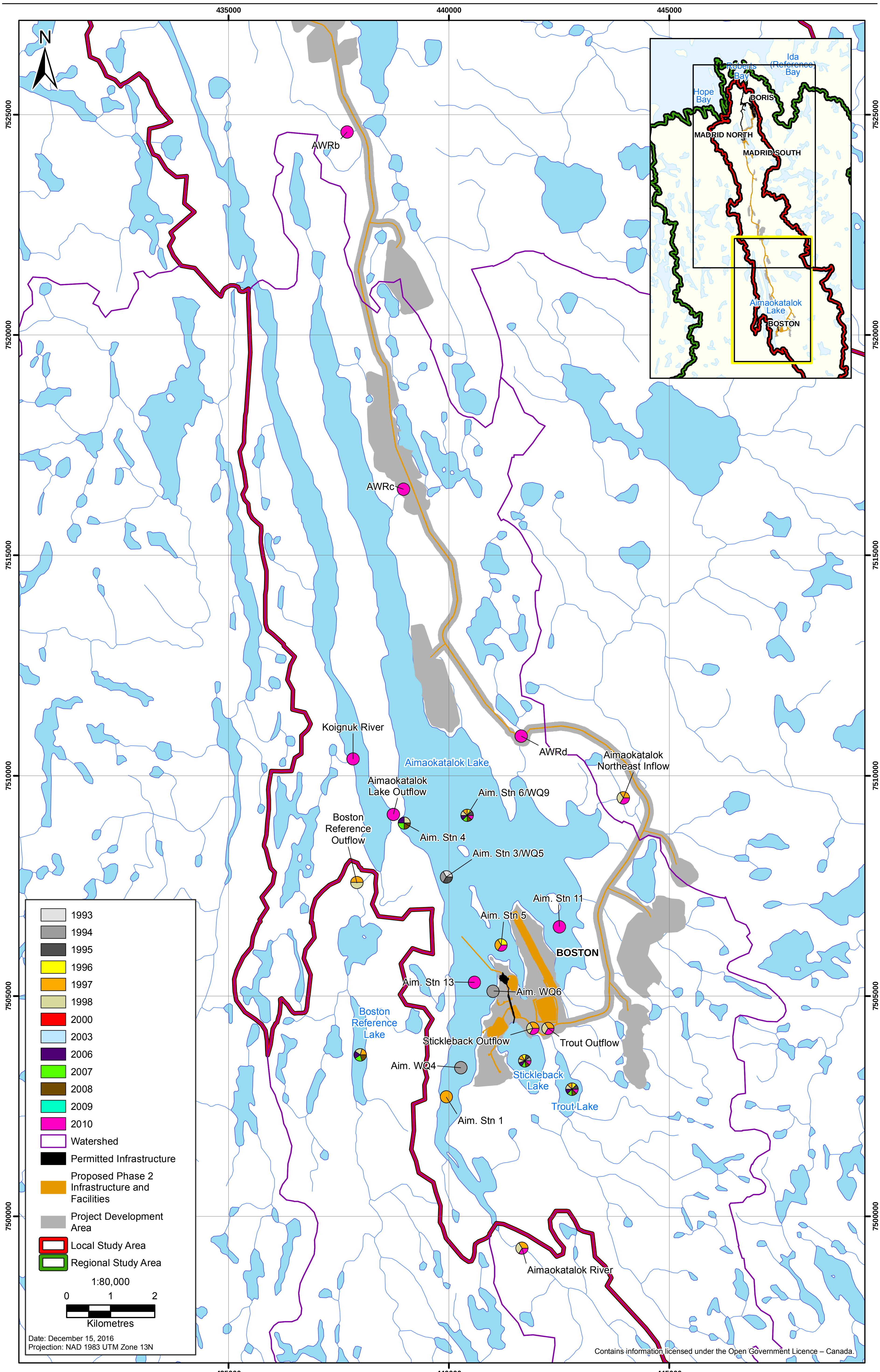


Figure 6.2-3
Freshwater Phytoplankton and Periphyton Sampling Sites, South Belt, 1993-2010

TMAC RESOURCES



Phytoplankton and periphyton taxonomy samples were preserved with Lugol's iodine solution and were sent to a qualified taxonomist for enumeration and identification. Phytoplankton taxonomy data from Golder (2008b) were not included in this baseline data compilation because results were reported in units (e.g., biovolume or carbon biomass) that are not comparable to data from other years, i.e. numerical abundance per unit volume.

Primary producer communities were described using abundance (cells/mL for phytoplankton and cells/cm^2 for periphyton), genus richness (number of genera per sample), and genus diversity (Simpson's Diversity Index). The Simpson's Diversity Index (1-D) considers both evenness amongst and the number of genera. Values range from 0 to 1 with lower values indicating a lower diversity, i.e. a larger number of genera and/or evenness of abundance amongst genera.

Zooplankton

Zooplankton are small aquatic organisms that feed on bacteria, phytoplankton, other zooplankton, and particulate organic matter. They are prey for larger organisms including other zooplankton, benthic invertebrates, and fish.

Zooplankton samples were collected in lakes throughout the LSA and RSA between 1993 and 2010 (Figures 6.2-4 and 6.2-5). Samples were typically collected using vertical hauls conducted by lowering a net (118 µm mesh size) to within 1 to 2 m of the lake bottom and bringing it to the surface at a constant, slow speed (~ 0.5 m/s). Nets with different mesh sizes were used for some samples (64 µm mesh size used in 1993, 180 µm mesh size used in 2000), which could contribute to variability in the data. An internally mounted flowmeter was used to record the volume of water passing through the net during all hauls. Taxonomic samples were preserved with buffered formalin and sent to a qualified taxonomist for enumeration and identification.

Zooplankton communities were described using abundance (organisms/m^3), genus richness (number of genera per sample), and genus diversity (Simpson's Diversity Index). Zooplankton taxonomy data from Golder (2008b) were not included in this baseline data compilation because results were reported as biomass per unit volume that were not comparable to taxonomy data from other years that were reported as numerical abundance per unit volume.

Benthic Invertebrates

Benthic invertebrates are a diverse group of organisms that live on or in the sediments, making up an important component of lake, stream, and river ecosystems. Crustaceans, insects, and molluscs compose the bulk of this community, at least by weight. These organisms feed on algae, bacteria, detritus, and other invertebrates and are an important pathway for energy and nutrients to move from primary producers into higher trophic levels, particularly fish.

Benthic invertebrate samples were collected in lakes, streams, and rivers throughout the LSA and RSA between 1993 and 2015 (Figures 6.2-6 and 6.2-7). Lake benthic invertebrate samples were collected using an Ekman grab sampler (surface area of 0.023 m^2) lowered to the lake bottom and triggered closed to collect sediments. Upon retrieval, sediments were sieved through a 500 µm sieve bucket to retain benthic macroinvertebrates. For some baseline studies, a 250 µm sieve bucket was used which would retain smaller organisms (meiofauna) than a 500 µm sieve bucket and contribute to some variability in the data. Lake benthic invertebrates were carefully collected and preserved in buffered formalin and send to a qualified taxonomist for enumeration and identification.

Stream and river benthic invertebrates were collected using a either a Hester-Dendy artificial substrate sampler that was installed in streams for approximately one month to allow for colonization by benthic invertebrates (1996 to 2000), or a Hess sampler with a sampling surface area of 0.096 m^2 and a net mesh size of 250 µm (1993, 1995) or 500 µm (2009-2015). Stream benthic invertebrates were carefully collected and preserved in buffered formalin and sent to a qualified taxonomist for enumeration and identification. A preliminary investigation of the pooled historical benthic invertebrate data showed that these two different sampling methods produced comparable results, so all benthic invertebrate data collected in LSA and RSA streams and rivers were included in this baseline data compilation.

Benthic invertebrate communities were described using abundance (organisms/m^2), genus richness (number of genera per sample), and genus diversity (Simpson's Diversity Index). There was some variability in the reporting of benthic invertebrate data in the historical dataset. Some studies included all counted organisms in the benthic invertebrate dataset, while others excluded some organisms for various reasons. For example, nematodes and harpacticoid copepods were sometimes excluded because these organisms are considered meiobenthic invertebrates and are not adequately sampled using mesh sizes of 250 to 500 µm which are typically used to collect macrobenthic organisms. Cladocerans, calanoid and cyclopoid copepods were also commonly excluded because these are largely pelagic organisms that do not typically live in benthic environments. These differences in data processing likely contribute to some of the variability in the pooled baseline data.

Quality Assurance and Quality Control

Although some quality assurance and quality control (QA/QC) measures differed among the aquatic resources baseline studies, common practices included the use of chain of custody forms to track all samples, and sample replication to account for within-site variability (between three and five replicates were usually collected for aquatic resources).

For most benthic invertebrate surveys, taxonomists determined the sorting efficiency of samples as an additional QA/QC measure. A re-sorting of randomly selected sample residues was conducted on a minimum of 10% of the benthos samples to determine the level of sorting efficiency. The criterion for an acceptable sorting was that more than 90% of the total number of organisms was recovered during the initial sort. The number of organisms initially recovered from the sample was expressed as a percentage of the total number after the re-sort (total of initial and re-sort count). Any sample not meeting the 90% removal criterion was re-sorted a third time. During this step of the QA/QC program, 90% minimum efficiency was attained for all benthos samples.

6.2.5.2 Freshwater Fish Habitat – Physical Characteristics

Fish habitat – the physical resources essential for fish to carry out life processes – was assessed in the Hope Bay Project area between 1993 and 2015. Multiple fish habitat survey methods were conducted in lakes ponds and/or streams, as follows:

Lakes and Ponds

- Aerial surveys by helicopter;
- Reconnaissance surveys of the shorelines and littoral zones on foot or by small boat;
- Bathymetric surveys using hydroacoustic methods;
- Habitat assessment of littoral zones;
- Estimation of surface area and maximum depth of small headwater lakes of the Roberts Watershed;

Figure 6.2-4
Freshwater Zooplankton Sampling Sites, North Belt, 1996-2010

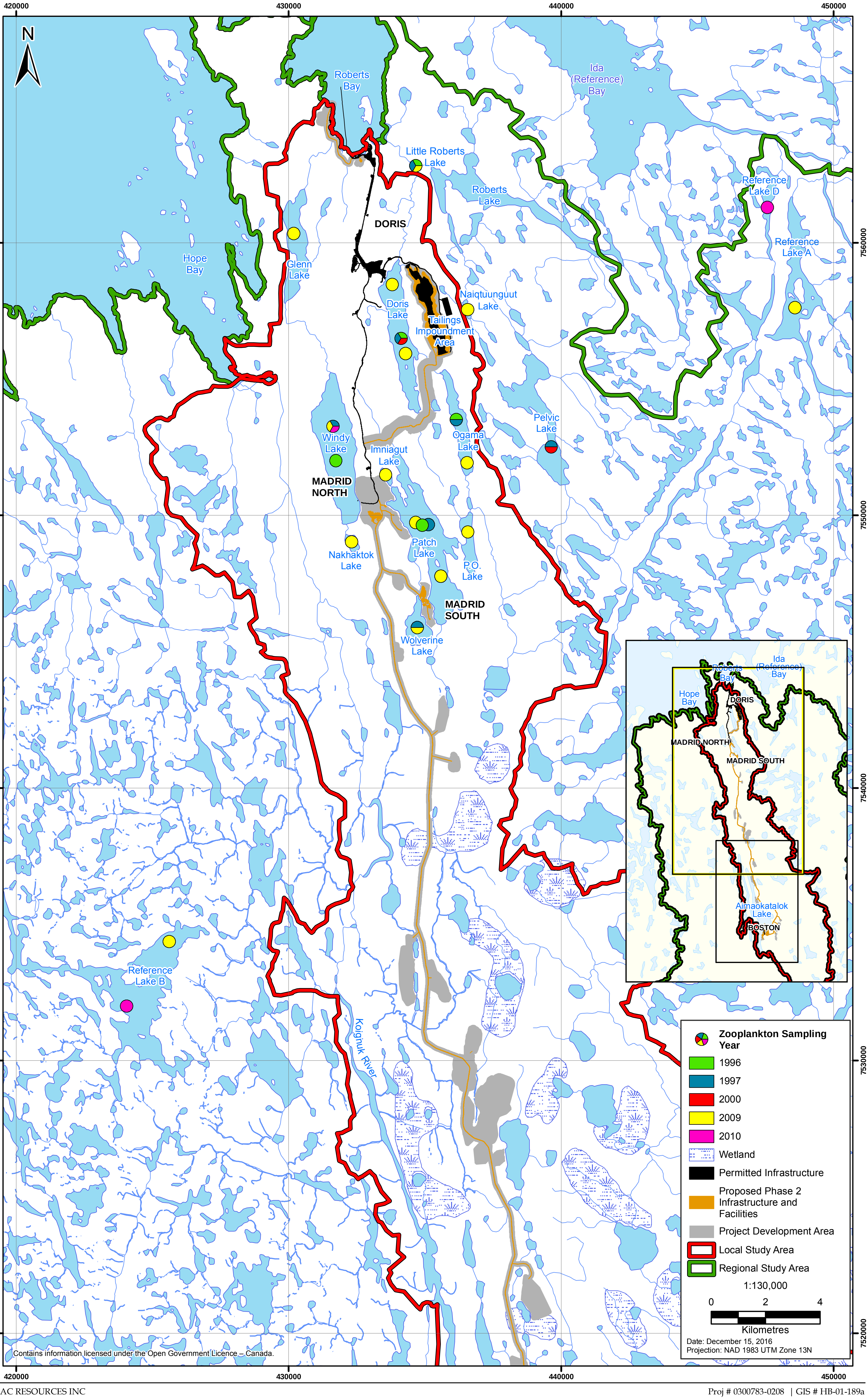


Figure 6.2-5
Freshwater Zooplankton Sampling Sites, South Belt, 1993-2010