6.0 BIOPHYSICAL ENVIRONMENT ASSESSMENT

6.1 ENVIRONMENTAL AND SOCIO-ECONOMIC ASSESSMENT METHODOLOGY

The environmental and socio-economic assessment for the Yellowknife Gold Project has been prepared in accordance with the Terms of Reference of the MVEIRB (2009), to assist the MVEIRB, regulatory agencies, First Nations organizations and other interested parties in understanding the anticipated environmental and socio-economic consequences of the proposed YGP development. As a result, this section of the DAR examines the predicted effects on the biophysical components of the environment in the proposed YGP area and the region.

Potential effects of the proposed YGP on the socio-economic environment are discussed in Section 7 of this DAR, while potential cumulative effects on the biophysical and socio-economic environment are discussed in Section 10. Potential effects of accidents and malfunctions related to the YGP and associated activities are discussed in Section 8.

The environmental (and socio-economic) impact assessment process methodology for the proposed YGP followed a typical EIA approach consistent with MVEIRB and Canadian environmental and socio-economic assessment guidelines and methodologies and involved the following phases:

Project Scoping – Scoping involves the identification of key issues of concern and the more important environmental and/or socio-economic components within the area of influence that may be affected by the proposed development (YGP). These components are commonly referred to as Valued Components (VCs). VCs are components of the natural and human world that are considered valuable by participants in a public review process (Beanlands and Duinker 1983). VCs need not be restricted to being of an environmental nature. Value may be attributed for economic, social, environmental, aesthetic or ethical reasons (CEAA 1999).

Scoping serves to focus the assessment on the more important and key issues. The development of appropriate temporal and spatial boundaries for the various environmental and socio-economic components of concern is also part of the scoping process.

Baseline Conditions – This phase involves the characterization of the existing environmental and socio-economic conditions (baseline) in the proposed development (YGP) area and includes additional site-specific field investigations, as necessary, to address relevant data deficiencies. The type and level of information required is typically related to the type or importance of an issue, the assessment boundaries and the potential effects predicted to occur.

Impact Assessment and Prediction – Using the baseline data, an understanding of the proposed development (YGP) and available mitigation measures to prevent or minimize impacts, standard assessment tools and professional judgement are employed to assess potential environmental and socio-economic effects (including residual and cumulative effects) associated with the construction and operation of the proposed development (YGP). As indicated in the MVEIRB Terms of Reference (MVEIRB 2009) (Table 6.1-1), project-related effects are typically characterized in terms of criteria, such as:

- The nature or type of the effect.
- The direction of the effect (i.e., beneficial vs. adverse).
- The magnitude of the effect, taking into consideration any trade-offs between beneficial and adverse effects.
- The geographic range of the effect and a list of affected groups/individuals.
- The identification of any communities, locations or groups especially sensitive to effects on the particular VC.
- The duration and frequency of the effect occurring.

For socio-economic parameters, the capacity of potentially affected groups, responsible authorities and/or the developer to manage the effect is an additional criterion that is commonly considered.

Mitigation Planning – Appropriate environmental/socio-economic management and mitigation measures, where applicable, are described and directly integrated into the assessment of the proposed development (YGP)-related effects.

Evaluation of Significance – The significance of potential residual effects of the proposed development (YGP) – effects remaining after the application of appropriate mitigation measures on the biophysical and socio-economic components of concern are determined.

Follow-up – Assuming that the YGP is approved and implemented, specific types of monitoring will be undertaken to confirm the accuracy of environmental and socio-economic predictions made during the assessment phase and to implement corrective actions if, and as may be warranted.

TABLE 6.1-1: EFFECTS ASSESSMENT CRITERIA

Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	Consequence
Negligible: Effect will produce no detectable change from baseline conditions	Local: Effect is confined to the LSA	Short-term: Effect occurs or lasts for short periods of time - hours, weeks, months	Isolated: Effect is confined to a discrete or specific period of time	Reversible Short-term: Effect can be reversed during the life of the Project	Low: Effect is unlikely but could occur	Negligible: Effect may result in a slight decline in condition of the VC in the study area for a very short duration but the VC should return to baseline conditions
Low: Effect is within the range of baseline conditions or natural variation	Regional: Effect is confined to the RSA	Medium-term: Effect occurs or lasts for the life of the Project	Sporadic: Effect occurs on occasion and at irregular intervals	Reversible Long-term: Effect can be reversed within 100 years	Moderate: Effect is likely but may not occur	Low: Effect may result in a slight decline in condition of the VC in the study area during the life of the Project. Research, monitoring, and/or recovery strategies would not normally be required
Moderate: Effect is at or slightly exceeds baseline conditions or the limits of natural variation	Beyond Regional: Effect extends beyond the RSA	Long-term: Effect extends or lasts beyond the life of the Project	Periodic: Effect occurs intermittently but repeatedly during the life of the Project	Irreversible: Effect cannot be reversed	High: Effect will occur	Moderate: Effect could result in a noticeable but stable change in the condition of the VC compared to baseline conditions which persists in the study area after Project closure and into the foreseeable future. OR Effect could result in a noticeable change in the condition of the VC in that established guidelines or thresholds are exceeded but the VC should return to baseline conditions. Management actions such as research, monitoring, and/or recovery strategies may be required.
High: Effect will produce a notable change beyond baseline conditions or the upper or lower limit of natural variation			Continuous: Effect will occur continually during the life of the Project			High: Effect results in notable changes to the condition of the VC. Research, monitoring, and/or recovery strategies should be implemented.

6.1.1 Project Scoping

Pursuant to Section 117(1) of the MVRMA, the MVEIRB (2009) determined that the Scope of Development was that generally described in the Project Description Report submitted by Tyhee NWT Corp in July 2008 to the Mackenzie Valley Land and Water Board. It was to consist of all the physical works and activities required to mine and process gold ore from the Ormsby and Nicholas Lake deposits.

Alternatives identified in the MVEIRB Term of Reference were also to be considered part of the Scope of Development to be considered by the developer (Tyhee NWT Corp).

More specifically, the MVEIRB Terms of Reference (2009) defined the Scope of Development to consist at minimum of the following physical works or activities that are anticipated to occur during the construction, operation and closure phases:

Mining Process

- Development of underground workings, portals, adits, raises, drifts, stopes and all other mine workings;
- Open pits;
- Management of topsoil, waste rock and overburden stockpiles, including associated water treatment and management;
- Management of ore stockpiles, including associated water treatment;
- Storage, handling and use of explosives;
- Management of waste rock with potential for metal leaching / acid rock drainage (ML/ARD);
- Transportation of ore from Ormsby Zone or Nicholas Lake deposits to the process plant;
- Mine dewatering and the management and treatment of mine water; and
- Mining equipment operation.

Milling Process

- Construction and operation of the process plant;
- Withdrawal and consumption of fresh water from Giauque Lake;
- Storage, handling, use and disposal of process chemicals;
- Disposal of process water and tailings; and
- Construction and operation of the tailing containment area, including recycling and disposal of process water, as well as its treatment and discharge to the receiving environment.

Support/Ancillary Facilities and Activities

Transportation activities that support the YGP's operation, including air transport or other methods for transporting staff, as well as use of the winter road for YGP-specific support activities;

- Expansion of the winter road for the purpose of supporting YGP operations;
- Construction and use of all-weather roads;
- Stream crossings and any proposed modifications to water courses;
- Construction and use of drainage control structures;
- Development and use of borrow sources for aggregate production;
- Construction and operation of power generation facilities and transmission infrastructure;
- Construction and operation of the change house, compressor house, offices, warehouses, storage yards, maintenance shops, laboratory and all other support buildings;
- Construction and operation of hydrocarbon storage and handling facilities;
- Construction and operation of camp facilities;
- Treatment of camp wastewater at Ormsby and Nicholas Lake;
- Solid and hazardous waste management and construction and operation of containment areas; and
- Modification and operation of the existing airstrip at the historic Discovery minesite or construction and operation of a new airstrip.

Closure and Reclamation Activities

- Removal of structures and equipment;
- Reclamation of the Tailings Containment Area;
- Reclamation of the road works;
- Reclamation of infrastructure foundations;
- Re-vegetation, where appropriate, of areas affected by mining ;
- Reclamation of waste rock and overburden piles;
- Reclamation of the airstrip, associated infrastructure, and,
- Reclamation of quarries, where necessary.

Related to the Scope of Assessment, the MVEIRB, after having reviewed Tyhee NWT Corp's Project Description Report, supporting appendices, and the Public Record to date, determined that it required more information on the potential biophysical, social, economic, and cultural effects of the proposed development (YGP) on the existing environment (MVEIRB 2009).

The Review Board determined that the minimum geographic scope of the EA should include the land covered by the developer's mineral leases, mining claims, and a local study area surrounding the proposed development. For individual valued components of the environment, the geographic scope may go beyond this minimum area (MVEIRB 2009).

The scope of assessment was also to include an examination of cumulative effects. Cumulative effects were to focus on other past, present and reasonably foreseeable future developments or human activities that may combine with the impacts of the proposed YGP to affect the same valued components. Such cumulative effects were to be assessed at a geographic and temporal scale appropriate to the particular valued component under consideration.

For cumulative effects on water resources, the geographic scope includes all areas that the proposed project may potentially affect, including the Yellowknife River Basin downstream of the YGP. The inclusion of lakes outside of the Giauque Lake and Round/Winter/Narrow Lake watershed that have not been contaminated by the historic Discovery Mine development is also required (MVEIRB 2009).

The geographic scope for assessing effects to the human environment is to encompass any potentially affected communities. Throughout this environmental assessment, the term 'potentially affected community' is intended to refer to any settlement, town, village, city or hamlet as well as any First Nation or Métis group that may be impacted by the proposed development. This includes the communities of Yellowknife, Déttah, N'Dilo, Behchoko, Gameti, Wekweeti and Whati.

Since the North Slave Métis Alliance (NSMA) is an organization representing the interests of Métis people in the North Slave region, the developer was to include the NSMA and its constituents in any consideration that affects Aboriginal persons, communities or organizations (MVEIRB 2009)

Regarding temporal boundaries, the Review Board determined that the temporal boundaries should reflect the potential long term effects, not the duration of YGP operations. The temporal scope was therefore to include all phases of the YGP from construction to post-closure, and until such time that potential significant adverse impacts attributable to the YGP are predicted to no longer occur (MVEIRB 2009).

6.1.2 Selection of Valued Components

The assessment methodology used to evaluate the potential environmental/socio-economic effects of the proposed YGP on the natural and socio-economic environment of the YGP development area has employed Valued Components (VCs). VCs consist of Valued Ecosystem Components (VECs) and Valued Social Components (VSCs). VCs are the primary focus for evaluating the possible effects of proposed project activities on the more important components of the biophysical and/or socio-economic environment in the development area and, as appropriate, the region. VCs can be defined as "attributes or components identified as a result of a social scoping exercise as having legal, scientific, cultural, economic, or aesthetic value" (Sadar 1994).

The selection of VECs for this DAR is based on a combination of the directions provided in the MVEIRB Terms of Reference (2009), such as the Key Lines of Inquiry, and Tyhee NWT Corp's understanding of the biophysical components, species, or species groups, that were identified as being important, either by residents, resource management agencies or by Tyhee NWT Corp as a result of the various consultation activities carried out by Tyhee NWT Corp over the past several years.

Potential VECs were screened using the following considerations:

- Species listed as rare, threatened, endangered or vulnerable by COSEWIC;
- Species considered culturally important (i.e. important food source such as moose);
- Species considered sensitive to exogenous disturbance; and
- Species which are dependent upon major vegetation community types in the study area.

Not all species/habitats selected as potential VECs encompassed all of the above criteria; some were selected on the basis of one category only. In addition, a species, or species groups, considered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as being endangered, threatened or vulnerable were automatically considered as potential VECs. VECs selected for this environmental assessment are listed in Table 6.1-2.

TABLE 6.1-2: SELECTED VALUED ECOSYSTEM COMPONENTS

VEC Grouping	Species or Environmental Parameter
Air Quality/Noise	Air Quality/ Noise Indicators
Water Quality	Surface/Groundwater Quality Indicators
Vegetation	Traditional Use Plants/Rare Plants
Wildlife	Bathurst Caribou
	Moose
	Wolf
	Wolverine
	Black Bear
	Common Nighthawk
	Olive-sided Flycatcher
	Rusty Blackbird
	Short-eared Owl
	Horned Grebe

6.1.3 Assessment Boundaries

Evaluating the significance of each potential effect associated with the YGP requires that appropriate spatial and temporal boundaries (space and time limits of potential effects) be defined.

To comply with the MVEIRB Terms of Reference (2009), the spatial and temporal boundaries for the YGP environmental assessment were set according to appropriate boundaries for the VEC being assessed.

6.1.3.1 Geographic/Spatial Boundaries

Local and regional spatial boundaries were determined for environmental and socio-economic components of concern based on their respective characteristics and anticipated interactions with YGP activities. The spatial boundaries were primarily based on the zone of YGP influence beyond which the effects of the YGP were expected to be non-detectable. For the biophysical components, two main assessment areas were defined.

Local Study Area - As requested by the Review Board, the Local Study Area (LSA) defined for the YGP assessment includes the land covered by the development footprint and a local study area surrounding the proposed development area. The LSA, shown in Figure 2.12-1 encompasses both of the proposed development areas (Ormsby and Nicholas Lake) and covers approximately 144.75 km^2, or 14,475 hectares. This local study area is considered to be appropriate for the assessment of air quality, noise, terrain, vegetation, groundwater quality, surface water quality, aquatic resources and most wildlife-related effects, including possible cumulative effects.

As requested by the MVEIRB, for potential cumulative effects to water resources, the geographic scope of the assessment includes all areas that the proposed project may potentially affect, including the Yellowknife River Basin downstream of the YGP (Figure 10.3-1). It also includes lakes outside of the Giauque Lake and Round/Winter/Narrow Lake watershed that have not been contaminated by the historic Discovery Mine development is also required (MVEIRB 2009).

Wildlife Study Area – The Wildlife Study Area (WSA) corresponds to the RSA (25.5 km x 25.5 km study area covering approximately 650 km^2, or 65,000 ha surrounding the LSA) and is illustrated in Figure 2.12-1. The WSA/RSA was used for documenting use by the larger wildlife species, in particular moose and Bathurst Caribou. For assessing potential cumulative effects on caribou, the entire annual range of the Bathurst Caribou herd has been considered.

Human Environment Study Area – As specified by the MVEIRB the geographic scope for assessing effects to the human environment includes the communities of Yellowknife, Déttah, N'Dilo, Behchoko, Gameti, Wekweeti and Whati and First Nation or Métis groups that may be impacted by the proposed development. Figure 3.1-1shows the extent of the human environment study area.

6.1.4 Temporal Boundaries

The Review Board determined that temporal boundaries should be set according to the potential long-term effects, rather than just the duration of YGP operations. Therefore, the temporal scope was determined to include all phases of the YGP, from construction to post-closure, until such time that no "potential significant adverse impacts" attributable to the YGP were predicted to occur (MVEIRB 2009).

As a result, potential effects specific to the YGP have been assessed based on the three anticipated time-related phases of the YGP. These include those activities related to the construction phase (two years), those related to the subsequent operations phase (~8 years) and those related to the anticipated closure and reclamation phase (2 years and beyond for some VECs).

6.1.5 Issue Identification

Potential environmental issues and/or concerns associated with the development of the proposed YGP were initially identified by Tyhee NWT Corp in the Project Description Report submitted in July 2008 to the MVLWB. Issues identified related to potential for effects on groundwater, effects on vegetation cover and terrain, effects on wildlife and effects related to noise from the development.

The MVEIRB (2009) indicated that the following items were to be given special consideration by Tyhee NWT Corp in the DAR:

- All water quality and quantity issues related to the Development.
- Impacts on Species at Risk Act (SARA)-listed species frequenting the area.
- Employment, training and business opportunities for local residents and aboriginal groups.

6.1.6 Impact Assessment

Using the VCs as the primary focus for the analysis, the assessment of potential effects for each environmental component begins with a review of the main project activities that could cause environmental disturbances during each of the three primary phases of activity (construction, operation, and closure/reclamation) associated with the implementation of the YGP.

The evaluation of impacts for each environmental component is addressed in terms of the type or nature of effects that may occur following the application of appropriate environmental management and mitigation measures (residual effects).

As indicated in the MVEIRB Terms of Reference (MVEIRB 2009) potential environmental effects and residual effects are typically described in terms of a number of possible impact criteria including:

- The nature or type of the effect.
- The direction of the effect (i.e., beneficial vs. adverse).

- The magnitude of the effect, taking into consideration any trade-offs between beneficial and adverse effects.
- The geographic range of the effect and a list of affected groups/individuals.
- The identification of any communities, locations or groups especially sensitive to effects on the particular VC.
- The duration and frequency of the effect occurring.
- The capacity of potentially affected groups, responsible authorities and/or the developer to manage the effect.

Table 6.1-1 provides definitions for the impact assessment and significance criteria used for the YGP environmental and socio-economic assessment.

6.1.6.1 Residual Effects

Potential residual effects of the YGP (those remaining after applying appropriate mitigation measures) on the biophysical and socio-economic components of concern were determined. For those components that may experience a residual effect, the residual effects were subsequently further characterized in terms of the assessment criteria: nature/type, direction, magnitude, frequency, timing/duration, geographic/ spatial scope, reversibility, likelihood/confidence and significance in a table. This process was not applied to those components that are not expected to experience residual effects from the YGP.

6.1.6.2 Assessing Impact Significance

Where sufficient information was available, determination of significance was completed for potential residual effects for construction, operation, and reclamation phases. In summary, the following information was used in the determination of the significance of potential effects from the YGP on VCs:

- results from the residual effect classification;
- application of professional judgment and ecological principals, such as resilience, to predict the duration and associated reversibility of effects; and
- application of additional adaptive management and mitigation measures that may increase resilience and decrease the significance of effects.

6.2 WATER RESOURCES

Water quality in the YGP area will be affected by the construction and operation activities, most notably associated with tailings disposal.

Potential impacts during construction could be related to runoff from the area resulting in increased silt loading. These can be mitigated through the application of construction best practices such as the DFO Land Development Guidelines for the Protection of Aquatic Habitat (DFO 1993) that provide comprehensive guidance regarding stormwater management and erosion and sediment control.

Potential impacts on water quality during the operational phase will be related to process tailings disposal, waste rock storage and mine site runoff. The mitigation of these impacts will be engineered into the mine, mill and tailings containment area design and operation. Tyhee NWT Corp is committed to ensuring that all effluent from the mine and mill site meet the Metal Mining Effluent Regulations[14] of the federal *Fisheries Act*.

In addition, discharge from the sewage treatment plant that would be incorporated into the overall camp infrastructure (such as an RBC plant/unit), will be combined with the tailings stream from the mill and deposited into the tailings containment area. Alternative sewage disposal options may be implemented following more detailed engineering which would be reviewed during the regulatory phase. The treatment plant will be designed to meet the *Camp Sanitation Regulations*, R.R. N.W.T. 1990, c. P-12, *Public Health Act*, R.S.N.W.T. 1998, c. P-12.

Possible effects on water quality and proposed mitigation measures are outlined in Table 6.2-1.

TABLE 6.2-1. WATER QUALITY IMPACTS AND MITIGATION SUMMARY

Project Component	Potential Impact	Mitigation
Site Preparation and Construction	There is potential for sedimentation impacts on water quality during the projects construction phase. These would be mainly related to the placement of material in and near water bodies and dam construction at the TCA.	Extensive use of silt barriers in areas where silt-laden water may enter surface waters as a result of construction activities. Use of silt barriers at Winter Lake to isolate the sedimentation during construction of the TCA Application of DFO Land Development Guidelines for the Protection of Aquatic Habitat (DFO 1993).
Mining	There is a potential for discharged mine water to impact surface water quality.	Mine water at the Nicholas site will be pumped to a settling pond prior to discharge to the environment. Mine

14 MMER (2002): http://laws-lois.justice.gc.ca/eng/regulations/SOR-2002-222/

TABLE 6.2-1. WATER QUALITY IMPACTS AND MITIGATION SUMMARY		
Project Component	**Potential Impact**	**Mitigation**
		water from the Ormsby pit will be pumped to the TCA for treatment, if necessary. Following more detailed studies, Ormsby mine water may be used in the mill process if not discharged to the TCA.
Waste Rock Storage	There is a potential impact from the drainage from the waste rock storage area. This could result in an increase in suspended solids or metal concentrations.	Drainage from the waste rock pile will be contained within a catchment basin, tested and treated as needed before being discharged to the TCA or directly to the receiving environment. Surface runoff will be intercepted, collected and pumped into the tailings containment area (Section 4.12.7)
Sewage	Sewage effluent may increase nutrients and bacteria in surface water.	Sewage will be treated using a packaged treatment plant and discharged to the tailings containment area, or to an alternate site following more detailed engineering. Any treatment plant used at the YGP will be designed to meet the *Camp Sanitation Regulations*, R.R. N.W.T. 1990, c. P-12, *Public Health Act*, R.S.N.W.T. 1998, c. P-12.
Tailings Containment Area	Project operations expect an annual discharge from the TCA most likely during the summer.	All discharge from the TCA will meet discharge criteria (*Metal Mining Effluent Regulations – Fisheries Act*).
Water Consumption (Ormsby)	Fresh water used in the mine, mill and camp will be pumped from Giauque Lake.	Project activities will not adversely affect the volume of Giauque Lake.
Water Consumption (Nicholas Lake)	Fresh water requirements for the mine and camp will be pumped from Nicholas Lake.	Project activities will not adversely affect the volume of Nicholas Lake.
Hazardous Materials	Any release of hazardous materials into surface waters may cause impacts.	Hazardous materials will be managed through a Management Plan covering the transportation storage, use, disposal, and emergency response. This plan will comply with the GNWT document Guideline for the General Management of Hazardous Waste in the NWT.

The YGP's Aquatic Effects Monitoring Program will be designed in accordance with the Water License requirements and the Metal Mining Effluent Regulations, which include specific protocols for the implementation of Environmental Effects Monitoring.

6.2.1 Surface Waters

6.2.1.1 Surface Water Flow

The Ormsby development is expected to have a generally localized effect on surface flow patterns and volumes within the Narrow Lake drainage. Under existing conditions, water flows from Round Lake to Winter Lake, which then discharges through a 165 m channel to Narrow Lake (Figure 2.2-1). Water then flows from Narrow Lake southwest to Morris Lake (el. 278 metres above sea level (masl)), then Goodwin Lake (el. 260 masl), Johnstone Lake (el. 232 masl), Clan Lake (el. 216 masl), and the Yellowknife River via numerous small lakes, ponds, and wetlands (Figure 6.2-1). The Narrow Lake drainage basin is 9.3 km^2 in area, or approximately 0.06% of the Yellowknife watershed (~15,000 km^2).

With development of the Ormsby site, the southern basin of Winter Lake will be converted to a tailings containment area (TCA), and the smaller but deeper northern basin will be drained to accommodate surface mining on its northern edge. Due to the degraded water quality conditions of Round Lake (see Section 2.9.6 of this DAR), which resulted from past mining practices, its natural surface water drainage will be directed into the TCA. Water from the TCA, supplemented as necessary with water extracted from Giauque Lake, will be used as plant process water and discharged back into the TCA.

Water in the TCA will then be pumped to the upper end of the Winter Lake outlet stream (hereafter called the Narrow Lake inlet stream) through which it will flow through the natural stream channel to Narrow Lake. Water balance information and calculations are detailed in Section 4.12.3. The withdrawal of water from Giauque Lake for process and domestic water purposes is discussed in Section 6.3.5, and was assessed as having an insignificant effect on lake water levels, and hence discharge volumes downstream.

Surface water discharge from Winter Lake and Narrow Lake has been recorded annually from 2005-2010, as described in Section 2.8 and Appendix B. Discharge rates were found to vary considerably from month to month, and year to year. Table 6.2-2 provides a summary of these flow ranges.

TABLE 6.2-2: MEAN MONTHLY DISCHARGE RANGES FROM WINTER AND NARROW LAKES, 2005-2010

Month	Average Monthly Discharge (L/S)	
	Winter Lake	Narrow Lake
May*	15.0 – 60.3	11.1 – 173.6
June*	6.5 – 48.2	9.6 – 156.4
July	4.0 – 33.3	9.4 – 55.0
August	0.3 – 23.6	1.9 – 30.8
September*	0 – 16.5	<1.0 – 28.5

* Data may not represent the full range of flows since data logger records are incomplete (see Appendix B).

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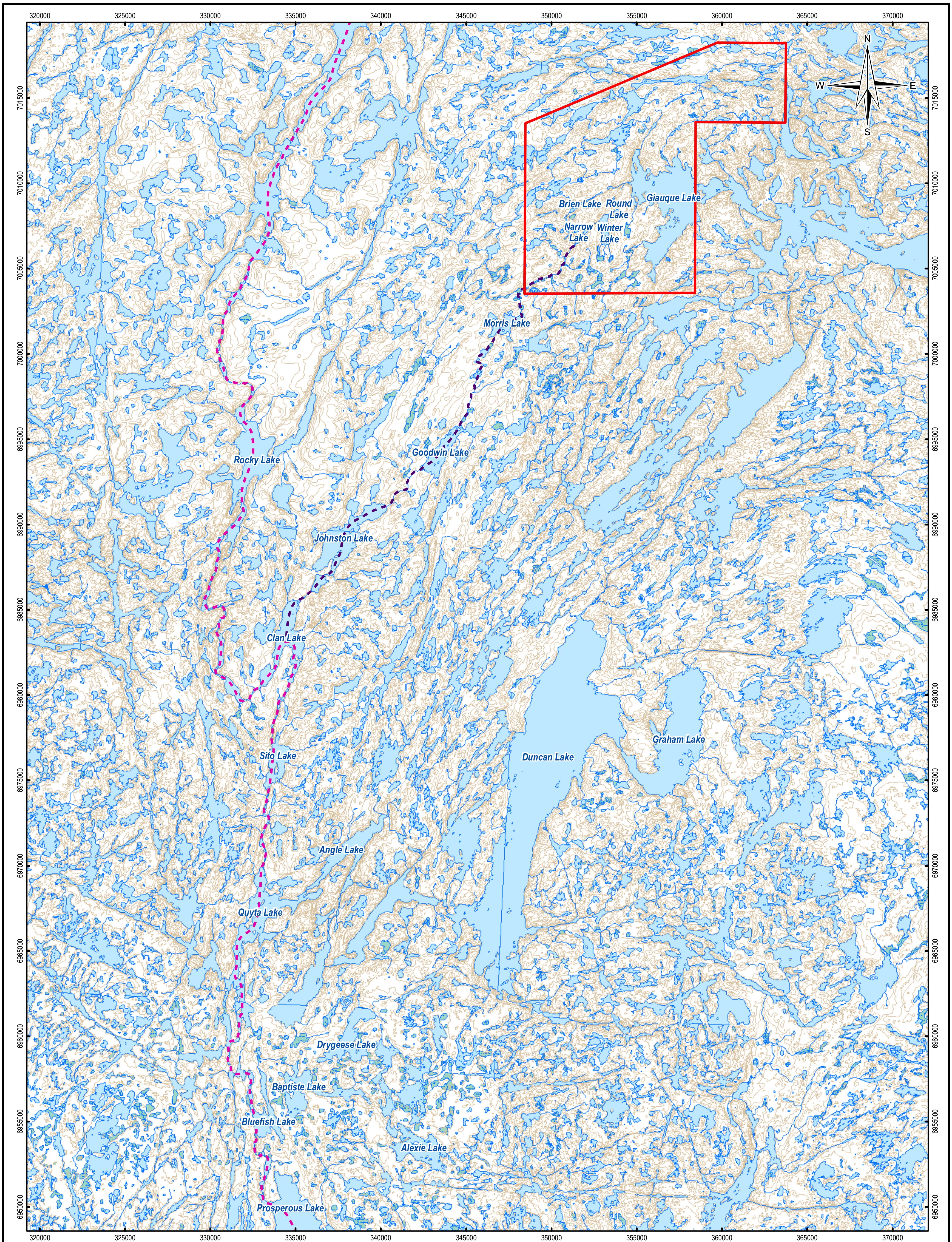


LEGEND

- Narrow Lake Drainage
- Yellowknife River Drainage
- Local Study Area
- Contour (10 m interval)
- Watercourse
- Waterbody
- Wetland

NOTES
Base data source: 1:50,000 NTS

ISSUED FOR USE

YELLOWKNIFE GOLD PROJECT

Narrow Lake Drainage Pattern

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:210,000
2 1 0 2 4 6
Kilometres

Tyhee NWT Corp

EBA Engineering Consultants Ltd.

FILE NO.			
V23201097-DAR-063.mxd			
PROJECT NO.	DWN	CKD	REV
V23201097	SL	DM	0
OFFICE	DATE		
EBA-VANC	April 14, 2011		

Figure 6.2-1

Although the flow ranges for the months of May, June, and September over the period of record shown in Table 6.2-1 are not complete, the data do portray the variability of surface flows that naturally exists within this system due to interannual variation in temperatures, precipitation, and the time and duration of snow melt.

As discussed in Section 4.12.3 and in Section 6.3.3.2, discharges from the TCA to the Narrow Lake Inlet stream will be regulated to simulate, within practical limits, background flow volumes and the seasonal cycle. Under natural conditions flows are maximum during freshet, fall to minimum levels in August, and then increase in September and October, just before freeze-up (see Section 2.8.1, e.g. Figure 2.8-3) These values, shown in Table 6.2-3, were based on a review of hydrographs developed from 2005-2010 Winter Lake outlet stream gauge data (Appendix B).

TABLE 6.2-3: RECOMMENDED FLOW DISCHARGES FROM THE TCA TO THE NARROW LAKE INLET STREAM

Time Period	Recommended Flow Release (L/S)
Ice-out to June 20	Variable - Based on discharges required to maintain a suitable water level in the TCA. Under normal flow conditions, flow releases will range from 110-170 L/s
June 21-July 10	20
July 11-August 10	10
August 11-August 31	5
September 1-September 30	15
October 1-freeze-up	20

The flow values shown in Table 6.2-3 will vary based on meteorological conditions and the time and duration of snow melt. Discharges to the Narrow Lake inlet stream during the spring melt period will be highly variable as they will be regulated to maintain appropriate water levels in the TCA, and will be higher at that time of year compared with the natural range shown in Table 6.2-2. During the remainder of the open water season, discharges to the Narrow Lake inlet stream will be within background levels.

Due to the low topography of the area, water presently spreads out from the main channel during freshet and flows to Narrow Lake through braided channels and the depression left by the winter road. Anticipated elevated flows to the Narrow Lake inlet stream in May and June will likely result in increased flows through these channels and a possible increase in the area of inundation during that period. However, it is expected that flows will be confined to the main channel once discharges decrease following the freshet period.

Since water is to be pumped into the Narrow Lake inlet stream and must therefore flow over a distance of approximately 150 m, it is expected that the temperature of the water reaching Narrow Lake will approximate ambient levels.

The seasonal discharges to Narrow Lake from the TCA, shown in Table 6.2-3, includes calculated precipitation, overland drainage, and evaporation data to provide estimates of outflow from Narrow Lake during the open water months, prorated on a monthly basis. Flows from Narrow Lake will not be regulated. These estimates are shown in Table 6.2-4.

TABLE 6.2-4: ESTIMATED MONTHLY OUTFLOWS FROM NARROW LAKE

Month	Estimated Flow Release (L/S)
May	199
June	150
July	31
August	13
September	23
October	21

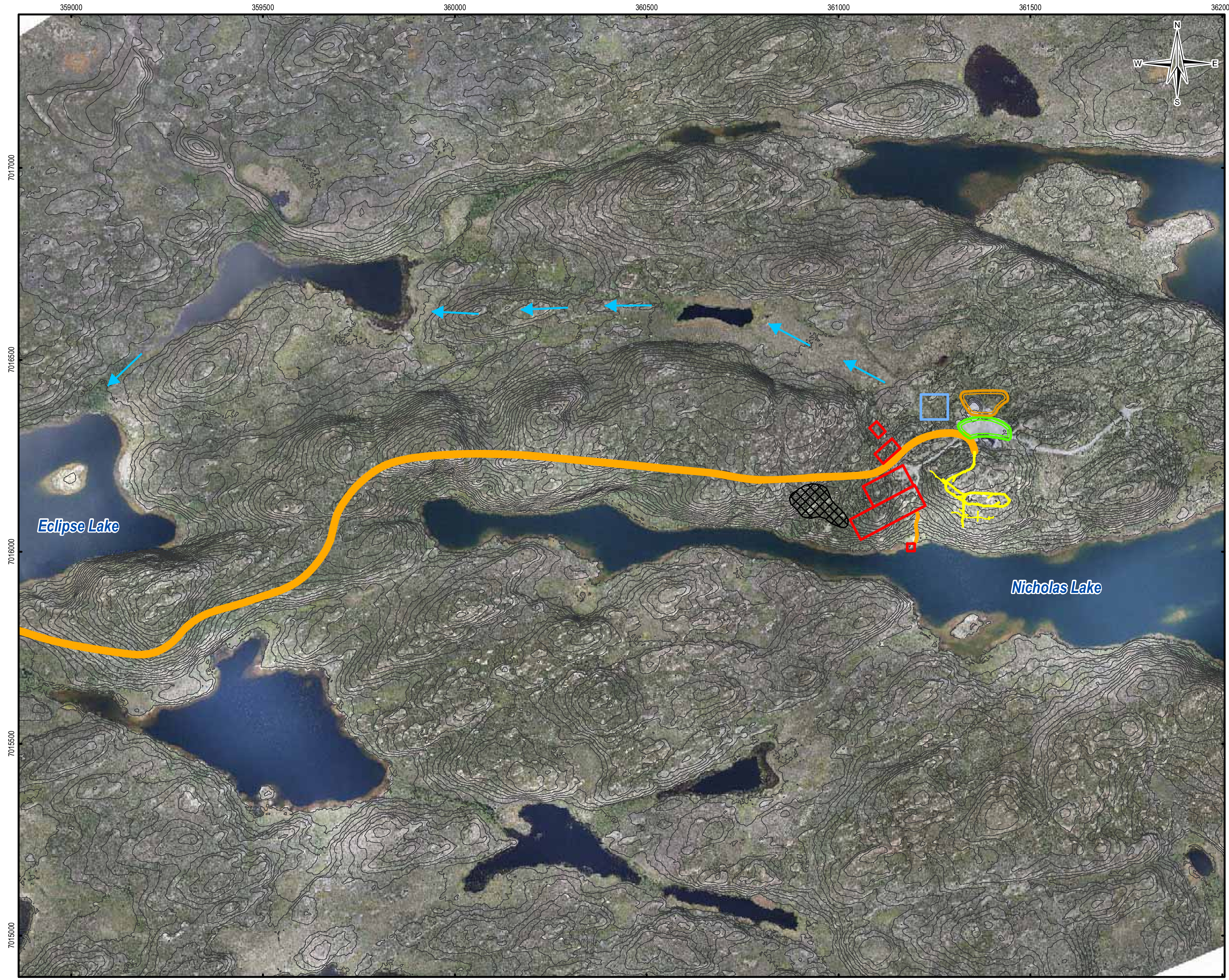
The values shown in Table 6.2-4 are subject to considerable variability due to potentially large interannual differences in precipitation amounts and timing, and surface runoff volumes and patterns. However, from a comparison of Tables 6.2-2 and 6.2-4, it is apparent that flow volumes at the outlet of Narrow Lake will fall within the background discharge range, suggesting that water surface elevations in Narrow Lake, following Ormsby development, will not differ appreciably from existing levels. Following from this, no adverse effect on water volumes or levels are anticipated in streams, ponds, and lakes downstream of Narrow Lake. It can also be assumed that small deviations from background flows would not affect flows in the Yellowknife River due to the relatively small size of the Narrow Lake drainage basin compared with the Yellowknife River watershed.

Groundwater seepage into the underground workings at the Nicholas Lake site will be pumped to a settling pond shown on Figure 6.2-2, which is located in a previously disturbed area to the north of Nicholas Lake. As indicated in Section 2.10.8.3, such flows may range anywhere from 8 to 1300 m^3/day, depending on bedrock conductivities.

Pumped discharge from the mine will be directed to a settling pond located in a previously disturbed area to the north of Nicholas Lake. The location, capacity and dimensions of the pond are described in Section 4.12.2.2. This settling pond will have a retention time of seven days at the maximum predicted flow rate of 1300 m^3/day. However, since flow rates are likely to be less on average than this conservative estimate, retention time is anticipated to be generally greater than seven days.

Outflow from the settling pond will flow toward a very small, narrow pond (~185 m long), located approximately 600 m to the northwest of the discharge point, and then through 700 m of wetland to another small pond (~660 m in length), which then discharges into Eclipse Lake through a 260 m vegetated channel. Flow direction is indicated on Figure 6.2 2.

Water withdrawal from Nicholas Lake will be minimal. Any water withdrawal will be to supply water to the camp and mine. Impacts to the water level of Nicholas Lake are considered negligible.



LEGEND

- Direction of Drainage
- Building
- Waste Dump
- Ore Stock Pile
- Sedimentation Pond
- Proposed Temporary Laydown Area
- Underground Development
- Road
- Contours (2.5 m interval)

NOTES

1. Contours and imagery provided by Tyhee (derived from LiDAR data; July 2010).

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Nicholas Lake Development Site Drainage

PROJECTION		DATUM	
UTM Zone 12		NAD83	
Scale: 1:10,000 (200 100 0 200 Metres)			
FILE NO. V23201097-DAR-056.mxd			
PROJECT NO. V23201097	DWN SL	CKD DM	REV 0
OFFICE EBA-VANC	DATE April 14, 2011		

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Figure 6.2-2

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6.2.1.2 Surface Water Quality

Introduction

During scoping, potential impacts of the proposed Yellowknife Gold Project on local and downstream water quality were identified as a Key Line of Inquiry by most interested parties. Accordingly, the following section discusses the potential effects of the YGP on the existing water quality of the local downstream drainage area and the much larger Yellowknife River watershed.

As previously discussed in Section 2.9.8, with the exception of Round Lake, which has been influenced by tailings since the 1950s, the water quality of the lakes in the YGP area, including 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 of 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 from the CCME guidelines were limited and explainable.

The natural discharge flow is from Round to Winter to Narrow Lakes. Round Lake has been impacted by untreated tailings from the historic Discovery mine and remains the recipient of surface runoff from these tailings. This observation is supported by the higher metal concentrations in Round Lake with a noticeable gradient in the metals as sampling proceeded downstream through Winter to Narrow Lakes.

Round and Winter lakes are considered to be mesotrophic in trophic state, while Narrow Lake is considered on the verge of being mesotrophic. All other lakes sampled were oligotrophic.

To assist in predicting the possible effects of YGP seasonal effluent discharges on the downstream receiving environment, a water quality modelling study was conducted. A technical memo summarizing the water quality modelling is included in Appendix B of this document, and is reproduced in its entirety here. The model employed simulated the limnology of Narrow Lake in response to runoff from the Narrow Lake watershed, meteorological forcing and Tailings Containment Area (TCA) inflows. The temperature and concentration of contaminants were modelled for an eight year period in response to average hydrological conditions.

The fate and transport of six potential contaminants were modelled: arsenic, copper, cyanide, nickel, lead and zinc. These chemical parameters were selected on the basis that they are considered to be typical parameters of environmental concern and because these parameters are regulated under the Metal Mining Effluent Regulations (MMER). As part of the modelling effort, anticipated dilution of the seasonal tailings effluent decant inflows in Narrow Lake were calculated and compared against current CCME guideline values for the protection of aquatic life and regulated MMER effluent limits.

Background Limnology of Narrow Lake

In summer, Narrow Lake stratifies into a shallow surface layer of warm water (epilimnion) and a cool deep layer (hypolimnion), separated by a thermocline. The two layers can have considerably different water quality. As surface temperatures decrease in the fall and eventually become similar to the temperature of the hypolimnion, the lake stratification is eventually broken down by wind-induced mixing. In winter, ice forms on the surface, forming an insulating layer and shielding the lake from wind and therefore eliminates wind-induced vertical mixing. Thermal stratification and a 'reverse' winter thermocline form under the ice as freshwater is densest near 4 °C and water between zero and 4 °C remains close to the surface. During ice melt in the spring surface water warms to 4 °C and sinks causing vertical mixing and destroy the winter thermocline.

Narrow Lake has two deep (>11m) basins that are isolated from the surface for much of the summer. Water column profiles collected by EBA in 2004 and 2005 showed significantly depleted dissolved oxygen (DO) at depth in one of these basins in August (Tyhee NWT Corp 2008). These DO levels are not necessarily critical, but it is clear that stratification is a common and important physical process in Narrow Lake. The preservation of cooler water at depth is an important consideration for fish habitat. The seasonal hypoxia (low DO) is also relevant to habitat quality, as well as having possible effects on the behaviour of various contaminants. Neither dissolved oxygen or biological processes were included in the modelling.

Hydrology

Monthly hydrologic data were taken directly from the water balance model, which is discussed in Section 4.12.3. Monthly runoff values, in millimetres, were applied to the Narrow Lake drainage area, including the lake surface area, of 3.8 square kilometres. Monthly discharges from the TCA were applied at the north end of the lake, and runoff discharges were applied at the location of an existing drainage (Figure 6.2-3). Input of runoff at one existing drainage is a simplification of actual hydrology, in which overland flow and other smaller drainages would contribute some of the flow. However, the energetic wind-induced mixing in the lake effectively mixes surface inflows regardless of their location, so that the spatial distribution of runoff flows is of minimal significance to lake physics. The volume entering Narrow Lake and therefore dilution will still be accurately represented.

The water balance assumes no runoff or TCA outflows during winter. The average flows entering Narrow Lake during ice-free months are shown in Figure 6.2-4. The outflow is located at the south end of the lake and a stage-discharge curve, based on lake levels and assumed outlet geometry, was used to calculate outflow discharges. Stream temperatures were estimated monthly based on air temperatures. The water balance is calculated for average conditions as well as for ten-year extreme dry and extreme wet conditions. The modelling was conducted using the average hydrologic conditions.

Meteorology

Winds are important for the mixing energy they provide to the lake surface, as well as their effect on temperature fluxes. Cloud cover and air temperatures are also needed for determining water temperatures and ice cover. Yellowknife Airport meteorological data were used to meet the model requirements for wind, temperature, and cloud cover data. The Yellowknife station, located approximately 80 km southwest of Narrow Lake, is maintained by the Meteorological Service of Canada and has been collecting hourly climate data such as wind, air temperature, humidity and cloud cover since 1953.

Tyhee NWT Corp's local meteorological station has a six year period of record, but the Narrow Lake modelling required the longer-term data, including cloud cover data. From a comparison of local wind data with Yellowknife wind data, it was found that wind speeds at the site were, on average, 86% of those at Yellowknife, and the wind time series was altered accordingly.

Contaminant Fluxes

The projected effluent quality used in the model was derived from a two-week old tailings effluent solution generated from a Lock Cycle Test effluent that was subsequently analyzed and reported by Inspectorate IPL for metals concentrations (Appendix J). Table 6.2-5 summarizes the predicted concentrations of the contaminants of concern in the tailings effluent and subsequently Narrow Lake.

Some assumptions regarding processes and dilution in the TCA were necessary to provide reasonable estimates of the contaminant flux into Narrow Lake. A dilution calculation was performed using fluxes into the TCA from water sources, as calculated in the water balance. For example, the concentration of arsenic in the plant effluent is 256 μg/L, while the water flowing from Round Lake into the TCA varies from 4.5 to 26 μg/L (Appendix C), and precipitation and natural runoff are assumed to have a concentration of zero. On average, contaminant concentrations in the TCA are 78% of the concentrations in the plant effluent. Detailed modelling of concentrations in the TCA was not conducted and some seasonal variation is expected.

Based on this calculation, the concentrations of the six contaminants after dilution in the TCA, and therefore discharged to Narrow Lake, are shown in the second column of Table 6.2-5. It was assumed that the concentration of the plant effluent was constant, regardless of whether the process water was recycled or fresh. Seasonal changes in the TCA concentration were not calculated and the TCA was assumed to quickly reach steady state. Detailed modelling of the way in which the TCA approaches steady state over the first two to three years of operation was not conducted, pending completion of detailed design and selection of implementation schedule.

TABLE 6.2-5: MODELLED CONTAMINANT CONCENTRATION IN PLANT EFFLUENT AND RESULTANT CONCENTRATIONS IN THE TCA		
Parameter	**Plant Effluent Concentration (Total µg/L)**	**TCA Concentration (Total µg/L)**
Arsenic (As)	256.0	199.7
Copper (Cu)	6.4	5.0
Cyanide (CN)	30.9	24.1
Nickel (Ni)	2.1	1.6
Lead (Pb)	1.1	0.9
Zinc (Zn)	33.9	26.4

Hydrodynamic Model

Releases and fate of contaminants from the tailings effluent discharge were simulated using EBA's proprietary three-dimensional hydrodynamic model H3D (Appendix C). It is a three-dimensional time-stepping model that computes the water velocity on a rectangular grid, as well as scalar fields such as temperature and contaminant concentrations. The contaminants were modelled as inert tracers, added at the tailings containment area release point and tracked in the model until it leaves the model domain. Non-conservative processes, such as chemical alteration, precipitation, or deposition, were not modelled.

Wind forcing produces currents within enclosed water bodies as well as water level differences and fluctuations. It also significantly affects vertical mixing, and hence scalar distribution. Turbulence modelling is important in determining the distribution of velocity and scalars such as water temperature and contaminants. The diffusion coefficients for momentum and scalars at each computational cell depend on the level of turbulence at that point. For momentum, H3D uses a shear-dependent turbulence formulation in the horizontal, and a shear stratification dependent formulation in the vertical. These parameters have been shown to correctly simulate the annual temperature cycle within several lakes in British Columbia, and are consistent with current practice (Stronach 2008). For scalars, the eddy diffusivity values are set equal to the corresponding eddy viscosity values.

The model operates in a time-stepping mode over the period of simulation. During each time step, values of velocity, temperature and concentrations of other scalars are updated in each cell. The effects of incoming solar radiation, outgoing longwave radiation, and sensible and latent heat flux on water temperature were included in the model. Evaporation and precipitation mass fluxes from the lake surface were not modelled as they are accounted for in the water balance, but the effect of evaporation on lake temperature was included, and both processes are represented in the water balance runoff calculations. The ice formation and melting module is closely coupled to the temperature and heat transfer calculation.

Model Implementation

The Narrow Lake model was constructed with 20-metre horizontal grid resolution and 0.5 metre vertical resolution. The vertical resolution is constant throughout the water column, in order to simulate stratification at any depth and represent possible subsurface discharge of TCA inflows. Lake bathymetry was collected by EBA for Tyhee in 2004 (Section 2.11). The model bathymetry and grid is shown in Figure 6.2-3, along with the locations of inflows and outflows.

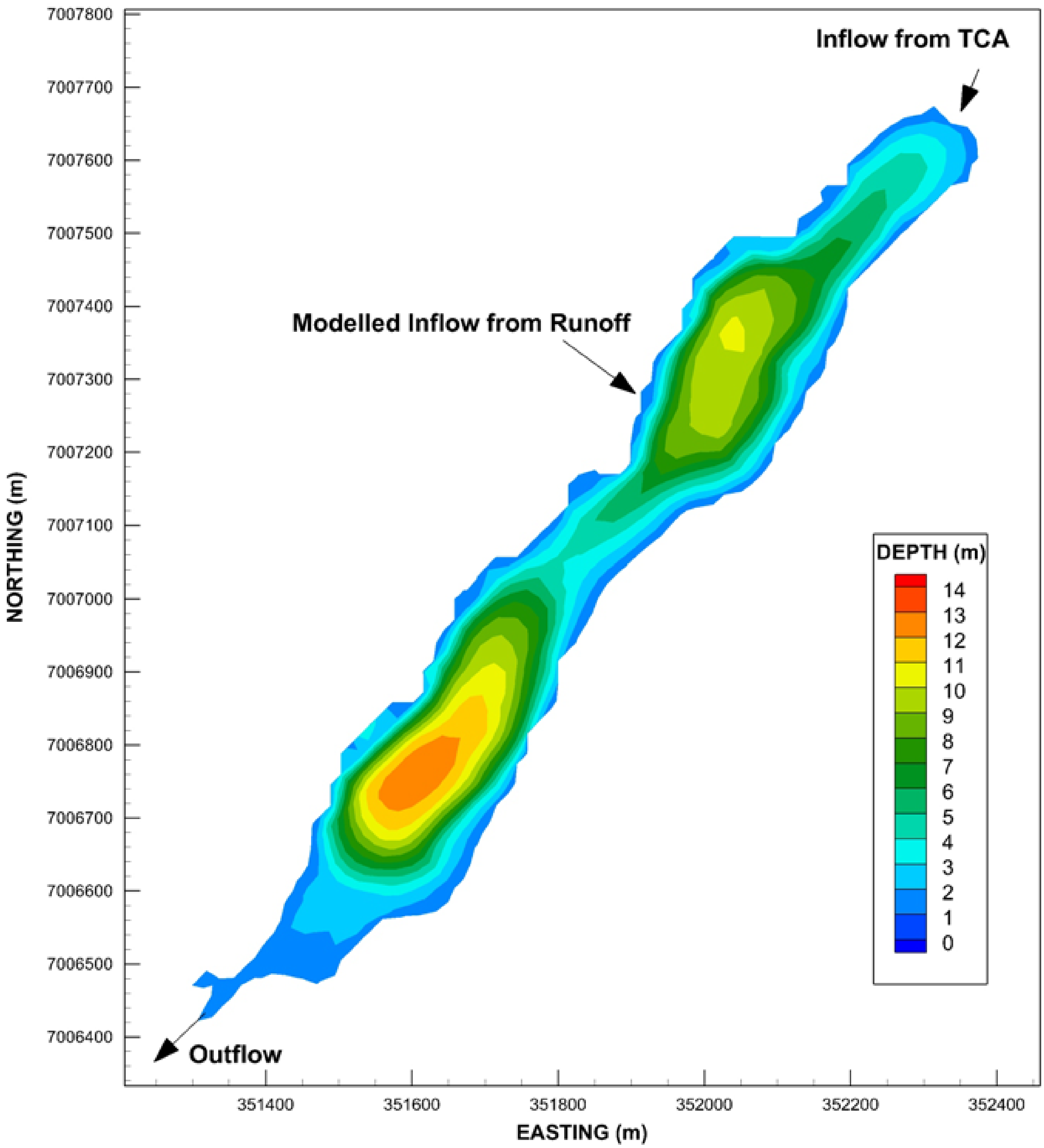
The model was run for a period of eight years, which is the current planned operating life of the mine and also a sufficient time for the concentrations in Narrow Lake to reach steady state. Hydrologic conditions remained constant throughout a model run, but meteorological forcing varied from year to year.

The most important control on contaminant concentrations in Narrow Lake is the balance between the TCA inflows to Narrow Lake and runoff from the local Narrow Lake drainage. The average monthly flows entering Narrow Lake from the TCA and the local Narrow Lake drainage area are shown in Figure 6.2-4. Outflow was calculated based on lake level and a stage-discharge relationship.

Model Results

Model outputs consist of hourly water temperature and contaminant dilution throughout the lake for eight years. To help visualize these results, an example of model output in cross-section form is shown in Figure 6.2-5. The cross-section is down the axis of the lake, with the inflow from the TCA on the right, outflow on the far left, and inflows from runoff entering the model near the middle. This example is from July 1 of the second year of simulation, a time during which the lake is stratified. The colour fill represents lake temperature, and the two layers can be seen, with a strong thermocline between 5 and 7 metres depth. The contour lines and labels show contaminant dilution. Dilution is the ratio of the initial concentration of a contaminant, in this case flowing into Narrow Lake, to its concentration at the point under consideration. Thus, high dilution is equivalent to low concentration, and vice versa. The concentrations are still increasing in Year 2, but this example shows a time when water at depth is somewhat lower in concentration than the surface layer. Minimal dilution is available from runoff.

Time series data were extracted from the model at two locations: the surface near the outflow location and the bottom of the deeper southern basin. A time series of temperature over eight years is shown in Figure 6.2-6, with the surface temperatures in red and the bottom in blue. Both summer and winter stratification are apparent, as well as the gradual increase of bottom temperatures and mixing that occurs in the fall. Times during which the lake is vertically mixed show up as overlapping lines. A temperature difference of greater than 10 °C is common in the summer, which has been observed by EBA in the 2004 and 2005 water temperature profiles (Figure 2.9-41).



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Narrow Lake Bathymetry, Inputs, and Model Grid

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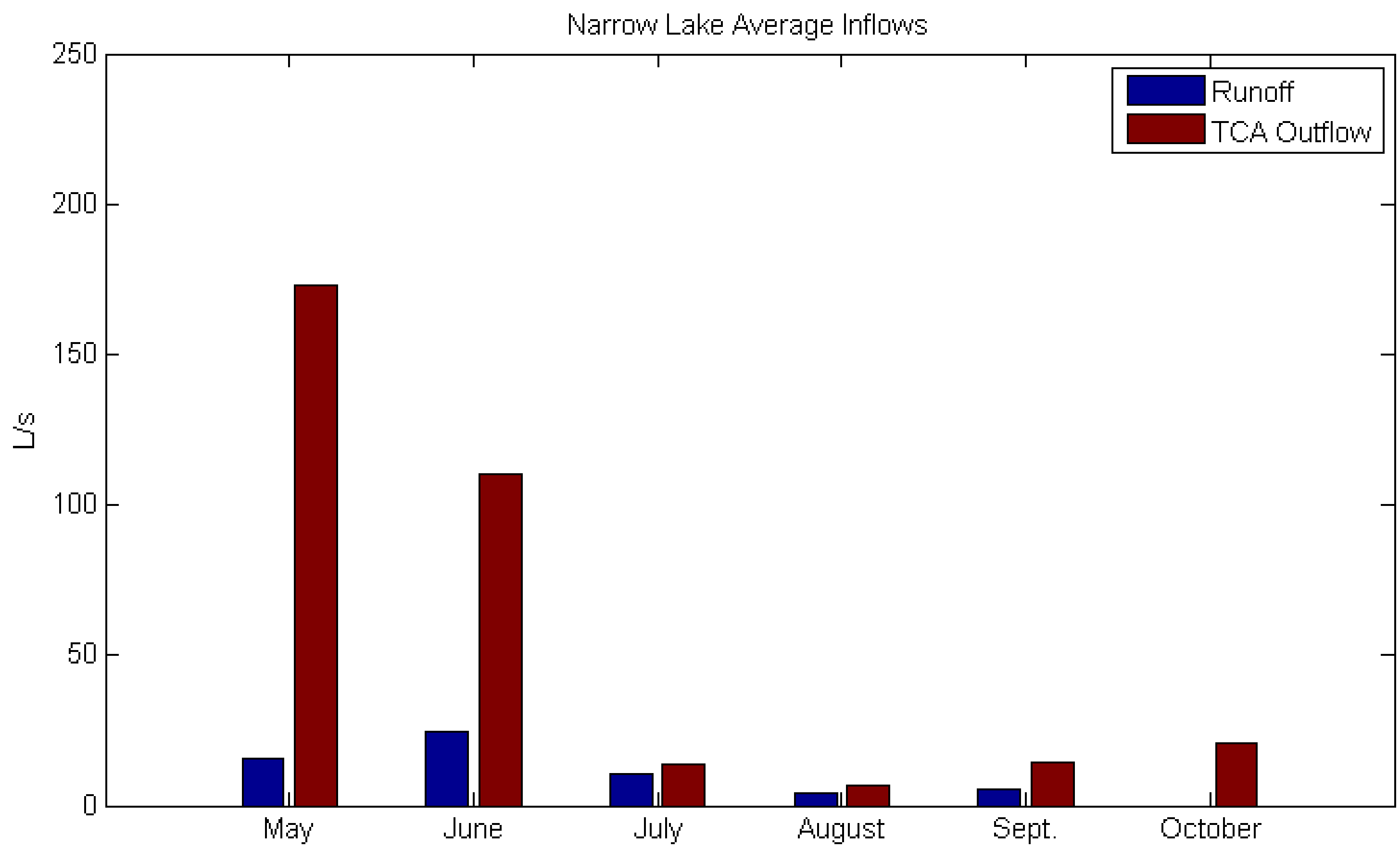
Figure 6.2-3



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Flow into Narrow Lake from the Tailings Containment Area and Narrow Lake Drainage Area

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Figure 6.2-4

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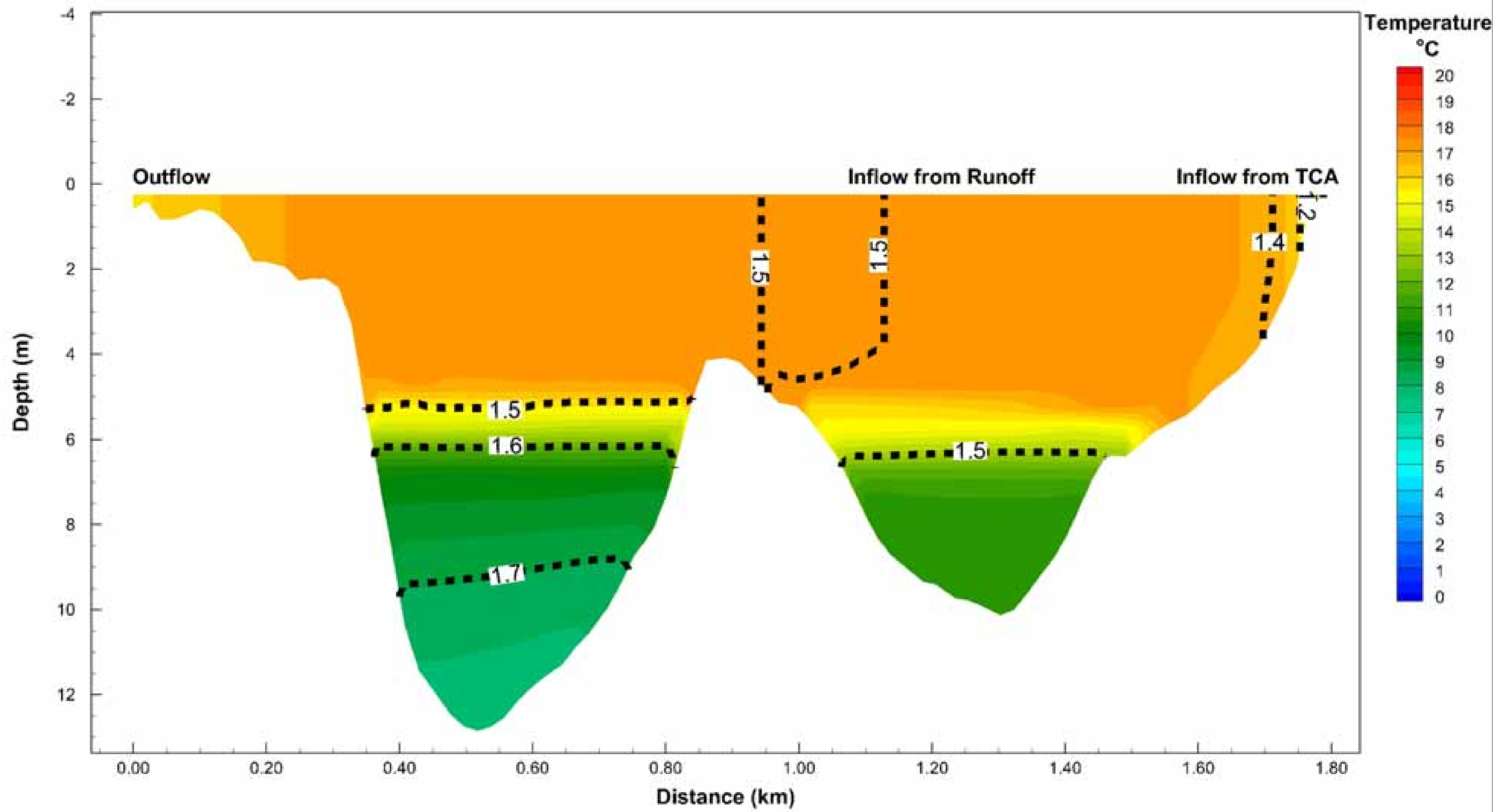
The time series of contaminant dilution under average hydrologic conditions at the same two locations is shown in Figure 6.2-7. The first three to four years are periods of major increases in contaminant concentration, or decreasing dilution, since the lake starts out with generally very small values of contaminants compared to the values delivered by the TCA stream. As time goes on, into Years 2, 3 and 4, contaminant concentrations in the lake build up, and a new, elevated, steady state concentration is reached by about Year 5. Using the final minimum dilution of approximately 1.16, the TCA effluent concentration required to meet CCME guidelines in Narrow Lake was calculated. For example, to meet the CCME guideline of 5 µg/L for arsenic, a TCA effluent concentration of 5 multiplied by 1.16, or 5.8, is required. Table 6.2.6 shows the contaminant concentrations required in Narrow Lake for arsenic, copper and cyanide. The nickel, lead and zinc concentrations in the TCA already meet CCME guidelines and are not altered in Table 6.2.6.

TABLE 6.2-6: REQUIRED TCA CONCENTRATIONS OF SIX POTENTIAL CONTAMINANTS

Parameter	TCA Concentration	CCME Water Quality Guideline (µg/L)	Required TCA Concentration	MMER Effluent Discharge Authorized Limit (µg/L)
As (µg/L)	199.7	5	5.8	500
Cu (µg/L)	5.0	2-4	2.3	300
Cyanide (µg/L)	24.1	5	5.8	1000
Ni (µg/L)	1.6	25-150	-	500
Pb (µg/L)	0.9	1-7	-	200
Zn (µg/L)	26.4	30	-	500

Figure 6.2.8 shows the modelled arsenic concentration in Narrow Lake over eight years assuming the required TCA concentration is met. The Narrow Lake water balance shows that runoff and TCA discharge starts in May. Narrow Lake starts with a well-mixed water column, indicated by the coincidence of the surface and bottom concentration lines in the first month or so. For the rest of the first summer, the bottom waters slowly increase in concentration but concentrations in the surface waters increase much more quickly as TCA outflows mix only with the top few metres of the lake. Mixing in the fall of the first year results in a constant concentration of around 2.5 µg/L until May of Year 2. This pattern of surface increases and relatively lower-concentration bottom waters continues until approximately Year 5. After this year, the May 'freshet' from the TCA causes both surface and bottom water concentration to increase by 4-5%, after which surface waters decrease due to a decrease in the ratio between TCA flows and runoff during the summer (Figure 6.2-8).

After Year 5, the lake reaches a relatively steady state as concentrations approach the long-term average dilution of TCA flows with local Narrow Lake drainage.



LEGEND

1.5 Dilution of contaminant concentration in TCA inflow.

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Example of Modelled Temperature and Dilution in Narrow Lake. July 1 of Year 2 - Stratified Conditions

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Figure 6.2-5

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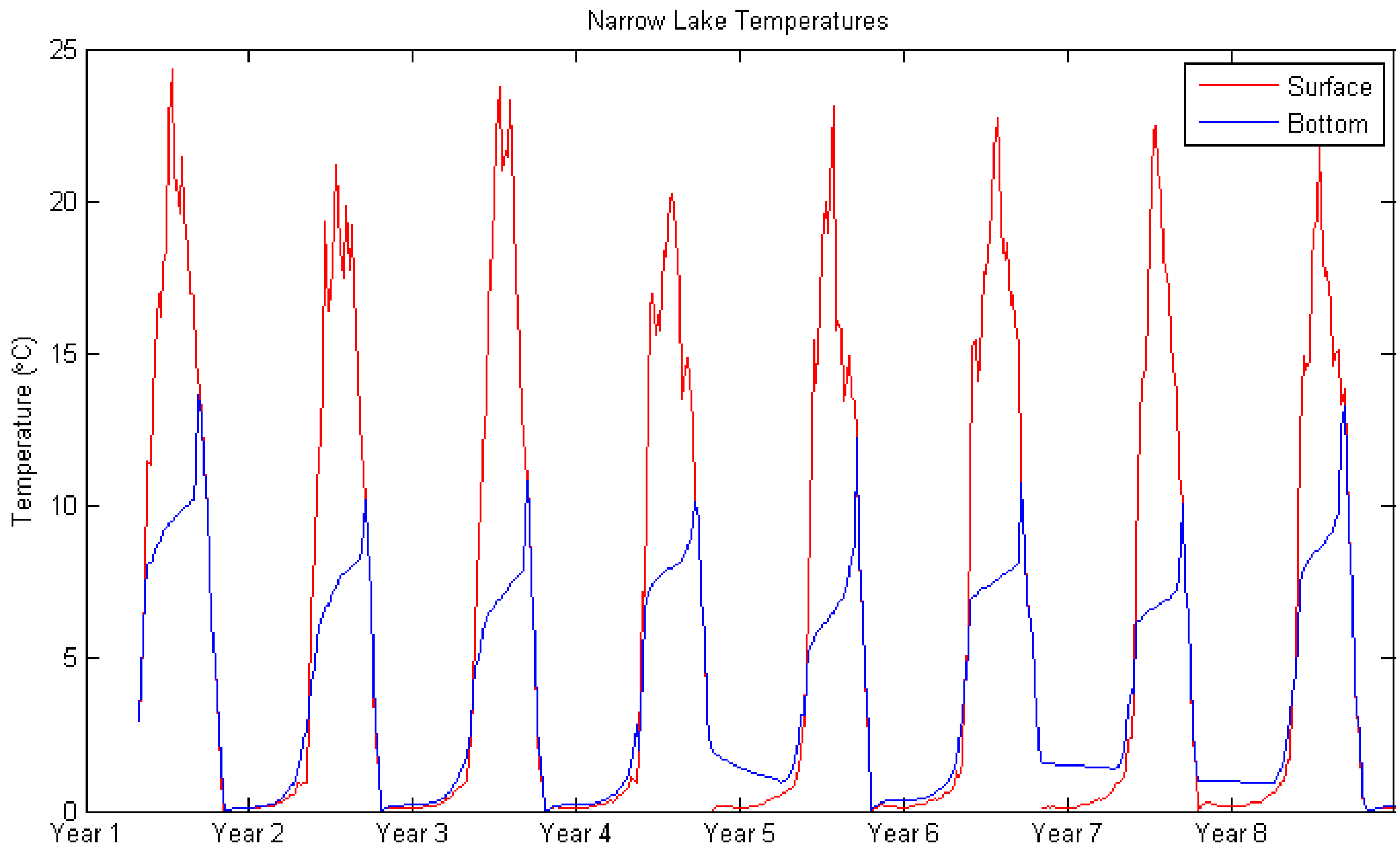

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Modelled Surface and Bottom Temperatures in Narrow Lake

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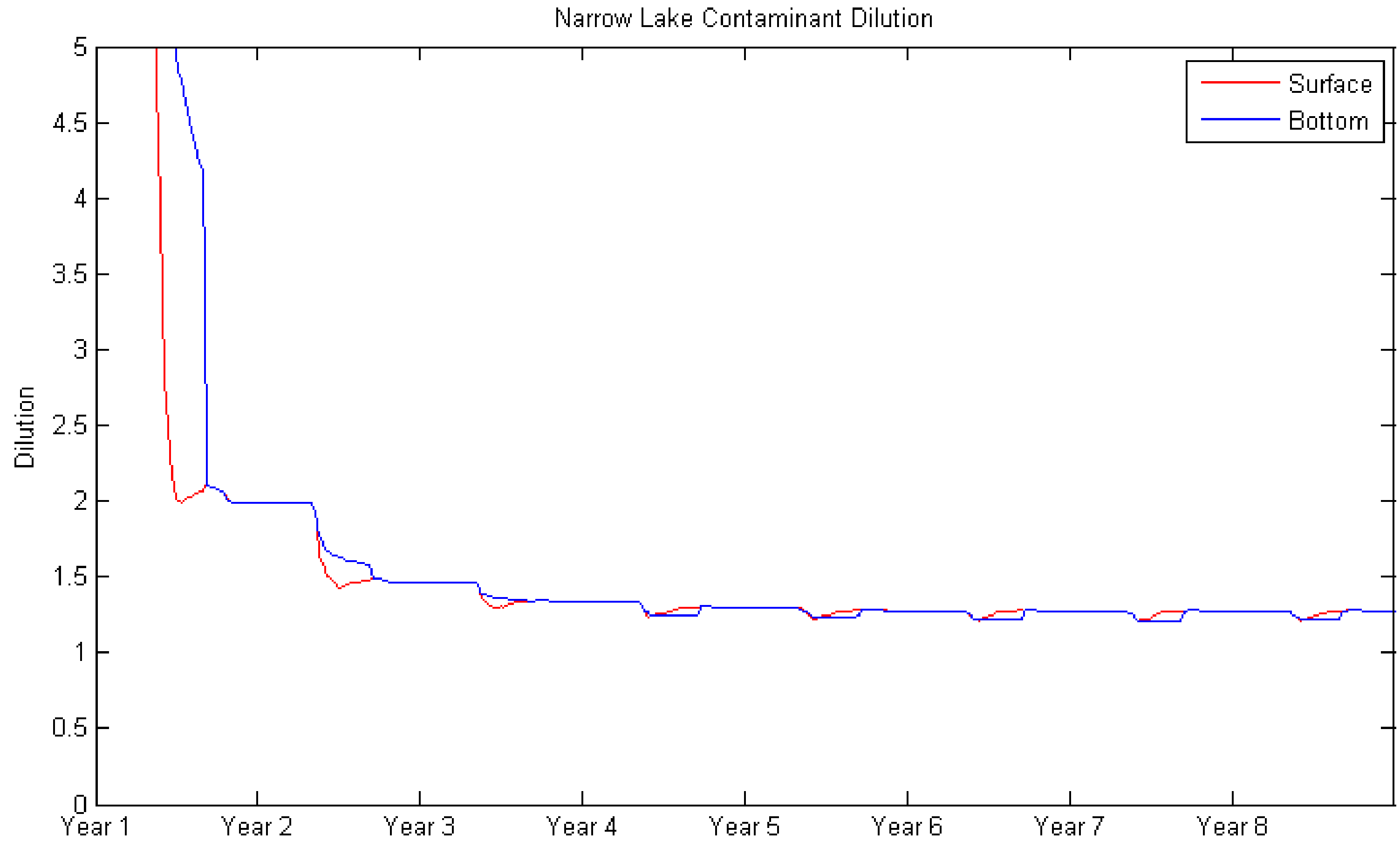
Figure 6.2-6



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Modelled Surface and Bottom Dilution in Narrow Lake

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Figure 6.2-7

The concentrations of nickel, lead, and zinc in Narrow Lake, due to effluent discharge from the TCA, are predicted from the model to be well within CCME Guideline limits, while arsenic, copper, and cyanide levels are anticipated to approach CCME guideline limits assuming the TCA discharge criteria concentrations are met. Maximum concentrations tend to occur in May, while minimums are generally seen in the fall when the TCA flows are lower as compared to the runoff.

6.2.1.3 Mitigation and Effects Assessment

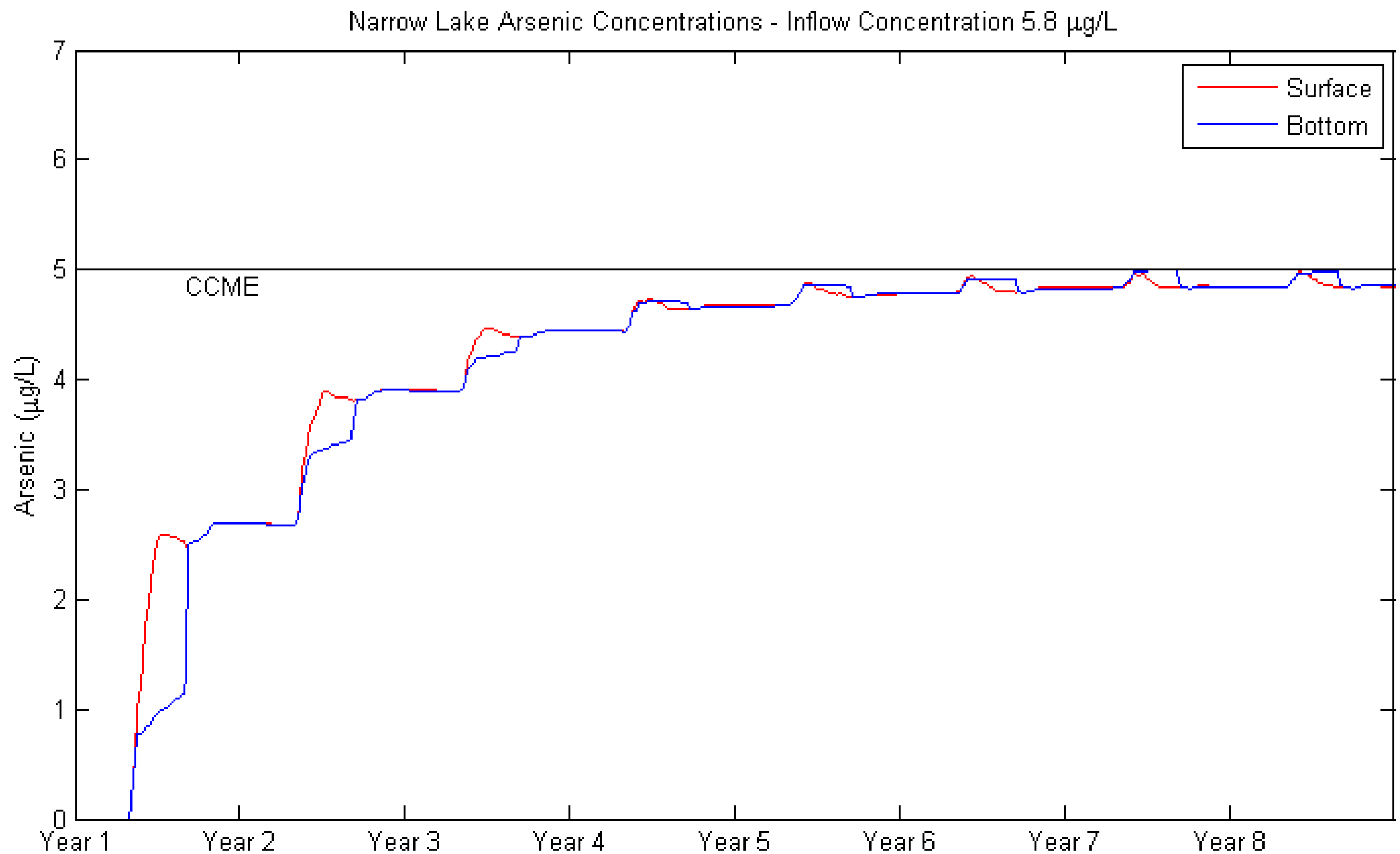
Steady state concentrations are achieved in approximately Year 5 (Figure 6.2-8) as levels increase only another 2% by Year 8. Both stratification and the balance between runoff and TCA discharge play a role in the rate of approach to steady state. Once steady-state conditions are reached, concentration increases are seen in both the surface and bottom waters during the high TCA discharge months of May and June. The concentrations in bottom water remain high after the lake stratifies, and drop to average values during the fall overturning of the lake. Surface concentrations decrease during summer and fall as less water is discharged from the TCA.

In summary, the Narrow Lake watershed does not produce sufficient runoff to significantly reduce the contaminant concentrations flowing from the TCA. All potential contaminants are below the MMER discharge criteria, however it appears that arsenic will require additional treatment to meet the CCME guidelines, and cyanide and copper may require chemical treatment. The numerical modelling, as summarized in Table 6.2.6, provides guidance with respect to the level of treatment required for these contaminants. Further discussion of issues related to arsenic, cyanide, and copper is provided below. Water quality residual effects assessment is included in Section 6.3.2.

Arsenic

Model results suggest that arsenic concentrations, in particular, may exceed CCME guideline values in Narrow Lake and are therefore the focus of these discussions, which include examination of the possible biological or geochemical processes that would reduce arsenic levels in waters discharged to the environment.

As reported in CCME (2001) and Sharma and Sohn (2009), arsenic speciation and levels are affected by chemical and microbiological oxidation, reduction, methylation, pH, and inorganic substances including sulphide, carbonate, and phosphate. It can also be affected by biotic uptake, sorption to iron and clay particles, and colloidal humic material. Arsenic exists in the environment in organic and inorganic forms, and in four oxidation states: arsenate, arsenite, arsenic, and arsine. In general, the inorganic forms tend to be more toxic to biota than the organic forms; arsenite in particular (Sharma and Sohn 2009). Mitigation of elevated arsenic concentrations is described in Section 4.11.8.



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Modelled Surface and Bottom Arsenic Concentration in Narrow Lake with TCA concentration of 5.8 µg/L

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Figure 6.2-8

Arsenic removed from the water column and deposited in deep basins of a lake can be altered and re-dissolved under anoxic conditions, so cannot assume to be sequestered (Bright et al. 1994). Arsenic in oxygenated waters tends to take the form of arsenate, or As (V), while arsenic under anoxic (reducing) conditions tends to be altered to arsenite, or As (III). Arsenite is more toxic than arsenate, and there exists the possibility that this altered arsenite may form during the summer hypoxia and be remobilized as the lake overturns in the fall. Arsenite, once formed, is unstable in oxygenated waters but only slowly oxidizes to arsenate and can be transported a number of kilometres before re-oxidizing (Bright et al. 1994). Two mechanisms were postulated to explain this transport: sediment/particulate transport; and, redissolution from sediments followed by diffusion and downstream transport. An understanding of these processes is important in the development of mitigation strategies, if these are determined to be necessary.

Effects of arsenic on freshwater biota vary considerably. Rainbow trout (Oncorhynchus mykiss) are among the most sensitive of fish species, having a 28-day LC50 of 550 µg/L (CCME 2001). Table 6.2.7 provides documented toxicity levels for other organisms, as reported by the CCME (2001).

TABLE 6.2-7: ARSENIC TOXICITY TO VARIOUS FRESHWATER ORGANISMS

Species	Toxicity Test	Toxicity Level (Total Arsenic- µg/L)
Invertebrates		
Cyclops vernalis (copepod)	14-day EC_{20} (growth)	320
Daphnia magna (crustacean)	21-day EC_{16} (reproduction)	520
Bosmina longirostris (crustacean)	96-hour EC_{50} (immobility)	850
Gammarus pseudolimnaeus (crustacean)	7-day LC_{80}	960
Ceriodaphnia dubia (crustacean)	7-day LOEC	1000
Plants		
Scenedesmus obliquus (green alga)	14-day EC_{50} (growth)	50
Melosira granulata (diatom)	14-day EC_{50} (growth)	75
Ochromonas vallesiaca (brown alga)	14-day EC_{50} (growth)	75
Scenedesmus quadricus	20-day VSUE	960

In addition to the toxicity test results reported in Table 6.2.7, Irving et al. (2008) report 12-day LC50 values for the nymph stage of the mayfly Baetis tricaudatis of 550 and 790 µg/L at high and low oxygen concentrations, respectively, for both arsenate and arsenite. These authors did note reduced growth for this mayfly nymph at 1000 µg/L of both species of arsenic.

These published toxicity test results are consistent with bioassays conducted on a sample of effluent taken from a locked cycle flotation tail, which likely represents a worst case scenario since it represents raw process effluent. The bioassays, which involved a 96-hour test on rainbow trout and a 48-hour test on Daphnia magna, both resulted in 100% survival of the test organisms (Appendix J). As well, there is no indication that arsenic biomagnifies in freshwater food chains (CCME 2001).

Due to the complex properties and the characteristics of the receiving environment, it is difficult to predict the actual levels and the species of arsenic that will occur in Narrow Lake (and downstream), which highlights the importance of post-development monitoring and the early initiation of water treatment and adaptive management strategies. As a result, YGP proposes to meet CCME guidelines for arsenic in Narrow Lake by implementing treatment of the tailings stream and/or decant water in the TCA. Further testing of effluents is necessary to determine the most efficacious treatment protocol. However, such treatment may include the addition of ferric and/or ferrous sulphate in the effluent stream along with pH adjustment to improve the efficiency of arsenic adsorption (Vogels and Johnson 1998). Ferric/ferrous sulphate treatment is commonly used to remediate arsenic in freshwater and drinking water (Bright et al. 1994; Vogels and Johnson 1998; Sharma and Sohn 2009). Ferrous sulphate has the additional advantage of reducing phosphorous levels in wastewater, due to the adsorption of phosphate ions to iron. Further bench tests will determine the levels of adsorbents that will best function to reduce arsenic and phosphorous to CCME guideline levels.

Cyanide

Cyanide has historically been used to extract gold from ores that could not be processed effectively. About 20% of the total production of cyanide is used by the mining industry (Logsdon et al. 1999). Following gold extraction, three principal forms of cyanide are recognized in wastewater or process water: free cyanide, weakly complexed cyanide, and strongly complexed cyanide, which combined, constitute total cyanide. Free cyanide refers to dissolved cyanide ion (CN-) and hydrogen cyanide that is formed in solution. Weak cyanide complexes, in which cyanide combines with cadmium, copper, nickel, silver, and zinc, are also referred to as weak acid dissociable (WAD) cyanide, which can dissociate to produce free cyanide. Strong cyanide complexes dissociate much more slowly than WAD cyanide and generally involve bonds with gold, cobalt, and mainly iron.

Cyanide is known to be acutely toxic to freshwater organisms; WAD cyanide is particularly toxic. Smith et al. (1978) found that acute toxicities ranged from 57-191 μg/L among fish species tested, and determined that juvenile fish were particularly sensitive but that eggs were more resistant. Moran (1998) further reported that sensitive fish species, such as rainbow and brown trout (Salmo trutta), exhibited acute toxicity in the 20-80 μg/L range when exposed to free cyanide. Aquatic insects are generally less sensitive to cyanide (Logsdon et al. 1999).

Cyanide levels in the TCA are likely to decline through such factors as natural degradation, precipitation, or biodegradation, which are known to attenuate cyanide concentrations in the environment. The natural degradation of cyanide occurs principally through volatilization with subsequent atmospheric transformations to less toxic chemical substances (Logsdon et al. 1999). Zagury et al. (2003) studied the fate and natural attenuation of cyanide in mine tailings and found that reactive cyanide species naturally degraded within the tailings area, mainly due to volatilization, leaching, and bacterial degradation.

The large surface area of tailings ponds provides the opportunity for relatively rapid removal of cyanide through volatilization. Logsdon et al. (1999) suggest that it may be typical for half the total cyanide to degrade within three weeks, with almost complete disappearance within 100 days. While site specific conditions, particularly related to sunlight (UV), temperature, bacterial composition, and tailings pond water chemical composition, will determine the rate of cyanide attenuation, evidence from other locations, as reported by Logsdon et al. (1999) demonstrate the relative efficiency of natural processes to reduce cyanide concentrations.

The maximum, unattenuated concentration of cyanide estimated to reach the Narrow Lake inlet stream is at the lower end of the cyanide toxicity scale (to aquatic organisms). In addition, water from the TCA will be pumped through a surface instream diffuser at the upstream end of the Narrow Lake inlet stream where it will be further exposed to the atmosphere over a distance of 165 m before emptying into Narrow Lake. This additional aeration will likely result in further volatilization of cyanide. It is therefore likely that actual levels will be substantially lower, and therefore not harmful to aquatic life. However, chemical oxidation or precipitation options exist (Logsdon et al. 1999), if necessary, to ensure that CCME guideline levels in Narrow Lake are not exceeded.

Copper

Concentrations of copper in effluents discharged to Narrow Lake are estimated to be considerably lower than MMER criteria (3.81 μg/L vs. 300 μg/L) and levels in Narrow Lake are not anticipated to exceed the CCME guideline level[15] of 2 μg/L. Copper concentrations in Narrow Lake presently range within this same level, and as a result, no significant change from background is expected to occur.

As discussed in relation to arsenic and copper, actual concentrations of copper in the TCA will likely be attenuated due to natural processes. In the dissolved state, copper appears in various forms, ranging from the cupric ion to numerous organic-inorganic complexes. The ionic form of copper is toxic at very low concentrations, while complexed copper is basically nontoxic. Copper toxicity is related to various physicochemical characteristics of the exposure water, including temperature, dissolved organic compounds, suspended particles, pH, and various inorganic cations and anions. Many of these physicochemical factors affect copper speciation, which determines both bioavailability and toxicity. The uptake of copper by aquatic organisms is reduced by various organic compounds and inorganic ligands, which are known to complex copper (U.S. EPA 2007).

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[15] CCME Cu guideline: 2 μg/L at [$CaCO_3$]=0-120 mg/L; 3 μg/L at [$CaCO_3$]=120-180 mg/L; 4 μg/L at [$CaCO_3$]=>180 mg/L. Narrow Lake $CaCo_3$ concentrations measured in 2004 and 2005 were consistently between 64-76 mg/L.

Through the processes of deposition, natural attenuation, and bioremediation, it is anticipated that arsenic, cyanide, and copper levels will diminish considerably prior to discharge from the TCA to the Narrow Lake inlet stream, and will be further attenuated downstream of Narrow Lake as water flows through numerous lakes, ponds, and wetlands before joining with the Yellowknife River at Clan Lake (Figure 6.2-1). However, since arsenic, in particular, may still reach levels above CCME guidelines, treatment is proposed within the tailings stream, as described above, to reduce levels sufficiently to attain approved limits.

The treatment options will be developed through effluent testing, and will be modified, as necessary based on the results of monitoring carried out in accordance with the MVLWB License conditions, and the environmental effects monitoring (EEM) requirements of the MMER. This will necessitate the development of an aquatic adaptive management program, which will proactively identify potential contaminant issues and develop treatment contingencies, if monitoring programs detect elevated levels of deleterious substances.

6.2.2 Groundwater

6.2.2.1 Groundwater Flow

Estimated Effects of Dewatering on Adjacent Surface Water Bodies

Long-term dewatering of the open pit and underground workings at Ormsby and the underground at Nicolas Lake will lower the groundwater table surrounding the excavated areas during the mining programs. This lowering will take the general shape of a cone and will likely reach its maximum extent when mining operations reach their maximum depths. The lateral extent of reduced groundwater elevations caused by dewatering will depend on bedrock hydraulic characteristics and surface-groundwater interactions.

As discussed in Section 2.10, shallow groundwater is likely contained in both overburden sediments and shallow bedrock fractures, while deeper groundwater is contained solely within deep fractures. Therefore, as shallow and deep groundwater elevations are lowered adjacent to the mine workings by mine dewatering, it is possible that surface water elevations surrounding the mine workings may also be reduced. However, there are several factors related to local hydrogeology and arctic conditions which indicate this effect will be minimized or non-existent in the Ormsby and Nicolas Lake areas.

The primary relationship that governs the potential effects of long-term mine dewatering on surrounding surface water bodies is the degree of hydraulic connection between underlying groundwater and overlying surface water. In the Ormsby and Nicolas Lake areas, it is likely that sediments underlying the lakes and muskeg serve as hydraulic barriers (aquitards) through which little or no vertical water movement occurs. As such, potentially reduced groundwater elevations beneath the surface water bodies will have little effect on overlying surface water elevations.

In addition, field measurements of bedrock conductivity conducted in the Ormsby and Nicolas Lake areas indicated that the overall permeability of bedrock in the proposed mine workings is very low. This low permeability will serve to reduce the lateral extent of groundwater dewatering and minimize any potential surface and groundwater hydraulic connections. These factors will result in reduced or minimal potential effects from long-term mine dewatering on overlying surface waters.

Permafrost is another factor which may influence the relationship between surface water and underlying groundwater. Groundwater drawdown and potential effects on surface water elevations will be limited or not occur in permafrost areas. As discontinuous permafrost is present in the Ormsby and Nicholas Lake mine areas, groundwater drawdowns and resulting effects on surface waters are not expected in these areas.

In addition, as most groundwater in the Ormsby and Nicolas Lake areas is expected to flow through shallow bedrock and surficial sediments, continued flow from the watershed catchment area into the surrounding lakes will maintain lake elevations.

Estimated Time for Excavations to Fill at Mine Closure

Once mining has been completed and dewatering operations have ceased, groundwater levels in the mine excavations will begin their recovery to approximate pre-mining elevations. A key consideration in post-mine operations will be the time required for the excavated areas to fill.

To estimate the approximate anticipated groundwater recovery times for both mining areas, the following assumptions and methodology were employed:

- The approximate volumes for each excavated mine area were estimated based on elevations with 11 elevation layers used at Ormsby and 5 layers at Nicholas Lake;
- The estimated low and high ranges of estimated groundwater inflow when the mines reach their maximum extent were used for this analysis (Section 2.10). Inflows at Ormsby are estimated to range between 500 to 1,500 m^3/day, while flows at Nicholas Lake are estimated to range between 100 and 1,200 m^3/day;
- Inflows based on precipitation and recharge were assumed to remain constant during the entire timeframe for water levels to recover;
- As the primary driving force which causes groundwater to enter the excavations will be the difference in hydraulic head inside and outside of the excavation, the estimated groundwater inflows excluding precipitation at each mine site were reduced for each step as the pit fills;
- The estimated mine volume per layer was divided by the estimated inflow per layer to obtain the time required for the inflow to fill that layer; and
- The fill times derived for each layer were then summed which provides the total estimated times for both Ormsby and Nicolas Lake mines to recover to pre-mine conditions.

Using this analysis, the pit and workings will begin to fill relatively quickly after mining ceases due to the large head difference between the excavations and surrounding areas and the relatively small excavation volumes. However, the fill rate will gradually slow as the groundwater contributions are reduced because of decreased hydraulic head and because the mined area volumes increase with elevation. The total excavated Ormsby mine volume including underground workings and open pit is estimated at approximately 29,000,000 m^3.

Based on this analysis, the time for groundwater levels to recover to pre-mine elevations at Ormsby is estimated to range between 50 and 500 years, depending upon groundwater inflow rate.

The volume of the Nicholas Lake underground workings is estimated at approximately 800,000 m^3. The time required for Nicholas Lake groundwater levels to recover to pre-mining conditions is estimated to range between 2 and 50 years, also depending upon groundwater inflow rate. For both mining areas, the actual time required will be a function of final excavation size, bedrock permeability, groundwater inflow and annual precipitation.

After groundwater has recovered to static conditions in the both the open pit and underground workings, the possibility exists that continued groundwater flow from the excavations and underground workings may occur. However, as discussed below the potential for significant flow is considered unlikely for both Ormsby and Nicolas Lake mine sites.

Long-term groundwater seepage to the surface may occur if the groundwater surface intersects the topographic surface and if a hydraulic differential between the two surfaces is present. As noted above, the permeability of deep bedrock in the mining areas is very low thus there is little ability for deep bedrock to transmit significant volumes of groundwater. In addition the regional hydraulic gradient is generally flat, thus no driving force to cause deep groundwater movement into the filled pits or underground workings will be present. Thus, it is likely that no significant long-term seepage from deep bedrock fractures into the pits or underground workings will occur.

However, shallow bedrock and overlying unconsolidated sediments may be somewhat more permeable than deep bedrock. Minor groundwater seepage from locally elevated topography around the mining areas may originate from these sources. As this minor seepage will predominately originate from seasonal precipitation, this flow would also occur seasonally with most seepage occurring primarily during freshet and reduced or no flow during the remainder of the year.

Ormsby Area

The top of the excavation elevation at the south end of the Ormsby Pit is planned for 280 masl. This elevation will be slightly below the current Winter Lake elevation of 286 masl, which is also the approximate elevation of the current outlet from Winter Lake to Narrow Lake. The current groundwater elevation adjacent to Winter Lake is likely equivalent to lake elevation. Although the northernmost portion of Winter Lake will be dewatered as part of the open-pit mining operation, post-mining groundwater elevation in the former lake area will likely remain close to current levels. Therefore, groundwater is likely to eventually fill the Ormsby Pit to this approximate elevation. Stated another way, the outlet elevation from the dewatered portion of the former Winter Lake to downstream Narrow Lake will likely be the final elevation of the Ormsby Pit Lake.

No surface water flow will be directed into the Ormsby Pit from upgradient sources. Annual freshet will likely cause minor discharge from the Ormsby Lake originating from direct precipitation and from shallow groundwater seepage from adjacent elevated topography. Therefore it is likely that water flow from the Pit Lake will behave similarly to that observed in nearby lakes, with minor seasonal flows tapering off as freshet ends.

Nicholas Lake Area

At present, no groundwater flow occurs from the existing portal at Nicholas Lake. Groundwater within the portal is at the approximate same level as the surrounding topography. As the existing portal will be used for planned underground mining at Nicholas Lake, post-mining groundwater flow is not likely to occur. Post-mining groundwater recovery may be expected to fill the portal to its current elevation of 325 masl.

Minor groundwater seepage from the portal could occur if bedrock above the portal elevation is mined, which would open pathways for precipitation on the overlying hill top to recharge shallow bedrock above the portal. Underground mining above the portal elevation could serve as drains for this recharge and cause minor flow from the portal. However, due to the low precipitation and recharge volumes as well as low bedrock permeability, the quantity of possible flow is expected to be very low.

6.2.2.2 Groundwater Quality

Values for existing groundwater quality parameters are presented in Table 2.10-2. Water quality parameter levels during operations and post closure are expected to be similar to those reported in Table 2.10-2.

6.2.2.3 Mitigation Measures

Mine water pumped out of the mine and pit at Ormsby will be directed to the Tailings Containment Area (TCA) for use/reuse during operations (as per the water balance). All water released from the TCA will be treated to comply with MMER.

Mine water pumped out of the Nicholas Lake underground will be directed to a mine water settling pond (65 m x 70 m), tested and treated if necessary (e.g. lime addition) prior to release to the receiving watershed to the north of the site (away from Nicholas Lake).

During the closure period groundwater quality in the pit will be monitored for 2-5 years. Should issues arise, management options for dealing with the water in the pit will be developed in consultation with MVLWB.

6.2.2.4 Residual Effects

Water quality parameter levels during operations and post closure are expected to be similar to those reported for baseline conditions (Table 2.10-2). If required, groundwater pumped to the surface will be treated. Therefore, no residual effects to groundwater quality are anticipated to occur.

6.3 AQUATIC RESOURCES

6.3.1 Aquatic Resource Summaries

The following sections summarize biophysical characteristics in the Ormsby and Nicholas development areas, and in streams crossed by the proposed all-season haul road, to provide background for the effects assessments, which follow in Section 6.3.3.

6.3.1.1 Ormsby Development Area

Winter Lake

Baseline fish and fish habitat studies conducted in 2004 and 2005 (see Section 2.11.4) (Appendix D) provided evidence that fish habitat conditions in Winter Lake are poor, and that there is little fish utilization of the lake. The following summarizes information related to existing fish and fish habitat characteristics of Winter Lake:

- No fish of any species were captured during over 31.5 hours of gillnetting during July, 2004. Similarly, no fish were captured in a total of over 31.5 hours of sampling using minnow traps in July 2004, and 43 hours of sampling using minnow traps set in August, 2005.
- A total of 10 juvenile northern pike were captured during 118 hours of gillnetting in August 2005, resulting in an average catch per unit effort of 0.55 fish per 100 m^2 of net per 12 hour period. In comparison, 106 fish were captured in Narrow Lake in 36.75 hours of gillnetting in August, 2005, for an average catch per unit effort of 15.78 fish per 100 m^2 of net per 12 hour period. No fish species other than pike were captured in Winter Lake.
- No fish were observed during any of the 12 underwater transect snorkel surveys conducted in 2005.
- Mean lengths and weights of pike captured in gill nets in Winter Lake were smaller than in Narrow Lake (Table 6.3-1), although the differences were not statistically significant (p=0.120 and 0.144, respectively), probably due to the large variances in the data. Similarly, the difference in the mean condition factor[16] between the two lakes was not statistically significant (p=0.251).

[16] Condition Factor is an index relating length and weight, which provides a relative comparison of the condition of fish. Undernourished/thin fish have a condition factor of less than 1. Adequately fed or fat fish have a condition factor greater than 1, although condition can be influenced by a variety of factors. The condition factor (K) is calculated as: $K=(W \times 100) \div (L)^3$, where W= weight in grams; L=length in centimetres.

TABLE 6.3-1: MEAN FORK LENGTHS, WEIGHTS, AND CONDITION FACTORS OF NORTHERN PIKE CAPTURED USING GILL NETS IN WINTER AND NARROW LAKES, AUGUST 6-8, 2005			
Lake	**Fork Length (cm)**	**Weight (g)**	**Condition Factor**
Winter[a]	35.4	620.9	0.839
Narrow[b]	48.2	1186.7	0.748

[a] 10 northern pike captured in 118 hours of gill net fishing

[b] 10 northern pike captured in 36.75 hours of gill net fishing.

- The south basin of Winter Lake has a maximum depth of two metres, indicating that this basin would freeze to the bottom or nearly to the bottom, depending on winter conditions. The north basin is deeper, with a maximum depth of six metres in two locations. However, much of this basin is also shallow and would almost completely freeze in winter. Dissolved oxygen levels in winter under the ice in the north basin were less than 0.25 mg/L. The combination of spatial limitation due to ice formation and anoxic conditions indicate that overwintering for fish in Winter Lake is very unlikely.
- Due to very poor overwintering conditions, the lack of suitable prey in Winter lake, and the absence of observed or captured fish in 2004, it is inferred that the juvenile northern pike captured during the summer of 2005 in Winter Lake were recent incidental migrants during the spring freshet and most likely would have either moved back into Narrow Lake to feed and overwinter or, would have perished after freeze-up.
- Present water quality in Winter Lake is somewhat degraded due to runoff from Round Lake which has been impacted from the historic Discovery mine untreated tailings cap. Measured levels of arsenic and copper in Round Lake, and to a lesser extent in Winter Lake, have been found to be seasonally elevated above Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life.

Winter Lake Outlet Stream

The following summarize the biophysical characteristics of the Winter Lake outlet stream:

- The outlet stream from Winter Lake flows over a distance of approximately 165 metres into Narrow Lake. The creek typically begins to flow in early to mid-May (EBA 2011). The stream flows sluggishly due to an overall gradient of less than 1.5%. The upper 50 m of this stream is confined in a well-defined channel made up of glides, riffles, and small pools, and a substrate of gravel and organic sediments. The lower portion of the stream is mainly unconfined, since the channel becomes braided and flow occurs through riparian vegetation and along depressions created due to the existing winter road. The channel widens from just over 3 metres near its source to 10 m, 75 m downstream, with a concomitant decrease in average depth (in May) from 36 cm to 21 cm.

- Based on empirical stream flow measurements from 2005 to 2010, discharges reach a maximum soon after snow melt during late May, early June, and then rapidly fall to very low levels in summer, which vary considerably depending on precipitation amounts. For example, average August stream discharges in the Winter Lake outlet stream between 2005 and 2010 ranged from <1.0 L/s in 2007 to 23.6 L/s in 2010. Typical August flows are less than 10 L/s (EBA 2011) but may fluctuate widely based on precipitation events. In August 2009 for example, flows remained relatively constant at less than 3 L/s, while in 2010, flows were very high (20-38 L/s) for a three week period beginning in the latter part of July, due to a series of heavy precipitation events (EBA 2011).

- A dissolved oxygen level of 3.5 mg/L was recorded in this outlet stream in July, 2004. This is less than the CCME guideline of 5.5 mg/L deemed to be generally acceptable for aquatic life. 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.

- Fish sampling in this stream was carried out in 2005, resulting in the capture of four juvenile northern pike and five slimy sculpin in a trap near the inlet to Narrow Lake. No fish were captured in the trap near the outlet from Winter Lake, although one large pike (presumed to be an adult) was observed in this area.

Narrow Lake

Narrow Lake, in contrast to Winter Lake, is relatively deep and provides suitable year-round habitat conditions for fish. Relevant lake characteristics are as follows:

- Lake whitefish and northern pike were the only fish species captured in Narrow Lake (slimy sculpin were only captured in the Winter Lake-Narrow Lake stream). Lake whitefish constituted 89% of the fish sampled in mid-summer 2004 and 91% in 2005 (total numbers of fish were 83 in 2004 and 106 in 2005).

- Narrow Lake has a maximum depth of 13 m in its south basin and 10 m in its north basin; the lake falls off steeply from the shoreline to depth. These depths and the presence of rocky bottom substrates, as well as emergent vegetation in shallower areas, provide adequate year round habitat for lake whitefish and northern pike.

- Dissolved oxygen levels at depth remained fairly high in winter (3.70 mg/L at 8 m depth; 5.1 mg/L at 5 m depth; 8.82 mg/L at 1 m depth; sampling on April 22, 2005, under the ice), providing suitable conditions for fish survival.

- Narrow Lake is a borderline oligotrophic-mesotrophic lake, since phosphorous levels tend to vary on a month by month basis from just below to just above the 0.01 mg/L threshold, which is commonly used to distinguish these two trophic states.

6.3.1.2 Nicholas Development Area

As described in Section 2.11.6, Nicholas Lake provides a diversity of fish habitats due to the presence of rocky bottom substrates and steep shoreline drop-offs, islands, rocky reefs, submerged boulder fields, and an abundance of sedge grasses and rushes along the shoreline, all of which provide spawning, rearing and foraging habitat for lake trout, northern pike, and burbot. No lake whitefish were captured during gill net sampling in Nicholas Lake, although habitat conditions would appear to be suitable for this species.

6.3.1.3 All-Weather Haul Road Stream Crossings

The proposed all-weather haul road between the Nicholas and Ormsby development sites will cross four unnamed streams (Figure 2.11-11). The streams at Sites 1 and 2 originate from small ponds and flow into Eclipse Lake. The stream at Site 3 flows south from a very small pond before discharging into Giauque Lake. The crossing at stream site 4 is located just to the west of Giauque Lake.

All of the sites flow out of very small ponds, which are not likely to provide suitable fish habitat due to the characteristic shallow depth of such tundra lakes. No fish were captured or observed during electrofishing surveys on June 3 and August 10, 2005, near stream crossings 1, 2, and 4. In addition, assessments made at the time of sampling at these locations concluded that habitat conditions for fish were marginal. Due to observations at site 1, 2 and 4, sampling was not conducted at stream site 3. Further investigations will be carried out prior to any road construction to ensure adequate protection of fisheries resources if needed.

6.3.2 Interactions, Potential Effects, and Mitigation

Construction, operation, maintenance, and decommissioning activities related to the Ormsby and Nicholas developments, and associated infrastructure, have the potential to affect aquatic resources within and downstream of these areas. Interactions between the YGP activities and aquatic environmental components are identified in Table 6.3-2 and subsequently assessed based on proposed mitigation measures, and the likelihood and significance of residual effects. Although water quality assessment and mitigation are discussed in Sections 6.2.1.1 and 6.2.1.3, respectively, they are noted in Table 6.3-2 and in subsequent discussions due to the linkage between water quality and the abundance and characteristics of aquatic communities.

TABLE 6.3-2: POTENTIAL PROJECT – AQUATIC ENVIRONMENT INTERACTIONS				
Project Phases/Components	Environmental Components[1]			
	Surface Water Quality	Surface Water Quantity	Fish	Fish Habitat
Site preparation and construction	X			X
Open pit mining	X	X	X	X
Underground mining	X	X		
Blasting	X		X	
Mine waste rock storage	X			
Acid rock drainage (if present)	X			
Tailings containment and effluent discharge	X	X	X	X
Water supply and management		X	X	
Sewage	X			
Roads and airstrip	X			X
Accidents and malfunctions	X		X	X

Notes:

[1] Species at Risk is not indicated as an environmental component since no aquatic species at risk have been identified within the effect footprint of the Tyhee Project.

Table 6.3-3 summarizes Project activity effects on the aquatic environment, proposed mitigation measures, and anticipated potential residual effects. Potential effects are then further discussed and assessed in subsequent sections.

6.3.3 Residual Effects Assessment

Potential residual effects identified in Table 6.3-3 are further assessed in Table 6.3-4 to assist in determining their significance in relation to fish and fish habitat. Assessment criteria are provided in Table 6.1-1. The following sections provide additional information and the rationale for the evaluations of effects and residual effects identified in Tables 6.3-3 and 6.3-4.

TABLE 6.3-3: PROJECT ACTIVITIES, EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS ON THE AQUATIC ENVIRONMENT

Environmental Components	Project Phase or Component	Description of Activity and/or Potential Environmental Effects	Recommended mitigation measures / Best Management Practices (BMPs) / Site Characteristics	Residual Effect	Residual Effect Description
Surface Water Quality	Site Preparation and Construction	• Soil exposure, erosion, sedimentation • Dust	• Application of erosion and sediment control (e.g. DFO Land Development Guidelines); runoff capture and treatment; exposed soil stabilization. • Dust suppression	No	
	Open Pit Mining (Ormsby)	Seepage water will be pumped to the TCA. Seepage water has the potential to contain substances that are deleterious to aquatic life.	Containment in the TCA prior to release will result in the settling of suspended solids and consequent decreases in associated metals and nutrients. Water discharged will be treated, if necessary, to ensure that water quality meets MMER criteria.	No	
	Underground mining	Water that infiltrates into the mine will be pumped to the TCA (Ormsby) and to a settling pond (Nicholas).	Water that is discharged to the environment will be monitored and will be treated, if necessary, to meet water quality requirements of the MMER. Nicholas property discharges will be directed to a settling pond with a minimum seven day retention time. Water from the settling pond will also undergo bioremediation as it flows through extensive vegetated wetland areas before reaching Eclipse Lake.	No	
	Blasting	Potential releases of deleterious substances (ANFO) to aquatic systems	Strict adherence to DFO Blasting Guidelines	No	
	Mine Rock Storage	Contaminated runoff carrying elevated concentrations of metals; toxicity and/or bioaccumulation in aquatic organisms.	*Ormsby site*: Drainage from the waste rock pile at Ormsby will be captured and directed to the TCA. Water from the TCA will be monitored and treated as needed before being discharged to the receiving environment. *Nicholas site*: Minimal waste rock will be generated; most NAG waste rock will be used for road base, stope backfill and general construction. If necessary, excess waste rock will be stored at a site that drains to a bog where metals levels will be reduced through bioremediation; if necessary, drainage will be collected and discharged to settling area for treatment. Discharges to fish habitats will meet *Metal Mining Effluent Regulations*.	No	

TABLE 6.3-3: PROJECT ACTIVITIES, EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS ON THE AQUATIC ENVIRONMENT

Environmental Components	Project Phase or Component	Description of Activity and/or Potential Environmental Effects	Recommended mitigation measures / Best Management Practices (BMPs) / Site Characteristics	Residual Effect	Residual Effect Description
	Acid Rock Drainage	Potential discharge of acidified drainage to natural waterbodies.	NAG and PAG materials will be identified and separated. NAG waste rock will be utilized for capping materials and encapsulating PAG rock. Short and long-term monitoring will consist of visual inspection and collection and analysis of seepage. If acid-generation/metal leaching is identified through monitoring efforts, mitigation measures such as increased capping requirements, drainage and monitoring will be put in place. All runoff at Ormsby will be collected and pumped directly to the TCA. Discharges to fish habitats will meet *Metal Mining Effluent Regulations*. (See Section 4.12.5.1)	No	
	Tailings Containment and effluent discharge	Potential concentration of metals or nutrients, which could result in elevated and potentially deleterious discharges to the receiving environment.	Waste stream discharges will be treated to reduce arsenic and phosphorous levels in the TCA. Chemical remediation, as necessary for other contaminants (e.g. cyanide and copper) will be implemented as necessary based on bench test results and on-site monitoring. Water releases to the environment will meet MMER criteria.	No	
	Sewage	Sewage effluent could contain BOD and nutrient concentrations that could affect oxygen levels and primary productivity, leading to degradation of water quality and adverse effects to the biological community.	Sewage will be treated using a packaged RBC plant and discharged to the TCA. The RBC will be designed to meet the *Camp Sanitation Regulations*, R.R. N.W.T. 1990, c. P-12, *Public Health Act*, R.S.N.W.T. 1998, c. P-12.	No	
	Roads and Airstrip	Effects on water quality may occur due to watercourse sedimentation resulting from soil exposure, erosion, fording, culvert installation and maintenance, and unimpeded ditch discharges to streams.	Adherence to erosion and sediment control guidelines; application of environmental road construction guidelines and BMPs, including appropriate design and installation of culverts; adherence to DFO Operational Statements for culvert maintenance and temporary stream crossings.	No	

TABLE 6.3-3: PROJECT ACTIVITIES, EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS ON THE AQUATIC ENVIRONMENT

Environmental Components	Project Phase or Component	Description of Activity and/or Potential Environmental Effects	Recommended mitigation measures / Best Management Practices (BMPs) / Site Characteristics	Residual Effect	Residual Effect Description
	Accidents and malfunctions	Potential spills of lubricants and fuels from heavy machinery	Training of staff in spill containment and treatment, and on-site availability of spill containment equipment and supplies. Fuel tanks will be contained within a bermed area to provide spill containment for 4 ML. Spills are unlikely to occur in the vicinity of natural watercourses.	No	
Surface Water Quantity	Open Pit Mining	• Pit water (groundwater seepage, runoff, precipitation) will be pumped to the TCA.	Water will be directed to the TCA.	No	
	Tailings Containment Area Water Discharge to the Environment	Water flow patterns at Ormsby will change as a result of diversion of upper watershed surface and channel flows to the TCA, resulting in flow modifications to Narrow Lake and downstream.	Water will be pumped to the upper end of the Narrow Lake inflow stream and will be regulated to simulate seasonal background flow patterns in summer.	Yes	Flow volumes pumped to the Narrow Lake inlet stream in May and June (freshet period) will be elevated compared with existing flows during that period
	Underground Mining	Seepage water to the underground workings at Nicholas will be pumped to a sediment pond, treated if needed, and then released. Groundwater volumes are varied based on baseline studies may result in above average flows to Eclipse Lake.	Flows will be contained in the settling pond to permit regulation of flow releases to the environment. If very high volumes of groundwater seepage are encountered, modifications may be made to the settling pond to increase capacity and water residence time. Two small lakes will provide additional storage capacity to mitigate sudden elevated flow releases to Eclipse Lake.	Yes	Potential increased flows to vegetated wetland areas and Eclipse Lake.

TABLE 6.3-3: PROJECT ACTIVITIES, EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS ON THE AQUATIC ENVIRONMENT

Environmental Components	Project Phase or Component	Description of Activity and/or Potential Environmental Effects	Recommended mitigation measures / Best Management Practices (BMPs) / Site Characteristics	Residual Effect	Residual Effect Description
	Water Supply and Management	Effects on water levels due to water withdrawal from Giauque Lake for Process Water.	Recycling of water from the TCA will reduce water requirements from Giauque Lake.	Yes	Minimal effect due to small volumes extracted relative to volume of lake.
Fish	Open Pit Mining	Development of the Ormsby pit will result in the loss of Winter Lake as a potential, periodic refuge for small fish.	No fish were sampled from Winter Lake in 2004; in 2005, 10 juvenile northern pike were captured by gill netting and no other species were located. Sampling of pike in Winter Lake is not considered to be an indication of suitable habitat conditions and Winter Lake is not considered to contribute to habitat productive capacity. Mitigation will involve ensuring that water quality and quantity released to the environment from the TCA are suitable for downstream fish populations.	No	
	Blasting	Potential lethal effects due to physical/anatomical damage to fish	Strict adherence to DFO Blasting Guidelines (Wright and Hopky 1998).	No	
	Tailings Containment and Effluent Discharge	Discharge of tailings and waste water to the TCA and potential effects of discharges from the TCA on downstream fisheries resources	Waste stream discharges will be treated to reduce arsenic and phosphorous levels in the TCA. Chemical remediation, as necessary for other contaminants (e.g. cyanide and copper) will be implemented as necessary based on bench test results and on-site monitoring. Water releases to the environment will meet MMER criteria. Effects on fish and fish habitat will be avoided by adherence to water quality criteria and guidelines for the protection of aquatic life.	No	
	Water Supply and Management	Potential entrainment of fish at the Giauque Lake water intake structure.	Adherence to the DFO Freshwater Intake End-of-Pipe Fish Screen Guideline (DFO 1995)	No	
	Accidents and Malfunctions	Potential acute or sub-acute effects on fish due to accidental spills or releases of fuels, lubricants, or due to tailings dam failure.	Training of staff in spill containment and treatment, and on-site availability of spill containment equipment and supplies. Spills are unlikely to occur in the vicinity of natural watercourses. TCA dams and berms will be engineered to conform with the Canadian Dam Safety Guidelines and the Mining Association of Canada Guide to the Management of Tailings Facilities.	Yes	Accidental spills may occur; dam or berm failure is potentially possible due to extreme climatic conditions.

TABLE 6.3-3: PROJECT ACTIVITIES, EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS ON THE AQUATIC ENVIRONMENT					
Environmental Components	**Project Phase or Component**	**Description of Activity and/or Potential Environmental Effects**	**Recommended mitigation measures / Best Management Practices (BMPs) / Site Characteristics**	**Residual Effect**	**Residual Effect Description**
Fish Habitat	Site Preparation and Construction	Site clearance resulting in erosion can potentially result in sedimentation of downstream watercourses.	Application of erosion and sediment control (e.g. DFO Land Development Guidelines); runoff capture and treatment; exposed soil stabilization.	No	
	Open Pit Mining	Development of the Ormsby pit will result in the loss of marginal habitat in Winter Lake; and the loss of the most upstream section of the Narrow Lake inlet stream as potential spawning for northern pike.	No fish were sampled from Winter Lake in 2004; in 2005, 10 juvenile northern pike were captured by gill netting and no other species were located. Sampling of pike in Winter Lake is not considered to be an indication of suitable habitat conditions and Winter Lake is not considered to contribute to habitat productive capacity; Habitat loss in the upstream area of the Narrow Lake inlet stream due to dam construction at the outlet of Winter Lake is not anticipated to reduce significantly the productive capacity of habitat since this section possesses marginal habitat for pike.	Yes	Minor habitat loss or change.
	Tailings Containment and Effluent Discharge	• Creation of the TCA in the south basin of Winter Lake and draining the north basin of the Winter Lake will eliminate marginal fish habitat. • The upstream portion of the Narrow Lake inlet stream will be lost. • Flow modification to the Winter Lake outlet stream and Narrow Lake may result in habitat changes (also see description under Water Supply and Management).	• Marginal habitat loss in Winter Lake and the upstream portion of the Winter Lake outlet stream is unavoidable. • Flows pumped to the upper section of the Winter Lake outlet stream will approximate mean seasonal flows.	Yes Yes	Loss of marginal habitat Potential flow changes resulting in habitat alteration in the Narrow Lake inlet stream

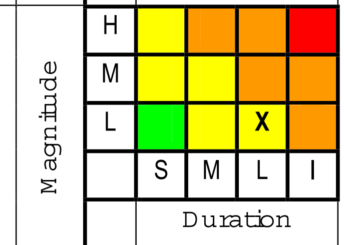
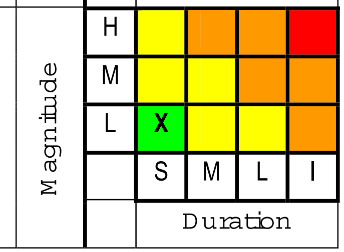
TABLE 6.3-3: PROJECT ACTIVITIES, EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS ON THE AQUATIC ENVIRONMENT

Environmental Components	Project Phase or Component	Description of Activity and/or Potential Environmental Effects	Recommended mitigation measures / Best Management Practices (BMPs) / Site Characteristics	Residual Effect	Residual Effect Description
	Roads and Airstrip	Stream crossings and road/airstrip drainage have the potential to result in sediment releases to waterbodies.	Conformance with erosion and sediment control Best Management Practices (BMP) and Environmental Protection Plans developed for the Project; adherence to DFO culvert installation guidelines.	No	
	Accidents and Malfunctions	Remote chance of TCA dam/berm failure resulting in downstream habitat alteration and disruption.	TCA dams and berms will be engineered to conform with the Canadian Dam Safety Guidelines and the Mining Association of Canada Guide to the Management of Tailings Facilities.	Yes	Dam or berm failure is potentially possible due to extreme climatic conditions.

TABLE 6.3-4: RESIDUAL EFFECTS ANALYSIS

Description of Residual Effect (after Mitigation)	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	Consequence
Underground Mining Effects on surface flows discharged from the Nicholas settling pond and reaching Eclipse Lake	Low	Local	Long-term	Sporadic	Reversible Long-term	Moderate	Magnitude: H, M, L; Duration: S, M, L, I — X at Magnitude L / Duration L
Tailings Containment and Effluent Discharge Elimination of natural downstream flows from Winter Lake to Narrow Lake due to the use of the southern basin of Winter L. as the TCA and draining of its northern basin; provision of pumped flows from the TCA to the Narrow Lake inlet stream.	Low	Local	Long-term	Continuous	Irreversible	High	Magnitude: H, M, L; Duration: S, M, L, I — X at Magnitude L / Duration I
Tailings Containment and Effluent Discharge; Open Pit Mining Loss of fish production potential and marginal fish habitat in Winter Lake due to conversion of southern basin to the TCA and draining of the north basin.	Low	Local	Long-term	Continuous	Irreversible	High	Magnitude: H, M, L; Duration: S, M, L, I — X at Magnitude L / Duration I
Tailings Containment/Effluent Discharge • The upstream portion of the Winter Lake outlet stream will be lost. • Flow modification to the Winter Lake outlet stream and Narrow Lake may result in habitat changes.	Low	Local	Long-term	Continuous	Irreversible	High	Magnitude: H, M, L; Duration: S, M, L, I — X at Magnitude L / Duration I

TABLE 6.3-4: RESIDUAL EFFECTS ANALYSIS

Description of Residual Effect (after Mitigation)	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	Consequence
Water Supply and Management Water Supply and Management Effects on water levels due to water withdrawal from Giauque Lake for Process Water.	Low	Local	Long-term	Continuous	Reversible Long-term	High	
Accidents and Malfunctions Potential acute or sub-acute effects on fish due to accidental spills or releases of fuels, lubricants, or due to tailings dam failure.	Low	Local	Short-term	Isolated	Reversible Short-term	Low	

6.3.3.1 Tailings Containment Area – Winter Lake

As a consequence of the Ormsby Pit encroaching on Winter Lake, the north basin of Winter Lake will be drained, as discussed in Section 4.12.2 and shown on Figure 2.2-2. All process tailings from the YGP will be deposited in the south basin of Winter Lake, initially sub-aqueously, and later sub-aerially.

The Ormsby Pit development will result in the total loss of the marginal fish habitat in Winter Lake and the uppermost section of the Winter Lake outlet stream. As reported in Section 6.3.1.1, sampling efforts indicate that only relatively few juvenile northern pike appear to have utilized Winter Lake habitats, and at that, only sporadically. Although pike spawning habitat may exist within Winter Lake's shallow, vegetated bays, there is no evidence that such areas are being used, perhaps because of the lack of overwintering habitat in the lake resulting from shallow depths, ice coverage, and low dissolved oxygen levels, and because of the absence of fish prey species.

Based on sampling results, fish habitat in Winter Lake is rated as poor. The data also suggest that Winter Lake may be a sink habitat[17], due to ice formation to the bottom or close to the bottom throughout much of the lake, anoxic conditions in unfrozen areas, and limited downstream access to Narrow Lake in late summer due to low flow conditions in the Winter Lake outlet stream. As well, there is virtually no food availability for pike in Winter Lake since the diet of fish older than young-of-the-year is composed mainly of small fishes (Doyon et al. 1988), which are absent from Winter lake. For these reasons, the habitat productive capacity of Winter Lake likely approaches zero.

Nutrient and organic input to Narrow Lake from Winter Lake is anticipated to be minimal during the peak period of biological activity, due to normally very low flows in the Winter Lake outlet stream in summer. Discharges from the TCA to Narrow Lake will meet MMER requirements, but will still contain residual levels of nutrients and organic material that are normally contained in flows from Winter Lake. As such, no effect on productive capacity of Narrow Lake is anticipated due to the removal of Winter Lake from the upper watershed.

Based on the above, it is anticipated that the removal of Winter Lake from the Narrow Lake watershed would not result in a significant change in the overall habitat productive capacity and fish production in this system. Residual effects on fish and fish habitat are therefore not anticipated to be significant.

[17] A habitat sink is a water body accessible to fish, which then cannot survive the winter.

6.3.3.2 Flow Modification – Winter Lake Outlet Stream and Narrow Lake

Fish sampling in the Winter Lake outlet stream revealed juvenile northern pike utilizing or migrating through the lower reaches of the Winter Lake outlet stream (near the inlet to Narrow Lake). These fish ranged in size from 98-127 mm in June, 2005, indicating that they were likely to be one year old fish (Scott and Crossman 1973). It is probable that this stream location offers protective cover for young pike due to its shallow depth and vegetative cover, and is therefore considered to provide suitable rearing habitat. Although no young of the year pike were captured, it is possible that the Winter Lake outlet stream also provides pike spawning habitat, particularly in its downstream end near Narrow Lake.

The uppermost section of the Winter Lake outlet stream will be eliminated due to the draining of the northern basin of Winter Lake and the construction of a berm to prevent backflow into the resultant depression. However, fish habitat (primarily northern pike and sculpin) in the remainder of the Winter Lake outlet stream will be maintained by flows pumped from the TCA to diffusers at the base of the berm. These flows will approximate average, seasonal flow conditions in this stream, although flows in May and part of June will be elevated relative to background levels to maintain appropriate water depths in the TCA. The seasonal adjustment of discharges is critical to the maintenance of suitable habitat conditions, since the various life history stages of fish are adapted to flows that normally occur during those times.

Although freshet flows to the Narrow Lake inlet channel will be elevated, it is not expected that increased flow volumes and velocities will impact significantly on the existing stream channel. Under high flow conditions, water spills from the confined low flow channel into a network of braided channels and into the depression left by the winter road. Increased flows during May and June will likely result in increased velocities through these channels and additional areas of inundations. However, it is anticipated that flows will be restricted to the main low flow confined channel once water discharges decline in late June. These early season flow increases are not anticipated to change significantly available habitat for northern pike or sculpins. Some additional inundations areas may be available, although habitat conditions would likely not be conducive for spawning due to the nature of the vegetation that would be temporarily flooded. Flow increases may also provide a somewhat prolonged period of high water in spring, which could be beneficial for northern pike egg and larval survival.

In addition to protecting stream habitats, seasonally adjusted flow releases are important to support the Narrow Lake whitefish and northern pike community, since significant deviations from the seasonal flow regime has the potential to alter available habitat and water quality characteristics. It is anticipated that adverse effects will be avoided by regulating pumping rates from the TCA to Narrow Lake via the Winter Lake outlet stream. Discharge volumes will approximate the mean seasonal background levels measured in the Winter Lake outlet stream between 2005 and 2010 (EBA 2011). Hydrographs constructed from these data were reviewed to determine appropriate flow time periods and associated flows, as shown in Table 6.3-5.

TABLE 6.3-5. RECOMMENDED FLOW DISCHARGES FROM THE TCA	
Time Period	**Recommended Flow Release (m^3/day)**
Ice-out to June 20	Variable - Based on discharges required to maintain a suitable water level in the TCA. Under normal conditions the range in flows would be 14,358 m^3/day in May gradually diminishing to 9764 m^3/day in June.
June 21-July 10	1728
July 11-August 10	864
August 11-August 31	432
September 1-September 30	1296
October 1-freeze-up	1728

Section 4.13 provides calculations and further discussion of the water balance that is recommended to provide suitable conditions within the TCA and the downstream environment.

The fish bearing Winter Lake outlet stream likely provides periodic summer habitat for northern pike juveniles and slimy sculpin. At high water conditions, deeper areas, particularly near the inlet to Narrow Lake may be used by adult northern pike. Habitat will be maintained and potentially increased and improved by the provision of seasonally adjusted flows from the TCA.

Based on the regulation of flows pumped from the TCA to the upper reach of the Winter Lake outlet stream, the residual effect on water input to Narrow Lake is not expected to be significant.

Monitoring

Fish and fish habitat characteristics in the Winter Lake outlet stream and in Narrow Lake will be monitored according to schedules determined as part of regulatory requirements for operation of the Tyhee minesite. Prior to site development, a quantitative habitat assessment of the Winter Lake outlet stream, at both high and low flows, will be carried out to provide a suitable baseline for monitoring and to allow adjustment of pumped flows to optimize habitat availability.

Habitat Compensation

Preliminary assessment indicates that flow regulation will likely result in an overall improvement in habitat quality in this stream, since flows will generally be augmented during the normally low July-August flow period. This increase in summer habitat availability may be sufficient to compensate for the habitat area in the upper section of the stream that will be lost due to draining of the north basin of Winter Lake and the construction of a berm to prevent backwatering into the resultant depression.

However, if habitat compensation is required as part of a *Fisheries Act* Authorization, quantitative habitat assessment and surveying of the Winter Lake outlet stream, carried out prior to site development, will be used as a basis for designing channel modifications to increase habitat quality and availability, primarily for northern pike and slimy sculpin. DFO will necessarily be consulted on channel design options.

At present, the Winter Lake outflow stream is relatively confined near its upstream end, but tends to braid and follow depressions created by the winter road, which follows the course of the stream. In summer, flows are very low, probably restricting habitat use and benthic invertebrate production. In principle, it is proposed to reconstruct portions of the channel to increase habitat availability and complexity as follows:

- Create a limited number of stable braided channels and/or off channel wetland pools within the wetland delta near the inlet to Narrow Lake. Where possible, these channels will incorporate existing emergent vegetation to enhance northern pike spawning and juvenile rearing opportunities;
- Channels and off channel pool designs will be guided by those described in Cott (2004), which referred to a habitat enhancement project for northern pike in the NWT. That project resulted in creating additional pike habitat, which compensated for habitat loss by a factor of 11:1;
- Similarly, enhance habitats for northern pike spawning and rearing at the upstream end of the stream. Water from the TCA will be discharged through diffusers that can be designed and spaced to provide flow to braided, vegetated channels constructed at this location;
- Create riffle-pool sequences that provide suitable areas for sculpin rearing and spawning by constricting and channelling flow using local materials, based on methods adapted from Newbury and Gaboury (1994). Benthic invertebrates, associated with gravel and cobbles, feed in shallow riffle areas where they can gather food from stream flow;
- Supplement stream gravel and cobble in selected riffle locations, if necessary; and,
- Restrict winter vehicular traffic from the area of the stream channel.

6.3.3.3 Nicholas Lake Development Area

Construction and Land Disturbance

Construction activities involving soil disturbance the removal of vegetation, will adhere to the DFO Land Development Guidelines (1992), which provide guidance and best management practices relating to erosion and sediment control and management. Drainage resulting from runoff from mine development in the Nicholas Lake area, including the construction laydown area, the camp area, and the mine site will be directed toward a 4550 m^2 settling pond (described in Section 4.12.2.2) constructed to the northwest and downgradient of the mine site (Figure 2.2-3).

As a result of adherence to accepted avoidance and mitigation, no adverse effects are anticipated to Nicholas Lake as a result of this project.

Waste Rock and Groundwater Seepage

The Nicholas Lake development will involve only underground mining, which will result in approximately 340,000t of waste rock. Most of this rock will be used for operating requirements such as the road base, stope backfill, and general construction. Only non-acid generating rock will be used for these purposes. Waste rock that is not utilized for site construction will be stored in a waste rock storage area located just north of the underground workings area (Figure 2.2-3). As indicated in Section 4.12.9, the waste rock is not anticipated to be acid generating. As a precaution, however, drainage from this site will be collected and discharged to the settling pond identified above.

Groundwater seepage into the underground workings will be pumped to the settling pond identified above. Discharges are currently estimated to range from 8-1300 m^3/day, based on bedrock conductivity (see Section 2.10.8.3). Discharges from the pond will be monitored to ensure conformance with MMER requirements.

Nicholas Area Settling Pond Discharges

The Nicholas Area settling pond will be primarily designed to provide passive treatment for suspended solids in water pumped from the underground mine working. The preliminary design of the settling pond is based on the conservative level of 1300 m^3/day of discharge and a retention time of seven days (see Section 4.12.2.2), which results in a two-metre deep pond that will have an area of 4550 m^2 (similar to linear dimensions of 65 x 70 x 2 metres).

From a review of LiDAR imagery (Figure 6.2-2), water discharged from the settling pond will drain toward a small lake (~185 m long) located approximately 600 m to the northwest of the discharge point, and then through 700 m of wetland to a small lake (~660 m in length), which empties into Eclipse Lake through a 260 m vegetated channel. Flow direction is indicated on Figure 6.2-2.

From a review of aerial imagery, the two very small lakes through which water from the settling pond will flow are likely to be non-fish bearing, due to their small size and shallow nature, and the absence of a suitable migratory channel between them. The area surrounding these lakes is vegetated wetland (see Figure 2.7-1), which is expected to provide passive bioremediation to reduce levels of potential contaminants (Johnson and Hallberg 2005). However, discharges from the settling pond will be routinely monitored and treatment options developed if necessary, to ensure that effluent quality conforms to MMER requirements.

Fish and Fish Habitat Assessment

It is anticipated that the measures described above to collect, and if necessary, treat water resulting from construction and operation of the Nicholas development, will not result in any residual adverse effects on fish or fish habitat. No discharges will be directed toward Nicholas Lake and no development is proposed that could affect its fish or fish habitat. Drainage from the minesite and underground workings will be discharged to a settling pond and then through a long series of wetlands prior to reaching Eclipse Lake. Effluent will be monitored to ensure conformance with regulated levels of potential contaminants. As such, fish and fish habitat are not anticipated to be affected in Eclipse Lake due to this development.

6.3.3.4 Giauque Lake

Direct effects on Giauque Lake due to mineral extraction are not anticipated since mining activities are not proposed within the lake's watershed. Effects may be possible, however, due to:

- runoff from the access road during construction and maintenance in the area where the road is in proximity (<100 m) of Giauque Lake; and,
- water withdrawal to provide fresh water for process and domestic purposes.

The discussion of potential effects and generalized mitigation measures for road construction, operation, and maintenance are contained in Section 6.3.6. However, it should be noted that the access road occurs within 100 m of Giauque Lake only over a short (~350 m) span at the top of the northwestern bay of the lake (Figure 2.11-11). The following is an assessment of potential effects due to water withdrawal.

Fresh water withdrawal from Giauque Lake will be necessary for ore processing and domestic water use purposes. Most water withdrawal will take place during the winter months when only a minimal amount of water may be available from the TCA due to ice depth. Effects on water levels in Giauque Lake were assessed assuming a worst case scenario of instantaneous water withdrawal of one million cubic metres of water, which is approximately 25% more than the forecasted annual water withdrawal. Since water replenishment to the lake in winter would be negligible, calculations for total water level reduction and subsequent recovery relate to the spring break up period.

Water Level Change Calculations

The following values and calculations were used to determine lake level change:

- Giauque Lake surface area: 16,537,000 m^2
- Level change: Water volume removed (m^3) ÷ Surface area of lake (m^2)

$$= 1{,}000{,}000\ m^3 \div 16{,}537{,}000\ m^2$$

$$= 0.06\ m = 60\ mm$$

Based on the above calculations, the Giauque Lake water level would drop by six centimetres if 1,000,000 m^3 of water was removed instantaneously.

Lake Level Recovery Time Calculations

The amount of time it will take Giauque Lake to recover the 1,000,000 m^3 of water removed can be estimated from the time history of lake levels recorded over the periods of August – September, 2009, and June – September, 2010. Figure 6.3-1 is a plot of Giauque lake levels over these two periods.

Four periods were selected for analysis and are summarized in Table 6.3-6. Three of the four periods are rates for falling lake levels. The fourth is for a rising level during mid-summer 2010. These results show that the lake's water level response is 3 to 5 mm/day of lake level change.

For the purpose of this analysis the lake recharge rate used is 4 ± 1 mm/day of level change.

- If recovery is 3 mm/day:

  Recovery = Level to recover (mm) ÷ Rate of recovery (mm) =
  60 mm ÷ 3 mm/day = 20 days

- If recovery is 4 mm/day:

  Recovery = Level to recover (mm) ÷ Rate of recovery (mm) =
  60 (mm) ÷ 4 mm/day = 15 days

- If recovery is 5 mm/day:

  Recovery = Level to recover (mm) ÷ Rate of recovery (mm) =
  0 (mm) ÷ 5 mm/day = 12 days

Based on the above calculations, the lake will therefore recover the six centimetres of level change in 16 ± 4 days. Given that the drainage basin of Giauque Lake is very large, and that there is considerable interannual differences in precipitation, a change of six centimetres in the lake level is arguably well within the range of natural lake level variability.

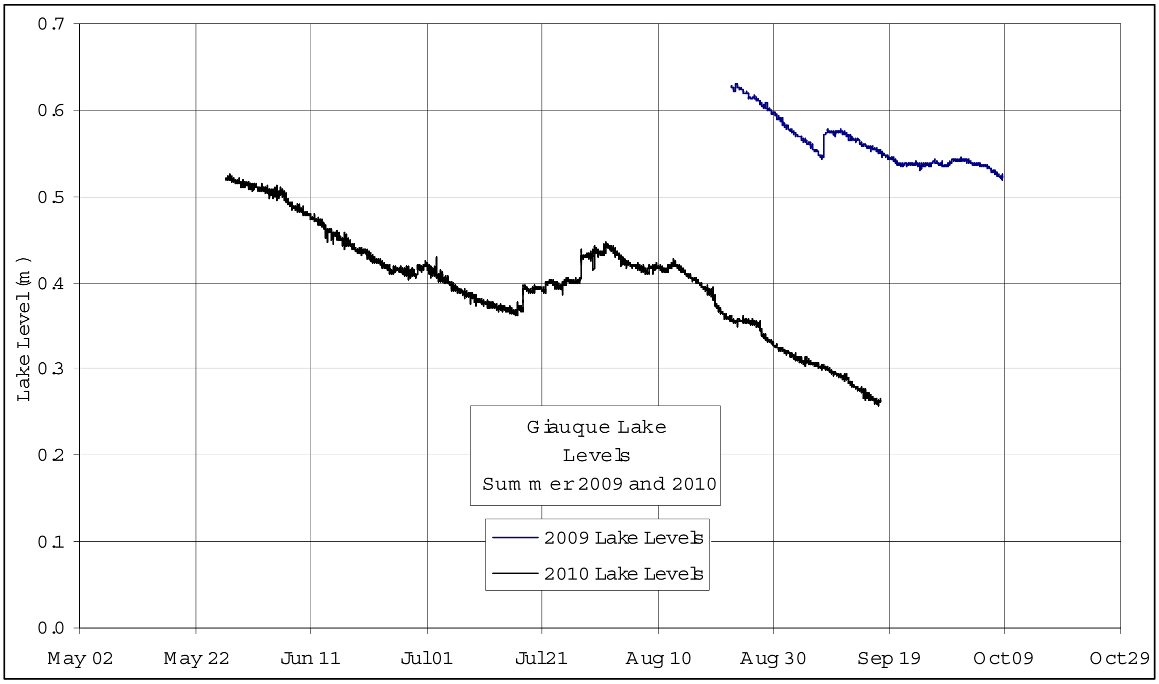


Figure 6.3-1
Recorded Giauque Lake Levels - Summer of 2009 and 2010

TABLE 6.3-6: GIAUQUE LAKE WATER LEVEL CHANGES AND RATES OF CHANGE							
Direction of Level Changes	**Start Date/Time**	**End Date/Time**	**Time Period**	**Starting Lake Level**	**End Lake Level**	**Change in Lake Level**	**Rate of Lake Level Change**
Up / Down			(days)	(m)	(m)	(m)	(m/day)
Down	8/23/2009 23:57:00	8/1/2009 13:12:00	14.6	0.626	0.549	-0.077	-0.005
Down	5/27/2010 23:12:00	7/16/2010 16:27:00	49.7	0.52	0.37	-0.15	-0.003
Up	7/16/2010 16:27:00	8/1/2010 13:12:00	15.9	0.37	0.443	0.073	0.005
Down	8/1/2010 13:12:00	9/17/2010 8:27:55	46.8	0.443	0.263	-0.18	-0.004

The DFO Protocol for Winter Water Withdrawal in the Northwest Territories restricts water withdrawal to not more than 10% of the available water volume, assuming an ice thickness of 2.0 m. Since a water withdrawal of one million cubic metres would result in a drawdown of 60 mm, the lake would have to be no greater than 60 centimetres deep overall for this volume to exceed the 10% protocol restriction. Although bathymetry, and hence volume for Giauque Lake is unavailable, it is well known that this lake greatly exceeds 60 cm in depth, and as such, there is no risk of exceeding the allowable withdrawal limit.

The water intake at Giauque will be screened based on DFO guidelines (DFO 1995). The pumphouse will be constructed on the shore of Giauque Lake at the mouth of the outlet stream originating from Brien Lake (Figure 2.11-11). The construction of this facility will follow siting and design guidelines to avoid erosion and sedimentation of the lake and stream, and to avoid obstruction of upstream and downstream fish passage in the stream. No effects on fish or fish habitat are anticipated from pumphouse construction or water extraction.

Based on the foregoing, withdrawal of water from Giauque Lake, even at volumes exceeding maximum forecast requirements, would not result in any significant effect on habitat availability, quality, or productive capacity.

6.3.3.5 Road and Airstrip Construction, Operation, and Maintenance

Although it is unlikely that road construction and maintenance will directly affect fish habitat productive capacity, appropriate measures will be implemented to avoid or mitigate downstream sedimentation effects. These measures will include:

- siting of crossings, if possible, in confined channels with gravel or cobble bottoms;
- use of non-acid generating, clean construction materials;
- sizing of culverts based on site specific hydrologic and hydraulic characteristics to reduce the likelihood of soil erosion and washouts;
- adherence to INAC guidelines for access roads and trails[18], and to the DFO Operational Statement for Culvert Maintenance[19];
- provision of cross drainage at suitable intervals to reduce erosion potential;
- dust suppression using water;
- setting low road speed limits to reduce dust generation; and,
- monitoring by qualified environmental professionals during construction to detect and manage adverse effects relating to erosion and sediment control.

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[18] INAC access road and trail guidelines: http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/nt/os-eo07-eng.htm.

[19] DFO Operational Statement for Culvert Maintenance: http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/nt/os-eo07-eng.htm.

A construction environmental management plan (CEMP) will be prepared in advance of site preparation and construction activities, and approved by a qualified environmental professional. This plan will prescribe best practices and mitigation measures to be employed during road construction and maintenance.

Road construction inherently has the potential to invite use for activities not related to the proposed mining development. Increased access for off road vehicles, such as ATVs, has the potential to cause rutting of the land, resulting in uncontrolled erosion, and the consequent sedimentation and degradation of streams and lakes and their fish habitats. Consideration will therefore be given to limiting recreational access.

The existing airstrip at the historic Discovery Mine has been used during the advanced exploration activities at the YGP and is the preferred option for continued use during the pre-production and operational phases of the YGP. This airstrip is located just north of Round Lake and is within 400 m of the western shore of Giauque Lake (Figure 4.1-1). Discussions with INAC's Contaminants and Remediation Directorate have determined that the continued use of the existing airstrip can be conducted in a manner that does not compromise the underlying tailings cap, once planned upgrades are implemented (Section 4.14.1.6).

Drainage from the airstrip and the proposed mine camp will be directed to Round Lake via a swale on the west side of the tailings cap. Sediment in waters flowing to Round Lake will undergo settling before being discharged to fish bearing waters in Narrow Lake.

Assuming adherence to accepted guidelines and best practices, and implementation of a construction monitoring program, road and airstrip construction will not result in adverse effects to fish or fish habitat.

6.4 SURFICIAL GEOLOGY AND SOILS

6.4.1 Changes to Soil and Permafrost

Development of the YGP will result in the disturbance and exposure of soils primarily during the construction phase. Additionally, infrastructure constructed on permafrost could result in changes to the local permafrost regime of the footprint area.

The various components comprising the primary YGP footprint are listed in Table 6.4-1 along with their estimated areas. The main footprint area is approximately 338 ha, of which the tailings containment and waste rock storage areas are the largest components.

To characterize areas adjacent to YGP facilities that may be affected by Project-related activities such as dust deposition, a 100 m buffer was added to the outer perimeter of all Project facilities, expanding the overall footprint by 486 ha. With the inclusion of the perimeter buffer, the total YGP footprint area is 824 ha, 41% of which is associated with infrastructure and 59% of which is associated with the perimeter buffer. Project-related effects are anticipated to be less severe within the perimeter buffer compared to areas that will support infrastructure.

TABLE 6.4-1: EXTENT OF FOOTPRINT COMPONENTS FOR THE YGP					
Footprint Component	**Nicholas Lake (ha)**	**Ormsby (ha)**	**Haul Road (ha)**	**Primary Footprint Area (ha)**	**Proportion of Total Footprint Area (%)**
Tailings Containment Area		116.8		116.8	34.6
Waste Rock Storage Area	0.6	98.0		98.6	29.2
Roads	0.1	12.4	22.4	34.9	10.3
Ormsby Pit		25.4		25.4	7.5
Dewatered Area		17.8		17.8	5.3
Dams		11.2		11.2	3.3
Buildings	2.2	8.7		10.8	3.2
Temporary Laydown Area	1.0	9.1		10.1	3.0
Landfill		4.1		4.1	1.2
Airstrip		4.0		4.0	1.2
Plant		1.9		1.9	0.6
Temporary Ore Stock Pile	0.6			0.6	0.2
Tailings Water Pipeline		0.4		0.4	0.1
Underground Development	0.4			0.4	0.1
Reclaim Water Pipeline		0.3		0.3	0.1
Sedimentation Pond	0.04			0.04	0.01
Total	**4.9**	**310.2**	**22.4**	**337.6**	**100.0**

6.4.1.1 Soils

Soil exposure and disturbance will likely be greatest during the construction phase. Efforts will be made to implement appropriate measures to minimize soil erosion, particularly in areas adjacent to watercourses. Additionally, soil compaction could occur throughout the proposed footprint area as a result of infrastructure placement (if not on bedrock) and repeated vehicle traffic, which could reduce site productivity. Areas of soil compaction will be assessed and treated during the reclamation phase of the Project.

Project activities will likely produce fugitive dust during the construction and operations phases, the extent of which is anticipated to occur within 100 m of dust sources. The effects of dust on soils themselves are anticipated to be negligible. Changes in soil pH, chemistry, and nutrient regime that may result from fugitive dust deposition are described in Section 6.5-2 in terms of potential effects to ecosystems and vegetation.

6.4.1.2 Permafrost

Surface disturbances primarily associated with infrastructure development would be the most likely sources initiating changes in permafrost in the YGP area. Wherever possible, all foundations of the structures currently proposed have been sited on competent bedrock that is either exposed or covered by a thin veneer of surficial material that will be removed prior to construction. In the event that infrastructure may need to be situated in areas that support permafrost, the structures will be engineered accordingly (e.g., materials will be stripped to bedrock or infrastructure design may incorporate the use of features such as Arctic foundations to ensure any heat generated does not transfer into the subsurface, compromising the permafrost).

With respect to mine roads and the haul road between the Ormsby and Nicholas Lake deposits, these will be situated on elevated terrain wherever possible to avoid permafrost areas and thus any potential instability issues. Ditches and culverts will be used as required, and care will be taken to avoid settlement associated with thawing of permafrost under culvert locations and ponding alongside the road embankments. Sections of road that cannot avoid deeper organic deposits or finer-textured soils (both of which were identified as areas more likely to support permafrost) will be assessed further during detailed engineering design. Organic materials will likely be left in place during road construction, as thaw settlement tends to be less severe under these conditions compared to areas that have been stripped.

6.4.2 Project Design and Mitigation Measures

Mitigation strategies to reduce potential effects to soils and permafrost generally involve limiting the overall size of the development footprint, siting infrastructure on bedrock wherever possible, minimizing water pooling and ponding on surfaces, and avoiding areas that could potentially support permafrost. In the event that permafrost cannot be avoided, structures will be appropriately engineered for the conditions. With respect to fugitive dust production, adhering to posted speed limits on roadways and using water as a dust suppressant will be implemented as part of day-to-day operations.

6.4.3 Residual Effects

Potential effects of the YGP on soils and permafrost can be addressed with appropriate mitigation and engineering strategies. As such, no residual effects are anticipated.

6.5 ECOSYSTEMS AND VEGETATION

The primary effects of the proposed YGP on ecosystems and plant species will be the removal and/or burial of these features as a result of footprint development. Other anticipated effects include the deposition of dust onto plants and substrates, an increase in air emissions that could affect more sensitive plant species or groups, and the potential introduction and spread of invasive or non-native plant species into previously undisturbed areas. These effects can directly or indirectly influence the health and function of the plant species and ecosystems present.

Valued Components (VC) considered in the assessment of potential Project effects include ecosystems and plant species in general, as well as ecosystems that are more sensitive to disturbance and those with a higher potential of providing habitat for rare plant species (Table 6.5-1). Sensitive ecosystems include those with a high lichen or *Sphagnum* component, and acidic and/or nutrient poor ecosystem types. Ecosystems with a high to very high potential of providing rare plant habitat were also considered in the effects assessment.

TABLE 6.5-1: VALUED COMPONENTS CONSIDERED IN THE ASSESSMENT OF POTENTIAL PROJECT EFFECTS

Valued Component	VC Description	Mapped Ecosystem Types
Sensitive ecosystems	High lichen cover	BF, JL, SL, TB
	High *Sphagnum* cover	CE, EA, TB, TF
	Acidic/nutrient poor ecosystems	CE, EA, JL, TB, TF
Rare plant habitat potential	Field identification	Site specific
	High potential	AM, CA, FA, SH, TF
	Very High potential	CE, EA, EM, WR

6.5.1 Removal/Burial of Ecosystems and Plant Species by the Project Footprint

Certain features of the YGP footprint (as listed in Table 6.4-1) will result in the permanent removal of vegetation and will not be re-vegetated as part of planned reclamation activities. These include the Ormsby pit, which will be flooded upon closure, the waste rock facilities at both Ormsby and Nicholas Lake, which will be stabilized but will not be deliberately prepared to support the establishment of vegetation, the airstrip, and the haul road between the Ormsby and Nicholas Lake sites.

Approximately 486 ha lies within the perimeter buffer (Figure 6.5-1; Table 6.5-2), which was identified as a means of characterizing areas adjacent to YGP facilities that may be affected by Project-related activities such as dust deposition. Potential effects are anticipated to be less severe within the perimeter buffer compared to areas that will support infrastructure.

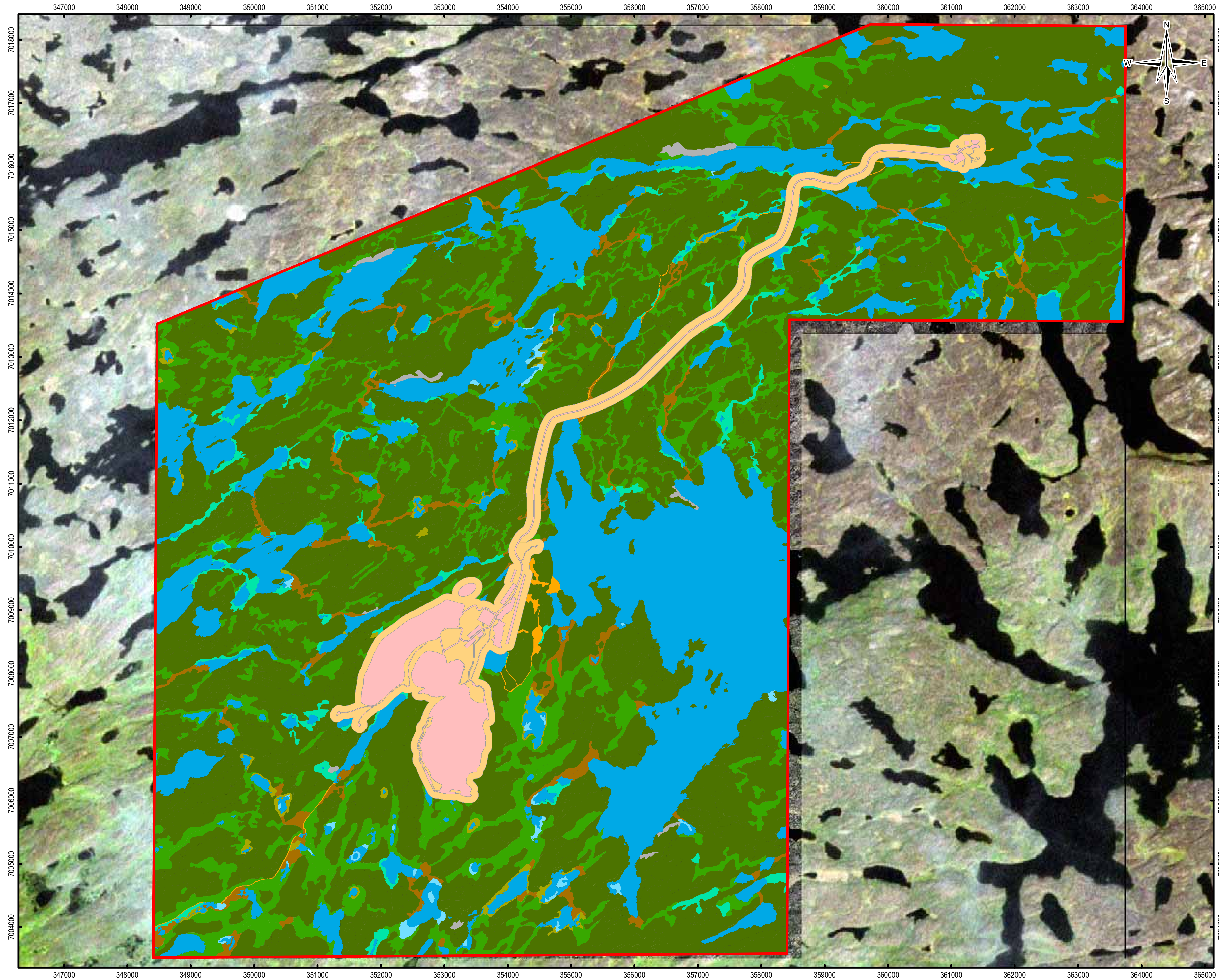
The YGP footprint covers approximately 6% of the study area overall, the majority (60%) of which is represented by upland forest/woodland ecosystems (Table 6.5-2). These ecosystems are also characteristic of the larger YGP study area. Approximately 43 ha (5%) of the YGP footprint is situated on previously disturbed land. None of the ecosystem types identified fall solely within the YGP footprint area; all are represented in the broader study area.

TABLE 6.5-2: DISTRIBUTION OF ECOSYSTEM TYPES WITHIN PROPOSED YGP FOOTPRINT AND STUDY AREA								
		YGP Footprint						
General Ecosystem Type	**Ecosystem Type[1]**	**Nicholas (ha)**	**Ormsby (ha)**	**Haul Road (ha)**	**Perimeter Buffer (ha)**	**Total YGP Footprint (ha)**	**Total YGP Area (ha)**	**Footprint Proportion of YGP Area (%)**
Anthropogenic	TD		12.8		13.7	26.6	36.8	72.3
	RP	0.2	3.2	0.1	3.6	7.0	18.4	38.1
	RR	0.7	3.3	0.2	4.5	8.9	8.9	100.0
	GP		0.9			0.9	5.9	15.5
Bedrock and Boulder Fields	BF[L]						26.5	0.0
	RO						8.9	0.0
Graminoid Wetland	EM[V]		0.2		2.9	3.1	88.5	3.5
	EA[SAV]		0.2	0.2	1.4	1.7	31.7	5.5
	CE[SAV]						16.5	0.0
	CA[H]		3.6		0.1	3.7	3.9	93.2
Open Water Wetland	FA[H]						40.8	0.0
Riparian	WR[V]	1.4	0.1	1.1	17.8	20.5	257.0	8.0
Shrub Wetland	SH[H]			0.7	8.6	9.3	234.3	4.0
	BR				0.1	0.1	89.2	0.1
Treed Wetland	TB[LSA]	0.3	18.4	2.3	56.1	77.2	1,515.4	5.1
	TF[SH]		34.5	0.3	7.6	42.4	461.8	9.2
Upland Forest/Woodland	SL[L*]	1.9	75.9	12.4	213.1	303.3	5,250.6	5.8
	JL[LA]	0.3	68.4	4.9	116.8	190.4	2,810.9	6.8
	AM[H]		18.9	0.2	27.5	46.7	479.2	9.7
Water	LA	0.0	69.1		8.3	77.4	2,764.2	2.8
	PD		0.7		4.2	4.9	294.5	1.7
	OW				0.1	0.1	30.8	0.4
Total		**4.9**	**310.2**	**22.4**	**486.5**	**824.1**	**14,474.6**	**5.7**

[1]Ecosystem type codes follow those provided in Table 2.7-1.

[H,V]Rare plant habitat potential: H = high potential; V = very high potential

[L,S,A]Sensitive ecosystem: L = high lichen cover; S = high *Sphagnum* cover; A = acidic/nutrient poor; * mature and old forest only



LEGEND

Local Study Area

Proposed Footprint

- Main Development Area
- Perimeter Buffer (100 m)

General Ecosystem Types

- Anthropogenic
- Bedrock and Boulder Fields
- Graminoid Wetland
- Open Water Wetland
- Riparian
- Shrub Wetland
- Sparsely Vegetated
- Treed Wetland
- Upland Forest/Woodland
- Water

NOTES

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

DISCLAIMER

ISSUED FOR USE

YELLOWKNIFE GOLD PROJECT

Proposed Footprint Layout in the YGP Study Area

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:60,000

1 0.5 0 1 2

Kilometres

Tyhee NWT Corp

EBA Engineering Consultants Ltd.

FILE NO.			
V23201097-DAR-066.mxd			
PROJECT NO.	**DWN**	**CKD**	**REV**
V23201097	SL	TP	0
OFFICE	**DATE**		
EBA-VANC	April 14, 2011		

Figure 6.5-1

Q:\Vancouver\GIS\ENVIRONMENTAL\V232\V23201097_Tyhee_DAR\Maps\DAR\V23201097-DAR-066.mxd

Approximately 127 ha (15%) of the YGP footprint is characterized by ecosystems rated as having a high to very high potential to support rare plant habitat (Table 6.5-2). These ecosystem types are largely represented by upland forest/woodland, treed wetlands, and riparian areas, which all generally occur outside the YGP footprint area as well. One exception is the water sedge – narrow leaved cottongrass fen (CA) ecosystem type, which is located primarily (i.e., 93%) within the YGP footprint area.

There remains a possibility that the ranked "Sensitive" plant *Potamogeton foliosus* occurs in Winter Lake, which will be altered during the course of the Project. There is currently no legal legislation for protection of plants ranked as "Sensitive" under the existing *NWT Wildlife Act* or the newly proposed *Territorial Species at Risk Act*. Assuming the plant identified during field investigations is *P. foliosus*, several mitigation measures have been proposed and are presented in Section 6.5.5.

Sensitive ecosystems comprise approximately 325 ha (39%) of the total YGP footprint area and are represented primarily by ecosystem types with a high lichen component (Table 6.5-2). The upland jack pine – lichen woodland (JL) ecosystem type is the most extensive, covering up to 23% of the YGP footprint alone. The spruce – cloudberry treed bog (TB) ecosystem type is also fairly common within the YGP footprint area, covering 77 ha (9.4%). Both of these ecosystem types occupy areas that are primarily within the perimeter buffer.

6.5.2 Effects of Dust Deposition

Project activities are likely to result in the production of fugitive dust which could adversely affect ecosystems and plant species in the vicinity of dust sources through ecosystem degradation, shifts in plant species composition, or reduced primary productivity. General construction activities and vehicle traffic on roads, particularly during the summer months, are expected to be the primary dust sources.

Dust deposition patterns can be influenced by factors such as particle size, wind velocity and direction, relative humidity, substrate, vegetation cover and structure (e.g., tall vs. short vegetation), vehicle size, and traffic volume. Studies characterizing the consequences of road dust on adjacent vegetation have detected effects at various distances from a source, including 100 m away (Auerbach et al. 1997), 200 m away (Santelmann and Gorham 1988; Angold 1997), and up to 400 m away (Lamprecht and Graber 1996).

These observations are consistent with dust deposition studies conducted by the United States Environmental Protection Agency (US EPA 1995). Larger particle sizes (e.g., with aerodynamic diameters >100 μm) were found to settle within 10 m of a source, while particles with aerodynamic diameters between 30 to 100 μm settled out within 100 m. Smaller particulates (e.g., <15 μm) tend to be less influenced by gravitational settling and more susceptible to atmospheric turbulence, resulting in their transportation over greater distances (US EPA 1995).

Dust can physically and physiologically affect plants by blocking stomata, smothering leaf surfaces, or increasing leaf surface temperature. These effects can lead to a reduction in photosynthetic efficiency (Thompson et al. 1984; Pyatt and Haywood 1989; Farmer 1993) but can positively affect respiration (Eller 1977).

Dust deposition can also affect the surrounding environment by influencing growing conditions such as soil pH, soil nutrient regime, snowmelt patterns through changes in surface albedo, and depth of permafrost thaw (Walker and Everett 1991; Auerbach et al. 1997; Gunn 1998). These subtle changes could elicit subsequent shifts in plant species health and community composition.

Certain plant groups, such as lichens and some moss species (e.g., *Sphagnum*), are more sensitive to disturbance and are often used as indicators of environmental health due to their sensitivity to pollutants (Spatt and Miller 1981; Tyler 1989; Markert 1993). Lichens in particular often accumulate substances such as sulphur, nitrogen, and metals from atmospheric sources better than vascular plants (Blett et al. 2003). Dust deposition could result in a decline in lichen cover overall or could lead to changes in lichen community composition (Santelmann and Gorham 1988). Depending on dust chemistry and loading, both lichen and *Sphagnum* moss cover could be expected to decrease in acidic/nutrient poor ecosystem types (Auerbach et al. 1997).

Any dust-related effects resulting from the YGP are anticipated to occur within 10 m of the main development footprint. To characterize the maximum extent of anticipated effects as they relate to dust, a spatial boundary has been defined by the perimeter buffer which extends 100 m away from the outer edge of the main YGP development area (Figure 6.5-1). Within the perimeter buffer, approximately 194 ha (40% of the perimeter buffer area) support ecosystem types with a high cover of lichen and/or *Sphagnum* moss which are known for their sensitivity to changes in their environment (Table 6.5-2).

6.5.3 Effects of Air Emissions

Air emissions from the YGP that may affect ecosystems and vegetation include nitrogen-containing compounds (including nitrogen oxides) and potential acid input (PAI), including sulphur dioxide (SO_2).

Plants vary in their sensitivity to atmospheric pollutants with lichen and moss species being particularly responsive (Hawksworth and Rose 1976; Hutchinson et al. 1987). Ecosystem types within the YGP that were identified as being sensitive to dust deposition (e.g., those with a high lichen or *Sphagnum* moss component) are also sensitive to air emissions.

Nitrogen-containing compounds deposited in nutrient poor ecosystem types (which are often nitrogen-limited) could result in nutrient enrichment and subsequent changes in plant community composition, favouring species that can adapt to a richer nutrient regime.

Exposure to air emissions containing nitrogen oxides can also physically damage plants (Bell and Treshow 2002). At low levels of exposure, plants may express subtle changes in growth rates, frost resistance, or increased resistance to disease or pests, while at higher exposure levels, plants may show physical damage to leaves and other tissues (Brimblecombe 2002).

PAI can affect plant health, disease resistance, and reproduction (Abrahamson 1987; Johnson 1987). More indirectly, PAI can alter soil and water nutrient levels and can influence the availability and solubility of certain metals (Johnson 1987; Bache 1980).

The potential effects of air emissions on ecosystems and plant species in the YGP area will likely be restricted to the 100 m perimeter buffer defined for the Project (Figure 6.5-1). Effects would likely manifest in sensitive ecosystem types with a high cover of lichen and *Sphagnum* moss (Table 6.5-2).

6.5.4 Potential Introduction and Spread of Invasive Plants

The successful introduction and colonization of an area by invasive plant species relies, in part, on the presence of suitable habitat, access to a source of invasive plant material, and a means of dispersal. Invasive plants have the ability to aggressively establish and spread quickly in new environments, often out-competing native species which can affect plant species richness, diversity, and the composition and function of the ecosystems present (Haber 1997).

Up until recently, the thinking around invasive plant establishment in areas such as the NWT was that the climatic conditions would be too severe for invasive plants to become problematic. The incidence of invasive plants in the north is still relatively low, particularly when compared to more temperate regions, however, recent studies suggest that invasive plants are becoming more prevalent (Shrader and Hennon 2005; Carlson ad Shephard 2007). Whether this prevalence is due to the conduct of more deliberate surveys for invasive species or the increased level of development in remote areas, or both, remains uncertain.

Development projects, particularly during the construction phase, can inadvertently provide the growing conditions favoured by invasive plants. Areas where vegetation cover has been removed and exposed soil remains, particularly along road edges, are particularly susceptible to colonization by invasive plants. Vehicles and machinery, particularly if transported to site dirty from other locales, can act as dispersal mechanisms for invasive plant propagules that were trapped in tires and other areas of the vehicle.

The overall effects of invasive plant species on the environment can be controlled through planned and effective management strategies implemented early and carried out for the duration of the Project. The most effective and efficient management strategies for invasive plants focus on preventing their establishment instead of managing their removal once established (Clark 2003; Polster 2005; USDA 2006; Carlson and Shephard 2007).

While invasive plant species are largely restricted to populated and high-use areas in the NWT, development and operation of the proposed YGP could result in an increase in invasive plant species presence, primarily in disturbed, un-vegetated areas.

6.5.5 Project Design and Mitigation Measures

Mitigation strategies to reduce potential effects to plant species and ecosystems are outlined in Table 6.5-3 and generally involve limiting the overall size of the footprint, incorporating previously disturbed areas into development plans, and avoiding sensitive ecosystems and rare plants, where possible. Reclamation trails will be developed throughout the life of the Project to identify the most effective treatment options for various conditions. Treatments will be applied progressively wherever possible as well as after Project closure.

The mitigation strategies presented for *P. foliosus* are based on the assumption that the plant identified during field studies is in fact *P. foliosus*. It has been recommended that Winter Lake be reassessed for the presence of *Potamogeton* so identification can be confirmed. Sampling should occur during the late summer after achenes have matured (mature achenes are a primary diagnostic feature). Specimens will be collected and submitted to the National Collection of Vascular Plants at Agriculture and Agri-Food Canada in Ottawa for identification. This herbarium currently contains the largest collection of NWT plant specimens and has extensive experience identifying uncommon and taxonomically difficult NWT plant species.

Once confirmed as *P. foliosus*, other lakes in the area that will not be affected by Project activities should be assessed for the presence of *P. foliosus*. If *P. foliosus* is found to occur in other, unaffected lakes, mitigation of the population in Winter Lake may not be required.

If other lakes are not surveyed, or if lake surveys do not confirm the presence of other populations of *P. foliosus*, the population of *P. foliosus* may be salvaged from Winter Lake for transplanting into another suitable lake. Seedlings of *P. foliosus* demonstrated encouraging growth following transplanting in controlled experiments (McFarland and Rogers 1998), so it is conceivable that *P. foliosus* can be transplanted successfully in a more natural environment as well.

A final mitigation option involves the collection of specimens of *P. foliosus* from Winter Lake for donation to various herbaria (e.g., University of Alberta, University of British Columbia, the National Collection of Vascular Plants at Agriculture and Agri-Food Canada in Ottawa, and the Canadian Museum of Nature) in an effort to facilitate future specimen identification. There is currently no institution based in the NWT with the capacity to store botanical specimens applicable to the NWT (Carrière et al. 2009).

TABLE 6.5-3: SUMMARY OF MITIGATION MEASURES FOR THE YGP

Potential Effect	Potential Consequence	Mitigation Measures
Removal and/or burial of ecosystems and plant species (including ecosystems that are particularly sensitive to disturbance and potentially provide rare plant habitat)	Long-term to permanent removal/disturbance of vegetation	Minimize footprint size; Incorporate previously disturbed areas into development plans; Avoid sensitive or unique vegetation types; Restrict off-site activities (e.g., ATV use) to footprint area; Conduct reclamation trials throughout the life of the Project to identify effective treatment options; Reclaim to viable and self-sustaining ecosystem types.
Removal/disturbance of rare plant species	Disturbance/loss of *P. foliosus* from Winter Lake due to proposed use of Winter Lake as a TCA	Confirm identification of *Potamogeton* in Winter Lake as *P. foliosus*; If confirmed, assess surrounding lakes for presence of *P. foliosus*; Presence of *P. foliosus* in other lakes may negate requirement for mitigation of populations in Winter Lake; Transplant *P. foliosus* from Winter Lake into other suitable lake; Collect specimens of *P. foliosus* from Winter Lake for donation to herbaria.
Increased dust deposition and air emissions	Potential reduction in plant health and productivity; alteration of plant species composition in affected ecosystems	Use of water as a dust suppressant as required; General adherence to the GNWT *Guideline for Dust Suppression* (GNWT 1998); Speed limit enforcement to help reduce dust production; Regular review and maintenance of generators and other emissions sources to ensure are operating efficiently, thus limiting avoidable emissions.
Potential Introduction and Spread of Invasive Plants	Alteration of plant species composition in affected ecosystems; displacement of native plant species	Minimize footprint size; Ensure machinery and equipment is clean prior to use on site; Periodic monitoring of disturbance areas, particularly roadsides, for invasive species presence.

6.5.6 Residual Effects

Within the YGP area, the removal or burial of ecosystem types and plant species will occur during construction and the effects will remain until the closure and decommissioning phase (Table 6.5-4). The effects are considered high magnitude and of moderate consequence overall. Activities that will result in the irreversible loss of ecosystems have also been assigned a moderate consequence due to the localized nature of the disturbance and the presence of these ecosystem types elsewhere in the YGP.

The potential degradation of ecosystem types and plant species resulting from dust deposition, air emissions, and the potential introduction of invasive plant species has been assessed as a low magnitude, local effect that will persist over the medium-term (Table 6.5-4). Effects will occur periodically throughout the life of the Project and are reversible in the long-term. As such these effects have been rated as being of low consequence.

TABLE 6.5-4: RESIDUAL EFFECTS SUMMARY FOR ECOSYSTEMS AND PLANT SPECIES

<table>
<tr><th rowspan="2">Description of Residual Effect (after Mitigation)</th><th colspan="6">Evaluation of Residual Effect</th><th rowspan="2">Consequence</th></tr>
<tr><th>Magnitude</th><th>Geographic Extent</th><th>Duration</th><th>Frequency</th><th>Reversibility</th><th>Likelihood</th></tr>
<tr><td>Removal/Burial of Ecosystems and Plant Species (Pit, Haul Road, Waste Rock Storage Areas)</td><td>High</td><td>Local</td><td>Long-term</td><td>Continuous</td><td>Irreversible</td><td>High</td><td><table><tr><td rowspan="4">Magnitude</td><td>H</td><td></td><td></td><td></td><td>X</td></tr><tr><td>M</td><td></td><td></td><td></td><td></td></tr><tr><td>L</td><td></td><td></td><td></td><td></td></tr><tr><td></td><td>S</td><td>M</td><td>L</td><td>I</td></tr><tr><td></td><td></td><td colspan="4">Duration</td></tr></table></td></tr>
<tr><td>Removal/disturbance of P. foliosus in Winter Lake</td><td>High</td><td>Local</td><td>Medium-term</td><td>Isolated</td><td>Irreversible</td><td>High</td><td><table><tr><td rowspan="4">Magnitude</td><td>H</td><td></td><td></td><td></td><td>X</td></tr><tr><td>M</td><td></td><td></td><td></td><td></td></tr><tr><td>L</td><td></td><td></td><td></td><td></td></tr><tr><td></td><td>S</td><td>M</td><td>L</td><td>I</td></tr><tr><td></td><td></td><td colspan="4">Duration</td></tr></table></td></tr>
<tr><td>Removal/Burial of Ecosystems and Plant Species (Other Infrastructure)</td><td>High</td><td>Local</td><td>Medium-term</td><td>Isolated</td><td>Reversible Long-term</td><td>High</td><td><table><tr><td rowspan="4">Magnitude</td><td>H</td><td></td><td>X</td><td></td><td></td></tr><tr><td>M</td><td></td><td></td><td></td><td></td></tr><tr><td>L</td><td></td><td></td><td></td><td></td></tr><tr><td></td><td>S</td><td>M</td><td>L</td><td>I</td></tr><tr><td></td><td></td><td colspan="4">Duration</td></tr></table></td></tr>
<tr><td>Dust Deposition</td><td>Low</td><td>Local</td><td>Medium-term</td><td>Periodic</td><td>Reversible Long-term</td><td>High</td><td><table><tr><td rowspan="4">Magnitude</td><td>H</td><td></td><td></td><td></td><td></td></tr><tr><td>M</td><td></td><td></td><td></td><td></td></tr><tr><td>L</td><td></td><td>X</td><td></td><td></td></tr><tr><td></td><td>S</td><td>M</td><td>L</td><td>I</td></tr><tr><td></td><td></td><td colspan="4">Duration</td></tr></table></td></tr>
</table>

TABLE 6.5-4: RESIDUAL EFFECTS SUMMARY FOR ECOSYSTEMS AND PLANT SPECIES

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect											
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood						
									Consequence			
Air Emissions and the Introduction of Invasive Plant Species	Low	Local	Medium-term	Periodic	Reversible Long-term	Moderate	Magnitude	H				
								M				
								L		X		
									S	M	L	I
									Duration			

6.6 WILDLIFE AND WILDLIFE HABITAT

Evaluation of the potential effects on wildlife and wildlife habitat from the proposed YGP first requires the identification of Valued Ecosystem Components (VECs). VECs can be defined as "the environmental attributes or components identified as having legal, scientific, cultural, economic, or aesthetic value" (Sadar 1994). These will be the primary focus for evaluating potential effects from the YGP activities on the more important components of the biophysical environment in the development area and, as appropriate, the region.

The selection of VECs for this DAR is based on a combination of the directions provided in the MVEIRB Terms of Reference (2009) and YGP's understanding of the biophysical components, species, or species groups, that were identified as being important, either by residents, resource management agencies or by YGP as a result of the various consultation activities carried out by YGP over the past several years.

Potential VECs were screened using the following considerations:

- Species listed by SARA and/or assessed by COSEWIC as endangered, threatened, and special concern;
- Species considered culturally important (i.e. important harvest species such as moose);
- Species considered sensitive to exogenous disturbance; and
- Species which are dependent upon the dominant vegetation community types in the local study area (LSA).

Not all species/habitats selected as potential VECs encompassed all of the above criteria; some were selected on the basis of one category only. In addition, a species, or species groups, considered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as being endangered, threatened or special concern were automatically considered as potential VECs. The wildlife species or species groups selected as VECs included the Bathurst caribou herd, wolverines, moose, black bears, wolves, and a number of listed bird species (Table 6.6-1).

TABLE 6.6-1: VECS EVALUATED AND SELECTED FOR YGP WILDLIFE EFFECTS ASSESSMENT

Group/Species	Conservation Status	Culturally Significant	Sensitive to Disturbance	Representative of Local Area	Selected for Assessment
Mammals					
Bathurst Caribou	Sensitive (ENR 2010)	Yes	Yes	Yes	Yes
Grizzly Bear	Special Concern (COSEWIC)	No	Yes	No	No, not anticipated to occur in YGP area
Wolverine	Special Concern (COSEWIC)	No	Yes	Yes	Yes

TABLE 6.6-1: VECS EVALUATED AND SELECTED FOR YGP WILDLIFE EFFECTS ASSESSMENT					
Group/Species	**Conservation Status**	**Culturally Significant**	**Sensitive to Disturbance**	**Representative of Local Area**	**Selected for Assessment**
Moose	None	Yes	No	Yes	Yes
Black Bear	None	Yes	No	Yes	Yes
Wolf	None	Yes	No	Yes	Yes
Birds					
Common Nighthawk	Threatened (SARA)	No	Yes	Yes	Yes, an assessment of 'upland nesting birds' in general will encompass any potential effects to these three species.
Olive-sided Flycatcher	Threatened (SARA)	No	Yes	Yes	
Rusty Blackbird	Special Concern (SARA)	No	Yes	Yes	
Peregrine Falcon	Special Concern (COSEWIC)	No	Yes	No	No
Short-eared Owl	Special Concern (SARA Schedule 3)	No	Yes	Yes	Yes
Horned Grebe	Special Concern (COSEWIC)	No	Yes	Yes	Yes

Using the VECs as the primary focus for the analysis, the assessment of potential effects for each environmental component begins with a review of the main project activities that could potentially cause environmental effects during each of the three primary phases of activity (construction, operation, and closure/reclamation, Table 6.1-2) associated with the implementation of the YGP.

Several activities associated with the YGP are predicted to result in either direct or indirect loss of habitat for wildlife. Direct habitat loss occurs through the physical removal or alteration of vegetation communities. Indirect habitat loss, for example, can occur through the effects of dust accumulating on vegetation.

The potential impacts and proposed mitigation measures for all wildlife species and wildlife habitat are summarized in Table 6.6-2.

TABLE 6.6-2: POTENTIAL WILDLIFE IMPACTS AND MITIGATION SUMMARY		
Project Component	**Potential Impact**	**Mitigation**
Site Preparation and Construction	Disturbance and removal of wildlife habitat by construction activity.	The habitat to be disturbed is not unique to the area and not critical to the life cycle of any wildlife species identified in the YGP study area.
Plant Site	Disturbance and removal of wildlife habitat by activity.	The habitat to be disturbed is not unique to the area and not critical to the life cycle of any wildlife species identified in the YGP study area.
Tailings	TCA may pose a hazard to both local and migrating wildlife.	Tailings will be disposed of sub-aqueously, minimizing interactions with wildlife
Solid Waste (includes kitchen wastes) and Hazardous Waste	Solid waste will attract wildlife, which becomes a safety hazard and health risk in the area of the development.	Kitchen waste will be incinerated on a daily basis. Other solid, non-hazardous waste will be disposed of into an approved landfill. Hazardous wastes will be stored and disposed of in an appropriate and approved manner, either on site or off site.
Winter Road	Regular winter access to the area could increase hunting pressure and reduce wildlife populations.	Winter road use will be monitored while open for operation.
Other Infrastructure	Disturbance and removal of wildlife habitat by activity.	The habitat to be disturbed is not unique to the area. Special care will be exercised in areas of sensitive habitat such as moraines.

The evaluation of residual effects for each VEC is addressed in terms of the type or nature of effects that may occur following the application of appropriate environmental management and mitigation measures.

6.6.1 Mammals

6.6.1.1 Barren-ground Caribou – Bathurst Herd

Barren-ground caribou from the Bathurst herd 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). Bathurst caribou are accessible to more people than any other herd (Case et al. 1996) and are ranked by ENR as "Sensitive[20]" under the general status program (ENR 2010b), but have not been assessed by COSEWIC (COSEWIC 2010).

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

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 can be effectively addressed for the in the vicinity of the YGP.

The Bathurst herd's annual range is approximately 350,000 km^2. The distribution of the Bathurst herd across their winter range varies each year.

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 general 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.

The YGP lies within the Bathurst herd's winter range; however, it is outside known important migration corridors. Therefore, the YGP is not anticipated to block migratory routes or confuse migrating caribou.

During the construction phase, the main ways that the YGP, associated infrastructure, and activities may affect caribou is through the minimal loss or degradation of habitat, and physical or behavioural disturbance, including displacement. Potential effects on caribou during the operations phase could also result from physical or behavioural disturbance, including displacement by localized development-related noise or activities. Caribou will also be exposed to low levels of vehicle traffic during the 8 – 12 weeks a year when the winter road is open along with other related activities such as hunting.

Caribou encountering such activities may show minor displacement behaviour and avoid the immediate YGP development area and/or roads. The duration of such exposures are expected to be brief, perhaps lasting a few minutes to a few hours, and are reversible upon cessation of the activity or by moving away from the activity. The number and frequency of such exposures to disturbance by caribou would be expected to be limited and sporadic.

To minimize any potential for direct YGP development-related caribou mortality, Tyhee NWT Corp will implement a no hunting policy for all project employees and contractors while working on-site. In addition, the company will require all project-related transportation activities to give the right-of-way to any wildlife, including caribou that such activities may encounter. Tyhee NWT Corp will also encourage participation in reporting all vehicle-wildlife collisions.

Due to the Bathurst Caribou herd's large winter range and infrequent occurrence in the YGP area, quality forage and travel habitats lost due to the construction of the mine is predicted to be negligible in magnitude. This reversible loss of such a small amount of habitat that may be utilized by caribou from time to time is considered to be insignificant at both the local and regional scale. The YGP is not anticipated to block migratory routes or confuse migrating caribou.

In addition, the harassment of wildlife, as defined under the NWT Wildlife Act, will be prohibited. An employee training program will be conducted to describe and illustrate the importance of following all wildlife mitigation measures (a training program may be incorporated into the site orientation for employees and contractors).

With the implementation of the mitigation measures as described and the GNWT's population monitoring and subsequent harvest closures or reductions, the YGP development-related activities are not expected to affect the overall health or well-being of the Bathurst caribou herd, specifically the adult population, adult survivorship, or potential herd recovery .

Residual Effects

Disturbance and habitat-related effects on all wildlife species including Bathurst caribou will be of a negligible and insignificant nature with no residual effects expected to occur.

A wildlife monitoring program will be implemented during construction, operation, and closure/reclamation phases to assess possible disruptions to local caribou that could potentially move through the area during the winter.

6.6.1.2 Moose

Moose are listed as secure in the Northwest Territories (ENR 2010a). Moose occur throughout the boreal forest of the NWT. Their distribution in NWT is believed to be increasing.

In the Taiga Shield ecoregion (including the YGP area), moose densities were estimated at 2.75 moose per 100 km² and 5.4 moose per 100 km² in 2004 and 2007, respectively (Cluff 2005; 2008).

Moose are generally non-migratory and occupy the boreal forest throughout the year. Moose are primarily browsers and require abundant food supplies juxtaposed with security cover. High quality browse primarily consists of shrubs and deciduous trees; therefore, conifer-dominated landscapes are sub-optimal moose habitat.

Moose habitats can be broadly categorized as fire-influenced, non- or limited-fire influenced or aquatic. Within the first two (forested) habitats, moose generally prefer semi-open successional stages with an abundance of browse. Such sites are commonly found on floodplains and in riparian areas or wetlands, as well as in regenerating burns. Use of aquatic habitats may occur during all non-winter months, but generally peaks during late June to early August, when plant nutrition and digestibility are highest. This period coincides with the peak of insect harassment and moose may seek relief in water for this reason as well.

The few moose present in the YGP area use a variety of habitats including lakeshores, river valleys and semi-open forests on a year-round basis (Britton 1983). Based on vegetation studies conducted in 2004 (EBA 2006), the majority of the habitat within the LSA (approximately 11630 ha, or 80%) is forested spruce lichen, spruce moss, jack pine lichen and open lake; while willow riparian (favoured moose habitat) represents less than 2% (approximately 257 ha) of the study area. Nevertheless, moose sign (pellets, browse, antlers and tracks) was observed across the YGP LSA in the majority of vegetation community types. Conifer-dominated landscapes are sub-optimal moose habitat. However, a portion of the conifer-dominated habitat has been burnt. A total of 23% (approximately 3330 ha) of the YGP LSA (north and east sides of Giauque Lake) was severely burnt in 1998.

Based on the YGP vegetation studies, the predominant moose habitat is considered to be poor quality, which corroborates the EBA survey results. Moose are believed to frequent the region at densities similar to those previously reported across the Taiga Shield ecoregion (Cluff 2005; 2008). However, current moose densities are likely higher in the burn since this area has been regenerating for 12 years, and deciduous shrubs and trees favoured by moose are likely more abundant.

Similar to caribou, the YGP and its associated infrastructure and activities may directly or indirectly affect moose through habitat loss, and physical or behavioural disturbance, including avoidance. Potential effects on moose could also result from increased hunting mortality.

Based on EBA's observations of moose sign within the RSA, moose may be expected to be present in the vicinity of the YGP footprint area quite regularly and may directly encounter or be disturbed by localized development-related noise or activities. Similarly, moose will be exposed to low levels of vehicle traffic during the 8 – 12 weeks a year when the winter road is open along with potentially associated activity such as hunting.

Moose encountering such activities may show minor displacement behaviour and avoid the immediate YGP development area and/or roads. The duration of such exposures are expected to be brief, perhaps lasting a few minutes to a few hours, and are reversible upon cessation of the activity or by moving away from the activity. The number and frequency of such exposures to disturbance by moose would be expected to be limited and sporadic.

To minimize any potential for direct YGP development-related moose mortality, Tyhee NWT Corp will implement a no hunting policy for all project employees and contractors while working on-site.

Tyhee NWT Corp will require all project-related transportation activities to give the right-of-way to any wildlife including moose that such activities may encounter. Tyhee NWT Corp will also encourage participation in reporting all vehicle-wildlife collisions.

In addition, the harassment of wildlife, as defined under the NWT Wildlife Act, will be prohibited. An employee training program will be conducted to describe and illustrate the importance of following all wildlife mitigation measures (a training program may be incorporated into the site orientation for employees and contractors).

With the implementation of the mitigation measures as described, YGP development-related activities are not expected to affect the overall health or well-being of the moose population, specifically the adult population, adult survivorship, or potential recovery effects.

Residual Effects

Disturbance and habitat-related effects on all wildlife species including moose will be of a negligible and insignificant nature with no residual effects expected to occur.

A wildlife monitoring program will be implemented during construction, operation, and closure/reclamation phases to assess possible changes in local moose population winter abundance and distribution.

6.6.1.3 Black Bear

Black bears are common throughout the boreal forests of the NWT, including the area of the YGP. The black bear population in the NWT is healthy and estimated at 10,000 (INAC 2007a).

Black bear habitat quality is based primarily on the abundance of seasonally important food items. Black bears occupy a variety of habitat types in search of food items, and occur throughout much of the YGP area. In the spring, bears gravitate toward areas with early-emerging vegetation, such as roadsides and wetlands dominated by sedges, cottongrass, grasses, and horsetails, and may be found in sites such as meadows with over-wintered berries. In summer, bears typically consume a variety of species of grasses, sedges, horsetails, and forbs. Insect activity peaks during summer, and black bears feed heavily on colonies of ants, bees, and wasps. By fall, their diet shifts as the nutritional quality of many plants decline and berries become ripe.

Disturbed habitats, including fire influenced habitats are known to provide good black bear habitat. Black bears benefit most from sites that have been burned at least 20 years prior (Laviviere 2001). These regenerating sites commonly provide summer and fall forage resources such as berries and ants in downed and burned trees. In addition, black bears benefit from higher moose densities and increased moose calf productivity from these regenerating sites (Nelson et al. 2008). Black bears are omnivores. In most areas, their diet is dominated by vegetation. However, meat, especially winter-killed ungulates during spring, moose calves, insects during summer, and possibly fish, can be locally important.

Black bears typically dig dens in till material available on eskers or drumlins, stream banks, or in natural cavities such as an upturned tree root. Black bears can be expected to den across much of the YGP area.

All incidental black bear observations were recorded during the 2004 and 2005 field surveys. A total of 54 black bear observations were documented including scat, claw marks, and feeding sites across the YGP study area; however, no black bears were seen.

The main ways that the YGP associated infrastructure and activities can affect black bear is through physical or behavioural disturbance, including displacement and habituation (e.g. attraction). Potential effects on black bear could also result from the loss or degradation of foraging and denning habitat.

Based on EBA's observations of black bear sign within the RSA, black bear may be expected to be present in the vicinity of the YGP footprint area quite regularly and may potentially directly encounter or be disturbed by localized development-related noise or activities. Similarly, black bear will be exposed to low levels of vehicle traffic at the local mine site.

To minimize potential attraction/habituation of black bears to the YGP, the worksites will be kept clean and free of garbage. All waste foods, human garbage, and non-hazardous waste will be burned in an on-site incinerator. Non-combustible waste will be disposed of in an approved on-site landfill.

To minimize any potential for direct YGP development-related black bear mortality, Tyhee NWT Corp will implement a no hunting policy for all project employees and contractors while working on-site.

Tyhee NWT Corp will require all project-related transportation activities to give the right-of-way to any wildlife including black bear that such activities may encounter. Tyhee will also encourage participation in reporting all vehicle-wildlife collisions.

In addition, the harassment of wildlife, as defined under the NWT Wildlife Act, will be prohibited. An employee training program will be conducted to describe and illustrate the importance of following all wildlife mitigation measures (a training program may be incorporated into the site orientation for employees and contractors), including the appropriate protocol for addressing nuisance bears and human-bear encounters.

With the implementation of the mitigation measures as described, YGP development-related activities are not expected to affect the overall health or well-being of the black bear population within the RSA.

Residual Effects

Disturbance and habitat-related effects on all wildlife species including black bear will be of a negligible and insignificant nature with no residual effects expected to occur.

6.6.1.4 Wolves

Grey wolf populations in the NWT are considered healthy (INAC 2007a). Wolves play a pivotal role in all levels of the food chain and are the predominant predators of caribou and moose (Williams 1990). Wolves are hunted and trapped and are important to local and regional economies.

In the YGP area, two different groups of grey wolves can be expected to occupy the YGP area: migratory and resident. Migratory wolves (also known as tundra wolves) follow the barren-ground caribou herds and would occupy the YGP area in the winter if caribou were present. The boreal resident wolves (also known as timber wolves) remain below the tree line year-round, including the YGP area and depend on non-migratory prey such as moose. Timber wolves maintain regular territories, which vary in size depending on prey densities. Tundra wolves do not maintain regular territories and travel extensively following the caribou herds.

Bromley and Buckland (1995) estimated 1,400 to 3,000 wolves were present within the annual range of the Bathurst caribou herd. In 2006, the wolf population within the winter range of the Bathurst herd (including the YGP study area) was estimated at 211 $\pm$ 66 (Mattson et al. 2009). Recent evidence suggests the number and productivity of wolves occupying the Bathurst caribou range has decreased in concert with the Bathurst caribou herd population decline (Adamczewski *et al.* 2009, Cluff 2006/2007). Similarly, timber wolf numbers and productivity respond positively to an increase in moose populations. As moose populations increase in the burned areas of the YGP, wolf numbers will likely increase in response.

Annual ranges for radio-collared tundra wolf males in the Slave Geological Province are large, reported to average over 63,000 km^2 (Walton 1999). Like most carnivores, wolves can be sensitive to disturbance, especially during their reproductive period (Chapman 1977). Nevertheless, their high productivity and dispersal capabilities ensure resiliency to sustained levels of moderate human disturbance (Weaver et al. 1996).

Tundra wolves are tied to specific areas only during the denning period; whereas, timber wolves maintain territories year-round. Wolf dens are traditional and may be used over many years (BHP 1995, 2000). Of 63 wolf dens found in the Bathurst caribou range, 26 were on the tundra, 28 in the tree line transition area and nine in the boreal forest (Heard and Williams 1992). The denning period for wolves typically begins in early May. Timber wolf dens are constructed in esker material, within a rock crevice, or an overturned stump, particularly near water or heights of land.

Grey wolf habitat, including denning habitat, exists throughout the YGP study area. A total of 37 incidental wolf observations were documented across the YGP study area, including a pack consisting of six individuals, a number of scats and tracks. No wolf dens were observed.

Wolves are expected to occur across the study area wherever abundant prey exists. The main ways that the YGP associated infrastructure and activities can affect wolves is through physical or behavioural disturbance, including displacement and habituation (e.g. attraction). Potential effects on wolves could also result from the loss or degradation of denning habitat.

Based on EBA's observations of wolf sign within the RSA, wolves may be expected to be present in the vicinity of the YGP footprint area quite regularly and may potentially directly encounter or be disturbed by localized development-related noise or activities. Similarly, wolves will be exposed to low levels of vehicle traffic and potentially associated activity such as hunting and trapping.

To minimize potential attraction/habituation of wolves to the YGP, the worksites will be kept clean and free of garbage. All waste foods, human garbage, and non-hazardous waste will be burned in an on-site incinerator. Non-combustible waste will be disposed of in an approved on-site landfill.

To minimize any potential for direct YGP development-related wolf mortality, Tyhee NWT Corp will implement a no hunting policy for all project employees and contractors while working on-site.

Tyhee NWT Corp will require all project-related transportation activities to give the right-of-way to any wildlife including wolves that such activities may encounter. Tyhee NWT Corp will also encourage participation in reporting all vehicle-wildlife collisions.

In addition, the harassment of wildlife, as defined under the NWT Wildlife Act (including feeding wildlife), will be prohibited. An employee training program will be conducted to describe and illustrate the importance of following all wildlife mitigation measures (a training program may be incorporated into the site orientation for employees and contractors).

With the implementation of the mitigation measures as described, YGP development-related activities are not expected to affect the overall health or well-being of the wolf population which may utilize the RSA.

Residual Effects

Disturbance and habitat-related effects on all wildlife species including the wolf population will be of a negligible and insignificant nature with no residual effects expected to occur.

6.6.1.5 Wolverine

Wolverines have been assessed by COSEWIC (2010) as "Special Concern" and ranked by ENR as "Sensitive" (GNWT ENR 2010b) because of their low resiliency to human-caused effects and decreasing caribou populations. Reproductive rates are low, and sexual maturity is delayed compared to those for other mammalian carnivores. However, wolverines are not protected under SARA.

Wolverines live at low densities even under optimal conditions (Banci 1994). Wolverines are expected to occur across the YGP study area year round, wherever abundant prey occurs. A single wolverine was observed in both 2004 and 2005 while conducting aerial surveys. A species account is provided in Section 2.12.1.5.

Although active year round, wolverines will construct snow dens to escape predators, cache food, and raise their young. Kits (young) are born in February or March in a shallow pit dug in the ground within a constructed snow den (Banci 1994). In addition, natal dens have been documented in abandoned beaver lodges and bear dens, in upturned roots and fallen logs, or rocks crevices (Banci 1994).

The main ways that the YGP associated infrastructure and activities can affect wolverines is through physical or behavioural disturbance, including displacement and habituation (e.g. attraction). Potential effects on wolverines could also result from the loss or degradation of denning habitat.

Based on EBA's observations in 2004 and 2005 within the RSA, wolverines may potentially be present in the vicinity of the YGP footprint area year round and may potentially directly encounter or be disturbed by localized development-related noise or activities. Similarly, wolverines will be exposed to low levels of vehicle traffic and potentially associated activity such as hunting and trapping. Tyhee NWT Corp will also encourage participation in reporting all vehicle-wildlife collisions.

To minimize potential attraction/habituation of wolverines to the YGP, the worksites will be kept clean and free of garbage. All waste foods, human garbage, and non-hazardous waste will be burned in an on-site incinerator. Non-combustible waste will be disposed of in an approved on-site landfill.

To minimize any potential for direct YGP development-related wolverine mortality, Tyhee NWT Corp will implement a no hunting policy for all project employees and contractors while working on-site.

Tyhee NWT Corp will require all project-related transportation activities to give the right-of-way to any wildlife, including wolverines, which such activities may encounter. Tyhee NWT Corp will also encourage participation in reporting all vehicle-wildlife collisions.

In addition, the harassment of wildlife, as defined under the NWT Wildlife Act, will be prohibited. An employee training program will be conducted to describe and illustrate the importance of following all wildlife mitigation measures (a training program may be incorporated into the site orientation for employees and contractors), including the appropriate protocol for addressing nuisance wolverines.

With the implementation of the mitigation measures as described, YGP development-related activities are not expected to affect the overall health or well-being of the wolverine population in the RSA.

Residual Effects

Disturbance and habitat-related effects on all wildlife species including wolverines will be of a negligible and insignificant nature with no residual effects expected to occur.

6.6.1.6 Mitigation Measures

Potential effects on wildlife and wildlife habitat may take place during YGP construction, operation, closure and reclamation phases. Tyhee NWT Corp is committed to providing mitigation to avoid or minimize potentially negative effects on wildlife and wildlife habitat, and adopting an adaptive management approach to increase effectiveness of mitigation measures where appropriate.

The main ways that the development can affect wildlife is through physical or behavioural disturbance, including displacement and habituation (e.g. attraction), loss or degradation of habitat, and increase in mortality from hunting and trapping.

To minimize impacts on wildlife habitats of the YGP development area, Tyhee NWT Corp has and/or will employ a number of specific mitigation measures. Initially, as part of project planning and design, Tyhee NWT Corp is proposing to minimize the YGP development footprint by locating YGP buildings and associated infrastructure on existing disturbed areas to the maximum extent possible, representing an area of approximately 21.6 ha. New disturbance to wildlife habitat in the project footprint area will be limited to approximately 243 ha. During the final abandonment phase, infrastructure pads, roads and development sites will be re-contoured and scarified as required to ensure surface stability encouraging the re-establishment of native.

Other possible effects on wildlife and wildlife habitat in the YGP area could be associated with air emissions, odours, noise and dust generation. However, the limited air emissions, odours and noise associated with the operation of standard internal combustion engines operating on the site, the occasional aircraft, and the amounts of dust generated mainly by moving vehicles and trucks are not anticipated to have a measurable effect on wildlife or wildlife habitat in the YGP area.

Potential effects related to the YGP development on all wildlife species will be mainly limited to the timeframes and activities associated with the 2-9.5 years duration of the development and reclamation operations.

To minimize any potential for direct YGP development-related wildlife mortality, Tyhee NWT Corp will implement a no hunting policy for all project employees and contractors while working on-site.

The company will require all project-related transportation activities to give the right-of-way to any wildlife that such activities may encounter. Tyhee NWT Corp will also encourage participation in reporting all vehicle-wildlife incidents.

To minimize potential attraction/habituation of certain wildlife species such as black bears, wolves, and wolverines to the YGP, all waste foods, human garbage, and non-hazardous waste will be burned in an on-site incinerator. Non-combustible waste will be disposed of in an approved on-site landfill.

To minimize impacts on wildlife habitats of the YGP development area, Tyhee NWT Corp has and/or will employ a number of specific mitigation measures. Initially, as part of project planning and design, Tyhee NWT Corp is proposing to minimize the YGP development footprint by locating YGP buildings and associated infrastructure on existing disturbed areas to the maximum extent possible.

In addition to the specific mitigation measures described above, the following additional mitigation measures will be employed to minimize potential impacts on wildlife and wildlife habitat of the YGP development area:

- Full compliance with Land Use Permit and Water License conditions to be issued by the MVLWB.
- Adoption of a cooperative approach involving First Nations and wildlife regulators, to effectively protect wildlife populations.
- Prohibit wildlife harassment, as defined under the NWT Wildlife Act, including the appropriate protocol for addressing nuisance wildlife.

- Staff training on worksite cleanliness and effective food waste management to mitigate potential wildlife attraction and habituation, and a protocol to address nuisance wildlife.
- Optimized recycling/reuse of process water.
- Salvage of organic and mineral top soils where appropriate for future reapplication during reclamation of the site.
- Implementation of erosion control measures if and as warranted - not anticipated to be required due to the generally level and porous nature of the terrain at the development site.
- Use of existing roads/highways for all YGP-related vehicle traffic.
- Application of dust suppressants at the local mine area- e.g. water or approved dust suppressant products.
- Disposal of all hazardous wastes in an approved manner.
- Development of a wildlife monitoring program in consultation with appropriate GNWT agencies and communities to be implemented during construction, operation, and closure/reclamation phases to assess possible changes in local wildlife abundance and distribution.
- Re-contouring, scarification of disturbed areas where appropriate with appropriate and approved native seed mixes to restore productive wildlife habitat.

6.6.1.7 Residual Effects

With the application of these mitigation measures and in consideration of the other aspects of the assessment presented in this section of the DAR, no residual effects on the wildlife resources of the YGP are anticipated to occur following reclamation and restoration of the site.

6.6.2 Birds

6.6.2.1 Upland Breeding Birds

Upland breeding birds are widely distributed throughout the YGP study area and occupy all terrestrial habitat types. A total of 67 upland breeding bird species may potentially occur in the YGP study area as summer or year-round residents (Table 2.12-2). Additional upland bird species that occupy the transitional and tundra zones may briefly occupy the YGP study area during spring and/or fall migration.

Upland breeding birds are common in the YGP study area during spring, summer and fall. Fourteen species may over winter. Within the study area, the density of upland breeding birds is dependent upon food abundance, nesting habitat, and predation. Appropriate nesting habitat is not considered a limiting resource for birds occurring in the YGP LSA.

In the NWT, two species that may occur in the YGP study area are listed by ENR as "At Risk[21]", one species is listed as "May Be At Risk[22], and seven species are listed as "Sensitive" (Table 2.12-2). Sensitive species are "not at risk of extinction or extirpation but may require special attention or protection to prevent them from becoming at risk" (GNWT ENR 2010b). Two of these 67 species (Olive-sided Flycatcher and Common Nighthawk) have been listed by SARA (2010) as "Threatened[23]", and one species (Rusty Blackbird) has been listed by SARA as "Special Concern[24]". Species with special conservation status potentially occurring within the YGP study area are discussed further in Section 2.12.3.

Local upland breeding birds will be directly and indirectly affected by all phases of the YGP, including construction, operation, closure and reclamation; however, the greatest effects may occur during clearing activities (direct habitat loss). To reduce localized direct habitat loss effects, the project footprint will be minimized as much as possible (including use of existing cleared lands), and during the final abandonment phase, infrastructure pads, roads and development sites will be re-contoured and scarified as required to ensure surface stability encouraging the re-establishment of native vegetation.

In addition to direct habitat loss, clearing activities occurring during bird nesting times may result in direct mortality. The majority of upland breeding birds and their active nests are protected under the federal Migratory Birds Convention Act. Clearing operations in all habitat types from May to August (sensitive nesting and fledging season for upland breeding birds) will be avoided, if at all possible. In addition, upland nesting birds may encounter low levels of vehicle traffic, which may lead to an increase in mortality, including hunting (*e.g.* ptarmigan and grouse species). A no hunting policy for all project employees and contractors while working on-site will be enforced. Tyhee NWT Corp will also encourage participation in reporting all vehicle-wildlife collisions.

Indirect project effects on upland breeding birds may include habitat avoidance, habitat alteration and fragmentation. Increased noise and edge effects may make adjacent habitats less favorable to some species. The YGP activities will create habitat edges which may benefit edge-dwelling species and habitat generalists, but negatively affect interior forest species and those more sensitive to human disturbances.

A few bird species, such as the flycatchers and swallows may utilize project buildings and infrastructure during foraging and as nesting substrates.

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[21] Species ranked by ENR as "At Risk" are at risk of extirpation or extinction and have been assessed by COSEWIC as endangered or threatened.

[22] Species ranked by ENR as "May Be At Risk" are potentially at risk of extirpation or extinction and are ranked as the highest priority for a more detailed assessment.

[23] Species assessed as "Threatened" are likely to become endangered if factors leading to its extinction or extirpation are not reversed.

[24] Species listed as "Special Concern" may become threatened or endangered because of a combination of biological characteristics (*e.g.* low reproductive rate) and threats.

With the implementation of the mitigation measures as described, YGP development-related activities are not expected to affect the overall health or well-being of the upland breeding bird population in the RSA.

Residual Effects

Disturbance and habitat-related effects on all wildlife species including upland breeding birds will be of a negligible and insignificant nature with no residual effects expected to occur.

Common Nighthawk

The Common Nighthawk is listed by SARA as "Threatened", and ENR ranks Common Nighthawks as "At Risk" since the NWT is at the species' northern range, and the species is considered threatened throughout its remaining Canadian range. A large decline in their population has been shown over the past 30 years across much of Canada (GNWT ENR 2010b).

Common Nighthawks migrate into the NWT in mid-May to early June to breed (CWS and GNWT ENR 2008). Preferred habitat includes: open forests, forest clearings, recent burn areas, rock outcrops, wetlands and marshes, lakeshores and gravel areas (including airports, quarries and roads) (CWS and GNWT ENR 2008). Nests are prepared directly on soil, sand, gravel and bare rock. Common Nighthawks are insectivores, and actively pursues flying insects at dawn and dusk, particularly over bodies of water. By mid-August to mid-September, Common Nighthawks depart the NWT (CWS and GNWT ENR 2008).

Common Nighthawk feeding and breeding habitat exists throughout the majority of the YGP study area. A pair of Common Nighthawks was observed in 2004 and 2005 feeding above small boreal ponds, and a single observation of a Common Nighthawk was recorded in August 2005 near the southwest end of Giauque Lake.

Species populations that occur in low densities (including those with special conservation status) may be especially vulnerable to further human disturbances and habitat loss. General impacts and mitigation outlined in the Upland Breeding Birds section above (including avoiding clearing activities during nesting and fledging seasons), are applicable to Common Nighthawk.

Olive-sided Flycatcher

The Olive-sided Flycatcher is listed by SARA as "Threatened", and is ranked by ENR as "At Risk" (COSEWIC 2010; GNWT ENR 2010b). In the north, potential threats to the population includes: fire suppression practices and extreme weather during breeding (CWS and GNWT ENR 2008).

In the NWT, typical Olive-sided Flycatcher habitat includes regenerating forests after a forest fire, and open areas (including man made openings) with surrounding large trees and standing snags (CWS and GNWT ENR 2008). Olive-sided Flycatchers forage from a high prominent perch from which it pursues flying insects such as bees, wasps and ants once sighted. Olive-sided Flycatchers arrive in the NWT in late May and early June and departs late July and early August (CWS and GNWT ENR 2008). For reasons unclear, Olive-sided Flycatcher populations have declined considerably, particularly in its southern range.

Olive-sided Flycatcher habitat exists throughout much of the YGP study area. A single Olive-sided Flycatcher was recorded in the YGP study area during the breeding bird surveys. Six other observations of Olive-sided Flycatchers were incidentally recorded near Winter Lake, Brien Lake and Giauque Lake.

Species populations that occur in low densities (including those with special conservation status) may be especially vulnerable to further human disturbances and habitat loss. General impacts and mitigation outlined in the Upland Nesting Birds section above (including avoiding clearing activities during nesting and fledging seasons), are applicable to Olive-sided Flycatcher.

However, clearing and construction activities of the YGP may benefit Olive-sided Flycatchers by increasing habitat edges preferred for nesting and foraging.

Rusty Blackbird

The Rusty Blackbird is listed by SARA as "Special Concern", and is ranked by ENR as "May Be At Risk" (SARA 2009; GNWT ENR 2010b). Threats to Rusty Blackbirds within the NWT include habitat alteration (GNWT ENR 2010b; Avery 1995). A NWT population estimate is not known; however, populations across southern Canada have declined 90% over the last 30 years (GNWT ENR 2010b).

Rusty Blackbirds occur in wet coniferous and mixed forests from the northern edge of the tundra southward to the beginning of deciduous forests and grasslands. Preferred habitat includes fens, shrubby bogs, muskegs, beaver ponds, and other openings in the forest such as swampy shores along lakes and streams (Avery 1995). Rusty Blackbirds occur throughout the YGP study area from approximately May to September (Bromley and Trauger ND, Alexander et al. 2003, Salter et al. 1973), wherever their preferred habitat occurs.

Rusty Blackbirds typically nest close to water. Nests occur in living and dead trees, shrubs and on stumps. They use spruce, fir, tamarack, willow, birch, alder, and other species, depending on location. Vegetation is customarily dense and thick, and nests are often situated among a network of many small side branches (Avery 1995).

Rusty Blackbirds feed opportunistically on plants and invertebrates. Summer diet is primarily aquatic insects (Avery 1995).

Rusty Blackbirds were documented within the YGP study area during the baseline surveys. A total of eight Rusty Blackbirds were observed occupying small boreal ponds during the breeding bird and waterfowl surveys. Based on ELC data collected within the YGP LSA, approximately 3% (approximately 434 ha) of the available habitat may be suitable for Rusty Blackbirds. Winter Lake is considered low quality Rusty Blackbird habitat since the shoreline is dominated by upland habitat types.

Species populations that occur in low densities (including those with special conservation status) may be especially vulnerable to further human disturbances and habitat loss. General impacts and mitigation outlined in the Upland Nesting Birds section above (including avoiding clearing activities during nesting and fledging seasons), are applicable to Rusty Blackbirds.

Mitigation measures may include maintaining at least 250 m distance from lakes/ponds/wetlands whenever possible during construction clearing and operations, to minimize impacts to Rusty Blackbird.

6.6.2.2 Raptors

Raptors, also known as "Birds of Prey," make up a small but important group of birds frequenting the YGP area. A total of 15 raptor species potentially occur within the YGP study area. One species is listed as "Special Concern" by SARA (Schedule 3[25]), the Short-eared Owl, and another species is assessed by COSEWIC as "Special Concern", Peregrine Falcon (Table 2.12-5). However, Peregrine Falcons within the study area are considered migrants, and are not expected to regularly reside within the study area. For this reason, Peregrine Falcons have not been further assessed. The remaining raptor species are ranked as "Secure" within the NWT.

Raptors breed throughout the YGP study area, with select areas attracting higher breeding densities (i.e., riparian zones) than other areas (i.e., jack pine stands). Raptors can be expected to breed wherever their habitat requirements are met. In addition, several raptor species over-winter in the study area, particularly during years with high prey abundance.

Incidental raptor observations (including nests) were recorded during the 2004 and 2005 field surveys, in particular, an active Osprey nest was found on an abandoned power pole at the inlet of Narrow Lake (approximately 220 m from the proposed Winter Lake tailings facility). Additional raptors observed occupying the YGP study area were: Northern Goshawk, Bald Eagle, Merlin, American Kestrel, Northern Harrier, Great Horned Owl, Great Gray Owl, and Northern Hawk Owl.

In addition to the incidental raptor observations, an owl survey was completed on the night of April 18, 2005 at seven locations along the winter road leading to the YGP property. At each location, standard owl survey protocols (Resources Inventory Committee 2001) were followed, including broadcasting a series of owl territorial calls using a CD player connected to a megaphone. Although the survey date was timed to coincide with the period that breeding owls should be defending territories, no owls responded to the recorded territorial calls at any of the call playback survey stations.

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[25] Legal protection is afforded to species officially listed in Schedule 1 under the *Act* as Extirpated, Endangered or Threatened (those listed as Special Concern under Schedule 1 do not benefit from full legal protection under the Act). For the purposes of this report, all SARA status designations are in Schedule 1, except if noted otherwise. Species listed under Schedules 2 and 3 of the *Act* may have been designated at risk by previous COSEWIC assessments (prior to the standardization of protocols); however, a reassessment by COSEWIC is required. Species listed under Schedules 2 and 3 are not yet protected under the *Act*, but may be protected in the future

However, visual observations of Great Horned, Great Gray, and Northern Hawk owls occupying the YGP were documented during other survey events. Low prey densities in the local area are a possible explanation for the lack of owls responding to the broadcast calls. Small mammal prey populations were their lowest in the Gordon Lake area in 2005 (Carriere 2010). Great Horned Owls, Boreal Owls, and some other raptor species, do not breed or fully engage in territorial or courtship calling when prey densities (hare and/or small mammal) are at their lowest (Doyle 2000).

Raptors nesting in the LSA will be directly and indirectly affected by all phases of the YGP, including construction, operation, closure and reclamation; however, the greatest effects may occur during clearing activities (direct habitat loss) at the mine site. In addition, the YGP may negatively affect the amount of foraging habitat available. To minimize localized direct habitat loss effects, the project footprint will be minimized as much as possible (including the use of existing cleared lands), and during the final abandonment phase, infrastructure pads, roads and development sites will be re-contoured and scarified as required to ensure surface stability encouraging the re-establishment of native vegetation.

In addition to direct habitat loss, clearing activities occurring during raptor nesting times may result in direct mortality. Clearing operations in all habitat types from mid-February to August (sensitive nesting and fledging season for raptors including the earlier nesters such as owls) will be avoided, if at all possible. In addition, raptors may encounter low levels of vehicle traffic, which may lead to an increase in mortality. All project-related transportation activities will be required to give the right-of-way to raptors, and Tyhee NWT Corp will encourage participation in reporting all vehicle-wildlife collisions.

Indirect project effects on raptors may include disturbance during nesting and fledging, habitat avoidance, habitat alteration and fragmentation, and attraction. Increased noise effects, particularly during construction activities may make adjacent habitats less favorable to some species. To mitigate, clearing activities will occur outside sensitive raptor nesting and fledging season, as much as possible, and operation, closure and reclamation activities will maintain a distance of at least 250 m from known raptor nests during sensitive raptor periods.

Some raptor species, such as Ospreys and Common Ravens (functional raptor) may utilize the project infrastructure as nesting substrates.

To minimize potential attraction of certain raptor species such as Common Ravens (functional raptor) to the YGP, all waste foods, human garbage, and non-hazardous waste will be burned in an on-site incinerator. Non-combustible waste will be disposed of in an approved on-site landfill.

With the implementation of the mitigation measures as described, YGP development-related activities are not expected to affect the overall health or well-being of the raptor population in the RSA.

Residual Effects

Disturbance and habitat-related effects on all wildlife species including raptors will be of a negligible and insignificant nature with no residual effects expected to occur.

Short-eared Owls

Within the YGP study area, Short-eared Owl habitat exists along lake shorelines and in open wetlands. Based on Ecological Land Classification (ELC) mapping, approximately two percent (354.87 ha) of the YGP study area includes habitats potentially suitable for Short-eared Owls. No Short-eared Owls were observed within the YGP study area during the 2004 and 2005 surveys.

The Short-eared Owl is listed by SARA as "Special Concern" (Schedule 3), and is ranked by ENR as "Sensitive" (COSEWIC 2010; GNWT ENR 2010b). Under SARA Schedule 3, the Short-eared Owl requires assessment or re-assessment by COSEWIC and is not yet protected under SARA. Therefore, species listed under Schedule 3, including the Short-eared Owl may be protected under SARA in the future, following re-assessment.

The Short-eared Owl arrives in the NWT to breed by late April or May and departs by late October (CWS and GNWT ENR 2008; Bromley and Trauger ND). Short-eared Owls occur wherever an abundance of small mammals are present, particularly in bogs, marshes, and other non-forested areas (CWS and GNWT ENR 2008). Nests are normally located in dry open sites with enough vegetation to conceal an incubating female.

The NWT population status of these owls is difficult to assess because individuals are nomadic and prone to annual fluctuations in numbers. Populations have declined throughout much of Canada; however, population trends in northern Canada still need to be confirmed. The NWT Short-eared Owl population is unknown but estimated to be between 1,000 and 10,000 individuals (Carrière 2000).

Short-eared owls nesting in the local study area will be directly and indirectly affected by all phases of the YGP, including construction, operation, closure and reclamation; however, the greatest effects may occur during clearing activities (direct habitat loss) at the mine site. In addition, the YGP may negatively affect the amount of foraging habitat available. To minimize localized direct habitat loss effects, the project footprint will be minimized as much as possible (including the use of existing cleared lands) in shrub meadows and open spruce habitats, and development areas will be re-vegetated with native vegetation mixes during the reclamation phase.

In addition to direct habitat loss, clearing activities occurring during nesting times may result in direct mortality. Clearing operations from May to August, sensitive nesting and fledging season for Short-eared Owls will be avoided, if at all possible. In addition, Short-eared Owls may encounter low levels of vehicle traffic, which may lead to an increase in mortality. All project-related transportation activities will be required to give the right-of-way to any raptor species, and Tyhee NWT Corp will encourage participation in reporting all vehicle-wildlife collisions.

Indirect project effects on Short-eared Owls may include disturbance during nesting and fledging, habitat avoidance, habitat alteration and fragmentation, and attraction. Increased noise effects, particularly during construction activities may make adjacent habitats less favorable to some species. To mitigate, clearing activities will occur outside sensitive raptor nesting and fledging season, as much as possible, and operation, closure and reclamation activities will maintain a distance of at least 250 m from known raptor nests during sensitive raptor periods.

6.6.2.3 Waterfowl and Waterbirds

The term "waterfowl" is used in a general sense; species are grouped together and treated collectively. Waterfowl is typically used in the context of swans, geese and ducks (Anseriformes); however, for this report it also includes loons (Gaviiformes) and grebes (Podicipediformes). The term "waterbird" includes rails and cranes (Gruiformes), and shorebirds, gulls and terns (Charadriiformes).

A total of 38 waterfowl and waterbird species may occur within the YGP study area (Table 2.12-6). One species (Horned Grebe) was assessed by COSEWIC as "Special Concern"; whereas, ENR has ranked eight species as "Sensitive". The remaining waterfowl and waterbird species are ranked as "Secure" and or "Undetermined" in the NWT. Species with special conservation status potentially occurring within the YGP study area are discussed further in Section 2.12.3.

Five waterfowl reconnaissance surveys were conducted during several periods including: July 31 to August 1, 2004, August 13, 2004, June 10 to 15, 2005 and July 18 to 21, 2005 and August 3, 2005 to document species of waterfowl utilizing water bodies in the general YGP study area (Table 2.12-6). Waterbirds were recorded incidentally during the waterfowl surveys. A number of lakes, including Nicholas, Eclipse, Maguire, Giauque (portions of), Round, Winter, Narrow, and Brien lakes, and nine small boreal ponds were surveyed.

Based on these waterfowl surveys, Nicholas, Eclipse, Maguire, Giauque, Narrow, and Brien lakes are rated as possessing relatively poor quality waterfowl habitat. These lakes are generally deep, with extensive rocky shorelines and limited areas of emergent vegetation, which are not preferred by waterfowl. Consequently, relatively few waterfowl were documented on these lakes.

Winter and Round lakes provide better quality waterfowl habitat, as they are shallow with a less rocky shoreline and more extensive submerged and emergent vegetation. The small ponds surveyed adjacent to the lakes in the YGP study area were typically rated as possessing the highest quality habitat for waterfowl. These ponds are very shallow, with extensive submerged and emergent vegetation providing better nesting habitat.

In 2004, 42 and 17 ducks were observed on Winter and Round lakes, respectively, including: Greater Scaup, White-winged Scoter, Surf Scoter, Tundra Swan, and Ring-necked Ducks. Nicholas, Eclipse, Maguire, and Giauque lakes are more typical of Canadian Shield lakes and were being used by a smaller number of waterfowl. Diving waterfowl include species such as Common Loons, Red-breasted Mergansers, Surf

Scoters, and White-winged Scoters. Waterfowl were not observed on Narrow Lake in 2004. Three additional waterfowl surveys were conducted during the periods of June 10 – 15, 2005, July 18 – 21 and August 3, 2005. These surveys focussed on Round Lake, Winter Lake, Narrow Lake, Brien Lake, and nine separate ponds in the vicinity of the YGP.

A total of 193 waterfowl were observed during the June 2005 surveys. The most abundant waterfowl recorded were Lesser Scaup, Surf Scoter and Greater Scaup. By the July 18- 21 and August 3, 2005 survey periods, a total of 133 waterfowl were observed. The most abundant waterfowl recorded during this period were scaup species, Surf Scoter, Ring-necked Duck, and Pacific Loon. Sixteen waterfowl species were observed in 2005. In general, the results for 2005 were similar to those reported in 2004.

Incidental waterbirds observed during the 2004 waterfowl surveys included Arctic Terns, Mew Gulls, Herring Gulls, Least Sandpiper and a Wilson's snipe. In 2005, Lesser Yellowlegs and Bonaparte's Gulls were also observed during the waterfowl survey. Additional incidental waterbird species documented during all other 2004 and 2005 surveys included Sandhill Crane and Solitary Sandpiper.

Residual Effects

Disturbance and habitat-related effects on all wildlife species including waterfowl and waterbirds will be of a negligible and insignificant nature with no residual effects expected to occur.

Horned Grebe

Horned Grebes occupy small ponds, wetlands, shallow lakeshores and protected bays, and other natural or man-made permanent or semi-permanent waterbodies (Government of Canada 2010). Their diet consists of aquatic insects, fish, frogs, and crustaceans. In the Yellowknife area, Horned Grebes were found to prefer lakes 0.3 to 2.0 hectares (ha) in size, although breeding also occurs on smaller and larger lakes if suitable conditions exist (Fournier and Hines 1999). Favourable breeding ponds include areas of open water and sufficient emergent (*e.g.* cattails and sedge) and submergent vegetation. Winter Lake is considered to provide moderate quality Horned Grebe nesting habitat.

Horned Grebes are expected to arrive within the study area in May and depart by September (GNWT ENR 2010). Nests are anchored to emergent plants, primarily cattails and willows, which provide cover and support (Fournier and Hines 1999). Adults are known to leave the young well before they've fledged (Fournier and Hines 1999). These adults may remain at larger water bodies immediately prior to fall migration (Fournier and Hines 1999).

A total of four Horned Grebes were observed on Round Lake (upstream from Winter Lake) during the 2005 waterfowl surveys. No Horned Grebes were observed on Winter Lake during the waterfowl surveys.

Horned Grebe may be affected primarily during tailings activities at Winter Lake through direct loss of moderate nesting habitat. Indirect habitat loss may occur from habitat alteration, particularly from changes in water quality and quantity to waterbodies downstream of the tailings facility at Winter Lake.

In addition to direct habitat loss, clearing activities occurring during nesting and fledging (most sensitive time) may result in direct mortality.

Indirect loss/mortality of eggs and young may potentially occur if water levels increase during the nesting season.

Clearing operations in all habitat types from May to August (sensitive nesting and fledging season) will be avoided, if at all possible.

Water quantity and quality will be maintained, particularly during nesting and fledging season to waterbodies downstream from Winter Lake and other development sites.

6.6.2.4 Mitigation Measures

Potential effects on bird species and their habitat may take place during YGP construction, operation, closure and reclamation phases. Tyhee NWT Corp is committed to providing mitigation to avoid or minimize potentially negative effects on wildlife and wildlife habitat, and adopting an adaptive management approach to increase effectiveness of mitigation measures where appropriate.

The greatest effects to bird species may occur during clearing activities (direct habitat loss). In addition to direct habitat loss, clearing activities occurring during bird nesting times may result in direct mortality. In addition, birds may encounter low levels of vehicle traffic, which may lead to an increase in mortality, including hunting (*e.g.* ptarmigan and grouse species).

Indirect project effects on bird species may include habitat avoidance, habitat alteration and fragmentation. Increased noise and edge effects may make adjacent habitats less favorable to some species. The proposed project will create habitat edges which may benefit edge-dwelling species and habitat generalists, but negatively affect interior forest species and those more sensitive to human disturbances.

For waterfowl and waterbirds there is potential for indirect loss/mortality of eggs and young if water levels increase during nesting season; as well as, indirect habitat loss from habitat alteration, particularly from changes in water quality and quantity to waterbodies downstream of the tailings facility at Winter Lake.

Other possible effects could be associated with air emissions, odours, noise, and dust generation. However, the limited air emissions, odours and noise associated with the operation of standard internal combustion engines operating on the site and the dust generated mainly by moving vehicles and trucks are not anticipated to have a measurable effect on wildlife or wildlife habitat in the YGP development area.

To minimize impacts on wildlife habitats of the YGP development area, Tyhee NWT Corp has and/or will employ a number of specific mitigation measures. Initially, as part of project planning and design, Tyhee NWT Corp is proposing to minimize the YGP development footprint by locating YGP buildings and associated infrastructure on existing disturbed areas to the maximum extent possible, representing an area of approximately 21.6 ha. New disturbance to wildlife habitat in the project footprint area will be limited to approximately 316 ha. During the final abandonment phase, infrastructure pads, roads and development sites will be re-contoured and scarified as required to ensure surface stability encouraging the re-establishment of native vegetation.

Clearing operations in all habitat types from May to August (sensitive nesting and fledging season for breeding birds) will be avoided, if at all possible; and operation, closure and reclamation activities will maintain a distance of at least 250 m from known raptor nests during sensitive raptor periods. Mitigation measures may include maintaining a reasonable setback from lakes/ponds/wetlands whenever possible during construction clearing and operations, to minimize impacts to Common Nighthawks and Rusty Blackbirds; particularly from May to August for Horned Grebe.

A no hunting policy for all project employees and contractors while working on-site will be enforced. Tyhee NWT Corp will also encourage participation in reporting all vehicle-wildlife collisions.

To minimize potential attraction of bird species, such as Common Ravens (functional raptor) to the YGP, all waste foods, human garbage, and non-hazardous waste will be burned in an on-site incinerator. Non-combustible waste will be disposed of in an approved on-site landfill.

Additional mitigation measures that will be employed to minimize potential impacts on wildlife and wildlife habitat of the YGP development area will include:

- Full compliance with Land Use Permit and Water License conditions to be issued by the MVLWB.
- Adoption of a cooperative approach involving First Nations and wildlife regulators, to effectively protect wildlife populations.
- Staff training and effective food waste management; to mitigate potential wildlife attraction and habituation.
- Use of existing roads/highways where practicable for all YGP-related vehicle traffic.
- Application of dust suppressants - e.g. water or approved dust suppressant products.
- Disposal of all hazardous wastes in an approved manner.
- During the final abandonment phase, infrastructure pads, roads and development sites will be re-contoured and scarified as required to ensure surface stability encouraging the re-establishment of native vegetation.

6.6.2.5 Residual Effects

With the application of these mitigation measures and in consideration of the other aspects of the assessment presented in this section of the DAR, no residual effects on bird species within the RSA are anticipated to occur following reclamation and restoration of the site.

6.6.3 Conceptual Wildlife Monitoring and Management Plan

Upon project approval, Tyhee NWT Corp will prepare a Conceptual Wildlife Monitoring and Management Plan in collaboration with the Department of Natural Resources, GNWT that will address furbearers, migratory birds, waterfowl, large ruminants, and large carnivores as specified in the MVEIRB May 2009 Final Terms of Reference. The Wildlife Monitoring and Management Plan will include adaptive management measures tailored specifically for the YGP to avoid, minimize and mitigate any potential effects to wildlife if problems or issues are detected during construction, operation, and decommissioning/ closure.

6.7 AIR QUALITY AND NOISE

The MVEIRB Terms of Reference (MVEIRB 2009) directed Tyhee NWT Corp to evaluate the development's potential impacts on air quality due to project emissions. RWDI Consulting Engineers and Scientists (RWDI) were retained to conduct the necessary quality assessment for the Yellowknife Gold Project. The following sections draw heavily on the RWDI (2011) report, which is provided in its entirety as Appendix B to the DAR.

6.7.1 Greenhouse Gas Emissions

There are no standards for GHG emissions and therefore Project GHG emissions are typically assessed by comparison with territorial and national totals as well as emissions from other, similar projects. Environment Canada's National Inventory Report (Environment Canada 2010) provides an estimate of Canada's GHG releases to the environment on an annual basis. In 2008, Canadians contributed about 734 Mt of GHGs while Northwest Territories and Nunavut contributed 1.81 Mt.

Environment Canada has a GHG emissions reporting program: if a facility emits more than 50 kt of CO_2 equivalent (reporting threshold), the facility has to report its GHG emissions in accordance with the requirements under the Canadian Environmental Protection Act, 1999.

Greenhouse gases are generally aggregated into "CO_2 equivalents" (CO_2E). The equivalence factor has generally been agreed to be the relative global warming potentials (GWP) of the gas as estimated by the Intergovernmental Panel on Climate Change (IPCC), the major international science body that is co-ordinating research on the climate change issue. The IPCC estimates GWPs for a number of GHGs for various time periods related to the effect of a quantity of the gas released on future atmospheric temperature rise. These numbers vary widely from gas to gas, and they also vary from time period to time periods for a given gas, depending on physical and chemical properties. The 100-year GWPs are generally used. The most recent estimates of 100-year GWPs used by Environment Canada are sanctioned by the IPCC and are shown in Table 6.7-1.

TABLE 6.7-1: GLOBAL WARMING POTENTIALS			
	CO_2	CH_4	N_2O
Global Warming Potential	1	21	310

These numbers mean, for example, that one kilogram of N_2O has 310 times the global warming effect of a kilogram of CO_2 over a period of 100 years from the year of release.

For the Yellowknife Gold Project, GHGs are emitted from the following main sources: underground and surface equipment, diesel generators, and ANFO explosives.

The GHG emissions for underground and surface equipment were estimated using emission factors from National Inventory Report – Greenhouse Gas Sources and Sinks in Canada (Environment Canada, 2010) based on the emission factors based on activity level expressed as per litre of diesel consumption. The expected fuel consumption varies each year throughout the mine life. The maximum annual consumption of 10.7 million litres is in year three while the average annual consumption is 7.2 million litres. Year three was selected for the GHG emission estimation.

CO_2 emissions associated with diesel generators were estimated in accordance with the US EPA NONROAD2005 model. Emissions of CH_4 and N_2O were estimated by scaling the CO_2 emissions using Environment Canada emission factors for non-road diesel equipment. The Project requires approximately 5,000 tpa of ANFO explosives.

Explosives are identified as one of the common sources of GHG emissions in the mining sector (The Mining Association of Canada, 2009). The Energy and GHG Emissions Management Guidance Document by the Mining Association of Canada indicates that 0.189 tonne of CO_2 is emitted for each tonne of ANFO explosives used.

Total GHG emissions from the Project are summarized in Table 6.7.2. The diesel generators at the Ormsby site are expected to emit the most GHGs. Total Project-related emissions of 123,954 tonnes per year would represent a 0.02% increase compared to the estimated Canadian total emissions in 2008 and a 7% increase compared to Northwest Territories and Nunavut's total reported GHG emissions in 2008. The expected GHG emissions during operation are greater than the Environment Canada reporting threshold of 50,000 tonnes.

TABLE 6.7-2: SUMMARY OF ANNUAL YGP GHG EMISSIONS				
Source	CO_2	CH_4	N_2O	CO_2E
Generators (four)- Ormsby	66,921	4	28	75,569
Generator (one) - Nicholas Lake	16,730	1	7	18,892
ANFO explosive	945	-	-	945
Equipment	28,547	2	12	32,236
Total	113,143	6	46	123,954

Greenhouse gas emissions from several other existing mines in the NWT are presented in Table 6.7-3. Total YGP GHG emissions during operations are approximately 1.5 times the total GHG emissions from Snap Lake Mine (63 kt/y) and less than the GHG emissions from Diavik Diamond Mine (159 kt/y) and the Ekati Diamond Mine (210 kt/y).

TABLE 6.7-3: ANNUAL GHG EMISSIONS SUMMARY FOR MINING PROJECTS IN THE NORTHWEST TERRITORIES

Project	Total Annual GHG Emissions (kt CO_2E)	Year and Comments
Snap Lake Mine[2]	63	2008 actual
Diavik Diamond Mine[3]	159	2006 actual
Ekati Diamond Mine[4]	210	2006 actual

Sources: 1: RWDI (2008); 2. De Beers Canada (2008); 3. Diavik (2007); 4. BHP Billiton (2007)

As discussed, the YGP will result in an increase in territorial and national GHG emissions. Since GHG emissions associated with this project are estimated at approximately 7% of total GHG emissions in the Northwest Territories and Nunavut, and 0.02% of total emissions in Canada, the magnitude is rated medium. Greenhouse gas emissions are a contributor to global climate change and therefore the spatial extent is global. GHGs have a long atmospheric lifetime that will extend beyond the life of the project and therefore the duration is rated long term. Emissions will occur continuously for the life of the project. The lifetime of GHGs is long but finite and therefore the potential effect of GHGs is reversible.

Since the GHG emissions from construction activities will cease at the end of construction, the residual effect is rated reversible. Due to the low magnitude, intermittent frequency and reversible nature of the effect, the residual effects of GHG emissions during the construction phase are considered less than significant. Since the construction phase was assessed qualitatively but is bounded by the quantitative assessment of emissions during operations, the level of confidence for GHG emissions during the construction phase is low to moderate.

Since GHGs will be emitted throughout the operation phase and will cease after the operation cease, residual effects are rated continuous and reversible. As the GHG emissions were estimated using a top-down approach based on fuel consumption and emission factors, the overall level of confidence is moderate. Due to the medium magnitude and reversible effect, the potential residual effects of the YGP GHG emissions are considered less than significant.

6.7.2 Air Quality

6.7.2.1 Scope of Air Quality Assessment

The scope of RWDI's air quality assessment of the Yellowknife Gold Project was generally defined by the MVEIRB Terms of Reference (MVEIRB 2009) in combination with communications with EBA and Tyhee NWT Corp. However, since only Dorè will be produced and poured at site, and there will be no gold refinery on site, emissions from a gold refinery are not included in the following assessment.

The YGP will be a source of criteria air contaminant (CAC) and greenhouse gas (GHG) emissions from diesel generators and equipment. There will also be sources of fugitive dust emissions including the mill, open pit, stockpiles, crushers, haul roads, handling and transfer of the ore and waste rock. The tailings containment area will not be a significant source of airbourne contaminants as the tailings will be deposited under water.

The measureable parameters of the assessment are ambient concentrations or deposition levels of CACs and total emissions of GHGs. The specific CACs included in the scope of this assessment are:

- nitrogen dioxide (NO_2);
- sulphur dioxide (SO_2);
- carbon monoxide (CO); and,
- particulate matter (PM);

The specific GHGs included in the scope of this assessment are:

- carbon dioxide (CO_2);
- methane (CH_4); and,
- nitrous oxide (N_2O).

Greenhouse gases are a concern due to their potential to affect global climate changes. Ambient concentrations of CACs are a concern due to their potential to affect human and wildlife health and deposition levels of particulate matter can affect vegetation and water quality.

Oxides of nitrogen (NO_x) are produced when fossil fuels are burned at high temperatures and are composed primarily of nitric oxide (NO) and NO_2. In humans, NO_2 acts as an irritant affecting the mucous membranes of the eyes, nose, throat, and respiratory tract. Continued exposure to NO_2 can irritate the lungs and lower resistance to respiratory infection, especially for people with pre-existing asthma and bronchitis. For this reason, ambient air quality standards are based on NO_2, not NO or NO_x. Nitrogen dioxide can combine with other air contaminants to form fine particulates, which can reduce visibility. It can be further oxidized to form nitric acid, a component of acid rain. Nitrogen dioxide also plays a major role in the secondary formation of ozone.

Sulphur dioxide is produced primarily by the combustion of fossil fuels containing sulphur. Sulphur dioxide reacts in the atmosphere to form sulphuric acid, a major contributor to acid rain, and particulate sulphates, which can reduce visibility. Sulphur dioxide is irritating to the lungs and is frequently described as smelling of burning sulphur.

Carbon monoxide is produced by incomplete combustion of fossil fuels. It is the most widely distributed and commonly occurring air pollutant and comes primarily from motor vehicle emissions. Space heating and commercial and industrial operations are also contributors. Short-term health effects related to CO exposure include headache, dizziness, light-headedness and fainting. Exposure to high CO concentrations can decrease the ability of the blood to carry oxygen and can lead to respiratory failure and death.

Particulate matter is often defined in terms of size fractions. Dustfall refers to the amount of particulate matter of all size classes that settles onto a collection surface in a given amount of time. It is a measure of the amount of particulate present in the ambient air that is deposited on the ground. Particles less than 40 μm in diameter typically remain suspended in the air for some time. This is referred to as total suspended particulate (TSP). Suspended particulate matter less than 2.5 μm in diameter is termed $PM_{2.5}$. Exposure to particulate matter aggravates a number of respiratory illnesses and may even cause premature death in people with existing heart and lung disease. The smaller particles ($PM_{2.5}$) are generally thought to be of greater concern to human health than the larger particles (TSP).

The local study area (LSA) for the air quality assessment of the YGP included both the Ormsby and Nicholas Lake sites. The LSA is a 30 km by 30 km area centred on the midpoint between the Ormsby site and the Nicholas Lake site, as shown in Figure 6.7-1.

The proposed YGP is expected to start construction in the winter of 2014 and commence operation in 2015 with an estimated mine life of 7.5 years. Production will start with mining of the Ormsby Open Pit and Nicholas Lake Underground for the first three years of operation. From year four, Ormsby Underground operation will start and will last until the end of the mine life. After the mine life of 7.5 years, the mine will be decommissioned and reclamation will take place. Four phases were assessed: construction, operation, closure and post-closure.

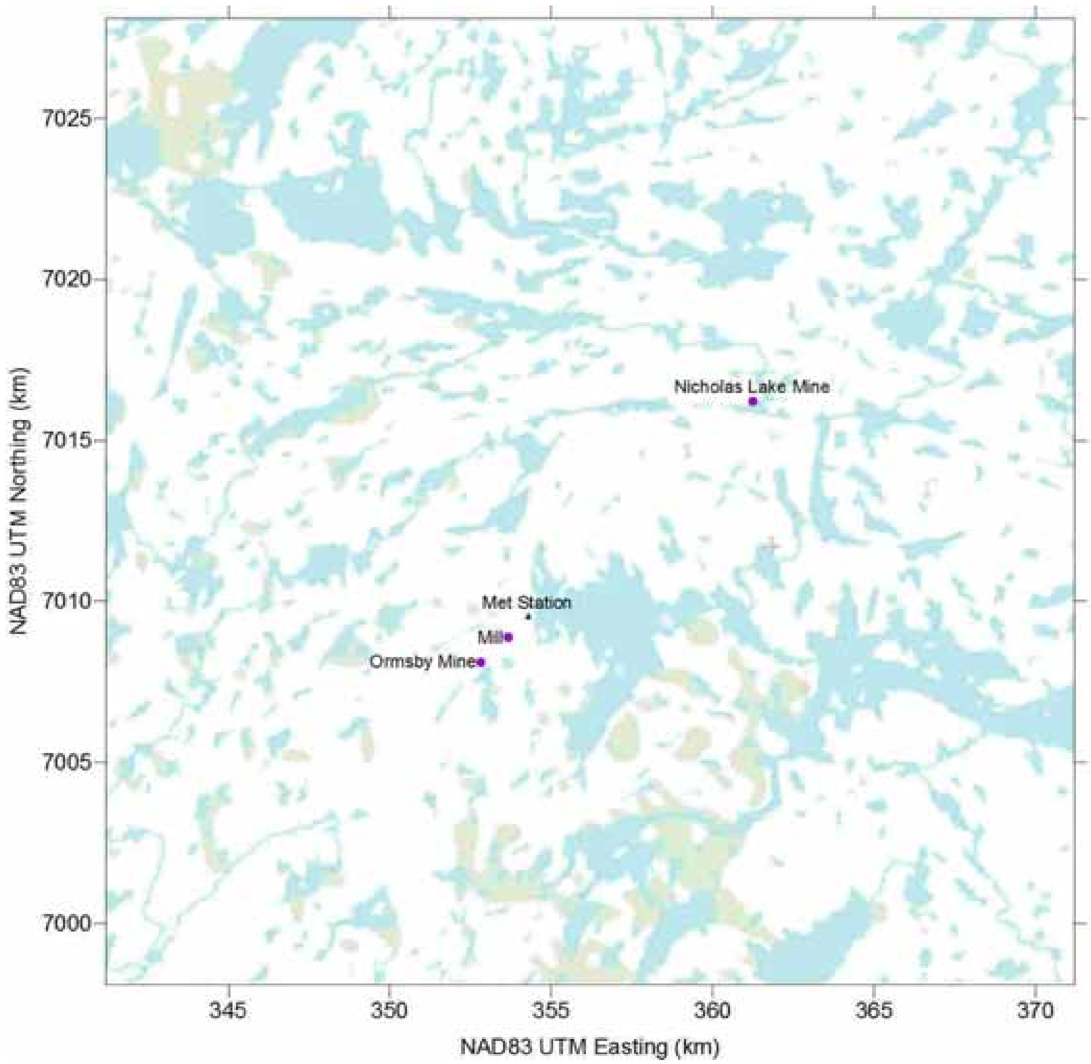

Figure 6.7.1
Yellowknife Gold Project Air Quality Assessment Local Study Area

6.7.2.2 Air Quality Assessment Endpoints

The assessment endpoints for CACs are the ambient air quality standards listed in the Government of the Northwest Territories' (GNWT) Environmental Protection Act. Air quality standards are developed by environmental and health authorities to provide guidance for environmental protection decisions. Contaminants that are included in the NWT's ambient air quality standards are on such receptors as humans, wildlife, vegetation, as well as aesthetic qualities such as visibility. The Government of the Northwest Territories (GNWT) Environmental Protection Act has ambient air quality standards for NO_2, SO_2, CO, TSP and $PM_{2.5}$ (Table 6.7-4).

There are no air quality standards for dustfall in the NWT but there are objectives for dustfall in other jurisdictions such as British Columbia, Alberta and Ontario. Table 6.7-5 shows the dustfall objectives in these jurisdictions to provide context for dustfall predictions in this air quality assessment.

TABLE 6.7-4: NWT AMBIENT AIR QUALITY STANDARDS FOR CRITERIA AIR CONTAMINANTS		
Contaminant	Averaging Period	NWT Standards ($\mu g/m^3$)
NO_2	1-hour	400
	24-hour	200
	Annual	60
SO_2	1-hour	450
	24-hour	150
	Annual	30
CO	1-hour	15,000
	8-hour	6,000
TSP	24-hour	120
	Annual	60
$PM_{2.5}$	24-hour	30

TABLE 6.7-5: DUSTFALL CRITERIA IN OTHER JURISDICTIONS		
Jurisdiction	Criteria	Notes
BC	1.75 $mg/dm^2/day$	In residential areas
	2.9 $mg/dm^2/day$	In all other areas
Alberta	$mg/dm^2/$ day	In residential and recreation areas
	$mg/dm^2/$ day	In commercial and industrial areas

6.7.2.3 Air Quality Assessment Modelling Approach

The air quality assessment focused on YGP operations since the majority of the emissions will occur during this phase and therefore it could be used to bound the overall effects assessment. If the potential effect of emissions during operations was found to be not significant then the potential effect of construction, closure and post-closure emissions, which are expected to be of lower magnitude and shorter duration, would also be not significant. Thus, the operation phase was assessed quantitatively while construction, closure and post-closure were assessed qualitatively.

The quantitative assessment of YGP emissions during the operations phase consisted of the following steps:

- Use professional judgment to rank sources as being major, moderate, or minor.
- Estimate emissions and other stack parameters for major sources of emissions. Generally, CACs were estimated using a bottom-up approach whereas GHGs were estimated using a top-down approach based on total fuel consumption.
- Predict ground-level concentrations of CACs in the LSA using a dispersion model.
- Compare ground-level CAC concentrations to NWT air quality standards and dustfall levels to objectives and guidelines from other jurisdictions. Compare GHG

emissions to territorial and national totals as well as emissions from other projects in NWT.

Based on the production schedule, mining activities and production vary each year of the 7.5 years of mine life. A simplified production schedule is shown in Table 6.7-6, where the shaded cells indicate projected mining activities. Based on the production schedule, year four was selected to represent the worst-case year for dispersion modelling since there will be mining activities at three sites.

TABLE 6.7-6: BASE CASE SIMPLIFIED YGP PRODUCTION SCHEDULE

Area	Year							
	1	2	3	4	5	6	7	8
Ormsby Open Pit								
Ormsby Underground								
Nicholas Lake Underground								
Total Ore (million t)	**0.9**	**1.3**	**1.1**	**1.3**	**1.3**	**1.1**	**0.4**	**0.09**

Ranking of Emission Sources

For the estimation of CAC emissions using a bottom-up approach, sources were ranked as being major, moderate, or minor sources using professional judgment based on previous experience with similar projects. The sources considered major or moderate were assessed quantitatively whereas minor sources were assessed qualitatively.

Using this approach, the emission sources identified for the YGP are listed and ranked in Table 6.7-7. Justification for the rankings is also provided in this table.

TABLE 6.7-7: YGP EMISSIONS SOURCES IN THE LSA

Source	Type of Emissions	Rank	Comments
Underground mining activities and processing	CACs and GHGs	Major	CAC, GHG and fugitive dust emissions from all mining activities will be concentrated through two ventilation raises
Open pit mining activities	CACs and fugitive dust	Major	Open pit mining activities include drilling, excavator loading onto truck and blasting. Note that blasting is assessed qualitatively because both frequency and affected area are unknown.
Exhaust from diesel generator stacks	CACs and GHGs	Major	Four diesel generators will be used at the Ormsby site and one diesel generator will be used at the Nicholas Lake site to support all power to the mine and mill activities.
Surface equipment	GHGs	Major	Fuel combustion in equipment is a large source of CACs and GHGs
Transfer and handling of ore	CACs	Moderate	Ore transfer and handling is a moderate source of PM emissions

TABLE 6.7-7: YGP EMISSIONS SOURCES IN THE LSA			
Source	**Type of Emissions**	**Rank**	**Comments**
Crushing of ore	CACs	Major	Crushing of ore is a large source of PM emissions
Wind Erosion from Run-of-mine (ROM) and crushed ore stockpiles	CACs	Minor	Stockpiles at the Ormsby site will be enclosed and therefore there will be no wind erosion.
ANFO explosive	GHGs	Moderate	ANFO explosives are a moderate source of CO_2 emissions
Fuel combustion in vehicles	CACs and GHGs	Minor	CAC emissions from fuel combustion in vehicles will be short-term and localized. GHG emissions were estimated
Fugitive dust emissions from haul trucks and roads	Fugitive dust	Minor	Fugitive dust emissions from trucks and roads will be short-term and localized
Fuel consumption in aircraft	CACs and GHGs	Minor	Limited effect on ground-level ambient concentrations with infrequent operating hours
Waste incineration	CACs	Minor	Waste will be incinerated daily and therefore the process that will not emit continuously

Emission Estimation

The emissions from the YGP were estimated using a systematic approach. Since the project has not yet been constructed, there are no direct measures of the emissions. Manufacturer's specifications were used for emission estimates when available. Industry-specific emissions factors were used to calculate emission rates if the manufacturer had not yet been selected by Tyhee NWT Corp. Emission factors are representative values that relate the quantity of a contaminant released into the atmosphere based on the type of activities associated with the release of contaminants. In this assessment, emission factors from the United States Environmental Protection Agency's (US EPA) compilation of Air Pollutant Emission Factors, known as AP-42, were employed in most cases.

Ventilation Raises

To estimate emissions from the underground mine ventilation raises, it was assumed that the quality of the ambient air underground will be maintained to meet the Mine Health and Safety Standards in NWT. The Mine Health and Safety Regulations R-125-95 for NWT states that threshold limit values (TLV) set out in the handbook Threshold Limit Values for Chemical Substances and Physical Agents issued by American Conference of Governmental Industrial Hygienists (ACGIH) are to be followed (ACGIH, 1997).

Since the ambient air underground were assumed to meet the standards outlined in the Mine Health and Safety Regulations, emission rates through the ventilation raises were conservatively estimated using the design air flow rate and the appropriate TLVs. ACGIH standards were obtained for NO_2, SO_2, CO and TSP, shown in Table 6.7-8. Emissions of $PM_{2.5}$ were assumed to be 7.5% of TSP according to Particulate Matter Speciation Profile by California Emission Inventory and Reporting System (CEIDAR,

2009) for mineral crushing, screening, and handling. There will be two ventilation raises at each mine site. The ventilation rate of 85 m3/s per mine was assumed to be distributed evenly between the two raises.

TABLE 6.7-8: THRESHOLD LIMIT VALUES FOR MINE HEALTH AND SAFETY STANDARDS IN NWT					
	NO_2	SO_2	CO	TSP	$PM_{2.5}$
ACGIH TLV (mg/m^3)	5.6	5.2	29	10	0.75

Open Pit Activities

Open pit activities will include drilling, excavator loading to haul trucks, and blasting. Because the frequency and the blast area are both unknown, blasting was assessed qualitatively. Drilling was assumed to occur once per hour. Emission factors were obtained from AP-42 Chapter 11 and speciation of $PM_{2.5}$ from TSP was from CEIDAR, 2009. The transfer to haul trucks using excavators will be performed outdoors and the emission is a function of the wind speed; therefore, the emissions were calculated based on AP-42 Chapter 13.

Diesel Generators

Four EMD 16-710GC 2985 kW (tier 2) diesel generators at the Ormsby site and one at the Nicholas Lake site will be required to operate continuously to meet the power demand. Additional diesel generators will be available for emergency standby but are not included in the assessment. The US EPA NONROAD2005 model was used to estimate emissions from the diesel generators. The manufacturer's specifications indicate a load factor of 90%.

Transfer and Handling

There will be several transfer points of dry ore. At Ormsby, there will be three enclosed transfer points: transfer from underground or open pit mine to ROM stockpile, transfer from tertiary cone crusher to crushed ore stockpile, and loading onto conveyor from crushed ore stockpile to the mill. Emissions from enclosed transfers of ore were estimated using AP-42 Chapter 11. Transfer from the underground mine to ROM stockpile at Nicholas Lake site, and the transfer to the waste dumps at Ormsby and Nicholas Lake will occur outdoors. Emissions from these sources were estimated using the methodology outlined in AP-42 Chapter 13.

At the Ormsby site, stockpiles and equipment will be enclosed in a large building with four rooms. The ROM stockpile will be in one room, the three crushers in another, crushed stockpiles in the third room, and the mill in another room. The milling processes are wet and therefore no emission is expected. Each of the other rooms will be equipped with a baghouse. A control efficiency of 99% was assumed for the baghouses.

Table 6.7-9 summarizes the total estimated annual emissions from the Ormsby and Nicholas Lake sites. The largest sources of TSP will be the ventilation raises at both the Ormsby and Nicholas Lake sites. The largest source of other CACs will be the set of diesel generators at the Ormsby site.

TABLE 6.7-9: SUMMARY OF ANNUAL CAC EMISSIONS					
Source	CAC Emissions (tonnes/y)				
	NO_2	SO_2	CO	TSP	$PM_{2.5}$
Ormsby Site					
Generators (four)	517	0.62	96	17	16
Ventilation (two raises)	30	28	155	54	4
Crushing of Ore	-	-	-	31	2
Open Pit	-	-	-	32	2
Transfer and Handling of Ore	-	-	-	28	2
Subtotal	547	28	252	134	25
Nicholas Lake Site					
Generator (one)	129	0.2	24	4	4
Ventilation (two raises)	30	28	155	54	4
Transfer and Handling of Ore	-	-	-	0.4	0.03
Subtotal	159	28	180	58	8
Total	707	57	431	192	33

Dispersion Modelling

Dispersion modelling was conducted using the US EPA CALPUFF dispersion model. CALPUFF is a multi-layer, multi-species, non-steady-state puff dispersion model. It simulates the effect of time- and space-varying meteorological conditions on pollutant transfer, transformation and deposition. CALPUFF can use three-dimensional meteorological fields developed by the CALMET model or simple, single-station winds in a format consistent with the meteorological files used to drive the ISCST3 steady-state Gaussian model. For this study, using meteorology from a single station was deemed sufficient.

Since the GNWT does not have dispersion model guidelines, CALPUFF modelling for the Project was performed in accordance with the Guidelines for Air Quality Dispersion Modelling in BC. Table 6.7-10 summarizes the CALPUFF model switch settings that were used in this assessment and Table 6.7-11 summarizes the emission source types.

NO_x emissions are comprised of NO_2 and NO. The primary emission is in the form of NO with reactions in the stack and atmosphere resulting in the conversion of NO to NO_2. There are two methods outlined in the Guidelines for Air Quality Dispersion Modelling in BC for converting NO_x to NO_2: ambient ratio and ozone limiting. The ozone limiting method was selected. Ozone observed in Norman Wells in 2006 (Environment Canada, 2008) were used in the calculation. The maximum one-hour and 24-hour concentrations were 51 and 44 ppb, respectively, and the annual average was 22 ppb.

TABLE 6.7-10: CALPUFF MODEL SWITCH SETTINGS

Parameter	Default	Project	Comments
MGAUSS	1	1	Gaussian distribution used in near field
MCTADJ	3	3	Partial plume path terrain adjustment
MCTSG	0	0	Scale-scale complex terrain not modelled
MSLUG	0	0	Near-field puffs not modelled as elongated
MTRANS	1	0	Transitional plume rise modelled
MTIP	1	1	Stack tip downwash used
MBDW	2	1	ISC type building downwash used
MSHEAR	0	0	Vertical wind shear not modelled
MSPLIT	0	0	Puffs are not split
MCHEM	1	0	Chemical transformation not modelled
MAQCHEM	0	0	Aqueous phase transformation not modelled
MWET	1	0	Wet removal modelled for fugitive dust sources
MDRY	1	0 or 1	Dry deposition modelled for fugitive dust sources
MDISP	2 or 3	2	Near-field dispersion coefficients internally calculated from sigma-v, sigma-w using micrometeorological variables
MTURBVW	3	3	This variable is not used for MDISP = 2
MDISP2	3	2	This variable is not used for MDISP = 2
MROUGH	0	0	PG σ_y and σ_z not adjusted for roughness
MPARTL	1	0	No partial plume penetration of elevated inversion
MTINV	0	0	Strength of temperature inversion computed from default gradients
MPDF	0	1	PDF used for dispersion under convective conditions as recommended for MDISP = 2
MSGTIBL	0	0	Sub-grid TIBL module not used for shoreline
MBCON	0	0	Boundary concentration conditions not modelled
MFOG	0	0	Do not configure for FOG model output
MREG	1	0	Do not test options specified to see if they conform to regulatory values

TABLE 6.7-11: CALPUFF EMISSION SOURCE TYPES

Emission Source		CALPUFF Source Type (Point, Area, or Volume)	Nature of Emissions (Constant or Variable)
Underground Mining Activities		Point	Constant
Ormsby Open Pit		Volume	Variable
Diesel Generators		Point	Constant
Crushing, Transfer and Handling of Ore	Enclosed sources (Crusher and indoor stockpiles)	Point	Constant
	Outdoor sources (outside stockpile and waste dump)	Volume	Variable

For this assessment, four years of site-specific surface meteorological data were used (2006 to 2009). Upper air data from Fort Smith were employed to determine mixing heights. These data were processed with CPrammet, the meteorological pre-processor for CALPUFF, to create an ISC-type meteorological file.

Figure 6.7-2 shows the joint frequency distribution of wind direction and wind speed in a polar histogram format based on the pre-processed meteorological data. The orientation of each bar indicates the direction from which the wind is blowing, with direction being shown for the 16 compass points. The length of each bar indicates the frequency of occurrence. The most frequent wind directions are from the east and east-northeast. The maximum wind speed from 2006 to 2009 was 10.3 m/s.

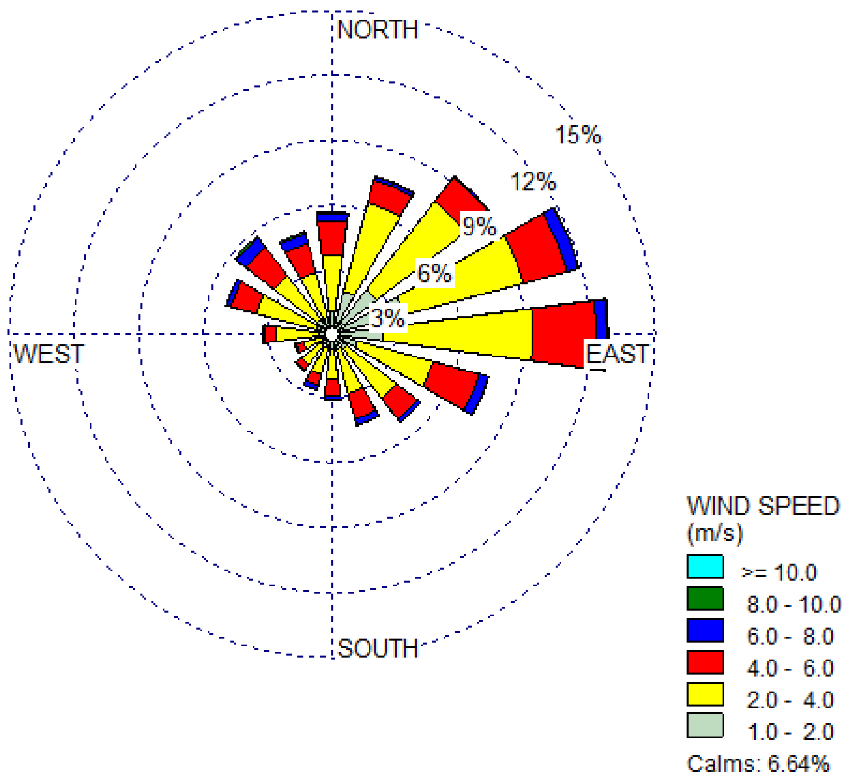

Figure 6.7-2
Joint Frequency Distribution of Wind Direction and Wind Speed Observed at the Ormsby Site from 2006 to 2009

To assess the potential effect of emissions from a facility on ambient air quality, concentrations are predicted beyond the facility boundaries, where ambient air quality standards apply. Within the facility boundaries, occupational health and safety guidelines apply; therefore, receptors inside the boundaries are excluded from the modelling. In this LSA, two areas were excluded, one at the Ormsby site and one at the Nicholas Lake site. A Cartesian receptor grid was adopted with the following receptor spacing:

- 20-m spacing along the plant boundaries where no public access is expected at both the Ormsby and Nicholas Lake sites;

- 50-m spacing for a 2.3 by 2.3 km area centred on the Ormsby site and a 0.77 by 0.77 km area centred on the Nicholas Lake site;
- 250-m spacing for a 3.8 by 3.8 km area centred on the Ormsby site and a 2.27 by 2.27 km area centred on the Nicholas Lake site;
- 500-m spacing for a 6.8 by 6.8 km area centred on the Ormsby site and a 5.27 by 5.27 km area centred on the Nicholas Lake site;
- 1000-m spacing for the remainder of the 30 km by 30 km LSA.

In addition to the Cartesian grid described above, discrete receptors were defined at the camps at the Ormsby and Nicholas Lake sites. The terrain elevations for these receptors were extracted from 1: 250,000 scale Canadian Digital Elevation Data. A map of the LSA with the receptors is shown in Figure 6.7-3.

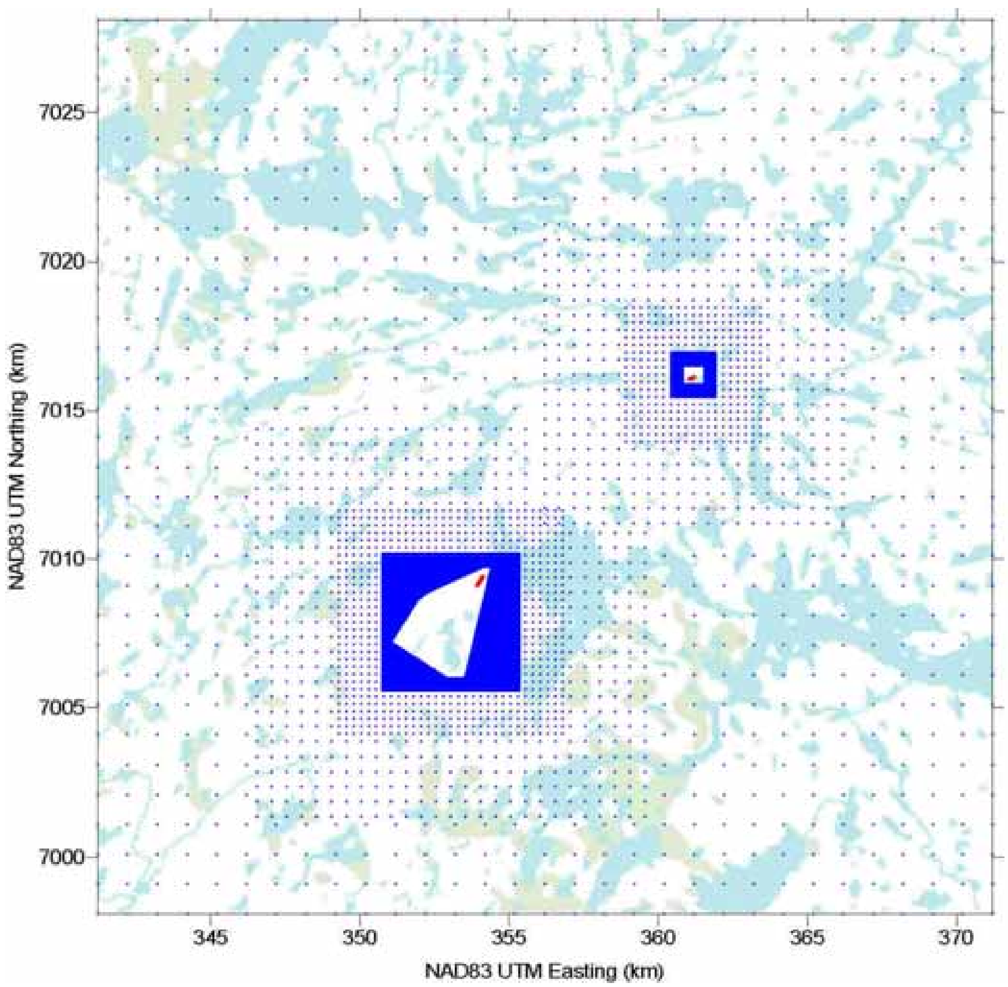

Figure 6.7-3
Local Study Area Showing Gridded Receptors (Blue Dots) and Discrete Receptors (Red Dots)

6.7.2.4 Air Quality Effects Assessment

Construction

Equipment and vehicles used for site preparation and construction of Project infrastructure will emit CACs. These activities will also be sources of fugitive dust. Construction will include upgrading an existing road and construction of an access road. Based on previous experience and professional judgment, it is expected that YGP construction emissions will be of smaller magnitude and shorter duration than emissions during operation. Therefore, it is assumed that potential effects due to construction are bounded by the potential effects due to YGP operations. Thus, residual effects due to construction emissions were assessed qualitatively. Furthermore, emissions during YGP construction will be managed using best practices outlined in the Air Quality Management Plan (Section 6.8.1.9).

Operations

As previously indicated, there will be four main sources of CAC emissions: underground mining activities; Ormsby open pit mining activities; diesel generators; and crushing, transfer and handling of ore. ROM stockpile, crushers, and crushed ore stockpile at the Ormsby site will be in separated rooms inside the same building. All the crushers will be inside the same room. Air from each room will be vented through separate baghouses.

The hourly emission rates that were used as inputs to the dispersion model are summarized in Table 6.7-12. The hourly emissions were calculated using design capacities (maximum obtainable output) where available. For the sources without maximum design capacities, annual production rates were converted to hourly emission rates based on the operation schedule of 365 days per year. Residual effects due to operations-related emissions are further assessed in the residual effects assessment section (Section 6.7.5).

TABLE 6.7-12: EMISSION RATES USED FOR YGP DISPERSION MODELLING

Sources	Emissions Rate (g/s)				
	NO_x	SO_2	CO	TSP	$PM_{2.5}$
Ventilation Raises (each, for both Ormsby and Nicholas Lake sites)	0.48	0.44	1.23	0.85	0.06
Ormsby Open Pit	-	-	-	1.07	0.08
Diesel Generator (one)	4.10	0.005	0.76	0.13	0.13
ROM Stockpile at Ormsby Site	-	-	-	0.02	0.002
Crushers at Ormsby Site	-	-	-	0.76	0.06
Crushed Ore Stockpile at Ormsby Site	-	-	-	0.04	0.003
Waste Dump at Ormsby Site	-	-	-	0.85	0.06
ROM Stockpile at Nicholas Lake Site	-	-	-	0.01	0.001
Waste Dump at Nicholas Lake Site	-	-	-	0.001	0.0001

The ventilation raises were assumed to be 3 m above ground with diameter of 2.1 m. The ventilation rate for each underground mine is expected to be 85 m^3/s, with each ventilation raise venting half the flow rate. The Ormsby open pit mining activities, including drilling and excavator loading to haul trucks, were modelled using a release height of 1 m. Diesel generator exhaust parameters were obtained from manufacturer's specifications (Electro-Motive-Diesel, 2009) and personal communication with Waterous Power Systems.

The emissions from crushing, wind erosion of the ROM stockpile and wind erosion of the crushed ore stockpile at Ormsby site were assumed to exit through the baghouse stacks. The flow rates through the baghouses were calculated assuming two building exchanges per hour assuming and that half the space in each room is occupied by either equipment or stockpile. The transfers to the waste dumps at Ormsby and Nicholas Lake would be outdoor and were assumed to emit at a height of 12 m. The release height of the transfer to the ROM stockpile at Nicholas Lake was assumed to be 5 m. The stack parameters used in the modelling are summarized in Tables 6.7-13 and 6.7-14.

TABLE 6.7-13: STACK PARAMETERS USED FOR POINT SOURCE DISPERSION MODELLING

Sources	Stack (m)	Stack Inner Diameter (m)	Stack Exit Temperature (°C)	Stack Exit Velocity (m/s)
Ventilation Raises	3	2.1	0	12.3
Diesel Generator (one)	4.6	0.6	335	40.1
ROM Stockpile at Ormsby Site	26.9	1.5	10	14.7
Crushers at Ormsby Site	26.9	0.7	10	11.3
Crushed Ore Stockpile at Ormsby Site	26.9	1.5	10	14.7

TABLE 6.7-14: STACK PARAMETERS USED FOR VOLUME SOURCE DISPERSION MODELLING

Sources	Release Height (m)	Initial Sigma –Y and –Z (m)
Ormsby Open Pit	1	2
Waste Dump at Ormsby Site	12	2
ROM Stockpile at Nicholas Lake Site	5	2
Waste Dump at Nicholas Lake Site	12	2

As the stacks are relatively short, the associated plumes may be influenced by building downwash. For this reason, building downwash effects were assessed in the dispersion modelling. Tables 6.7-15 and 6.7-16, respectively, summarize the building dimensions that were used for each of the Ormsby and Nicholas Lake sites.

TABLE 6.7-15: ORMSBY SITE BUILDING PARAMETERS USED FOR DISPERSION MODELLING						
Description		**Camp**	**Diesel Storage**	**Power Generation**	**Process Plant Building**	**Truck shop, warehouse, and office**
Base Elevation	(m)	309.25	309.25	309.25	309.25	309.25
Height	(m)	3.048	6.096	4.572	25.908	6.096
Number of Vertices		4	4	4	4	4
Vertices:						
Corner1	(mE)	354.09	353.47	353.59	353.63	353.56
	(mN)	7009.43	7008.58	7008.68	7009.03	7008.77
Corner2	(mE)	354.15	353.51	353.63	353.81	353.60
	(mN)	7009.39	7008.53	7008.63	7008.93	7008.73
Corner3	(mE)	353.94	353.36	353.55	353.71	353.41
	(mN)	7009.08	7008.40	7008.56	7008.75	7008.56
Corner4	(mE)	353.89	353.32	353.51	353.53	353.37
	(mN)	7009.12	7008.44	7008.61	7008.85	7008.60

TABLE 6.7-16: NICHOLAS LAKE SITE BUILDING PARAMETERS USED FOR DISPERSION MODELLING					
Description		**Camp**	**Shop**	**Diesel Storage**	**Power Generation Plant**
Base Elevation	(m)	341.8	341.8	341.8	341.8
Height	(m)	3.048	3.048	6.096	4.572
Number of Vertices		4	4	4	4
Vertices:					
Corner1	(mE)	361.20	361.06	361.14	361.10
	(mN)	7016.17	7016.17	7016.30	7016.34
Corner2	(mE)	361.23	361.17	361.16	361.12
	(mN)	7016.12	7016.23	7016.27	7016.31
Corner3	(mE)	361.06	361.20	361.12	361.10
	(mN)	7016.03	7016.17	7016.23	7016.30
Corner4	(mE)	361.03	361.09	361.09	361.08
	(mN)	7016.08	7016.12	7016.25	7016.32

The maximum ambient concentrations of CACs and dustfall levels predicted using the CALPUFF model are shown in Table 6.7-17 and 6.7-18, respectively. The maximum predicted CAC concentrations within the LSA are less than the corresponding NWT ambient air quality standards for all contaminants. Most of the maximum CAC concentrations were predicted to be less than half of the NWT AQ standards except 24-hour TSP. The maximum 24-hour TSP is 119 ug/m^3 compared to the standard of 120 ug/m^3. The maximum predicted 30-day dustfall depositions level is much less than the most stringent criteria. Maximum predicted 24-hour TSP concentrations at the camps were predicted to be less than 40 ug/m^3, which is less than a third of the ambient ambient quality standard.

TABLE 6.7-17: MAXIMUM PREDICTED CAC CONCENTRATIONS			
Pollutant	Averaging Period	Maximum Concentrations (ug/m^3)	NWT (AQ Standard ug/m^3)
NO_2	1-hour	152	400
	24-hour	105	200
	Annual	7	60
SO_2	1-hour	146	450
	24-hour	48	150
	Annual	5	30
CO	1-hour	407	15,000
	8-hour	217	6,000
TSP	24-hour	119	120
	Annual	11	60
$PM_{2.5}$	24-hour	13	30

TABLE 6.7-18: MAXIMUM PREDICTED DUSTFALL DEPOSITION LEVELS		
Dustfall	Maximum Predicted Deposition Level ($mg/dm^2/day$)	Most Stringent Criteria ($mg/dm^2/day$)
	0.39	1.75

The spatial distributions of maximum predicted concentrations and dustfall levels are presented in the form of isopleth maps. Since all predicted concentrations are less than the ambient standards, only one plot is shown per contaminant for the shortest relevant averaging period.

The highest one-hour NO_2 concentration was predicted to occur immediately west of the Ormsby camp (6.7-4). The highest one-hour SO_2 and CO concentrations (Figure 6.7-5 and Figure 6.7-6) were predicted to occur immediately north of the Nicholas Lake camp. The highest 24-hour TSP (Figure 6.7-7) and 24-hour $PM_{2.5}$ (Figure 6.7-8) concentrations, and 30-day dustfall levels (Figure 6.7-9) were predicted to occur immediately outside the waste dumps at Ormsby and Nicholas Lake sites.

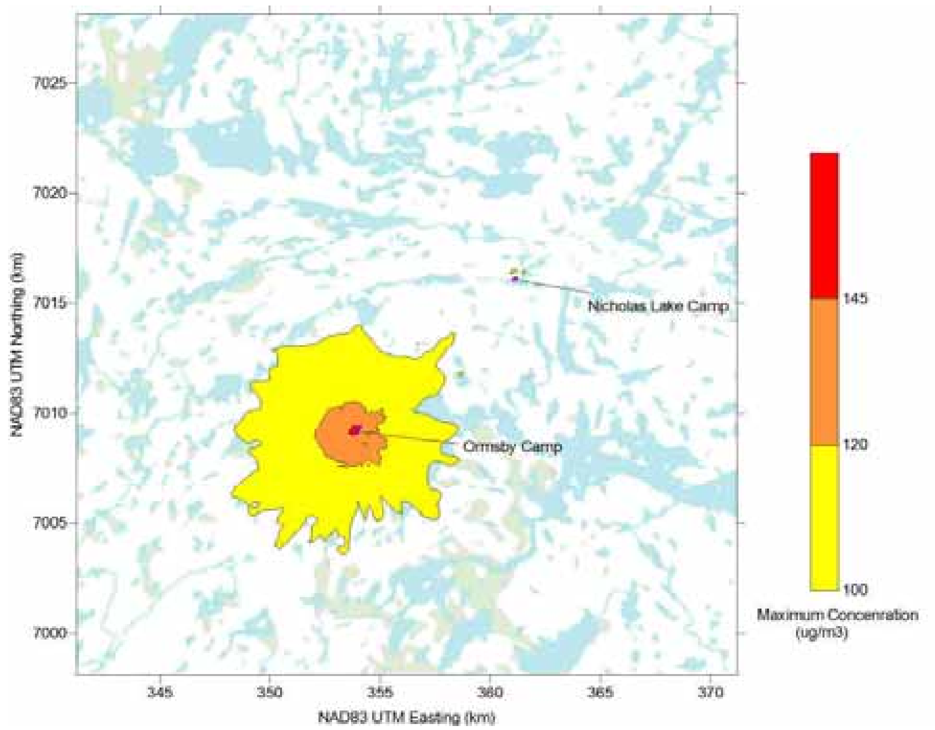

Figure 6.7-4
Isopleths of Maximum Predicted One-Hour Average NO_2 Concentrations

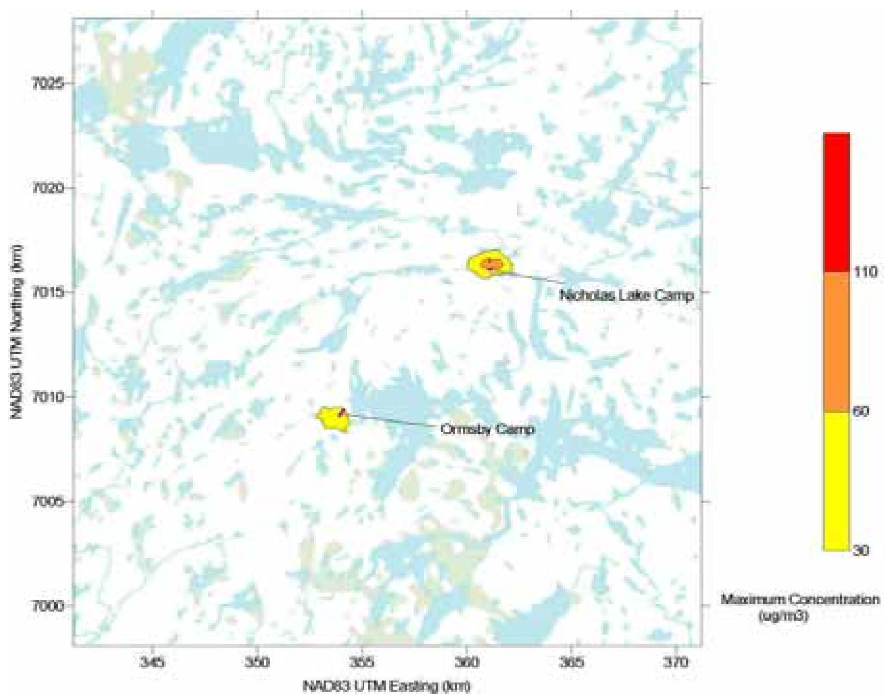

Figure 6.7-5
Isopleths of Maximum Predicted One-Hour Average SO_2 Concentrations

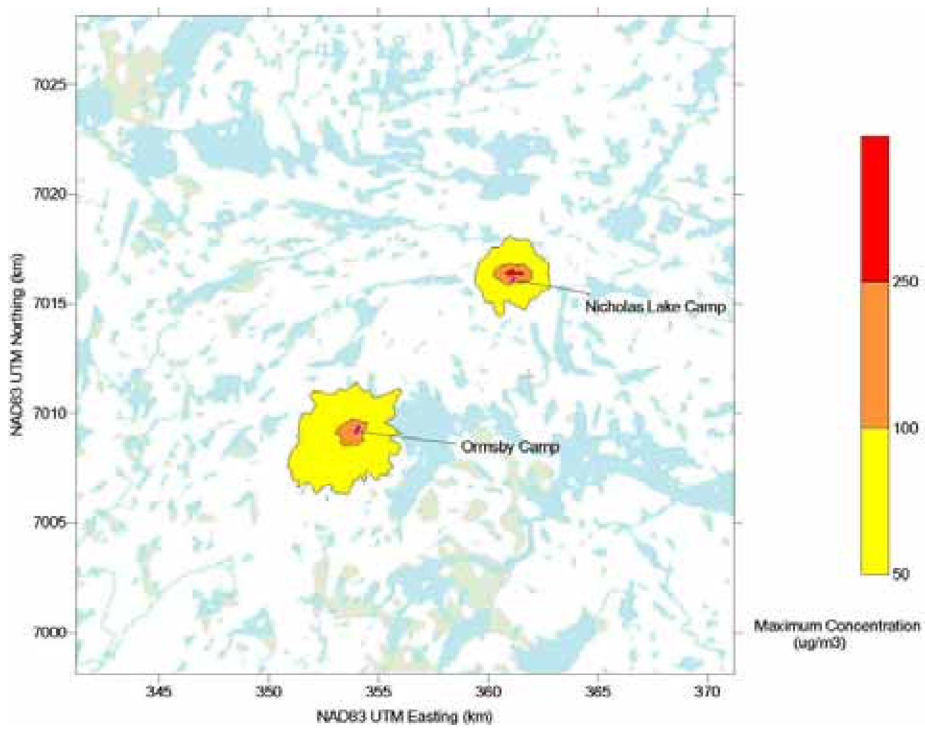

Figure 6.7-6
Isopleths of Maximum Predicted One-Hour Average CO Concentrations

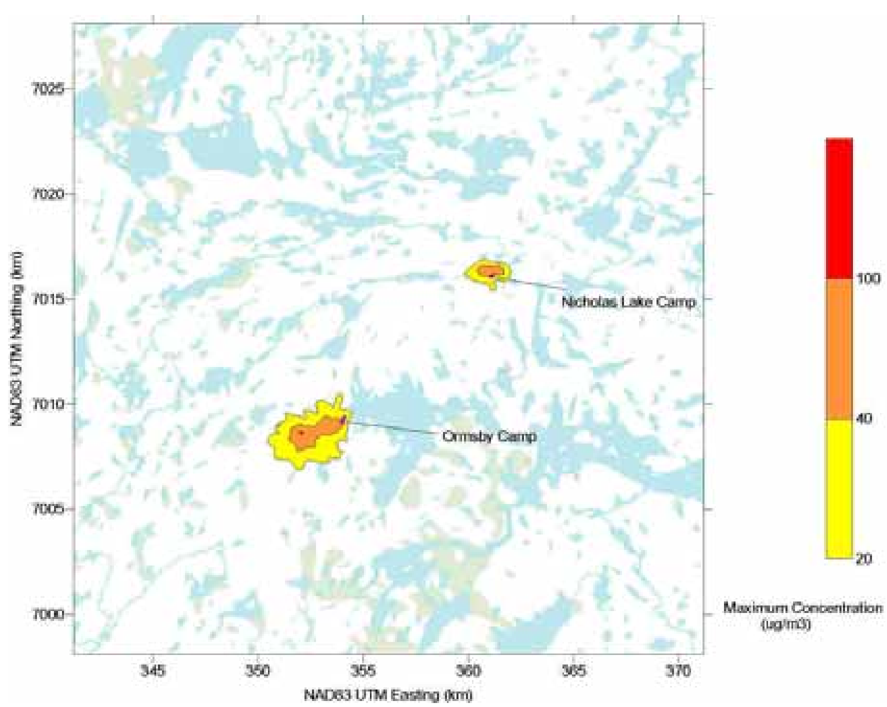

Figure 6.7-7
Isopleths of Maximum Predicted 24-Hour Average TSP

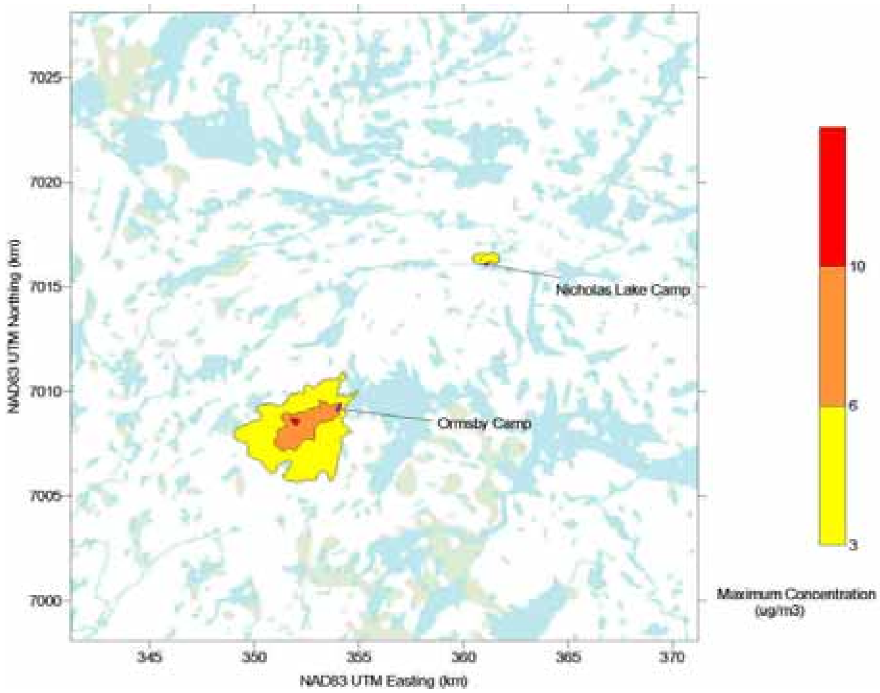

Figure 6.7-8
Isopleths of Maximum Predicted 24-Hour Average $PM_{2.5}$

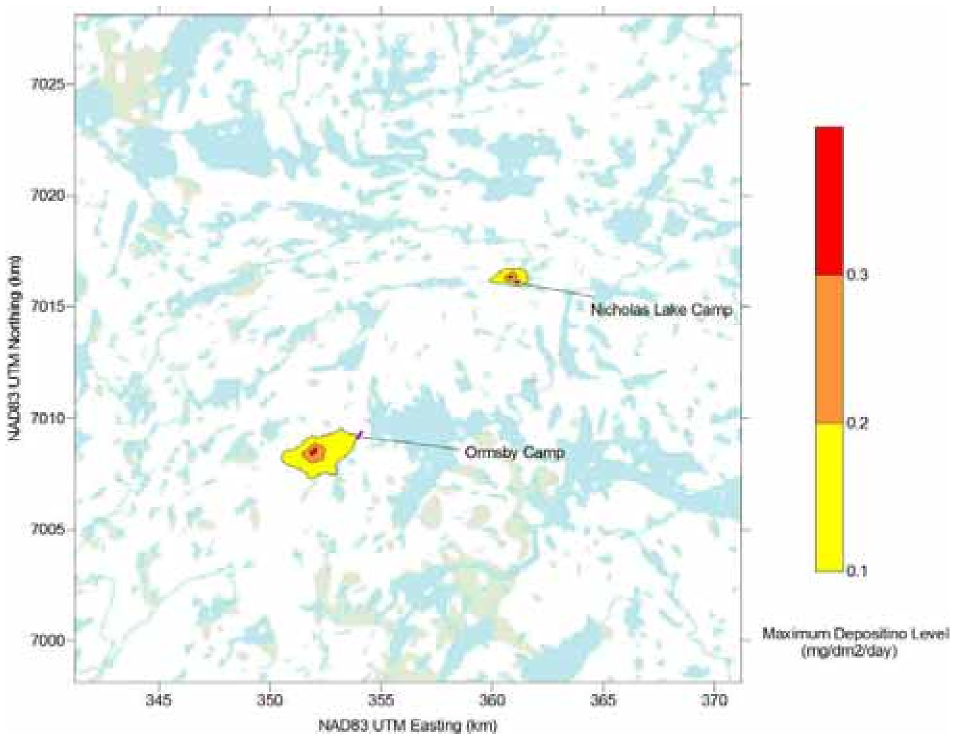

Figure 6.7-9
Isopleths of Maximum Predicted 30-day Average Dustfall Deposition Levels

6.7.3 Noise

The Yellowknife Gold Project is located in a remote area where natural background ambient noise levels are expected to be low, generally in the range of 35 dBA. The acoustic environment is dominated by the sounds of nature, e.g. wind rustling through the foliage, birds singing, waves lapping on the shores of Thor Lake, etc.

Man-made sounds that can currently be heard in the YGP Area from time to time are those associated with the limited and intermittent ongoing exploration drilling program, the existing mining camp at Ormsby, the camp power generator, local exploration-related vehicle traffic, and the limited fixed-wing aircraft flights that use the airstrip or Giaque Lake.

During the short (1 year) construction phase, noise levels would be expected to be considerably greater and extend for longer periods of time. Sources of noise at that time would be related primarily to overburden removal for the open pit, general site preparation and infrastructure construction activities, including blasting, excavation, earth-moving, tailings dam and building construction.

Upon completion of construction, noise levels would be expected to be lower because the the process plant, camp and power generation plant will be contained inside solid, insulated structures. Continuing sources of noise generated during the long-term operations phase would be mainly associated with ongoing blasting and open pit mining, the movement of haul trucks and other mine-related vehicle traffic, and air traffic into and out of the airstrip.

Table 6.7-19 from Harris (1991) identifies typical sound levels associated with common sources of noise that are familiar to the residents of the communities in vicinity of the YGP.

TABLE 6.7-19: TYPICAL SOUND LEVELS OF COMMON NOISES

Description	Type of Noise	Sound Level (dBA)
Rural area – background noise	Continuous	30 - 35
Small town residential – background noise	Continuous	35 - 40
Snowmobile at 15 m	Intermittent	75 (peak)
Snowmobile at 1 km	Intermittent	50 (peak)
Truck at 15 m	Intermittent	85 (peak)
Truck at 1 km	Intermittent	65 (peak)

Mining equipment and activities associated with the YGP will produce various kinds of intermittent and/or continuous sounds throughout the 7.5 life of the project. The main sources of steady, continuous noise during the operations phase at the two YGP mine sites will be produced by the power plants.

Short-term, intermittent noise will be generated during blasting in the open pit, by the mobile equipment required to construct and/or operate the YGP and associated infrastructure and by aircraft using the airstrip (Table 6.2-20). This would include earth-moving and open pit mining equipment including bulldozers, loaders, haul trucks, construction cranes(s), haul trucks, water truck, pickups/SUVs and other miscellaneous equipment

TABLE 6.2-20: TYPICAL MAXIMUM CONSTRUCTION AND MINING EQUIPMENT SOUND LEVELS

Noise Source	Sound Level (dBA) at Various Distances			
	15 m	30 m	60 m	120 m
Bulldozer	85	79	73	67
Loader	85	79	73	67
Crane	83	77	71	65
Moving haul truck	88	82	76	70
Idling haul truck	65	59	53	47
Diesel generator	70	64	58	52

Notes:

(1) Reference sound level obtained from OMOE Publication NPC-115, contained in the OMOE *Model Municipal Noise Control By-Law* 1977.

(2) Reference sound levels obtained from US Department of Transportation , *Transit Noise and Vibration Impacts Assessment*, Chapter 12: Noise and Vibration.

(3) Reference sound level obtained from *British Standards No. 5228, Second Edition, May 1997*.

When comparing sound level values, the following general rules from De Beers (2002) may be used:

- a difference in sound level of less than 3 dBA is barely perceptible to the human ear
- a difference of 5 dBA is noticeable
- a difference of 10 dBA corresponds to a halving or doubling in perceived loudness
- a 20 dBA difference corresponds to a four-fold difference in perceived loudness.

It is also important to note that sound propagation between a noise source and receptor (e.g. person or animal listening) is affected by several sound attenuation (reducing) mechanisms. These include the following:

- Distance dissipation - sound naturally decreased with increasing distance from the source.
- Ground attenuation - sound is absorbed by the ground that it passes over.
- Atmospheric absorption – sound is absorbed by the atmosphere it passes through.
- Barrier attenuation – sound can be blocked by physical barriers (e.g. buildings, hills or forest.

Sound is affected by wind conditions (i.e. a distant noise source will be louder under downwind conditions than it will be under calm conditions. Conversely, a distant source will be quieter under upwind conditions than it will be under calm conditions).

Sound is affected by temperature conditions in the atmosphere (i.e. a distant noise source will be louder under atmospheric inversion conditions than it will be under neutral atmospheric conditions).

Sound level attenuation predictions and modelling of construction and operations-related activities, as reported in the environmental assessment conducted for the Snap Lake Project (De Beers 2002) were considered to be relevant and directly applicable to evaluating anticipated noise levels associated with the YGP components.

De Beers (2002) determined that "worst case" site construction noise would be at a level of less than 40 dBA at a distance of 1.5 km from the site. As a result of the natural attenuation of outdoor sound with distance, continuous noise from the site would be close to, or less than ambient sound levels at distances of about 6 km from the site.

For the operations phase of the Snap Lake Project average values for continuous noise emanating from the site were also predicted to be less than 40 dBA at a distance of 1.5 km from the site. It was noted that this sound level was similar to the level of continuous background noise that would occur in a small town residential area.

Although the continuous noise produced by the site at this distance was identified to be greater than pre-existing ambient sound levels during calm conditions, the predicted sound level met the guideline criteria of the Alberta EUB Noise Control Directive (EUB 1999) for industrial facilities in remote locations.

The construction and operations phase of the two YGP mine sites and associated activities, are expected to generate similar noise levels to those discussed in this section for the Snap Lake Project.

Based on the available information, noise levels emanating from the YGP area during all phases of the project are predicted to be typically less than 40 dBA at a distance of 1.5 km from the site.

As discussed, noise generated by the two YGP sites and associated activities will be variable and will continue for the life of the project. Following cessation of project-related activities noise levels will immediately return to existing ambient conditions.

Some wildlife may show minor displacement behaviour and avoid the immediate YGP development area during periods of particularly loud and irregular noises. The duration of such exposures are expected to be brief, perhaps lasting a few minutes to a few hours, and are reversible upon cessation of the activity or by moving away from the activity. The number and frequency of such exposures to noise disturbance by wildlife would be expected to be limited and sporadic.

The overall environmental consequences of noise generated by the two YGP mine sites and associated activities are expected to be low and the residual impact on the existing noise environment of the LSA and RSA is expected to be negligible.

6.7.4 Project Design Features and Mitigation Measures

The construction and operation of the Yellowknife Gold Project and associated infrastructure will release gaseous and particulate emissions and generate varying degrees and types of noise for the projected 7.5-year life of the YGP. Emissions will emanate from fuel combustion, vehicle exhausts, exhausts from the underground mine, the process plant and other sources associated with operation of the YGP.

6.7.4.1 Air Quality

Tyhee NWT Corp is committed to employing an adaptive management approach including a number of applicable mitigation measures. Various mitigation measures have already been incorporated into the Project design. Acid-generating waste-rock will not be used in the construction of haul roads, dams and tailing storage facilities. Enclosing the ROM and crushed ore stockpiles in a building will greatly reduce the fugitive dust emissions at the Ormsby site.

The dust emissions from the crushers and the stockpiles will be vented through baghouses, with greater than 99% capture of particulate matter. There will also be sufficient dust control devices on the mining and processing equipment to meet the Mine Health and Safety Regulations in the underground mine.

Hauling of fuel and other heavy or bulk material from Yellowknife will be by winter roads between Prosperous Lake and the mine sites during February and March, which should minimized fugitive dust emissions. Milling will be a wet process with negligible fugitive dust emissions. To minimize potential effects on local and regional air quality and to control greenhouse gas emissions, additional mitigation measures that will be employed by the YGP will include:

- Full compliance with Land Use Permit conditions to be issued by the MVLWB.
- Conformance with the Guidelines for Ambient Air Quality Standards in the NWT.
- Use of low sulphur diesel fuel and regular equipment and engine maintenance.

Use of low NO_x and SO_x diesel power generators.

- Conformance with GNWT Guideline for Dust suppression through the application of dust suppressants – e.g., water or approved dust suppressant products.
- Conformance with GNWT and WCB standards for mine and process plant(s) air quality.
- Disposal of all hazardous wastes in an approved manner.

6.7.4.2 Noise

The construction and operation of the YGP will generate varying degrees and types of noise for the projected 7.5-year life of the Project.

The overall environmental consequences of noises generated by the YGP and associated activities are expected to be low, with no residual effects to the environment. Tyhee NWT Corp is committed to employing an adaptive management approach including a number of mitigation measures to minimize potential effects on the existing noise environment. Such mitigation measures will include:

- Regular maintenance of mobile and stationary equipment used during construction and operations;
- Use of high performance engine exhaust silencers at the YGP power plants.

6.7.5 Residual Effices

6.7.5.1 Air Quality

As previously discussed, based on previous experience on similar projects and professional judgment, the majority of the emissions will occur during the YGP operations phase. Therefore, the effect assessment of the operations phase will bound the construction, closure, and post-closure phases. Emissions associated with the operations phase are assessed quantitatively while construction, closure, and post-closure phases are assessed qualitatively. The residual effects of the YGP on air quality are summarized in Table 6.2-21.

Construction

Since construction of the Project will result in increased emissions of CACs and GHGs, the direction of effect is negative and the likelihood of occurrence is high. Based on previous experience and professional judgment, the magnitude of effect is expected to be low for both CACs and GHGs. The geographical extent of CACs is expected to be limited to the LSA and therefore is rated local while the geographical extent of GHGs is global. Since CACs will only be emitted during the construction phase, duration is rated short term. GHGs have a long atmospheric lifetime and therefore the duration is rated long term.

It is expected that CACs and GHGs will be emitted intermittently during construction. The LSA has not been substantially disturbed by human development and therefore the ecological context is rated undisturbed. Since the CAC and GHG emissions from construction activities will cease at the end of construction, the residual effect is rated reversible. Due to the low magnitude, intermittent frequency and reversible nature of the effect, the residual effects on ambient air quality and GHG emissions are considered less than significant. Since the construction phase was assessed qualitatively but is bounded by a quantitative assessment of emissions during operations, the level of confidence is low to moderate for both CACs and GHGs.

TABLE 6.2-21: SUMMARY OF RESIDUAL EFFECTS ON AMBIENT AIR QUALITY

Phase	Potential Residual Effect	Direction	Magnitude	Likelihood	Geographical Extent	Temporal Extent		Ecological Context	Reversibility	Significance	Level of Confidence
						Duration	Frequency				
Construction	Change in ambient CAC concentration or deposition	Negative	Low	High	Local	Short term	Intermittent	Undisturbed	Reversible	Less than significant	Low to Moderate
	Change in GHG emissions	Negative	Low	High	Global	Long term	Intermittent	Undisturbed	Reversible	Less than significant	Low to Moderate
Operation	Change in ambient CAC concentration or deposition	Negative	Low to Medium	High	Local to Regional	Medium term	Continuous	Undisturbed	Reversible	Less than significant	Moderate
	Change in GHG emissions	Negative	Medium	High	Global	Long term	Continuous	Undisturbed	Reversible	Less than significant	Moderate
Closure	Change in ambient CAC concentration or deposition	Negative	Low	High	Local	Short term	Isolated	Undisturbed	Reversible	Less than significant	Low to Moderate
	Change in GHG emissions	Negative	Low	High	Global	Long term	Isolated	Undisturbed	Reversible	Less than significant	Low to Moderate
Post-Closure	Change in ambient CAC concentration or deposition	Neutral	Negligible	High	Local	Short term	Isolated	Undisturbed	Reversible	Less than significant	Low to Moderate
	Change in GHG emissions	Neutral	Negligible	High	Global	Long term	Isolated	Undisturbed	Reversible	Less than significant	Low to Moderate

Operations

Criteria Air Contaminants

As shown in Table 4.6, the maximum predicted CAC concentrations due to the major sources of emissions during operations are less than the corresponding NWT AQ standards. Similarly, the maximum predicted dustfall levels are less than the most stringent criteria from other Canadian jurisdictions (Table 4.7).

There is the potential for wind erosion of ROM stockpile at Nicholas Lake since it will be located outdoors. Ore size distribution for this Project was not available; however, the primary crusher is designed to reduce the ore to less than four inches (10 cm). Based on a sample calculation of ore with aggregate size of 7 mm using methods detailed in the Control of Open Fugitive Dust Sources (US EPA, 1986), the minimum wind speed required to generate wind erosion is 13 m/s. Since the maximum wind speed from the site specific data for 2006 to 2009 is 10.3 m/s and the aggregate size is unlikely to be smaller than 8 mm, it is assumed that fugitive dust emissions due to wind erosion of the ROM stockpile will be negligible. -

Mobile sources, including aircraft and vehicles, will emit CACs. However, the aircraft will emit CACs at high elevation and therefore should have limited effect on the ground-level concentrations. Fuel combustion emissions from mobile sources are expected to be relatively low in magnitude and intermittent. CACs will be emitted during the entire operation phase and therefore the duration for CACs is medium term. Since all aircraft and vehicles traveling to the Project site will normally pass through Yellowknife, the geographic extent is local to regional for CACs.

Fugitive dust emissions from haul roads tend to be deposited within several hundred metres of the road and are not considered transportable particulate matter; therefore the geographical extent is local and the magnitude is low. The frequency is considered intermittent. The potential effect of CACs is short term.

Waste incineration will be a batch process and therefore the duration is short term and frequency is intermittent. Since the CCME standards will be met the magnitude is considered low.

Blasting typically does not occur on a daily basis and therefore the duration is short term and frequency is intermittent. Particulate matter and dust emissions from blasting tend to be localized and, thus, the geographical extent is local, magnitude is low and potential effect is short term.

Considering both the quantitative assessment of the major sources and qualitative assessment of the minor sources, the YGP has the potential to increase ambient CAC concentrations, the likelihood is high and direction is negative. Most of the maximum ground-level CAC concentrations and maximum dustfall deposition levels are less than half the corresponding NWT AQ standards and criteria from other jurisdiction except 24-hour TSP; therefore, the magnitude is low to medium. Emissions from most of the sources are confined to the LSA except mobile sources, which will extend to the territorial boundary. The geographical extent is rated local to regional.

Since the emission sources will be operating continuously throughout the operation phase of the YGP, the frequency is continuous and the duration is medium term. The ecological context of the LSA is undisturbed. Since the emissions will cease once operations cease the residual effect is reversible. Since the magnitude is low to medium, the geographic extent is local for most emissions, the duration is medium-term and the effect is reversible, the residual effect is considered to be less than significant. The overall level of confidence is rated moderate since only major sources of emissions were included in the quantitative assessment; emissions were estimated using emission factors; and a considerable degree of professional judgment was exercised.

Greenhouse Gases

Since YGP operation will result in an increase in GHG emissions, the direction is negative and the likelihood is high. Since GHG emissions associated with the YGP are approximately 7% of total GHG emissions in the Northwest Territories and Nunavut, and 0.02% of total emissions in Canada, the magnitude is rated medium. The potential effect of GHG emissions on climate change is global and long term due to the long lifetime of the individual gases. Since GHGs will be emitted throughout the operation phase and will cease after the operation cease, residual effects are rated continuous and reversible. Due to the medium magnitude and reversible effect, the potential residual effects of YGP GHG emissions are considered less than significant. Since the GHG emissions were estimated using a top-down approach based on fuel consumption and emission factors, the overall level of confidence is moderate.

Closure

Both CACs and GHGs will be emitted during the closure phase; therefore, the direction is negative and likelihood is high. Since the magnitude of emissions during closure is expected to be low. The geographic extent of the effect of emissions during closure is expected to be local for CACs and global for GHGs. The closure phase is expected to be short term and frequency of emission is expected to be isolated. Since the potential residual effects during closure were assessed qualitatively, the level of confidence is rated low to moderate. Due to the low magnitude, isolated frequency and reversible nature of the effect, the potential effects of the closure phase on ambient air quality and GHG emissions are considered to be less than significant.

Post Closure

After the closure phase, post-closure phase takes place. There is no emission expected during the post-closure phase and therefore, the direction is neutral, magnitude is negligible and likelihood is low. If there are emissions associated with the post-closure phase, the geographic extent of the effect of emissions is expected to be local for CACs and global for GHGs; the frequency would be isolated and the residual effects would be reversible, and less than significant. Since the potential residual effects during post-closure were assessed qualitatively, the level of confidence is low to moderate.

6.8 ENVIRONMENTAL MANAGEMENT SYSTEM

A project Environmental Management System (EMS) will be implemented to provide a systematic method for managing YGP activities in the biophysical environment. It will consist of two key elements:

- environmental management plan (EMP), and
- an environmental monitoring program.

These elements are described below.

The Environmental Management Plan (EMP) will outline how the project will be operated to manage the interaction between: the project components, activities, and the biophysical environment, to prevent or mitigate adverse effects. The EMP will be prepared prior to project construction and will include the following plans:

- Induction procedures for all personnel on site
- Spill Contingency/Emergency Response Plan
- Bulk Materials Management Plan
- Fuel and Hazardous Materials Handling Management Plan
- Explosives Handling and Storage Management Plan
- Waste Rock Management Plan including ARD/ML issues
- Tailings Management Plan
- Solid Waste and Hazardous Waste Management Plan
- Reclamation & Closure Plan

An ongoing Environmental Monitoring Program will be integrated into the EMS as a tool to provide feedback on how well potential impacts have been predicted and to allow appropriate corrective actions to be taken, should unexpected impacts occur. A comprehensive monitoring program will be developed for the project as required by the terms and conditions outlined in the project's land use permits and water license.

Mitigation procedures for construction, operation, care and maintenance, and closure, will be integrated into the EMP to ensure that development is proceeding as predicted and can be maintained in an acceptable state. The EMP will also ensure mitigation measures are implemented correctly; project effects on biophysical components are documented; natural changes in the environment (distinguishing them from project-related impacts) are measured; the effectiveness of reclamation efforts is measured; and permit requirements are met.

6.8.1 Environmental Management Plan

The environmental management plan (EMP) will have three primary goals:

- to keep the YGP in compliance with all governing regulatory instruments;
- to direct mine activities so as to minimize environmental impacts; and
- to continually strive to reduce residual impacts and improve pollution prevention, i.e., reduce the generation of contaminants at source.

The principal methods Tyhee NWT Corp will use to ensure environmental compliance include: monitoring; training of employees to recognize potential environmental problems before they occur; and emergency and spill response plans.

Annual evaluation of the EMP, evaluation of response if accidents occur, and continual evaluation of ways to reduce pollution at source will be integral management functions at YGP. Feedback and suggestions from employees and the community liaison committee will be key tools in pollution prevention analysis. The mine safety committee will also be charged with evaluation of environmental issues and responses.

It is important to note, the various plans outlined below will be updated during the regulatory phase of the Project.

6.8.1.1 Emergency Response and Spill Contingency Plan

Emergency Response Plan

The emergency response plan (ERP) is designed to provide a pre-determined set of instructions for all employees to respond, quickly and efficiently, to any foreseeable emergency that would likely occur at the YGP site or on roads linked to the YGP site. The ERP is a preliminary document, which will evolve as the facilities and on-site activities are finalized and a formal environmental management system (EMS) is developed.

The ERP will work in conjunction with Tyhee NWT Corp's environmental policy and programs currently in place, such as Tyhee NWT Corp's Hazardous Materials Spill Contingency Plan (Appendix K and discussed below).

Scope

An emergency is defined as an unplanned situation on-site that poses a risk to employee health and safety and/or the environment. The ERP forms a link to the Spill Contingency Plan and existing emergency response procedures developed by Tyhee NWT Corp. The ERP forms a foundation from which procedures will be developed that will address the details of emergency response to specific emergencies identified in the ERP. The ERP will be updated as these documents are updated. Tyhee NWT Corp's senior management will approve the plan in writing.

The following additional documents will be consulted during the development of this plan:

- Northwest Territories Water Board's Guidelines for Contingency Planning;
- Environment Canada's Guidelines for Preparing or Reviewing an Emergency Response Plan for a Canadian Pulp and Paper Mill;
- The Canadian Standards Association's Emergency Planning for Industry: A National Standard for Canada;
- Environment Canada's Implementing Guidelines for Canadian Environmental Protection Act, 1999 Section 199 - authorities for requiring environmental emergency plans;
- The Government of the Northwest Territories' Spill Contingency Planning and Reporting Regulations; and,
- The Government of the Northwest Territories' Mine Health and Safety Regulations.

The ERP will contain information pertaining to the organization and responsibility of Tyhee NWT Corp's employees in the case of emergencies, emergency communications, links to specific response procedures and resources, and emergency response training commitments.

Updates to the YGP ERP will be tracked by the operations manager or designate, who will be responsible for distribution of updated versions to all relevant personnel and agencies.

Contractors who will be carrying out certain aspects of the on-site work (*e.g.*, site civil construction and underground mining activities) will be required to perform their work in accordance with all applicable laws and regulations as well as Tyhee NWT Corp's corporate policies.

Distribution

Numbered, controlled copies of the most recent version of this ERP will be distributed annually to the individuals/groups outlined in the ERP. Updates to new emergency communications information (new phone numbers, changes in reporting structure, *etc.*) will be distributed as soon as the new information becomes available.

Review

The entire ERP will be reviewed annually to update the plan as required. The ERP will subsequently be re-issued in its entirety to ensure that all recipients have complete, up-to-date versions.

Tyhee NWT Corp Hazardous Materials Spill Contingency Plan

Tyhee NWT Corp's current Hazardous Materials Spill Contingency Plan (developed for the current advanced exploration program, Appendix K) will be expanded to encompass the overall range of types of accidents or malfunctions that may require the initiation of an emergency, medical or environmental response. The plan will be designed to efficiently and effectively respond to any medical or environmental emergency and/or accidental spill that may be associated with the construction, operation or decommissioning of the YGP.

The scope of the Hazardous Materials Spill Contingency Plan will consider the possibility that more than one type of response may be required for any one incident. Response preparedness will be maintained for incidents involving medical, fire or other emergency response, fuel or chemical spills or other environment related incidents (e.g. wildlife collisions).

YGP Construction Phase

- Fuel for the construction equipment will be transported to the YGP mine site by fuel truck from local suppliers.
- All YGP traffic will comply with existing NWT traffic laws and the Winter Road Regulations and Rules of the Road (updated annually by Winter Road Joint Venture).
- Fuel and other hydrocarbons will be stored in accordance with the existing CCME environmental code of practice for storage of these products (CCME 2003) and Canadian petroleum products storage tank regulations (CEPA 2008).
- All vehicles and equipment will be refueled at least 30 m from water bodies following DIAND fuel storage guidelines.
- Any spills will be immediately reported to the 24-hour Spill Report Line (867) 920 8130 and spill containment and cleanup activities will be implemented in accordance with Tyhee NWT Corp's Hazardous Materials Spill Contingency Plan.

YGP Operations Phase

- Fuel for the operations phase will be transported to the mine site by fuel truck from local suppliers.
- All YGP traffic will comply with existing NWT traffic laws and the Winter Road Regulations and Rules of the Road (updated annually by Winter Road Joint Venture).
- Fuel and other hydrocarbons will be stored in accordance with the existing CCME environmental code of practice for storage of these products (CCME 2003) and Canadian petroleum products storage tank regulations (CEPA 2008).
- All vehicles and equipment will be refueled at least 30 m from water bodies following DIAND fuel storage guidelines.
- Explosives ingredients (e.g. Ammonium Nitrate, diesel) will be transported to the mine site in accordance with federal *Transportation of Dangerous Goods* (TDG), *Workplace Hazardous Materials Information System* (WHMIS) and *Explosives Act* requirements.
- YGP operations will comply with Land Use Permit and Water License requirements and conditions.
- YGP operations will conform to existing applicable federal, GNWT and Workers' Safety and Compensation Commission (WSCC) standards.

- All hazardous wastes (if any) recovered from spill incidents will be treated and/or disposed of in an approved manner.
- Any spills will be immediately reported to the 24-hour Spill Report Line (867) 920-8130 and spill containment and cleanup activities will be implemented in accordance with Tyhee NWT Corp's Hazardous Materials Spill Contingency Plan.

With the application and implementation of the preventative and mitigation measures as outlined, it is unlikely that any significant fuel, chemical or reagent spills will occur. As a result, it is equally unlikely that any potential negative effects to the terrestrial or aquatic environments of the YGP area will arise.

Review

The plan will be reviewed for accuracy and completeness annually. Changes to procedures or in chemicals /raw materials used and the locations used will be incorporated as amendments to the plan. The internal contacts list will be updated every 90 days (once the mine is in operation), and the date of update noted on the contact list.

6.8.1.2 Fuel Storage and Handling Plan

The purpose of Fuel Storage and Handling Plan will be to provide a consolidated source of information on the safe and environmentally sound storage and handling of fuel products used at the YGP site. In combination with the Emergency Response and Spill Prevention plans, the Fuel Storage and Handling Plan will provide instruction on the prevention, detection, containment, response, and mitigation of accidents resulting from fuel handling.

Fuel handling practices at YGP will comply with existing regulations to prevent, to the greatest extent possible, both accidental release of these substances to the environment and accidents resulting from mis-handling or mishap. Further, fuel handling practices will focus on prevention, as does the spill plan, through inspection of facilities by Tyhee NWT Corp and contractors, periodic drills to test systems, and a program of review and continual improvement combined with training and refresher courses for all employees.

All staff will be required to report fuel management concerns to their supervisors who may notify the Health and Safety Committee and senior site management. All staff will be encouraged to participate in procedures improvements and to bring ideas and suggestions to the Health and Safety Committee so that they may be reviewed and incorporated into procedure revisions as appropriate.

Scope

The Fuel Storage and Handling Plan will address the following:

- Safe handling and personal protective equipment;
- Storage; and
- Fuel truck transfer procedures.

6.8.1.3 Explosives Handling and Storage Plan

The purpose of Explosives Handling and Storage Plan will be to provide a consolidated source of information on the safe and environmentally sound storage and handling of explosives used at the YGP site. In combination with the Emergency Response and Spill Prevention plans, the Fuel Storage and Handling Plan will provide instruction on the prevention, detection, containment, response, and mitigation of accidents resulting from explosives handling.

Explosives handling practices at YGP will comply with existing regulations to prevent, to the greatest extent possible, both accidental release of these substances to the environment and accidents resulting from mis-handling or mishap. Further, explosives handling practices will focus on prevention, as does the spill plan, through inspection of facilities by Tyhee NWT Corp and contractors, periodic drills to test systems, and a program of review and continual improvement combined with training and refresher courses for all employees.

All staff will be required to report explosives management concerns to their supervisors who may notify the Health and Safety Committee and senior site management. All staff will be encouraged to participate in procedures improvements and to bring ideas and suggestions to the Health and Safety Committee so that they may be reviewed and incorporated into procedure revisions as appropriate.

Scope

The Explosives Handling and Storage Plan will address the following:

- Documentation and inventory of all explosive products, quantities, hazard classes, potential impacts;
- Product handling, storage, and personal protective equipment; and
- Storage locations.

6.8.1.4 Tailings Containment Area Management Plan

The goal of the Tailings Containment Area Management Plan is to minimize the impact of the YGP on the aquatic ecosystem of Narrow Lake.

Scope

Tailings from the Ormsby mill processing facility will be pumped to and contained within a Tailings Containment Area (TCA) located at Winter Lake (Figure 4.3-1).

Where the TCA perimeters against an undisturbed area, the tailings containment dams will comprise of internally lined structures keyed into the bedrock, namely; Southwest Dam, South Dam, Southeast Dam, East Dam, Saddle Dam, North Dam and the southern leg of the West Dam (Figure 4.3-1). The portion of the West Dam that divides Winter Lake (the northern arm) will be a rock fill dam that will, over time, blind off with tailings. This dam embankment structure will be constructed in stages according to the mine tailings storage requirements. The northern portion of the lake will be drained to accommodate the boundaries of the proposed open pit. During operations, water seepage through this structure will be either eliminated through the installation of an impermeable geomembrane or will be collected and managed within a containment ditch located in the northern portion of the drained Winter Lake (to be determined at detail design stage). Any seepage that is collected in the containment ditch will then be pumped back into the TCA. Over time, tailings deposition at the dam will contribute to creating an impermeable boundary that will eliminate seepage in the long run. All tailings dam structures will be constructed to a design crest elevation of 297 masl using suitable material borrowed from the Ormsby Pit area. Material will be blasted, crushed, hauled, placed and engineered to construct the dam structures. The West Dam, South Dam and Southeast Dam will be constructed prior to the commencement of tailings deposition. The remaining dams will be constructed during the mine life as they are only required for containment at higher elevations. Initial deposition of tailings within the TCA will commence with spigot discharge along the upstream face of the West Dam to blind off the structure and limit future seepage northwards into the drained portion of Winter Lake. Tailings will continue to be discharged upstream of the West Dam and will be augmented by additional spigot points around the perimeter of the TCA to maximize tailings storage capacity within the facility. The estimated final tailings elevation will be approximately 292.5 masl with a water cap elevation of 293.5 masl which equates to a freeboard and wet year water storage allowance of 3.5 metres for all dams.

During operation of the TCA, a water cap of approximately 1 metre will be maintained over the majority of the tailings surface. For closure and reclamation it is the intent to construct a material cap, either with or without a liner, over the exposed tailings instead of maintaining a water cover. This material cover will be a more effective long term closure scenario ensuring minimal environmental impacts on the receiving environment and will be easier to maintain.

The Tailings Management Plan will include a periodic release of water from the Winter Lake tailings containment area to the downstream receiving environment at the north end of Narrow Lake via a pipeline. This will control the maximum water level within the TCA facility.

6.8.1.5 Waste Management Plan

Tyhee NWT Corp is committed to ensuring that all wastes generated by the YGP are collected, stored, transported, and disposed of in a safe, efficient, and compliant manner. The waste management plan will build on procedures and policies presently in place at YGP for the advanced exploration program.

Although the plan will primarily be intended for use during the construction phase of the project, the plan will be adapted for the operations phase.

The overall waste management philosophy, under Tyhee NWT Corp's Environmental Policy will be based on the following principles:

- health and safety of all site employees, visitors and the environment;
- reduction, reuse, and recycling of waste materials;

- proactive management of wastes that may attract wildlife or result in the interaction between humans and wildlife;
- environmental awareness and waste management training;
- a site-based waste management auditing program; and,
- contractors' compliance with site waste management procedures.

The following are minimum standards of acceptability of the plan:

- establish compliance with the following federal and Government of the Northwest Territories (GNWT) environmental legislation:
  - Government of the Northwest Territories *Public Health Act*;
  - Government of the Northwest Territories *Environmental Protection Act*;
  - *Canadian Environmental Protection Act*;
  - *Transportation of Dangerous Goods Act* and Regulations;
  - Work Site Hazardous Materials Information System;
  - *Northwest Territories Waters Act*;
  - *Government of the Northwest Territories Pesticide Act*; and,
  - *Territorial Lands Act*.
- establish compliance with the following American Petroleum Institute (API), American National Standards Institute (ANSI), and Canadian standards of practice:
  - *Design, Construction, Operations, Maintenance and Inspection of Terminal & Tank Facilities*, API-2610;
  - *Standards for Aboveground Steel Tanks for Fuel Oil and Lubrication Oil*, Underwriters' Laboratories of Canada (UL Canada) - S602M;
  - *Lining of Above Ground Petroleum Storage Tank Bottoms*, ANSI/API-652; and,
  - *Environmental Code of Practice for Above Ground Storage Tank System Containing Petroleum Products, National Task Force on Storage Tanks for Canadian Council of Ministers of the Environment.*

Scope

The waste management plan principles will be fulfilled by using proven strategies and applying modern methods to ensure materials are used efficiently and then disposed of in an environmentally compatible manner. General strategies include the following:

- the most environmentally suitable materials, equipment, and products will be used;
- procurement procedures will consider product substitution for materials that are hazardous to handle, generate hazardous wastes, or create an environmental liability;
- a "no feeding of wildlife" policy will apply to all site personnel and visitors. Adherence to this policy is a condition of employment and site visitation privileges;

- all site personnel will attend an orientation, which will address waste management and handling of hazardous goods, prior to being exposed to the work site. The site orientation for visitors will include a waste management module;
- a committee will be formed to conduct monthly waste management audits; and,
- a waste management facility will be built to facilitate the three R's philosophy – reduction, reuse, recycling.

6.8.1.6 ARD/Waste Rock Management Plan

The ARD/Waste Rock Management Plan currently in place related to the advanced exploration activities is provided in Appendix H. This plan would be updated to cover the operational phase during and subsequent to the regulatory process.

6.8.1.7 Wildlife Protection Plan

The most effective protection from potential environmental effects will be an operating ethic that reduces and avoids interactions between YGP operations and wildlife to the maximum practical extent. Guidelines for minimizing effects on wildlife and wildlife habitat have been discussed in Section 6.6. These guidelines will be used to develop the YGP's formal Wildlife Protection Plan.

6.8.1.8 Conceptual Closure and Reclamation Plan

This is addressed in Section 11.0.

6.8.1.9 Air Quality Management Plan

The air quality management plan for the Project outlines the best management practices and mitigation measures to minimize the potential air quality effects. Mitigation measures already incorporated in the Project design are outlined in Section 5. Additional mitigation measures that could be considered to reduce emissions of CACs, GHGs, fugitive dust, or dioxins and furans are provided in this section.

CACs and GHGs

The sources of CAC and GHG emissions associated with the Project include diesel generators, mobile equipment, and nonroad equipment. The best management practices for CAC and GHG emissions include:

- Use of higher tier diesel generators instead of Tier 2;
- Restrict unnecessary idling of YGP equipment; and,
- Inspect and maintain equipment regularly.

Fugitive Dust

The sources of fugitive dust emissions include blasting, drilling, handling of ore, and haul road dust. The best management practices for fugitive dust include:

- Minimize drop heights for waste rock;
- Equip drilling rigs with dust suppression mechanism;

- Apply wet suppression system to maintain relatively high material moisture;
- Water roads during dry, non-freezing periods;
- Restrict vehicle speed of haul trucks; and,
- Cover haul trucks.

Dioxins and Furans

Waste incinerators can be a source of dioxins and furans. There are Canada-wide standards (CWS), developed by Canadian Council of Ministers of the Environment (CCME), for emissions of dioxins and furans (Table 6.8-1). Dioxin and furan standards were developed for two types of sources: pulp and paper boilers burning salt-laden wood, and waste incineration. The emission limits are expressed as the toxic equivalent (TEQ) and international toxic equivalent (I-TEQ) concentrations in the exhaust gas exiting the stack of the facility. For this Project, the relevant standard is the one for a new municipal waste incinerator, which is 80 pg/m3 I-TEQ.

TABLE 6.8-1: CWS FOR DIOXINS AND FURANS

Emission Source			Numerical Targets
Pulp and paper boilers burning salt laden wood		Existing boiler by 2006	500 pg/m³ TEQ
		New boilers	100 pg/m³ TEQ
Waste Incineration	Municipal waste	Existing facilities by 2006	80 pg/m³ I-TEQ
		New facilities	80 pg/m³ I-TEQ
	Medical waste	Existing facilities by 2006	80 pg/m³ I-TEQ
		New facilities	80 pg/m³ I-TEQ
	Hazardous waste	Existing facilities by 2006	80 pg/m³ I-TEQ
		New facilities	80 pg/m³ I-TEQ
	Sewage sludge	Existing facilities by 2005	100 pg/m³ I-TEQ
		New facilities	80 pg/m³ I-TEQ

The waste incinerator for this Project will be CA50 from Eco Waste Solutions. The exhaust from this incinerator will meet the CCME standards for dioxins and furans, without an additional air pollution control system (Eco Waste Solutions, 2011).

6.8.2 Environmental Monitoring Program

Requirements for monitoring the biophysical resources throughout the mine life will be part of the terms and conditions appended to the Project's Water License and Land Leases. Occupational health and safety monitoring requirements are set out in the North West Territories Mine Health and Safety Act and Regulations and will be implemented at YGP. Presented here are monitoring plans for the biophysical environment to cover those aspects normally required of operating mines.

Monitoring at YGP will be accomplished through a combination of on-site personnel and periodic use of consultants as required to accomplish specialized tasks. The final responsibility for the data will rest with the permit holder (Tyhee NWT Corp, a wholly owned subsidiary of Tyhee Gold Corporation). Monitoring specific aspects of the environment began with the commencement of baseline studies in 2004. Much of the information obtained will be used as background to measure changes that may occur with construction and operation of the mine.

Aquatic monitoring specifically designed to provide an assessment of predicted impacts began in 2004. The study provides detailed background information of fisheries populations and aquatic habitats at YGP.

6.8.2.1 Surface and Groundwater Quality Monitoring

A water quality monitoring network will be established at YGP prior to construction and will continue through until abandonment, modified as appropriate. Proposed monitoring sites will be selected and monitored from July through September, and in winter under the ice in December and April, where possible. For streams, sampling will be from July through September. Parameters monitored will be pH, alkalinity, suspended solids, nutrients, and metals. Hardness will also be measured, as it relates to metals availability. Surface and groundwater monitoring requirements of the project which are conditions of the water license will be integrated with the EEM requirements below to produce one document that complies with both requirements.

6.8.2.2 Aquatic Effects Monitoring

The Metal Mining Effluent Regulations (MMER)

The Yellowknife Gold Project development will be subject to the requirements of the Metal Mining Effluent Regulations (MMER), in addition to other monitoring requirements stipulated in relevant permits and approvals. The MMER directs metal mines to carry out periodic aquatic Environmental Effects Monitoring (EEM) with the objective of evaluating the effects of mine effluent on fish, fish habitat and the use of fisheries resources. It is recognized that the establishment of effluent limits alone may not be sufficient to ensure adequate site specific protection of aquatic resources.

As such, EEM studies are conducted to evaluate the effects of mine effluent on the aquatic environment and permit adjustments to mitigate adverse effects, where they are identified. The MMER is administered by Environment Canada, which is responsible for reviewing and approving EEM study designs and the interpretative reports that provide data and assessments based on relatively prescriptive procedures. These procedures are contained within Guidance Documents for Aquatic Environmental Effects Monitoring (Environment Canada 2002c, 2005b).

The MMER prescribes limits for the discharge of deleterious substances, including arsenic, copper, total cyanide, lead, nickel, radium-226, zinc, pH of effluent, and total suspended solids (TSS), and a requirement for effluent to be non-acutely lethal to rainbow trout.

The MMER sets out requirements for periodic studies of the aquatic environment to monitor and measure: fish, benthic invertebrates, effluent characteristics and water quality, sediment quality, and sub lethal toxicity in order to determine and quantify effects on fish and fish habitat[26].

It is important to note that the MMER defines an effect as follows (Environment Canada 2002c):

- an "effect on the fish population" means a statistical difference between fish population measurements taken in an exposure area and a reference area.
- an "effect on fish tissue" means measurements of total mercury that exceed 0.45 μg/g wet weight in fish tissue taken in the exposure area and that are statistically different from the measurements of total mercury taken in the reference area.
- an "effect on the benthic invertebrate community" means a statistical difference between benthic invertebrate community measurements taken in an exposure area and a reference area (e.g., control/impact design) or a statistical difference between measurements taken at sampling areas in the exposure area that indicate gradually decreasing effluent concentrations (e.g., a gradient design).

Aquatic Effects Monitoring Studies

In adherence to MMER requirements, monitoring studies for the Yellowknife Gold Project will consist of:

- Effluent and water quality monitoring studies;
- Sub lethal toxicity testing; and,
- Biological monitoring studies.

Effluent and Water Quality Monitoring

Effluent and water quality sampling and analysis will need to be carried within six months of mine startup (as defined in the MMER), and thereafter, at least four times per year, spaced at least one month apart. Effluent will be sampled at the final discharge point[27] and will include analyses for: hardness, alkalinity, aluminum, cadmium, iron, mercury[28], molybdenum, ammonium, and nitrate.

Water quality samples will be collected from an exposure area (i.e. water containing fish habitat and/or fish that are exposed to effluent) surrounding the point of entry of effluent into water from each final discharge point and from the related reference areas, as well as

[26] The *Fisheries Act* definition of fish habitat is: spawning grounds and nursery, rearing, food supply, migration and any other areas on which fish depend directly or indirectly in order to carry out their life processes.

[27] final discharge point, in respect of an effluent, means an identifiable discharge point of a mine beyond which the operator of the mine no longer exercises control over the quality of the effluent.

[28] Mercury analysis may be discontinued if the concentration is less than 0.10 μg/L in 12 consecutive samples.

in areas included in the biological monitoring studies. Water quality samples will be analyzed for the same constituents measured in effluents, as well as temperature, dissolved oxygen, and pH.

Sub lethal Toxicity Testing

Sub lethal toxicity testing on a fish species, an invertebrate species, a plant species and an algal species will be carried out as specified in the MMER two times each calendar year for three years and once each year after the third year. The first testing will occur on an effluent sample collected not later than six months after the mine becomes operational (as defined in the MMER).

Biological Monitoring

Generally, the first study design for biological monitoring studies must be submitted for approval to Environment Canada not later than 12 months after the mine begins operations, although exceptions can apply, particularly if biological monitoring studies were completed prior to formal notification of mine start-up. Monitoring studies will then take place not sooner than six months from submission of the study design. The study design will incorporate specific details to justify sampling locations (exposure and reference sites), timing, and field, analytical, and statistical assessment methods according to specifications outlined in the MMER and in Environment Canada (2002b).

Following data collection and analysis, an Interpretative Report will be submitted to Environment Canada not later than 30 months after the date the mine becomes operational. The contents of the Interpretative Report are prescribed in the MMER and in Environment Canada (2002c), as is the scheduling for the second and all subsequent biological monitoring studies. The sampling frequency following review of the second Interpretative Report is dependent on results of previous studies and can be increased if no effects are demonstrated in two successive studies.

Adaptive Management

The implementation of site specific monitoring that is based on a peer reviewed study program design lends itself well to the principle and practice of adaptive management (AM). An objective of the Yellowknife Gold Project is to minimize adverse effects on the environment through appropriate studies of existing natural resource characteristics, designing and employing environmentally compatible extraction, handling and processing methods, and modifying procedures if monitoring identifies potential or ongoing adverse environmental interactions. This is consistent with AM, which is a systematic, rigorous approach for deliberately learning from management actions with the intent of improving management policy or practice.

Water discharge from the TCA is a specific example of the potential application of AM at the Yellowknife Gold Project. Seasonally varied discharges have been proposed to simulate pre-development flows that presently occur from Winter Lake to Narrow Lake, to avoid or minimize effects on water levels and fish habitat in Narrow Lake and further downstream areas. The efficacy of this discharge protocol will be tested through ongoing monitoring of discharge volumes from Narrow Lake, and fish and fish habitat effects identified in the MMER biological effects monitoring programs. The identification of unexpected adverse effects might then be used to adjust discharge levels or timing to reduce or eliminate such effects.

6.8.2.3 Air Quality Monitoring

The assessment of CAC emissions during operation was based on emission estimates. To confirm the input parameters used in the dispersion modelling, stack testing is recommended for the diesel generators and baghouses. Dispersion modelling results shows that the maximum predicted concentrations are less than half of the NWT ambient air quality standards for all CACs except 24-hour TSP. Therefore it is recommended that TSP be re-modelled once the Project design has been finalized. If elevated TSP is still predicted, it is recommended that an ambient monitoring program for TSP be developed.

6.8.2.4 Wildlife Monitoring

Upon project approval, Tyhee NWT Corp will prepare a Conceptual Wildlife Monitoring and Management Plan in collaboration with the Department of Natural Resources, GNWT that will address furbearers, migratory birds, waterfowl, large ruminants, and large carnivores as specified in the MVEIRB May 2009 Final Terms of Reference. The Wildlife Monitoring and Management Plan will include adaptive management measures tailored specifically for the YGP to avoid, minimize and mitigate any potential effects to wildlife if problems or issues are detected during construction, operation, and decommissioning/ closure.

YGP will follow the Bathurst Caribou Management Plan monitoring objectives (Bathurst Caribou Management Planning Committee 2004), where appropriate, including monitoring caribou numbers, distribution, predator abundance, and adult sex ratios within the Project area.