



REVISED Water License Application Support Document

**Doris North Project
Nunavut, Canada**

Submitted to the Nunavut Water Board by:

Miramar Hope Bay Ltd.

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- S3 Technical Specification for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, prepared by SRK Consulting (Canada) Inc., March 2007– SRK 2007c
- S4 Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, prepared by SRK Consulting (Canada) Inc., March 2007– 2007d

- S5 Revised Doris North Project Hydroclimatic Parameter Re-Evaluation 2007, prepared by Golder Associates, April 2007– Golder 2007a
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 - S10l Mine Closure and Reclamation Plan, prepared by Miramar Hope Bay Ltd., April 2007
 - S10m Monitoring and Follow-up Plan, prepared by Miramar Hope Bay Ltd., April 2007
- S11 Final Report on Effluent and Aquatic Study Monitoring Design for Doris North Project, prepared by Golder Associates Limited, November 2003 – Golder 2003

Executive Summary (English, Inuinnaqtun and Inuktitut)

This document is being submitted to the Nunavut Water Board (NWB) by Miramar Hope Bay Ltd. (MHBL) in support of its application for a Water License (covering water use and waste disposal) for the proposed Doris North Project. MHBL intends to develop the Doris North Mine for the purpose of extracting gold for sale on global markets. The Doris North Project (the Project) is located on the mainland in the West Kitikmeot region of Nunavut, approximately 125 km southwest of Cambridge Bay and 75 km northeast of Umingmaktok. The Project is located on Inuit Owned Lands at 68 deg. 09 min. N x 106 deg. 40 min. W, 5 km south of Roberts Bay, an extension of Melville Sound, which connects with Bathurst Inlet about 80 km west of the Project.

MHBL is proposing to construct, operate and reclaim a small underground gold mine (average throughput of 720 tonnes per day) that will have a two year life. According to current mine reserves, the mine will produce approximately 311,000 ounces of gold from 460,000 tonnes of ore. Processing of the ore will occur on site, with the gold being shipped off site by air in the form of dore bullion bars to a commercial refiner. The project will be self-sufficient, and will have a footprint of approximately 54 hectares.

The site is remote and there are no permanent or winter roads that link it to any neighboring communities or facilities. Currently, there is no infrastructure development on the site, with the exception of an exploration camp on the east shore of Windy Lake, located approximately 10 km southwest of the project site.

The primary access route to the project for fuel, equipment and supplies will be via the Arctic Ocean (sealift barges from Hay River) and by charter aircraft for employees, contractors and food. The proposed mill site is located approximately 5 km from Roberts Bay, which is accessible by ships and barges for a short ice-free shipping season each summer. A jetty will be constructed in Roberts Bay as a landing facility for the sealift barges. Equipment will be offloaded and stored in a lay down area close to the shore. Annual fuel supply will be trucked from the sealift vessels to a tank farm constructed at the plant site.

A 4.8 km all-weather road will link the Roberts Bay sealift landing site with the mill and camp location (plant site), allowing year-round haulage of supplies from the sealift landing site laydown area. The mill, crushing plant, fuel storage tank farm, camp, office complex, workshops, power generation plant, sewage treatment plant and all other operational mine infrastructure will be located in a central location adjacent to the underground mine adit.

An all-weather airstrip, suitable for small aircraft, will be constructed along the alignment of the main road between the plant site and Roberts Bay. During summer months the site will also be serviced by float planes, and for that purpose a dock, will be constructed on the shore of Doris Lake. This dock will be linked to the mill site with an all-weather road. During winter months, an airstrip capable of handling larger aircraft will be constructed on the ice on Doris Lake, and the site serviced from this airstrip.

Tailings produced during the milling process will be deposited in Tail Lake about 5 km from the proposed mill location. Tailings deposition will be sub-aqueous, requiring the construction of two water retaining structures: the North and South Dams. The tailings will be contained in Tail Lake by constructing a low permeability frozen core dam across the outlet of Tail Lake to the north, and by a similar second dam constructed across a topographic low point at the south end of the lake. Mill tailings will be treated in a water treatment plant within the mill to destroy residual cyanide and precipitate heavy metals before the tailings are discharged into Tail Lake. The water quality eventually discharged from Tail Lake will meet discharge standards established by the NWB, which are set to meet water quality guidelines for the protection of freshwater aquatic life (fish and benthic invertebrates) in Doris Creek below the point of discharge.

MHBL is currently scheduling the initial mobilization of construction equipment to the Doris North site across the sea ice from Cambridge Bay in April 2007. A limited program of pre-development construction is scheduled to commence in the second quarter of 2007 (pending appropriate approvals from the Kitikmeot Inuit Association (KIA)). Additional construction material and supplies will be shipped to Roberts Bay in the summer sealift in 2007 to be offloaded in August and moved to the mill site early in the winter of 2007/2008. This will include the permanent accommodation camp and fuel storage tank farm. The remaining milling equipment and operating supplies would arrive on the 2008 sealift. The mill and camp pads, remaining access roads, the airstrip, and the tailings containment dams and access roads will be constructed over the 2007-2008 winter.

Mine development will start in the 3rd quarter of 2007 with the collaring of the portal. Production mining (ore) would commence in the 3rd quarter 2008 and continue through to the end of 2010. Milling will start approximately one month after production mining starts (4th quarter 2008) and continue through to the end of 2010.

MHBL is continuing its exploration program in the region of the Doris North Project (the Hope Bay greenstone belt) to find other economic gold deposits, which could potentially extend the life of the Project or lead to development of other gold mines in this area.

A construction workforce peaking at 120 will be required to carry out construction and site development work from April 2007 through October 2008. During operations, milling and processing will need a total workforce of 24 from the 3rd quarter of 2008 to the end of 2010, underground mining will require a peak workforce of 60 from the 3rd quarter of 2007 through the end of 2010, while maintenance support, catering, supervision and administration will require a total workforce of 81. Of the total operating workforce, it is expected that half would be on site at any given time.

The Project is predicted to result in an increase in direct employment in Nunavut by 371 person-years, with 159 person-years of this total predicted to go to Inuit. The Project is predicted to increase total (direct plus indirect) Territorial employment by 443 person-years; 371 person-year increase in employment in the Goods Industries (the same as the direct effect), a 71 person-year increase in the Service Industries, and a 2 person-year increase in Public Administration. MHBL has completed an Inuit Impact Benefit Agreement (IIBA) with the KIA, which focuses on employment, training, and community wellness. A signing ceremony for the IIBA was held in Cambridge Bay in September of 2006.

The Doris North Project has completed the Environmental Assessment Process, and the Nunavut Impact Review Board (NIRB) recommended (March 2006) to the Minister of Indian and Northern Affairs Canada (INAC) that the Project should proceed to the regulatory phase. In August 2006 the Minister for INAC approved the NIRB decision, and a Project Certificate was issued by the NIRB in September 2006. The NWB water license is one of the key permits required for the Doris North Project. MHBL is also working with the: KIA to secure land leases; INAC for a foreshore lease for the Roberts Bay jetty; the Department of Fisheries and Oceans Canada (DFO) and Environment Canada (EC) for required authorizations under the Fisheries Act and for amendment of the Metal Mining Effluent Regulation (MMER) to include Tail Lake on Schedule 2; Natural Resources Canada (NRCan) for explosives storage and use permits; with Transport Canada (TC) on various project related permits and authorizations, and with Nunavut Tunngavik Incorporated (NTI) to finalize a Production Lease Agreement.

The application for Doris North water license is based on Guidelines provided by the Nunavut Water Board, which were developed in consultation with other reviewers. This application support document outlines specific details and plans regarding the water related components of the Doris North Project. MHBL has endeavored to address all of the Guidelines provided.

Havaotikhat Naitot

Hamna titigak toniyaolikt okononga Nunavutmi Emalikiot Katimayiinot (NWB) okonanit Miramar Hope Bay Ltd. (MHBL) ekayutikhat apikhinahoaktitlogit Emaktutikhanik Laisimik (emaktutikhat emakogotikhat) omonga angmagahoaktomot Ogholiotilikmi Oyagakhiokvikhak. MHBL angmaktiknahoaliktat Ogholiotilik Oyagakhiokvik amogainiaktot haviknik kogeektanik oyagaknik neovgotikhat nunakyoanit. On Ogholiotilik Oyagakhiokvik (ona Oyagakhiokvik) hamaniitom nunainakmi Oalikmi Kitikmeot nunaitni, hamani 125 km hivogaani Ikaluktutiak ovalo 76 km tonongani Umingmaktop. Ona Oyagakhiokvik ovaniitok Inuinait Nunaotaini ovani 68 deg. 09 min. N x 106 deg. 40 min. W, 5 km hivogaani Kapihiliktup, ona Kongokyoap elangani, elanga hamna Kengaop onghaktigot 80 km oataaniitok Oyagakhiokviop.

MHBL oktogumayut nappaktigilotik, aolaliklogo ovalo algagomayat manikaknik nunap ataaniitok havik kogeektak (algakniaktot emakak 720 tonnes oblotoak oyagaknik) ona manikaknik amoniaktat malgoknik okioknik algaktaoloni. Hamani manikaknik elihimayat talvani, ona amohiniaktot 311,000 ounces gol-nik ovaniit 460,000 tonnes oyagak. Amogainiaktot manikaknimik tahamani oyakikivikmi, ona manikaknik amoyuk aolaktitaovakniaktot tingmiaktot taononga kablonakakninot pinnikhaktaoloni. Ona oyagakhiokvik elikokniaktot, oalo 54 hectares nuna atokniaktat.

Tamna oyagakhiokvik inuilmomeetok nunami ovalo hania nuna iglokangitok naliak apkotaitok homot inukakninot. Hajja, nuna honakangitok igloitoni inuitok, kihime oyagakhioktit tupikpait napayut tahmani kivatani Ogholiotiliop, hivogani 10 km hivogani tupikakviop.

Tamna nuna tikimmalaktok oyagakhiokvik apkotikot hikkokot taggiokot oghokyoanik, tamayanik agyaktagiami (umiaktot tamayat kaivakniak Hay River-mit) ovalo tingmiaktot satakotot havaktitlo tikikatakpakniaktot, okoalo kantolaktit nikkitlo. Tamna oyagaknik pilokyiligivik ovaniitok 5 km Agingamit, ona umiat atolaktat taggiok hikkotitlogo aoyami. Umiakakvik hanayaoniaktok ovani Agingami umiat tulaktakvikhat. Tamayat oheeyaktaoniaktot tutkottiklogit hinnani Agingak Oghokyoat tikigakpakniaktot Agingamot ovalo agyaklogitlo oghokyoakakvikmot.

Ema 4.8 km okiok-aoyak atoktokhak apkot hanayaoniaktok Agingap umiakakvianot ovaniit pilokyiligivikmit ovalo iglopkakakvikmot (oyakikivik), ema okiok aoyak agyakovianiaktok tamayanik umiakakvikmit. Ona pilokyiligivik oyakanot, oghokyoakakviklo, iglopkakakviklo, afisikakviklo, aghalutikakviklo, paowahaosikakviklo, annakokviklo okoalo allat oyakikotit aolatjutait tahamani oyakikivikmeeniaktot.

Hamaniilo okiok-aoyak atoktokhaklo milvik, mikkait tingmiat atoktakhat, hanayaoniaktok apkotip haniani oyakikivikmi ovani Agingakmot. Talvani aoyami oyagakhiokvik agyaktakvioniaktok tingmiat kayaliknit, ovalo tingmia tulakvikhatlo hanayaoniaktok ovalo hinaniu Ogholiotiliop. On tingmiakakvik apkotikakniaktok iglopkakmot. Ovani okiomi, angiomik milviliokpakniaktot tingmiat angiot milvikhanik hikkomi.

Oyagakot pilokyiligivikmit naptiktaoniaktot omonga Oyagakokvikmot ovani 5 km pilokyiligivikmit. Emmakottaok kovvigaktaoniaktot emmakokvikmot, tamna ahinot

kovilaiyakaklogo malok tahigak emaiyakaklogik; ona Tononganio hivoganilo kovilaiyaklogik. Okoat emmakot tutkomaniaktot Emmakokvik hanalogok hikkoat mahalaiyaklogo ovani Emmakokvik tonogani, ovalo ajikota kovilaiyakhimayukhak hivogaani tattip. Emmakot pilokyiligivikmi halummaktiktaovakniaktot emaknik halummaktikvikmi ongovaktiklogit tokonat cyanide okoalo havilgatlo kovittinnago emmat Emmakokvikmot. Halumanik emak koviniaktok Emmakokvikmot kovviniat nammaktokhak NWB, okoa eliiyaohimayut emmat koviinagialgit halumakaklogit ema emakmiotat atokmagit tahigat (ikaluitlo okoalo kommagot emakmiotat) ovani Ogholiotilikmi.

MHBL hajja kakogomot eliogainiakhimaliktot hanalotik tamayanik nappaktigakhanik ovani Ogholiotilikmi aiyayukhat umiakot Ikaluktutiamit ovani April 2007. Mikiot havaakhatlo napaktigiliktinagit igloni hananiaktot aipaani tatikhiotmi ovani 2007 (naliak apikotit angiktaokpata laisikhanik okonanga Kitikmeot Inuit Katimayiniit (KIA)). Elaitlo havaat tamayat iglokpakhatlo tamayat aoakot umiakoktitaoniaktot ovani 2007-mi oheeyaktaoniaktot Agasimi ovalo nuutikniaktait pilokyiligivikmot ovani okiok 2007/2008. Hamna elanga iglokpait tahamaniitotokakhat okoalo kattakyukakviit. Okoa elait pilokyiligiviop tamayait okoalo aoyatjutikhat tikinniaktot ovani 2008 umiakot. Ona pilokyiligivik okoalo iglot tungavikhait, apkotitlo, milviklo, okoalo emmakokvikhat apkotaitlo hanayaoniaktot ovani 2007-2008 okiok.

Oyakikivikhak nappaktiktaoniaktok ovani 3rd quarteri 2007 ovalo etiakatakvikhap paanga nunap ataanoktikvik hanayaoloni. Oyagat amoyaovalikniaktot (oyagat) aolaliklotik 3rd quarter 2008 ovalo aolahimaklotik nonggolikat okiok 2010. Manikakninik amogailikniaktot oyagaknik tatikhiot atolikat oyagakikiviklo angmakat (4th quarter 2008) ovalo aolahimakniaktok nonggolikat 2010.

MHBL hajja nalvaakhiokhimaktot manikakninik tahamani nunami ovani Ogholiotilikmi (ona Kapihiliktup oyagakaknia) allanik pikagonakhiok, allakakkat oyagakhiok angmaomakhakniaktok tahamani nunami.

Hanayut iglokpaknik oyagakhiokvikmik inugiakhiniaktot 120 inuit havaktitaoniaktot nappaktigiot oalo iglokpakakvikhak nappaktiktaolotik ovani April 2007-mit Aktobamot 2008. Talvani aolalikata, pilokyiliginiik ovalo amogainik manikakninik havaktikakniaktot ematot 24 ovani 3rd 60 ovani 3rd quarter ovani 2007 nonggolikat ona 2010, okoalo havaktit ekayuktit, kukioyut, ataniit ovalo titigalikiyiit havaktikaktokhat 81-nik. Ovani aolalikat oyakikivik, inuit havakpakniaktot.

Tamna Oyagakhiokvik aolaniaknahogiyat havaktinik amigaikniaktok Nunavutmionot ovani 371 inuit-okiok, kaffit 159 inuit-okiok havaklotik tamaita Inuinait havaktitaoliliklotik. Ona Oyagakhiokvik inugiakhiniaktok kakogo (tahamani ahinitlo) Nunami havaktit emakak 443 inuit-okiok; 371 inuit-okiok amigaiklotik ovani Hanayit Pitainik (emalot tamayaniklotik tahamanga), ema 71 inuit-okiok havaliklotik Hanayiniit, ovalo 2 inuit-okiok amigaiklogit Inuknik Monagiyit. MHBL enikhiot Inuknot Kanogilitjutiniaktot Ekayutit Angigotit (IIBA) okoalo KIA-kot, okoa havaktitiomayut inuknik, elihailotik, ovalo inutiakoiyut havaktinik. Ona sainikhivaktot angigtinik IIBA ovani Ikaluktutiami ovani Saptaija 2006.

Tamna Ogholiotilik Oyagakhiokvik eniktok Nunalikotat Ehivgioknia, ovalo Nunavutmi Kanogilitjutiniaktonik Ehivgioktit (NIRB) pitkoyat (Masi2006) Ministamot Itkilinot

Okioktaktolikiomot Kanatami (INAC) tamna Oyagakhiokvik angmakoyat maligakhait eniklogit. Ovani Agasimi 2006 ona Ministak okononga INAC angiktat okoat NIRB angikoyat, ona Oyagakhiogot Laisinikovlogo okoat NIRB ovani Saptaiapa 2006. Okoa NWB emaktutikhak laisik ehagiagiyat oyakikotikhak omonga Ogholiotilikmot Oyagakhiokvik. MHL hamalo havakatigiyait: KIA nunamik atutikhamik laisimik; INAC umiakakvikhak lalisiniktoklo omonga Agingak Agingak; okoa Kavamat Taggiokmialikiot Kanatami (DFO) okoalo Nunalikiot Kanatami (EC) laisikhak angiktaoyagiakaktok ovani Ikaluknot Maligat allangoktokhak Haviknik Oyakikioni Oyagakoknik Maligakhat (MMER) elakhatlo Emmakokvik ovani Havakvikhak 2; Natural Resources Canada (NRCan) tutkomavikhat kaggaktitaotit laisikagiakaktok angiktaoloni, ovalo okoa Nunavut Tunngavik Incorporated (NTI) eniktokhat laisikhak angigotini.

Ona apikot omonga Ogholiotilikmot emaknik laisikhak atokniaktok Maligakot toniyaini okoa Nunavutmi Emalikiyit Katimayiini, okoa hanayaohimayut okakvigilgaklogit ehivgioktit. Ona apikot laisikhami ekayutaoyuk titigat onipkangit malikhogit ovalo opalongaiyaotini emaktutunik ovan Ogholiotilikmot. MHL tamainik havaktot pitkoyaoyunik Maliktakhanik tonionik

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1.0 INTRODUCTION

Oingaiknik

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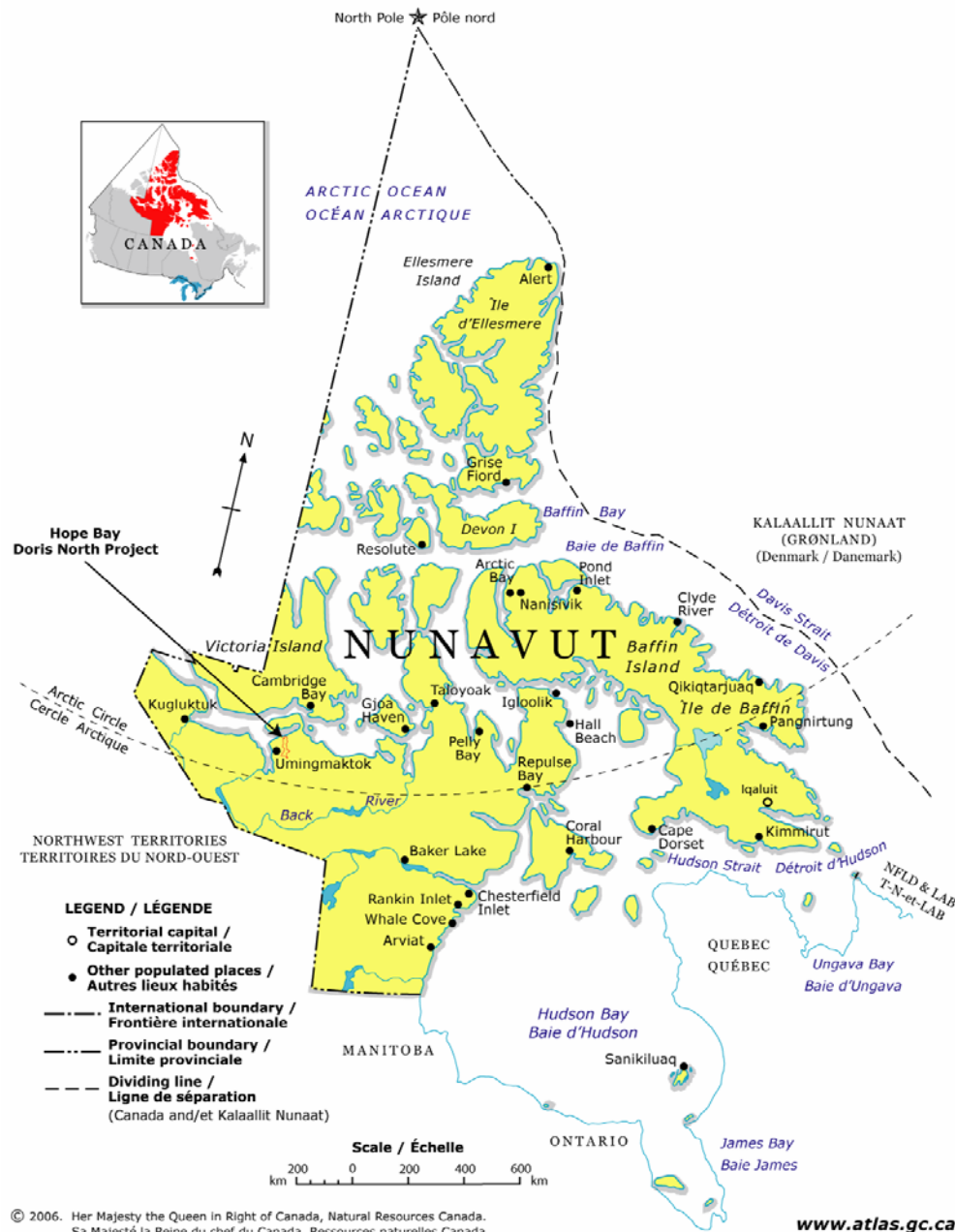
1.1 Project Introduction and Location

This document is being submitted to the Nunavut Water Board (NWB) by Miramar Hope Bay Ltd. (MHBL) in support of its application for a water license (covering water use and waste disposal) for the proposed Doris North Project (the Project). The application for this water license was initially submitted to the NWB in March of 2002. A copy of the completed Water License Application Form and the Water License Application Supplementary Questionnaire for Mine Development are attached as Appendix A to this document. The NWB referred the Project to the Nunavut Impact Review Board (NIRB) for environmental screening. The Project was referred to a Part 5 Review under Section 12 of the Nunavut Land Claims Agreement (NLCA) by the Minister of Indian and Northern Affairs Canada (INAC) following a Nunavut Impact Review Board (NIRB) 12.4.4(b) Screening Decision. In February of 2006 MHBL took part in the Final Hearing process conducted by the NIRB. During that process MHBL and its consultants presented the Project to the NIRB and NIRB staff, and went into extensive detail from an impacts assessment prospective for the Project. The Doris North Project has now completed the environmental assessment process and the NIRB recommended (March 2006) to the Minister for INAC that the Project should proceed to the regulatory phase. In August 2006 the Minister approved the NIRB decision and a Project Certificate was issued by NIRB in September 2006. MHBL asks that the Nunavut Water Board issue an eight year water license for the Doris North Project with built-in periodic license reviews at three year intervals. This would cover the construction, operation and reclamation time frame.

This report is intended to provide a summary of the information for the NWB in support of MHBL's application for a water license for the Doris North Project. The document is intended to be inclusive, with the detailed engineering reports, drawings and specifications attached as supporting documents. The focus is on all planned facilities and operational activities at the proposed Project dealing with water use and waste disposal. The report includes operational and environmental management plans relating to water use and waste disposal, including plans for the reclamation of the mine following closure. This document strives to be inclusive; however, due to the scope of this application, the reader will be referred to the attached appendices and supporting documents to appreciate the full context of the information provided. Where MHBL and its consultants have made assumptions in the designs or operational plans for the Doris North Project, these assumptions have been stated. MHBL, where possible, has included information on the monitoring initiatives that will be implemented to check on the accuracy of these assumptions, and has included information on how MHBL proposes to adapt its planned actions, if necessary, where this monitoring indicates that these initial assumptions were not correct.

MHBL intends to develop the Doris North Project for the purpose of extracting gold for sale on global markets. The Doris North Project is located on the mainland in the West Kitikmeot region of Nunavut approximately 125 km southwest of Cambridge Bay and 75 km northeast of Umingmaktok (see Figure 1.1). The Project is located on Inuit Owned Lands Parcel BB-60, at 68 deg. 09 min. N x 106 deg. 40 min. W, 5 km south of Roberts Bay, an extension of Melville Sound which connects with Bathurst Inlet about 80 km west of the Project.

Figure 1.1: Location Map



MHBL is proposing to construct, operate and reclaim a small underground gold mine (average throughput of 720 tonnes per day) that will have a two year life. According to current mine reserves, the mine will produce approximately 311,000 ounces of gold from 460,000 tonnes of ore. Processing of the ore will occur on site, with the gold being shipped off site by air in the form of dore bullion bars to a commercial refiner. The project will be self-sufficient, and will have a footprint of approximately 54 hectares.

The site is remote and there are no permanent or winter roads that link it to any neighboring communities or facilities. Currently, there is no infrastructure development on the site, with the exception of an exploration camp on the east shore of Windy Lake, located approximately 10 km southwest of the project site.

1.2 Changes to Project Development Plan from October 2005 Final EIS

Several changes have been made to the Doris North Project in relation to what was indicated in the October 2005 Final Environmental Impact Statement (FEIS) submission and supplementary documents submitted for the February 2006 NIRB final hearing. These modifications reflect advances in Project design as well as input from regulatory agencies such as the Department of Fisheries and Oceans Canada (DFO). All of the changes are relatively minor, and generally lessen the potential for the Project to have an adverse impact on the environment. Some of these changes reflect specific commitments established under the NIRB process. These changes or advancements are highlighted here to avoid confusion as participants commence their reviews in advance of the Water License Hearings. Specifically the following changes or advancements have been made to the Project:

- The proposed milling process has been modified to allow all of the leached flotation concentrates to be placed underground as backfill material. This modification was made in response to suggestions put forward by DFO. It means that the solid residue resulting from the cyanide leaching of the flotation concentrate will now be filtered within the mill with the relatively dry solids (~8.5% moisture) trucked underground to be placed in stopes as backfill. Consequently, this waste stream will be diverted from Tail Lake and will lessen the potential impact on Tail Lake. The filtrate solution will be recycled within the milling circuit, with a small bleed solution being sent to Tail Lake with the flotation tailings. The cyanide leach residue will be treated in an effluent treatment circuit within the mill to destroy residual cyanide and to reduce metal concentrations before being filtered to produce backfill;
- The layout of the ANFO explosives mixing plant, magazines and AN storage has been modified following consultation with the proposed explosives supply contractor and Natural Resources Canada (NRCAN). The location of these proposed facilities remains unchanged, but the physical layout of the mixing plant and magazines has been changed on the advice of the explosives supplier to reflect their experience and to comply with regulatory requirements for distance between these facilities;

- Under the NIRB process, MHBL committed to construction of a small landfarm facility for the remediation of hydrocarbon contaminated soils generated by unplanned events during the mine life. The preferred location for this facility has now been established as being within the footprint of Quarry 2 adjacent to the mine's planned landfill. A design and operating plan for this landfarm have been developed and are included with this document;
- MHBL arranged for additional bathymetry data to be obtained in the area of Roberts Bay where the jetty is to be constructed. During the NIRB process MHBL had committed to assess the required length of this jetty and to shorten it if possible while still accommodating the required draft for the NTCL barges. The new bathymetry data reaffirmed the initial design at 103 metres in length to provide suitable draft; consequently, it is not possible to shorten the planned length of the jetty;
- The layout of the plant site (mill, maintenance shop, camp, power house and reagent storage area) has been refined based on new topographical survey data and geotechnical drilling. The location of the plant site has not been changed just the arrangement;
- In the early winter of 2006, MHBL undertook a geotechnical drilling program on the proposed four quarry sites (Quarry 1 at Roberts Bay, Quarry 2 near the plant site, Quarry 3 near Tail Lake and Quarry 4, which is a cut and fill leveling near the portal to found the mill foundations) (this program was initiated to address NIRB Project Certificate Condition #18). The drill holes were sampled at 1 m depth intervals and the samples sent out for acid base accounting analysis. The objective was to adequately demonstrate that these quarry sources will provide geochemically suitable rock fill for mine site construction. The program did verify that rock from these quarried sources will be non-acid generating; and
- The original plan for a rock-fill boat and float plane dock in Doris Lake was changed to a modular floating dock, which likely would have less effects on fish and fish habitat (i.e., would not require blasting of the rock along shore to make the dock). Also, the camp and mill water supply intake was changed from a floating structure in Doris Lake to an intake pipe laid on the bottom out from shore and covered with rock to weigh it down, and an intake structure about 25 m offshore.

Additional detail on these modifications has been included in the Project Description portion of this report (Section 2).

1.3 Water Board Application Guidelines - Conformity Tables

The role of the NWB in granting a water license is a significant component in the approvals process for the proposed Doris North Project. This document was prepared in accordance with published NWB guidelines for water license applications and with Project specific application guidelines for the Doris North Project provided by NWB staff, the "Nunavut Water Board Preliminary Guidelines for Applicant – Miramar Hope Bay

Limited – Doris North Project” dated October 27, 2006; as well as the “Additional Guidelines for the Doris North Water License Application” dated December 27, 2006.

To aid readers in determining where in this document the NWB Project specific guidelines have been addressed, two conformity tables have been prepared: Table 1.1 for the Preliminary Guidelines issued in October 2006 and Table 1.2 for the Additional Guidelines issued in December 2006. These tables direct the reader to the appropriate location within this report and within the appendices and supporting documents where each guideline has been addressed. For some guidelines, the reader will be required to refer to more than one document where a particular subject has been discussed. As much as possible, the subject matter has been addressed within this summary document so that the reader only has to go to the supporting document if more detail is needed to address the reader’s interest.

The content of this submission reflects the evolution of a project moving through the environmental assessment and regulatory process. The most up to date information available for the project has been provided in this document, and should replace any previous plans or concepts.

Table 1.1: Conformity Table

Guidelines Section No.	Guideline	Reference Document	Section/Page No.	Comment
4.a - General information presented for application designs and plans				
4.a(i)	Design requirements, design criteria, design parameters, design standards/analysis/method	1) Design of the Tailings Containment Area - Supporting Document S1 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Technical Specifications for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S3 4) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4	1) Full document 2) Full document 3) Full document 4) Full document	
4.a(ii)	Design assumptions and the limitations associated with such design assumptions	1) Design of the Tailings Containment Area - Supporting Document S1 2) Design of the Surface Infrastructure Components - Supporting Document S2	1) Section 3 (Pages 6 thru 10) 2) Section 3 (Pages 6 thru 9)	
4.a(iii)	The inclusion of clear, definable engineering qualifiers with all design drawings and reports	1) Design of the Tailings Containment Area - Supporting Document S1 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4	1) Sections 3 and 5 2) Section 3 (Page 6) 3) Full document	1) Section 3 contains design criteria and assumptions, Section 5 contains dam design information 2) Design criteria and assumptions.

Guidelines Section No.	Guideline	Reference Document	Section/Page No.	Comment
4.a(iv)	Site specific data and analysis to support the design and management decisions made	1) Design of the Tailings Containment Area - Supporting Document S1 2) Design of the Surface Infrastructure Components - Supporting Document S2	1) Section 5.3.1 (page 15), Section 5.5 (thermal analysis), Section 5.6 (creep deformation analysis), Section 5.7 (stability analysis), Section 5.8 (settlement analysis), Appendix D (geotechnical investigations), Appendix E (wave run up calculations) and Appendix F (water balance calculations) 2) Appendices A, B and D	2) Bathymetry information, Foundation investigations, thermal pad design
4.a(v)	Materials that appropriately delineate the particulars of a design or plan	1) Design of the Tailings Containment Area - Supporting Document S1 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components, Supporting Document S4	1) Sections 3, 4, 5, 7 and 9 2) Sections 3, 4, 5 and 6 3) Full document	1) Design criteria, site selection, design and operational plan 2) Design criteria and assumptions, Design of surface infrastructure components, operation and maintenance procedures and construction information.
4.a(vi)	Construction methods and procedures in how infrastructure will be put in place on-site	1) Design of the Tailings Containment Area - Supporting Document S1 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components, Supporting Document S4	1) Section 8 (pages 30 thru 34) 2) Section 6 (Pages 32 thru 36) 3) Full document	1) Construction of tailings containment area 2) Construction of surface earthworks for infrastructure.

Guidelines Section No.	Guideline	Reference Document	Section/Page No.	Comment
4.a(vii)	Instrumentation and monitoring requirements of the proposed designs and plans	1) Design of the Tailings Containment Area - Supporting Document S1 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components, Supporting Document S4	1) Section 11.1.3 Dam instrumentation, Section 11 (pages 42 thru 45 covers monitoring of the tailings containment area) 2) Section 7 (Page 37) 3) Drawings G-04, T-09 and T-10	
4.a(viii)	Details on how facilities, structures, and plans will be operated, maintained and implemented	1) Revised Water License Application Support Document 2) Design of the Tailings Containment Area - Supporting Document S1 3) Design of the Surface Infrastructure Components - Supporting Document S2	1) Section 3, Section 4 2) Sections 9 (operation) and Section 10 (maintenance) 3) Section 5 (Pages 22 thru 31)	
4.a(ix)	Construction, chemicals, and other materials used and are in contact or may impact waters either directly or indirectly	1) Revised Water License Application Support Document 2) Hazardous Materials Management Plan - Supporting Document S10e	1) Section 3.8 and Section 4.5 2) Full document	
4.a(x)	Mitigation for construction in and in close proximity of waters	1) Environmental Protection Plan - Supporting Document S10, Appendix A 2) Design of the Surface Infrastructure Components - Supporting Document S2	1) Equipment Movement / Supply and Working In Or Near Water 2) Section 6.2 (page 32) for the jetty construction	
4.a(xi)	Appropriate referencing of other documents and annexed materials	1) Revised Water License Application Support Document	TOC and throughout the text	

Guidelines Section No.	Guideline	Reference Document	Section/Page No.	Comment
4.b - Plans and designs presented where water use or waste deposition occurs				
4.b(i)	Earthwork infrastructure	1) Revised Water License Application Support Document 2) Design of the Tailings Containment Area - Supporting Document S1 3) Technical Specifications for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S3 4) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4	1) Section 2.4.1 thru 2.4.5 and Sections 2.4.8. thru 2.4.16 2) Section 5 (dam design) 3) Sections 4, 5, 6, 7, 8, 9, 10 and 11 4) Drawings T-01 thru T-14	
4.b(ii)	Water intake facilities and how water will be withdrawn	1) Revised Water License Application Support Document 2) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4	1) Section 2.4.13 2) Drawing T-11, and T-12	

Guidelines Section No.	Guideline	Reference Document	Section/Page No.	Comment
4.b(iii)	Interim waste rock facilities	1) Revised Water License Application Support Document 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Technical Specifications for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S3 4) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4 5) Waste Rock Management Plan - Supporting Document S10d	1) Section 2.4.7 and 3.3 2) Sections 4.13, 5.5.5, 5.5.6 and 6.10 3) Section 10.2.14 (page 72) and 10.2.16 and 10.2.17 (Pages 72 and 73) 4) Drawings S-07 and S-08 5) Full document	
4.b(iv)	Tailings containment area	1) Revised Water License Application Support Document 2) Design of the Tailings Containment Area - Supporting Document S1 3) Technical Specifications for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S3 4) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4	1) Section 2.4.8 and 3.6 2) Full document 3) Section 11 (Pages 80 thru 90) 4) Drawings T-01 thru T-14	

Guidelines Section No.	Guideline	Reference Document	Section/Page No.	Comment
4.b(v)	Landfills	1) Revised Water License Application Support Document 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Technical Specifications for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S3 4) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4 5) Landfill Management Plan - Supporting Document S10g	1) Section 2.4.11 2) Sections 4.16, 5.10 and 6.14 3) Section 10.2.22 (Page 74) 4) Drawing S-13 and S-14 5) Full document on landfill facility	
4.b(vi)	Landfarms	1) Revised Water License Application Support Document 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Technical Specifications for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S3 4) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4 5) Landfarm Management Plan - Supporting Document S10h	1) Section 2.4.11 2) Sections 4.17, 5.11 and 6.15 3) Section 10.2.23 (Page 75) 4) Drawings S-13 and S-14 5) Full document on landfarm facility	

Guidelines Section No.	Guideline	Reference Document	Section/Page No.	Comment
4.b(vii)	Fuel and chemical storage facilities	1) Revised Water License Application Support Document 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Technical Specifications for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S3 4) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4 5) Hazardous Materials Management Plan - Supporting Document S10e	1) Section 2.4.9 and Section 3.8 2) Sections 4.9, 4.10, 5.6, 6.7 and 6.8 3) Section 10.2.5 (Page 67) and Section 10.2.9 (Page 70) 4) Drawings S-01, S-02, S-05 and S-06 5) Full document on hazardous materials management	
4.b(viii)	Explosives management areas and facilities	1) Revised Water License Application Support Document 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Technical Specifications for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S3 4) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4 5) Explosives Management Plan - Supporting Document S10f	1) Section 2.4.10 2) Sections 4.8, 5.5.3 and 6.4 3) Section 10.2.6 (Page 68) 4) Drawing S-04 5) Full document on explosives management	

Guidelines Section No.	Guideline	Reference Document	Section/Page No.	Comment
4.b(ix)	Construction materials (i.e. quarried rock)	1) Revised Water License Application Support Document 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Technical Specifications for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S3 4) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4 5) Geochemical Characterization of Quarry Materials - Supporting Document S7	1) Section 2.4.15 and Figure 2.4 2) Sections 3.5 and Appendix E 3) Section 7.2 (Page 37) 4) Drawing G-05 5) Full document on geochemical characterization	
4.b(x)	Hazardous waste facilities	1) Revised Water License Application Support Document 2) Hazardous Materials Management Plan - Supporting Document S10e	1) Section 3.8 2) Section 2.4.2 (Page 13)	

Guidelines Section No.	Guideline	Reference Document	Section/Page No.	Comment
4.b(xi)	Site water management facilities	1) Revised Water License Application Support Document 2) Design of the Tailings Containment Area - Supporting Document S1 3) Design of the Surface Infrastructure Components - Supporting Document S2 4) Technical Specifications for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S3 5) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4 6) Water Management Plan - Supporting Document S10j 7) Water Quality Model - Supporting Document S6	1) Sections 3.6.5 and 3.7 2) Full document 3) Sections 4.14, 4.15, 5.9 and 6.12 4) Section 5.2.4 (page 30), Section 9.2.8 (page 60), Section 10.2.16 thru 10.2.18 (pages 72-73) 5) Drawings S-07 and T-01 and T-13 6) Full document 7) Section 2 (page 4)	
4.b(xii)	Wastewater treatment facilities	1) Revised Water License Application Support Document 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4	1) Section 2.4.12 and Section 3.5 (mill effluent) 2) Section 4.11 Page 17/18 3) Drawing S-07	

Guidelines Section No.	Guideline	Reference Document	Section/Page No.	Comment
4.b(xiii)	Ore stockpiles and recovery reject materials	1) Revised Water License Application Support Document 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4	1) Section 3.3 2) Sections 4.11, 5.5.1 and 6.9 3) Drawings S-07 and S-08	
4.b(xiv)	Dewatering programs	1) Revised Water License Application Support Document	1) Section 3.2	No dewatering programs are planned. Mining will be under "dry" permafrost conditions.
4.b(xv)	Hydrostatic testing programs	1) Design of the Tailings Containment Area - Supporting Document S1		No hydrostatic testing programs are planned
4.b(xvi)	Road, airstrip and ice road construction	1) Revised Water License Application Support Document 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Technical Specifications for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S3 4) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4	1) Sections 2.4.2 thru 2.4.5 2) Sections 4.2, 4.3 4.4, 4.5, 5.2, 5.3, 6.3 and 6.4 3) Sections 10.2.2 thru 10.2.4 (Page 67) and Sections 10.2.7 and 10.2.8 (Page 68 and 69) 4) Drawings G-02, S-01 thru S-03, S-10 thru S-12 and S-15 thru S-26	
4.b(xvii)	Water use	1) Revised Water License Application Support Document	1) Sections 5.1, 5.2 and 5.3	

Guidelines Section No.	Guideline	Reference Document	Section/Page No.	Comment
4.b(xviii)	Macroscopic site water management	1) Revised Water License Application Support Document 2) Water Management Plan - Supporting Document S10j 3) Water Quality Model - Supporting Document S6 4) Design of the Tailings Containment Area - Supporting Document S1	1) Section 2.4.4, Section 3.7 and Section 3.6.5 2) Full document 3) Sections 4 and 5 (pages 55 thru 69) 4) Section 7 - tailings water management	
4.b(xix)	Spill contingency and emergency response	1) Revised Water License Application Support Document 2) Emergency Response and Contingency Plan - Supporting Document S10a	1) Section 4.1 2) Full document	
4.b(xx)	Interim and final abandonment and reclamation of the mine site	1) Revised Water License Application Support Document 2) Mine Closure and Reclamation Plan - Supporting Document S10l	1) Section 8 2) Full document	
4.b(xxi)	Aquatic effects monitoring	1) Revised Water License Application Support Document 2) Monitoring and Follow-Up Plan - Supporting Document S10m 3) Final Report on Effluent and Aquatic Study Monitoring Design - Supporting Document S11	1) Section 7.9 2) Section 8.0 3) Full document	3) Item 3 is a Supporting Document from the October 2005 Doris North FEIS
4.b(xxii)	General monitoring	1) Revised Water License Application Support Document 2) Monitoring and Follow-Up Plan - Supporting Document S10m	1) Section 7 2) Full document	

Guidelines Section No.	Guideline	Reference Document	Section/Page No.	Comment
4.b(xxiii)	Quality assurance and quality control	1) Revised Water License Application Support Document 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Technical Specifications for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S3 4) Quality Assurance/Quality Control Plan - Supporting Document S10k 5) Design of the Tailings Containment Area - Supporting Document S1	1) Section 4.11 2) Section 6.1 3) Section 9.2.9 and 9.2.10 (Page 60) 4) Full document 5) Section 8.3	1) Water quality monitoring QA/QC 2) Construction QA/QC 3) Construction QA/QC 4) Water quality monitoring QA/QC 5) QA/QC for tailings dam construction
4.b(xxiv)	Geotechnical and structural monitoring	1) Revised Water License Application Support Document 2) Design of the Tailings Containment Area - Supporting Document S1 3) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4	1) Section 7.7 2) Section 11 3) Drawings G-04, T-09 and T-10	

Guidelines Section No.	Guideline	Reference Document	Section/Page No.	Comment
4.b(xxv)	Marine jetty design and management	1) Revised Water License Application Support Document 2) Design of the Surface Infrastructure Components - Supporting Document S2 3) Technical Specifications for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S3 4) Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components - Supporting Document S4	1) Section 2.4.1 2) Sections 3.2.2, 4.1, 5.1, 6.2 and Appendix C 3) Section 10.2.1 (Page 65) 4) Drawings J-01 thru J-03	
4.b(xxvi)	The collection of weather data for purposes of mine design	1) Revised Water License Application Support Document 2) Revised Hydroclimatic Parameter Re-Evaluation 2007 - Supporting Document S5 3) Air Quality Management Plan - Supporting Document S10b 4) Monitoring and Follow-Up Plan - Supporting Document S10m	1) Section 3.6.1 2) Full document 3) Section 3.3 (Page 10) 4) Section 2.3	
NIRB: Doris North Project Certificate Terms and Conditions related to Nunavut Water Board, Water Licensing Process				
Condition 10	<i>In commentary</i> : "...the sampling shall be conducted in accordance with a methodology approved by NWB though a Quality Assurance/Quality Control ("QA/QC") plan...."	1) Revised Water License Application Support Document 2) Quality Assurance/Quality Control Plan - Supporting Document S10k	1) Section 4.11 2) Full document	

Guidelines Section No.	Guideline	Reference Document	Section/Page No.	Comment
Condition 13	MHBL shall collect additional water quality data for the 2006 field season and incorporate it into a revised water quality model to be submitted to the NWB as part of the water license application. MHBL will meet discharge criteria on a site specific basis set by the NWB where possible, for the protection of the receiving environment at the point of discharge.	1) Revised Water License Application Support Document 2) Water Quality Model - Supporting Document S6	1) Section 3.6.5 2) Section 3.3.2 (Page 12)	
Condition 14	MHBL shall collect additional precipitation, evaporation and runoff data and incorporate it into a revised water balance to be submitted to the NWB as part of the water license application.	1) Revised Water License Application Support Document 2) Revised Hydroclimatic Parameter Re-Evaluation 2007 - Supporting Document S5	1) Section 3.6.1 2) Full document	
Condition 18	MHBL shall submit to the NWB, as part of the water licence application, a program detailing the methodology for testing quarried rock for acid generation and metal leaching potential. The sampling, testing and analysis must me done by a professional geologist registered in Nunavut.	1) Revised Water License Application Support Document 2) Geochemical Characterization of Quarry Materials - Supporting Document S7	1) Section 2.4.15 2) Full document	
Condition 31	A complete Closure and Reclamation Plan prepared in accordance with the NWB requirements shall be filed by MHBL at the time MHBL makes application to the NWB for a water license for the mine.	1) Revised Water License Application Support Document 2) Mine Closure and Reclamation Plan - Supporting Document S10l	1) Section 8 2) Full document	

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
	GLOBAL CONCERNS		
i.	Decision Making Criteria, Adaptive Management (AM), and Conceptual Design As detailed through Page 8 of the Guidelines and reiterated through our face to face discussions, MHBL shall consider AM when a final design can not be presented. MHBL was unable to provide adaptive management strategies in instances where management and design commitments were not made in the Doris North application. DIAND's Intervention, filed December 8th, 2006, had also reported that AM had not been identified in the application documents. The NWB, and also supported through GN DOE's Intervention (filed December 4th, 2006), have determined that the application designs and plans presented, without an AM strategy, have not been developed beyond the conceptual stage.	Tail Lake Shoreline Erosion Adaptive Management Plan - Supporting Document S1, Section 7.6 & Appendix G; Supporting Document S4, Drawing T-14. Tail Lake Water Management Contingency Measures - Supporting Document S6, Section 5.3 ; Revised Water license Application Support Document, Section 3.6.6. Stormwater discharge contingency strategies for landfill, mill/camp area, landfarm and fuel containment areas - Revised Water license Application Support Document, Section 3.7.	contd
ii.	Appropriate Referencing, Inconsistencies, and Interconnectivity The NWB had stressed, through face to face discussions and the Guidelines, the need to appropriately reference (document, section, and page) as it is essential to present application information to the NWB and respective interveners. As shown through the content of this letter document interconnectivity was not demonstrated and absent in many instances. The NWB has also identified numerous items within the application that are contradictory and inconsistent. Regulators, including the NWB, require MHBL to direct them through the water license application through consistent and fluid presentation absent of contradictory discussion. As stated in the Guidelines information management is the responsibility of MHBL.	Referencing and connectivity was added throughout all of the Revised Water license Application Support Document and Supporting Documents. A third party editor was used to search out all inconsistencies	Documents have been revised for referencing, consistency and connectivity
iii.	Appropriate Delineation and a Stand-Alone Document MHBL shall understand that the water license application is a communication tool where elements of water and waste management and design are sufficiently detailed. The NWB once again encourages MHBL to provide materials that effectively communicate and eliminate the ambiguity outlined in this letter document. The NWB would like to reiterate (previously discussed during NWB-MHBL face-to-face meetings and the Guidelines) that the information presented in individual technical reports should be stand-alone. The NWB expects the resubmission to include all information so its individual designs and plans may be considered independent and stand-alone (with appropriate annexing and referencing where applicable).	Supporting Documents have been written as stand alone documents with appropriate cross referencing.	Reports have been revised to act as stand alone documents with cross references added where appropriate
iv.	The Absence of Professional Qualifications and Authorship on Report Documents In many instances design reports were not appropriately qualified (through professional seal) and in most instances documents were not signed by the document author. As aforementioned, supplementary application documents are to be stand-alone and as this is the case shall be qualified and signed accordingly. The NWB requests a CV (curriculum vita) for each signing professional as well as any other representative that intends to participate at a Public Hearing. This CV collection shall companion the water license resubmission.	(2) Revised Water license Application Support Document, Appendix B	(1) All design reports, including the documents that form elements MHBL's Environmental Protection Plan (Supporting Documents S10 and S10a thru S10m) have been signed and stamped. (2) CV collection is included
v.	Intervention Comments NWB has annexed Intervener comments to this letter document. The NWB requests a formal response to all Intervener comments not addressed in this NWB letter document.	Revised Water license Application Support Document, Table 1.2 (Additional Conformity Table)	Intervener comments addressed in conformity table and throughout the revised content of the application documents

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
vi.	Guidelines for Resubmission MHBL will be required to provide a complete resubmission of the water license application. In the resubmission MHBL will be required to outline through red text and a text strikethrough any deletion made from the November 7th, 2006 license submission and will be required to outline through blue text any addition made after the November 7th, 2006 license submission. MHBL will also be required to provide a guiding document that will accompany the water license application resubmission. This guiding document will point Regulators and the NWB to where any alteration from the November 7th, 2006 has been made. The NWB would like to restate that information management is the responsibility of MHBL.	(1) CD entitled Revised Water License Application Support Document - Redline (2) Additional Conformity Table, Revised Water License Application Support Document, Table 1.2	(1) Redline version of all documents submitted on CD with submission. (2) This table guides the reader through additional guidelines and where these have been addressed in the application documents

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
ADDITIONAL INFORMATION ITEMS			
S1- Tailings Containment Area			
1.	The NWB understands that the <i>Preliminary Tailings Dam Design</i> report, which was submitted as part of the environmental screening process, provided the major framework as well as background information to the TCA Design report. Consequently, should this document be referenced where applicable and included as an appendix to the TCA design report? Furthermore, in Section 4.1.2 of the <i>Preliminary Tailings Dam Design Report</i>, MHBL indicated that an Adaptive Management Plan would be prepared as part of the final dam design. Given that the TCA Design report has been submitted to the NWB as a final design, why has the Adaptive Management Plan, noted above, not been included in the report?	Supporting Document S1 throughout & Supporting Document S1, Section 1.1 & new Appendix G	Appropriate referencing to previous work added throughout report; Added specific chapter in report (Section 1.1); Shoreline erosion extracted as standalone Adaptive Management Plan in Appendix G
2.	Section 3 (S1) – The main report does not mention the wind data collected from the closer Doris Lake, nor any discussion that Boston camp data is more appropriate. Was the Doris Lake data not considered and if so how so? Is the Boston camp data considered more representative of the conditions within the TCA? For record purposes the NWB requests detailed discussion on the reasoning on the use of the selected wind data.	Supporting Document S1, Section 2.4	More explanation added
3.	Section 3.2.2 to Section 3.2.4 (S1) – No other assumptions or criteria, as presented in the <i>Preliminary Tailings Dam Design</i> report, such as design capacity, design freeboard, assumptions for the climatic changes, or other upset conditions are presented. Does MHBL believe that these assumptions should be included in this report given the need for stand-alone reporting?	Supporting Document S1, Sections 1.1, 3.23 and 3.2.4	Additional referencing added throughout report
4.	Section 3.2.4 (S1) - No reference was made to Appendix B (Thermal Design of Tailings Dam) on the discussion of stability. Does MHBL believe that information presented in Appendix B compliments stability? If so should not the contents of Appendix B be incorporated into the discussion of stability?	Supporting Document S1, throughout	Appropriate referencing to Appendix B added
5.	Section 3.2.3 (S1) – The report states that the Spillway has been designed to pass a 24-hour, 500 year return period flood event (annual exceedance probability of 0.05).	Supporting Document S1, Section 7.5	Clarification added
6.	MHBL has not provided an analysis to provide understanding and ensure that water quality will not exceed MMER guidelines during discharge over the Spillway during a design flood event. In the event that water quality is predicted to exceed MMER guidelines, has MHBL considered and developed contingencies to address any mitigative measures that could be employed under this instance?	Supporting Document S1, Section 7.5	Clarification added

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
7.	Section 3.2.4 (S1) – The NWB understands that detailed information related to Section 3.2.4 is presented in Appendix B (Sections 4.3, 5.2 and 6.2) for thermal, creep deformation and stability criteria, respectively). Does MHBL agree that this information should be presented/discussed/referenced in Section 3.2.4 ?	Supporting Document S1, throughout	Appropriate referencing added to Appendix B
8.	Section 5.2 (S1) – MHBL states that “ <i>The storage capacity of the entire TCA at elevation 33.5 m is about 7.4 million m³, compared to a tailings volume requirement of about 400,000 m³.</i> ” The referenced Drawing T-01 for the TCA Storage Stage Curve may provide a different storage capacity than above (shown as closer to 9 million m ³). The NWB assumes that the 400,000 m ³ tailings is based on 2 years of tailings production at a solids production rate of 544 m ³ /day (or 1727 total tailings feed/day). The NWB requests clarification on the above. The assumed final tailings elevation applied in the above quoted estimate may be at el. 24.3 m. However, the same TCA Storage Stage Curve appears to show less than 400,000 m ³ for the 24.3 m elevation. Furthermore, the planned maximum operating water level shown on the TCA Storage Stage Curve is 29.4m, while the planned maximum operating water level shown on the Water Balance Conditions for TCA chart appears to be 29.2m. The NWB requests clarification on the statements listed under this bullet.	Supporting Document S1, throughout Supporting Document S4, Dwg. T-01 revised	Inconsistencies fixed throughout
9.	Section 5.5.3 (S1) – In the third paragraph of this section MHBL states that “ <i>Beneath the frozen core, permafrost temperatures are predicted to progressively cool with time over the first ten years or so due to the thermal influence from the thermosyphons but then become warmer because of long-term climate warming.</i> ”. The main report does not indicate or mention that the thermosyphons will be an important part of the dam design, as presented in Appendix B ? Does MHBL believe that the thermosyphons are critical in maintaining the frozen foundation of the dam, particularly during the first ten years of operation? If so, does MHBL agree that the above discussion, included in Appendix B , should be included and further discussed in the main report?	Supporting Document S1, Sections 5.4.1 & 5.4.2	Reader directed to appropriate statement in report
10.	Section 7.5 and Section 8.5.2 (S1) – In the last sentence of Section 7.5 MHBL states that “ <i>Details regarding the predicted timing of spillway construction are presented on Dwg. T-01.</i> ” Further, in the first sentence of Section 8.5.2 MHBL states “ <i>As has been described previously, there is a real possibility that the spillway may never be put to use, and certainly, for at least 5 ½ years, the spillway will not be required.</i> ” However, the NWB understands that the Water Balance Conditions depicted in the TCA chart on Drawing T-01 indicate that the implementation of spillway construction may be in Year 4. Why has an estimated duration of construction for the Spillway not been presented in Section 7.5 of the TCA Design Main Report?	Supporting Document S1, Section 7.5	Additional clarification provided
11.	Section 7.1 (S1) – The report provides a procedure for evacuating tailings from the pipeline and temporary storage in the emergency dump catch basins. Is there a procedure for removal of the evacuated tailings from the emergency dump catch basins? How will the slurry be completely removed from the basins without incurring damage to the liner or displacement of the cover soil? What, if any, repair will be required to the catch basins as a result of removing the slurry, and what additional equipment and supplies will be required on site to pump the slurry into Tail Lake?	Supporting Document S1, Sections 9.3 & 10.4	Procedures documented - more clarification provided and reader directed to appropriate sections

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
12.	Appendix C, Section 3.4 (S1) - It was suggested that determination of the lake ice thickness on Tail Lake has not been carried out. However, the report also indicates that selected ice thickness measurement taken during the water sampling and drilling programs reveal maximum thicknesses between 1.9 and 2.2 m. The NWB understands that it is suggested that the minimum water level depth, to ensure lake bed stability, is dominated by the ice entrainment process. Will ice thickness be monitored at Tail Lake to ensure that it is less than the predicted 2.2 m? If so, at what frequency to this monitoring is MHL committing to? If the ice thickness is greater than 2.2 m, what actions will be implemented to minimize ice entrainment potential? How often and how will tailings levels in Tail Lake be monitored?	Supporting Document S1, Section 11.4	Statements added as requested
13.	Appendix D, Section 1.2 (S1) - The NWB understands that 2 drill holes were only completed during the 2006 geotechnical field investigation program and due to unseasonable warm conditions these two drill holes were located at the South Dam area. The NWB understands that boreholes were not drilled on the North Dam area in 2006. An EBA letter report dated February 28, 2005, Re: Review of Alternative Dam Design, Hope Bay Doris North Project, suggested that additional drilling consisting of at least three boreholes is recommended in the North Dam area. The NWB understands that these holes were intended to supplement the subsurface conditions and to reduce uncertainties at the site. No discussion was provided in the Main Report regarding the impact the unsuccessful drilling program in Winter 2006 had on the analyses and design of the dams. Was the limited data overcome with more rigorous analyses, including sensitivity analyses that resulted in high confidence in the various analyses to support or confirm the frozen dam scheme for the North Dam? What uncertainty exists as a result of the additional drilling not being completed? Are there plans to complete the desired drilling before dam construction?	Supporting Document S1, Section 8.5.1	Statement added to address issue
14.	Appendix D (S1) - This report indicates that Ground Penetrating Radar (GPR) was useful in mapping shallow bedrock, within 5 to 10 m penetration. Appendix 1 shows the results of the field survey along the perimeter of Tail Lake. The NWB understands that the GPR was utilized along the perimeter of Tail Lake and the results may provide information for the characterization of the potential for shoreline erosion. There is no analysis or summary of results presented in the Winter 2006 investigation report on the GPR survey. How are the results presented in Appendix 1 of the AMCL report utilized to help characterize the perimeter conditions of Tail Lake? Have the existing boreholes in the perimeter area been included in the analysis of the GPR survey?	Supporting Document S1, Section 5.3.1	Appropriate comment added
15.	Appendix D (S1) - The NWB understands that this section reports that the maximum hydraulic freeboard required to prevent overtopping of the dam is 0.29 m. The NWB requests sufficient details of the waste run-up calculations used to determine the freeboard height of the dam.	Supporting Document S1, Section 3.2.4	Information added

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
16.	Section 8.5.1 (S1) - Engineering Drawings T-02, T-04, and T-05 stated that <i>"The dam construction may only proceed at temperature below 15 degrees Celsius"</i> ; however, in S1 it was stated that <i>"Placement of the dam material will require an ambient air temperature of at least - 10°C"</i> . The NWB requests clarification on the required air temperatures for construction.	Supporting Document S3 Supporting Document S4, Revised Drawings	Inconsistencies removed and statement revised
17.	Engineering Drawings T-03, T-04, and T-06 – The NWB understands that the cut-off trench, as shown, is 2 m in depth. In the North dam drawings (T-03 and T-04) a typical additional trench excavation is shown to remove peat materials. The EBA letter report dated February 28, 2005, Re: Review of Alternative Dam Design, Hope Bay Doris North Project , indicated that the depth of the cut-off trench for the North Dam should be increased from 2 to 3.5 m. This letter also suggested that an additional drilling program, consisting of at least 3 holes, be carried out to supplement the geotechnical data and reduce uncertainties in the stratigraphy of the North Dam. Does MHBL believe there is adequate data and analysis to confidently support the implementation of a 2 m cut-off trench under the North Dam? If trench depth is altered in the field during construction, what impact would this have on the installation and performance of the thermosyphons?	Supporting Document S3 Supporting Document S4, Revised Drawings	Inconsistencies removed and statement revised
18.	Tailings Drawing T-07 - There is no reference to the two details provided in Drawing T-07 . What is the significance of these thermosyphon details?	Supporting Document S4, Revised Dwg. T-07	Additional information provided
19.	The NWB understands that the TCA design report contains a limited scope of in-depth discussions, compared to the Preliminary Tailings Dam Design submitted as part of the FEIS document in 2005, and appeared to be tailored for providing additional information obtained after the FEIS submission. The NWB also understands that additional studies and analyses have been carried out since the submission of the preliminary design report. Does MHBL agree that if MHBL's intention is to complement the TCA design report with the preliminary design document, then references to the preliminary design report should be made in this document and the preliminary design report should be included as an appendix? Sections of the preliminary design report that have been modified, revised or changed should be indicated for clarification. Additional cross-referencing and detail are requested to address this concern.	Supporting Document S1, throughout	Appropriate references added throughout
20a.	The NWB understands that the creep/deformation analyses provide estimates of vertical and lateral deformation along the dam foundation. The NWB also understands that MHBL indicates that settlements due to consolidation of the marine clay and silt foundation soils are less of a concern than those predicted to result from creep and thaw. The NWB understands that the North Dam is expected to have larger differential settlement than the South Dam; however, the South Dam will have large settlements. The NWB also understands that creep and thaw settlements are expected to be high along the upstream and downstream foundation sections of the dam, but low beneath the core. Figure 24 of the TCA Design report provides predicted settlement over time under the crest of the core. The NWB understands that Figure 24 may be based only on creep deformation. The NWB requests additional information on the predicted total settlement including contributions from other mechanisms (such as thaw and consolidation)? Has this total settlement been estimated?	Supporting Document S1, Appendix H	Additional clarification and discussion provided
20b.	The NWB understands that there may be variation in settlement across the dam, including where the thermosyphon's evaporator pipes will be located within the foundation of the dam. How will the estimated settlements affect the performance of the thermosyphon? Will the evaporator pipes be able to tolerate settlement/ deformation along the foundation without rupture or damage?	Supporting Document S1, Appendix H	Additional clarification and discussion provided

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
20c.	Figure 24 shows only settlement under the crest of the core. How large are the settlements along the upstream and downstream sections of the dam?	Supporting Document S1, Appendix H	Additional clarification and discussion provided
21a.	Does MHL believe that the latest thermal modeling generally confirms that the thermosyphon will be required to keep the dam foundation frozen? If so, Is there precedent for installation of thermosyphon in dam foundations with complex stratigraphy and expected foundation deformation/settlement on the same order as that for the North and South Dams?	Supporting Document S1, Appendix H	Additional clarification and discussion provided
21b.	What is the expected behavior of the evaporator pipes subjected to high total and differential settlements?	Supporting Document S1, Appendix H	Additional clarification and discussion provided
21c.	Does MHL agree that the thermal modeling report indicates that the contribution of the thermosyphons in the first ten years of operation is critical to keeping the dam foundation frozen? From the Technical Specifications the NWB understands that that the thermosyphon will have a five year manufacturer's warranty against loss of heat transfer. How is this discrepancy resolved?	Supporting Document S1, Appendix H	Additional clarification and discussion provided
21d.	What kind of installation measures, if any, to accommodate total and differential settlements will need to be implemented to ensure that the thermosyphon will function as required, in view of the complex dam foundation at the site?	Supporting Document S1, Appendix H	Additional clarification and discussion provided

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
21e.	Will the thermosyphons function in at least the first ten years? Does MHBL believe this is critical to keep the dam frozen?	Supporting Document S1, Appendix H	Additional clarification and discussion provided
21f.	In the event that the installed thermosyphon stops functioning as required, what alternative options can be implemented? Does MHBL plan to install additional thermosyphons after the dam is constructed?	Supporting Document S1, Appendix H	Additional clarification and discussion provided
21g.	Have thermal analyses been carried out to include short term application of the thermosyphon (i.e. thermosyphon that will only function in the first few years of the dam operation)? Does MHBL believe that this type of analysis may provide information on the critical time period at which the thermosyphon will no longer be required? Does MHBL believe this type of analysis should be completed and provided to Regulators? If not, why not?	Supporting Document S1, Appendix H	Additional clarification and discussion provided
22.	The NWB understands that the finite element thermal modeling analyses that were carried out for the North and South Dams were completed using two different modeling softwares. The initial analyses completed for the FEIS utilized commercially available SVHEAT software, while those carried out for the Water License Application utilized a proprietary EBA's GEOTHERM modeling software. With the GEOTHERM modeling, has MHBL's latest data been used? Are the model results from the two different software packages comparable and complementary to the design of the frozen dam foundation? The NWB requests a detailed discussion outlining this comparison and detailed discussion outlining any new finding discovered through GEOTHERM modeling.	Supporting Document S1, Appendix H	Additional clarification and discussion provided

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
	S2- Design of the Surface Infrastructure Components		
1.	Section 7 (S2) - Reference was made to visual and thermal monitoring to be conducted for the surface infrastructure components described in S2 . The NWB understands that cross-referencing to the Monitoring and Follow-Up Plan (S10m) was not provided in S2 and is requested. Within S10m , with exception of the tailings geotechnical monitoring descriptions, no details or summary of visual and thermal monitoring were provided for the remainder of the surface infrastructure components described in S2 . Additional detail regarding monitoring of the other surface infrastructure components, which includes but not limited to parameter(s) to be monitored, location, frequency, and mining phase, is requested to be included within S10m report and Table 1 . Cross-referencing to this information in S10m within S2 is requested.	Supporting Document S2, Section 7.1	Appropriate reference added
2a.	Section 7.2 (S2) - It was stated that new thermistors should be installed at the jetty (two strings), fuel transfer station (one string), airstrip (three strings), camp pad (two strings), pollution control pond (one string), sedimentation pond (one string), float plane dock laydown area (one string), roads (five strings), and bridge abutments (two strings) as part of the fill construction. Is Miramar committing to the installation of these thermistors?	Supporting Document S2, Table 7.1	Table providing an overview summary of the monitoring parameters, sampling location, and sampling frequency for each proposed follow-up monitoring program.
2b.	Acknowledging that site specific conditions may alter the exact location of the thermistors, a map detailing the location of all thermistor installation is requested. If this information is provided in the engineered drawings, appropriate cross-referencing is requested.	Supporting Document S2, Section 7.2	Appropriate reference added
2c.	Additional details pertaining to location, frequency, and mining phase for thermistor monitoring are requested to be included in S10m report and Table 1 . Cross-referencing to S10m from S2 is requested.	Supporting Document S2, Section 7.1	Appropriate reference added
3.	Detail design of the emergency dump catch basins for draining tailings from the discharge pipe were not provided in the application presented. The NWB requests additional design detail and volume balance calculations.	Supporting Document S1 Supporting Document S4, Dwg. T-13	This is not covered in this report at all because it forms part of Supporting Document S1. This is explained in the introductory chapters of each report.
4.	Upon mine discharge stoppage, it was stated that the return water line from Tail Lake to the mill will be drained and allowed to flow directly onto the tundra. The NWB requests additional detail and clarification to understand if the discharged waters are contained within the Tail Lake catchment basin. How will these waters be managed to not negatively impact the environment? How will sediment control be ensured?	Supporting Document S1, Section 9.3	Incorrect wording revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
	JETTY		
5.	Appendix C (S2) - Details pertaining to foundation bearing capacity and settlement for the jetty were provided. It was stated that the <i>"design is preliminary in nature, and is intended to be used to confirm general feasibility of the concept proposed, and allow for cost estimation to +/- 15% accuracy"</i> . The technical memorandum was dated Sept 14, 2005, which is before the result of the geotechnical investigation and soil laboratory testing was conducted in 2006. Thus, the NWB understands that, the input parameters for the bearing capacity and settlement calculations were based on previous geotechnical testing (e.g. vane shear) and assumed values (e.g., compression index, coefficient of consolidation). Additionally, details for select soil characteristics were not provided in Appendix C .	Supporting Document S2, Appendix C	Memo rewritten to accommodate latest data and address the detail requested.
5a.	The NWB understands that final design calculations for bearing capacity and settlement calculations for the jetty that considers the site specific soil geotechnical properties measured for the jetty location and the results of the testing completed in 2006 as presented in Appendix B were not provided. Why were the new data not included in a final design calculation for bearing capacity and settlement? Will the bearing capacity analysis follow the procedures outlined for embankments on soft ground detailed in the Canadian Foundation Engineering Manual? If not, why not?	Supporting Document S2, Appendix C, Section 2.1	Memo rewritten to accommodate latest data and address the detail requested.
5b.	What is the acceptable factor of safety against bearing capacity failure of the foundations?	Supporting Document S2, Appendix C, Section 2.5	Memo rewritten to accommodate latest data and address the detail requested.
5c.	Section 4.0 Appendix B (S2) stated that the 2006 geotechnical <i>"investigation confirms that the design parameters used for the proposed jetty design (SRK 2005a) is appropriate"</i> . The NWB requests that MHLB expands on this statement with additional discussion. What specific design parameters are being referred to and what comparisons to the 2006 measured soil parameters can be made?	Supporting Document S2, Appendix C, Sections 2.2 and 2.4	Memo rewritten to accommodate latest data and address the detail requested.
5d-i.	In addition to above, based on the provided bearing capacity and settlement calculations in Appendix C . Further clarification is requested to address each of the following: The NWB requests detailed calculations on how initial effective stress, including pore water pressure, was calculated. Has consideration been given to 5.0 m of water column acting above the marine sediment?	Supporting Document S2, Appendix C, Section 2.3.1	Memo rewritten to accommodate latest data and address the detail requested.
5d-ii.	The NWB requests details on how the live load applied stress was calculated. What area is this load applied over? Lateral loads such as ice and wind may not be considered in the analysis. Additionally, lateral loads induced from a docking or docked barge onto rock fill may not be considered in the analysis. What is the expected live lateral load from a barge? What are the details and implications of not including this potentially large lateral live load in the foundation analysis?	Supporting Document S2, Appendix C, Section 2.3.2	Memo rewritten to accommodate latest data and address the detail requested.
6.	Appendix C (S2) - Preliminary design commentary was provided regarding the use of geogrid reinforcement over the base of the jetty to provide foundation support and reduce differential settlement. It was stated that a multiple layer structure of three or four layers of bi-axial geogrid separated by select rock fill could be used as a configuration. It was further stated that to SRK knowledge, geosynthetic reinforcement in pad construction in an arctic environment has not yet been attempted; however, SRK believes that this application is feasible. Further, the supplier was prepared to guarantee their product for this application in the arctic. The NWB requests additional information on the following:	Supporting Document S2, Appendix C, Section 3.2	Memo rewritten to accommodate latest data and address the detail requested.

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
6a.	Select geogrid product specifications were provided in S3. The heading on Table 8.4 stated that the geogrid specifications are for a "typical product". The NWB would like to confirm that the geogrid characteristics, as specified in S3 Table 8.4, are final design specifications.	Supporting Document S2, Appendix C, Section 3.2	Memo rewritten to accommodate latest data and address the detail requested.
6b.	The NWB requests detailed design calculations and analysis, with a description of the method of analysis and any assumptions, to detail i) selected geogrid strength and ii) aperture size characteristics, specific to the embankment and foundation characteristics. Details for all soil, geogrid, and soil-geogrid strength parameters used in the analysis, which may include but not limited to: allowable geogrid reinforcement force governed by strength and allowable strain, geogrid stiffness over applicable strain range, and geogrid strength reduction factors, are also requested.	Supporting Document S2, Appendix C, Section 3.2	Memo rewritten to accommodate latest data and address the detail requested.
6c.	Engineering considerations, with any associated design calculations, on the selection of the proposed layout for the geogrid position of two geogrids bound together and placed off axis to each other, as specified in S3, are requested.	Supporting Document S2, Appendix C, Section 3.2	Memo rewritten to accommodate latest data and address the detail requested.
6d.	Will a guarantee from the supplier for use of the product in this application be obtained?	Supporting Document S2, Appendix C, Section 3.2	Memo rewritten to accommodate latest data and address the detail requested.
AIRSTRIP			
7.	A winter airstrip has been proposed for implementation on Doris Lake. No details of operation and impact on Doris Lake waters were provided. The NWB requests additional detail regarding construction, operations, and maintenance of the winter airstrip, along with mitigative measures to reduce impact on freshwaters.	Supporting Document S2, Section 4.3	Appropriate reference added
CULVERTS			
8.	Section 4.4 (S2) - A 900 mm diameter culvert has been proposed. It was stated that "hydraulic design suggests that smaller culverts may be used". There were no hydraulic characteristics of the site or culvert sizing calculations provided to substantiate this statement. The NWB requests MHBL's design calculations that demonstrate the appropriateness of a 900 mm diameter culvert for use. Additional detail into the adaptive management strategy in determining when "smaller culverts may be used" is also requested by the NWB.	Supporting Document S2, Section 4.4	Text revised and additional requested detail provided

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
	BRIDGE AND BRIDGE ABUTMENTS		
9a.	Section 4.5 (S2) - It was stated that “the minimum bridge deck height above Doris Creek will be 4.1 m”. Clarification is requested if this height is based on normal flow conditions in Doris Creek?	Supporting Document S2, Section 4.5 and new Appendix G	Additional clarification and detail provided
9b.	For purposes of adding to the application record, how was the minimum bridge deck height selected as a design constraint?	Supporting Document S2, Section 4.5 and new Appendix G	Additional clarification and detail provided
9c.	For purposes of adding to the application record, what is the elevation and width of Doris Creek at the bridge crossing for high water flow conditions and how does this compare to the proposed elevation of the bridge deck and distance between abutments?	Supporting Document S2, Section 4.5 and new Appendix G	Additional clarification and detail provided
10a.	Section 4.5 (S2) - It was stated that the “stream bank-full width (i.e. the ordinary high water mark) of Doris Creek at the crossing location is about 15 m”. How was this value determined?	Supporting Document S2, Section 4.5 and new Appendix G	Additional clarification and detail provided
10b.	What flow event does “ordinary high water mark” refer to?	Supporting Document S2, Section 4.5 and new Appendix G	Additional clarification and detail provided
10c.	How will the abutments impact the flow of Doris creek during normal and extreme flow condition	Supporting Document S2, Section 4.5 and new Appendix G	Additional clarification and detail provided
10d.	What provisions have been made to minimize erosion and scour of the abutments?	Supporting Document S2, Section 4.5 and new Appendix G	Additional clarification and detail provided
11a.	The NWB understands that details were not provided regarding the geotechnical considerations with respect to the bridge and abutment structure or the foundation conditions at the crossing. Understanding that a bridge failure will result in the deposition of materials in Doris Creek additional detail and clarification are requested to address each of the following: Has the soil stratigraphy been delineated at the abutment locations along with critical geotechnical laboratory testing of the foundation soils? If so, borehole logs, cross-section, and results of the laboratory testing are requested. If not, why not?	Supporting Document S2, Section 4.5 and new Appendix F	Additional clarification and detail provided
11b.	Have appropriate bearing capacity and settlement calculations been completed for the abutments? The NWB requests sufficient discussion on MHBL's reasoning and detailed design calculations along with details for all input parameters used in the analysis. If not, why not?	Supporting Document S2, Section 4.5 and new Appendix F	Additional clarification and detail provided
11c.	What is the acceptable amount of settlement that the bridge can accommodate and what is the expected amount of settlement? Will settlement be monitored and how?	Supporting Document S2, Section 4.5 and new Appendix F	Additional clarification and detail provided

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
11d.	Have appropriate slope stability calculations with consideration given to dead and live loadings and retaining wall configuration been completed? If so, detailed design calculations along with details for all input parameters used in the analysis are requested. If not, why not? The NWB requests additional discussion and detail to demonstrate that the slope of the abutment (1.2H:1V, which is about angle of repose of the run of quarry rock) on the facing Doris Creek will be stable under the applied loads and configuration shown in engineered drawing S-12.	Supporting Document S2, Section 4.5 and new Appendix F	Additional clarification and detail provided
11e.	Have appropriate retaining wall and sill design analysis been completed to ensure the run of quarry material will be retained in the configuration shown in engineering drawing S-12 and sill to be stable under the applied loads? If so, detailed design calculations along with further details for all input parameters used in the analysis are requested. If not, why not?	Supporting Document S2, Section 4.5 and new Appendix F	Additional clarification and detail provided
BEACH LAYDOWN AREA			
12.	Section 4.6 (S2) - It was stated that <i>"following development of Quarry #1, the quarry itself will be considered for use as a laydown area"</i> . The NWB understands that this is contingent if suitable and competent rock is exposed. Final designs are to be submitted as part of this application. The above mentioned statement reflects adaptive management. The criterion decision to use Quarry #1 was provided; however, the design and key characteristics of Quarry #1 laydown area have not been provided. Additional details are requested to complete this adaptive management.	Supporting Document S2, Section 4.6	Statement removed
FUEL TRANSFER STATION			
13.	The NWB requests additional detail and discussion into how the liner integrity is checked after construction and covered with soils.	Supporting Document S2, Section 6.1 and new Appendix H Supporting Document S3 throughout Supporting Document S4 throughout	Additional information provided
14.	Design report S2 did not include any details of how the geomembrane and geotextile product specifications provided in report S3 Section 8.2.4 were considered in the design of the fuel transfer station. Additional detail and clarification are requested to address how the product specifications of the geosynthetics a) ensure protection of the geomembrane from damage/puncture during construction and operation loadings, and b) considered in the anchor trench design.	Supporting Document S2, new Appendix H	Additional information provided

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
FUEL TANK FARM			
15.	Section 2.1 (S10) - It was stated that bermed and earthworks will be “ <i>constructed and maintained to be liquid tight to a permeability of 25 L/m²/day</i> ”. <i>We don't know where this comes from.</i> Testing to ensure this quality of construction and assurance of liner permeability was not discussed within the Landfarm Design and Management Plan [S10h] or the Fuel Tank Farm section within the Design of Surface Infrastructure Components [S2] . The NWB would like to understand why this testing for liner permeability was not addressed in the design of the landfarm or tank farm. Additionally, what frequency of liner permeability testing will be completed to ensure that the integrity is “ <i>maintained</i> ”?	Supporting Document S2, new Appendix H	Additional information provided
16.	Additional detail and discussion is requested into how the liner integrity is checked after construction and covered with soils? If this information is contained in a separate document, appropriate cross-referencing is requested.	Supporting Document S2, new Appendix H	Additional information provided
17.	The NWB understands that design report S2 did not include any details of how the geomembrane and geotextile product specifications provided in report S3 Section 8.2.4 were considered in the design of the fuel tank farm. Additional detail and clarification are requested to address how the product specifications of the geosynthetics a) ensure protection of the geomembrane from damage/puncture during construction and operation loadings, and b) considered in the anchor trench design.	Supporting Document S2, new Appendix H	Additional information provided
18.	The NWB understands that the cover at the base of the tank farm is 0.2 m thick. Are there any “high traffic areas” within the tank farm which would require adherence to the minimum 0.3 m thick cover over the liner (as specified in S3 Section 8.3.1f)? For purposes of the application record what is the path fuel trucks will take to enter the tank farm and unload?	Supporting Document S2, Section 4.10	Confusion clarified and more detail provided
SEDIMENTATION POND			
19.	The NWB understands that the camp/mill sedimentation pond has been designed to retain waters draining from the camp and mill, excluding the temporary waste rock pile and ore stockpile. The pond is located down gradient of the camp and banked by the portal access road on one side. The NWB would like to better understand MHL's rationale for placing a culvert south of the camp and west of the sedimentation pond. Is there potential for water drained from the camp/mill to be diverted through the culvert onto tundra and by-pass the sedimentation pond? If so, doesn't this defeat the purpose of the sedimentation pond?	Supporting Document S2, Section 4.15	Confusion clarified and more detail provided
20.	The NWB understands that the sedimentation pond is bermed on one side adjacent to the portal access road. The berm is comprised of run of quarry material. The NWB requests detailed discussion on how water will be contained within the sedimentation pond and permit a long enough retention time for sediment to settle given, the understood, high hydraulic conductivity of this gravel material.	Supporting Document S2, Section 4.15	Confusion clarified and more detail provided

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
	S5- Revised Hydroclimatic Parameter Re-Evaluation		
1.	On Page 62 of the Main Application Document , it was stated that <i>"it is recommended that climate and hydrology monitoring continue at Doris North, prior to and during operations"</i> . Is MHL committing to this monitoring program?	Supporting Document S10m, Table 1 Section 2.3 (Climate) and Section 4 (Hydrology) Revised Water License Application Document, Sections 7.1 , 7.2 and Table 7.1	MHL has committed to continue climate and hydrology monitoring
2.	Section 2.1.1 (S5) - In Table 2.1 , the precipitation in Doris North is the sum of rainfall and snowfall; however, the NWB understands that the precipitations for Cambridge Bay and Kugluktuk are larger than the sum of rainfall and snowfall. Should the calculation for precipitation be the sum of rainfall and snowfall with the correction of undercatch factor? How was total precipitation calculated? Is it correct that Table 2.1 has rainfall in units of mm and snowfall in units of cm?	Supporting Document S5, Table 2.1.	Three footnotes have been added to Table 2.1 to address these questions.
3.	Section 3.4 (S5) - Has the validity of the derived undercatch values for Doris North ~~specified in Table 3.4~~ been confirmed by the post-baseline program 2003-2006? If so, what are the results? If not, should these undercatch values be deduced using the post-baseline data? Does MHL believe that the post-baseline data will not significantly impact the previously derived undercatch values?	Supporting Document S5, Section 3.4.	Two paragraphs have been added at the end of Section 3.4 to address these questions.
4.	Section 4.3 (S5) - A value of 235 mm lake evaporation was provided for Doris North in the body text, which is inconsistent with the value of 220 mm provided in Table 4.3 . What is the correct value for lake evaporation? Clarification is requested to address this inconsistency.	Supporting Document S5, Section 4.3.	Added sentence in Section 4.3 saying "The baseline report placed more weight on the site-specific data and recommended using the lower value as a baseline mean annual value."
5.	Section 4.5 (S5)- It was stated that <i>"four years of data for Doris Lake (1997 and 2004 to 2006) provide a mean annual lake evaporation value of 233 mm"</i> . What is the individual year lake evaporation that was used to calculate the average?	Supporting Document S5, Section 4.5.	Added sentence in Section 4.5 saying "This is based on annual values of 220 mm for 1997 (refer to Section 4.3) and 209 mm for 2004, 216 mm for 2005 and 286 mm for 2006 (refer to Table 4.4)."
6.	Section 5.4 (S5) - Does MHL agree that a more appropriate title for this section would be <i>"Doris North Post-Baseline Monitoring 2003-2006"</i> ?	Supporting Document S5, Sections 4.4 and 5.4.	Added "Post-" in titles of Sections 4.4 and 5.4.
7.	Section 6.2 (S5) - In response to INAC (2006a) comments regarding <i>"unrealistically high runoff coefficient of 87%...additional water balance sensitivity analysis, beyond the cases previously examined"</i> were proposed by SRK consulting. Of the four recommended cases: • Bullet point 2 of [S5] was not addressed in Table 6 Appendix F of [S1] • Bullet point 4 of [S5] is not fully addressed in Table 6 Appendix F of [S1] Why weren't these additional sensitivity analyses provided? What are the results of these additional sensitivity analyses? What are the conclusions regarding the calculated runoff coefficient?	Supporting Document S1, Appendix F Supporting Document S1, Appendix F Supporting Document S5, Section 6.2.	Missing sensitivity runs completed and documented Revised For item 1, added text in Section 6.2 and also added a paragraph in Section 6.2 to address water quality sensitivity modeling and clarified that the previous recommendations applied to water quantity modeling only. Added a note to point the reader to Document S1 for the sensitivity runs.

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
	S6 Water Quality Model		
1.	General Comments- The NWB understands that MHL completed a post-baseline monitoring program and is presented in report S5. (1) The post-baseline data was not inputted into the water quality model for prediction of water quality and quantity in Tail Lake; rather, the water quality data was used to explain why additional model simulation(s) were not necessary(2) Within the conclusions of report S5 additional model simulations were proposed to be completed to reflect the post-baseline hydrologic data; however, this hydrologic data was not considered in the water quality model. These conclusions are similar to those determined by DIAND through their December 8th, 2006 Intervention. As per NIRB's Project Certificate Condition 14: <i>"MHL shall collect additional water quality data for the 2006 field season and incorporate it into a revised water quality model to be submitted to the NWB as part of the water license application. (3) MHL will meet discharge criteria on a site specific basis set by the NWB where possible, for the protection of the receiving environment at the point of discharge."</i>	Supporting Document S6, Section 3.3.3 (background concentrations) and Section 6 (updated modelling)	(1) Hydrological data were incorporated in the revised water and load balance modelling to reflect base case, base case low yield, and extreme low yield conditions. (2) Background Water Quality has been incorporated into the water and load balance model; three runs were completed with the entire dataset. (3) The water quality objectives for the receiving environment will be met downstream of the waterfall.
1.cont'd	As per DIAND's recommendation set out in DIAND's Intervention December 8th, 2006: (1) <i>"INAC's review of this rationale finds it to be inadequate and, as a result, recommends that MHL update the water quality model as was initially directed by the NIRB, based on the strong recommendations of INAC and other parties. INAC feels that an updated model be required before the application's technical review can proceed."</i> MHL is to address DIAND's concerns. The NWB also understands that MHL have revised the milling process and disposal plan for tailings to Tail Lake from that originally assumed in an earlier report outlining the water quality model and that this change in milling may not be reflected in the current water quality model results presented in S6. Given the post-baseline dataset and (2) the changes in the milling process, are the results of the model valid and representative of site and operation condition?	(1) See above; (2) Supporting Document S6, Section 3.3.8 and Table 3.11	(1) See above; (2) The water and load balance model has been revised to reflect the revised milling circuit. The difference in water quality between the original submission and that for the revised circuit are included in SD06. The results now reflect all the changes requested.
1.cont'd	Should the model be rerun to reflect the changes in the milling process and the post-baseline dataset? What level of confidence does the MHL have that the model results aid in the management of waters at the Doris North site?	See above	See above
2.	Section 1.2 (S6) - Of the two milling rates provided (690 TPD-p2 and 668 TPD-p1), which one is used in the water quality model?	Supporting Document S6, overall	The milling rate has been corrected in the water and load balance model and in the text

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
3.	Section 2.3 (S6) - The NWB understands that the description of tailings slurry feed (1727 m ³ /d=544 m ³ /d solids +1183 m ³ /d water) may be inconsistent with the other tailings description (668TPD: the tailings production rate, 2.7: specific gravity of the tailings solids, and 36.1%: the solids ratio). What are the details of the milling process change on tailings slurry quantity and quality? With consideration given to the current proposed milling process was mass balance considered or direct measurement used to assess the tailings slurry feed quality? If mass balance was used, what are the details of this calculation with consideration given, but not limited to, excess water after dewatering, clear bleed solution treated by detoxification system, and frequency for backfilling filtered and washed flotation concentration? If direct measurement of tailings slurry was relied upon, what are the results and were the tailings slurry representative of the current proposed milling process.	Supporting Document S6, overall	The milling rate has been corrected in the water and load balance model and in the text
4.	The NWB understands that there may be an inconsistency between the milling process description in the Main Application Document and that provided in the Water Quality Model (S6) . Specifically, the main application states 7.5% of the flotation circuit process material will be subjected to chemical treatment, whereas the water quality model states that this amount will be 10%. Additionally, the main document states that 70% of the barren leach solution will be recycled, whereas the water quality model states this to be 60%. Clarification from MHBL is requested to address these inconsistencies.	Supporting Document S6, overall Revised Water License Application Support Document	Water and load balance and main text descriptions should now be consistent
5.	Section 3.3.2 (S6) - Table 3.1 summarizes the monthly average concentration of copper in Doris Lake outflow from June to September. The data from October is absent in the table. What is the October data and why was it not included? Except for the comparisons provided for copper, aluminum and chromium, discussion for other contaminants are absent in this sub-section. What is the rationale for focusing the discussion on copper, aluminum and chromium? Are there other constituents that are of concern? If not, why not? Additionally, there was no discussion about the background concentrations of metals and other contaminants in Tail Lake, as was completed for Doris Lake. What are the background concentrations for Tail Lake and basis for selection of the values used in the water quality model?	Golder 2006; Supporting Document S6, Sections 3.3.3, and 6.	Addressed in conformity table; Addressed in Supporting Document S6
6.	Section 3.3.2 (S6) – (1) The NWB understands that the Selection of Background Water Quality Concentrations section discusses the difference between the average 2004 to 2006 water quality data and the assumed water quality model inputs based on 2004 data (Table 3.1) . MHBL states that "the assumed inputs will result in conservative estimates of allowable discharge rates", and it is to the understanding of the NWB that MHBL believes no additional model runs are required. (2) In the discussion, reference was made to the flow hydrograph in Doris Lake; however the flow hydrograph was not provided or cross-referenced. What are the details of the flow hydrograph and location within the application?	(2) Supporting Document S6, Sections 3.3.2, 3.3.4, 3.3.5, 3.3.6 and 3.3.9	(1) This item no longer applies since the water and load balance model has been updated to address the requested changes. (2) Appropriate references have been provided for the flow hydrograph.
7.	Section 3.3.6 (S6) - What kind of package sewage treatment will be used for the Doris North project? Does it include a nutrient (e.g., N and P) removal process? The NWB requests sewage treatment design details and discussion.	Revised Water License Application Support Document, Section 2.4.12	Text has been revised
8.	MHBL is to define the units of ammonia, nitrite and nitrate in Table 3.5?	Supporting Document S6, all tables and text as applicable	Text has been revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
9.	Section 3.3.7 (S6) - The NWB understands that the bench scale pilot testing completed may be for the original process tailings, not the revised process tailings as described in Section 1.2 . How does this compare to the revised blended effluent stream proposed and how does this change impact the water quality model predictions?	Supporting Document S6, Table 3.10	The text and the water quality model have been revised to address the changes. A comparison of the effects on the tailings discharge water quality is provided in Supporting Document S6.
10.	Section 4.2 (S6) - It was stated that "in most cases, total copper concentration was the controlling parameter", with chromium and selenium elevated in select scenarios. From the model results shown in Table 4.1 to 4.3 , nitrite discharge may exceed CCME guideline limits in scenarios 1, 3, 4, 7, and 8. If nitrite was also considered as a controlling parameter to determine discharge from Tail Lake, how would this change the expected discharge rates and full-supply level for the TCA? Should nitrite be considered a controlling parameter?	Supporting Document S6, Section 6.5	Sensitivity runs have been completed in Supporting Document S6 to assess the effects on the discharge strategy should nitrite be limiting. The results indicate that discharge is still possible and that the full supply level would not be reached.
11.	Section 4.5 (S6) - Nutrient degradation has been proposed to be enhanced within Tail Lake by adding phosphorous. What are the proposed methods, operation, and frequency of phosphorous addition? How does the proposed method of phosphorous addition support the model assumptions of an instantaneous mixed system?	As demonstrated by the modeling results, the likelihood of enhanced nutrient degradation being required is so low that it has not been included in the report. It is not considered appropriate in SRK's Professional opinion.	Addressed in conformity table: All the modelling indicates that nutrient degradation will not affect the discharge strategy and will therefore not be required. Enhanced nutrient degradation would be implemented as an adaptive management strategy only. In the very unlikely event that it will be required, it would be implemented as follows: The addition rate would be carefully calculated to ensure that most that there is sufficient phosphorus to stimulate algal growth but so that most of the phosphorus would be removed from the water column by the end of the season. Typically it would be anticipated that the phosphorus levels would not be raised above 0.05 mg/L. Phosphorus addition would occur as a liquid fertilizer that would be dispersed in Tail Lake within the propeller wash of a boat, by criss-crossing the lake. This approach has been found to be very effective at other locations (e.g. Island Copper Mine in BC, Faro Mine, Yukon). The application would likely only two to three times a season. Exact details of the strategy would be developed if the early operational conditions indicate that it was required.
12.	Section 4.5 (S6) - Erosion control has been proposed as a means to reduce discharge water quality from Tail Lake. What are the proposed methods, operation, and locations where erosion controls are proposed? If any of these details are provided in a separate document, appropriate cross-referencing is requested.	Supporting Document S1, Appendix H	Appropriate cross referencing to Supporting Document S6 in Supporting Document S1
13.	Table 4.5 provides hydrograph data on a monthly basis. What is the reference or source of this data?	Supporting Document S6, Sections 3.3.2, 3.3.4, 3.3.5, 3.3.6 and 3.3.9	Table has been removed but there are other references

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
14.	Section 4.5.2 (S6) - (1) MHL states that “since the dilution within Tail Lake does not change between the low and base flow conditions, the outcome after Tail Lake overflows is the same irrespective of the flow conditions”. (2) Can MHL please provide additional detail on the above. How was the maximum possible discharge (550,000 m3 per year) calculated?	SRK 2005a as referenced in Supporting Document S6	(1) This section has been removed from the text and now only exists in the original report. Nonetheless, the total contaminant loading to Tail Lake is constant and independent of the runoff conditions. Therefore, should 50 kg of dissolved copper enter Tail Lake, then the concentration in Tail Lake will be the same when it reaches an equivalent elevation; the only difference would be that it would take a longer or shorter time period to reach that elevation and hence a corresponding concentration. (2) The maximum discharge rates in the scenarios that the comment refers to were calculated based on copper being the limiting contaminant, with the maximum copper concentration in the background for any month, and, the flow from Tail Lake distributed according to the hydrograph but limited to be in proportion to the month of least discharge.
15.	Section 4.5.3 (S6) - The units for ammonia, nitrite and nitrate used in the report are mg NH3-N/L, mg NO2 --N /L and mg NO3 --N /L, respectively; however, CCME guidelines for these parameters adopt units of mg NH3/L, mg NO2 -/L and mg NO3 -/L, respectively. The NWB understands that - MHL may have converted the CCME guideline limits to mg NH3-N/L, mg NO2 --N /L and mg NO3-N /L to compare the maximum nutrient concentrations in Table 4.1- Page 50, Table 4.2- Page 51 and Table 4.11- Page 61.	Supporting Document S6, Section 3.3.1	The text has been revised to indicate that ammonia, nitrate and nitrite are in nitrogen equivalent concentrations except as noted in the text.
15.contd	Clear indication, as a table note, that CCME guidelines for ammonia, nitrite, and nitrate units have been converted from the published units are requested in Tables 4.1, 4.2, and 4.11.	Supporting Document S6, Section 3.3.1	The text has been revised to indicate that ammonia, nitrate and nitrite are in nitrogen equivalent concentrations except as noted in the text.
16.	Section 4.5.3 (S6) - (1) The total ammonia limit (CCME) in Table 4.11 (and other tables with a CCME column) is listed as 0.97 mg NH3-N/L. The NWB understands that the CCME guideline for total ammonia is not a specific value, but rather a range of values over various pHs and temperatures. How did MHL determine the total ammonia limit listed? (2) In addition, how were nutrient concentrations in Doris Creek considered in the selection of nutrient degradation rates and the impact of any assumptions on predicted results?	(1) Supporting Document S6, Section 3.3.1 (2) Supporting Document S6, Section 6.5	(1) The basis for the derivation of the ammonia guideline is provided in the text. (2) Conservatively, nutrient degradation within Doris Creek were not considered. As discussed in the submission to NIRB, with the exception of nitrite, nutrient degradation does not impact the discharge strategy or ability to achieve receiving water quality in Doris Creek. In the current submission (Supporting Document S6) it has been demonstrated that the discharge strategy can be adjusted to also meet nitrite guidelines in Doris Creek with little effect on the maximum water elevation in Tail Lake nor the time to lower the water elevation back to the natural outflow level.
17.	Section 4.5.6 (S6) - Is the calculation of free and total cyanide concentration in Table 4.15 reflective of the current milling process? If not, what is the expected free and total cyanide concentration for the current milling process?	Supporting Document S6, Section 3.3.8	The revised model addresses the current milling configuration

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
18.	Section 4.5.8 (S6) – The NWB understands that MHL has not provided analytical data for the blended tailings slurry following the milling process revision. Has this analysis been completed? Given the change in the blended tailings slurry, how does this impact the management plan to discharge waters?	Supporting Document S6, Sections 3.3.8 and 6, Table 3.11.	While no analytical data for the blended effluent of current milling configuration are available, the concentrations were calculated from the analytical results for the individual streams. The results indicate that the contaminant concentrations in the treated flotation concentrate stream are generally significantly higher than for the flotation tailings; since the bleed stream in the revised milling circuit is substantially less than the total stream, the net loading to Tail Lake will be lower and concentrations in Tail Lake are predicted to peak at lower levels than previously indicated.
19.	Section 4.5.8 (S6) – Does MHL believe that in Table 4.17 , the flow for the Float Tails Solution is 46.5 instead of 2.8 m3/h and the flow for the Cyanide Detoxified Solution be 2.8 instead of 46.5 m3/h?	Supporting Document S6, Table 3.11.	Table has been corrected
20.	A site specific risk-based criterion for copper was provided in S11 which states that a copper concentration of 4 ppb should be acceptable compared to the CCME limit of 2 ppb. There was no reference to report S11 within the Water Quality Model (S6) or Tailings Management Plan (S10i) ; however the Main Application Document states that the site specific copper concentration of 4 ppm will be used. Clarification is requested on the intent of use of a site specific copper concentration of 4 ppb. If 4 ppb is intended for use as a discharge criterion, what is the impact for not including and incorporating this value into the water quality model or tailings management plan to manage Tail Lake waters?	Not applicable, S11 removed from document	Not applicable, S11 removed from document
21.	The NWB understands that the water quality model may assume complete mixing of all input solutes instantaneously in Tail Lake. Does MHL agree that the discharge of the tailings slurry is spatial and a point source at the various discharge pipe location within Tail Lake? The NWB understands that there has been no details provided to demonstrate that a completely and instantaneous mix reactor is appropriate for Tail Lake. Is it conservative to assume a completely mix reactor? What is the basis for assuming an instantaneous mix reactor in Tail Lake? What contingency measures are in place if short circuiting of discharge waters to Tail Lake to the decant location occur?	Supporting Document, Section 5.2.2	The water management plan indirectly addresses this issue because the water sampling will be undertaken at the intake. Because the water management strategy automatically adjusts for the concentrations at the intake it is of little consequence whether or not the lake is completely mixed.
22.	The NWB understands that solute loadings to Tail Lake from non-mill sumps (e.g., fuel farm, landfill, landfarm, etc) may not be considered in the model. What are these expected loadings and concentrations? A table that summarizes all model input source water quality and quantity would alleviate any uncertainty regarding these model inputs. The NWB requests MHL to provide summary table that summarizes all model inputs.	Discharge strategy for these sources is presented in Revised Water License Application Support Document, Sections 6.2.2, 6.2.3 and 6.2.4 Supporting Document S10j, Sections 6.2 and 6.3. Supporting Document S6, Figure 3.1 shows a graphic of loads included in the Tail Lake WQ Model. Supporting Document S6, Section 5.3 in this report provides summary of the predicted loads and the assumptions used.	MHL proposes to separately treat the precipitation runoff collected in the fuel storage containment facility sumps and in the landfarm sump using a oil-water separator unit. Consequently this water will not report to Tail Lake. MHL predicts that precipitation runoff collected in the non-hazardous landfill sump will meet proposed standard for direct discharge. Water from these sources would only be transferred to Tail Lake in exceptional circumstances and the potential water volume and contaminant load is projected to be insignificant in comparison to the other loads entering Tail Lake. No allowance has been included in the Tail Lake Water Quality Model for such contingent loads as they are not expected.
23.	MHL states that cyanide treatment needs to be 95% efficient for base case modeling to ensure free cyanide concentration at or below CCME guidelines in Doris Creek. Was this value of 95% efficient derived for the original or changed milling process? If the former, what is the required efficiency for the current milling process?	Supporting Document S6, Section 4.2	Text has been revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
24.	The Hydroclimatic Parameter Re-evaluation (S5) report supports the use of the "dry case" scenario for water balance modeling at Doris North, but believes that "it would still be prudent to model the 'wet case' scenario to continue to account for existing uncertainty" (Page 31 of S5). Does MHL agree that it is reasonable to use "wet case" for water balance modeling to assess maximum dam elevation? Does MHL also agree that the "wet case" may not be a conservative assumption for water quality modeling due to dilution? Does MHL agree that hydroclimatic parameters under a "dry case" may result in lower flow conditions in lakes and creeks and therefore lower dilution function of natural water bodies? Does MHL agree that the assumptions of water quality modeling are critical for the discharge scenario evaluations? Does MHL believe the "wet case" assumption in water quality modeling is conservative from a water quality perspective compared to the "dry case"? If not, does MHL believe that additional model runs based on the "dry case" should be completed to characterize the discharge strategy?	Supporting Document S6, Section 6.5	Additional runs have been completed to assess base case, low yield and extreme dry conditions. All scenarios show that the water management strategy for Tail Lake can be operated successfully within similar boundary conditions.
S7- Geochemical Characterization of Quarry Materials			
1.	Report (S7) was not signed for authorship and professional approval. The NWB requests that this design report be signed and sealed by the responsible professional.	Supporting Document S7, Section 5	Signed and stamped signature page included in March 2007 revision
2.	On Page 51 on the Main Application Document , it was stated that the quarry rock is non-acid generating and that a program of ARD characterization will be conducted during construction to verify this conclusion. The NWB requests sufficient detail of this program?	Supporting Document S7, Section 4.3	Cross reference to Supporting Document S10m, Monitoring and Follow-Up Plan
3.	Section 2.0 (S7) - It was stated that "shake flask leachate indicated that aluminum and copper leached at concentrations exceeding CCME guidelines for the protection of aquatic life". Further, it was stated that "shake flask leachate indicate only potential elements of concern, and are not indicative of potential impacts to the receiving environment". With respect to the shake flask test results, further clarification and detailed discussion is requested on how the measured results are "not indicative of potential impacts to the receiving environment".	Supporting Document S7, Section 4	Revised to clarify that metal concentrations in test leachates are not directly comparable to metal concentrations in receiving environment
4.	Section 4.1.4 (S7) - A correlation was provided to relate NPCa/Mg to NPIC , the NWB requests details on how this relationship was determined.	Supporting Document S7, Section 4.1.4	Revised to include more detail on how $\text{NPCa}<\text{Mg/NPIC}$ relationship was determined
5a.	Section 4.2.3 (S7) – The NWB understands that shake flask extraction tests indicate the potential for leachate with alkaline pH and elevated concentrations of aluminum. Shake flask extraction test results presented in the AMEC 2005 reported alkaline pH with elevated concentrations of aluminum and copper. The samples of rock tested in Report S7 and in AMEC 2005 were from near surface.	Supporting Document S7, Section 4.2.3	Report discusses results from 2006 testing, and contrasts these results with previous results
5b-i.	It was stated that the "elevated pH is thought to be an artifact of the test procedure...[and that these] conditions will not be present under rock fill placement scenarios where pH is buffered at lower levels by interaction with atmospheric CO ₂ . Significant leachate of aluminum is not expected to occur from placed quarry rock". The statement above suggests that the test methods may not be representative. The following information is to be clarified: What field testing will be completed to assess if there is an acceptable leachate composition from the quarry rock?	Supporting Document S7, Section 4.3	Cross reference to Supporting Document S10m, Monitoring and Follow-Up Plan, S10m addresses mitigation
5b-ii.	If an unacceptable leachate composition is measured in field application, what mitigating measures are in place to control release of potentially contaminated waters and impact freshwaters (as defined by NWANSRTA)?	Supporting Document S7, Section 4.3	Cross reference to Supporting Document S10m, Monitoring and Follow-Up Plan, S10m addresses mitigation

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
6a.	Kinetic humidity cell testing prediction results for sulphide depletion and ARD onset were presented in the Main Application Document and used in the Water Quality Model[S6]. The NWB understands that these results were not presented or discussed within report S7. Why was this data not presented in report S7?	Supporting Document S7, Section 1	Revised Introduction to accurately reflect the scope of the document
6b.	What are the results of this testing?	Supporting Document S7, Section 2	Supporting Document S7 references AMEC (2005)
6c.	Kinetic humidity cell testing of quarry samples were completed using the siderite correction method for NP (AMEC). Subsequent rock characterization did not measure any siderite in the rock. What impact does the siderite correction method for NP have on the results if no siderite is present in the rock? Are these results valid?	Not addressed in Supporting Document S7	Supporting Document S7 addresses results of 2006 testing only, and results of siderite correction procedure are not addressed
7a.	Report S10m indicates that ongoing monitoring to verify ABA characterization work on quarried rock materials at a frequency of "approximately 100 samples spread over construction quarrying". Cross-referencing between Report S10m was not provided in report S7 . Appropriate cross-referencing is requested where applicable. Additionally, the NWB requests clarification if the approximately 100 samples will be taken from each of the four quarries or from the total amount of rock quarried? From this sampling, What is the expected turn around time (from sample collection to obtaining results) for ABA characterization? And how has this turn around time been considered in the schedule of quarry development and rock placement?	Supporting Document S7, Section 4.3	References inserted as appropriate
7b.	If ABA results show a change in rock geochemistry that would be susceptible to metal leaching / acid rock drainage compared to originally expected, what is the resulting action plan for future construction and already placed materials?	Supporting Document S7, Section 4.3	Cross reference to Supporting Document S10m, Monitoring and Follow-Up Plan, S10m addresses mitigation

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
1.	Report (S8) was not signed for authorship and professional approval. The NWB requests that this design report be signed and sealed by the responsible professional.	Supporting Document S8, Section 5	Signed and stamped signature page included in March 2007 revision
2.	Within report S8 , the NWB understands that results from four boreholes that were drilled along the portal alignment to obtain samples for geochemical characterization were provided. With this in mind,	Supporting Document S8, Section 1	Final Environmental Impact Statement referenced in Supporting Document S8 introduction
2a.	How confident is the applicant that the four boreholes drilled provides good representation of the total amount of material that will be stockpiled? The NWB requests detailed discussion on MHL's level of confidence on this issue.	Supporting Document S8, Section 1	Final Environmental Impact Statement referenced in Supporting Document S8 introduction
2b.	What practices will be completed during mining to validate the geochemical characterization completed within report S8 ?	Supporting Document S8, Section 1	Final Environmental Impact Statement referenced in Supporting Document S8 introduction
2c.	Within report S10d , results of acid generating potential of the waste rock from the underground mine were provided. It appears as if the samples tested are different that that reported in S8. The NWB requests MHL to comment on the following:	Supporting Document S8 , Section 1	Scope of Supporting Document S8 clarified in Introduction
2c-i.	Clarification, detail, and comparison (if applicable) to address the interconnectivity between these two documents with respect to geochemical characterization of the portal development rock.	Supporting Document S8 , Section 1	Supporting Document S8 addresses characterization of portal development rock only; does not address characterization of ore zone waste rock
2c-ii.	Why are the geochemical results provided in report S10d not provided in report S8 ?	Supporting Document S8 , Section 1	Supporting Document S8 addresses results from 2006 characterization program only
2c-iii.	The geochemical results from report S8 are the basis for interim waste rock stockpiling. Why is report S8 not cross-referenced in S10d ?	Supporting Document S8 , Section 5	Cross-reference to Supporting Document S10d inserted
3.	Section 4.2.1 (S8) - As illustrated in Figure 4 , the majority of the samples tested appear to have NP-TIC:AP ratios to be greater than 3. In report S8 MHL states the ratios to be less than 3. Clarification is requested to address this inconsistency.	Supporting Document S8 , Section 4	Correct statement to indicate NP-TIC:AP ratios greater than 3
4.	Section 4.2.2 (S8) - It was stated that other than copper and zinc, " <i>median trace element concentrations ranged from <0.1 to 1.6 times crustal average concentrations</i> ". The comparison of median trace elements to crustal average concentrations was not provided to substantiate this claim. A table or reference to appropriate document to validate this comparison is requested.	Supporting Document S8 , Section 4.2.2 (table and reference included)	Reference Price (1997) and append modified table
5a.	Section 5 (S8) - It was stated that " <i>basalt appears to be strongly net acid consuming. However, the lower 6 m of MHL06-12 had generally lower NP:AP ratios, and this material could be net acid generating</i> ". For purposes of the application record the NWB requests clarity on the following: What is the estimated mass of potential "net acid generating" materials that would be stockpiled and percentage of this material to the total mass stockpiled?	Supporting Document S8 , Sections 1 and 5	The drill sampling carried out was not intended to support quantitative estimates of rock properties along the entire length of the decline, and it is not technically appropriate to extrapolate the available information over long distances.

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
5b.	Given this uncertainty, are there specific mitigating measures or contingencies for the potentially net acid generating material compared to net acid consuming materials to ensure containment of waste and its by-products? If so, what are the mitigating/contingency details (e.g., blending) and implementation? If not, why not?	Supporting Document S8 , Section 5	Reference to Revised Water License Application Support Document, which references B4 in the FEIS

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
	S10- Environmental Protection Plan		
	The NWB understands that the Environmental Protection Plan (S10) includes operations and maintenance; however much of the document is not referenced in the conformity table within the Main Application Document . The NWB will only consider Section 2.7 and Section 2.13 of the document to gain an understanding for practices in close proximity to waters since only Section 2.7 and Section 2.13 were referenced in the conformity table. If additional information contained within S10 is to be considered by the NWB, appropriate referencing (e.g., sub-document number, page, section title) to subdocuments should be outlined in S10 and/or within the entire submission. Is MHBL committing to following the mitigating measures and operations outlined in each of the S10 sub-documents?	Supporting Document S10 - Revised	Revised Supporting Document S10 to provide a clear introduction to the EPP We placed the miscellaneous operating environmental procedures into an Appendix and referenced these accordingly
	S10a - Emergency Response and Contingency Plans		
1.	General- Given the layout, organization, and communication of this plan, the NWB would like to reconfirm that the document is intended for <i>"each member of management and all employees"</i> . Does MHBL believe that the document is clear and concise enough that "site personnel" will be able to respond effectively and in a timely manner to an emergency situation with guidance from the plans?	Supporting Document S10a, Sections 1 and 3.1	Text revised
2.	Section 4.6 (S10a) – This section lists procedures to follow in the event that equipment or people have fallen through ice. Due to ambiguity in the document, additional detail and discussion are requested to address each of the following:	Supporting Document S10a, Section 5.6	Text revised
2a.	The opening paragraph of this section states that <i>"if accidents happen the following procedure will be the guide to response."</i> Who is responsible for following this procedure?	Supporting Document S10a, Section 5.6	Text revised
2b.	In the second last bullet point listed in this section, the response to equipment falling through ice is to: <i>"Ensure that leaks of fuel or engine oils are minimized wherever possible by pumping the fuel from tanks into other containers where this can be safely done without danger of a spill"</i> . How will this be accomplished?	Supporting Document S10a, Section 5.6	Text revised
2c.	In the last bullet of this section it is stated that <i>"Where a vehicle has gone completely through the ice and is submerged, contact the appropriate government spills hot line and ask for advice."</i> What is the appropriate government spills hotline? Should the contact information for this hotline be also included here, or referenced so a situation of this manner, if were ever to occur, could be handled promptly?	Supporting Document S10a, Section 5.6	Text revised
3.	Section 6.2 (S10a) – In this Section MHBL states that hazards at the Doris North Mine site include <i>"the release of toxic vapours, fire, spills, and explorations."</i> Are explorations a hazard?	Supporting Document S10a, Section 4.2	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
4.	Section 6.3 (S10a) – In the second bullet point of this section one of the principal objectives of the Spill Response Plan is to “promote the safe and effective recovery or disposal of spilled materials”. Is MHLB committing to the safe and effective recovery or disposal of spilled materials?	Supporting Document S10a, Section 4.3	Text revised
5a.	Section 6.4 (S10a) – Additional detail and discussion are requested to address each of the following: In Section 6.4 MHLB provides a list of petroleum products and other chemical substances that may be stored at the Doris North Mine site. Is there a site plan that identifies the location of these substances at the Doris North Mine site? If this plan does exist, MHLB is invited to appropriately reference where this plan may be found. Given that this is an emergency response document, should this site plan be included within this report?	Supporting Document S10a, Sections 4.4 and 4.4.3, Figure 4	Text revised
5b.	The types of petroleum derived materials included in the Spill Response Plan are listed in Section 6.4 in bullet form as “flammable immiscible liquids” and “flammable compressed gasses”. This is followed by Section 6.4.1 which begins with a general description of “flammable immiscible liquids” and then closes with a list of examples of these substances in bullet form. In Section 6.4.2 , the structure is entirely different, with the characteristics of “flammable compressed gasses” listed in bullet form, followed by a list of these gases that are likely to be present on site (in a single bullet). Does MHLB believe that the structure and organization of this section is sufficiently clear to allow easy understanding of the material by management and employees at the Doris North Mine site in an emergency situation?	Supporting Document S10a, Sections 4.4, 4.4.1, and 4.4.2	Text revised
5c.	As noted above, a list of types of “petroleum derived materials” is provided in Section 6.4 , followed by more detailed descriptions and examples of each type in Section 6.4.1 and Section 6.4.2 . Section 6.4.3 , however is headed “Other Products” which are not “petroleum derived”. Why was the heading “Other Products” not listed in Section 6.4 ?	Supporting Document S10a, Section 4.4	Text revised
5d.	Section 6.4.3 states in the first paragraph that “there are chemicals and reagents that are needed for use in the gold abstraction process” and then goes on to list these “chemicals and reagents” in bullet form. The last two bullets listed are “Domestic sewage” and “Tailings”. Aren’t these waste products and not “chemicals and reagents needed for use in the gold abstraction process”?	Supporting Document S10a, Section 4.4.3	Text revised
5e.	The final paragraph in Section 6.4.3 states that the MSDS’s will be available on site. Will the MSDS’s be made available with this document? Should MSDS’s be annexed in order to provide a quick reference in the event of an emergency situation?	Supporting Document S10a, Section 4.4.3	Text revised
6.	Section 6.5 (S10a) – Sections 6.5.1.1 through 6.5.1.5 list the responsibilities of various mine staff in the event of a spill. However, both Section 6.5.1.2 and Section 6.5.1.5 are labeled “Mine General Manager”. Clarification is requested regarding this apparent duplication.	Supporting Document S10a, Sections 4.5.1.2 and 4.5.1.5	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
7.	Section 6.5.1.3 (S10a) – One of the responsibilities of the “Spill Clean Up Supervisors” is to “Assess whether burning is a viable clean up measure”. Under what circumstances does MHBEL believe that this would be a viable clean up measure?	Supporting Document S10a, Section 4.5.1.3	Text revised
8a.	Section 6.7 (S10a) – Additional detail and discussion are requested to address each of the following: The first bullet point of Section 6.7 identifies a “ <i>Spill Response Coordinator</i> ”. However, this title is not listed in Section 6.5.1 , along with the various other mine personnel involved with the spill response. What are the responsibilities of the “ <i>Spill Response Coordinator</i> ”?	Supporting Document S10a, Sections 4.5.1.2 and 4.7.1	Text revised
8b.	The last bullet point in Section 6.7.1 states that in the event of a spill the “ <i>Mine General Manager will liaise with...Regulatory Agencies and the KIA to keep them informed as to the status of the ongoing operations.</i> ” Who are these “Regulatory Agencies”? Will the contact information for these agencies as well as the KIA be referenced here?	Supporting Document S10a, Section 4.7.1	Text revised
9.	Section 9.1.5 (S10a) – This section describes “three levels of warning signs or emergency conditions” for the Doris North tailings dams. What are examples of observations which would indicate an “obvious emergency”, a “potential emergency”, or that are “noted as being unusual”? Does MHBEL agree that a description of typical scenarios or cases for each of these three levels would be beneficial to the Reader and Regulators in providing an understanding to the three levels of warning or emergency conditions?	Supporting Document S10a, Section 7.1.5	Text revised
10a.	Section 9.3 (S10a) – This section describes the EAP (Emergency Action Plan) for dams at the Doris North Project site. The NWB requests additional detail and discussion to address each of the following: This section identifies “dam failure” as the case for which an EAP for the Doris North Mine site will be developed. Does MHBEL believe that it is appropriate to develop an EAP or a response plan for a break in the tailings delivery line?	Supporting Document S10a, Section 7.3	Text revised
10b.	In the final paragraph of this section MHBEL states that “ <i>the EAP will be developed for potential failure of south and north dams</i> ”. The NWB requests clarification in if MHBEL considers this document to be the EAP or rather a commitment for MHBEL to develop the EAP for this instance. Does MHBEL intend to develop EAP’s for fuel spills, explosives spills, or chemical spills?	Supporting Document S10a, Section 1.0 Supporting Document S10a, Section 4.0	Purpose of the plan described Tailings failure addressed

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
10c.	Section 9.3.1 identifies potential causes of dam failure in bullet form. The third last and second last bullets are listed as "Upstream dam failure" and "Downstream dam failure". Does MHL believe that this appears to be a circular statement in that dam failure will cause dam failure or should these statements be built upon?	Text left as is	Upstream failure refers to cracking, or other failure mechanisms short of a breach that occur on the upstream face of the dam. Downstream failure refers to cracking, or other failure mechanisms short of a breach that occur on the downstream face of the dam.
10d.	Section 9.3.2 states that "regulatory authorities" will be notified "If or when there is a need to reduce the level of water in the dam". Who are these "regulatory authorities"? Does MHL believe the contact information for the "regulatory authorities" should be included or referenced in this section? If not, why not?	Supporting Document S10a, Section 7.0 Supporting Document S10a, Table 4.1: Notification Contact List	Text left as is, notification of regulatory authorities included as a component of the Emergency Preparedness Plan (sub plan 3)
10e.	Section 9.3.4 states that "access to the North and South Dams...will be maintained properly at all times." The NWB requires additional clarification (to add to the application record) into what are MHL's standards to which the access routes will be maintained and what measures have been set in place to ensure these standards?	Supporting Document 10a, Section 7.3.1 Supporting Document S10m Monitoring and Follow-up Plan, Section 6.2	The access roads to the dam will be cleared as soon as possible following a fall of snow (pending whiteout and safety conditions) so that the inspection program laid out in Supporting Document S10m Monitoring and Follow-up Plan can be continued (daily & weekly)
10f.	Section 9.3.6 is headed " <i>Equipment that may be needed for Emergency Operation and Repair</i> " and lists in bullet form said equipment. However, the final bullet in the list is "Machine operators". What other personnel may be required for emergency operation and repair?	Supporting Document S10a, Section 7.3.6	Text revised
10g.	Section 9.3.7 illustrates the Notification Process in the event of an emergency condition with either of the dams at the Doris North site. Do the mine personnel identified in the Notification Process also make up the emergency response team? If not, who are the mine personnel that constitute the emergency response team? What are their responsibilities during each of the three levels of emergency conditions noted in Section 9.1.5 ?	Supporting Document S10a, Section 7.3.7	Text revised - notification is to Mill Supt and Mine General Manager who will contact outside assistance as needed based on assessment
11.	Appendix A (S10a) – The "Emergency Procedures" contained in this appendix do not appear to be referenced anywhere in the rest of the document. The NWB requests clarification in where these procedures apply and appropriate referencing where applicable.	Supporting Document S10a, Section 5.3.3	Procedures are now referenced in Section 5.3.3
12.	Appendix B (S10a) – This appendix contains " <i>Spill Procedures for Products on site</i> " in tabular format. The NWB understands that these tables do not appear to be referenced in the text. Each table indicates spill responses according to whether the spill occurred on land/tundra, snow, ice, or water. The storage, transfer, and disposal methods for petroleum products, explosive substances, and process chemicals present at the Doris North Mine site were also included. What restoration measures may be required in each potential spill event noted? Has this information been provided in the Closure and Reclamation Plan (if so a reference should be included)? Who are the mine personnel involved with the spill responses?	(1) Supporting Document S10a, Section 4.4 (2) Supporting Document S10a, Sections 4.43, 4.11.1, 4.11.2 and 4.16.1	(1) Cross reference added to Supporting Document S10e Hazardous Materials Management Plan (2) Reference added to Supporting Document 10a, Appendix B (MSDS sheets)

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
	S10d- Interim Waste Rock Storage Plan		
1.	Report (S10d) was not signed for authorship and professional approval. The NWB requests that this design report be signed and sealed by the responsible professional.	Supporting Document S10d, Section 2.0 Supporting Document S10d, end of the document before references	Added Supporting Document S10d, Section 2.0: Purpose of the Waste Rock Management Plan Added sentence in Section 2.0: "It is not intended to be a design document for the waste rock management facilities." Name and designation added
2a.	A significant portion of the storage plan involves description of the type of rock to be stored and acid generating potential. The importance of this topic can't be understated; however, report S8 was solely devoted to describing acid generating potential for the portal rock. As was discussed in the review of report S8 , and should be addressed in response of S8 review, was the differences in the geochemistry rock analysis presented between the report S8 and S10d . It is requested that there be consistency between documents and appropriate cross-referencing. Since the portal rock discussed in report S8 is temporarily stockpiled and this stockpile is discussed in report S10d , how come report S8 was not referenced?	(1) Supporting Document S10d, Section 2.0, 6th bullet (2) Supporting Document S8 Sec.5.0	(1) Cross reference to Supporting Document S8 inserted (2) Cross reference to Supporting Document S10d inserted
2b.	Section 1.2 (S10d) – The results of the ABA analysis were provided in a summary table format in Appendix 1 . The report states that this material is presented graphically in Appendix 1 ; however, the graphs were not provided. The NWB requests clarification and the inclusion of graphs required to support information presented.	Supporting Document S10d, Section 6.0	Text revised ("and graphically" was removed)
3.	Minimal details were provided on the construction, design, and layout of the interim waste rock pile within report S10d . In fact, there was no reference to the design drawings S-07 and S-08 that depict pile layout plan and critical cross-sections within report S10d . Does MHL agree that appropriate cross-referencing should be provided to include drawing details within report S10d? With regards to construction, design, and layout of the interim waste rock pile, additional detail and clarity are requested to address each of the following:	(1) Supporting Document S10d, Section 2.0 (2) Supporting Document S10d, Section 2.0, second bullet	(1) Added Sec 2.0 : Purpose of the Waste Rock Management Plan (2) Cross reference to Dwg S-07 and Dwg S-08 inserted
3a-i.	Executive Summary (S10d) - It was stated that the <i>"pile will be constructed within a 0.5 m high perimeter berm designed to contain and direct all runoff from the pile into a dedicated runoff collection pond. The berm will also direct clean runoff away from the waste rock pile"</i> . Section F-F' in engineered drawing S-08 provides a cross-section of a typical containment berm with a minimum of 1.0 m in height. Technical specification document (S3) Section 10.2.14 , the berm is referenced to be 1.0 m high. The Main Application Document (Section 3.3) stated that a 0.5 m high berm will be designed. Clarification is requested to address this inconsistency. What is the minimum berm height?	(1) Supporting Document S10d, Section 1.0 (2) Supporting Document S10d, Section 2.0 (3) Revised Water License Application Support Document, Section 3.3	(1) Text revised ("0.5m high" removed) (2) Cross reference to drawing inserted (3) Text Revised
3a-ii.	Will the construction of the berm be completed according to the technical specifications outlined in Section 7.0 and 9.0 of report S3 ? Clarification and cross-referencing is requested	Supporting Document S10d, Section 2.0 third bullet	Cross reference to Supporting Document S3 inserted

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
3a-iii.	The construction material type was not referenced in report S10d, Section F-F' in engineered drawing S-08 depicts the berm to be constructed of run of quarry materials. Technical specifications S3 (Section 10.2.14) stated that the <i>"berm will be constructed from select subgrade material"</i> . Clarification and cross-referencing is requested to address this inconsistency into what the material type will be used to construct the berm.	Supporting Document S10d, Section 2.0, third bullet	Cross reference to Supporting Document S3, Section 10.2.14 inserted
3a-iv.	Engineered drawing S-07 depicts the waste pile and berm layout, surrounding infrastructure, and topographic elevations. Does MHL believe that this drawing should be cross-referenced in report S10d where applicable? A berm has been proposed along the west and east sides of the waste rock pile. The NWB understands that the south end of the pile allows water to drain into a pollution control pond. The NWB also understands that the north end of the pile is open to receive any waters draining from the mill, crusher, and ore stockpile areas. What is MHL's rationale for not constructing the berm along the north end of the waste rock pile? Does MHL intend for waters to drain from the north and enter into the pile location? If reliance is on surface grading of the mill stockpile area to divert waters from entering the temporary waste rock pad, will there be engineering oversight during construction to ensure that waters drain on surface as depicted in S-08 ? If so what is in place?	(1) Supporting Document S10d, Section 2.0 second bullet (2) Supporting Document S4, Dwg S-07	(1) Cross reference to Dwg S-07 and Dwg S-08 inserted (2) Dwg S-07 Revised
3a-v.	The NWB understands that the function of the berm is to contain and direct water from within the waste rock pile to the pollution control pond and to divert clean runoff away from the waste rock pile. Further the berms appear to be generally positioned perpendicular to surface contours to facilitate diversion of waters. The NWB understands that the berm will be constructed of materials (either select Subgrade or run of mine; see Bullet iii above) that have high gravel with some sand contents. With consideration given to, as understood by the NWB, the high hydraulic conductivity of this material, discussion and detail are requested on how berms comprised of this material will contain waters and not permit seepage.	(1) Supporting Document S10d, Section 2.0 (2) Supporting Document S2, Section 5.10.2	(1) Cross reference inserted (2) Additional clarification provided
3b-i.	The Executive Summary in report S10d stated that "only runoff that meets acceptable criteria for discharge will be released onto the tundra" from the runoff collection pond (pollution control pond). In Main Application Document Section 2.4.7 it is stated that <i>"all water contained in this pond is considered contaminated and will be pumped to Tail Lake via the mill circuit"</i> . Clarification is requested on the method of disposal of waters from this collection pond to address this inconsistency.	Supporting Document S10d, Sections 1.0 (text removed and Section 4.0, fourth bullet (text added)	Text revised
3b-ii.	If waters are pumped to Tail Lake, how will the pollution control pond waters be directed to the mill circuit? Is there a plan to monitor water quality from the pollution control pond? Appropriate cross-referencing between reports S10d and S10m is requested where applicable?	Supporting Document S10d, Section 4.2	Cross reference to Supporting Document S10m inserted

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
3c.	The NWB understands that engineer drawing S-07 does not provide access road details into the waste rock pile location for rock placement or removal. No details were provided regarding location of tailings slurry and reclaim water pipelines in the vicinity of the camp location. Does MHL agree that this detail should be included on the engineered drawing? If not, why not?	Supporting Document S4, Dwg S-07	Revised Dwg. S-07
3d.	Report S2, Section 5.5.6 provides discussion on the stability analysis for the waste rock pile. Details were provided that the pile may be classified as Stability Class 1 according to BCMWRPRC 1991 and therefore the <i>"design can be based on basic reconnaissance and baseline data"</i> for the site. The NWB understands that there were no details provided in S10d , or elsewhere, regarding the pile stability analysis and design. The NWB requests full details regarding the stability analysis method and results with detailed discussion of assumed input parameters completed for the waste rock pile.	Supporting Document S10d, Section 4.1	Cross reference to Supporting Document S2 inserted
4.	There were no details pertaining to the construction, stability, erosion control, operation, and containment of waters generated from the ore stockpile within report S10d . Does MHL agree that the ore stockpile may also be considered an "interim" waste rock pile? If not, why not? What plans are in place to manage the ore stockpile? How will waters that come into contact with the ore stockpile be managed?	Supporting Document S10j, Section 6.1	Item addressed in a separate plan
S10e- Hazardous Materials Management Plan			
		Supporting Document S10e, Section 1.1	Text revised
1.	Section 2.2 (S10e) - It was stated that the hazardous materials management procedures <i>"will be reviewed by MHL and revised as required to reflect all implemented and projected changes to the HMMP, to correspond with new information and latest technology"</i> . What is the proposed frequency for review of the procedures and/or what would constitute the review of the procedures? How will any changes be communicated to the Board?	Supporting Document S10e, Sections 1.1, 2.2 and 9.0	Text revised
2.	Section 2.4.3 (S10e) - The plan to dispose of assay lab crucibles includes storage in a drum and on a yearly basis <i>"disposed of through burial in the tailings solids within Tail Lake"</i> and <i>"covered by tailings solids"</i> . What is the rationale for disposing of the crucibles in this manner instead of an alternate method? Are these crucibles considered hazardous waste after use?	Supporting Document S10e, Section 2.4.	Text revised
3.	Section 2.4.4 (S10e) - It was stated that <i>"plywood boxes used to contain sodium cyanide bulk bags will be burned at an approved burn site on the property to prevent this wood being used for other purposes"</i> . How will the ash and any other waste from this burn product be managed to ensure there is no impact on waters while minimizing ash from blowing away from the burn site?	Supporting Document S10e, Section 2.4.	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
4.	Select sections of the report (S10e) discussed emergency response and contingency plans, storage of fuel and disposal of waste and the landfill and landfarm. A brief description of these reports was provided; however, reference to the appropriate report and section number should have been provided for completeness.	Supporting Document S10e, Sections 1.2, 1.4, 2.1, 2.4.2 and 5.3 (emergency response and contingency plans) Supporting Document S10e, Section 3.3 (fuel storage / tank farm) Supporting Document S10e, Sections 2.4.4, 3.6 (waste disposal and landfill) Supporting Document S10e, Section 3.6 (landfarm)	Text revised, references added
S10f- Explosives Management Plan			
1.	General – In the first paragraph of the Executive Summary of the Explosives Management Plan (S10f) MHLB states “ <i>The plan is provided in support of a water license application by Miramar Hope Bay Limited for gold mine operation</i> ”, and further, introductory Section 1.2 states that “ <i>The explosives management plan will be cross referenced in other plans for mine operation including: training manuals (where appropriate); MHLB Hazardous Materials Management Plan; MHLB Emergency Response and Spill Contingency Plan; mine operating procedures (where appropriate).</i> ” These two statements raise the following questions:	Supporting Document S10f, Executive Summary, Section 1.3	Text revised, cross references inserted
1a.	Does MHLB believe that the use and fate of the plan is described clearly enough in this document?	Supporting Document S10f, Executive Summary, Sections 1.1 and 1.3	Text revised, cross references inserted
1b.	MHLB is invited to provide an explanation on how this plan is <i>in support of the water license application</i> ” as stated in the Executive Summary .	Supporting Document S10f, Executive Summary, Section 1.3	Text revised, cross references inserted
1c.	Does MHLB intend to make this document available for cross-referencing or does MHLB believe that a reference alone is sufficient?	Supporting Document S10f, Section 1.3: Cross Reference to MHLB Plans Cited in the Explosives Management Plan Appendix A	Referenced document included as Appendix A, URL links provided for applicable legislation
2.	Section 1.2 (S10f) – As noted above MHLB states “ <i>The explosives management plan will be cross referenced in other plans...including: MHLB Emergency response and Spill Contingency Plan</i> ”. However, upon review of the Emergency Response and Spill Contingency Plan no such reference was found. Does MHLB intend to include the reference to the Explosives Management Plan in the Emergency Response and Spill Contingency Plan ?	Supporting Document S10a, Section 4.4.3	Cross reference added as footnote to Section 4.4.3 in Supporting Document S10a, Emergency Response and Contingency Plan

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
3a.	Section 1.4 (S10f) – Additional detail and discussion are requested to address each of the following: The temporary explosives storage site will be built directly on the frozen tundra, and as such, will be used during one winter season only <i>with all explosives transferred to the permanent site by the end of the first winter season.</i> In the event that the permanent explosives storage facility is not completed by the end of the first winter, what course of action does MHBL suggest to take to prevent or minimize environmental impact to the tundra (through the definition of 'water' outlined in the NWANSRTA) due to the presence of explosives stored on site? In other words, does MHBL believe that a contingency plan for this possibility is unnecessary?	Supporting Document S10f, Section 1.5	Text revised
3b.	What contingency is in place in the event that the permanent explosive storage site is not available after the first winter season?	Supporting Document S10f, Section 1.5	Text revised
3c.	Additional details of the temporary storage facility are requested to demonstrate that waters will not be impacted, which includes, but not limited to a brief site layout plan.	Supporting Document S10f, Section 1.5	Text revised
3d.	The explosives storage and handling facilities are noted in the text to be shown or Figures 1 and 2 . However, the drawings provided are numbered S-04 and G-02 . Clarification is requested.	Supporting Document S10f, Figure 1 Supporting Document S10f, Figure 2	Drawings re-labeled
3e.	In Table 1-1 reference is made to the fuel laydown area, the temporary and permanent explosives area, the fuel farm, and the explosives mixing building. While the meaning of these areas and facilities are understood by the reviewer, consistency in terminology throughout the text, tables, figures, and drawings would facilitate understanding of the document. Does MHBL agree that a defined nomenclature assists Regulators through the assessment of application materials?	Supporting Document S10f, Table 1-1, Sections 1.5 and 2.2.9	Text revised
4a.	Section 2.2.2.2 (S10f) – Additional detail and discussion are requested to address each of the following: MHBL states in the first paragraph of this section that <i>"Although AN (Ammonium Nitrate) is classified as a hazardous product, its storage and handling at Doris North is not considered to be a significant risk activity."</i> The NWB understands that this statement may imply that handling and storage of AN would not constitute a significant risk either to site personnel or to the surrounding environment. However, report S10e outlines safety procedures for the handling of this product. Clarification is requested as to why handling and storage of a "hazardous product" is not considered a significant risk to the surrounding environment.	Supporting Document S10f, Section 2.2	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
4b.	B. In the second paragraph of this section MHL states that runoff from the AN storage pad will be absorbed by the pad itself or the surrounding tundra. Does MHL believe that absorption of AN by the tundra does not represent a significant environmental impact? If so, how and why is this so? Also in the event runoff transports sediment MHL states that <i>temporary silt curtains can be placed in the water path to screen sediment</i> ". Are there circumstances where screening sediment from runoff from the AN storage pad would not be required?	Supporting Document S10f, Section 2.2.	Text revised
4c.	In paragraph four of this section MHL states that <i>"empty bags"</i> , of AN, <i>"will be shaken clean at the point of use"</i> . For purposes of adding to the application record what happens with the AN residue once it is <i>"shaken"</i> from the bag?	Supporting Document S10f, Section 2.2.	Text revised
5.	Section 2.2.6.1(S10f) – In Table 2-1 , in the column headed "Response", the explosive chemicals spill response is described repeatedly as "clean up". How is the cleanup of potentially "hazardous" chemicals, which may cause adverse environmental impacts, achieved? To what level will clean up be completed to? Are different methods used for each of the explosive chemicals noted?	Supporting Document S10f, Section 2.2.6.2, Table 2.1	Text revised
6.	Section 2.2.11 (S10f) – MHL states in paragraph one of this section that <i>"the supplier will be consulted on the appropriate handling and disposal"</i> for explosives identified as deteriorated or damaged. Is there any advantage to discussing appropriate handling and disposal methods with the suppliers of the various explosive materials prior to the arrival of such on-site?	Supporting Document S10f, Section 2.2.	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
	S10g- Landfill Design and Management Plan		
		Supporting Document S10g, Section 1.2	Text revised, cross references added
1.	Report (S10g) was not signed for authorship and professional approval. The NWB requests that this design report be signed and sealed by the responsible professional.	Supporting Document S10g, signed page at end of the document before References	Authorship added
2.	Section 3.0 (S10g) – The NWB understands that the landfill will be constructed within a rock quarry and the bedrock will undergo preparation to ensure gradation to facilitate surface water drainage. The NWB requests clarity on the following:	Supporting Document S2, Section 4.16 Supporting Document S4, Dwg. S-13	Design details removed from Supporting Document S10g and are discussed in Supporting Document S2
2a.	For purposes of adding to the application's record, is the quality of the rock high so that leachate from the waste does not penetrate into the subsurface through fractures?	Revised Water License Application Support, Section 3.7 Supporting Document S10g, Section 3.2	Text revised
2b.	It was stated within the design report that the surface within the landfill will be "graded at approximately 1% in the down slope direction"; however, engineered drawing S-13 (or Drawing #2 within S10g) depicts a graded slope to 0.5%. Clarification is requested to address this inconsistency.	Supporting Document S10g Executive Summary and Section 3.0	Text revised
3.	Section 3.0 (S10g) – The NWB understands that containment berms will be constructed to divert storm and melt water away from the landfill. Does MHBL agree that if the containment berms will divert surface waters from entering the landfill, they will also serve the function to divert surface waters within the landfill to the pollution control sump? Additional detail and discussion are requested to address each of the following:	Supporting Document S10g, Section 5.2 Supporting Document S2, Section 4.16	The downslope berms will divert water into the landfill pollution control sump - text indicates this
3a.	Details of the berm cross-section are not visible in engineered drawing S-14 Typical Landfill Section A-A' . Additionally, Section A-A' does not contain a berm on the east edge of the landfill as is depicted in engineered drawing S-13 . The NWB requests comment from MHBL on this issue.	Supporting Document S2, Section 4.16	More detail and clarification provided. The drawing was however not revised since as discussed on the drawing it is a typical representation rather than a detailed design.
3b.	What is the material type(s) used in the berm and dimensions?	Supporting Document S2, Section 4.16	More detail and clarification provided
3c.	If MHBL believes containment berm serves the function of diverting waters from entering and leaving the landfill facility then what berm design features (e.g., liner, low permeability material, etc.) will ensure that this design function, and thus, containment of leachate, will be achieved?	Supporting Document S2, Section 5.10.2	More detail and clarification provided
3d.	Report S2, Section 4.16 stated that <i>"the landfill will be completely hydrologically isolated via a set of containment and barrier berms"</i> . The NWB requests additional information such as a topographic map delineating surface water drainage patterns around the landfill cell along with catchment area(s) and discussion to compliment this topographic map and detail the quoted claim above.	Supporting Document S2, Section 4.16	More detail and clarification provided

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
3e.	Report S3 Section 10.2.22 stated a “1.0 m diversion berm built from Selected Subgrade material will be constructed around the landfill to ensure external surface runoff does not enter the landfill area”. The NWB understands that according to Drawing G-05 , Select Grade material is comprised of a sandy gravel to gravel with some sand. These details were not provided in the design report S-10g . With consideration given to, as the NWB understands, the high hydraulic conductivity of this material, discussion is requested on how berms comprised of this material will hydrologically isolate waters from entering or leaving the landfill cell.	Supporting Document S2, Section 3.6	More detail and clarification provided
4.	Engineered drawing S-13 or drawing #2 within S10g - A “pollution control sump” is depicted in the engineered drawing; however, the NWB understands that there is no description of the design of the pollution control sump within report S10g. What are the engineering characteristics and design limits of the “pollution control sump”? Additional information and detail of sump design are requested that include, but not limited to, the following:	Supporting Document S2, Sections 4.16 and 3.3 Supporting Document S10g, Section 5.2	More detail and clarification provided - see responses to 4a, 4b and 4c below
4a.	The engineered drawing does not provide dimensions of the sump. What are the engineered dimensions of the sump and containment volume?	Supporting Document S2, Section 4.16	More detail and clarification provided
4b.	Details of how the design capacity of the sump was determined are requested. With consideration given to all input water and snow sources that may include: specified storm event(s), snow-melt water, and snow drift and accumulation within the facility, etc., how was the volume of water and melted snow that enter the sump determined?	Supporting Document S2, Section 3.3	More detail and clarification provided
4c.	What are the operations and management procedures MHL plans to employ to ensure that the sump capacity is not exceeded?	Supporting Document S10g, Section 5.2	Text revised
4d.	Within the Monitoring and Follow-up Plan report (S10m), it was stated that the water quality from the landfarm sump will be tested on a monthly basis and prior to any planned discharge during open water season and that “no water will be discharged onto the tundra until water sampling has demonstrated that water is of sufficient good quality to meet discharge standards as established within the water license”. Report S10m was not referenced in the S10g. Clarification and confirmation is requested to address how monitoring and discharge of landfill sump water will occur.	Supporting Document S10g, Section 5.2	Text revised
5a.	The NWB understands that the landfill is to contain non-hazardous wastes. Types of waste were provided in Section 4.1 of design report S10g. Details of an approximate volume balance were not provided and thus details and discussion demonstrating that landfill capacity will contain the estimated amount of waste generated on site are deficient. Additional detail and discussion is requested to confirm and understand containment and that the proposed size of the landfill is of sufficient size that includes, but not limited to, the following:	Supporting Document S2, Section 4.16	More detail and clarification provided
5a-i.	Expected mass of waste to be landfilled on a yearly and cumulative basis with discussion on how these values were determined.	Supporting Document S2, Section 4.16 Supporting Document S10g, Section 4.1 , Table 4.2	Text revised
5a-ii.	Estimated volume of waste and cover material with consideration given to estimated bulk (as-placed) density of waste and cover material.	Supporting Document S2, Section 4.16	More detail and clarification provided

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
5a-iii.	Calculation of volume capacity of the landfill to contain waste and cover material, with consideration given to ensure stable slopes, placement, construction, winter storage area, access to the landfarm, etc. What are the expected heights for each yearly constructed cell?	Supporting Document S2, Section 4.16	More detail and clarification provided
5a-iv.	Comparison of the expected required volume of waste and cover material to the volume capacity of the landfill.	Supporting Document S2, Section 4.16	More detail and clarification provided
5b.	What contingency measures are in place to dispose of waste in excess of estimated volumes?	Supporting Document S10g, Section 4.2	Text revised
6a.	Additional detail and discussion is requested to address the following items with respect to landfill cover and related operations: Section 4.0 (S10g) - A graded cover has been specified to be placed before the winter period of snow accumulation. What material will be used as an annual cover?	Supporting Document S2, Section 5.10.1	More detail and clarification provided
6b.	Report S2, Section 5.10.1 states that "at least once every three months, any open cells will be closed by covering them with a nominal layer of surfacing material, and a new cell will be started". Details of cover application in the design report S10g included only the placement of an annual cover. Clarification is requested to address this inconsistency. If surfacing material is used every three months, what material type will be employed?	(1) Supporting Document S10g, Section 5.1 (2) Supporting Document S2, Section 5.10.1	(1) Text revised (2) More detail and clarification provided
6c.	Report S2, Section 5.10.1 states that "winter cells must be kept small such that a minimum amount of snow will be captured when the cell is closed". Design report S10g stated that waste will be temporarily stored in the winter within the landfill area until final placement can proceed in the summer. Clarification is requested to address this inconsistency.	Supporting Document S2, Section 5.10.1	More detail and clarification provided
7a.	Section 4.4 (S10g) - It was stated that "water will be collected within the landfill area" and "tested for the presence and absence of oil and grease". If "oil and grease are present in the samples, water contained within the landfill will be treated using water/oil filtration system before releasing onto the tundra". Depending on the characteristics of the oil-water "filter" style separator, hydrocarbons may be removed from the waters removed from the landfill. Does MHL agree that since the source of waste will be derived from a variety of locations, there is potential for the other dissolved contaminants and suspended solids to not be removed to acceptable levels by an oil water "filter" style separator? The NWB requests MHL discussion on the following: What are the typical characteristics of an acceptable oil-water "filter" style separator that would be appropriate for this application?	Characteristics of filter discussed in Supporting Document S10h Sec 4.5 and Appendix B	Text revised
7b.	Where will the water removed from the landfill be discharged?	Supporting Document S10g, Section 5.2	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
7c.	What water quality criteria will the proposed method of discharge and fluid treatment ensure in this application? Will there be monitoring of the discharge prior to release be completed?	Supporting Document S10g, Section 5.2, Table 5.1	Text revised
7d-i.	Report S2 Section 4.16 stated that water from the landfill will be pumped out and clean water directed on to the tundra and contaminated water to a tanker and then on to Tail Lake. There remain some inconsistencies between report S2 and S10g (described above) with regards to water collection and disposal operations. Clarification is requested to address each of the following:	Supporting Document S10g, Section 5.2 Supporting Document S2, Section 5.10.1	More detail and clarification provided
7d-ii.	If so, what are the details of the testing program? If not, why not?	Supporting Document S10g, Section 5.2	Text revised
7d-iii.	What will be the practice employed to dispose of contaminated waters pumped from the landfill cell? For example, will it pass through an oil-water separator, or will it be collected by a tanker truck and then on to Tail Lake?	(1) Supporting Document S10g, Section 5.2 (2) Supporting Document S2, Section 5.10.1	(1) Text revised (2) More detail and clarification provided
8.	Section 5.5 (S10g) - It is proposed that clean wood and paper will be burned <i>well away from the perimeter of the landfill</i> ". What is a safe location and minimal distance from the landfill and landfarm to ensure damage to the geomembrane in the landfarm is not compromised?	Supporting Document S10g, Section 4.2	Text revised
9a.	Section 5.7 (S10g) - The NWB understands a final cover of clean rock has been specified to cover the refuse and surface contour the topography to blend into the surrounding terrain and to direct surface drainage away from the site. What are the material specifications/type of the clean rock used for cover?	Supporting Document S2, Section 5.10.1	More detail and clarification provided
9b.	Has slope stability and surface drainage of the final elevations been considered? If so, what are the characteristics for construction of the final elevations that will ensure a stable slope? If not, why not?	Supporting Document S2, Section 5.10.1	More detail and clarification provided
9c.	Is there a minimum amount of final cover that is required to be placed over the waste and what is this amount? If not, why not?	Supporting Document S10g, Section 5.8	Text revised
9d.	What is the engineering design function of the cover material?	Supporting Document S2, Section 5.10.1	More detail and clarification provided
10.	Section 5.7 (S10g) - It was stated that since <i>"this landfill does not contain any hazardous waste its closure plan does not require infiltration or thermal control"</i> . Reference to the appropriate location within the Closure and Restoration plan is requested that may address the following issues. Additional detail and description is requested to address each of the following:	Supporting Document S10g, Section 5.8	Text revised
10a.	If waters are required to be collected from the landfill during active operation and the cover material does not control infiltration, how will controlled discharge of waters from the landfill be completed after closure?	Supporting Document S10g, Section 5.8	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
10b.	If waters collected from the landfill during active operation are monitored for potential contaminants (e.g., oil and grease), will monitoring of waters from the landfill be completed after closure? If so, what are the long term monitoring plans? If not, why not?	Supporting Document S10g, Section 5.8	Text revised
10c.	Does MHL agree that a landfill that does not accept hazardous waste still has the potential to generate a leachate that may not be acceptable for release into the environment? Further discussion on why "infiltration or thermal control" are not required for this landfill is requested.	Supporting Document S10g, Section 5.8	Text revised
11.	Section 2.10 (S10) - It was stated that drill cutting are to be moved from drill location to an "approved storage area on the property". Will these cuttings be placed in the landfill? Clarification is requested on where drill cuttings will be stored.	Reference to disposal of drill cutting has been removed. The Doris North Project will not generate any drill cuttings that require separate disposal. Drill cuttings from exploration activities elsewhere on the Hope Bay belt will be handled under the exploration licenses and permits	Reference removed
S10h- Landfarm Design and Management Plan			
1.	Report (S10h) was not signed for authorship and professional approval. The NWB requests that this design report be signed and sealed by the responsible professional.	Supporting Document S10h, signed page inserted at the end of the document before references	Authorship added
2.	Section 1.0 (S10h) - It is stated that the "proposed landfarm is relatively small, consistent with the mine size and underground operations mode, but could be expanded if required". This statement suggests that consideration has been given to expected volume of soil to be landfarmed and appropriate sizing of the facility to accommodate contaminated soil; however details of a volume balance were not described in the design report. Additional information and detail is requested to address each of the following:	(1) Supporting Document S10h, Section 4.2 (2) Supporting Document S2, Section 5.11	(1) Text revised (2) Reference to Supporting Document S10h inserted
2a-i.	Based on past and current experiences at mine sites and exploration camps, details of a volume balance are requested that includes, but not limited to, the following: Expected yearly and cumulative volume of contaminated soil entering the facility with details on how these approximate values and soil properties used in the analysis were determined.	(1) Supporting Document S10h, Section 4.2 (2) Supporting Document S2, Section 5.11	(1) Text revised (2) Reference to Supporting Document S10h inserted
2a-ii.	Estimated yearly and cumulative volume of soil remediated within the landfarm and removed from the facility with details on how this approximate value was determined.	(1) Supporting Document S10h, Section 4.2 (2) Supporting Document S2, Section 5.11	(1) Text revised (2) Reference to Supporting Document S10h inserted
2a-iii.	Expected volume of contaminated snow entering the facility with details on how this approximate volume was determined.	(1) Supporting Document S10h, Section 4.2 (2) Supporting Document S2, Section 5.11	(1) Text revised (2) Reference to Supporting Document S10h inserted

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
2a-iv.	What height of freeboard has been provided in the design of the landfarm to ensure containment?	(1) Supporting Document S10h, Section 4.2 (2) Supporting Document S2, Section 5.11	(1) Text revised (2) Reference to Supporting Document S10h inserted
2a-v.	Calculation of the total containment volume of the landfarm with consideration given to freeboard.	(1) Supporting Document S10h, Section 4.2 (2) Supporting Document S2, Section 5.11	(1) Text revised (2) Reference to Supporting Document S10h inserted
2a-vi.	Calculation of the volume of soil and volume of snow that could be contained within the landfarm.	(1) Supporting Document S10h, Section 4.2 (2) Supporting Document S2, Section 5.11	(1) Text revised (2) Reference to Supporting Document S10h inserted
2a-vii.	What volume of contingency is there in the design capacity of the landfarm to contain soil and contain snow if the estimates of soil and snow volume to be contained are not correct?	(1) Supporting Document S10h, Section 4.2 (2) Supporting Document S2, Section 5.11	(1) Text revised (2) Reference to Supporting Document S10h inserted
2a-viii.	If the volume of soil or snow exceeds containment volume, how will these materials be managed to ensure containment of contaminants?	(1) Supporting Document S10h, Section 4.2 (2) Supporting Document S2, Section 5.11	(1) Text revised (2) Reference to Supporting Document S10h inserted
2b-i.	B. The statement aforementioned in Bullet 2 detailed that the landfarm <i>"could be expanded if required"</i> . Adaptive management of this nature requires a complete understanding of the engineered design limits (e.g., containment volume) of the facility with fully defined alternative contingency scenarios defined with appropriate quantifiable triggers on when a change in original design and management. Additional information is requested to address each of the following:	Supporting Document S10h, Sections 1.0 and 4.2	Text revised
2b-ii.	Will expansion of the landfarm remain enclosed within the landfill containment berm area?	Supporting Document S10h, Section 4.2	Text revised
2b-iii.	Since the landfarm is located within the landfill containment berm area, how has the potential expansion of the landfarm been considered in the design, management, and operation of the landfill? This issue was not addressed in the landfarm or landfill design reports.	Supporting Document S10h, Section 4.2	Text revised
3.	Section 3.0 (S10h) - The NWB understands that there may be inconsistency between the submitted documents and engineered drawing S-14 or Drawing #3 within S10h . Clarification is requested to address each of the following inconsistencies:	(1) Supporting Document S4, Dwg S-14 (2) Supporting Document S10h	(1) Dwg S-14 revised (2) Text revised
3a.	There is no mention of the use of geotextiles to be place on each side of the HDPE liner within report S10h as is depicted in the engineered drawing. Will geotextiles be used in design as depicted in the engineered drawing S-14 ?	Supporting Document S10h, Section 3.0	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
3b.	The terms used to define the soil types, such as "crushed quarry rock" and "fine crushed rock" used in report S10h are not consistent with the terms used in engineered drawing S-14 or as-specified in report S3 Section 7.0 Fill Material Specifications . The NWB requests clarification to clear any potential confusion and ambiguity between documents.	Supporting Document S10h has been altered to reference Supporting Documents S2, S3 and S4. Supporting Document S10h is intended as an operational plan for MHBL personnel operating the landfarm facility and is not intended as a source for design info. Supporting Document S10h, Section 3.0 was adjusted to reference the surfacing material specified by SRK as the referenced crushed material used in the levelling layer.	The text in the engineering drawings are correct; any references in Supporting Document S10h must be revised accordingly
	Report S10h states "A pad of crushed quarry rock will be laid down to provide a bermed area for the landfarm. Finer crushed quarry rock will then be placed on the pad to provide a suitable bedding layer for the HDPE impervious liner". Engineered drawing S-14 Detail 1 depicts a nominal surfacing layer of ~0.1 m below the geomembrane and overlying the bedrock. What are correct details for material placement below the geomembrane?	Supporting Document S10h, Section 3.0	Text revised
3d-i.	Report S10h states "A ramp will be constructed of crushed rock to allow vehicles to enter and exit the landfarm without damaging the containment berm. More fine crushed rock will be placed on top of the liner to protect it from damage from vehicles delivering contaminated soils to the landfarm will be placed by hand so as not to damage the liner. An additional approximate 30 cm of fine crushed rock will be placed with a small crawler or wheeled dozer". From above, the NWB understands that total cover thickness over the geomembrane would be 0.45 m. Engineered drawing S-14 Detail 1 depicts a material thickness above the geomembrane to be 0.2 m. Clarification is requested to address the inconsistencies between the B314 document text and the engineered drawing.	(1) Supporting Document S4, Dwg S-14 (2) Supporting Document S10h, Section 3.0	(1) Drawing revised (2) Text revised
3d-ii.	Reference is given to placement methods for materials above the liner, such as "by-hand" and use of a "small crawler or wheeled dozer". Are these specifications specific to construction of this facility and in addition to that provided in report S3 Section 8.3 and Section 9.0 ? Is HBL committed to placement of this material by hand?	Supporting Document S10h, Section 3.0	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
3e.	Report S10h stated "Should heavier equipment be required to service the landfarm, additional fine crushed rock or soil will be placed over the HDPE liner prior to use of the area for soil decontamination". This statement is an adaptive management strategy that requires further clarification of the technical specifications required for additional HDPE protection (e.g., thickness for each material type used), or reference to applicable specification if provide in a separate document.	Supporting Document S10h, Section 3.0	Text revised
3f.	The access ramp is potentially an area with heavy traffic, clarification is required if Technical Specification 8.3.1(7f) in report S3 is applicable for this design? If not why not?	Supporting Document S4, Dwg. S-13 and	No revisions needed. The appropriate drawings show the design thicknesses
4.	Engineered drawing S-13 or drawing #2 within S10h - A "pollution sump" and "temporary storage area" are depicted in the engineered drawing; however, there is no description of the design of the pollution sump or the purpose/design of the temporary storage area within report S10h . Clarification is requested to address each of the following:	Supporting Document S10h, Sections 3.0 and 4.5	Text revised
4a-i.	What are the engineering characteristics and design limits of the "pollution sump"? Additional information and detail of sump design are requested that include, but not limited to, the following: The engineered drawing depicts a dimension of 1 m by 1 m area for the sump, but the sump depth is not provided. What are the approximate engineered dimensions of the sump and containment volume?	Supporting Document S4, Dwg. S-02 and Dwg. S-03	The sump design will be similar to that of the fuel tank farm and fuel transfer station.
4a-ii.	How is the sump integrated into the construction of the liner? Additional detail, potentially with an engineered drawing, is requested.	Supporting Document S4, Dwg. S-02 and Dwg. S-03	The sump design will be similar to that of the fuel tank farm and fuel transfer station.
4a-iii.	Details of how the design capacity of the sump was determined are requested as insufficient description and discussion was not included. With consideration given to all input water and snow sources that may include: specified storm event(s), moisture conditioning of the landfarm soils, contaminated snow-melt water, and snow drift and accumulation within the facility, how was the volume of water and melted snow that enter the sump determined?	Supporting Document S10h, Section 4.3	Text revised - information included
4a-iv.	How will non-contaminated snow and drifted snow that accumulates within the landfarm be managed?	Supporting Document S10h, Section 4.5	Text revised
4a-v.	What are the operations and management procedures to ensure that the sump capacity is not exceeded and saturate the landfarmed soil and alter the design moisture content of the contaminated soils?	Supporting Document S10h, Section 4.5	Text revised
4b.	All details with regards to the purpose, design intent, operations, and management of the temporary storage area are requested.	Supporting Document S10h, Section 4.5	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
4c-i.	The temporary storage area does not include a sump to remove any accumulated liquid. The NWB understands that it may be assumed that any water that may accumulate within the temporary storage area will drain through the unlined berm inside the landfarm and enter the pollution sump. The NWB requests MHBL clarification.	Supporting Document S10h, Section 4.5	Text revised
4c-ii.	If no to above, how will accumulated fluid be removed from the temporary storage area?	Supporting Document S10h, Section 4.5	Text revised
5.	Throughout the landfarm design, landfarming experiences brought forward from the Boston (Water License NWB1BOS0106) and Windy (Water License NWB2HOP0207/B1) camps have been used to assist in detailing how the Doris North landfill is designed and operated. This is shown through the following: • Executive Summary and Section 1.1: "The design and proposed management are based on successful landfarms operated at the Boston and Windy exploration camps operated by MHBL" • Section 3.0 - "A mixture of ammonium nitrate and corn cobs will be used as a bacterial medium and mixed with contaminated soil as it is placed within the landfarm. This medium has proven to have worked successfully at the nearby Boston and Windy exploration camps over the 2005 and 2006 summer seasons". • Section 3.0 - "Any standing water in the landfarm will be passed through an oil-water "filter" style separator prior to release to the environment (a similar unit is in operation than the Boston and Windy Camp landfarm facilities). Normally, water should be adsorbed by landfarm soil". Additionally, within Section 6.8 of report S10a it is stated "Two approved Land Treatment Area (LTA) operations on the Belt. One is located at Boston Camp and the other is located at Windy Lake camp. Contaminated top soil will be removed and placed in these LTA for treatment"	Supporting Document S10h, Section 1.1	Text removed
5.contd	It is the NWB's understanding that the landfarms at the Windy and Boston exploration camps are unlicensed facilities. The following correspondence has been issued communicating the need to license these facilities: • Oct 27, 2005 NWB to MHBL (RE: Acknowledgement Annual Report 2004)- "The NWB generally requires that Landfarm facilities be operated under a water license....the Licensee incorporate the Land Treatment Area (Landfarm) into the current License through application for amendment to be submitted as a stand alone amendment or in conjunction with other foreseeable changes required. This application should be submitted at least four (4) months prior to active monitoring in 2006." • July 12, 2006 INAC to NWB (RE: 2BE-HOP –Miramar Hope Bay Ltd. – Hope Bay Project – 2005 Annual Report)- "The 2005 Annual Report states that exploratory drilling activities have commenced in the project area and that the Windy Lake Camp has a land treatment area for the remediation of soils contaminated with petroleum hydrocarbons. The project's license permits water use for domestic purposes only. In light of these water use activities, INAC recommends that the project's license be revised to incorporate water use for domestic purposes." Currently the NWB has yet to receive a license application for the above listed landfarms. Through this letter document the NWB is notifying Regulators on references to the Boston and Windy landfarms in the Doris North application and the correspondence provided by the NWB and Regulators to MHBL in the recent past for Regulator advisement and action on the issue.	Supporting Document S10h, Section 1.1	Text removed

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
6.	Section 3.0 (S10h) - It is stated that a "mixture of ammonium nitrate and corn cobs will be used as a bacterial medium and mixed with contaminated soil as it is placed within the landfarm". With regards to this operation, additional detail and discussion are requested for each of the following:	Supporting Document S10h, Section 4.5	Text revised
6a.	What are the specifications for ammonium nitrate concentration, application rate, method of application, operator requirements, etc. associated with operation with details on their selection?	Supporting Document S10h, Section 4.5	Text revised
6b.	What is the required or target mass/volume of corn cobs to be mixed with contaminated soil (i.e., density of corn cobs per unit volume of soil) with details on how this was determined?	Supporting Document S10h, Section 4.5	Text revised
6c.	Will the required amount of corn cobs always be available for use in this application? If not, what contingency measures are in place and what are the details of this contingency measure?	Supporting Document S10h, Section 4.5	Text revised
6d.	Drawing upon experience in design and operation from past projects is advantageous. However, without providing fully documented design and operations description or comparisons of similarities and differences between past design and operations to the proposed design and operations, and quantifiable data to justify the term "successful", demonstration that the proposed design will be "successful" may not be fulfilled. If past experience is relied upon for the proposed design and operations, additional information and detail are needed to detail and demonstrate the applicability.	Supporting Document S10h, Section 1.1 and Appendix C	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
6e-i.	It was further stated that the <i>"bioremediation medium will be added as needed during the biodegradation process"</i> . What are the required application specifications for adding additional bioremediation medium during biodegradation process?	Supporting Document S10h, Section 4.5	Text revised
6e-ii.	What criteria will be used to benchmark when the bioremediation medium should be applied is required through this adaptive management strategy?	Supporting Document S10h, Section 4.5	Text revised
6f-i.	It is understood that mixing of the soil is routinely employed to minimize the potential uneven biodegradation with depth in the landfarmed soil. Will soil be mixed to maximize even biodegradation?	Supporting Document S10h, Section 4.5	Text revised
6f-ii.	How does the penetration depth of the equipment used to mix the soil (i.e., plow or till) compare to the expected thickness of soil landfarmed, which depending on freeboard requirements may be less than the height of the containment berms? Will the method employed ensure a well mixed soil?	Supporting Document S10h, Section 4.5	Text revised
6f-iii.	If the soil is not to be mixed evenly, how does this impact the proposed density of soil sampling of one composite of ten samples per 25 m3, which was stated to be <i>"sufficient when soils have been well mixed during the decontamination process"</i> ?	Supporting Document S10h, Section 4.5	Text revised
6g.	Within the Main Application Document , it was stated that incinerator ash if uncontaminated "will be mixed into any soil undergoing remediation within the landfarm". Details pertaining to this operation were not provided in report S10h . Further detail is requested to address this operation process and mixing ratios.	Supporting Document S10h, Section 41	Text revised
7a.	Tilling of the soil was specified to occur when it is dry enough. Is this based on equipment operation constraints? Further clarification on how "dry enough" will be determined is requested.	Supporting Document S10h, Section 4.5	Text revised
7b-i.	Mixing of clean and contaminated soil has been proposed to keep the average hydrocarbon fuel content in the soil below 5%. Does "clean" mean soil that has no hydrocarbon content? If so, what is the source of the clean soil? If not, does "clean" refer to soil that is currently landfarmed and potentially partly bioremediated?	Supporting Document S10h, Section 4.5	Text revised
7b-ii.	What testing will be completed to determine the soil hydrocarbon percentage entering the facility? If no testing will be completed, what procedures will be implemented to ensure a mixture of soil will have hydrocarbon content below 5%?	Supporting Document S10h, Section 4.5	Text revised
7c-i.	Soils will be kept moist to a target soil moisture content of 15 to 30% on a weekly basis during summer months. Will moisture content be measured according to ASTM D2216 – Water (Moisture Content) in Soil and Rock ? If not, what standard will be employed?	Supporting Document S10h, Section 4.1	Text revised
7c-ii.	What are the method of moisture addition and source of the water used for moisture conditioning?	Supporting Document S10h, Section 4.1	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
7d-i.	It was stated that <i>"any standing water in the landfarm will be passed through an oil-water filter style separator prior to discharge to the environment"</i> . What situations would cause standing water to be within the landfarm?	Supporting Document S10h, Section 4.3	Text revised
7d-ii.	If standing water occurs within the landfarm, what measures are in place to ensure that it is temporary so as to not impact the biodegradation process?	Supporting Document S10h, Section 4.3	Text revised
7d-iii-1.	Depending on the characteristics of the oil-water "filter" style separator, hydrocarbons may be removed from the waters removed from the landfarm. However, since ammonium nitrate is being applied to the landfarmed soil and the contaminated soil source will be derived from a variety of sources, there may be a potential for the other dissolved contaminants and suspended solids to not be removed to acceptable levels by an oil-water "filter" style separator. What are the typical characteristics of an acceptable oil-water "filter" style separator that would be appropriate for this application?	Supporting Document S10h, Section 4.5	Text revised
7d-iii-2.	Where will the water removed from the landfarm (i.e., standing water or collected from the sump) be discharged?	Supporting Document S10h, Section 4.5	Text revised
7d-iii-3.	How will the proposed method of discharge and fluid treatment minimize impacts to water (as through the definition of 'water' in NWANSRTA)?	Supporting Document S10h, Section 4.5	Text revised
7d-iv.	Within the Monitoring and Follow-up Plan report (S10m) , it was stated that the water quality from the landfarm sump will be tested on a monthly basis and prior to any planned discharge during open water season and that "no water will be discharged onto the tundra until water sampling has demonstrated that water is of sufficient good quality to meet discharge standards as established within the water license". Report S10m was not referenced in the S10h . Clarification and confirmation is requested to address how monitoring and discharge of landfill sump water will occur.	Supporting Document S10h, Section 4.7	Text revised
7e.	It was stated that <i>"ultimate degradation rates are site-specific and cannot be predicted"</i> . Within the Hazardous Materials Management Plan (S10e) it was stated that <i>"sampling will be done to assess the effectiveness of the cell under different climatic conditions"</i> . Further details into how "effectiveness" will be determined with respect to soil remediation rates and climatic conditions are requested.	Supporting Document S10e, Section 3.6 Supporting Document S10h, Section 4.5	Text revised
8.0	Section 4.3 (S10h) - With regards to environmental monitoring, additional detail and clarity are requested to address each of the following:	Supporting Document S10h, Sections 4.5, 4.6 and 4.7	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
8a-i.	In the event of an uncontrolled release of water from the landfarm, it was stated that the landfarm is contained within a 'controlled drainage area (Quarry 2) where any accidental release can be captured and treated'. What is the site drainage pattern in the vicinity of the landfarm and the capture point for Quarry 2 catchment area? Reference to the appropriate document and section is requested to clarify this statement.	Supporting Document S10h, Section 3.0	Text revised
8a-ii.	In the event of water release from the landfarm, what procedures will be implemented to collect and treat the water?	Supporting Document S10h, Section 3.0	Text revised
8b.	It was stated that "soil samples will be collected and tested for BTEX and CCME PHA's." What is the frequency of soil testing?	Supporting Document S10h, Sections 4.6 and 4.7	Text revised
9.	Section 4.4 (S10h) - During landfarm closure, it was stated that "bedding rockfill (below the geomembrane) will be tested for presence of petroleum hydrocarbons...". What procedures will be employed to ensure a representative sampling of the entire landfarm footprint? Has this information been included in the Mine Closure and Reclamation Plan (S10I) ? An appropriate reference is required to interconnect these documents.	Supporting Document S10h, Section 5.3 Supporting Document S10I, Section 6.1.5.1 presents the general procedure for identifying and sampling contaminated soils. This procedure will be applied for the leveling rockfill under the landfarm liner. Supporting Document S10I, Section 6.1.5.6 addresses	Text revised
10.	Section 4.4 (S10h) - At landfarm closure the facility will be disassembled and the various soil materials contained within the landfarm and comprising of the landfarm structure will be disposed of in the stated locations. The landfarm and landfill are intimately connected through a shared berm. The potential interactions of landfarm closure on landfill performance and closure were not discussed. Additional detail and discussion are requested to address how landfarm decommissioning may impact landfill performance and decommissioning. Has this information been included in the Mine Closure and Reclamation Plan (S10I) ? An appropriate reference is required to interconnect these documents.	Supporting Document S10h, Section 5.3	Text revised
11.	Additional detail and discussion is requested into how the liner integrity is checked following construction?	Supporting Document S10h, Section 3.0	Text revised
12.	Upon consulting the Hazardous Waste Management Plan (S10e) , Section 3.5 there were inconsistencies with the Landfarm Design and Management Plan (S10h) . Further detail and discussion is requested to address the following items:	Supporting Document S10e Section 3.6	Text revised
12a.	In report S10e , it was stated that the landfarm will be no more than 2 m deep. Drawing S-14 shows the berm height of the facility to be 1 m. With consideration given to freeboard height, what is the maximum soil depth?	Supporting Document S10e Section 3.6	Text revised
12b.	In report S10e , it was stated that after the soil is remediated, it "will be removed and transferred to the landfill". However in report S10h , it was stated that remediated soil will be used for reclamation. What is the end use of remediated soils?	Supporting Document S10e Section 3.6	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
12c.	In report S10e , it was stated that <i>"if the harsh climatic conditions at the Doris North Gold Mine site inhibit natural biological activity, special bacteria may be introduced"</i> . There is no mention of applying "special bacteria" to the landfarmed soil within report S10h . Additional detail and discussion is requested to address this matter. Will "special bacteria" be applied, and if so, what are the details of this process?	Supporting Document S10e Section 3.6	Text revised
12d.	In report S10e , it was stated that the landfarm "will be operated in accordance with Nunavut government guidelines". These guidelines were not referenced in the design report S10h , why not? What is the complete reference to this guideline?	Supporting Document S10e Section 3.6	Text revised
13.	Design report S10h did not include any details of how the geomembrane and geotextile product specifications provided in report S3 Section 8.2.4 were considered in the design of the landfarm. Additional detail and clarification are requested to address how the product specifications of the geosynthetics a) ensure protection of the geomembrane from damage/puncture during construction and operation loadings, and b) considered in the anchor trench design.	Supporting Document S2, Appendix H	Additional information provided
S10i- Tailings Management Plan			
1.	The NWB understands that there is interconnectivity between the Tailings Management Plan (S10i) , Water Quality Model (S6) , and Tailings Containment Area Design (S1) . Generally, the NWB understands that the discharge volume into Doris Creek will impact the required volume of Tail Lake water and therefore the elevation of the dams. Does MHL agree that if there is a change in the management strategy to discharge waters, it will in turn, impact the water quality in Tail Lake and the storage of waters in Tail Lake?	Supporting Document S10i, Section 1.0	Text revised, reference added
1.contd	Currently, the NWB understands that the management plan uses MMER limits to control how much water is decanted from Tail Lake. The NWB understands that the rate of discharge may be controlled, in part, by ensuring CCME limits are achieved at a location downstream of the effluent end of the decant pipe from Tail Lake and downstream of the Doris Creek waterfall. Does MHL agree that if the location for CCME limit compliance point is moved from a location downstream of the waterfall in Doris Creek to the point where Tail Lake waters enter Doris Creek, that current management strategy for water discharge and design of the tailings containment area and dams would require re-evaluation to assess adequacy? The NWB requests detailed discussion from MHL to add to the applications record and address the above.	Supporting Document S10i, Section 4.1	Text revised
2.	Report S10i was not signed for authorship and professional approval. The NWB requests that this design report be signed and sealed by the responsible professional.	Supporting Document S10i	Signature added
3.	Minimal details linking the management strategy for discharged water from Tail Lake presented in report S10i to the water quality modeling results in report S6 was provided. The likely intent of the water quality model may be the assessment of appropriate management for discharge of waters from Tail Lake to Doris Creek. However, an empirical method to deduce Tail Lake discharge rate and Doris Creek concentrations at the monitoring point is presented and suggested for use to manage waters. Additional detail and discussion is requested into how water quality modeling was used to define the planned water management strategy outlined in S10i .	Supporting Document S10i, Section 4.3	Text revised, references added

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
4a.	Section 4.1 (S10i) - It was stated that "<i>Tail Lake water management strategy is to meet CCME guidelines for parameters of concern to protect freshwater aquatic life in Doris Creek, downstream of the waterfall</i>". Details and reasoning are requested on how and why MHL has determined the location of the recommended compliance point to achieve CCME guidelines (which is located downstream of the waterfall in Doris Creek).	Supporting Document S10i, Section 4.1	Text revised
4b.	Since Tail Lake discharge will occur upstream of the waterfall in Doris Creek and monitoring will be completed downstream of the waterfall, the management strategy may be relying on dilution within Doris Creek to reduce concentrations compared to decant. As a result, there are locations in Doris Creek that may exceed CCME water quality guidelines. Why has MHL not recommended the end of pipe water quality as the point of compliance for CCME guidelines?	Supporting Document S10i, Section 4.1	Text revised
4c.	If water quality downstream of the waterfall in Doris Creek does not achieve CCME guidelines what contingency or mitigating measures are in place to control downstream impacts? What contingency and mitigating measures are in place if the predicted concentrations at the downstream monitoring point do not achieve CCME guidelines for water quality?	Revised Water License Application Support Document, Section 6.1.4 Supporting Document S10i, Section 4.1	Text revised, references added
5a.	Section 4.3 (S10i)- A method to determine discharge rate into Doris Creek from Tail Lake was outlined and may be based, in part, on dilution within Doris Creek and background, discharge, and CCME water quality concentrations. It was stated that the ADV (Allowable Discharge Volume Ratio) will be calculated for copper and "<i>other key parameters</i>". Clarification is requested into what key parameters will be used to assess minimum ADV?	Supporting Document S10i, Section 4.3 , Table 4.2	Text revised
5b.	The water quality modeling within report S6 identified that select water discharge scenarios had copper, nitrite, chromium, and selenium exceeding CCME guidelines. Will all of these parameters be included as some of the "other key parameters" to calculate ADV? If not, why not?	Supporting Document S10i, Section 4.1 and Table 4.1	Text revised
5c.	It was stated in report S6 that discharge rates are based on metal concentrations in Doris Creek. Additionally, it was stated that nitrite may exceed CCME guidelines within Doris Creek. Nitrite is not a metal but does MHL agree that it may impact aquatic environment? Will nitrite be considered as one of the "<i>other key parameters</i>"?	Supporting Document S10i, Section 4.3 and Table 4.2	Text revised, footnote to table
5d.	A Target Discharge Rate (TDR) may be calculated based on the flow rate in Doris Creek, minimum ADV, and a 20% reduction which acts as a factor of safety. The NWB requests additional detail on how Doris Creek flow rate will be measured and the location of measurement to ensure representative conditions in Doris Creek.	Revised Water License Application Support Document, Section 3.6.5 Supporting Document, Section 5.2.5	Text revised to provide added detail and referencing

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
5e.	Additional detail into the planned strategy for discharge duration is requested. For example, will discharge only occur for a set number of hours per day and discharged each day of the month? Specifics are needed to add to the application record.	Supporting Document S10i, Section 4.4	Text revised
5f.	According to Table 1 within report S10m , water quality will be monitored every two days during discharge. What frequency will the Target Discharge Rate be adjusted during the discharge period?	Supporting Document S10i, Section 4.3	Text revised
6.	Section 4.4 (S10i) – The NWB understands that discharge from Tail Lake will be controlled by a PLC and will be measured over a flow range of 50 to 275 L/s. Does this range of measurable flow rate encompass all potential discharge scenarios outlined in report S6? The NWB requests comparisons of discharge rates from Tail Lake to the measurable range?	Supporting Document S6, Section 5	Text revised
7.	Section 4.4 (S10i) - MHL stated that the method of discharge “ <i>will not lead to erosion or degradation of the creek bed</i> ”. Further clarification is requested on how erosion and degradation of the creek bed will be prevented and what measurements will take place to assess the potential for erosion and degradation of the creek bed at the discharge location.	Supporting Document S10i, Section 4.4	Text revised
8a.	Section 4.4 (S10i) - The NWB understands that the addition of waters from Tail Lake to Doris Creek during controlled discharge may impact the regular conditions in Doris Creek downstream of the pipe outlet. Does MHL agree that depending on the discharge rate from Tail Lake to Doris Creek, the added volume of water conveyed within Doris Creek compared to normal conditions may increase the potential for erosion and bank stability at locations downstream of the discharge point? The NWB requests additional information regarding the following: How does the expected flow in Doris Creek during discharge compare to the normal and freshet flow rate measured and outlined in S5 ?	Supporting Document S10i, Section 4.4	Text revised
8b.	With consideration given to the comparison outlined above, what is the potential for erosion and bank instability as a result of controlled discharge from Tail Lake?	Supporting Document S10i, Section 4.4	Text revised
8c.	What monitoring measures are in place to assess erosion and bank stability along Doris Creek during controlled discharge?	Supporting Document S10i, Section 4.4, Revised Water License Application Support Document, Section 3.6.5 Supporting Document S10i, Section 9.4	Text revised
8d.	If erosion and bank stability along Doris Creek are impacted by discharge from Tail Lake, what measures will be implemented to mitigate these effects?	Supporting Document S10i, Section 4.4	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
9a.	Section 4.5 (S10i) - MHBL stated that <i>"commencing with the start of tailings deposition, Tail Lake will be monitored an additional two weeks every second day"</i>, and that as the dynamics of the system becomes better understood, <i>"the frequency of monitoring could be reduced"</i>. Where is the sample location for Tail Lake water? If this location is not at the intake pipe location of Tail Lake, details are requested on how representative the sample water quality will be to the intake location.	Supporting Document S10i, Section 4.5 second bullet Supporting Document S10m, Table 1	Text revised
9b.	What is being referred to with respect to "monitoring an additional two weeks"? How does this frequency compare with Table 1 in report S10m?	Supporting Document S10i, Section 4.5 second bullet Supporting Document S10m, Table 1	Text revised
9c.	Within Table 1 of report S10m it stated that location of water quality monitoring will be at the end of the discharge pipe, as well as, upstream and downstream of the discharge point. All three sample locations will be tested every second day during annual discharge period during operation, closure, and post closure. Clarification is requested to establish if the stated water quality sample location, monitoring, and frequency location in report S10i is consistent with report S10m.	Supporting Document S10i, Section 4 Supporting Document S10m, Section 5.1 references Tail Lake Discharge Sample locations described in Supporting Document, Sections 5.2.2 thru 5.2.5 and Supporting Document S10i, Section 4 to ensure consistency in the description of the sampling locations proposed. Supporting Document S10m, Table 1 is a summary reference table only. Reader is referred to text for detail descriptions.	Text revised
9d.	What criteria will be used to benchmark if the dynamics of the system are understood to establish a reduction in monitoring frequency?	Supporting Document S10i, Section 4.3	Text revised
10a.	Section 4.5 (S10i) - MHBL stated discharge from Tail Lake will commence <i>"only if the water meets MMER criteria"</i>. Where is the sample location for Tail Lake water? If this location is not at the intake pipe location of Tail Lake, details are requested on how representative the sample water quality will be to the intake location.	Supporting Document S10i, Section 4.5 second bullet Supporting Document S10m, Table 1	Text revised
10b.	What is the basis of the water management decision to achieve MMER criteria in Tail Lake discharge waters, but not achieve CCME guidelines for Tail Lake discharge waters?	Supporting Document S10i, Section 4.1 and Table 4.1	Text revised
11a.	Section 4.5 (S10i) - MHBL stated that the <i>"actual water quality in Tail Lake will regularly be compared with the predicted water quality to assess the accuracy of the model"</i>. Where will the comparison of predicted and measured concentrations be documented and how will it be submitted to the Board?	Supporting Document S10i, Section 4.5	Text revised
11b.	What is the frequency of assessing the accuracy of the model?	Supporting Document S10i, Section 4.5	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
11c.	Will the comparison of predicted and measured concentrations be used to assess the validity of model assumptions and site specific input parameters? If so, what specific model input parameters and model assumptions are to be checked? If not, why not?	Supporting Document S10i, Section 4.5	Text revised
12a.	Section 4.5 (S10i) - It was stated that <i>"if necessary, the model may be recalibrated to the actual water quality observed in Tail Lake"</i> . Is this a commitment that the model will be rerun? If so, what will be the basis to decide when to rerun the model?	Supporting Document S10i, Section 4.5	Text revised
12b.	What criteria will be used to benchmark if calibration of the model to site conditions is necessary?	Supporting Document S6, Section 5	Text revised
12c.	Given that many of the input parameters applied to the model are estimates (The NWB understands that many are self proclaimed conservative values) and the model assumes, as understood by the NWB, complete mixing in Tail Lake, the latter of which would promote dilution and potentially lower concentrations compared to actual, what degree of confidence is there that the model will accurately predict Tail Lake water?	Supporting Document S6, Section 6	Appropriate statements revised
12d.	Does MHL agree that there is uncertainty in the input data to the model and also uncertainty in the model assumptions? How has this been considered in whether model calibration is needed?	Supporting Document S6, Section 7	Appropriate statements revised
13.	On Page 66 of the Main Application Document , it was stated that a human health and ecological risk assessment will be completed to determine if the quality of water contained in Tail Lake is suitable for release in an unregulated fashion. Details of this assessment were not provided in the Tailing Management Plan (S10i) or Water Quality Model (S6) . What will benchmark when a study will be completed? What parameters are of concern?	Revised Water License Application Support Document, Section 8.7 Supporting Document S10m, Section 6.1.7	Reference added
14.	On Page 69 of the Main Application Document , it was stated that a water treatment plant could be implemented as a contingency if Tail Lake water quality is unacceptable for discharge. Additional details to benchmark when this adaptive management strategy is to be implemented are requested. Additionally, where will the treatment plant be located and will it be capable of treating the required discharge volumes to effectively manage Tail Lake waters?	Revised Water License Application Support Document, Section 3.6.6	Reference added
15a.	On Page 87 Section 6.3 of the Main Application Document , there is a description of the discharge strategy from Tail Lake that is not discussed in the Tailings Management Plan (S10i) or Water Quality Model (S6) reports. Of particular interests was the management of discharge waters from Tail Lake to Doris Creek, specifically the following: Site specific copper concentrations are recommended for use as a discharge limit. The NWB understands that this recommendation was not considered in the management plan for water discharge in supporting documents. Why not? What impact does this have on the discharge water management strategy outlined in the supporting documents?	Revised Water License Application Support Document, Section 6 consistent with Supporting Document S10i and Supporting Document S10j	Text revised, strategy in Section 6 is consistent with strategy in S10i and S10j

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
15b.	Table 6.2 provided proposed water license discharge standards for end of pipe water quality from Tail Lake. Additional detail is requested on how the proposed discharge concentrations were generated. Table 6.2 provides limits for “average allowable concentration”. Clarification is requested on how many samples and frequency rate of sampling will be used to calculate the average concentration? How come this information wasn't provided in the supporting documentation?	Supporting Document S10m, Section 5	Text revised, sampling frequency covered in S10m
15c.	The NWB understands that MHL stated that the proposed discharge limits for CN and ammonia were based on a 10x dilution ratio to ensure that CCME guideline values will be achieved within Doris Creek. How was this dilution ratio determined to be effective? What impact does this ammonia concentration have on nitrate and nitrite concentration in Doris Creek? Nitrite has been identified as a parameter that may exceed CCME limits in discharged waters. What is the rationale for not including a discharge limit for this parameter in Table 6.2?	Revised Water License Application Support Document, Section 6.1	Text revised, dilution ratio removed
	S10j- Water Management Plan		
1.	Although MHL has stated that S10j is a “ <i>living document and will be reviewed and updated periodically during the mine life</i> ”, the submitted Water Management Plan appears to be incomplete as presented. What is the proposed frequency for review of the document and/or what would constitute the review of the document? How will any changes be communicated to the NWB? The NWB requests detailed discussions involving the management of the fresh water, wastewaters (combined tailing slurry), reclaim water and underground mine discharge water, and the water management of infrastructures such as access roads, camps/mill pads, landfill and landfarm (channels, culverts, sumps, natural depressions) to be included in the Water Management Plan (S10j) .	S10j, Sec 1.0 (updates & communication) S10j Sec 3.0 (Freshwater) S10j Sec 3.2, (underground) S10j Sec 4.0 (reclaim) S10j sec 6.0, fig 6.1 (infrastructure) S10j Sec 8.0 (tailings) S10j Sec 7.0 (sewage)	Text revised
2.	Discussions formulated on storm water management, grey water management, and the management for snow melt and storm water collected with in fuel containment are not detailed sufficiently. The NWB invites MHL to appropriately reference where this information may be found if it is present in another document. The NWB requests further details, including but not limited to, water quantity and quality, operations strategies and practices. The submitted Water Management Plan uses infrastructure water management for the Tail Lake, and water flow management for storm water, grey water and snow melt. However, it fails to identify all the components of the water management system and address each of them clearly. MHL may find it of use to provide this information (in reasonable detail) in a framework as follows: Objective: Minimize the impacts on the receiving waters quantity and quality Report Content Sources -- Site structures Pathways -- Water flows Sinks -- Water basins (receiving waters) Report Format Description -- Site descriptor Visualization -- Map delineation Detail discussion -- Major concerns Brief discussion -- Minor concerns MHL is also invited to provide sufficient detail in how the construction and operation phases have been considered in site water management.	Supporting Document S10j, Section 1.0 (cross references) Supporting Document S10j, Section 6.0 (stormwater) Supporting Document S10j, Section (fuel transfer, tank farm, landfarm) Supporting Document S10j, Section Sec 7.0 (sewage)	Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
3.	The design and operation of the waste water treatment plant was not provided in this report. MHL is invited to appropriately reference where within the application detailed discussion and sufficient specifics to wastewater treatment may be found if they have been provided. The effluent waters and sludge waste from this process may impact water quality on site. The NWB requests a complete design and detailed operations of waste water treatment and sludge management proposed for the Doris North mine site.	Supporting Document S10j, Section 7.0 (sewage) Revised Water License Application Support Document, Section 2.4.12	Text revised
4.	Additional detail and delineation of the water courses on a site map with an appropriate scale that adequately connects and interlinks sources and receptors drainage (including, but not limited to, water intake, reclaim water, and drainage) is requested of MHL.	Supporting Document S10j, Figure 6.1	Figure added
5.	Both the effluent and sludge of the sewage treatment will be discharged to the Tail Lake (Section 3, Page 1). Does MHL believe that this is an acceptable sludge management strategy? How will sludge be managed during mine construction, operation, and post-operation stages?	Supporting Document S10j, Section 7.0	Text revised
6.	Appropriate referencing and connecting to other application reports is requested for the following sections: Modular sewage treatment plant and modular packaged biological treatment (plant) (Section 3, Page 1) • Filtration system for removing hydrocarbons of surface run-off from work area of the fuel transfer station and the fuel tank farm facility (Section 4, Page 1 and 2)	Supporting Document S10j, Section 6.2 (reference) Supporting Document S10j, Section 7.0 (section includes information on plant) Revised Water License Application	Text revised
6.contd	"Monitoring results to date suggest that significant changes in the background water quality in Doris Creek occur over periods of weeks rather than days" (Section 3.1, Page 2).	Supporting Document S10j, Section 9.0	Text revised
6.contd	Active discharge period (Section 3.1, Page 2).	Revised Water License Application Document, Section 3.6.5 Supporting Document S10j, Section 9.3	Text revised
6.contd	Documented internal quality control program (Section 3.2.3.1, Page 5).	Supporting Document S10j, Section 9.6.7	Reference added
6.contd	Other key parameters for the calculation of the ADV (Section 3.2.7, Page 8).	Supporting Document S10j, Section 9.3	Reference added
6.contd	The approximate discharge location in Dwg G-02 (SRK 2006a) (Section 3.2.8, Page 8), and what is SRK 2006a?	Supporting Document S4 Dwgs G-02 and	Text revised
7.	Tail Lake water management included the option of phosphorous/nutrient addition and erosion control measures. What are the decision criteria details and quantitative benchmark that will be used to assess when phosphorous addition and erosion control will be implemented? What are the details of these operations?	Addition of nutrients not proposed Supporting Document S10j, Section 9.4 (erosion control)	Text revised
S10k- QA/QC Plan			
1.	It is stated that the procedures are applied to water samples for both the purposes of regulatory compliance monitoring and due diligence (Page 1). However, Section 2.2 (Sampling Locations and Frequency, Page 3) only addresses the Surveillance Network Program (SNP) sampling stations. MHL is requested to provide additional information on the water sampling locations for the purpose of due diligence.	Supporting Document S10k, Section 2.1 Supporting Document S10k, Section 2.2	Text revised Reference added
2.	The Plan provides two tables showing the sample containers for each analysis Table 1, Page 4) and sample preservation (Table 2, Page 7). The parameters to be measured may be inconsistent with the parameters to be analyzed and stated in the Water Management Plan S10j (Table 1 3.1, Page 6). The NWB requests clarity and discussion on this issue.	Supporting Document S10k	Table revised
3.	The Plan is for water sampling protocol only and does not include on-site laboratory QA/QC protocol. Does MHL agree that the document title should be changed to reflect that it is only for water sampling only?	Supporting Document S10k, Section 4.0	Text revised, PC condition 9, lab QC protocols
4.	What standard methods are being used to complete the desired water quality testing?	Supporting Document S10k, Section 4.0	Reference added

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
5.	Are standard methods being employed for sample collection? If so, what method? What is the rational and impact for not filtering water samples on site before submission to the laboratory for analysis? What is the approximate expected holding time between sample collection and sample testing, and how does this holding time impact the measured results?	Supporting Document S10k Sections 2.7, 2.8, 2.9 and 2.10 (method) S10k Section 2.11 (holding time) S10k Section 2.10 (filtering) S10k Appendix A (filtering)	Text revised, Reference added
S10l- Mine Closure and Reclamation Plan			
	As detailed in the introduction in this letter document, MHBL has not provided the appropriate referencing needed to review individual reports as stand alone. At this time the NWB advises MHBL to include closure and reclamation elements identified in other sections in this letter if they are not present in the Mine Closure and Reclamation Plan (S10l) or to point the Reader/Reviewer to another document in the application through proper referencing. The NWB can not give global guidance on the Mine Closure and Reclamation Plan (S10l) until this referencing has been provided by MHBL. The following issues related to S10l are to be addressed by MHBL:	Supporting Document S10l, Section 1.4	Cross references added
1.	Section 3.1.7 (S10l) – Geochemistry: MHBL states that samples of rock from the Doris North deposit as well as from adjacent areas around the mineralized zone were tested by ABA analysis. It is stated that results of this testing as well as ABA testing on mill tailings material indicate that the majority of the mine waste has a low acid generating potential. MHBL is proposing to use rock from four quarries for use in construction of surface infrastructure such as building pads laydown areas, and roads; the Plan states tests on the proposed quarry material <i>“is not likely to be acid generating or a source of metal leaching”</i> . However, the Plan does not document nor reference another document that includes the potential	Supporting Document S10l, Section 3.1.7	Cross references added
2.	Section 4.4 (S10l) – Waste Rock Management The Plan states that waste rock will be placed into a temporary stockpile located on surface and then returned into the underground mine as backfill during the mine life. Depending on the reactivity of the waste rock and length of time stored on surface, pockets of waste rock with elevated temperatures could develop and potentially lead to localized thawing of the permafrost surrounding the underground workings. This material, if placed near the active surface layer, could lead to localized settlement and potential development of sinkholes. Has MHBL given consideration to the above? The NWB requests that MHBL formally comment to the above and also provide any required references in their revision under this part interlinking waste rock management to S10l .	Supporting Document S10l, Section 4.4	Text revised Cross reference added

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
3.	Section 6.1.7 (S10I) – Tailings Containment Area: The final closure for the Tail Lake tailings impoundment is a permanent water cover of 4.0 m above the highest tailings elevation in the impoundment. S10I states the following: <i>"Research has shown that a minimum stagnant water cover of 0.3 m is sufficient to prevent oxidization of tailings. Tailings, however, can be resuspended due to wave action induced by environmental factors, and therefore the rule of thumb is to design a water cover of at least 1.0 m thick. Based on the orientation of Tail Lake, the predominant wind direction, maximum wind speeds, and the particle size of the tailings, using the most conservative calculation method, and the worst case input variables, the maximum water cover would have to be 3.6 m."</i> S10I does not document nor reference another document that describes the method or inputs for calculating the minimum required water cover. In short, the inputs nor methods utilized for developing the Tail Lake tailings impoundment water balance is not included in S10I. An insufficient quality of water discharging from Tail Lake over the short, medium, and long term. The NWB in reference all the information in the application that will assist a Reader/Reviewer in understanding alone presentation.	Supporting Document S10I, Section 6.1.7	Cross reference added
4.	Section 6.1.7 (S10I) – Tailings Containment Area In S10I MHL states the tailings surface is expected to be below 24.3 m and thus, the minimum final water elevation in Tail Lake must be at 28.3 m. This corresponds to the pre-mining elevation of Tail Lake. S10I states that once the water quality in Tail Lake returns to background concentrations, the North Dam can be breached to allow Tail Lake to return to its pre-mining elevation. Section 3.1.1 of S10I (Climate and Air Quality) states the mean annual precipitation ranges from 94 to 207.3 mm while the annual lake evaporation is estimated to be 220 mm; based on this information, the site experiences a moisture deficit on an annual basis. This brings into the question the sustainability of the elevation of Tail Lake remaining at 28.3 m over the long term; saying this, however, the inflow to Tail Lake from the upstream catchment may be sufficient to maintain this elevation on an annual basis. However, insufficient information and references are provided in S10I regarding the hydrology of the site. Has MHL given consideration to the above? The NWB appropriately reference all the information in the application that will assist a Reader/Reviewer in	Supporting Document S10I, Section 6.1.7	Cross reference added Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
5.	Section 6.1.7 (S10I) – Tailings Containment Area: Section 4.1 (Project Summary) of S10I states the following: <i>"Tailings deposition will be sub-aqueous, requiring the construction of two water retaining structures: the North and South Dams. The tailings will be contained in Tail Lake by constructing a low permeability frozen core dam across the outlet of Tail Lake to the north and by a similar second dam constructed across a topographic low point at the south end of the lake."</i> No additional information is included in S10I regarding the design of the proposed South and North Dam. The final heights of tailings and water that will remain behind the North Dam are not documented in S10I nor referenced to a document with this information. In short, there is insufficient information to determine if the proposed North Dam will remain in a stable condition over the long term. MHBL states that the North Dam will be breached by the end of the ninth year following the cessation of mining; however, no details are provided on the actual undertaking of the breach and potential impacts this may have on the long-term stability of the tailings impoundment. The NWB also invites MHBL to appropriately reference all the information in the application that will assist a Reader/Reviewer in understanding the above through stand alone presentation.	Supporting Document S10I, Section 6.1.7	Cross reference added Text revised
6.	Section 6.1.7 (S10I) – Tailings Containment Area: S10I states the following: <i>"Predictive water quality modeling conducted in support of the Doris North environmental impact assessment process suggests that no further water treatment of the tailings containment area supernatant will be required in the post closure time period. The modeling suggests that natural processes (volatilization and dilution with snow melt and precipitation runoff) will within a short time period (three years) following the cessation of mining, allow for the unrestricted volume release of supernatant from the tailings containment area while still meeting water quality objectives in the Doris outflow watershed below Tail Lake."</i> S10I does not include nor reference other documents containing a description of the numerical model and inputs used as well as the actual model predictions. It is difficult to determine whether the proposed closure and reclamation plans for the Tail Lake tailings impoundment are technically feasible without reviewing and confirming the technical soundness of the predictive water quality modeling program. Thus an appropriate reference should be provided by MHBL. The NWB also invites MHBL to appropriately reference all the information in the application that will assist a Reader/Reviewer in understanding the above through stand alone presentation.	Supporting Document S10I, Section 6.1.7	Cross reference added Text revised
7.	Section 7.5 (S10I) – Mine Waste and the Tail Lake Tailings Containment Area: S10I states the following: <i>"Water level modeling has been conducted to verify that the water cover can be maintained even following successive dry years."</i> S10I does not include nor reference other documents containing a description of the numerical or analytical model and inputs used as well as the actual model predictions. It is difficult to determine whether the proposed closure and reclamation plans for the Tail Lake tailings impoundment are technically feasible without reviewing and confirming the technical soundness of the predictive water level modeling program. Thus an appropriate reference should be provided by MHBL. The NWB also invites MHBL to appropriately reference all the information in the application that will assist a Reader/Reviewer in understanding the above through stand alone presentation.	Supporting Document S10I, Section 7.5	Cross reference added Text revised

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
8.	Section 7.5 (S10I) – Mine Waste and the Tail Lake Tailings Containment Area: S10I states the following: <i>"It is assumed that pore water within the tailings will in time be similar to the overlying lake water due to the relatively shallow depth of stored tailings and water within the lake. A small volume of seepage may emanate from the Tail Lake tailings containment area, affecting shallow groundwater quality in the active layer in the immediate area. The effects will be localized to the Tail Lake outflow channel area and should in time be similar in quality to water draining through the spillway in the North Dam."</i> The "assumption" that pore water within the tailings will in time be similar to the overlying lake water may or may not be reasonable. Insufficient information and references are included in S10I to back up this assumption. S10I does not include nor reference other documents containing a description of the numerical model and inputs used for predicting the volume of seepage that may emanate from the Tail Lake tailings impoundment. The predicted seepage rates through and under the North Dam are also invites MHL to appropriately reference all the information in the application that will assist understanding the above through stand alone presentation.	Supporting Document S10I, Section 7.5	Cross reference added Text revised
9.	Section 7.6.5 (S10I) – Water Quality and Aquatic Resources: S10I states the following: <i>"Predictive water quality modeling was conducted to predict how the project would affect water quality in the downstream aquatic environment during the mine's operating life. Metal leaching from the tailings has been tested and the data suggests that the tailings left in Tail Lake will not significantly contribute additional metal loadings into the Doris outflow and Little Roberts Lake watersheds in the post-closure period."</i> As stated previously, the Plan does not include nor reference other documents containing a description of the numerical model and inputs used for predicting the post-closure quality of water in Tail Lake and downstream receptors. The NWB invites MHL to appropriately reference all the information in the application that will assist a Reader/Reviewer in understanding the above through stand alone presentation.	Supporting Document S10I, Section 7.6.5	Cross reference added
	S10m- Monitoring and Follow-up Plan		

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
	The NWB understands that the Monitoring and Follow-Up Plan (S10m) is a summary document that consolidates the monitoring commitments associated with various structures and operation components of the mine. A summary table of monitoring commitments has been provided and is a useful reference tool. The level of detail provided for monitoring requirements and location is minimal. Details pertaining to specific structures and operation components are provided in individual reports (when available). The monitoring programs that are described in depth outside of report S10m include: noise monitoring, hydrology monitoring, site water quality monitoring, waste rock characterization, and aquatic effects monitoring. Appropriate cross-referencing between the detailed report and the monitoring plan is requested. Some of the structures or operations that require monitoring do not have a separate detailed report. Thus, the monitoring and follow-up plan is the sole location for any details to be provided. The monitoring programs that are solely described in report S10m include: air quality and climate monitoring, tailings geotechnical monitoring, fish monitoring, vegetation and soil quality monitoring. It is requested that this summary table be updated to include all and any monitoring undertaken on site with appropriate cross-referencing, where applicable, to the individual section	Supporting Document S10m, throughout	Text revised
	S11- Site-Specific Water Quality Objective for Copper		
1.	Why was a site specific water quality study only completed for copper? The NWB requests detailed discussion from MHBL on this issue.	Section removed from document	Section removed from document
2.	Section 1.1 (S11) - What is the source of the data contained in the table? Appropriate referencing is requested.	Section removed from document	Section removed from document
3.	Section 1.3 (S11) - What are the aquatic organisms tested in the USEPA biotic ligand models (BLMs)? Are the applications calibrated to suit the northern regions and northern aquatic organisms? The NWB requests detailed discussion from MHBL on these issues.	Section removed from document	Section removed from document
4.	Section 1.3 (S11) – MHBL states that the BLM can be run in either “toxicity” or “speciation” mode. With regard to the outputs (LC50) of each mode what are the main identifiable differences? How will a difference be dealt with? How will a site-specific water quality objective be developed?	Section removed from document	Section removed from document
5.	Section 2.1 and Section 3.1.1 (S11) - A post-baseline monitoring program was conducted from 2004 to 2006, and the NWB understands that up-to-date monitoring results were not used in the report. Further, in Section 5.0 the report states that if new information is discovered in future work, Golder Associates Ltd should be requested to re-evaluate conclusions. Did MHBL use up to date monitoring results in the report? If not the NWB would like to understand why MHBL did not update the report with data obtained during the post-baseline monitoring program?	Section removed from document	Section removed from document
6.	Section 2.2 (S11) - There may be duplication in operation between Step 2 and Step 3 of the sensitivity analysis presented. Can MHBL please outline the main differences between Step 2 and Step 3 (line 12 to 16) for purposes of adding to the application record?	Section removed from document	Section removed from document
7.	Section 2.2 (S11) - Both the speciation mode and toxicity mode are considered in the sensitivity analysis. Can MHBL please outline which tables or figures show the results of each running mode?	Section removed from document	Section removed from document

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
8.	Section 2.3 (S11) – Tables 1 to 4 provide results of sensitivity analyses to assess the impact of DOC, temperature, pH, and select inorganic water constituents on LA_{50} . The NWB understands that the value for LA_{50} was consistently 0.041 nmol/g wet for each model simulation, regardless of model input values. Are the LA_{50} values reported in Tables 1 to 4 presented correctly? For purposes in adding to the application record, if the LA_{50} values are presented correctly in Tables 1 to 4 , additional detail is requested into how the calculated WQVs can vary for the same LA_{50} .	Section removed from document	Section removed from document
9.	Section 3.2 (S11) - A formula is provided to derive copper site-specific water quality objective using USEPA's current (2002) water hardness-based equation. Can MHL please outline parameters represented in each item of the equation?	Section removed from document	Section removed from document
	S12- Aquatic Effects Monitoring Study Plan		
	The NWB will issue additional guidelines to the AEMSP in the near future		No further guidance received from NWB

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
Additional Errata			
S5- Hydroclimatic Parameter Re-evaluation			
1.	Section 3.6.2 (S5) - Shall <i>Table 3.7</i> replace <i>Table 3.6</i> in line 7 and 20? S6- Water Quality Model	Supporting Document S5, Section 3.6.2	Revised
2.	Section 3.3.4 (S6) – Shall <i>Figure 3.5</i> replace <i>Figure 3.6</i> in line 6?	Supporting Document S6	Revised
3.	Section 4.3.2 (S6) - There seems to be inconsistency between tables and the text description. The water level in Tail Lake is 29.4m (Page 48) for Scenario 3 , but 29.3 m in Table 4.3 (Page 52) . The nitrite limit of CCME guideline is listed as 0.02 mg/L in Table 4.1 , but 0.018 in Table 4.2 .	Supporting Document S6	Revised
4.	Section 9 is referred to here for training details. However, according to the Table of Contents and the text, Section 10 is, in fact, headed “Training”.	Supporting Document S10a, Section 3.7	Section 3.7 now deals with training
S10j- Water Management Plan			
5.	The Table of Contents is inconsistent with the layout of the document	Supporting Document S10j	Document revised
6.	Table 3.1 notes are inconsistent with the contents of the table.	Supporting Document S10j	Document revised
7.	Section 3.1.1, Page 19- Figure 7 may contain error. The NWB is hopeful that the MHBL resubmission will provide the additional information and clarity that will allow the NWB to evaluate the qualitative and quantitative effects of the use of or deposits on waters. As outlined in the Guidelines the NWB is available to assist and provide guidance on the additional information required in each design and management plan in the Doris North submission. The NWB has arranged to meet MHBL on January 3rd, 2007 to discuss application materials with MHBL so they may provide a “pants that fit” application. MHBL shall understand that if these items are not addressed in the resubmission than there will be a requirement for another revision to the application materials	Section removed from document	Section removed from document

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
INAC			
ANNEX A			
1.	Geotechnical Characterization of Sulphide Leach Residue. Through a proposed change to the ore processing method, some tailings that are cyanide leached are proposed to be placed in the underground mine. This change in approach has not been supported in the documentation by geochemical characterization of the leach residue or a description of potential management implications.	Revised Water License Application Support Document, Section 3.4 (see results reported in Tables 3.4 and 3.5).	Additional information on geotechnical characterization of sulphide cyanide leach residue was added. Potential management implications are also presented in the same section.
2.	Adaptive Management Plan An Adaptive Management Plan to prevent and mitigate shoreline erosion was a commitment by MHBL to be provided as part of the regulatory approvals phase but has not been provided	(1) Revised Water License Application Support Document, Section 3.6.7 (2) Supporting Document S1, Section 10.5 (3) Supporting Document S1, Appendix G	(1) See Summary (2) Detail of adaptive management provided (3) Adaptive Management Plan for shoreline erosion is attached (4) Consideration of water quality impacts from shoreline erosion is presented
3.	Doris Creek Water Quality Criteria MHBL provides a general statement of their commitment to achieve Canadian Council of Ministers of the Environment (CCME) guidelines in Doris Creek but do not provide a list of specific values that would benefit a technical review.	(1) Revised Water License Application Support Document, Section 6 (2) Revised Water License Application Support Document, Tables 6.1, 6.4 and 6.5. (3) Supporting Document S6, Table 5.1, Supporting Document S10j, Section 9 and Supporting Document S10i, Section 4	(1) Additional text added (2) Specific parameters (tbl 6.1) and proposed compliance limits (tbl 6.4 & 6.5) are presented (3) Data also provided in supporting documents
4.	Doris Creek Water Quality Criteria MHBL has proposed a major change to the proposed copper criteria in Doris Creek that should be resolved immediately and, if necessary, assessed.	Revised Water License Application Support Document, Section 6, Supporting Document S10j, Section 9 and Supporting Document S10i, Section 4	Reference to a site specific copper criteria in Doris Creek has been removed (1) Revised text
5.	Water Balance / Mass Loading Model MHBL was directed by the NIRB to update the site water model with current baseline data; MHBL chose to provide a rationale as to why this was not necessary which INAC considers to be inadequate. INAC recommends that MHBL update its project's water balance / mass loading model.	Supporting Document S6, Section 3.3.3	Water Quality Model was re-run to incorporate the 2004, 2005 and 2006 baseline data
6.	Water Laboratory Quality Assurance / Quality Control (QA/QC) Plan MHBL proposes that information required for a full review of its QA/QC Plan be provided at a later date. INAC suggests the this information be addressed in the license application's technical review.	(1) Revised Water License Application Support Document, Section 4.11 (2) Supporting Document S10k	The QA/QC Plan was updated. Full QAQC data provided however additional QAQC procedures will be added as the on-site environmental laboratory is designed, staffed and commissioned in 2008. (1) See summary (2) Full plan is included
7.	Investigations for Final Design of Dams Several information items that were agreed to by MHBL as required for final dam designs have not been provided.	(1) Supporting Document S1, Section 5.3 (2) Supporting Document S1, Appendix H	(1) Geotechnical investigations conducted to provide information for the design parameters are summarized (2) SRK direct response to the additional guideline issues raised in the December 2006 letter from the NWB which includes the issue raised by the INAC review team

Table 1.2: Conformity Table

Guidelines Ref#	Additional Guidelines	Reference Document and Section	Comment
8.	Landfarm Detailed information on water balance and water release procedures are not provided.	(1) Supporting Document S10h Section 4.3 (Water Balance), Section 4.7 (performance monitoring and water release procedures). (2) Revised Water License Application Support Document, Section 6.2.3 and Supporting Document S10j, Section 6.2	(2) SRK direct response to the additional guideline issues raised in "Additional Guidelines for the Doris North Water License Application " dated December 2006 from the NWB which includes the issues raised by the INAC review team.
ANNEX C: Technical Deficiencies			
TD-1.	Water Quality Monitoring The proposed Water Quality Monitoring Program does not address all of the requirements of the NIRB Project Certificate or of INAC's recommendations to NIRB.	Supporting Document S10m, Section 5 Revised Water License Application Support Document, Section 4.13 Supporting Document S10j, Sections 6 and 9	The proposed water quality monitoring programs have been expanded.
TD-2.	Construction ML/ARD Monitoring Plan The proposed plan does not address all of the requirements of the NIRB Project Certificate or of INAC's recommendations to NIRB.	Revised Water License Application Support Document, Section 2.4.1.5 Supporting Document S7	Additional information to address NIRB Project Certificate Condition # 18 is presented
TD-3.	Operations ML/ARD Monitoring Plan The proposed plan does not address all of the requirements of the NIRB Project Certificate or of INAC's recommendations to NIRB.	Revised Water License Application Support Document, Sections 2.4.1.5, 3.3, 4.4, 4.10 and 4.13 Supporting Document S7, Section 4.3 Supporting Document S10m, Sections 5.3.2 and 7.0 Supporting Document S10d, Sections 4.2 and 7 Supporting Document S10j, Section 6.1	Additional information on operational ML/ARD Monitoring was added
DFO			
	Fisheris habitat assessment for Doris Lake pump Intake	Revised Water License Application Support Document, Section 2.4.13	Text Revised

2.0 PROJECT DESCRIPTION

Havaakhat Okaotait

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2.1 Project Phases

The Doris North Project (the Project) will consist of four distinct but contiguous phases; construction, operations, closure and post closure, with exploration activities being conducted throughout the development and operations periods. These phases are defined as follows:

- **Construction** – The period of time required to mobilize equipment and materials to the Doris North Project site once regulatory requirements have been met and a decision to proceed given by the MHBL Board of Directors; and the time required to physically construct all of the necessary facilities on surface to allow production to commence and to develop the underground workings to a point where sufficient ore can be extracted to sustain surface milling operations. It is expected
- **Operations** – The period of time required to extract and process the known ore reserves at the Doris North Project. It is expected that this phase will last approximately 24 months;
- **Closure** – The period of time after operations have ceased and while the site is being decommissioned and reclaimed. It is expected that this phase will last two years to remove the buildings and infrastructure and an additional five years until no further active management of Tail Lake discharge is required. In other words, the closure phase is expected to last seven years. The camp will be used during the initial two year period. After two years the summer management of the active Tail Lake discharge would utilize a small tent camp (two people on site for a short summer window) for five years; and
- **Post Closure** - The post closure phase starts after there is no longer an active management of the discharges from Tail Lake, and continues until post closure monitoring verifies that reclamation of the site is complete and that no further active management is required.

2.2 Project Summary

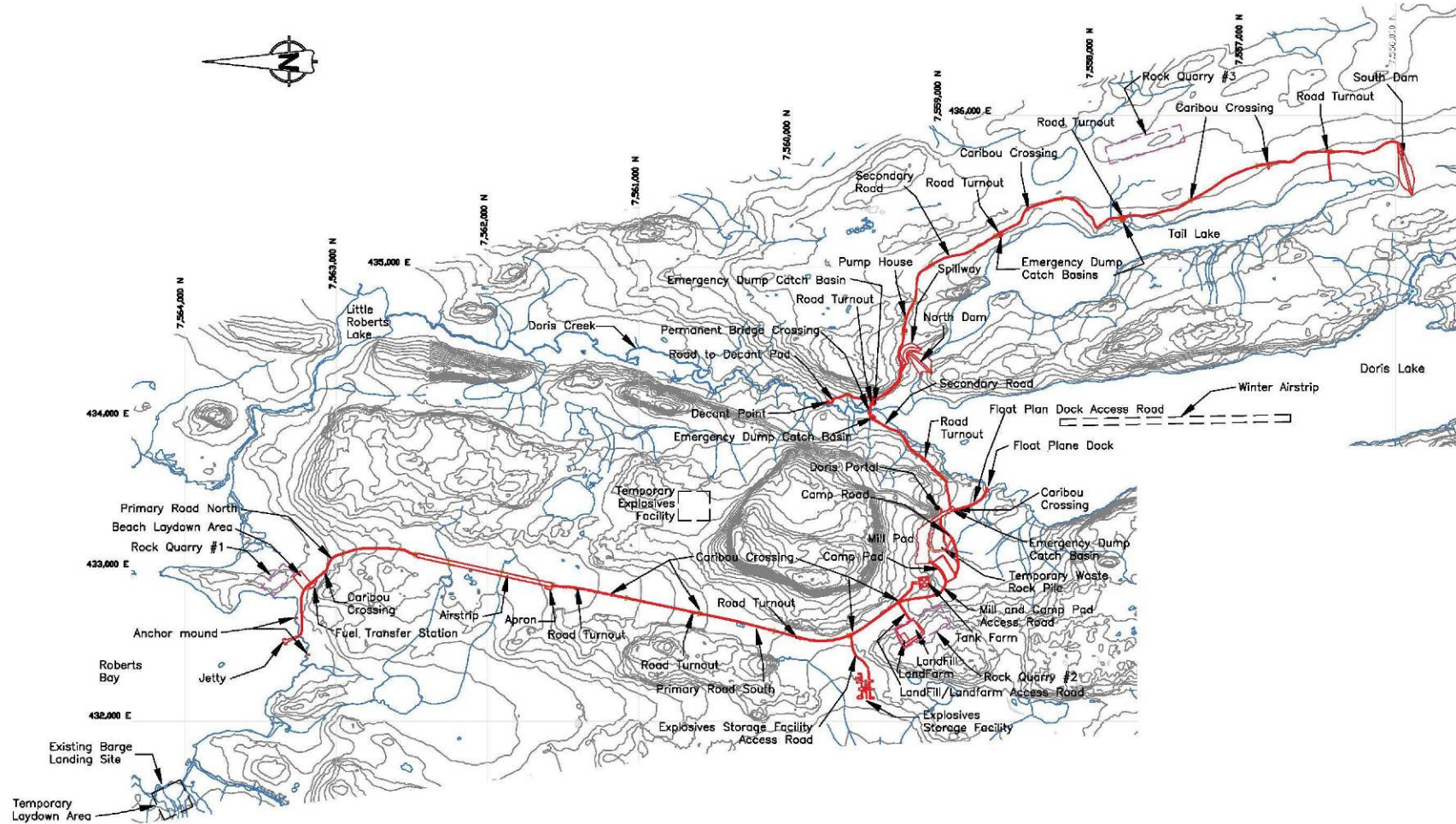
Mineral exploration on the 80 km long Hope Bay greenstone belt has been ongoing since the early 1990s. MHBL has been exploring for commercial mineral deposits in the area since 2000 when it acquired the right to conduct such exploration from BHP Minerals Ltd. Since then a number of prospective gold deposits have been found, out of which three significant mineralized areas have been identified: the Boston area, the Doris North area (includes Doris North, Doris Connector and Doris Central) and the Madrid area (includes the Naartok, Suluk and Madrid mineralized resource areas).

Exploration work conducted through 2001 indicated that the Doris North deposit had readily accessible higher ore grade resources than the Boston or Madrid mineralized areas, and thus offered MHBL an opportunity to reach commercial production at a lower capital outlay. A feasibility study was completed on developing the Doris North resource in early 2003. This feasibility study indicated that this resource could be economically developed as a low tonnage underground mine (subject of this document). This feasibility study is currently being updated by SNC-Lavalin to reflect 2007 market conditions, in preparation for an MHBL Board of Directors decision on whether to proceed to commercial production. The updated feasibility study is scheduled to be completed by mid 2007.

MHBL has continued exploration activity at other sites on the belt, with primary focus on the Boston and Madrid areas, with the objective of upgrading gold resources at the Boston and Madrid deposits to technical levels. If results are positive, the information would be incorporated into feasibility studies to be started in the second half of 2007. To date, feasibility studies on the resources at these other two areas have not been completed, and thus it is not known whether the resources identified in these areas can be commercially developed. However, MHBL is encouraged by its exploration activity at both the Madrid and Boston areas, and feels that there is good reason to be optimistic that sufficient resources will be identified at both of these sites to allow these deposits to also be brought into commercial production in the foreseeable future.

The Doris North Project will consist of an underground mine with a single adit and ramp access. The ore will be brought to surface where it will be stockpiled and processed through a crushing and milling plant with a nominal capacity of 720 t/day (design capacity of 800 TPD and an operating factor of 90%). The product will be shipped off site in the form of dore bars. This Project is expected to operate for 24 months, process 460,000 tonnes of ore yielding approximately 311,000 ounces of gold. The site is remote and there are no permanent or winter roads that link it to any neighbouring communities or facilities. Currently, there is no infrastructure development on the site, with the exception of an exploration camp on the east shore of Windy Lake, located approximately 10 km west of the project site. The primary access route to the property for fuel, equipment and supplies will be via the Arctic Ocean (sealift from Hay River using tugs and barges). The proposed mill site is located approximately 5 km from Roberts Bay. This area is accessible by ships and barges for a short ice-free shipping season. A jetty will be constructed in Roberts Bay as a landing facility for the barges. Equipment will be offloaded and stored in a lay down area close to the shore. Annual fuel supply will be trucked from the barges to a 7.5 million litre capacity tank farm constructed at the plant site. The layout of the proposed facilities is presented in Figure 2.1.

Figure 2.1: Overall Site Infrastructure Layout



A 4.8 km all-weather road will link the Roberts Bay jetty site with the mill and camp location (plant site), allowing year-round haulage of supplies from the sealift landing site laydown area. The mill, crushing plant, fuel storage tank farm, camp, offices, workshops, power generation plant, sewage treatment plant and all other operational mine infrastructure will be located in a central location adjacent to the underground mine adit. An all-weather airstrip, suitable for small aircraft, will be constructed along the alignment of the main road between the plant site and Roberts Bay. During summer months, the site will also be serviced by float planes, and for that purpose, a floating dock will be constructed at the north end of Doris Lake. This dock will be linked to the mill site with an all-weather road. During winter months, an airstrip capable of handling larger aircraft will be constructed on the ice on Doris Lake, and the site serviced from this airstrip.

Flotation tailings and treated barren bleed solution produced during the milling process will be deposited in Tail Lake about 5 km from the proposed mill location. Tailings deposition will be sub-aqueous, requiring the construction of two water retaining structures: the North and South dams. The tailings will be contained in Tail Lake by constructing a low permeability frozen core dam across the outlet of Tail Lake to the north, and by a similar second dam constructed across a topographic low point at the south end of the lake. An all-weather service road will be constructed along the east side of Tail Lake, all the way to its southern end. The tailings pipeline will follow the roadway, and emergency tailings dump ponds will be constructed at strategic locations.

A barren bleed solution from the concentrate leach circuit will be treated in a water treatment plant within the mill to destroy residual cyanide and precipitate heavy metals. This treated solution will then be mixed with flotation tailings, and discharged into Tail Lake. The water quality eventually discharged from Tail Lake will meet discharge standards established under the Metal Mining Effluent Regulation. A discharge strategy has been developed to release water from Tail Lake on an annual basis during open water periods. This water will be pumped to Doris Creek at a point immediately upstream of a 4.3 m high waterfall, where the Tail Lake water will mix with the outflow from Tail Lake. Under the discharge strategy, it is predicted that water quality within Doris Creek downstream of the waterfall will meet Federal water quality guidelines (Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life – Canadian Council of the Ministers of Environment (CCME)).

MHBL is currently scheduling the initial mobilization of construction equipment to the Doris North site across the sea ice from Cambridge Bay in April 2007. A limited program of pre-development construction is scheduled to commence in the second quarter of 2007 (pending appropriate approvals from the KIA) and will include: a) opening up the construction quarry site at Roberts Bay (Quarry 1); b) constructing the beach laydown area at Roberts Bay and the road to the jetty site, c) construction of the all weather road between Roberts Bay and the Doris North site with construction starting from Quarry 1 and 2 and stopping ~30 m back from the first ephemeral stream crossing (at the north end of the airstrip – Figure 2.1); d) construction of a containment berm to accommodate two 75,000 litre Envirotanks to provide fuel storage for this pre-development work,

erection of a temporary equipment maintenance shop (tent structure), two "weatherhaven" tents for emergency shelter and a bermed pad for the powder magazines currently located at the exploration barge offloading site on the west side of Roberts Bay; and e) construction of the Roberts Bay jetty in the summer of 2007. The fuel containment berm, the temporary explosives storage, the temporary maintenance shop and the emergency shelter tents will be constructed on widened portions of this initial section of the Roberts Bay access road that would ultimately become road turnarounds and a turn around apron on the final airstrip to keep construction within the design project footprint. For this pre-development work the construction crews will be housed at the Windy Lake exploration camp and commute on a daily basis by snow-cat and/or helicopter and/or float plane. All of the primary earthworks, with the exception of the jetty, will be constructed under winter conditions to protect the permafrost. The jetty would be constructed in the summer of 2007 (pending appropriate authorizations from INAC and DFO).

Additional construction material and supplies will be shipped to Roberts Bay in the summer sealift in 2007 to be offloaded in August and moved to the mill site early in the winter of 2007/2008. This will include the permanent accommodation camp and fuel storage tank farm. The remaining milling equipment and operating supplies would arrive on the 2008 sealift. The mill and camp pads, remaining access roads, the airstrip and the tailings containment dams and access roads will be constructed over the 2007-2008 winter (early 2008).

Mine development will start in the 3rd quarter of 2007 with the collaring of the portal. Production mining (ore) would commence in the 3rd quarter 2008 and continue through the end of 2010. Milling will start approximately one month after production mining starts (4th quarter 2008) and continue through to the end of 2010.

A construction workforce peaking at 120 will be required to carry out construction and site development work from April 2007 through October 2008. During operations, milling and processing will need a total workforce of 24 from late 2008 to the end of 2010, underground mining will require a peak workforce of 60 from the 3rd quarter of 2007 through the end of 2010, while maintenance support, catering, supervision and administration will require a total workforce of 81. Of the total operating workforce, it is expected that half would be on site at any given time. The Project is predicted to result in an increase in direct employment in Nunavut by 371 person-years, with 159 person-years of this total predicted to go to Inuit. The Project is predicted to increase total (direct plus indirect) Territorial employment by 443 person-years: 371 person-year increase in employment in the Goods Industries (the same as the direct effect), a 71 person-year increase in the Service Industries, and a 2 person-year increase in Public Administration.

The closure phase of the Project will commence after all ore has been depleted, and will consist of reclamation and decommissioning activities related to all of the facilities constituting the Project.

2.3 Proposed Construction Activity

The major proposed construction components and activities include:

- Development of a rock quarry (Quarry 1) adjacent to the new jetty at the south end of Roberts Bay;
- Construction of a 103 m long rock fill jetty into the southern end of Roberts Bay to facilitate offloading of sealift barges during construction and operations;
- Construction of a rock fill lay down area near the south end of Roberts Bay to store equipment and materials arriving at site by barge, while awaiting transfer to the Doris North Project Site;
- Construction of a diesel fuel shore manifold and delivery piping system, and a contained tank truck loading facility to be sited in a bermed facility located near Roberts Bay jetty;
- Construction of a 4.8 km long all weather access road from the south end of Roberts Bay to the Doris North Project site; the proposed road will generally follow the previous winter road alignment to the Doris North Project site;
- Construction of a 914 m long gravel airstrip runway and associated apron areas along the all weather road between Roberts Bay and the Doris North Project area;
- Construction of a rock fill pad c/w safety berm at the end of a small spur road adjacent to the all-weather road, over the ridge west of the accommodation camp, to act as the permanent explosives storage area (explosives magazine);
- Installation of pre-fabricated explosives (powder) and detonator storage magazines, and an ANFO mixing facility (sea-can containers container storage units);
- The construction of an all-weather road to the shore of Doris Lake as access to the freshwater pump intake and float plane dock;
- Development of a second rock quarry near the Doris North Project plant site to provide clean broken rock for construction of roads and building pads (Quarry 2);
- Development of a third rock quarry (Quarry 4) at the Doris North Project plant site. This quarry will provide a source of clean broken rock for use in constructing the plant side building pad. Quarry 4 is the levelling of a rock outcrop area to provide a solid bedrock foundation for the grinding circuit portion of the mill;
- Construction of a 7.5 million litre capacity fuel storage tank farm (5 x 1.5 million litre tanks) in a bermed, lined containment area at the plant site;
- Construction of rock fill pads to accommodate various infrastructure components, including the camp, mill, mine site lay down area and ore stockpiles;
- Development of the Doris North underground mine, with access via a decline ramp from surface including construction of three ventilation raises that will come to surface;
- Construction of the ore processing plant (the mill). This will be a building that will house the ore processing equipment, including a cyanide detoxification circuit;
- Installation of diesel-fuelled power generator units (powerhouse);
- Construction of a maintenance/warehouse workshop building;

- Installation of a waste oil burner unit c/w storage tank within the shop building to facilitate the disposal of waste hydrocarbons, and in the process, to generate heat for this area;
- Construction of a 175-person accommodation camp, with attached offices and change house (dry) facilities (primarily composed of modular trailer units);
- Installation of a packaged potable water treatment plant;
- Installation of a packaged primary sewage treatment plant, with the treated wastewater being pumped to the ore processing plant to be combined with the mill tailings slurry for discharge to Tail Lake;
- Installation of incinerator units to burn all kitchen and combustible waste generated by the camp;
- Construction of a floating boat and float plane dock on the northwest shore of Doris Lake;
- Construction of a potable water supply pump intake on the north end of Doris Lake and installation of a fresh water pipeline to the water treatment plant at the camp and to the mill;
- Installation of a freshwater storage tank and distribution piping adjacent to the mill;
- Construction of a rock fill all-weather road (length approximately 5.9 km) to the south end of Tail Lake, including a clear-span bridge crossing over the outlet creek from Doris Lake;
- Development of a rock quarry (Quarry 3) on the east side of Tail Lake to provide broken rock for construction of roads and the tailings dams;
- Installation of a tailings pipeline along the side of the road to the south end of Tail Lake, and the construction of four tailings pipeline dump catch basins at strategic points along the pipeline;
- Installation of a reclaim water pump in Tail Lake and a pipeline along the Tail Lake road to reclaim water back to the ore processing plant for use in milling;
- Construction of low permeability dams at the north and south ends of Tail Lake to create the tailings containment area;
- Installation of a pumping system and pipeline to manage periodic release of excess water from within the Tail Lake tailings containment area into the Doris Lake outflow creek; and
- Construction of a non-hazardous solid waste disposal site (landfill) and a landfarm facility to treat hydrocarbon contaminated soils within the quarry to be located northwest of the Doris North Project site camp (Quarry 2).

2.4 Project Components

Section 2.4 is intended to provide the reader with a summary description of each of the components that make up the Doris North Project. This is not intended to provide design details for these facilities. The reader is referred to the following sources for the design information:

- Design of the Tailings Containment Area, Doris North Project, Hope Bay, Nunavut, Canada, prepared for MHL by SRK Consulting (Canada) Inc., dated

March 2007. (Supporting Document S1 to the Revised Water License Application Support Document, April 2007)

- Design of the Surface Infrastructure Components Doris North Project, Hope Bay, Nunavut, Canada, prepared for MHL by SRK Consulting Engineers and Scientists, dated March 2007. (Supporting Document S2 to the Revised Water License Application Support Document, April 2007)
- Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, Nunavut, Canada, prepared for MHL by SRK Consulting Engineers and Scientists, dated March 2007. (Supporting Document S4 to the Revised Water License Application Support Document, April 2007)
- Technical Specifications for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, Hope Bay, Nunavut, Canada, prepared for MHL by SRK Consulting Engineers and Scientists, dated March 2007. (Supporting Document S3 to the Revised Water License Application Support Document, April 2007)

Key components of the proposed Doris North Project include:

2.4.1 Jetty

The Doris North project site is approximately 4.5 km inland from the Arctic coastline at the south end of Roberts Bay. MHL will ship supplies and equipment to site via annual sealift (barges from Hay River). To accommodate this sealift, a new jetty will be constructed on the southeastern shore of Roberts Bay.¹ The bay is relatively shallow at this location, necessitating the construction of a 103 m long jetty out into the bay to reach water deep enough for tugs and barges to safely operate. The selected design is a 103 m long, 6 m wide rock fill structure jetty, with a 25 m long mooring face. The final height of the jetty will provide 1.0 m of freeboard above the HHWL (Higher High Water Level, Large Tide).

Construction will be completed through the placement of run-of-quarry rock from the shoreline, progressively moving out. Prior to placement of the rock fill on the marine sediments, layers of geogrid will be placed to assist in providing support against foundation failure. In deeper water, rock will be placed with an extended boom excavator to allow better control over the placement of the fill on the geogrid layers.

During construction, silt curtains will be deployed around the construction zone, to prevent migration of suspended solids that may be mobilized as the rock fill is placed on the soft marine sediments. It is anticipated that the jetty will undergo settlement, and that it would require annual maintenance to ensure trafficability.

The jetty footprint will cover approximately 1,800 m² of ocean bottom. The bulk of the jetty will be constructed from run-of-mine quarry material (1,000 mm maximum size).

¹ Additional information on the proposed jetty can be found in Section 4.1, Design of the Surface Infrastructure Components, Supporting Document S2 and Drawings J-01 thru J-04, Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

The final surfacing grade above the water line will consist of 0.2 m of a surfacing grade layer (38 mm maximum size fraction) and 0.3 m of a select grade material (200 mm maximum size fraction), which would act as intermediary between the sub base and the surfacing layer. The side slopes of the jetty will be at the angle of repose for the quarry rock (approximately 40°).

The overall jetty width will be 6 m, which would allow easy and safe off loading of the 6.1 m (20 ft) long sea-can containers with forklifts and trucks; NTCL provides a Komatsu 500 loader for such purposes. The jetty will end in a widened working area, with a 25 m long mooring face. Bollards and mooring chains will be anchored into the jetty to allow securing of barges to the jetty structure. Barges will be moored end-on to the jetty due to depth limitations at the south end of Roberts Bay, and off-loading will take place via the end of the barges. In rough weather conditions, the barges may be kept in place by the tugs, or off-loading may be suspended until the weather conditions improve.

Upon closure, all bollards and mooring attachments will be removed and the jetty will be graded down so that the surface of the rockfill is below water (30 cm below the low water level, 50 cm below the mean water level).

2.4.2 Winter Ice Roads and All Weather Access Roads

In 2007, a winter road was constructed across Roberts Bay once the bay ice was thick enough to support road traffic. This road was used to transfer equipment and supplies to the Windy Lake and Boston exploration camps. After 2007, no further winter ice road construction is required to support the Doris North Project, however, winter roads from the Doris North mine site will continue to be used to resupply the two exploration camps.

The proposed Project all-weather roads² will be constructed of quarried rock, with a minimum fill thickness of 1.0 m required to cover micro-relief and protect permafrost. Wherever possible, roadways will be constructed in the winter to ensure the integrity of the permafrost. Some settlement of roads is expected, and will be addressed through an annual maintenance program.

All roadway fill will be from non-acid generating rock material from four different quarry locations (Quarry 1 thru 4). No underground waste rock will be used to construct the all weather roads, airstrip, building pads, laydown areas or other surface infrastructure components.

The road surface will be 6 m wide for the main road and 5.0 m wide for the tailings containment area access road. Side slopes will be at angle of repose. Roadway drainage will be via 0.5% surface grading in both directions from the centreline of the roadway for all roads. The pad will consist of a 0.2 m thick surfacing grade layer overlying a 0.3 m thick select grade layer. Both these will overlie a 0.5 m thick sub grade layer.

² See Section 4.2, Design of the Surface Infrastructure Components, Supporting Document S2 and Drawings S15 thru S26, Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

MHBL will install graded caribou crossings at appropriate locations along all of the proposed all-weather roads. These crossings will typically consist of a gently sloped section with fine grained crushed rock covering to allow caribou to cross the roads with low risk of injury. MHBL will work with the Kitikmeot Inuit Association (KIA), community Elders and representatives of the local hunters and trappers associations as appropriate to determine the number and location of these caribou crossings prior to the start of construction. MHBL will work with the KIA to arrange appropriate consultation and site visits with Elders from local communities and representatives of the local hunters and trappers associations before the start of the 2008 construction season to look at the proposed road alignments and presence of any indications on the ground of caribou travel routes. In consultation with the KIA, MHBL will use information obtained from these site visits together with Inuit Qaujimajatuqangit obtained from these consultations to determine where and how many caribou crossings should be installed. The final design (width, grade, capping material, etc.,) of the crossings will be verified in a similar manner.

Subject to the outcome of these consultations, caribou crossing will be provided at all road junctions, major bends and at regular intervals along stretches of road where no junctions are present. Proposed crossing locations are indicated on Figure 2.1. The caribou crossings will entail flattening of the roadway shoulder to 5H:1V for a 10 m wide section on either side of the road. This flattened section will be clad in transition zone and surfacing grade material to ensure a suitable surface for caribou to travel on.³ Roadway signposts will be installed to warn traffic of the locations of these crossings.

2.4.2.1 Main Road from Roberts Bay to Mill/Camp Site

The 4.8 km all weather road between the jetty at Roberts Bay and the mill area will follow the natural topography, which is well suited towards road construction. There are no natural obstacles, and the grades are low, suggesting few construction difficulties. Between Roberts Bay and where the road will turn southeast towards the mill, the road will be constructed towards the windward side of the valley to avoid snowdrifts that occur in the lee side of the western outcrops. Between the turn in the road and the mill, the road will follow along the northeastern edge of the valley before turning east into the mill location. There are a number of areas where culverts will have to be installed to allow seasonal runoff to continue flowing along its original routes (see Figure 2.1). None of these culvert locations are actual permanent streams, but merely topographic lows where runoff collects.⁴

The soil conditions along the route consist of open tundra underlain by thick marine silts and clays, with abundant ground ice overlying bedrock. Areas where the surface is marked by large ice-wedge polygons indicate that abundant ground ice, encountered during drilling operations, is widespread.

³ A typical plan and cross section of the caribou crossings are presented in Drawing S-10, Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

⁴ Typical culvert installation details are shown on Drawing S-11, Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

At two locations along the route, the 6 m wide road will be widened to 10 m for a distance of 30 m to form passing turnouts. These turnouts provide space for passing and turnaround of vehicles traveling along the road.⁵

2.4.2.2 Tailings Service Road

Tailings will be deposited into Tail Lake, necessitating a 5.9 km, 5.0 m wide all-weather service road. A 127 mm diameter insulated HDPE tailings feed line and a 100 mm diameter, insulated and heat traced return water pipeline will be placed on the shoulder of the road, taking up at least 1.5 m of the roadway space. The pipelines will be placed on the outside edge of the roadway, *i.e.*, closest to the Tail lake shorelines. This will minimize the number of pipe crossings required. Eight passing zones measuring 10 m wide and 30 m long will be constructed along this stretch of road to ensure safe passing of traffic. The locations of these passing zones are indicated on Figure 2.1.

The road will start at the mill and pass the portal on the south before following a northeasterly direction towards the northern end of Doris Lake. At this location a clear span bridge will be constructed to cross the Doris Lake outlet creek. The road will then turn southeast and will approximately follow the east shore of Tail Lake, always above the projected full supply elevation in Tail Lake of 33.5 m. There will be a 10 m x 10 m turning platform adjacent to the South Dam where the road ends.

This roadway has been designed to minimize the number of low-points. Since the tailings and return water pipeline follow the roadway grade, these aspects will enable the lines to be drained by gravity flow in the event of a stoppage of either pipeline. Contents of the tailings line will be collected at selected emergency dump catch basins. The return water (reclaim or recycle water) line will not be captured during these dump periods, but will be allowed to flow directly onto the Tundra to drain back into Tail Lake.

2.4.2.3 Explosives Magazine Service Road

A permanent explosives storage and mixing facility will be constructed 800 m northwest of the camp, and accessed by the main all-weather road coming from the barge landing site (Figure 2.1). The detonator magazine will be set back to ensure that it is tucked in behind a rock outcrop effectively shielding it from view to the mill and campsite. The powder magazine will be located on the same road. These roadways will be 5.1 m wide, allowing only one-way traffic to and from the main road. Sufficient turn-around room will be provided in the magazine areas to allow for safe vehicle turn around.

For the construction phase, a temporary explosives storage site will be constructed directly on the frozen tundra east of the permanent airstrip. This site will only be used in the winter of 2007/2008 and will consist of pre-fabricated magazines set directly onto the frozen tundra. No rockfill pad or road or berm will be constructed at this site, so that the site can be returned to an undisturbed condition prior to the spring melt in 2008.

⁵ Road turnout installation details are shown on Drawing S-11, Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

2.4.2.4 Doris Lake Dock Service Road

The link between the boat and float plane dock will be a 300 m long, 6 m wide all-weather road. The road will join up with the airport access and tailings service road immediately south of the portal. This roadway will also provide the bedding platform for the two 100 mm (four inch) diameter water pipelines from Doris Lake (fresh, and fire/mill water supply). These pipelines will be heat traced and insulated, and will take up at least 1.5 m of the width of the road. At the road junction, a series of culverts will be installed to allow crossing of the two fresh water pipelines, the return water pipeline and the tailings pipeline.

2.4.2.5 Tailings Decant Pipe Access Road

The decant pipe access road is located at the north end of Doris Lake, leading out from the tailings service road. This 378 m long, 5.1 m wide road segment provides access to the tailings discharge decant location immediately upstream of the waterfall in Doris Creek. This roadway will act as a bedding platform for the discharge pipeline leading from the discharge pump station.

2.4.2.6 Non-Hazardous Solid Landfill Access Road

The permanent non-hazardous solid waste disposal site will be located in the rock quarry immediately west of the camp site (Quarry 2). A 150 m long stretch of all-weather road will link the landfill with the main access road to the camp. This roadway will be 6 m wide to permit access by large equipment.

2.4.2.7 Road Usage and Maintenance

The all-weather roads⁶ will be periodically maintained using a conventional road grader using standard road grading procedures for gravel topped roads. Typically the grader will roughen up the surface of the road, re-shape the crown of the road, remove any ruts or potholes and to fill in areas of settlement. Periodically new topping gravel will be placed on the surface to fill in settlements, potholes or to re-shape the road crown, as required. Stockpiles of crushed quarried rock will be maintained in the site quarries for this purpose.

The only dust suppression agent used on these roads will be water laid down from a truck mounted tank used solely for this purpose. The truck will be filled from the fresh water supply system at the plant site. No chemical suppressants are planned for or thought necessary.

Road maintenance on the road to Roberts Bay will be required during the period of mid July through mid September, when material is being brought to site by the annual sea lift. The frequency is estimated to be once per week during this period. Road

⁶ Additional information on the proposed all weather roads can be found in Section 4, Design of the Surface Infrastructure Components, Supporting Document S2 to the Revised Water License Application Support Document, April 2007.

maintenance of the other site all-weather roads, including the road to Tail Lake, is expected to only be required monthly during the non-snow months.

During the operational period, the majority of road traffic along the all-weather access road that deal with movement of material and supplies will occur during and immediately after each annual sealift, expected to occur in mid August of each year.

2.4.3 Doris Creek Stream Crossing

Doris Creek is at least 7 m wide, under normal flow conditions, in the area where the tailings containment area access road must cross. Since Doris Creek is a fish bearing water body, and is defined as navigable water; as a consequence, the crossing will be by means of a free span bridge. A pre-fabricated modular steel bridge will be assembled on two rock fill abutments such that the minimum bridge deck height above Doris Creek will be 4.1 m. The stream bank-full width (i.e., the ordinary high water mark) of Doris Creek at the crossing location is about 15 m. This, therefore, is the minimum distance that the abutment toes can be apart.⁷

The bridge will be a modular 7.3 m wide by 32 m long steel deck bridge, with a loading capacity of up to 75 tonnes.

There are suitable founding conditions just upstream of the small set of falls in the stream. The roadway will be widened to 10 m on either side of the stream crossing, and raised to greater than 2.5 m thick for a bridge approach angle slope of less than 20H:1V (5%).

2.4.4 Diversion of Natural Drainage Paths

The Doris North Project is an underground mine, and no natural streams will be diverted to accommodate mine infrastructure. The plant and camp complex does not interfere with any natural drainage systems, other than diffuse natural runoff. Water from upslope will be naturally diverted around the pads, due to the elevated nature of the pads, whilst runoff from the pads will be collected in sumps and disposed of by pumping to the tailings containment area unless, through monitoring, it can be demonstrated that collected water is acceptable in quality for direct release onto the tundra.

MHBL will install road culverts at select locations for two reasons: (1) road culverts will be installed where there is evidence of permanent seasonal flow channels, which concentrates freshet and summer rainfall flows, and (2) to ensure that no standing water is created by the presence of the roads.⁸

⁷ Additional information on this bridge crossing can be found in Section 4.5, Design of the Surface Infrastructure Components, Supporting Document S2 and Drawings S12a and S12b, Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

⁸ Additional information on the road culverts can be found in Section 4.4, Design of the Surface Infrastructure Components, Supporting Document S2 and Drawing S-11, Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

2.4.5 All Weather and Winter Airstrips

The all-weather airstrip must meet the minimum requirements of two design aircraft: Dornier-228 and the De Havilland Twin Otter. The airstrip is to be equipped with lights for night use and with the instrumentation necessary to support IFR (Instrument Flight Rules) flights. A winter airstrip on Doris Lake will be sized to accommodate up to a Lockheed C-130/ L-100 Hercules, and is also to be equipped with lights and IFR instrumentation.

The permanent all-weather airstrip will be constructed by widening a 914 m long section of the all weather road, between the barge landing site and the mill, to 23 m. This will provide year round air access for both the Twin Otter and Dornier 228 aircraft. This airstrip is not located in an optimum location with respect to the prevailing northwest winds. However, MHBL is aware of the risks associated with this airstrip location and orientation of the airstrip.

A 40 m x 17 m apron for vehicle parking will be constructed adjacent to the southern end of the runway. This apron will also provide ample room to allow the design aircraft to turn around. Most of the preferred area for the airstrip would be on tundra, which overlies ice-rich marine clays encountered in drill holes SRK-21, -22, and -23. Thermal modeling has indicated that 2.0 m of fill should provide sufficient insulating capacity to protect permafrost beneath the airstrip.

According to the standard specifications for permanent airstrips less than 1,200 m long and intended for night time use with a non-precision approach system, lighting requirements to be installed include an approach lighting system, visual approach slope indicators, runway edge, runway threshold, runway end and obstacle lighting. MHBL estimates that during the mine life there will be on average 3 to 4 flights per week to and from the Doris North Project site.

Every year, once sufficient ice has developed on Doris Lake (approximately 1.5 m), a Hercules size airstrip (1,524 m x 30.5 m) will be constructed. The winter airstrip will also be instrumented and illuminated for IFR night operations, similar to lighting and instrumentation proposed for the permanent all-weather airstrip. Lights are to be placed every 61 m (200 ft) on either side of the airstrip.⁹

⁹ Additional information on the airstrip construction can be found in Section 4.3, Design of the Surface Infrastructure Components, Supporting Document S2 and Drawing S-03, Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

2.4.5.1 Airstrip Maintenance and De-icing

The airstrip will be periodically maintained using the same techniques as proposed for the all-weather roads. Airstrip maintenance will be required during the period of mid May through November when the ice strip on Doris Lake is not available. The frequency is estimated to be once per month during this period.

No de-icing of aircraft is planned at the Doris North site; thus, no de-icing equipment is planned. There will be no de-icing storage tank or de-icing fluids stored at the airstrip. Charter aircraft will come to site on a scheduled basis and depart soon after arriving. These flights will typically not stay overnight. Other northern mine sites typically operate without the requirement for de-icing equipment and Doris North plans to operate in a similar manner.

The only dust suppression agent used on the airstrip will be water laid down from a truck mounted tank used solely for this purpose. The truck will be filled from the fresh water supply system at the plant site. No chemical suppressants are planned for or thought necessary.

2.4.6 Underground Mine Development

Underground mining will be carried out by a combination of mechanized cut and fill and open stoping, assuming a minimum mining width of 2.5 m and external dilution averaging 17% at zero grade. Mining of the entire deposit has been planned and scheduled, all required waste and on-ore development has been laid out, and individual stopes engineered with ore and grade release schedules. Costs and productivity estimates utilize experience from Miramar's Yellowknife operations, adjusted to site-specific conditions.

A full spectrum of mining methods was considered. One of the most important aspects to consider was control of excavation geometry, as this is a very high-grade deposit with variable and narrow geometry. Mining methods selected were open stoping (drilling with electric hydraulic jumbo drills and jacklegs) and mechanized cut and fill. Mining methods were assigned to portions of the deposit, based on shape of the mining solid and apparent vein variability defined by drilling. The selected methods are described in the following sections:

- Open stoping was chosen for all of the hinge area. It is a top-down mining method where the majority of the drilling will be done by electric-hydraulic jumbos using 4 m steel. A 3 m by 3 m pilot drift will be driven in ore, following the hanging wall near the apex of the hinge, and the ore along the sides will be slashed into the drift. Ground support will be installed, and the floor will be benched by drilling and blasting to recover all the ore.
- The design allowed for a maximum of 20% in-stope-ramp grade on the hanging wall and footwall. Where the hinge plunged more steeply than could be followed

with an in-stope-ramp at 20% grade, waste mined to maintain the 20% was included in the mining solid as internal dilution.

- Mechanized cut and fill, using development waste for fill, was chosen for the remaining portions of the deposit. This method is highly flexible and will allow for dealing with irregularities in structure or grade.

A drift is driven along the ore structure at a planned width of 2.5 m. As it is an ore extraction drift, and not a travel way, there is no legal minimum clearance required beyond the width of the equipment. Rock bolting is done along the ribs where necessary, and then a 3 m lift is slashed down from the back, either by horizontal breasting, or by using uppers. Ground support is installed in the new back and ribs, and then the broken ore is mucked out using a scoop tram.

The initial access from the haulage system to a cut and fill stope is driven at minus 15% gradient, and results in a decrease in elevation of 7.5 m. After each lift of ore is mucked out from the stope, the back of the access ramp is slashed and the broken muck is used to fill the ramp to provide level access to the stope at the elevation of the top of the next lift of fill (an increase of 3 m in elevation).

Waste rock is then placed in the stope, filling it to within 3 m of the new back, and the next lift is mined. When successive lifts have been mined to the point that the access ramp has increased in gradient to plus 15%, a new access to the ore is driven at a gradient of minus 15%. In this way, the accesses to each stope will be spaced 15 m vertically apart.

Underground mining for the Doris Hinge ore zone will commence with construction of a 4 m high by 5 m wide portal, collared at surface near the mill. It will access the northeast trending ore zone by way of a decline ramp going down to a vertical depth of approximately 36.5 m. The ramp will have a 10% slope and be approximately 900 m in length.

Initial ventilation of the ramp development will use two 45 kW (60 HP) high pressure fans with 1.2 m (48") diameter vent tubing supplying the required 21 m³/s (45,000 cfm) to four pieces of equipment: one 2-boom jumbo, one 3 m³ load hull dump (low profile underground front end loader — (LHD), one 30 tonne truck, and one utility vehicle.

When the main ramp reaches the ore body, approximately 500 m ramp length from surface, a temporary ventilation raise/escape way (Vent #1) will be driven to surface. At the top of the vent raise, a large diameter low pressure 45 kW (60 HP) main fan will be installed to force 47 m³/s (100,000 cfm) up the main ramp. The auxiliary fans used for development will then be relocated to the bottom of the vent raise.

As the ramp development reaches the northern and southern extents of the mine, two additional ventilation raises/escape way (Vent #2 and Vent #3) will be driven to surface. The temporary raise (Vent #1) will then be sealed off and the two new raises (Vent #2 and Vent #3) will each have a low pressure large diameter 45 kW (60 HP) fan mounted on top of them. The fan, which will have a total capacity of 85 m³/s (180,000 cfm), will be

adjusted to force a total of 70 m³/s (150,000 cfm) through the ramp system and up to surface, sufficient to accommodate the mobile equipment, which will be in use at that time, as required by the NWT/Nunavut Mine Safety Act and Regulations. Fresh air will be drawn off the main ramp with auxiliary fans and forced into the working stopes. This configuration will remain in place until the ore body is mined out.

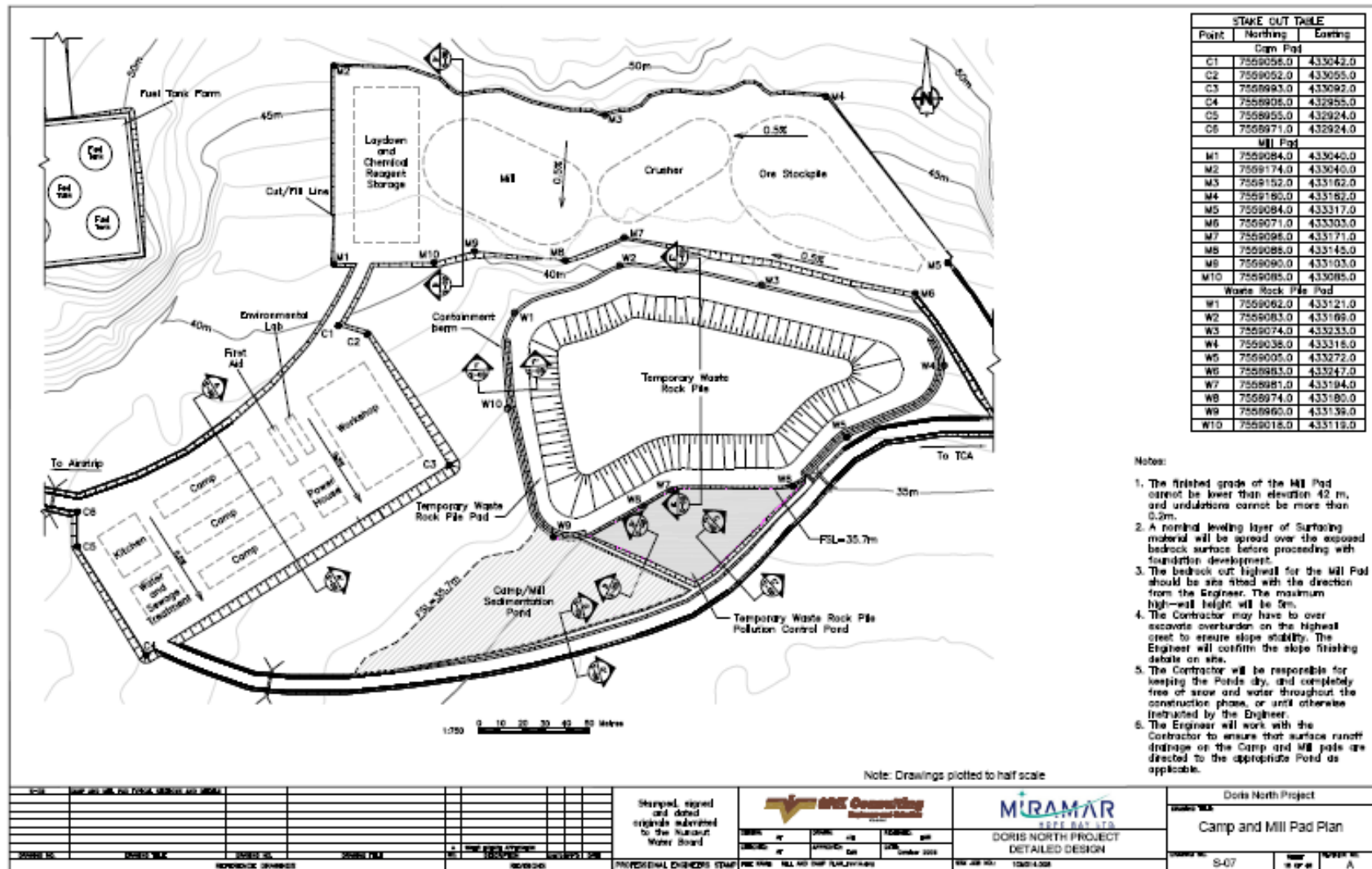
It should be noted that all of the underground workings required to mine the Doris Hinge zone will be to the north of Doris Lake; none of the mine workings will extend underneath Doris Lake. Consequently, groundwater inflow from Doris Lake is expected to be minimal. The mine workings for the Doris North Project are located within permafrost and are sufficiently distant from Doris Lake that groundwater inflow is not expected (i.e., based on geotechnical investigations conducted in 2002/2003, the talik zone caused by Doris Lake is limited to the perimeter of the lake).

2.4.7 Plant Site Facilities (Mill, Camp, Workshops)

The detailed engineering for the mill and workshop buildings is not yet complete; however the proposed layout of the facilities and the underlying rockfill pad has been engineered by SRK.¹⁰ The proposed layout of the plant site facilities is shown in Figure 2.2.

¹⁰ Details of this layout are presented in Section 4.11, Design of the Surface Infrastructure Components, Supporting Document S2 and Drawings S-07 and S-08, Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

Figure 2.2: Plan Layout of Mill/Camp Facilities



A summary of the various facilities to be constructed at the plant site is presented in the following paragraphs:

- A 1,500 m² (30 m x 50 m) workshop and storeroom (service complex) will be erected on site, immediately between the camp and the mill complex. The shop will be supplied with all tools and equipment required for service and maintenance of the underground mining equipment fleet. The shop will be linked to the mill and camp via Arctic Corridors, minimizing exposure of the workforce to the elements.

The workshop floor will be a concrete bunded structure, with selected sumps to collect any spillage or wash water. Mining equipment and other surface and underground vehicles will be washed prior to maintenance in a dedicated wash bay to be located in the surface service maintenance shop. Wash water for this activity will come from the site's fresh water supply tank. The wash bay will be equipped with a sump to collect the dirty water from the vehicle washing activity. The sump will be equipped with a divider to allow light hydrocarbons to be collected from the surface using oil adsorbent materials. There will be provision to remove the mud through conventional settling, which will be sent to the mill tailing pump box for co-disposal with the tailings solids. The wash bay system will contain equipment to allow heavier hydrocarbons to be removed from the wastewater using cyclone action, and to facilitate some recycle of the wash water.

Due to the presence of permafrost, it is not planned to wash any equipment within the underground mine workings. This equipment will be brought to surface as required for washing and major maintenance.

- Mill reagents will be shipped and stored in 6.1 m x 2.4 m sea-can containers. A storage area will be provided immediately adjacent the mill for storing 20 containers, single stacked, 2 m apart. The mill reagent storage area has been sized based on the number of containers required to supply the mill for one year.
- An additional lay-down area for equipment and supplies will be constructed on the mill pad.
- A conventional 175-person capacity camp will be constructed at the Doris North Project site, consisting of modular skid mounted units linked together by use of Arctic Corridors. The kitchen and recreation facilities will be contained within additional skid mounted modular units joined to the rest of the camp via the Arctic Corridor. The first aid station will be located in a separate modular unit connected to the rest of the facilities by an Arctic Corridor. The camp will be located west of the mill complex, with access for workers provided via Arctic Corridors. Where bedrock is not present, the modular camp units will be placed on 2.0 m thick rock-fill pads to protect the underlying permafrost.

- The office, dry complex and environmental laboratory will consist of two combined modular units; the environmental lab will be one unit, and the dry complex will be four combined units, and ultimately joined to the dorms via an Arctic Corridor.
- All mine power for the mill and camp pads will be generated on site using four diesel generators. The generators will be installed in a permanent building. Remote power at the tailings containment area, Roberts Bay fuel transfer station and the airstrip will be by small local portable diesel generators.
- The mill and crushing plant will be located immediately west of the portal, on exposed bedrock. The bedrock is already exposed in this area, and thus the foundation preparation will be limited to levelling of the site using precision blasting. The areas surrounding the mill and crusher complexes that are not on exposed bedrock will be levelled by infilling with run-of-mine quarry rock to form a final pad at least 2.0 m thick. This will serve to protect the underlying permafrost.

In the area between the portal and the crusher, an ore stockpile pad will be constructed with approximately 10,000 tonnes, or 15 days of mill feed. Ore will be dumped by the underground haul trucks; drawn from the surface stockpile using a front-end loader and fed into the primary crusher.

The crushing circuit will be a conventional single stage crushing plant. The crushing plant will be housed within a building.

The milling equipment will be housed in a building constructed on concrete footings founding on bedrock. The floor in the ore processing plant will be concrete, with concrete sumps designed to contain and facilitate recovery of spilled process material. Where practical, the milling equipment will arrive on site as a number of modular prefabricated ore processing units mounted on skids that will be shipped to site completely pre-piped and electrically wired. The units will be assembled inside the mill building and interconnected. However, the larger pieces of milling equipment, such as the grinding mills and the larger tanks, will have to be erected on site on concrete footings using conventional construction techniques.

The mill will be equipped with sumps designed to hold spillage equivalent to a minimum of 110% of the volume of the largest tank or vessel within that circuit. The mill will be arranged so that spillage is segregated by circuit (i.e., spillage from the cyanide leach circuit will be kept apart from spillage from the flotation circuit so that cyanide solution does not contaminate the flotation process, thereby interfering with gold recovery and potentially by-passing the cyanide detoxification circuit). The individual sumps will be equipped with pumps designed to recover spillage for return to the appropriate circuits. These sumps will be concrete lined to prevent release of solution and slurry into the underlying rock fill pads and ground.

- During mine development, a peak of 137,041 tonnes of waste rock will require temporary storage, prior to being returned underground. In all, waste rock storage space will only be required for a period of 32 months. The temporary waste rock pile will be constructed upslope of the ore stockpile and east of the mill. The pile will be situated on a 1 m thick pad constructed from clean quarry rock placed directly onto the tundra. This pad will be completely banded, allowing for full containment of on-pad surface water. A HDPE lined storm water collection pond (Temporary Waste Rock Pollution Control Pond) will be constructed on the low point of the pad, sized to contain the 1:100 year, 24-hour duration storm event (assuming a 6-hour pumping cycle). All water contained in this pond is considered contaminated and will be pumped to Tail Lake via the mill circuit. The waste rock pile will be constructed in five lifts, each 5 m high. Secondary lifts will be benched in 10 m for stability and access. Pile side slopes will be angle of repose.

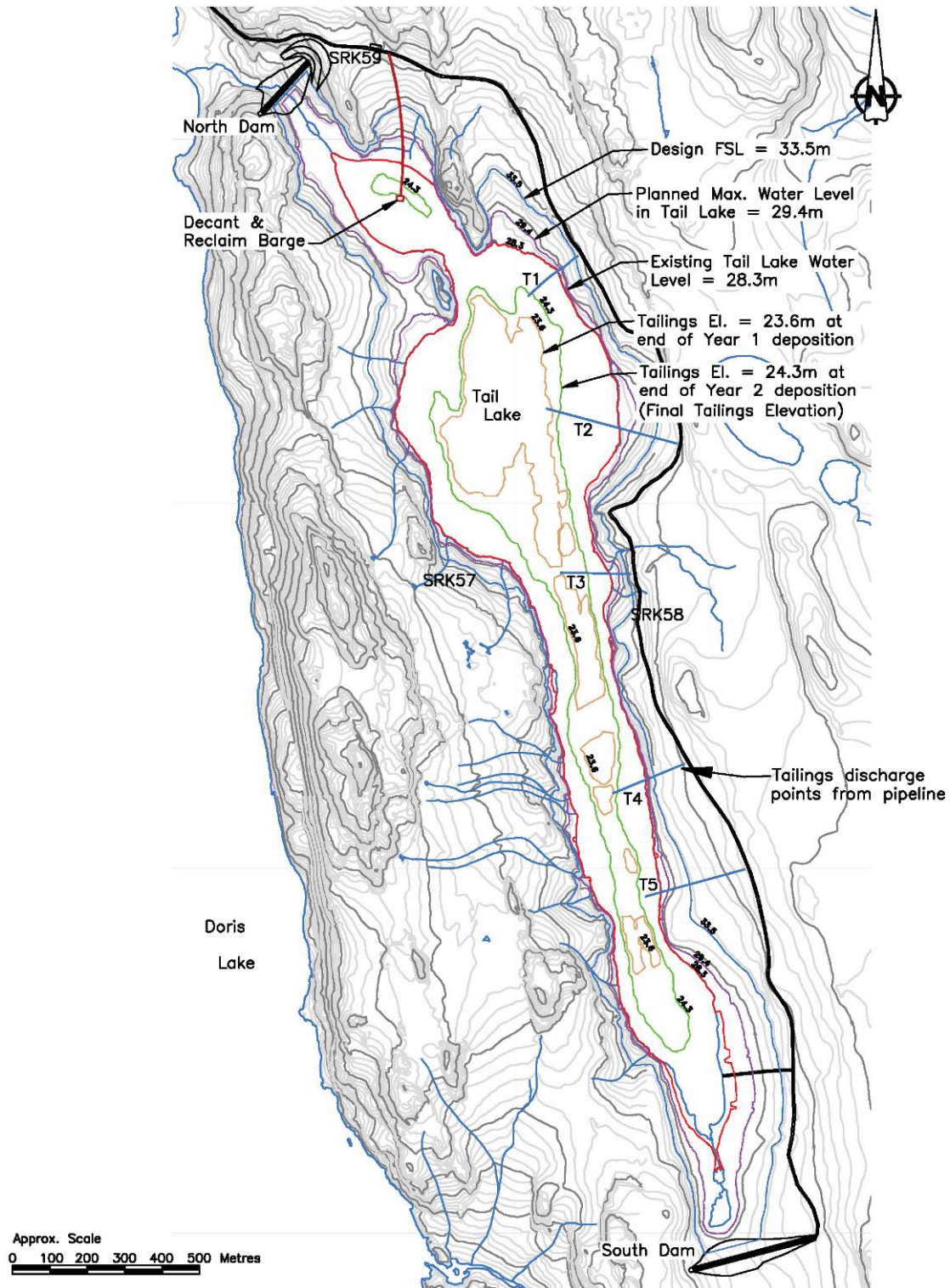
2.4.8 Construction of Tailings Containment Area (Tail Lake)

Flotation tailings and a small volume of treated barren bleed solution produced during the milling process will be deposited in Tail Lake, located about 5 km from the proposed mill location (see Figure 2.3). Tailings deposition will be sub-aqueous, requiring the construction of two water retaining structures: the North Dam and the South Dam. The North Dam is designed to retain a maximum hydraulic head of 7.5 m and the South Dam 2.0 m.¹¹

The TCA is sized to operate as a zero discharge facility during the two years of operation, if necessary; however, the proposed water management strategy is based on the annual release of supernatant from the impoundment. In addition, under the most conservative water balance assumptions, Tail Lake would take just over five years to reach the design Full Supply Level (FSL) of 33.5 m with no discharge. A permanent spillway will be constructed at this elevation, to prevent the possibility of dam overtopping.

¹¹ For design information on the tailings containment area see Design of the Tailings Containment Area, Supporting Document S1 to the Revised Water License Application Support Document, April 2007.

Figure 2.3: Site Plan of Tail Lake



2.4.8.1 Construction of Dams and Embankments

The two proposed dams will be constructed as rock fill structures, with a geosynthetic clay liner (GCL), filter and transition zones, and a frozen key trench founded on non-organic permafrost soils and/or bedrock.¹²

Passive looped thermosyphons are incorporated in the design. The purpose of the looped thermosyphons is to lower the ground temperature of the foundations to overcome the uncertainties associated with salinity and the unfrozen water content of the marine deposit. The thermosyphons will consist of passive horizontal loop evaporators that would be installed at the base of the key trench during the construction of the dams. The thermosyphons will each have a single loop evaporator that will cover half of the dam along the longitudinal axis. The looped evaporator will be offset by 1.5 m apart and will cover the entire length of the dam.

Each dam will be keyed into the foundation by clearing the organic layer and excavating a key-trench. The dam abutments will extend to bedrock, which appears competent at shallow depth but have some open and contiguous discontinuities. The slope of the rock will be limited to a 1H:1V slope, thus resulting in some rock excavation. Slush grouting or similar surface treatments may be required to fill voids in fractures, and to prepare the key trench. The condition of the abutments will be assessed during construction excavation.

The geometric design of the dams has been based on the results of numerous field investigations, including seven detailed geotechnical drilling programs between 2002 and 2006. A geophysical investigation was also completed in 2006. These investigations specifically targeted geotechnical and thermal information on potential dam locations and along the perimeter of Tail Lake. The subsurface investigations included the installation of temperature measuring devices (thermistors) in selected holes, to aid in the determination of temporal permafrost conditions.

Generally the ground surface is covered by tundra vegetation, intersected with clearings of exposed overburden soils and bedrock. The stratigraphy at the North dam is characterized by two distinct zones. About two-thirds of the dam longitudinal section is dominated by a frozen and saturated sand deposit with a thickness of 10 to 15 m. The remaining one-third portion is dominated by frozen marine clayey silt with a thickness reaching a maximum of about 15 m. This deposit contains excess ice. Bedrock consists of intact basalt.

The stratigraphy along the South dam alignment consists of a marine deposit comprised of marine silt and clay overlying a till deposit. The marine deposit reaches a thickness of about 20 m in the middle of the valley and gradually become thinner towards the valley sides. The fine grained marine deposit is ice-saturated and contains excess ice. Bedrock

¹² For detailed design reports for both dam structures see Design of the Tailings Containment Area, Supporting Document S1, for detailed construction specifications see Technical Specifications of Surface Infrastructure and Tailings Containment Area, Supporting Document S3 and for design drawings see Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

consists primarily of basalt along the west and central portions of the valley, and argillite near the east abutment.

Ground temperature measurements along the dam alignments indicate that permafrost is present over the entire length of the dams, with mean annual ground temperatures ranging between -9 °C and -7 °C.

Salinity measurements on pore water extracted from soil samples indicate that the frozen pore water in the marine deposit (silt and clay) is saline. The salinity measurements were similar or slightly exceeded the range for seawater.

Dam construction activities will occur during the winter months to benefit from the cold temperatures. Dam construction will be carried out by a qualified contractor under the supervision of a qualified design engineer's representative. Construction will be subject to strict quality assurance and quality control (QA/QC) procedures.

Detailed equipment to monitor the dam performance will be built-in during the construction phase, and a rigorous monitoring and reporting program will be followed through to final decommissioning of the dams.

2.4.8.2 Roads, Pipelines and Distribution Lines

Tailings will be deposited into Tail Lake, necessitating a 5.5 km, 5 m wide all-weather service road. A 127 mm diameter insulated tailings feed line and a 100 mm diameter, insulated and heat traced return water pipeline will be placed on the shoulder of the road, taking up at least 1.5 m of the roadway space. The pipelines will be placed on the outside edge of the roadway, i.e., closest to the Tail Lake shoreline. This will minimize the number of pipe crossings required.

A pump house pad will be constructed next to the tailings service road close to the North Dam (Figure 2.4). The control instrumentation for the tailings decant and reclaim system will be housed in a structure erected on this pad.

2.4.9 Fuel Storage and Handling Facilities

Every year, 7.5 million litres of diesel fuel will be shipped to Roberts Bay via sealift and pumped to a fuel truck at a contained fuel transfer station. Pumps and floating fuel hoses are supplied by the shipping company for the purpose of this fuel transfer. The fuel transfer station will be located across the all-weather access road from the lay-down area, a minimum of 100 m inshore from Roberts Bay. From the fuel transfer station, fuel will be hauled by standard fuel trucks via the all-weather access road to a permanent tank farm at the mill.

The fuel transfer station will be constructed on a HDPE lined pad with lined containment berms. The containment berms will allow for the station to retain over 110% of the capacity of the largest fuel truck at 40,000 L. Ramp accesses for the fuel trucks will be located at opposite ends of station, allowing for safe drive through access. The access ramps will be 6 m wide and graded at a 5H:1V slope.

Surface run-off from the work area of the fuel transfer station will be directed towards and collected in a sump. The sump and containment area of the fuel transfer station will have sufficient capacity to contain the 1:100 year, 24-hour duration storm event. Contaminated water from the sump will be treated through a filtration system to remove hydrocarbons before discharge onto the surrounding tundra.

The regulations governing the bulk storage of fuel in aboveground storage tanks are in the process of being upgraded. The tank farm has been designed in accordance with the principles outlined in two working documents: Environment Canada's 'Proposed Federal Petroleum Products and Allied Petroleum Products Storage Tank Systems Regulations' and the Canadian Council of Ministers of the Environment's (CCME's) 'FINAL DRAFT: Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products'.

The 7.5 million liter capacity fuel tank farm (five 1.5 million litre steel tanks, measuring 14.8 m diameter and 9.8 m high) will be constructed on a level precision blasted surface, on a partially exposed bedrock section at the mill site. Founding the tank farm on bedrock eliminates the risk of foundation settlement, which may lead to pipe rupture and fuel spills.

The tanks will be erected in an engineered containment area consisting of a HDPE lined pad having sufficient capacity to retain 100% of the volume of the largest single fuel tank (1,500 m³) plus 10% of cumulative volume of all additional tanks (600 m³). The base of the containment area will be graded to a corner sump location. Contaminated water will be treated through a filtration system to remove hydrocarbons before discharge onto the tundra. Any fuel spills will be pumped to appropriate containers.

To ensure capture of any fuel spills during transfer from tanker trucks to the storage tanks, a secondary fuel transfer station will be located inside the secondary containment berm. Ramp access for the fuel truck to the fuelling station will be located at one corner of the secondary containment berm. This ramp will be 6 m wide and will be graded at a 5H:1V slope to allow safe access for the fuel truck.

The tank farm requires a small building to house a generator and provide general storage. For these purposes, a metal sea-can container will be located immediately adjacent to the tank farm at one corner of the secondary containment berm.¹³

2.4.10 Explosives Mixing and Storage Facility

MHBL will provide permanent and temporary storage for the following annual amounts of explosives and detonators on site:

- 38,000 kg of explosives,

¹³ Additional information on the construction of the fuel storage facilities can be found in Sections 4.9 and 4.10, Design of the Surface Infrastructure Components, Supporting Document S2 and Drawings S-01, S-02, S-05 and S-06, Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

- 39,000 detonators, and
- Peak annual supply of bulk ammonium of 700,000 kg.

ANFO will be mixed on site on a batch basis by mixing bulk ammonium nitrate with diesel fuel in a prefabricated mixing plant. After mixing, ANFO will be placed into 25 kg bags and stored within the ANFO storage magazine. ANFO bags will be withdrawn on a daily basis to meet underground consumption needs. ANFO mixing will be done on a batch basis by the explosives supply contractor personnel. For design purposes, the total amount of mixed product was assumed to be 20,000 kg, which includes the weight of mixed explosives and half the weight of ammonium nitrate in the mixing plant building.

The facility layout is in accordance with Federal regulations that govern the storage and mixing of explosives. These regulations require that powder and detonators be stored in independent magazines, and that all bulk ammonium nitrate storage, explosives and detonator magazine and the mixing plant be separated by minimum distances based on the amounts that are being stored. In addition, these regulations require the explosives storage and mixing facilities to be separated by minimum distances from permanently occupied buildings and roadways. In interpreting the minimum distance requirements, it should be noted that the road between Roberts Bay and the mill site has been classified as a lightly traveled road based on the following:

- The road is used to haul goods from the annual sea-lift to the camp lay-down area (a couple of weeks every year);
- Fuel is only hauled along this road for a two week period every summer;
- The road is used to transport personnel from the airstrip to the camp (three to four scheduled flights a week);
- Explosives will be hauled to the mine along this roadway; and
- The transportation of explosives shall be in accordance with the Explosives Act.

The actual explosives and detonator magazines will be Type 4 prefabricated magazines, contained within sea-can containers. The mixing plant will also be a pre-manufactured facility contained within sea-can containers.

The permanent explosives magazines and storage areas will be placed on a 2 m thick rockfill pad, whereas the temporary explosives magazines and storage areas will be founded on ice pads and accessed by an ice road. The temporary facilities will be used during the construction phase and then decommissioned. The permanent facilities will be used during the operational phase and then be decommissioned.

The explosives magazines have to be a minimum distance away from the camp. The temporary explosives magazine layout will have a setback distance of 1,436 m from the camp, and the permanent explosives magazine layout will have a setback of 760 m from the camp. In both case, a significant rock outcrop is in the direct line of site between the explosives magazine area and the camp and other plant site buildings, providing additional safety buffering. MHBL has consulted with Natural Resources Canada over

these setback distances, and is of the opinion that they meet all appropriate guidelines and regulations.¹⁴

2.4.11 Landfill and Landfarm

All solid non-combustible, non-hazardous waste will be disposed of in a portion of the rock quarry (Quarry 2) immediately west of the camp. An area approximately 100 m x 100 m will be dedicated to landfill operations. In addition, any remaining surface area within the quarry that is not occupied by the landfarm will be used for landfill. Details regarding expected waste volumes and types to be deposited in the landfill are provided in the Landfill Management Plan.¹⁵ These estimates suggest that the total expected waste volume generated during operations will be less than 1,000 m³, and the landfill will have a capacity of at least 30,000 m³. This will provide capacity for non-hazardous demolition debris when the Doris North site is reclaimed.

The final quarry configuration will consist of a flat surface, graded in the down slope direction, adjoining a steeper angled rock surface that forms the transition to natural ground on the ridge above. Storm and melt water will be diverted away from the landfill by berms on the upslope edges of the excavation.

Annual landfill operation will involve clearing of snow prior to spring melt, placement of waste rock over the summer period, and placement of a graded cover prior to the winter period of snow accumulation. Wastes produced during the winter months will be stored temporarily in the solid waste disposal site area and relocated to its final location following snow removal.¹⁶

Upon closure, the disposal site will receive a final cover of clean rock, the surface will be re-graded to blend in with the surrounding terrain, and surface drainage will be directed away from the site.

Kitchen waste will be incinerated on a daily basis in a small diesel fuel incinerator unit to prevent food waste from becoming a wildlife attractant. A good supply of spare parts, including a spare burner unit, will be kept on site to minimize the downtime for this unit. Incinerator ash will be drummed and transferred for storage to the landfarm facility within Quarry 2. The ash will be tested, and if found to be uncontaminated, will be mixed into any soil undergoing remediation within the landfarm. Once the combined soil-ash meets all regulatory standards for soil remediation, the soil will be used on site for remediation of disturbed lands. If the ash does not meet acceptable standards, it will be placed

¹⁴ Additional information on the construction of the explosives storage and mixing facility can be found in Section 4.8, Supporting Document S2 and additional information on the operational management of explosives can be found in Supporting Document S10f to the Revised Water License Application Support Document, April 2007.

¹⁵ Landfill Management Plan, Supporting Document S10g to the Revised Water License Application Support Document, April 2007.

¹⁶ Additional information on the proposed design for the landfill facility can be found in Section 4.16, Design of the Surface Infrastructure Components, Supporting Document S2 and Drawings S-13 and S-14 in Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4, and for information on the operational management of the landfill facility see Landfill Management Plan, Supporting Document S10g to the Revised Water License Application Support Document, April 2007.

underground in an appropriate area for permanent isolation from the surface environment, where it will become encapsulated within the frozen ground upon final mine closure. Experience from the Windy Camp incinerator suggests that this ash will meet current soil standards for use in site remediation.

A small landfarm facility will be constructed inside the footprint of Quarry 2 to allow for the on-site remediation of hydrocarbon contaminated soils produced as a result of unplanned accidents on site. This landfarm will be bermed and have an underlying impervious HDPE liner. Accumulated water and snowmelt will be passed through a filter system to remove hydrocarbons, and then land applied onto the nearby tundra for adsorption into the surface layer of the tundra. Any contaminated soil that cannot be successfully remediated will be placed underground in an appropriate area for permanent isolation from the surface environment, where it will become encapsulated within the frozen ground upon final mine closure.¹⁷

Additional information on the proposed design for the Doris North landfarm facility can be found within supporting document S2 (SRK 2007b – Design of the Surface Infrastructure Components – Section 4.16 and on Drawings S-13 and S-14). Additional information on the operational management of the landfarm facility can be found within supporting document S10 – Environmental Protection Plan in a sub document entitled Landfarm Design and Management Plan (S10h).

2.4.12 Sewage Treatment Plant

In the past, sewage from mining sites was often not treated, and either released separately to the receiving environment or co-disposed in an untreated condition with the mill tailings. More recently, sewage from human activities is typically treated at northern mine sites through the use of sewage lagoons or through packaged sewage treatment plants that use biological activity to digest the sewage. This reduces its biological oxygen demand (i.e., its ability to consume oxygen).

Sewage sludges typically consume oxygen from the water column if they are placed into areas where they ultimately will end up on the bottom of a lake. In northern lakes, this can have adverse effects in lakes that are shallow and are covered by a relatively thick ice cover over an extended winter period. In these lakes, dissolved oxygen within the water column will decrease naturally over the winter months, as oxygen is used up by biological activity within the remaining unfrozen portion of the water column; however, generally sufficient oxygen remains to sustain aquatic life. Any additional oxygen consumer (such as untreated sewage sludge) can result in there being insufficient oxygen in the water column under the ice cover to sustain life within the lake, which would lead to the death of the over-wintering fish populations within these lakes.

¹⁷ Additional information on the proposed design for the landfarm facility can be found in Section 4.16, Design of the Surface Infrastructure Components, Supporting Document S2 and Drawings S-13 and S-14, Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4, for information on the operational management of the landfarm facility see Landfarm Management Plan, Supporting Document S10h to the Revised Water License Application Support Document, April 2007.

The release of sewage water and sludge into water bodies also adds nutrients to the receiving lakes which, under certain conditions, can lead to increase rates of algal growth. When the algal matter decays, oxygen is consumed within the water column, again reducing the available oxygen in the water column to sustain aquatic life.

Consequently, the release of untreated sewage wastewater and sludge into receiving water bodies can affect the ability of these water bodies to sustain aquatic life.

For the Doris North Project, MHBL is proposing to install and operate a packaged sewage treatment plant to treat all sewage and grey waters produced on site. The treated wastewater and sludge from this sewage treatment plant will then be co-disposed with the mill tailings slurry through the tailings storage facility. In this way the sewage sludge will be fully encapsulated within tailings solids and will not be available to consume oxygen in the overlying water column. The treated sewage sludge will represent less than 0.1% of the total weight of mill tailings discharged into the tailings storage facility. The treated sewage wastewater will be similarly managed by mixing it with the tailings. After mixing with the tailings, the residual oxygen demand of the treated waste water will be very small, and will not represent a concern. Water from the tailings containment area will be released to the environment (into Doris Creek) in a controlled fashion only during the open water season. The water will be discharged at a point upstream of a waterfall, where the water will be re-oxygenated through passing over the waterfall. Thus, after mixing the Doris Creek water, the oxygen demand will be further reduced and the sewage wastewater management proposed for the Doris North Project will prevent adverse effects typically associated with uncontrolled release of sewage wastewater into northern lakes and streams.

Sewage treatment will be via a modular packaged biological treatment plant that will be brought to site fully assembled within two skid mounted 12.2 m x 2.4 m containers (61 m²). The plant will have a treatment capacity of 68.6 m³/day, which is sufficient capacity for a fully manned 175-person camp.

The plant will be located down slope of the camp. The camp wastewater will be collected in a grinder pump lift station and discharged to the solids settling tank within the skid-mounted container. Clarified raw sewage overflows to the equalizing tanks that feed the extended aeration bioreactors.

Each bioreactor consists of an aerated primary side and a clarifier cone. Wastewater will enter the primary aerated side, and will be mixed with the existing water by means of an extremely efficient, fine bubble aeration system. The clarification cone separates developed solids from the treated wastewater, allowing solids to settle back into the aerated side of the tank. This action reduces the amount of total solids and improves treatment.

The ROTORDISK® sewage treatment plant is a high-efficiency packaged plant using the process of rotating biological contactors (RBCs) to remove pollutants from wastewater. ROTORDISK® employs disks made from 3/8" grid extruded medium density polyethylene material with U.V. light inhibitors. The grid pattern promotes oxygen

transfer into the wastewater and particularly into the core of the media. The assembly is specially designed to prevent anaerobic conditions from developing.

ROTORDISK® is a multi-staged, fixed steel baffle RBC that has been proven to be more efficient for the removal of carbonaceous biological oxygen demand (BOD) and nitrification than a rotating baffle and plug flow media system. This process utilizes a fixed growth bacteria process, whereby bacteria are grown on a media surface that is rotated into and out of the wastewater. The treated wastewater flows through four zones, each with a progressively higher standard of treatment. Unlike most suspended growth bioreactors, the ROTORDISK® is not prone to upsets, and can be operated with very low flows during early years of project development (construction phase). The system can be operated from zero influent to above design capacity.

Treated effluent is collected in a discharge/recycle tank for delivery into the tailings line. Final discharge is into the tailings containment area via the mill tailings pump box. Sludge will be similarly pumped via the mill tailings box into the tailings containment area.

Sewage from the construction camp will be collected and treated in the same modular sewage treatment plant set. During the construction phase of the Project, the treated wastewater from the sewage treatment plant will be pumped overland and discharged approximately 200 m to 500 m to the northwest of the camp, in a direction away from Doris Lake. The discharge technique would be similar to that used at the Windy exploration camp, where, over the past several years, the treated wastewater is pumped into a small depression on the tundra, and the flow is not directed through any existing drainage swale that could flow directly into a lake or watercourse. In this manner the treated wastewater can be distributed across the tundra avoiding direct impact on the local lakes. During the short construction phase, it may not be necessary to remove sludge from the plant; however, in the event that sludge levels rise to the point where sludge must be removed to maintain performance of the RBC treatment, then the sludge will be pumped into drums, sealed and held on site until the mill and TCA are operational. At that time the sludge will be transferred into the TCA.

Water quality performance estimates were obtained from a manufacturer of package sewage treatment plants (information provided by PJ Equipment Sales Corp). Expected average solute concentrations and annual loadings for a 175 person camp are summarized in Table 2.1. It was assumed that these loadings would report to Tail Lake continuously throughout the mill operational period, and for one year thereafter.

This wastewater stream has been incorporated into the water quality model prepared for the TCA.¹⁸

¹⁸ For additional information on how this waste water stream was incorporated into the modeling see Section 3.3.6 and for a discussion on nutrient degradation reactions considered within the Tail Lake water quality model see Section 3.5, Water Quality Model, Supporting Document S6 to the Revised Water License Application Support Document, April 2007.

Table 2.1: Summary of estimated treated sewage water quality and loadings

Parameter	Average Concentration (mg/L)	Average Loading (kg/year)
Total Ammonia	10	250
Nitrate	1.0	25
Nitrite	30	751
Aluminum	0.052	1.3
Arsenic	0.0002	0.004
Cadmium	0.0001	0.0013
Chromium	0.0025	0.063
Copper	0.0020	0.050
Iron	0.025	0.63
Lead	0.0001	0.0013
Molybdenum	0.0001	0.0013
Nickel	0.0005	0.013
Phosphorus	1.0	25
Uranium	0.0002	0.005
Zinc	0.002	0.05

2.4.13 Fresh Water Intake Facilities

During the construction phase, potable water for the construction camp will be obtained from Doris Lake using the same pumping facilities that will be in place for the operational phase. Potable water will be chlorinated and stored within the camp.

During the operational phase of the project, potable water, fire suppression water and up to 67% of the mill water will be supplied from Doris Lake. A single 100 mm diameter insulated and heat traced HDPE line will allow water to be pumped from the lake to storage tanks at the mill and camp sites.

The freshwater pump house will be located on the north shore of Doris Lake in close proximity to the proposed float plane dock. The pump intake will be a 100 mm (4 in) diameter HDPE DR17 fusion welded pipe set on the bottom of the lake, with the intake approximately 25 m from shores. The pipe will be covered in clean rockfill (transition material) to anchor it in place.¹⁹ The intake end of the pipe will be screened in accordance with the guidelines for pump intakes published by DFO (Freshwater Intake End-of-Pipe Fish Screen Guidelines, DFO 1995).

¹⁹ Additional information on the freshwater pump intake facility is in Section 4.11, Design of the Surface Infrastructure Components, Supporting Document S2 and intake design is presented in Drawings T-11 and T-12 (detail no. 7), Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

Prior to placement of the water intake line in Doris Lake, a fisheries habitat assessment will be conducted to assess the fisheries habitat quality in the area to be disturbed by the intake line and rock cover. If high quality spawning or rearing habitat is identified, the location of the water intake will be adjusted to avoid disruption of the high quality habitat.

2.4.14 Float Plane Dock

A boat and floatplane dock will be constructed in the small bay on Doris Lake immediately southeast of the mill. The dock portion will be a pre-fabricated modular unit, designed and manufactured by a specialist contractor. The modular unit can be dragged on shore during freeze-up.

The dock has been designed to allow offloading of supplies from a Twin Otter plane using a Bobcat forklift. The plane requires 7.5 m of berthing face against the dock, and a minimum water depth of 1.5 m when fully laden. Based on the most recent Doris Lake bathymetry²⁰, the dock will have to be 25 m long to ensure compliance with the design plane berthing requirements. To ensure sufficient buoyancy of the dock, as well as a safe working platform, the minimum width will be 4 m. Dock buoyancy will be provided via sealed HDPE pontoons. The dock will be held in place via six permanently installed bollards. These bollards will be imbedded in bedrock.²¹ Three sets of concrete filled bollards (two bollards per set) will be constructed along the dock to secure the dock in place. The bollards will be set into the lake bottom at a depth of approximately 5 m below the lake bottom and grouted in place using cement grout. Mooring cleats will be imbedded in the platform to provide contact points for securing float planes and watercraft.

2.4.15 Construction Rock Quarries

Geotechnical drilling undertaken during 2003 and 2006 has provided information on the foundation conditions at all proposed locations of the major surface infrastructure components. The information obtained from exploration and geotechnical drilling and thermistor installations suggests that the active layer over the permafrost is between 1.5 and 2.5 m thick. Thermal modeling suggests that to protect permafrost, the minimum pad thickness under all buildings and critical infrastructure will have to be a minimum of 2.0 m.

All of the construction rock fill will be obtained from four quarry sites located close to the major infrastructure components:

- Quarry 1 at the south end of Roberts Bay adjacent to the proposed sealift offloading jetty site;
- Quarry 2 at the Doris North Project site west of the proposed camp;

²⁰ See Appendix A, Design of the Surface Infrastructure Components, Supporting Document S2 to the Revised Water License Application Support Document, April 2007.

²¹ Complete dock design details are provided on Drawing S-09, Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

- Quarry 3 on the east side of Tail Lake close to the proposed tailings dam site; and
- Quarry 4 at the proposed plant site (this quarry is actually the leveling of an outcrop to found the mill, specifically the grinding circuit equipment).

While there will be non-acid generating rock available from the development of the underground mine, MHBL has decided not to use this material for the following reasons:

- The rate at which this non-acid generating waste will be generated by underground mining is too slow to be effective during the limited construction window. MHBL plans to construct all roads and building pads under winter conditions necessitating that a supply of non-acid generating rock be available in a timely manner to meet this schedule; and
- The amount of waste available from underground development will be small in comparison to the overall construction needs.

The quarries will be drilled and blasted in benches, and the rock will be hauled to where it will be required. The construction rock properties have been assumed to be as follows: specific gravity = 2.50, swell = 40%, load cubic metre (LCM) density = 1.79 Mg/m^3 , moisture content = 4%, reconsolidation = 50%, and the reconsolidated (excavated cubic metre (ECM)) density = 2.08 Mg/m^3 .

The quarries will be developed through conventional drill and blast techniques. The rock mass is competent, and conventional hard rock bench design parameters are envisioned, consisting of 3 to 5 m high benches blasted with 80 degree wall slopes. Bench setback will be between 3 to 5 m. These parameters will be adjusted as needed based on observed rock quality once quarry development starts.

During quarry development and operation, surface runoff (rain and snowmelt) management will consist of an upstream quarry berm to prevent runoff from outside of the quarry footprint from entering the area, as well as a downstream berm to contain surface runoff within the quarry footprint. The quarry base will have a low spot where this water can collect without affecting quarry operations. This will contain any development sediment by allowing it to settle out in a central location.

Assuming an average powder factor of 0.9 kg/bank cubic metre, 245 tonnes of ammonium nitrate (ANFO) will be required to complete the surface infrastructure construction.

The estimated quantity of quarried rock material that will be required to construct the Doris North infrastructure components as described in this application is $502,600 \text{ m}^3$ (1,044,500 dry tonnes). This includes estimated rockfill quantities for the North and South Dams required to contain Tail Lake, material to construct the fish habitat compensation structures, and material for the pro-active shoreline protection rock for Tail Lake perimeter.

A breakdown of this quarry material is presented in Table 1 of Appendix E to Supporting Document S2 - SRK 2007b – Design of the Surface Infrastructure Components. Table 1 also includes a column that identifies the most likely quarry source for each of the surface infrastructure components. Figure 2.4 presents this information in graphical form, by color coding all the surface infrastructure components according to the quarry source.

The estimated quarry rock requirement for maintenance of the surface infrastructure components over the mine life is 111,300 m³ (231,400 tonnes).²²

The additional construction rock volumes that may be required at mine closure is estimated to be 232,200 m³ (482,900 tonnes).²³

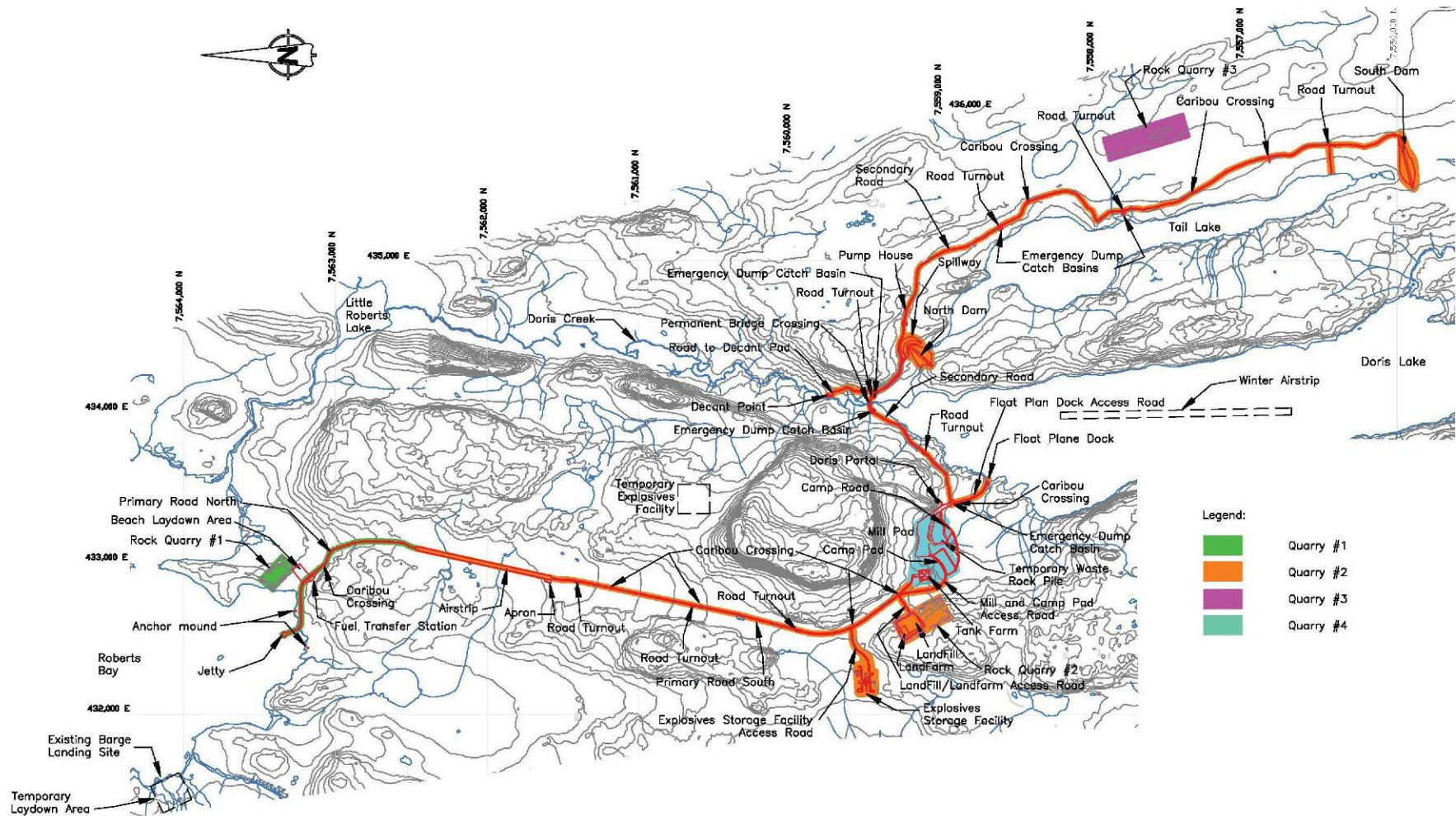
The cumulative total quarry rock volume expected to be developed from each of the four rock quarries is 846,100 m³ (1,758,800 tonnes).²⁴

²² Table 2, Appendix E, Design of the Surface Infrastructure Components, Supporting Document S2 to the Revised Water License Application Support Document, April 2007.

²³ As shown in Table 3, Appendix E, Design of the Surface Infrastructure Components, Supporting Document S2 to the Revised Water License Application Support Document, April 2007.

²⁴ As shown by quarry source in Table 4, Appendix E, Design of the Surface Infrastructure Components, Supporting Document S2 to the Revised Water License Application Support Document, April 2007.

Figure 2.4: Estimated Construction Quarry Source



Metal Leaching/Acid Rock Drainage (ML/ARD) characteristics of rock at the proposed quarry locations were the focus of a series of investigations carried out by MHBL and AMEC Earth and Environmental during 2002 through 2005. The results of these investigations were summarized in a supporting document to MHBL's Final Environmental Impact Statement for the Doris North Project (AMEC 2005). The following briefly summarizes the findings of AMEC's work and provides the rationale and context for the recent 2006 investigations carried out by MHBL and SRK Consulting (Canada) Inc. (SRK 2007f). The reader is referred to AMEC (2005) for detailed description of methods, and for results and analysis.

Evaluation of static geochemical characteristics, consisting of metal analysis and determination of ABA parameters, was carried out on samples collected during two rounds of surface grab sampling in 2002 and 2003, as well as during a round of chip sampling in 2003. Results of these analyses showed that exposed bedrock at the proposed quarry locations had neutralization potential ratios (Sobek NP:AP and carbonate NP:AP) greater than 3:1. Rock with NP:AP>3 is generally considered to be unlikely to generate acid.

Trace element leaching was evaluated by subjecting surface chip sample composites to shake flask extraction tests. Leachate from samples tested from quarries 1, 2 and 3 were alkaline (pH 8.58 to 9.52). Metal concentrations in shake flask leachate indicated that aluminum and copper leached at concentrations exceeding CCME guidelines for protection of aquatic life. However, aluminum concentrations in leachate were likely elevated due to alkaline test conditions that resulted from exposure of fresh silicate mineral surfaces by crushing and grinding during sample preparation. Under site conditions, excess alkalinity in rock contact water would be consumed by reaction with carbon dioxide in the atmosphere, a process which is incomplete under test conditions. In addition, the particle size of the samples tested was small in comparison with quarry rock. Further, as CCME guidelines are receiving environment water quality objectives, concentrations exceeding CCME guidelines in shake flask leachate indicate only potential elements of concern, and can not be taken as indicative of metal concentrations in any receiving water as a result of seepage or runoff inputs from quarry rock.

Kinetic geochemical characteristics were evaluated with three humidity cell tests (HCT) conducted on chip sample composites from quarries 1, 2 and 3. Kinetic test results showed that the three samples tested did not generate acidic conditions over the duration of testing, and that the rates of NP and AP depletion were consistent with generation of neutral to alkaline drainage in the long term.

A number of follow-up tests were carried out on HCT residues following the completion of kinetic testing to provide a better understanding of the mineralogical form of measured neutralization potential. These tests included determination of neutralization potential via a method designed to correct for NP generated by siderite (iron carbonate), determination of total inorganic carbon (TIC), and determination of mineralogy by quantitative x-ray diffraction (QXRD).

Results from the siderite-correction method of NP determination were inconclusive. Siderite was not identified in any of the HCT residues through QXRD, yet the siderite correction procedure indicated that siderite was present and represented up to a third of the measured Sobek NP. As a result, a need for further characterization of carbonate mineralogy was identified.

In the Doris North Project Certificate issued on September 15, 2006, The Nunavut Impact Review Board included Condition number 18:

- MHBL shall submit to the NWB, as part of the water license application, a program detailing the methodology for testing quarried rock for acid generation and metal leaching potential. The sampling, testing and analysis must be done by a professional geologist registered in Nunavut.

In the winter of 2006, a geotechnical drilling program was conducted at all four quarry sites to better define and characterize subsurface rock conditions (two holes per quarry site). The quarry outcrops are 15 to 20 m in height, and will not be mined below grade to prevent creating permanent ponds at closure. Given the nature of the bedrock geology in the area, it is unlikely that the rock types seen at surface will significantly change as the quarries are developed, given the relatively shallow depth of the proposed quarries (maximum of 20 m in depth). This was validated during the 2006 geotechnical drilling program.

MHBL commissioned SRK Consulting (Canada) Inc. to conduct a study on the samples derived from this drilling program, to provide the geochemical characterization required to proceed with detailed project engineering for this project. A total of 157 samples was taken from this drill program and subjected to conventional acid base accounting analysis. The data verified that the construction rock from these four quarry sites will be non-acid generating rock.²⁵ The following is a brief summary of the results.

- To improve the understanding of the ML/ARD characteristics of rock at the proposed quarry locations, supplementary laboratory and field investigations were conducted. These investigations consisted of additional analyses on the remaining residues from prior humidity cell tests, and of additional sampling of diamond drill core at each of the four proposed quarry locations. The following points summarize the conclusions from the SRK study regarding the geochemical characteristics at the four proposed quarry locations for the Doris North Project.
- Quarry rock is not potentially acid generating, based on static and kinetic test results from analysis over the period from 2002 through 2006. Diamond drilling in 2006 expanded the lateral sample coverage, and tested the vertical dimension with two drill holes at each of the proposed quarry locations. Uniform geology was intersected at each location, and geochemical parameters showed no obvious vertical patterns.

²⁵ The full study report is in Geochemical Characterization of Quarry Materials, Supporting Document S7 to the Revised Water License Application Support Document, April 2007.

- Most of the neutralization potential measured in standard acid-base account testing is in the form of calcite and dolomite (calcium and magnesium carbonates). Quantitative x-ray diffraction analysis did not identify any siderite (iron carbonate) in the three humidity cell residues tested.
- Electron microprobe analysis of carbonate grains supported the findings that calcite and dolomite were the host minerals for all inorganic carbon in the samples tested. Calcite was found to contain trace to no iron, manganese or magnesium. Dolomite was found to contain up to 0.22 mole fraction iron and manganese, with calcium and magnesium making up the balance.
- The mineralogy and carbonate speciation data show that most analytically-determined NP is hosted by calcium and magnesium carbonates. These minerals are sufficiently abundant and reactive to neutralize any acid that forms during the weathering of sulphide minerals from the proposed quarry rock fill.

Shake flask extractions, major and trace element determinations, and previous static and kinetic testwork have demonstrated that the risk of metal leaching from quarry rock and subsequent impacts on receiving waters is very low.

Monitoring of quarry rock during placement will verify the ML/ARD characteristics determined during 2006 and previous testing.²⁶ In summary, the monitoring plan will consist of visual monitoring of quarry rock by field geologists to confirm that the expected rock types are being exposed, along with sampling of placed quarry rock to verify that placed material has the expected ML/ARD characteristics.

In addition, a program of check ABA (acid base accounting) testing will be conducted on the quarried rock used in site construction to verify that all rock used is non acid generating. A target of collecting 100 samples spread equally over the approximately one million tonnes of rock to be quarried has been established for this follow-up program.

During construction, samples of quarried rockfill will be collected from the various road and pad construction sites and sent to an accredited external lab for acid base accounting analysis. The following information will be collected for each sample collected:

- Location of sample point
- GPS coordinates of sample point
- Name of quarry from which the rockfill came from
- Date rockfill was placed
- The name of the person who performed the sampling
- Date and time of sampling
- Date of analysis

²⁶ The proposed quarry rock monitoring program is summarized in Section 7.8 of this document, and in Section 7.1, Monitoring and Follow-Up Plan, Supporting Document S10m to the Revised Water License Application Support Document, April 2007.

- Name of person who performed the analysis
- Analytical method or techniques used
- Results of analysis.

The data will be cross-referenced to a site infrastructure map. The objective is to collect ~100 samples from across the site (spread to capture a representative cross-section of all rockfill used in site construction) to verify that the rock used in construction is non-acid generating.

In the unlikely event that potentially acid generating rock is identified at any of these sample locations, a more intensive sampling program will be conducted around the spot where the rock was discovered. Construction records will be checked to find any other locations where rock from that same quarry on the same date could have been placed. These will also be sampled. Any potentially acid generating rock located by this means will be tagged for removal and replacement during the next winter season. The material removed will be moved to the temporary waste rock stockpile, to ultimately be placed underground.

A seep survey will be conducted in the first spring freshet following the major earthworks construction (Spring of 2008) along the roadways and beside the pads to measure pH levels in the precipitation runoff and snowmelt that comes in contact with this rock. The pH of each seep will be measured using a field pH meter, with the following data recorded:

- Location of sample point
- GPS coordinates of sample point
- The name of the person who performed the sampling
- Date and time of sampling
- Date of analysis
- Name of person who performed the analysis
- Analytical method or techniques used
- Results of analysis.

The data will be cross-referenced to a site infrastructure map. The objective is to collect ~100 samples from across the site (spread to capture a representative cross-section of all rockfill used in site construction) to verify that the rock used in construction is non-acid generating. In any location where the field pH is measured to be below 5.0 or above 8.0, a water sample will be collected and submitted for analysis for:

- pH;
- Total Sulphate;
- Total Ammonia;
- Nitrate;
- Alkalinity; and
- Dissolved metals, including Al, As, Cd, Cu, Pb, Ni, and Zn.

Any potentially acid generating rock located by this means will be tagged for removal and replacement during the next winter season. The material removed will be moved to the temporary waste rock stockpile, to ultimately be placed underground.

This seep survey will be repeated in the Spring freshet of 2009 and 2010.

2.4.16 Concrete Production

Use of concrete during construction will be kept to a minimum due to the lack of a natural on-site source of sand and gravel aggregate from which to make concrete. All concrete aggregate will have to either be made on site through fine crushing or shipped to site in bulk bags. There will, however, be a need for concrete production for construction purposes, specifically in relation to the mill foundations and building floors. A batch concrete plant will be brought to site and erected in one of the quarry sites to make concrete as needed.

2.4.17 Construction Schedule

MHBL is currently scheduling the initial mobilization of construction equipment to the Doris North site across the sea ice from Cambridge Bay in April 2007. A limited program of pre-development construction is scheduled to commence in the second quarter of 2007 (pending appropriate approvals from the KIA, INAC and DFO).

Additional construction material and supplies will be shipped to Roberts Bay in the summer sealift in 2007 to be offloaded in August and moved to the mill site early in the winter of 2007/2008. This will include the permanent accommodation camp and fuel storage tank farm. The remaining milling equipment and operating supplies would arrive on the 2008 sealift. The mill and camp pads, remaining access roads, the airstrip and the tailings containment dams and access roads will be constructed over the 2007-2008 winter (early 2008).

Mine development will start in the 3rd quarter of 2007 with the collaring of the portal. Production mining (ore) would commence in the 3rd quarter 2008 and continue through the end of 2010. Milling will start approximately one month after production mining starts (4th quarter 2008) and continue through to the end of 2010.

3.0 OPERATIONS

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The following sections present a summary of the planned operation of the key components of the Doris North Project.

3.1 Management Structure

The proposed management structure for the Doris North Project is presented in Figure 3.1 along with the reporting relationship to the corporate office of Miramar Mining Corporation. This organizational is under review and will be adjusted as the project moves through detailed engineering and construction, and as key management staff are hired.

The organizational chart does provide the NWB with an understanding of the planned reporting relationships, including health and safety and environmental monitoring and compliance. The responsibility areas for the key management positions at the mine site are shown as follows:

Mill Superintendent

- Mill Operators
- Mill Supervision
- Mill Maintenance
- Metallurgical Performance
- Effluent Treatment
- Tailings Containment Area Management

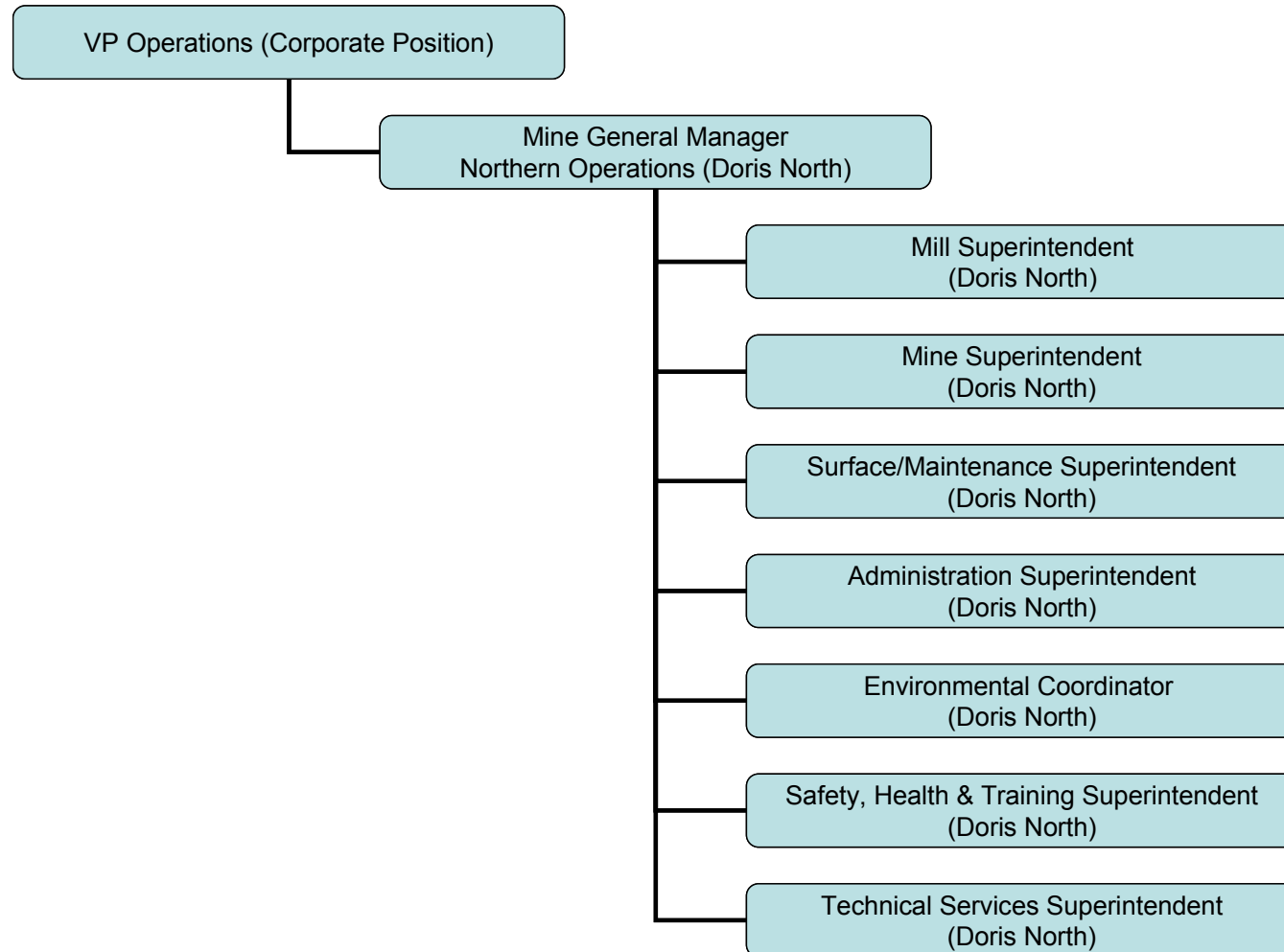
Mine Superintendent

- U/G Miners
- U/G Supervision
- U/G Mine Maintenance

Surface/Maintenance Superintendent

- Camp Maintenance
- Road & Airstrip Maintenance & Operation
- Landfill and Landfarm Operation and Maintenance
- Fuel Storage and Transfer Operations and Maintenance
- Surface Mobile Equipment Maintenance
- Barge and Aircraft Off-loading and transfer of Materials including Hazardous Materials
- Operation and Maintenance of the Potable Water Treatment System, the Sewage Treatment Plant and the Camp Kitchen Waste Incinerator

Figure 3.1: Proposed Doris North Responsibility and Accountability Chart



Administration Superintendent

- Human Resources
- Benefits
- Employee Training
- Inuit Relations
- Employee Induction
- Materials Management
- Accounting and Payroll
- Logistics and Travel
- Camp Management
- Emergency Medical Care
- Recreational Activities

Environmental Coordinator

- Implementation, Delivery and Maintenance of the Environmental Component of the Environmental, Health and Safety Management System
- Environmental Monitoring and Reporting (Internal & External)
- EPP (Environmental Protection Plan) Training and Implementation
- Internal Environmental Auditing
- Environmental Training
- Maintenance & Updating of the Environmental Protection Plan Components
- Emergency Preparedness Training

Safety, Health & Training Superintendent

- Skills Training for U/G, Mill, Site Support and Maintenance Employees
- Occupational Health and Safety Monitoring and Training
- Mine Rescue Training and Preparedness
- Surface Emergency Response Training and Preparedness
- Property Security
- Internal Safety Audits for both Operations and Exploration

Technical Services Superintendent

- Mine Planning Engineers
- Surveyors
- Geologists
- GIS Support

Ventilation Technicians

3.2 Underground Mine

Underground mining will be carried out by a combination of mechanized cut and fill and open stoping, assuming a minimum mining width of 2.5 m and external dilution averaging 17% at zero grade. Mine engineering has been well advanced. Underground mining for the Doris North ore zone will commence with construction of a 4 m high by 5 m wide portal, collared at surface near the mill. It will access the northeast trending ore zone by way of a decline ramp going down to a

vertical depth of approximately 36.5 m. The ramp will have a 10% slope and be approximately 900 m in length. The first 100 m of the ramp will have an up-grade slope to prevent surface water from draining into the underground workings.

Underground trucks will haul the ore from the underground mine to a stockpile located on surface near the mill. The mining rate will be nominally 720 tonnes per day, with 460,000 tonnes of ore being extracted over the 24-month operating life. Mining is projected to be complete in the fourth quarter of 2010.

The underground mine operations workforce is expected to consist of approximately 60 operational personnel and 15 supervision and technical personnel. The breakdown of the projected underground labour force is presented in Table 3.1.

Table 3.1: Projected Underground Workforce

Mine Operations	Owner	From Nunavut*
Miners	20	8
Raise Miner	4	
Trammer	8	4
Mucker	8	2
Truck Driver	4	4
Nipper	4	4
Timberman	2	
Mechanics	6	
Electrician	4	
Supervision/Technical Services	15	
Total	75	22

Note: * Staffing levels from Nunavut are estimates only. Actual numbers will depend upon availability of qualified personnel.

Water for drilling and dust suppression will be supplied from underground sumps. This solution will be recycled to the maximum extent practical. The underground workings are totally within permafrost, and consequently, due to the freezing conditions, a brine solution will be used for underground drilling and dust suppression. The sumps will be charged by a 50 mm (2") line from the mill. Once a sump is full, the pumping will stop and the line blown clean with compressed air to eliminate freeze-up. Potable water will be supplied in bottles.

The mine workings will be wholly within permafrost and do not encroach on the Doris Lake talik; consequently, no groundwater is expected within the mine. In the highly unlikely event that groundwater is encountered, MHLB will collect this water in internal mine sumps and transfer this water to the tailings containment area via the mill tailings pump box (an allowance for such an event has been included in the Tail Lake water quality model).

A leaky feeder system will provide communication for the entire underground mine. The system will also allow radio contact directly to the maintenance shops. A second communications line (emergency phones) will be installed directly to the underground safety station and to an

appropriate location on surface, such as the security desk, the first aid room, or the surface mine rescue station.

The major pieces of mobile equipment required for mine operations (mining and surface) will consist of:

- 2 double boom electric/hydraulic jumbo drills;
- 3 single boom electric/hydraulic jumbo drills;
- 3 3-m³ scoop trams;
- 4 1.5-m³ scoop trams;
- 2 20-tonne underground diesel haul truck;
- 2 diesel powered portable air compressor units;
- 1 scissors lift truck;
- 4 underground equipped pick up trucks;
- 1 966 Front-end loader;
- 1 road grader; and
- 1 20-person capacity minibus.

3.3 Waste Rock Management

As discussed in Section 2.4.15, MHBL does not plan to use any of the underground waste rock for construction of the site roads, building pads, laydown areas, tailings dams or other site infrastructure to ensure that only non-acid generating rock is used in such construction. While there will be non-acid generating rock available from the development of the underground mine, MHBL has decided not to use this material for the following reasons:

- The rate at which this non-acid generating waste will be generated by underground mining is too slow to be effective during the limited construction window. MHBL plans to construct all roads and building pads under winter conditions necessitating that a supply of non-acid generating rock be available in a timely manner to meet this schedule; and
- The amount of waste available from underground development will be small in comparison to the overall construction needs.

ARD/ML Characterization of Waste Rock from Underground Mine Development

The following is a brief summary of the characterization work conducted on underground waste rock to date. The reader is referred to the following sources for additional information:

- ARD and Metal Leaching Characterization Studies in 2003 – 2005 Doris North Project, Nunavut Canada, prepared for MHBL by AMEC Earth and Environmental, dated October 2005 (Supporting document B2 to the Final Environmental Impact Statement Technical Report submitted to NIRB in June 2005) – Section 2; and
- Hope Bay Joint Venture Hope Bay Project Integrated ARD Characterization Report, prepared for MHBL by Knight Piesold, dated June 2002 (Supporting Document B4 to the

Final Environmental Impact Statement Technical Report submitted to NIRB in June 2005) – Section 1 through 3; and

- Geochemical Characterization of Portal Development Rock, Doris North Project, Hope Bay, Nunavut, Canada, prepared for MHL by SRK Consulting Engineers and Scientists, dated October 2006 (Supporting Document S8 to the Water License Application) – deals with additional characterization of drill holes along the upper portion of the underground decline.

Significant test work was completed to determine the acid rock generating and metal leaching potential of the rock to be disturbed by underground mining. Almost all of the rock outside the mineralized zones has low acid generating potential, and is not expected to be a source of acid rock drainage or other metal contaminants.

Acid rock drainage (ARD) can occur when sulphide minerals in rock are exposed to air and water. It can cause environmental degradation if allowed to enter natural water bodies. Metal leaching can also occur under near neutral conditions from rock containing soluble metals. A total of 163 samples of drill core from the Doris North deposit (Hinge Zone) were tested by acid base accounting analysis.²⁷

The following criteria were used to assess ARD potential:

- **AP** – Acid Potential reported as kg of CaCO_3 equivalent per tonne of sample. AP is a measure of the maximum potential acidity that the sample can generate if all of the contained sulphide minerals oxidize and form acid. AP is a calculated value based on the total sulphur or total sulphide sulphur concentration within the sample. $\text{AP} = \text{wt\% Sulphide Sulphur} \times 31.25$. The Total Sulphur and the Sulphide Sulphur content in the sample are determined by analysis. The factor 31.25 is based on the acidity generated as derived from the general stoichiometry for the complete oxidation of pyrite and the subsequent hydrolysis of the Fe^{3+} generated. This factor, therefore, relates the total acidity produced with the equivalent alkalinity as CaCO_3 required for neutralization.
- **NP** – Neutralization Potential reported as kg of CaCO_3 equivalent per tonne of sample. NP is a measure of the neutralizing potential of the sample. NP is a measured value determined by measuring the amount of acid that the sample can neutralize under standardized laboratory conditions.
- **NNP** – Net Neutralization Potential reported as kg of CaCO_3 equivalent per tonne of sample.
- **NNP** = NP-AP. NNP is a measure of the balance between the acid generating and acid consuming potential of the sample. Typically if the NNP is greater than +20 kg CaCO_3 equivalent per tonne, then the sample is unlikely to be a net source of acid generation. Conversely, a NNP equal to zero or less indicates that the sample is likely to be a net source of acid generation. NNP values between 0 and +20 kg CaCO_3 equivalent per

²⁷ This ABA database is presented in a summary table in Appendix 4A to the October 2005 FEIS and also included as Appendix 1, Waste Rock Management Plan, Supporting Document S10d to the Revised Water License Application Support Document, April 2007.

tonne of sample indicate uncertain acid generating potential, requiring better understanding of the proportion of the neutralizing minerals that are readily available to neutralize acidity, and at what rate.

- **NPR** – Neutralization Potential Ratio. $NPR = NP/AP$. NPR is the ratio of Neutralizing Potential to Acid Generating Potential for the sample. Under Indian and Northern Affairs Canada (INAC) Guidelines²⁸, the criteria presented in Table 3.2 are suggested for the screening of the ARD potential of a sample:

Table 3.2: INAC Guidelines for Screening of ARD Potential¹

Potential for ARD	Initial Screening Criteria	Comments
Likely	$NPR < 1$	Likely ARD generating unless sulphide minerals are non-reactive
Possibly	$1 < NPR < 3$	Possibly ARD generating if NP is insufficiently reactive or is depleted at a faster rate than sulphides
Low	$NPR > 3$	Not likely to be acid generating

In Summary:

- Four of the five samples from the Mg Tholeiite rock types (altered wall rock) were classified as non-acid generating ($NPR > 3$), with one sample classified as having uncertain acid generating ($NPR = 2.4$);
- Twelve of 13 samples of Gabbro (Fe Tholeiite group) were classified as being non-acid generating ($NPR > 3$), with one sample classified as having uncertain acid generating ($NPR = 1.3$);
- All five samples of unaltered wall rock (Fe Tholeiite group) were classified as non acid generating ($NPR > 3$);
- Sixty-four of 73 samples (88%) of Mafic Volcanic rock (Fe Tholeiite group) were classified as being non-acid generating ($NPR > 3$), with the other nine samples all being classified as having uncertain acid generating ($1 < NPR < 3$);
- Twenty-five of 65 samples (38%) of mineralized or quartz vein material (Fe Tholeiite group) were classified as being non-acid generating ($NPR > 3$), 21 samples (32%) were classified as having uncertain acid generating ($NPR = 1.3$) and 19 samples (29%) were classified as likely to be acid generating ($1 < NPR$);

²⁸ Guidelines For Acid Rock Drainage in the North, Northern Mine Environmental Neutral Drainage Studies No. 1, prepared for the Department of Indian Affairs and Northern Development by Steffen, Robertson and Kirsten (B.C.) Inc. in association with B.C. Research and Development, dated September 1992

At Doris North, high or uncertain acid generating potential is associated with the mineralized quartz veining or mineralized material immediately adjacent to the quartz veining. This material is typical of ore grade, and will end up being processed through the mill if mined. The surrounding country rock is typically non-acid generating, with NPR values well in excess of 3.0. Consequently, bedrock material disturbed by development mining to reach the ore zones is likely to be non-acid generating. There is some mineralized material within the strong Dolomitic sericitic alteration zone surrounding the quartz veining that has low or uncertain acid generating potential.

Characterization of the portal development rock (rock to be encountered in developing the access ramp from surface to the ore body), based on an additional 125 samples taken from a geotechnical drilling program conducted in 2006, are presented in the SRK report "Geochemical Characterization of Portal Development Rock, dated March 2007."²⁹ This report concluded that the diabase and gabbro rock has low NP and low AP, limiting the potential for acid production (total Sulphur generally less than 0.30 wt%) and the Basalt appears to be strongly net acid consuming. In general, rock excavated for the underground access ramp outside the mineralized zone will have low acid generating potential.

Temporary Management of Waste Rock on Surface

Under the mining plan, it is expected that all development waste rock will be used internally as backfill within the mine workings. All of the underground waste rock brought to surface will be placed onto the temporary waste rock stockpile to be returned into the underground mine during the mine life.

A schedule of mine waste rock and ore production over the mine life (eight months of development and 24 months of production) is presented in Table 3.3. The table shows, on a month by month basis, the predicted tonnage of underground waste rock generated, the amount of waste rock moved from the mine to the temporary stockpile, the amount of waste rock returned into the underground mine as fill and the net stockpile balance. This production schedule shows the stockpile growing in size to reach a maximum of 137,041 tonnes in month 13 (five months after mill production starts), then dropping to a zero balance by the end of the projected mine life. The pile is projected to be fully gone by the end of August 2010, with the mill ceasing production four months later.

There is sufficient open void space within the planned production stopes at the Doris North underground mine to receive all of the underground waste and the dewatered cyanide leach residue. The estimated void space is 148,000 m³. The dewatered leach residue generated over the two year mine life is estimated to be 25,000 m³ at the average concentrate weight pull of 10% (i.e., 10% of the tonnes milled reports to the dewatered cyanide leach residue, the remaining 90% being flotation tailings), leaving 123,000 m³ of void space to accommodate the estimated 110,451 m³ (198,812 tonnes at a broken specific gravity of 1.8 tonnes/m³) of underground mine waste rock.

²⁹ Geochemical Characterization of Portal Development Rock, Supporting Document S8 to the Revised Water License Application Support Document, April 2007.

Table 3.3: Doris North – Backfill and Waste Rock Stockpile Schedule

Month*	Tonnage Mined		Ore Tonnage Source			Fill Requirement**		Stockpile Movement	Ending Stockpile
	Ore	Waste	Dev	C&F	Open	C&F Stope	Open		
1	0	6,387	0	0	0	0	0	6,387	6,387
2	0	12,230	0	0	0	0	0	12,230	18,617
3	0	12,638	0	0	0	0	0	12,638	31,255
4	0	13,804	0	0	0	0	0	13,804	45,059
5	0	12,136	0	0	0	0	0	12,136	57,195
6	1,738	11,817	1,738	0	0	0	0	11,817	69,012
7	5,839	16,036	5,839	0	0	0	0	16,036	85,048
8	11,430	17,440	7,182	4,248	0	1,159	0	16,281	101,329
9	12,958	16,214	5,907	2,747	4,304	6,724	0	9,489	110,818
10	19,520	14,580	3,688	5,724	10,107	6,619	0	7,961	118,779
11	21,742	13,738	5,407	5,613	10,722	7,754	0	5,984	124,763
12	18,328	12,994	3,734	4,909	9,685	6,201	0	6,793	131,556
13	21,789	12,363	5,165	5,902	10,722	6,878	0	5,485	137,041
14	19,567	10,970	3,998	11,024	4,545	6,424	21,779	-17,233	119,808
15	21,557	10,681	5,559	7,068	8,930	10,793	0	-112	119,696
16	21,767	663	4,591	0	17,176	7,377	0	-6,715	112,981
17	24,700	0	6,403	467	17,831	3,706	0	-3,706	109,275
18	21,795	0	1,759	2,206	17,831	3,372	0	-3,372	105,904
19	22,887	0	0	6,846	16,041	5,739	0	-5,739	100,165
20	17,653	0	0	6,935	10,718	5,736	0	-5,736	94,428
21	20,506	0	0	10,134	10,372	4,623	0	-4,623	89,805
22	18,487	0	0	8,756	9,731	6,756	0	-6,756	83,050
23	18,654	0	0	1,975	16,679	5,837	0	-5,837	77,212
24	17,086	0	0	4,153	12,932	1,316	0	-1,316	75,896
25	22,002	0	0	11,517	10,485	2,769	0	-2,769	73,127
26	15,498	0	0	15,498	0	7,678	0	-7,678	65,449
27	16,088	0	0	16,088	0	10,332	0	-10,332	55,117
28	19,303	0	0	19,303	0	10,725	0	-10,725	44,392
29	19,793	0	0	19,793	0	12,869	0	-12,869	31,523
30	17,245	0	0	17,245	0	13,195	0	-13,195	18,327
31	10,246	0	0	10,246	0	11,497	0	-11,497	6,831
32	0	0	0	0	0	6,831	0	-6,831	0
Total	458,177	194,689	60,969	198,397	198,812	172,910	21,779		

* Month 1 is the start of the main ramp development

** Fill placed takes into consideration swell factor from SG 2.7 to 1.8 (solid to broken rock)

C&F: Cut and Fill Stopping (mining method requiring fill)

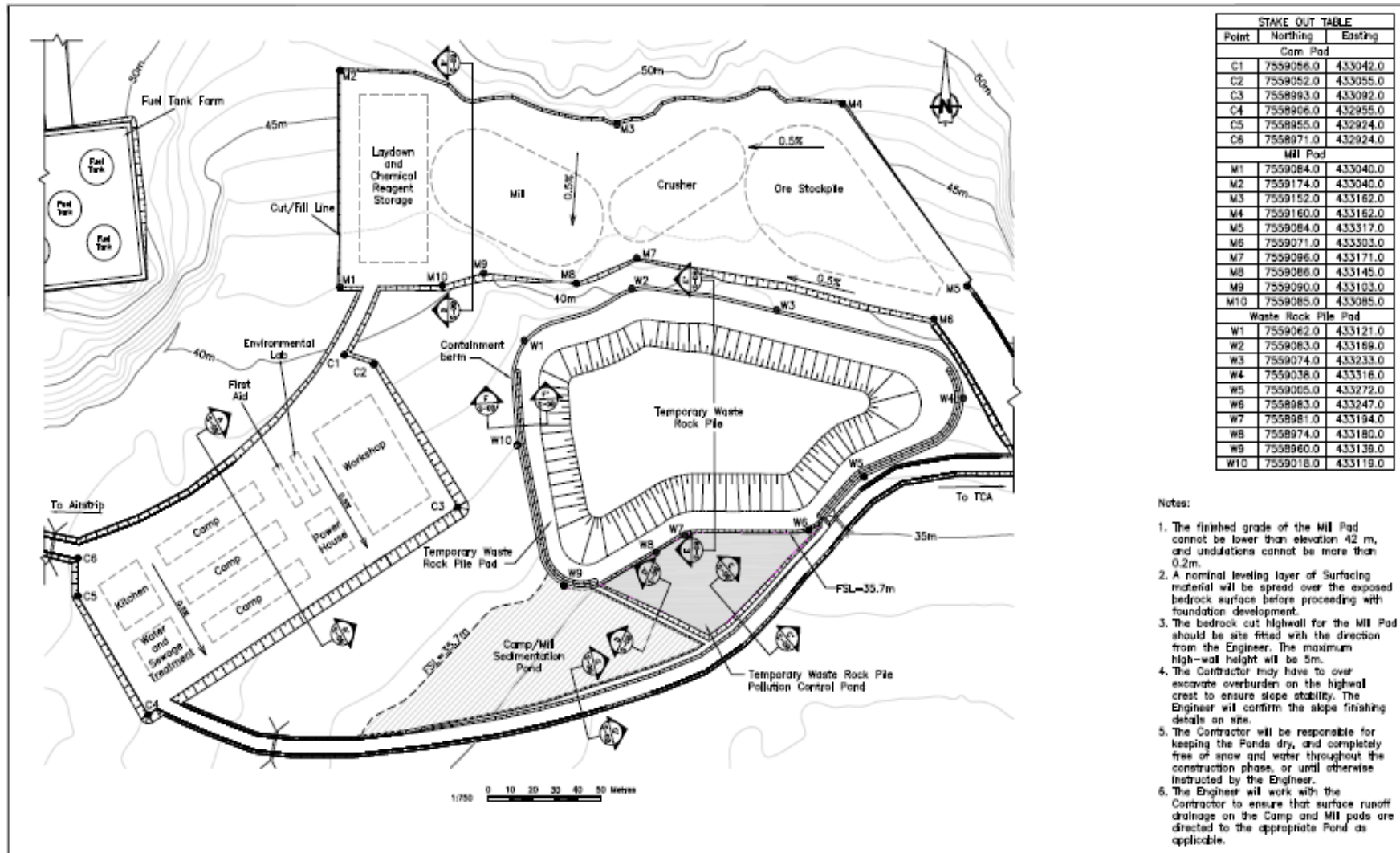
Open: Open Stopping (mining method typically requiring no fill)

All waste rock brought to surface from the underground mine will be trucked to the bermed Temporary Waste Rock Pile pad, and end dumped onto the pad. The location of this temporary waste rock pile in relation to the mill and ore stockpile is shown on Figure 3.2. The pile will be constructed with a down slope perimeter berm designed to contain and direct all runoff from the pile into a dedicated runoff collection pond (The Temporary Waste Rock Pile Pollution Control Pond). Berms will also direct clean runoff away from the waste rock pile. Periodically, a dozer will be used to shape the pile to maintain stable angles, that is to reduce any overhangs or over steepened slopes and to maintain a safe truck access ramp onto the pile.

This section presents only a summary and is not intended to be a design document for the waste rock management facilities. The reader is referred to the following sources for this design information:

- Design of the Surface Infrastructure Components Doris North Project, Hope Bay, Nunavut, Canada, prepared for MHBL by SRK Consulting Engineers and Scientists, dated March 2007. (Supporting Document S2 to the Revised Water License Application Support Document, April 2007.)
 - o Section 4.13 Temporary Waste Rock Pile Pad; and
 - o Section 4.14 Pollution Control Pond.
- Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, Nunavut, Canada, prepared for MHBL by SRK Consulting Engineers and Scientists, dated March 2006. (Supporting Document S4 to the Revised Water License Application Support Document, April 2007.)
 - o Drawing S-07 Camp and Mill Pad Plan; and
 - o Drawing S-08 Camp and Mill Pad Typical Sections and Details
- Technical Specifications for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, Hope Bay, Nunavut, Canada, prepared for MHBL by SRK Consulting Engineers and Scientists, dated March 2007. (Supporting Document S3 to the Revised Water License Application Support Document, April 2007.)
 - o Section 10.2.14 Temporary Waste Rock Pile Pad; and
 - o Section 10.2.16 Temporary Waste Rock Pile Pollution Control Pond

Figure 3.2: Location of Temporary Waste Rock Pile



No underground waste rock is to be taken anywhere outside this Temporary Waste Rock Pile pad without authorization from the General Manager, who will ensure that appropriate authorization has been obtained from the Nunavut Water Board using the procedures outlined in Section 6.0 of the Waste Rock Management Plan.³⁰

All precipitation runoff from within the bermed area of the Temporary Waste Rock Stockpile is to be directed to the Temporary Waste Rock Pile Pollution Control Pond.³¹ The water that accumulates within the Temporary Waste Rock Pile Pollution Control Pond is to be pumped to the tailings pump box within the mill so that it can be transferred to the tailings containment area. No water is to be discharged onto the surrounding tundra without the authorization of the Nunavut Water Board.

The water that accumulates within the Temporary Waste Rock Pile Pollution Control Pond is to be sampled monthly during periods of open water, and the samples will be sent for analysis (pH, TSS, Total Ammonia, Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, Al, As, Cu, Fe, Pb, Ni, and Zn). The results are to be reported to the Nunavut Water Board under the Surveillance Network Program (SNP) contained within the water license. MHBL environmental staff will use this data as one key input required to verify calibration and updates of the Tail Lake water quality model.

In the event that during the mine life, MHBL wishes to use some of the underground waste rock on surface for some unspecified purpose, such as cover material in the non-hazardous landfill area, then the following procedures will be used to demonstrate that such rock is suitable for such use:

- Only waste rock that has been demonstrated through confirmatory test work to be non-acid generating and non-metal leaching will be allowed for use on surface. This will require the authorization of the Nunavut Water Board;
- Acid Base Accounting test work will be used to demonstrate that underground waste rock is suitable for use on surface. Typically one ABA test for every 5,000 tonnes of rock to be used will be required to meet this requirement, assuming that the 5,000 tonnes is all from one rock lithology and location; and
- The NPR value derived from the ABA test must exceed 3.0 to meet the threshold of being classified as non-acid generating for this purpose.

3.4 Mill (Ore Processing)

Ore will be transported from the underground mine with underground haul trucks, and end dumped onto the ore stockpile, which will have approximately 10,000 tonnes capacity.

The mill is being designed for a rated capacity of 800 tonnes per day. The average milling rate will be 720 tonnes per day (~ 30 tonnes per hour). This incorporates an anticipated mill operating factor of 90% (i.e., the mill will operate for 90% of available hours on an annual average basis). The simplified milling flowsheet is presented in Figure 3.3.

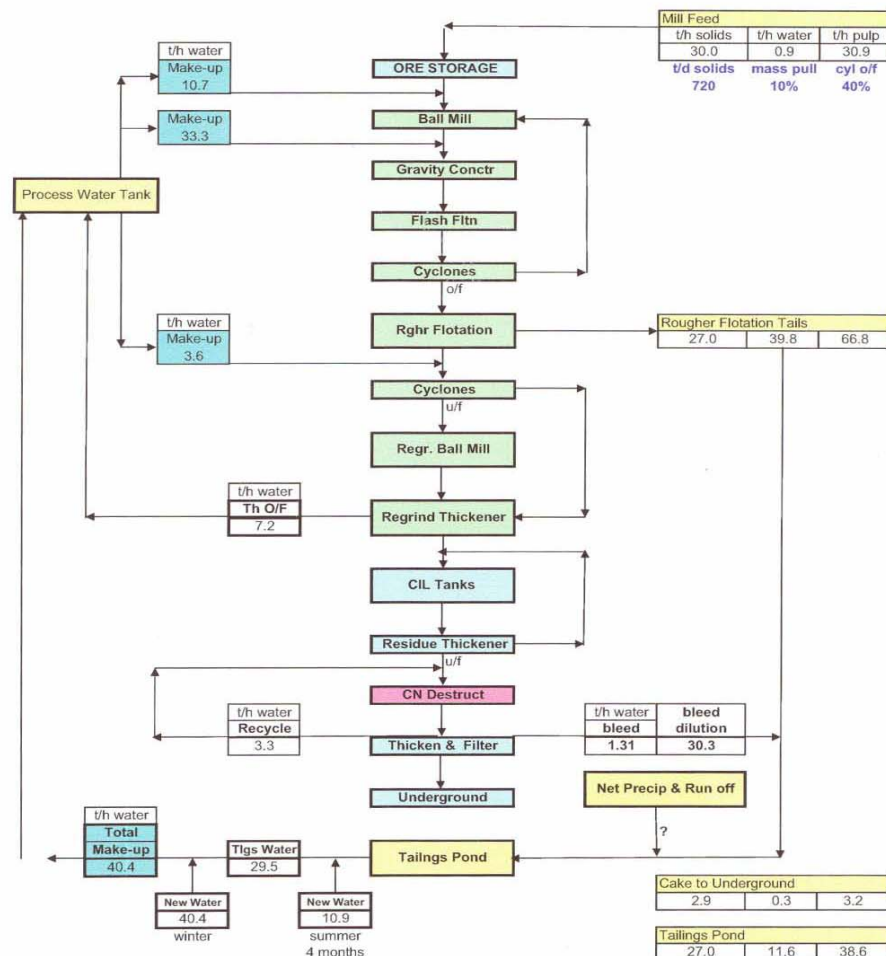
³⁰ Waste Rock Management Plan, Supporting Document S10d to the Revised Water License Application Support Document, April 2007.

³¹ For hydraulic design criteria, see Section 3.3, Design of the Surface Infrastructure Components, Supporting Document S2 to the Revised Water License Application Support Document, April 2007.

Ore will be fed from the ore pad to the primary crusher by front-end loader. The product from the crushing plant will be conveyed to a crushed ore bin to be located indoors. Crushed ore will be drawn by a conveyor belt from the bin to feed the ore into the grinding circuit (ball mill). The slurry output from the ball mill will pass over a gravity concentrator and through a flash flotation cell to recover the “free milling” gold. It is projected that up to 30% of the gold contained in the ore will be recovered from the gravity circuit, prior to the addition of any chemicals or reagents. The underflow from the flash flotation cell will be passed through a set of cyclones, with the coarse underflow particles being recycled to the ball mill for additional grinding. The overflow slurry output from the cyclones (finer sized particles) will be sent to a one stage froth flotation process (Rougher Flotation) to recover the gold bearing sulphide minerals in the form of a flotation concentrate. The flotation circuit will reduce the mass of material going on for further processing to about 10% (72 TPD) of the total weight of the ore processed. The remaining 90% (648 TPD - the Rougher Flotation tails) will be discharged to the tailings containment area, with no further treatment.

Figure 3.3: Simplified Milling Flowsheet

DesignCriteria DN Nominal 720tpd



The Rougher Flotation concentrate will be passed through a set of cyclones, with the coarser particles contained in the underflow being sent to a regrind ball mill to further reduce the particle size prior to gold leaching. The slurry output from the regrind ball mill will be combined with the cyclone overflow (the finer particles) and sent to the Regrind Thickener to remove excess water prior to leaching. The overflow water from the Regrind Thickener will be recycled to the mill process water tank for use in the grinding circuit.

The gold contained in the flotation concentrate (Regrind Thickener underflow) will be extracted in a conventional agitated tank leach circuit (CIL – carbon in leach circuit) using a dilute sodium cyanide solution to leach out the gold. Activated carbon will be added to the leach tanks to adsorb gold leached from the concentrate. At the end of the CIL circuit, the gold bearing activated carbon will be recovered from the slurry using screens. The remaining slurry (leach residue) will be fed to a Residue Thickener to remove excess water. The excess water contained in the thickener overflow will be recycled to the head end of the CIL circuit.

The Residue Thickener underflow slurry will be pumped to the cyanide destruct circuit where the remaining cyanide will be destroyed in a cyanide destruction circuit (water treatment plant). The treated slurry will then be sent to a thickener, with the excess water (thickener overflow) recycled back to the cyanide destruction circuit. The thickener underflow slurry will then be filtered through a pressure filter to produce a “dry” filter cake, which will be placed underground as backfill. The target moisture content in this filter cake is 8.5% moisture by weight. The filtrate from the filter will also be recycled back to the cyanide destruction circuit.

Approximately one third of the recycled residue thickener overflow and filtrate from the pressure filter will be bled to tailings (estimated to average 1.31 tonnes per hour) to prevent a build up of dissolved metal contaminants. This bleed stream will be mixed with the rougher flotation tails and pumped to the tailings containment area (tailings pond). This will provide a dilution ratio of 30.3:1 (rougher flotation tails solution to bleed solution).

The gold bearing activated carbon recovered from the CIL circuit will be washed in a pressure stripping circuit to extract the recovered gold from the carbon. This gold will then be recovered from the wash water using electrowinning to plate the gold onto wire wool cathodes. The “stripped” carbon will be thermally reactivated, as required, and recycled back to the carbon-in-leach circuit. The gold bearing wire wool cathodes will be periodically washed with a high pressure hose to remove the gold as a sludge, which will be filtered and then dried in an oven, mixed with fluxes (such as silica sand, borax and sodium nitrate), and smelted in a smelting furnace to produce gold bullion and a slag. Similarly, the gravity table concentrates will be mixed with fluxes and smelted on site to produce gold bullion and a slag. The slag will be recycled back to the milling process through the grinding circuit. The bullion will be cast into dore bars, which will be shipped off site to a custom refiner. Overall gold recovery in the milling process is projected to be 95%.

The filtered cyanide leach residue will be stored in a steel bin located within the mill with a nominal live capacity of approximately three days (~216 tonnes). The filtered cyanide leach residue will be trucked to the underground mine and used to backfill mined out areas. The mine plan indicates that there will be sufficient space underground in the mined stopes to accommodate all of the filtered cyanide leach residue generated as well as all of the underground mine waste rock. The mining schedule indicates the mining of stopes can be

sequenced so that there is always space available for the filtered leach residue generated. MHBL intends to place as much as practical of the filtered leach residue back into the underground mine as backfill. However in the event that (in the short term) space is not available underground, then the cyanide leach slurry will be treated through the cyanide destruction circuit and then co-disposed with the flotation tailings into the tailings containment area. It is MHBL's intention to keep the need for co-disposal of the cyanide leach residue into Tail Lake to a minimum in accordance with the commitment made during the NIRB final public hearing, specifically to maximize the amount of mill tailing placed underground as backfill.

In July/August of 2003, MHBL commissioned Bateman Minerals to conduct a program of metallurgical testing on samples of representative ore from the Doris North Hinge ore zone. Samples of the ore and various tailings products from this program were shipped to BC Research in Vancouver to allow for geochemical characterization of these materials. The samples characterized were:

- A sample of the ore (metallurgical head sample) used in the test program;
- A sample of flotation tailings;
- A sample of cyanide leach residue following cyanide detoxification; and
- A sample of the combined final mill tailing (cyanide leach residue combined with flotation tailings).

The results of this characterization work were reported in the November 2003 Environmental Impact Study submitted to NIRB in Supporting Document B2³² – Table 4.1, reproduced here as Table 3.4. All of these metallurgical samples met the requirements to be classified as non-acid generating. The cyanide leach residue contained 4.12 wt% total sulphur, but also contained a high neutralization potential, probably from the alkalinity added as lime in the cyanide leaching process.

In 2002, PRA was commissioned by MHBL to conduct a series of metallurgical tests on the Doris North ore. Three samples of cyanide leach residues, together with five samples of flotation tailings, all from different tests, were characterized by acid base accounting. The results are reproduced here in Table 3.5. All of the samples met the criteria to be classified as non-acid generating (NPR>4). In this case, the samples of cyanide leach residue had not gone through a cyanide destruct step. These three residues had a Total Sulphur concentration, on average, of 0.45 wt%, with significant neutralization potential. There is a substantive difference in both Total Sulphur and measured NP between the PRA and Ammtec residues, but both residues were non-acid generating. These two sets of samples came from different metallurgical head samples. The Ammtec sample represents a carefully constructed metallurgical head sample still thought to be representative of the Doris North ore body, whereas the PRA samples came from an earlier head sample.

³² ARD and Metal leaching Characterization Studies in 2003, Doris North Project, Nunavut Canada, prepared for Miramar Hope Bay Ltd. By AMEC Earth & Environmental, dated November 2003.

Table 3.4: ABA Results for Doris North Metallurgical Samples (Sobek Method) (Received August 06, 2003 from Ammtec Laboratories)

Sample Location	Paste pH	CO ₂ (wt%)	CaCO ₃ Equiv. #	Total Sulphur (wt%)	Sulphate Sulphur (wt%)	Sulphide Sulphur* (wt%)	Maximum Potential Acidity **	Neutralization Potential [#]	Net Neutralization Potential [#]	Neutralization Potential Ratio	Fizz Rating
Cyanide Leach Residue	7.9	22.93	521.1	4.12	<0.01	4.12	128.8	412.9	284.2	3.2	Moderate
Flotation Tailings	7.7	3.56	80.9	<0.02	<0.01	<0.02	<0.6	39.1	39.1	39.1	None
Combined Final Tailings	8.1	4.95	112.5	0.34	<0.01	0.34	10.6	93.3	82.7	8.8	Moderate
Metallurgical Head Sample	8.0	5.13	116.6	0.42	<0.01	0.42	13.1	79.6	66.5	6.1	Moderate

Reported as Kq CaCO₃ Equivalent per tonne of sample

* Based on difference between total sulphur and sulphate sulphur

** Based on Total Sulphur

Table 3.5: ABA Results for Doris North Metallurgical Samples (Sobek Method) from Metallurgical Testing at PRA in Vancouver (December 09, 2002)

PRA Sample ID Certificate Date Dec 09, 2002 Certificate # 103005	Paste pH	CO ₂ (wt%)	CaCO ₃ Equiv. #	Total Sulphur (wt%)	Sulphate Sulphur (wt%)	Sulphide Sulphur (wt%)	Maximum Potential Acidity **	Neutralization Potential [#]	Net Neutralization Potential [#]	Neutralization Potential Ratio	Fizz Rating
C27 Tls	8.7			0.47			14.7	46.4	31.7	3.16	
C28 Tls	8.7			0.42			13.1	43	29.8	3.27	
C29 Tls	8.5			0.47			14.7	44.7	30.0	3.05	
F24 Tls	8.6			<0.01			<0.3	39.3	39.3	-	
F25 Tls	8.6			0.01			0.3	45.5	45.2	146	
F42 Tls	8.7			<0.01			<0.3	36.3	36.3	-	
F43 Tls	8.8			<0.01			<0.3	36.1	36.1	-	
F44 Tls	8.9			<0.01			<0.3	36.1	36.1	-	
F24 Tls DUP	8.6			<0.01			<0.3	38.7	38.7	-	
Standard - Std (52.1)								52.4			

C series are cyanide leach residues - no cyanide destruct

F series are flotation tailings

Reported as Kq CaCO₃ Equivalent per tonne of sample

* Based on difference between total sulphur and sulphate sulphur

** Based on Total Sulphur

Based on these data, MHBL has assumed that the filtered cyanide leach residue to be placed underground will be non-acid generating. This assumption will be confirmed once milling starts by monthly sampling and analysis of the backfill material. This sample point has been added to the proposed water license Surveillance Network Program.³³

This backfill material will be placed underground as a dry filter cake, and should soon freeze with the permafrost conditions within the mine. The presence of frost will both inhibit sulphide mineral oxidation and prevent any water coming into contact with the backfill over the long term. Even with current global warming projections, it is unlikely that deep permafrost will be lost in the area of the Doris North Mine in the foreseeable future. On this basis the placement of this material underground should present little to no risk to the surrounding environment.

The decision to segregate the cyanide leach residue from the combined mill tailing and place it underground was made by MHBL in response to a position put forward by the Department of Fisheries and Oceans before the Nunavut Impact Review Board at the final hearing in which MHBL was asked to commit to maximize the amount of mill tailing placed underground. The objective was to reduce the environmental impact on Tail Lake and enhance the potential for recovery of the lake as a fish bearing lake, especially in the event that no further deposition takes place in this lake once the Doris North ore body is mined out. MHBL made this undertaking in front of the NIRB as set out in the list of MHBL commitments attached to the Project Certificate. After consultation with DFO and EC, MHBL agreed that segregating this metal enriched portion of the mill tailing would be a sound approach from an environmental perspective and could enhance long term recovery of Tail Lake if no further tailings deposition takes place (i.e., should later phases of development on the Hope Bay Belt not proceed). The treated barren bleed solution will be combined with the flotation tailings slurry and pumped to the Tail Lake tailings containment area.³⁴

Mill Reagents

The type and projected annual consumption of reagents to be used within the milling process are summarized as follows:

- 45 tonnes of sodium cyanide in 1 tonne tote bags;
- 2.5 tonnes of sodium hydroxide (caustic) in 1 tonne tote bags;
- 25 tonnes of copper sulphate in 1 tonne tote bags;
- 4 tonnes of frothing agent MIBC (for flotation) in drums;
- 9 tonnes of Aero Float 208 promoter in 1 tonne tote bags;
- 18 tonnes of Potassium Amyl Xanthate (PAX) collector in drums;
- 118 tonnes (98,000 litres) of 50% hydrogen peroxide and 917 tonnes (715,000 litres) of 37% sulphuric acid delivered in either 1000 litre bulk tanks or 208 litre drums for use in making Caro's Acid for cyanide detoxification;
- 440 tonnes of steel grinding media (steel balls) in barrels;
- 1 tonne of zinc dust; and
- 6 tonnes of smelting flux (borax, sodium nitrate, silica sand) in 1 tonne tote bags

³³ See Section 7.6 of this document and Section 5, Monitoring and Follow-Up Plan, Supporting Document S10m to the Revised Water License Application Support Document, April 2007.

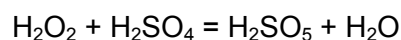
³⁴ The water quality of the combined slurry solution is provided in Section 3.3.8 and Table 3.11, Water Quality Model, Supporting Document S6 to the Revised Water License Application Support Document, April 2007.

3.5 Cyanide Treatment

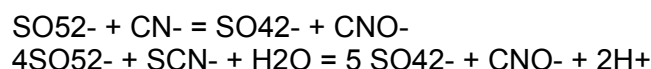
The entire thickened (thickener underflow) cyanide leach residue slurry stream will be treated in a cyanide destruct circuit to reduce contaminant concentrations (cyanide and metals) in the cyanide leach tailings streams going underground as backfill, as well as the bleed solution that will be discharged to the tailings containment areas as barren bleed solution.

Cyanide detoxification will be achieved using the Caro's Acid process. Caro's Acid is an oxidant prepared by reacting hydrogen peroxide with sulphuric acid. It is a more powerful oxidant than hydrogen peroxide and does not require a catalyst to remove copper cyanide complexes. Weak acid dissociable (WAD) cyanide is removed at near stoichiometric addition rates for Caro's Acid, amounts that are approximately half the addition required by hydrogen peroxide. Further, the molar ratio of acid to cyanide remains constant over a range of cyanide concentrations down to 0.1 ppm.

The Caro's Acid reagent is prepared as follows:



The reactions involving oxidation of cyanide using Caro's Acid are as follows:



The reaction times are fast (seconds) and residual total cyanide levels in the range of 1 to 2 mg/L can readily be achieved. An advantage of the process is the reduction in the pH level of the cyanide leach solution being detoxified as a result of the reaction. Test work on Doris North ore produced a terminal pH range of 8.2 to 8.5 following cyanide detoxification with Caro's Acid, which is close to the ore's natural alkalinity in fresh water.

In this detoxification process, free and weak acid dissociable cyanide complexes are oxidized to the much less toxic cyanide complex, cyanate (CNO). Metals are precipitated. The treated barren bleed solution will then be combined with the flotation tailings slurry and pumped to the Tail Lake tailings containment area. The quality of the combined effluent discharged into the tailings containment area has been calculated, and is presented in the Water Quality Model.³⁵ This predicted water quality is based on the outcomes of a test program supervised by Bateman Minerals Limited conducted at Ammtec Labs in Perth, Australia in 2003.³⁶

The cyanide detoxification process will be largely automated. The operator will monitor free and WAD cyanide concentrations by titration on a two and four hourly basis, respectively. An ORP probe will be used to prevent excessive cyanide discharge to the tailings containment area, resulting from a short term upset in the cyanide detoxification process. A site-specific relationship between redox potential and cyanide levels will be developed, but generally, negative redox values indicate a surplus of cyanide species present in the final tails. The ORP probe output will be input directly to the DCS (Digital Control System) in the mill for continuous

³⁵ Water Quality Model, Supporting Document S6 to the Revised Water License Application Support Document, April 2007.

³⁶ The full report from this work was attached to the Doris North Final Environmental Impact Statement submitted to NIRB in October of 2005 as Supporting Document A9 to the Technical Support Document.

logging, with excessive values triggering operator intervention and/or feed stoppage. The prevention of excessive cyanide in the mill discharge will be accomplished by the following action: An ORP alarm or operator intervention due to excessive WAD cyanide levels (typically in excess of 4 ppm, as measured by titration) will trigger the cessation of barren bleed solution being fed to the effluent treatment circuit until the detoxification process upset is resolved. During this period, all barren solution will be recycled to the head end of the cyanide leach circuit.

In October of 2006, MHLB commissioned CyPlus Canada Inc. (part of the Degussa Group) to conduct a two phase program to provide final design criteria for the mill cyanide destruct circuit. CyPlus has the rights to provide full technical design support for the INCO SO₂-Air Process and their own Caro's Acid process. Phase 1 of this program involved doing an independent assessment of the following cyanide destruction treatment technologies on fresh samples of cyanide leach residue generated by leaching flotation concentrate derived from the Doris North ore:

- Continuous cyanide destruction optimization by the SO₂-Air process;
- Continuous cyanide destruction by the CyPlus Cold Caro's Acid (peroxymonosulphuric acid) process; and
- Continuous cyanide destruction by the CyPlus CombinOx process.

In all cases, CyPlus were tasked with achieve treated water quality equal to or better than that obtained in the Ammtec work, specifically 0.29 mg/L Total CN (0.04 mg/L WAD CN), 32 mg/L CNO, <0.1 mg/L SCN, 1.0 mg/L Total Ammonia, 0.039 mg/L Total Cu, <0.05 mg/L Total Pb, 0.03 mg/L Total Nickel and 0.09 mg/L Total Zn.

To conduct this study, MHLB arranged to have PRA generate a bulk flotation concentrate sample from ~500 kg of Doris North ore. This concentrate was transferred to CyPlus late in 2006. CyPlus then subjected the concentrate to cyanide leach using the design conditions provided by MHLB's metallurgical consultant. CyPlus is coming closing to completing their testwork and will provide a report on their findings. At that time MHLB will confirm the cyanide destruct process to be used, and authorize CyPlus to complete the engineering design criteria for final plant engineering. This study will be submitted to the NWB for inclusion in the public registry soon after it becomes available. This is expected well ahead of any potential final hearing date for the Doris North water license application. Pending outcome of this study, MHLB may be advised to use the SO₂-Air process in place of the Cato's Acid process; however, this should not impact the predicted water quality of the treated barren bleed solution reporting to Tail Lake.

3.6 Tailings Management and Discharge Strategy

Treated barren bleed solution combined with flotation tailings produced during the milling process will be deposited in Tail Lake about 5 km from the proposed mill location. The tailings will be pumped as a slurry with a solids content of ~36% solids by weight, and will be discharged sub-aqueously into Tail Lake.

3.6.1 Hydroclimatic Parameter Re-Evaluation

Intervener submissions during regulatory hearings suggested that estimates of mean annual precipitation and mean annual runoff derived in the Doris North FEIS - Meteorology and Hydrology Baseline Study (the baseline study) could be low, and result in inaccurate water balance modeling. During preparation of the Environmental Impact Statement for the project, two sets of hydroclimatic values were used. One set ("dry case") was based on the values presented in the baseline study, and the second set ("wet case") was based on a wetter scenario as suggested by regulators and interveners.

MHBL commissioned Golder Associates to prepare a follow-up study to re-assess the hydroclimatic parameters used for the Doris North Project. A report was prepared³⁷ in compliance with the NIRB Project Certificate Condition 14, which states that "MHBL shall collect additional precipitation, evaporation and runoff data and incorporate it into a revised water balance to be submitted to the NWB as part of the water license application." The objective of this report is to re-evaluate baseline hydroclimatic parameters, including mean annual rainfall, snowfall and precipitation, evaporation, and water yield. The water balance focuses on the Tail Lake tailings impoundment and Doris Lake and outflow as a source of water supply and for disposal of treated tailings decant water. Because these water bodies have the capacity to store water, the water balance is most sensitive to annual values, and the cumulative effects of successive years of precipitation, rather than short-duration events. Therefore, the focus of this report is to establish whether the mean annual values presented in the baseline study are accurate or whether they should be revised for use in future water balance modeling.

Data used during the baseline study included long-term climatic and hydrometric data reported by Environment Canada, as well as short-term climatic and hydrometric data collected in the Doris North area. Subsequent to the baseline study, MHBL has undertaken additional studies from which climatic and hydrometric data are available for the period 2003 to 2006. Additional relevant climatic data were received from Indian and Northern Affairs Canada, and a precipitation analysis by the Canadian Institute for Climate Studies was also considered.

Monthly and annual rainfall in the Doris North area is similar to that recorded at the Environment Canada climate station at Cambridge Bay. This is based on three years of concurrent data for the two stations, and is further supported by nine years of concurrent data for Cambridge Bay and the INAC Walker Bay climate station. Thus, the recommendations of the baseline study are supported.

Comparison of snowfall at the local and regional climate stations is complicated by the use of different measurement methods (snow-on-ground, snowfall gauging and snow course surveys) and by variations in snow density, consolidation, melt and sublimation of the snow pack, exposure and wind redistribution. However, the snow water equivalent displays a decreasing trend to the north, and snow water equivalents measured at Doris North from 2004 to 2006 are consistent with those reported for the Environment Canada climate station at Cambridge Bay. Thus, the recommendations of the baseline study are supported.

³⁷ Attached as Revised Doris North Hydroclimatic Parameter Re-Evaluation, Supporting Document S5 to the Revised Water License Application Support Document, April 2007.

Based on the recommendations of the baseline study with regards to mean annual rainfall and snowfall at Doris North, it follows that recommendations with regard to mean annual precipitation are also supported. The conclusions of the baseline report concerning lake evaporation are further supported by the new data. Previous studies have established a decreasing gradient in lake evaporation to the northeast, and have established reliable long-term mean values at sites to the southwest. The baseline estimate is supported by these observations, as well as one year of local pan evaporation data and three years of local calculated evaporation data.

A decreasing gradient in water yield to the northeast exists in the region surrounding Doris North. Local annual water yield data are only available for five years, but indicate that water yields at Doris North are lower than those for the Ellice River, as suggested by the baseline study. The mean annual water yield measured at Doris North over the monitoring period is less than that estimated by the baseline study, but given the short monitoring period and the fact that monitoring took place during regional dry conditions; it is unlikely to be representative of long-term conditions. The baseline study conclusion that the mean annual water yield at Doris North is substantially lower than that of the Ellice River is supported by the additional data collected subsequent to the baseline study.

Water balance modeling for the Doris North project currently considers two sets of data. One set reflects the conditions estimated by the baseline study (dry case) and one set incorporates higher runoff estimates, as suggested by interveners and regulators (wet case). Both of these cases were modeled to account for uncertainty in local conditions. The climate and hydrology data that were collected during post-baseline monitoring (2003 to 2006) are consistent with the results of the baseline study, and do not support the suggestion that conditions at Doris North are similar to those of areas to the west (Kugluktuk) or south (Ellice River watershed). This supports use of the “dry case” scenario for water balance modeling at Doris North.

The available data, however, include only three years of complete annual data (precipitation, evaporation and water yields for 2004 to 2006) and an additional two years of partial annual data (water yields for 1997 and 2000). Furthermore, it appears that the three years of complete data occurred during years that may have been drier than average in the region. Therefore, it would still be prudent to model the “wet case” scenario to continue to account for existing uncertainty. It was recommended to MHBL that climate and hydrology monitoring continue at Doris North, prior to and during operations. This will provide additional data to confirm local hydroclimatic conditions and to provide vital input for water management and adaptive management planning during project construction, operations and closure. MHBL has committed to continue the collection of climate and hydrology data at the Doris North site³⁸.

After discussions with the INAC review team, MHBL committed to running additional water quality model runs for successive dry periods. These were completed and are addressed in the Water Quality Model prepared by SRK for MHBL.

³⁸ See Sections 7.2 and 7.3 of this document and Sections 2 and 4, Monitoring and Follow-Up Plan, Supporting Document S10m to the Revised Water License Application Support Document, April 2007.

3.6.2 Tailings Solution Characterization

In 2003, MHBL commissioned work to characterize the properties of the final mill tailings slurry that are of interest from an environmental perspective. Bateman Minerals³⁹ conducted a metallurgical testing program on a representative sample of the Doris North ore. As part of this work, Bateman created a bulk sample of both the flotation tailings slurry and the cyanide leach slurry. The cyanide leach tailings were then subjected to the Caro's Acid cyanide detoxification process using the optimized operating parameters previously developed by Bateman. Both the solid and liquid fractions of each of these tailings slurry materials were analyzed for a wide spectrum of parameters. The flotation tailing slurry was then combined with the detoxified cyanide leach slurry from the Caro's Acid treatment process in the same proportions that they will be produced in the mill to create a bulk sample of combined tailings. A sample of both the solid and liquid phases of this combined tailings slurry was sent for analysis for a wide spectrum of parameters. A sample of the solution was subjected to an LC50 toxicity test (Reference Method for Determining Acute Lethality of Effluent to Rainbow Trout, EPS 1/RM/13, Second Edition, December 2000) conducted at BC Research in Vancouver. A sample of the combined tailings slurry was subjected to a standard settling test, and the supernatant analyzed for total suspended solids to assess the expected clarity of the tailings containment area supernatant. The bulk sample of combined tailings was then left to sit for one month to age and then the solutions were re-analyzed to look at changes, especially in relation to cyanide and nitrogen compounds.

The results indicate that the combined tailings solids are expected to be non-acid generating (NPR = 8.8). The tailings solution will meet MMER discharge criteria, is not acutely toxic and will have a supernatant total suspended solids concentration of < 5 mg/L after 24 hours of settling time.

3.6.3 Tailings Acid Rock Generating Potential

ABA testing indicates that mill tailings will have low acid generating potential.

In July/August of 2003, MHBL commissioned Bateman Minerals to conduct a program of metallurgical testing on samples of representative ore from the Doris North Hinge ore zone. Samples of the ore and various tailings products from this program were shipped to BC Research in Vancouver to allow for geochemical characterization of these materials. The samples characterized were:

- A sample of the ore (metallurgical head sample) used in the test program;
- A sample of flotation tailings;
- A sample of cyanide leach residue following cyanide detoxification; and
- A sample of the combined final mill tailing (cyanide leach residue combined with flotation tailings).

³⁹ The full report from this work was attached to the Doris North Final Environmental Impact Statement submitted to NIRB in October of 2005 as Supporting Document A9 to the Technical Support Document.

The results of this characterization work were reported in the November 2003 Environmental Impact Study submitted to NIRB in supporting document B2⁴⁰ – Table 4.1, reproduced above in Section 3.4 as Table 3.4. All of these metallurgical samples met the requirements to be classified as non-acid generating. The sample of combined mill tailing had an NPR of 8.8 (containing 0.34 wt% total sulphur, a measured NP of 93.3 to give an NNP of 82.7). The sample of flotation tailing had an NPR of 39.1 (containing <0.02 wt% total sulphur, a measured NP of 93.3 to give an NNP of 39.1).

In 2002, PRA was commissioned by MHBL to conduct a series of metallurgical tests on the Doris North ore. Five samples of flotation tailing, all from different tests, were characterized by acid base accounting, with the results reproduced above in Section 3.4 as Table 3.5. All of the samples met the criteria to be classified as non-acid generating (NPR>3). All five samples had Total Sulphur concentrations at or below the detection point of 0.01 wt%, with significant neutralization potential (ranging between 36.1 and 45.5). The average NPR for these five samples was 38.6.

These two sets of samples came from different metallurgical head samples. The Ammtec sample represents a carefully constructed metallurgical head sample still thought to be representative of the Doris North ore body, whereas the PRA samples came from an earlier head sample.

Based on these data, MHBL has assumed that the final mill tailing (flotation tailing) to be placed into Tail Lake will be non-acid generating. This assumption will be confirmed once milling starts by monthly sampling and analysis of the final mill tailings solids sent to Tail Lake.⁴¹

In 2004, a sample of combined mill tailing (flotation tailing combined with cyanide leach residue) from the Ammtec lab scale pilot plant testing was subjected to both static (ABA testing) and kinetic testing using a conventional humidity cell for a period of 100 weeks (May 2004 – July 2005). The static ABA testing gave a total neutralization potential ratio (NPR) of 8.8 and a carbonate neutralization potential of 10.6. The total Sulphur concentration was 0.34 wt% S with not detectable Sulphate sulphur. The Net neutralization potential was +82.7 kg CaCO₃/tonne equivalent, and a carbonate net neutralization potential of +101.9 kg CaCO₃/tonne equivalent.

The humidity cell test results confirmed that the combined mill tailings are not acid generating, and are not expected to be a significant source of metal leaching. The predicted time for total sulphide depletion was estimated at 24 years, and the predicted time for total neutralization potential depletion was estimated at 76 years (predicted time for carbonate neutralization potential was estimated at 75 years).

The Doris North deposit is known to contain siderite (an iron carbonate). Conventional ABA testing can overestimate actual available neutralization when iron carbonate minerals are present, specifically siderite. To confirm that the combined tailings will be non-acid generating, the metallurgical composite tailings sample and the tailings humidity cell close out residue were

⁴⁰ ARD and Metal leaching Characterization Studies in 2003, Doris North Project, Nunavut Canada, prepared for Miramar Hope Bay Ltd. By AMEC Earth & Environmental, dated November 2003.

⁴¹ This sample point has been added to the proposed water license Surveillance Network Program (see Section 7.6 of this document and Section 5, Monitoring and Follow-Up Plan, Supporting Document S10m to the Revised Water License Application Support Document, April 2007).

both subjected to conventional ABA analysis using the EPA Modified Sobek Method and to the Peroxide Siderite Correction for NP ABA procedure. The results confirm that there is considerable NP tied up in the siderite; however, the tailings will still meet the criteria to classify as non acid generating (NPR>3). The results are as shown in Table 3.6:

Table 3.6: Mill Tailings – NPR Comparison (Modified Sobek vs. Siderite Correction Method)

	NPR Modified Sobek	NPR Siderite Correction
Metallurgical Tailings Composite	5.9	3.0
Tailings HC Close out Residue	7.5	3.6

For the same purpose, a Static NAG test using hydrogen peroxide (Miller, 1997 procedure) was conducted on both samples as shown in Table 3.7:

Table 3.7: Static Net Acid Generating Test Result using Hydrogen Peroxide

	NAG pH
Metallurgical Tailings Composite	5.1
Tailings HC Close out Residue	5.3

The results confirm that the Doris North mill tailing is not likely to be net acid generating.

3.6.4 Tailings Disposal and Impoundment

Flotation tailings and treated barren bleed solution (tailings) produced during the milling process will be deposited in Tail Lake about 5 km from the proposed mill location. Tail Lake is 81 ha in size within a catchment area of 4.4 km². The normal water level in Tail Lake is 28.3 m above sea level. Detailed bathymetry for Tail Lake confirms that it is a shallow lake, with a maximum depth of 6 m. Tail Lake has a discontinuous outflow into Doris Lake immediately upstream of the Doris Creek. Ogama Lake (158 ha in size) is situated immediately south of Tail Lake, and its normal water level is at 24.3 m above sea level. The height of land between the lakes is at 33 m above sea level. The normal volume of Tail Lake is approximately 2.2 million m³.

Section 3.6.4 is intended to provide the reader with a summary description of each of the components that make up the Doris North tailings containment system. This is not intended to provide design details for these facilities. The reader is referred to the following sources for the design information:

- Design of the Tailings Containment Area, Doris North Project, Hope Bay, Nunavut, Canada, prepared for MHL by SRK Consulting (Canada) Inc., dated March 2007. (Supporting Document S1 to the Revised Water License Application Support Document, April 2007.);

- Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, Nunavut, Canada, prepared for MHL by SRK Consulting Engineers and Scientists, dated March 2007. (Supporting Document S4 to the Revised Water License Application Support Document, April 2007) – Drawings T01 thru T-14; and
- Technical Specifications for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, Hope Bay, Nunavut, Canada, prepared for MHL by SRK Consulting Engineers and Scientists, dated March 2007. (Supporting Document S3 to the Revised Water License Application Support Document, April 2007) – Section 11.

The tailings will be pumped as a slurry with a solids content of ~36% solids by weight and will be discharged sub-aqueously into Tail Lake. The discharge location will not be fixed, but will be moved around such that the tailings impoundment can be sequentially filled from its deepest location. This deposition methodology will enable the final closure water level to be returned to its pre-deposition value of 28.3 m. Tailings will be pumped from the mill to Tail Lake via a 127 mm insulated pipeline. The pipeline route will be southwest from the mill site towards the northwest shore of Doris Lake. From there the pipeline will continue along the Doris Lake shore towards a crossing at Doris Creek before continuing south-west towards the Tail Lake shoreline. The maximum piping distance from the mill to the southern tip of Tail Lake will be 5.5 km.

Return (Reclaim) water will be pumped from Tail Lake to the plant through a heat traced and insulated 100 mm diameter HDPE line. Both tailings and return water pipelines will follow the alignment of the tailings service road. The tailings and reclaim water pipelines will be placed on the shoulder of the road, taking up at least 1.5 m of the roadway space. The pipelines will be placed on the outside edge of the roadway, i.e., closest to the Tail Lake shoreline. This will minimize the number of pipe crossings required. Operationally the pipe settling and freezing risk will be managed by constructing six emergency dump catch basins strategically along the pipeline to allow drainage of the pipeline in the event of a pump stopping. The tailings pipeline service road will be graded to provide positive drainage by gravity towards one of the six emergency dump catch basins. This is to provide controlled containment of the tailings in the event of a pipeline system failure. The emergency dump catch basins located outside the Tail Lake watershed will be sized to hold the contents of both the tailings and reclaim water pipelines. Within the Tail Lake watershed, the reclaim water line will drain by gravity onto the tundra and into Tail Lake; consequently, the emergency dump catch basins within the Tail Lake watershed have been sized to hold only the contents of the tailings pipeline.

The emergency dump catch basins have been sized to allow two sequential fillings plus an additional 0.5 m of freeboard. Containment in each basin will be provided by HDPE lining.⁴²

In the event of a spill of tailings or reclaim water, operational personnel will take the following actions:

- Shut down the mill tailings or reclaim water pumps immediately to bring spill to a halt;

⁴² Details on the emergency dump catch basin designs are presented in Drawing T-13, Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

- Initiate the Spill Contingency Plan⁴³ reporting and response measures as quick as possible after halting the spill;
- Repair the cause of the Spill before resuming pumping;
- Pump the fluid reporting to the emergency dump catch basins affected by the spill back into the tailings containment area as soon as practically possible;
- Recover the settled tailings solids reporting to the emergency dump catch basins using a small backhoe or bobcat loader, and return the solids to the TCA as soon as practically possible. Hoarding must be placed over each emergency sump catch basin and the area heated if freezing conditions prevail.

The mill superintendent will arrange to have these emergency dump catch basins inspected at a minimum frequency of once per week. Following the spring melt and immediately following any significant rain events (> 20 mm in 24 hours) the mill superintendent will arrange to have these emergency dump catch basins pumped out to ensure that capacity is maintained within these catch basins for their intended purpose. The precipitation water pumped out must be returned to the TCA to prevent any pre-existing contaminants contained in these catch basins being released outside the tailings water management system.

The tailings impoundment is sized to operate as a zero discharge facility during the two years of operation, if necessary; however, the proposed water management strategy is based on the annual release of supernatant from the impoundment. In addition, under the most conservative water balance assumptions, Tail Lake would take just over five years to reach the design Full Supply Level (FSL) of 33.5 m with no discharge.⁴⁴ A permanent spillway will be constructed at this elevation, to prevent the possibility of dam overtopping.

The two dams will be constructed as water retaining structures. They will be frozen core dams founded on non-organic permafrost and/or bedrock. The frozen core integrity will be ensured by the installation of passive thermosyphons in the key trench, immediately underneath the frozen core. Secondary containment will also be provided by installation of a geosynthetic clay liner (GCL) upstream of the core. The core, transition (filter) and outer shell construction materials will be processed local quarry rock.

Detailed equipment to monitor the dam performance will be built-in during the construction phase, and a rigorous monitoring and reporting program will be followed through to final decommissioning of the dams.⁴⁵

3.6.5 Tailings Water Management Strategy

The tailings water management strategy is based on a revision of the water quality modeling presented to the NIRB as part of the October 2005 FEIS. The revised model incorporates new baseline water quality data collected in 2005 and 2006 as required under the NIRB Project Certificate condition 13, which states "MHBL shall collect additional water quality data for the

⁴³ Section 4, Emergency Response and Contingency Plan, Supporting Document S10a to the Revised Water License Application Support, April 2007.

⁴⁴ Section 6.3 and Section 9, Design of the Tailings Containment Area, Supporting Document S1 to the Revised Water License Application Support Document, April 2007.

⁴⁵ Additional information on the location and operation of this monitoring equipment is found in Section 11.1.3, Design of the Tailings Containment Area, Supporting Document S1 to the Revised Water License Application Support Document, April 2007.

2006 field season and incorporate it into a revised water quality model to be submitted to the NWB as part of the water license application. MHBL will meet discharge criteria on a site specific basis set by NWB where possible, for the protection of the receiving environment at the point of discharge.”

The water management strategy for the Tail Lake tailings containment system was developed by SRK Consulting (Canada) Inc. for MHBL and is a component of the Water Quality Model.⁴⁶ The following management plan is drawn from this source.

The primary objective of the Tail Lake water management strategy is to meet CCME guidelines (Canadian Water Quality Guidelines) for parameters of concern⁴⁷ to protect freshwater aquatic life in Doris Creek, downstream of the waterfall. These guidelines were established by the Canadian Council of the Ministers of Environment and represent a vigorous determination of levels for each parameter that are protective of aquatic life within fresh waters in Canada. These are guidelines not regulated limits, and incorporate a highly conservative approach in determining from scientific research world-wide at what level of each parameter are harmful effects noted on aquatic life. Consequently they provide guidance as to levels of each parameter in receiving waters below which there is assurance of “low to no” risk of adverse effect on aquatic life. It should be noted that quite often natural levels of parameters within Canadian freshwaters may already exceed the CCME Guideline values. Consequently, by meeting the CCME Guidelines in the receiving water, MHBL is striving to ensure that there will be no adverse effect on aquatic life downstream of its discharge point.

MHBL chose to meet these CCME Guideline values at a point immediately downstream of a 4.3 m waterfall in the Doris Creek, as this is the closest point at which Arctic char can come into contact with the water released from the TCA. This waterfall acts as natural barrier to the migration of Arctic char and other downstream fish species up into Doris Lake.

Technology does not exist that would allow MHBL to treat the water to be released from Tail Lake to meet these CCME Guideline values; consequently, MHBL acknowledges that it cannot achieve the CCME Guidelines at the end of the discharge pipe from Tail Lake. MHBL’s discharge strategy relies on metering the amount of water released from Tail Lake so that the combined water meets the CCME Guideline values below the waterfall. The location of the discharge pipe was placed immediately upstream of this waterfall to protect aquatic life upstream of the discharge point within Doris Lake and the upper reaches of the Doris Creek. In other words, the proposed end of pipe discharge point was selected to minimize, to the greatest extent possible, the amount of Doris Creek that could be exposed to the end of pipe discharge before it mixes completely with the receiving water as it goes over the waterfall.

The Federal Government acknowledges that CCME Guidelines are to be used for guidance purposes only, and are thus not incorporated into regulated discharge standards. The Federal discharge standards that apply to the Canadian mining industry are set out in Schedule 4 of the Metal Mining Effluent Regulations (MMER) under the Fisheries Act. These are based on best-

⁴⁶ See Section 5.2, Water Quality Model, Supporting Document S6 to the Revised Water License Application Support Document, April 2007.

⁴⁷ MHBL expects to meet all CCME Guideline values for the parameters of concern listed in Table 6.1 at the monitoring point downstream of the waterfall within Doris Creek with the possible exception of selenium. Selenium is occasionally above the CCME in the background water draining from Doris Lake. Tail Lake discharge is not predicted to increase these background Se concentrations as Se concentrations in Tail Lake are predicted to consistently below the CCME guideline.

practical-available-technology for water treatment, and not necessarily meant to be protective of aquatic life. In most regulatory jurisdictions, these end of pipe discharge standards are assessed on a case by case basis to determine acceptable levels of impact once the discharge has been mixed in the receiving waters. In other words, setting of discharge criteria typically relies upon a natural mixing zone within the receiving waters. Under the MMER, by law, the end-of-pipe discharge from Tail Lake must meet the MMER discharge limits and pass the LC₅₀ fish toxicity test.

MHBL, however, recognizes that indiscriminate discharge of water from Tail Lake at these limits would not necessarily result in water quality meeting CCME guidelines in the Doris Creek. Consequently MHBL devised a discharge strategy that allows for the load (kg per time period) of contaminants discharged from Tail Lake to be varied in proportion to the background flow and load in the Doris Creek so that concentrations are consistently at or below CCME guideline values in Doris Creek, below the point of mixing. To be successful this approach departs from the traditional fixed end of pipe discharge limit and maximum flow rate normally contained in water licenses, and replaces it with a fixed allowable concentration in the receiving water.

The water management strategy for the Project entails an actively managed discharge from Tail Lake beginning in Year 1 of operations, and continuing until it can be shown that there is no adverse impact on downstream aquatic life from an unregulated discharge from Tail Lake. For the base case assessment, at the end of Year 9 (seven years after mining ceases), water quality in Tail Lake is predicted to be within the CCME Guidelines, allowing for a complete “walk-away” closure scenario.

During the mine’s operating life (two years), and for an additional three years after mining and milling ceases, the volume of water to be released from Tail Lake will exceed the natural inflow into Tail Lake. By the third year following the cessation of mining and milling, the water level in Tail Lake will reach the pre-development elevation of 28.3 m above sea level, and the amount of water that needs to be released from Tail Lake is predicted to be equal to the natural inflow. In the year prior to this (i.e., during the 2nd year following the cessation of mining and milling), MHBL will commission a human health and ecological risk assessment⁴⁸ to determine if the quality of the water contained in Tail Lake is suitable for release in an unregulated fashion through the former Tail Lake outflow into Doris Lake without resulting in an adverse impact to aquatic life downstream. In the event that the risks are shown to be unacceptable, MHBL will continue to actively manage the annual discharge from Tail Lake by pumping this water to the discharge point in Doris Creek upstream of the waterfall. Pumping would only cease if it can be demonstrated that no adverse impact on downstream aquatic life will occur with an unregulated discharge. At that time, the North Dam will be breached and the outflow from Tail Lake will be restored to the pre-mine outflow channel (Tail Lake Outflow creek) into Doris Lake. Under this scenario, no further management of water releases from Tail Lake will be required, although monitoring will continue for a minimum of one more year to verify that water quality remains acceptable for discharge.

Under this water management strategy, the maximum water level in Tail Lake will be 29.4 m, with a flooded footprint of 94 ha.

⁴⁸ See Section 6.19, Mine Closure and Reclamation Plan, Supporting Document S10I to the Revised Water License Application Support Document, April 2007.

Various alternate water management strategies were also assessed, all of which would result in minimal changes of water quality in the receiving environment. For example, all water could be contained in Tail Lake until the full supply level is reached. While this strategy would provide ample time to monitor the development of water quality in Tail Lake to verify the predictive modeling results, it would necessitate an extended period of site management. The strategy selected by MHBL involves maximizing the annual discharge volume from Tail Lake as early as possible in the mine life, while minimizing water quality changes in the receiving environment. Other benefits for this strategy include the fact that the full supply level of Tail Lake will not be reached, and, as a result, the effects of permafrost thaw and associated silt release will be minimized.

The estimated maximum concentrations in Doris Creek are predicted to meet the CCME Guidelines with one exception:⁴⁹

- **Selenium** - The background selenium concentration in Doris Creek intermittently exceeds the CCME guideline of 0.001 mg/L, and it is for this reason that it is predicted to exceed the guideline. The selenium concentration in Tail Lake is predicted to be below the background concentration in Doris Creek so that discharge would not be constrained, and, in fact discharge would fractionally lower the selenium concentration in Doris Creek during the initial discharge period. Thereafter, it reverts to the background concentration.

Starting in Year 1, the discharge strategy will be implemented as follows:

- Prior to commencement of milling, the laboratory will be set-up and analytical procedures developed, documented and verified. Sampling protocols will also be documented and verified. The laboratory will be equipped with a low level inductively coupled plasma (ICP) mass spectrophotometer (MS) to enable low detection analyses of metals.⁵⁰
- Two weeks prior to commencement of operations (assuming a spring start-up), water quality in Tail Lake and Doris Creek will be monitored every second day to establish baseline conditions. The sampling point for water quality in Tail Lake will be the discharge from the reclaim water pump house set on a floating barge on Tail Lake. This barge will be left in place on the lake year round and equipped with circulation capacity to keep the water below the barge from freezing. This is the same point in the lake from where the discharge pump will draw water for discharge into the Doris Creek. Samples will be obtained from the barge at depths of 1.0 m, 1.5 m and 2.0 m for this initial two week period (the discharge pump intake will be set at a depth of 1.5 m).
- Real-time monitoring of the flows in Doris Creek will commence as soon as practical during the open water season. The pressure transducer would be connected to a programmable logic controller (PLC) that would record flows in Doris Creek, which will be used to control the discharge flow rate. In addition, a staff gauge will be installed in

⁴⁹ See Section 6 – Table 6.1, Water Quality Model, Supporting Document S6 to the Revised Water License Application Support Document, April 2007.

⁵⁰ Technical information for the proposed ICP-MS is provided in Appendix J, Water Quality Model, Supporting Document S6 to the Revised Water License Application Support Document, April 2007.

Doris Creek to enable daily verification of the water level and flow rates during periods of active discharge.

- Commencing with the start of tailings deposition, water quality within Tail Lake will be monitored every second day for a further period of two weeks, again at a depth of 1.0 m, 1.5 m and 2.0 m. After two weeks, the frequency will be lowered to a minimum of once per week at a single depth of 1.5 m on the assumption that, given the relative size of Tail Lake, the water quality within the lake will not change very quickly. Consequently, MHBL has proposed that the frequency of sampling be decreased to a minimum of once per week at a depth of 1.5 m after this initial two week period has passed. The results of this monitoring will be plotted for each measured parameter against time. From this data the rate of change for each parameter can be determined and compared to its water quality objective and the predicted concentration from the water quality model. MHBL will determine the rate of change for all key parameters before making a decision to reduce the sampling and analytical frequency. If these calculations indicate that the water quality in Tail Lake is changing at a significantly more rapid rate than predicted, then MHBL will return the frequency of sampling to once every 24 hours until it can be shown that the water quality within Tail Lake is not varying quickly on a day to day basis.

Before any discharge commences, Tail Lake water (taken from the reclaim floating pump house at a depth of 1.5 m) will be submitted for toxicity testing and metals analysis. Only if the water meets MMER criteria will discharge from Tail Lake commence. The flow ratio will be calculated for each sampling event, and adjusted as necessary. The discharge flow will be controlled by the automated flow control system, which will use the real time flow monitoring in Doris Creek to control the discharge flow rate. Flow rates will automatically be logged by the flow control system.

In subsequent years, it is anticipated that at the start of the open water season the analytical turnaround time will likely prevent discharge for the first few days; however, a similar sampling frequency will be used for the first two weeks of the discharge period (daily at depths of 1.0 m, 1.5 m and 2.0 m) and then decreased to once per week at a single depth of 1.5 m for the remainder of the discharge season.

Doris Creek Flow Monitoring

A pressure transducer will be installed at a suitable location within Doris Creek to facilitate real time monitoring of flow. The pressure transducer will be connected to a programmable logic controller (PLC) that would record flows in Doris Creek and be used to control the discharge flow rate. If initial monitoring suggests that greater accuracy is required, a flow monitoring weir may be constructed in Doris Creek at a location approximately 50 to 100 m upstream of the waterfall, as dictated by site conditions.

During periods of active discharge, the flow level in Doris Creek will be monitored visually on a daily basis, and checked against the real time monitoring results. For this purpose, a staff gauge will be installed at the location where the pressure transducer is located. The area will also be inspected on a daily basis for ice and any debris, and cleared as required to ensure accurate monitoring of flows.

Determination of the Discharge Rate

The discharge rate would be determined once it has been established that discharge may proceed. The following steps would be undertaken.

First, prior to discharge, Tail Lake water would be assessed to determine if it meets MMER criteria as listed in Table 3.8.

Table 3.8: Summary of MMER Criteria

Parameter	Units	Maximum Monthly Mean	Maximum in a Composite	Maximum Grab Sample
Arsenic (As)	ug/L	500	750	1000
Copper (Cu)	ug/L	300	450	600
Lead (Pb)	ug/L	200	300	400
Nickel (Ni)	ug/L	500	750	1000
Zinc (Zn)	ug/L	500	750	1000
Total Suspended Solids	mg/L	15	22.5	30
Total CN	mg/L	1.0	1.5	2.0
Radium 226	Bq/L	0.37	0.74	1.11

It is also a requirement of the MMER criteria that the water not be acutely toxic. If these criteria are exceeded, water would not be discharged from the TCA. For example, if the copper concentration is at or above 300 ug/L, water would not be discharged.

The baseline water quality monitoring results have indicated that occasionally some parameters may naturally exceed the CCME guidelines. While the intent is to not exceed CCME guidelines in Doris Creek, discharge from the TCA should be constrained only if the discharge water would further increase the concentrations of those parameters that exceed CCME guidelines. If, for example, selenium is the only solute in Doris Creek that exceeds its guideline (say at a concentration of 1.5 ug/L), and the selenium concentration in the TCA is below that (say 1.2 ug/L), then any amount of discharge would in fact cause a decrease in the selenium concentration downstream of the discharge point. The volume of discharge would then be determined subject to meeting CCME guidelines for all remaining parameters and selenium would be excluded as a constraint.

Therefore, the next step in determining the allowable discharge volume would be as follows. Solute concentrations in Doris Creek would be compared to the CCME guidelines for the protection of freshwater aquatic life as listed in Table 3.9, and those that exceed these values would be identified.

Table 3.9: Summary of CCME Water Quality Guidelines

Parameter	Units	CCME
		WQG
Aluminium (Al)	ug/L	100 ⁵¹
Arsenic (As)	ug/L	5
Cadmium (Cd)	ug/L	0.017
Chromium (Cr)	ug/L	1 ⁵²
Copper (Cu)	ug/L	2
Iron (Fe)	ug/L	300
Lead (Pb)	ug/L	1
Mercury (Hg)	ng/L	26
Molybdenum (Mo)	ug/L	73
Nickel (Ni)	ug/L	25
Selenium (Se)	ug/L	1
Silver (Ag)	ug/L	0.1
Thallium (Tl)	ug/L	0.8
Zinc (Zn)	ug/L	30
Ammonia-N	mg/L	1.27
Nitrate-N	mg/L	2.94
Nitrite-N	mg/L	0.060 ⁵³
pH	pH	6.5-9.0
Free CN	mg/L	0.005

⁵¹ Where CCME Guideline is dependent on other water quality values, the mean values of these parameters were used to calculate the guideline for the Doris North Project. Al is dependent on pH and hardness and thus this guideline value is a calculated value

⁵² The guideline for chromium is for Cr(VI+) and not total chromium; ammonia, nitrate and nitrite are in units of nitrogen equivalency

⁵³ The CCME Guideline for Nitrite was updated in December 2006 (Update 6.0.1) to reflect Nitrite measured Nitrite-nitrogen which is equivalent to 0.197 mg/L Total Nitrite.

For each parameter identified to exceed its CCME guideline in Doris Creek, its concentration in Doris Creek would be compared to its concentration in Tail Lake, and if the concentration in Tail Lake is above that in Doris Creek, water would not be discharged.

If the concentrations in Tail Lake of these parameters are below their corresponding concentrations in Doris Creek, these parameters would be excluded from further consideration in determining the allowable volume of discharge.

The Allowable Discharge Volume Ratio (ADVR) would be calculated as follows:

$$\text{ADVR}(\text{Cu}) = (\text{CCME}_{\text{Cu}} - [\text{Cu}]_{\text{DC}}) / ([\text{Cu}]_{\text{TL}} - \text{CCME}_{\text{Cu}})$$

Where: $[\text{Cu}]_{\text{DC}}$ = copper concentration in Doris Creek (mg/L),

$[\text{Cu}]_{\text{TL}}$ = copper concentration in Tail Lake (mg/L), and

CCME_{Cu} = CCME Freshwater Aquatic Guideline for copper (mg/L).

The ADVR for other key parameters would then be calculated on the same basis. The lowest ADVR (ADVR_{MIN}) would then be selected as the controlling ADVR. Note that nitrite is expected to oxidize rapidly within Doris Creek, and field monitoring would be undertaken to assess actual oxidation rates and determine allowances for calculation of the ADVR. For example, if the ADVR for chromium is 0.23 and that for copper is 0.35, then the ADVR for chromium would be selected for further evaluation.

The key parameters (parameters of concern) that will be measured for effluent characterization and water quality monitoring are listed in Table 3.10.⁵⁴

⁵⁴ Section 5.2.3 and Table 5.1, Water Quality Model, Supporting Document S6 to the Revised Water License Application Support Document, April 2007.

Table 3.10: Parameters to be measured for effluent characterization and water quality monitoring

Deleterious substances and pH ^{1,2}	Required Effluent Characterization and Water Quality Monitoring Parameters ^{2,3}	Required Additional Water Quality Monitoring Parameters	Site-Specific Parameters ⁶
Arsenic	Aluminium	Dissolved oxygen ⁵	Chromium
Copper	Cadmium	Temperature ⁵	Manganese
Lead	Iron		Selenium
Nickel	Mercury ⁴		Total phosphorus
Zinc	Molybdenum		Nitrite ⁷
Radium 226	Ammonia		Conductivity
Total cyanide	Nitrate		Calcium
Total suspended solids	Alkalinity		Chloride
pH	Total hardness		Magnesium
			Potassium
			Sodium
			Sulphate
			Dissolved organic carbon ⁵ Total organic carbon ⁵

Notes:

1. List of parameters regulated (deleterious substances and pH) as per Schedule 3 of the MMER; concentration limits specified in the regulation (Schedule 4).
2. All concentrations are total values; dissolved concentrations may also be reported; effluent loading (Section 20 of MMER) will also be calculated and reported.
3. List of parameters required for effluent characterization and water quality monitoring as per Schedule 5 of the MMER
4. Analysis of mercury may be discontinued if the concentration of total mercury in effluent is less than 0.10 µg/L in 12 consecutive samples of effluent.
5. In situ measured parameters only for water quality monitoring (in receiving waters).
6. These other parameters are potential contaminants or supporting parameters; analysis is optional and may be added based on site specific historical monitoring data or geochemistry data.
7. Nitrite will not be considered as a controlling parameter for the calculation of the ADVR and TDR unless actual concentrations significantly exceed the predicted values

In the next step, the target discharge rate (TDR) is calculated as follows:

$$TDR = Q_{DC} * 0.8 * ADVR_{MIN}$$

Where: TDR = target discharge rate (m³/s), and

ADVR_{MIN} = lowest allowable discharge ratio.

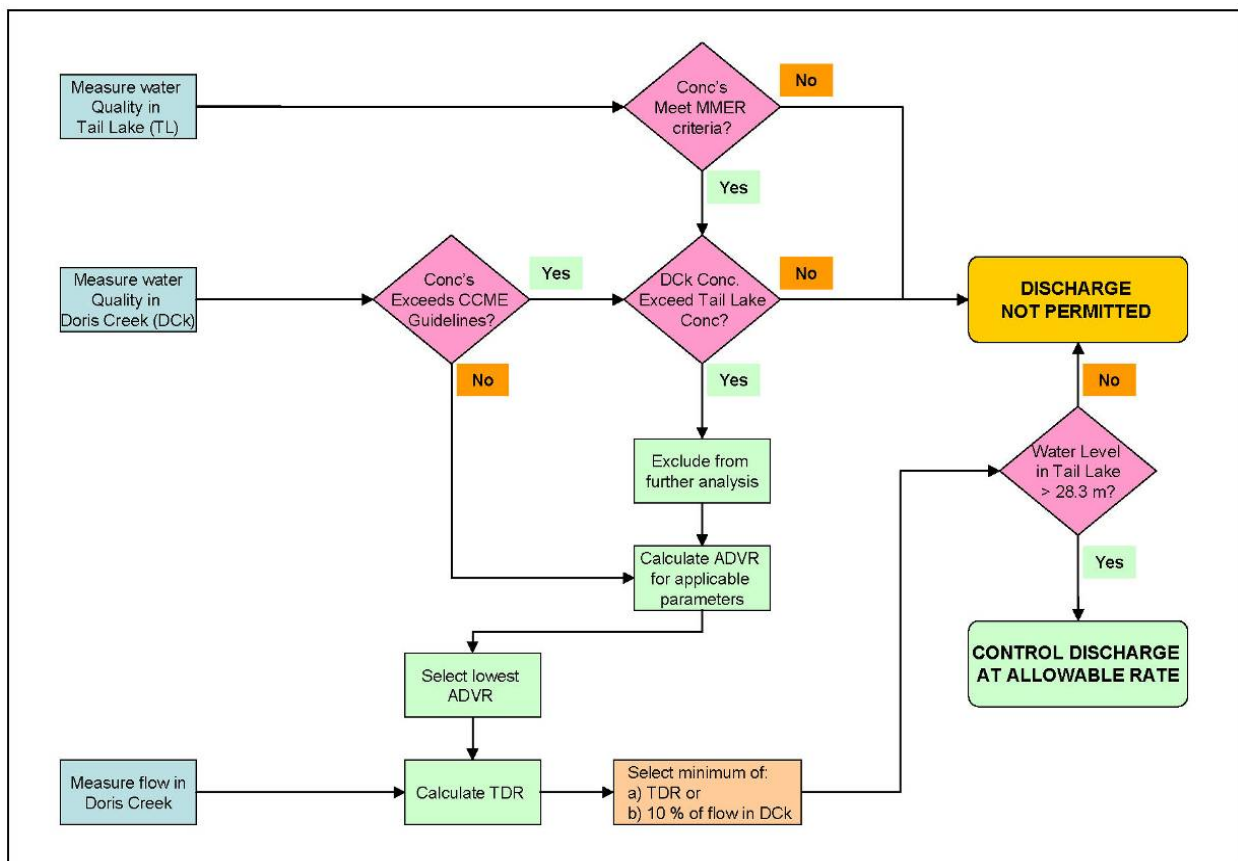
The factor 0.8 is a factor of safety that will ensure that the discharge flow remains at or below 80 percent of the maximum flow rate at which concentrations would be equal to CCME guidelines in Doris Creek. This conservatism is applied to allow for potential upset conditions in flows or analytical results.

Furthermore, the control simulation modeling⁵⁵ indicated that, initially when the solute concentrations are low in Tail Lake, there may be no constraints on the discharge rate. For this reason two additional constraints have been placed on the discharge rate as follows:

- First, the discharge rate cannot exceed 10 % of the flow in Doris Creek; and,
- Second, the water in Tail Lake will not be drawn down below the current elevation of 28.3 m ASL to ensure that an adequate water cover is maintained.

The overall decision process is illustrated in Figure 3.4.

Figure 3.4: Decision Flow Diagram for Determining Discharge Flow Rate



⁵⁵ See Section 6, Water Quality Model, Supporting Document S6 to the Revised Water License Application Support Document, April 2007.

The ADVR and TDR will be calculated at least once every 48 hours during the discharge season, with the calculation tied to the frequency of water quality monitoring analytical data provided by the on-site environmental laboratory. The ADVR and TDR will be calculated for each set of water quality data obtained.

How often the ADVR and TDR are to be re-calculated should be tied to the rate of change of water quality within Tail Lake and Doris Creek. Given the relative sizes of these water bodies, MHBL does not expect that the water quality within the two water bodies will change very quickly. Consequently MHBL has proposed that the ADVR and TDR be re-calculated every second day.

This assumption will be verified through water quality monitoring conducted once operations begin. The results of this monitoring will be plotted for each measured parameter against time. From these data, the rate of change for each parameter can be determined and compared to its water quality objective, and the operational or active ADVR. For example if the rate of change of copper concentration is less than 2 ppb per month in Tail Lake, and at a dilution of about 20:1 in Doris Creek, the rate of change in the receiving environment would translate to a net incremental increase of 0.1 ppb in the receiving environment over a one month period at the proposed fixed ADVR. In such a case, sampling and analysis every second day is not likely to be meaningful. A frequency of once per week will be more reasonable in this case, if only to confirm that concentrations are not changing rapidly. The water quality modeling indicates that the rate of change is likely to be very small—in the order of about 0.5 ppb per month during operations. Based on this example, the anticipated change over a one month period would be well within analytical error, and could not be reliably detected.

MHBL will determine the rate of change for all key parameters before making a decision to reduce the sampling and analytical frequency. If these calculations indicate that the water quality in Tail Lake is changing at a significantly more rapid rate than predicted then MHBL will return the frequency at which the ADVR and TDR are calculated to once every 24 hours. This will also require a similar increase in the frequency of water quality sampling and analysis for both sampling points used in this calculation.

Discharge Control

The discharge system will include the installation of a discharge control system that will accurately control and measure the discharge flow rate over a flow range spanning 50 L/s to 275 L/s. A programmable logic controller (PLC) will be used to control the discharge rate, as well as log instantaneous flow rates and cumulative discharge volumes. The flow would be controlled with an actuated flow control valve, with excess flow recycled back to Tail Lake. The PLC will actuate the flow control valve to discharge Tail Lake water at a fixed ratio, equal to the TDR, relative to the flow in Doris Creek.

Discharge will occur 24 hours per day, 7 days per week during the open water season, and will commence as soon as practical after the start of the open water season, providing that the operating conditions as set out above are being met. The real time flow monitoring and PLC control will allow the discharge rate to be adjusted on a continuous basis to meet the target discharge rate.

The start of the discharge season will not start until ice conditions allow for flow measurements within the Doris Creek, and the requirements under the MMER are verified, specifically:

- That water quality within Tail Lake meets the MMER regulated discharge limits; and
- The water in Tail Lake passes the LC₅₀ fish toxicity test

The pump intakes in Tail Lake (for the operational period) will be mounted on a floating barge system well away from the tailings discharge point to minimize suspended solids in the intake. Silt curtains will be installed around the pump intake to minimize intake of suspended solids.

The discharge to Doris Creek will be located sufficiently downstream from the flow monitoring location to ensure that the discharge will not interfere with flow measurements in Doris Creek, but sufficiently upstream of the waterfall to ensure complete mixing with Doris Creek water. The outlet will be placed such that the discharge flow will not lead to erosion or degradation of the creek bed. This will be achieved by ensuring that the creek bottom at the point of discharge is armoured either by natural rock or by placing large pieces of non-acid generating rock to provide such armoring to prevent erosive scour at the point of discharge. MHBL will visually monitor the discharge location to ascertain whether significant erosive scour is taking place. MHBL does not feel that a diffuser mechanism will be required but if scour is noted, then a diffuser will be installed. Total Suspended Solids will be monitored in the Doris Creek monitoring point to be sited downstream of the waterfall and can be used as a backup to the visual monitoring discussed in the previous sentence.

Discharge from Tail Lake will always be proportional to the background flow in the Doris Creek and will increase flows within Doris Creek by no more than about 10% of background flows. Consequently the risk of downstream bank erosion is considered relatively small. Spring freshet flows are typically the highest natural flows seen in the creek, and these occur early in the open water season and quickly drop off (typically within two weeks). Consequently the risk of downstream bank erosion is at its highest during the peak freshet flow, and will quickly pass each spring. MHBL will visually monitor for such erosion during daily sampling at the monitoring point located downstream of the waterfall.

In the unlikely event that significant erosion resulting from the MHBL discharge is noted, then MHBL will initiate the following actions:

- Immediately terminate the discharge from Tail Lake to allow Doris Creek to return to natural background;
- Halt further discharge until the measured flow in Doris Creek falls to at least 90% of the measured peak freshet flow. At this point the discharge from Tail Lake can be re-started;
- Conduct additional geotechnical and geo-morphological inspections of the downstream banks where erosion was noted and develop an adaptive management plan;
- Consult with KIA, NWB and DFO once an adaptive strategy has been devised, and seek authorization for implementation of such a strategy.

Water sampling will be undertaken upstream of the discharge location in Doris Creek, at the end of pipe discharge from Tail Lake and downstream of the waterfall in Doris Creek. Results of the analyses of these samples will be used to verify the performance of the discharge system at regular intervals, and to make flow control adjustments, as appropriate.

As part of the control strategy, the actual water quality in Tail Lake will be compared with the predicted water quality on a monthly basis to assess the accuracy of the model. If significant deviation is noted, then the model will be recalibrated to the actual water quality observed in Tail Lake. The model will be rerun if there is a more than 20% deviation above the predicted concentrations for any of the critical or significant parameters (MMER, CCME). The model will then be rerun to assess potential implications on the discharge strategy and to determine future operational requirements. This comparison of actual water quality to predicted water quality in Tail Lake will be communicated to the NWB for inclusion in the public registry as part of the monthly Surveillance Network Program reporting. Model calibration would be required only if the model significantly underestimates solute concentrations in Tail Lake AND it is shown to potentially have a significant impact on the water management strategy.

3.6.6 Contingency Discharge Strategy

Tail Lake can be operated successfully at several lower than optimum discharge rates. In the event that maximum allowable discharge flow rates are lower than estimated in the water balance base case discharge scenario, the proposed control system will automatically adjust to the lower flow rates.

MHBL will monitor actual performance (water quality and volume) in Tail Lake from the start of operations, and will compare actual results with the modeled predictions. This will allow MHBL to adapt its water management strategy, if needed, as early as possible in the mine life.

In the unlikely event that no discharge is possible at or after commencement of operations, water balance modeling has shown that Tail Lake has sufficient capacity to store water for several years after operations would cease. During this time it will be possible to monitor changes in water quality in Tail Lake, and either commence active discharge if suitable conditions develop, or project water quality into the future to the time that the FSL will be reached. The effects of natural discharge would be re-assessed for that time, and if acceptable for natural discharge, Tail Lake would be allowed to fill to its FSL, and then allowed to overflow naturally until solute concentrations approach CCME guidelines to enable discharge of excess water contained in Tail Lake, and allow breaching of the North Dam. This represents the first contingency strategy.

A second contingency is available for the management of the water contained in Tail Lake. The water quality monitoring undertaken in the early stages of the 'holding' period will identify the solutes that may be of concern at the time the FSL is reached. This will provide ample time to identify water treatment requirements, if any, that may be applied to enable discharge of excess water when the FSL is reached. Construction and commissioning of a water treatment plant would represent a second level contingency; however, it is unlikely that this contingency would ever have to be developed.

The minimum design life of both dams has been set at 25 years. In reality, under the proposed water management strategy, the North dam will be breached by Year 9, and the water in Tail Lake will return to its original elevation of 28.3 m. Under this scenario, there will be no water ponding behind either dam.

Under the most conservative water balance assumptions, including upset conditions of extreme precipitation events, the fastest time that Tail Lake would take to reach the FSL is just under 5½ years. Using more realistic water balance assumptions, Tail Lake can operate as a zero discharge facility for at least 7½ years.

3.6.7 Tail Lake Shoreline Erosion

MHBL has acknowledged that there is a potential for shoreline erosion around Tail Lake as the permafrost shoreline is thawed through raising and lowering of the water level, and proposed an adaptive management plan to put mitigation measures in place. MHBL subsequently conducted an extensive literature search into the mechanics of shoreline erosion processes in permafrost environments, and subsequently developed a hypothesis for how shoreline erosion impacts can be estimated at Tail Lake. This hypothesis was subsequently used to redesign an appropriate mitigation plan for shoreline erosion, based on measurable environmental triggers. Baseline monitoring for these processes has already been put in place.

Five specific case studies used to develop the hypothesis were (1) Southern Indian Lake reservoir in northern Manitoba, (2) the Discovery Mine borrow pit in the NWT, (3) the Garrow Lake tailings impoundment at Polaris Mine, (4) three natural permafrost degradation and shoreline erosion features in the Doris North Project area, and (5) shoreline erosion features in Alaska.

Based on the estimated maximum erosion loss from Tail Lake at the dam FSL of 33.5 m, over an estimated 49 ha of inundated shoreline, the total suspended sediment load concentration in Tail Lake is estimated to be less than the MMER criteria, and therefore discharge is not likely to be affected.

Under the proposed mine development plan, the water level in Tail Lake is expected to rise from the pre-development elevation of 28.3 m to a flooded level of 29.4 m over the mine's operating life. There is concern that this rise in water level will result in the thawing of frozen marine sediments in the newly flooded shoreline, and that this thawing will result in sloughing and erosion of the thawed sediments into the lake. As part of the development plan, MHBL has proposed to install rock armouring over geotextile over the area it has identified as being most susceptible to such sloughing. This rock armour would be installed at the time of dam construction prior to the start of tailings deposition.

The total area of shoreline that will be inundated as the water level rises from 28.3 to 29.4 m is 12.9 ha. Through field investigations, MHBL has identified 40% of this 12.9 ha (30,600 square metres) as being most susceptible to such sloughing based on observed ground conditions (slope angle, etc). During dam construction, MHBL will place 25,800 square metres of geotextile and 7,600 cubic metres (15,800 dry tonnes) of quarried rock over half of this area (20% of the 12.9 ha), a 15,300 square meter area, to create a 0.5 m thick rock armour layer to prevent potential sloughing. Adaptive management will involve MHBL monitoring the area on an annual basis and placing additional rock armouring as needed to prevent further erosion.

MHBL has included within the closure plan cost estimate a contingency allowance for the placement of additional quarried rock and geotextile to stabilize potential shoreline erosion that may occur along the edges of Tail Lake once the North Dam has been breached. This is a

contingent measure in the event that receding water levels in Tail Lake following the breaching of the North Dam result in melting of frozen marine sediments and result in sloughing and erosion of the thawed shoreline into the lake after closure. The following allowance has been included for the placement of both geotextile and quarried waste rock onto the shoreline slopes to prevent such erosion:

- An allowance to armour the remaining 60% of the 12.9 ha surface area between the predevelopment lake level of 28.3 up to the planned flooded elevation of 29.4 m; 0.5 m thickness of placed quarried rock over 47,500 square metres of shoreline – 22,800 cubic metres (47,500 dry tonnes) of rock and 77,400 square metres of geotextile.

Consequently the closure cost estimate includes an allowance of \$1.2 million to cover this contingency measure, *i.e.*, placement of an additional 22,800 cubic metres of armouring rock and 77,400 square metres of geotextile.

3.6.8 Tailings Water Balance

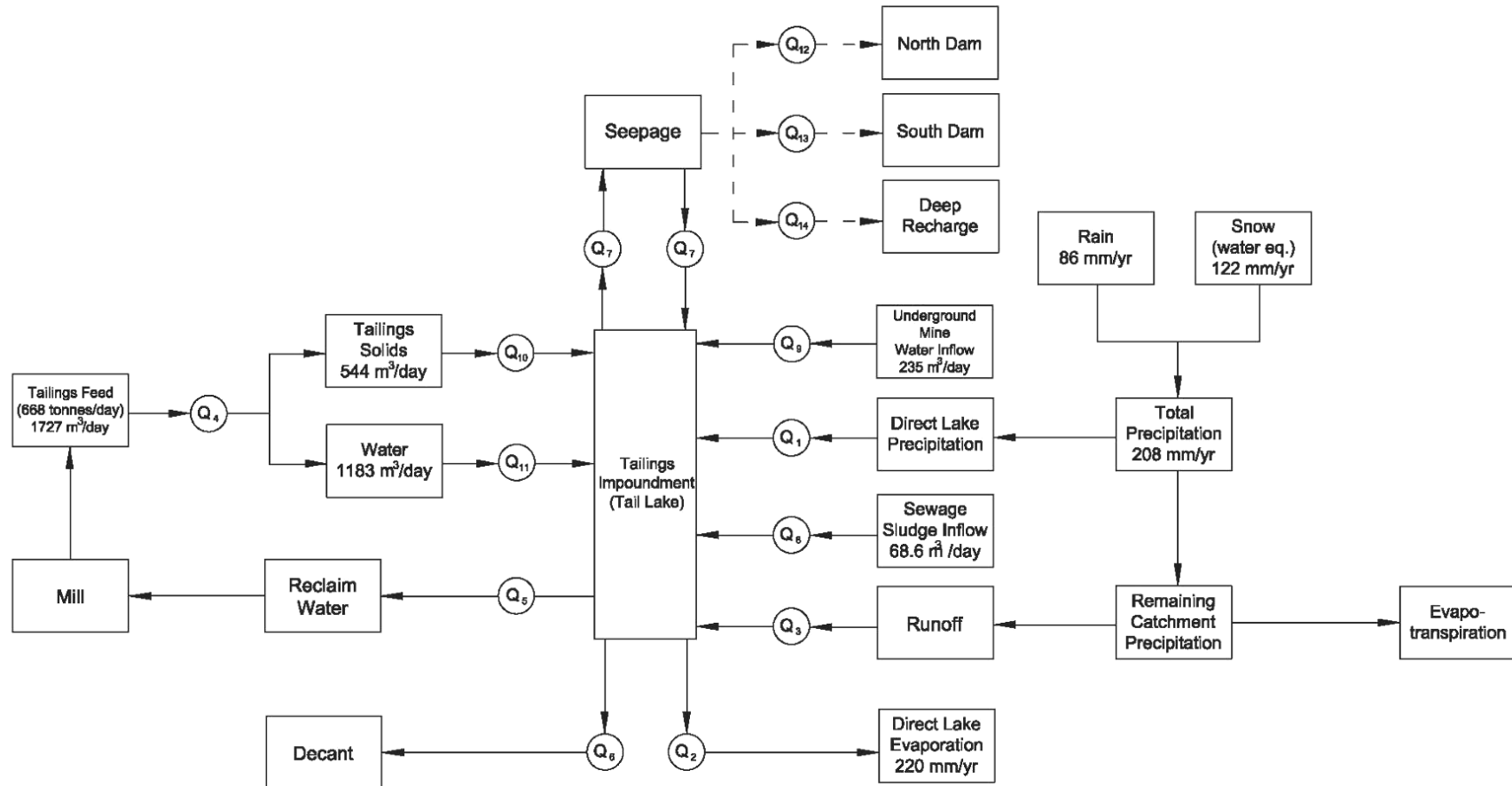
A water balance, as shown schematically in Figure 3.5, was developed for the Doris North Project to model potential receiving water quality that may result from various tailings management strategies. This section summarizes this water balance.⁵⁶

This water balance has been used in conjunction with other relevant technical data to determine the design height of the impoundment containment dams and to form the basis for the Tail Lake water quality predictions, both during operational, closure and post-closure periods.

The water balance illustrates that an operating FSL of 33.5 m for Tail Lake is appropriate. Under the most conservative water balance assumptions, Tail Lake can operate as a zero discharge facility for just under 5½ years before reaching FSL. Using more realistic water balance assumptions, Tail Lake can operate as a zero discharge facility for at least 7 ½ years.

⁵⁶ Additional information can be found in Section 6, Design of the Tailings Containment Area, Supporting Document S1 to the Revised Water License Application Support Document, April 2007.

Figure 3.5: Simplified Water Balance Schematic



The water balance also illustrates that, by allowing an annual discharge, the time to reach FSL in Tail Lake is dramatically increased. Allowing as little as 100,000 m³/year of discharge increases the time to FSL under the base case (Scenario #1) to just under 9 ½ years, which is a 27% increase in time. If the annual discharge is 500,000 m³/year, FSL in Tail Lake will likely not be reached, since the decant rate will exceed the annual inflow.

3.7 Storm Water Management

Storm water includes precipitation runoff and snowmelt. MHLB will intercept, collect and manage storm water from those areas of the mine site where the risk of contamination pick up is significant, specifically from:

- The camp and mill pad area where most of the surface mine related activities will occur;
- The lined fuel transfer station, the fuel tank farm and the landfarm facility;
- The non-hazardous landfill facility

The methods to be used to manage this storm water are covered in the Water Management Plan⁵⁷ and summarized in the following sub-sections:

Camp and Mill Pad Area, Temporary Waste Rock and Ore Stockpiles

The camp and mill pads will house all the processing and accommodation facilities for the Project. From a water management aspect, the following operational procedures will apply:

- The mill, crusher and workshop will be in individually enclosed buildings, and will have self contained sumps to contain any spills. Emptying of these sumps will depend on the nature of the spill, and may be returned to the mill or pumped to Tail Lake.
- The temporary waste rock pile is considered to be “dirty” water areas, and all runoff from these locations will be directed to the pollution control pond. Water in this pond will be pumped to Tail Lake.
- The remaining surface areas of the camp and mill pads are generally considered “clean” surfaces; however, all runoff and melt water from these pads will be collected in the sedimentation pond. Once suspended matter has settled, and if the water quality in the pond is deemed acceptable (meets the proposed discharge standards as set out in Table 6.6 – See Section 6.2 for a discussion of the discharge standard proposed by MHLB for this release), this water will be pumped out onto the tundra. If the water quality is not deemed to be of acceptable quality, it will either be used as mill make-up water or pumped to Tail Lake.

The sedimentation pond is designed to retain all surface water runoff and melt water from the remaining areas of the mill and the entire camp pad. The hydraulic design criteria are identical

⁵⁷ Section 6, Water Management Plan, Supporting Document S10j to the Revised Water License Application Support Document, April 2007.

to that for the pollution control pond.⁵⁸ The sedimentation pond is not lined. The run-of-quarry material that will be used to construct the pond will contain a significant amount of fines and the embankment retaining the water will be at least 8 m wide. Leakage is expected to be very low and as such will allow ample retention time to ensure settling of solids. However, once the pond has been constructed, the embankment will be inspected and if deemed too coarse, the upstream face of the dyke will be clad with a 12 oz geotextile to ensure appropriate retention time.

An emergency overflow is provided for the pond in the form of an outflow culvert located at the pond full supply level of 35.7 m. The overflow is provided such that the access road will not be overtopped during an extreme storm event. During the spring melt, the water collected in this sedimentation pond will be sampled by the on-site environmental personnel, and analyzed for pH, TSS, Total Ammonia, Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, Al, As, Cu, Fe, Pb, Ni, and Zn. Water will be pumped from the sedimentation pond onto the tundra, as long as it meets the proposed discharge standard. The water will be discharged to the area immediately to the south of the pond where it will have a ~500 m cross country flow path before reaching Doris Lake. Pumping from the sedimentation pond will only start once water in the pond has been verified as meeting the proposed discharge standards.

Once pumping starts, the discharge from the pond will be sampled daily for each day of pump operation, with the sample analyzed for pH, TSS, Total Ammonia, Total Sulphate, Total CN, Total Oil and Grease, Al, As, Cu, Fe, Pb, Ni, and Zn.

The ore stockpile area will be graded to drain towards the pollution control pond immediately downstream of the temporary waste rock pile.

The Temporary Waste Rock Pile Pollution Control Pond is designed to contain all surface runoff and melt water from the temporary waste rock pile. The pond is designed for full containment of the 1:100 year storm event of 24-hour duration, plus an additional freeboard of 0.3 m. Containment is provided, at least to the full supply level of 35.7 m, by an HDPE liner sandwiched between two geotextiles. A protective cover layer is placed over the liner. No emergency spillway is provided, since it is intended that pumping out of this facility be initiated whenever there is at least one hour of pumping capacity in the pond. The pond pumps are designed to completely empty the pond within six hours.

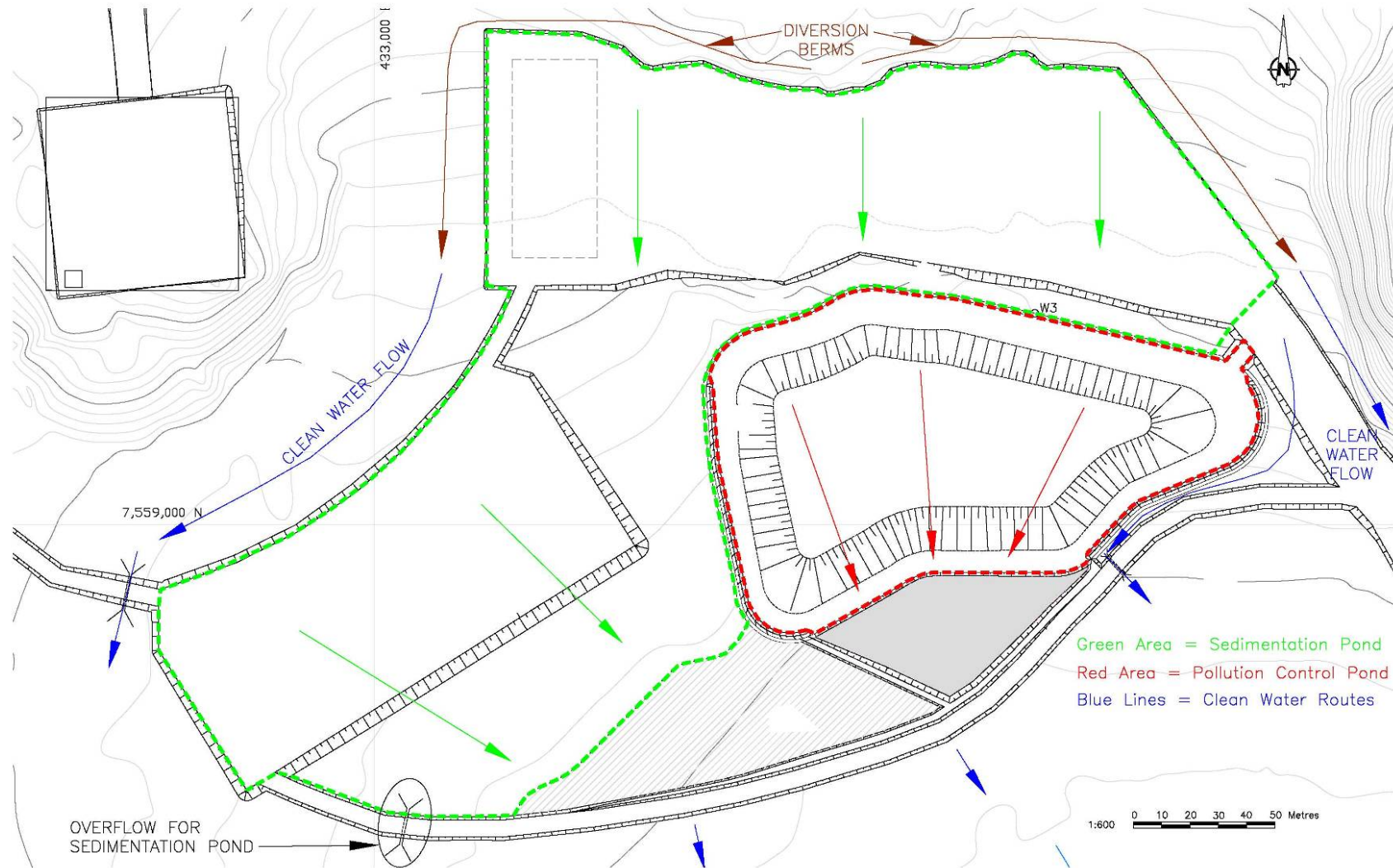
The water that accumulates within the Temporary Waste Rock Pile Pollution Control Pond is to be pumped to the tailings pump box within the mill so that it can be transferred to the tailings containment area. No water is to be discharged onto the surrounding tundra without the authorization of the Nunavut Water Board. The water that accumulates within the Temporary Waste Rock Pile Pollution Control Pond is to be sampled monthly during periods of open water and sent for analysis (pH, TSS, Total Ammonia, Total Sulphate, Total CN, Total Oil and Grease, Al, As, Cu, Fe, Pb, Ni, and Zn). The results are to be reported to the Nunavut Water Board under the Surveillance Network Program (SNP) contained within the water license.

The water flow pathways for the Camp and Mill Pad Area are shown on Figure 3.6. The blue arrows represent uncontaminated runoff directed by berms away from the pad area. This water

⁵⁸ Section 3.3, Design of the Surface Infrastructure Components, Supporting Document S2 to the Revised Water License Application Support Document, April 2007.

will be directed around the pad. The green arrows represent the runoff flow from the “clean” areas of the pad, which will be directed to the Sedimentation Pond. The red arrows represent the runoff flow from the “dirty” areas of the pad, which will be directed to the pollution control pond for transfer to the TCA.

Figure 3.6: Water Flow Patterns at the Camp and Mill Pad Area (Including the Temporary Waste Rock and Ore Stockpiles)



Storm Water and Snowmelt from the Fuel Transfer Station, Fuel Tank Farm and Landfarm Facility

The precipitation runoff and snowmelt collected in the sumps at the fuel transfer station, the fuel tank farm and within the landfarm facility will be treated by passing this water through an F1 “Flow and Plug” Oil Adsorption System (Model F11-C-180-TM-Cx2 as supplied by Terry Ruddy Sales of Edmonton Alberta). This is a portable unit set up on standard pallets so that it can be moved to the fuel transfer station, the fuel tank farm and the landfarm facility as and when needed. The system consists of a self priming electric positive displacement pump, a particulate filter, a drum containing TM-100 oil adsorbing media and two activated carbon media containers connected in series. The unit operates at 5 to 7 gpm. The unit is designed so that the TM-100 oil adsorbing media will blind off when it reaches its absorbent capacity. The unit will be moved into location soon after the spring snowmelt so that the sumps in the fuel transfer station, the fuel tank farm and the landfarm can be drained of precipitation runoff and snowmelt water collected inside the lined facility sump. The unit will then be moved back into the transfer station, the fuel tank farm and the landfarm whenever the sump fills (such as in the late summer or fall when precipitation falling as rain normally increases).

No allowance has been made to remove uncontaminated snow from each of these facilities (the fuel transfer station, the fuel tank farm and the landfarm) before the spring melt. It has been assumed that all snow collected in these three lined facilities will melt and have to be treated through the oil-water adsorption system. In reality, MHBL will attempt to remove uncontaminated snow from these facilities, specifically in areas of drift in the late winter ahead of the spring thaw. A combination of hand shoveling and a small bobcat front end loader will be used to clear this snow, where practical. This activity will be directed by the on-site environmental coordinator to ensure that the liner integrity is protected.

All precipitation runoff and snowmelt from these three facilities will be treated through the Oil Adsorption System, with the treated water then directed onto the nearby tundra to be land applied in a method that prevents erosion at the point of application. The discharge from the Oil Adsorption System will be sampled and analyzed on a once per day basis whenever the system is in operation.

Samples of the water collected within the landfarm facility liner will be conducted early each summer following the spring melt to determine water quality prior to the start up of the oil adsorption treatment system. The samples will be analyzed for pH, Total Suspended Solids, Total Oil and Grease, Benzene, Toluene, Ethyl benzene and Total Ammonia (Total Ammonia only at the landfarm as it is not expected to be present at the other two facilities).

The discharge from the Oil Adsorption system will be sampled and analyzed on a once per day basis whenever the system is in operation. The sample will be taken from the discharge of the oil adsorption system prior to this water being land applied onto the tundra. The samples will be analyzed for pH, Total Suspended Solids, Total Oil and Grease and Total Ammonia (Total Ammonia only at the landfarm as it is not expected to be present at the other two facilities).

In Section 6.2, MHBL has recommended a discharge standard that must be achieved for discharge of storm water and snowmelt (see Table 6.8) from these facilities.

Storm Water and Snowmelt Management at the Non-Hazardous Landfill Facility

Non-combustible and non-hazardous waste will be disposed of in a landfill that will be constructed in a portion of the rock quarry immediately west of the camp (Quarry #2). A surface area of at least 100 m x 100 m will be dedicated to the landfill. The landfill will be isolated from the surrounding watershed via a set of containment and barrier berms. The landfill surface will be graded towards a single sump to allow pump out of clean water directly onto the tundra, or contaminated water to a tanker and then on to Tail Lake. The landfill will be fenced, and access will be via a lockable vehicle gate. Geotechnical drilling⁵⁹ conducted in the winter of 2006 indicates that the rock in Quarry 2 is competent basalt and gabbro rock, with little variation in rock type with depth. The tightness of the bedrock and the presence of permafrost ensures that there is no potential for leachate to drain away from the landfill site through the underlying rock. Any drainage is predicted to be on surface across the floor of the quarry.

Uncontaminated precipitation runoff will be directed away from the landfill area by small rockfill berms located along the upslope edge of the quarry excavation. Similar rockfill berms constructed along the down slope edge of the quarry excavation will retain precipitation runoff and snowmelt within the landfill footprint. The floor of the quarry is founded on bedrock and will be sloped gently to drain into an excavated sump located at the south-east corner of the landfill area.

During the spring melt, the water collected in this sump will be sampled by the on-site environmental personnel, and analyzed for pH, TSS, Total Ammonia, Total Sulphate, Total CN, Total Oil and Grease, Al, As, Cu, Fe, Pb, Ni, and Zn.

Water will be pumped from the sump onto the tundra and be land applied, as long as the water quality is deemed to be acceptable (meets the proposed discharge standards as set out in Table 6.6 – See Section 6.2 for a discussion of the discharge standard proposed by MHBL for this release). This is the same discharge standard as proposed for the mill and camp pad sedimentation pond. Pumping from the landfill pollution control sump will only start once water in the sump has been verified as meeting the proposed discharge standards. Once pumping starts, the discharge from the sump will be sampled daily for each day of pump operation, with the sample analyzed for the same parameters during the spring melt.

The water will be discharged to an area immediately to the east of Quarry 2 where it will have a long cross country flow path before reaching Doris Lake. If water quality does not meet the proposed discharge standards, then the water contained in the landfill pollution control sump will be pumped into a truck mounted tank and transferred to the tailings containment facility at Tail Lake. This transfer of water will continue until sampling verifies that the landfill pollution control sump water complies with the proposed discharge standards.

⁵⁹ See Section 4.2.1 and Appendix C, Geochemical Characterization of Quarry Materials, Supporting Document S7 to the Revised Water License Application Support Document, April 2007.

The volume of water collected in the sump is expected to peak in the spring freshet, then remain relatively dry throughout the summer months, increasing during the final 30 days leading up to winter.

3.8 Waste Oil & Hazardous Waste Management

Waste oil will be burned on site in a dedicated waste oil burner specifically designed for that purpose. Unused explosives will be burned or destroyed on-site, and unused chemicals as well as any other hazardous material will be disposed of in an appropriate manner.

Other waste products, such as used glycol, vehicle batteries, waste grease, etc., will be packaged in appropriate containers and stored in a secure fashion pending shipment off-site for disposal in an appropriate manner. These materials will be placed into sea-can containers and held (pending shipment) on the plant site rockfill pad area where any spillage can be captured in the storm water sumps and directed to the tailings containment area.

As part of the Doris North Environmental Protection Plan, MHBL has prepared a Hazardous Materials Management Plan, which covers the management of waste oil and other hazardous wastes (other than tailings and waste water) generated by mine activity.⁶⁰ This Plan summarized in Section 4.5.

⁶⁰ Hazardous Materials Management Plan, Supporting Document S10e to the Revised Water License Application Support Document, April 2007.

4.0 ENVIRONMENTAL, HEALTH & SAFETY MANAGEMENT SYSTEM & PLANS

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MHBL is developing an integrated environmental health and safety management system (EHSMS) to encompass all of its operational activities at the Doris North Project. This system is under development and will be in place prior to the start 2008.⁶¹

MHBL management is committed to managing all aspects of their organizations' environmental, health and safety requirements and commitments through a formal, independently audited management system (EHSMS).

The EHSMS will be based on the most widely accepted international standards for environment – ISO 14001:04, and for health and safety – OHSAS 18001. A decision to certify the system(s) to these standards will be made in the future by MHBL management. The EHSMS will provide overall control over MHBL's commitments to meet all applicable laws and regulations, permit requirements, monitoring and reporting requirements, best management practices and community involvement programs.

The MHL EHSMS will be developed on the PLAN, DO, CHECK, ACT and continual improvement principles. Basically this approach ensures that expectations are clearly stated, all individuals understand their responsibilities in normal and accidental situations, there is regular monitoring of expected performance and changes made to the system as operations change or tests of the system indicate a need for change. At the heart of the system is a commitment to clear and appropriate communication – both internal and external.

A major component of this system is the Environmental Protection Plan (EPP), which encompasses the operational management plans covering how the key components and activities of the project will be managed and monitored, with the objective of minimizing the impact of the mine on the surrounding environment. This section summarizes the management and mitigation plans that have been developed for implementation at the Doris North Project.

All of these management and mitigation plans are considered “living documents”, that is, they are intended to be reviewed and amended on a regular basis to reflect lessons learned and to allow experienced input from the operational staff at the mine and other stakeholder groups, such as local communities, hunters and trappers associations, regulatory agencies, etc., to be incorporated in subsequent revisions. In other words, these plans will be modified and updated to adapt to lessons learned, i.e., adaptive management.

⁶¹ A description of the EHSMS framework is attached to this application as Environmental, Health and Safety Management System Outline, Supporting Document S9 to the Revised Water License Application Support Document, April 2007.

These Management Plans will be updated after the water license has been issued, to incorporate any new commitments made by MHBL during the license process and to incorporate conditions contained within the water license relating to environmental management.

At a minimum, these Management Plans will be reviewed annually during the first quarter of each calendar year by the mine's environmental staff, and will be updated as needed to reflect changes in operating procedures. The revised Plan will be made available to the appropriate mine operating staff, with appropriate refresher training, and will be sent to the Nunavut Water Board and to the Nunavut Impact Review Board Monitoring Officer for inclusion in the public registry.

The Environmental Protection Plan for the Doris North Project is attached to this application as Supporting Document S10, and encompasses the following management plans:

- S10a Emergency Response and Contingency Plan
- S10b Air Quality Management Plan
- S10c Noise Abatement Plan
- S10d Waste Rock Management Plan
- S10e Hazardous Materials Management Plan
- S10f Explosives Management Plan
- S10g Landfill Management Plan
- S10h Landfarm Management Plan
- S10i Tailings Management Plan
- S10j Water Management Plan
- S10k Quality Assurance/Quality Control Plan
- S10l Mine Closure and Reclamation Plan
- S10m Monitoring and Follow-up Plan
- Wildlife Mitigation and Monitoring Program; and
- Heritage Resource Protection Plan

While these last two plans have not been included in the water license application as they do not immediately deal with water related resources, they do form an important component of the EPP.

The following sections provide the reader with a high level summary of the objectives for each of these management plans:

4.1 Emergency Response and Contingency

MHBL has developed an Emergency Response and Contingency Plan for the Doris North Project.⁶² The following is a summary of the key elements of the Emergency Response and Spill Contingency Plan.

⁶² The Emergency Response and Contingency Plan forms a component of the Environmental Protection Plan for the Project, and is Supporting Document S10a to the Revised Water License Application Support Document, April 2007.

The Emergency Response and Contingency Plan was developed to establish a guidance document for emergency response at the Doris North Project site. The document includes information on response procedures, spill containment and clean up, and information on recommended clean up procedures for hazardous materials to be present on site. The Plan is intended to guide mine staff in their response to any site emergency that has the potential to adversely affect the natural environment and/or the safety of personnel. The plan is driven by the Miramar Hope Bay Ltd. (MHBL) environmental and safety policies and in compliance with regulatory requirements.

A focus of the Emergency Response and Contingency Plan is to provide:

- A clear chain of command, contacts and reporting procedures to be followed for all responses to spills and other emergencies;
- A framework to be followed to ensure that accountability for the performance of the spill and emergency response activities is defined and communicated to site staff before an event occurs;
- A defined list of responsibilities to be followed in conducting spill clean up and emergency response activities established and communicated to site staff before an event occurs;
- Information on available resources and potential operational hazards/risks that may be encountered during spill clean up and emergency response activities.
- Reporting and record keeping requirements for spill and emergency response to facilitate tracking of response progress, incident investigation and mitigation planning after the event.

The plan will be a “living” document, and will be updated on a regular basis as new information comes to light or procedures, permits and authorizations change. The responsibility for the administration of the plan will rest with the Mine General Manager. The Environmental Department will support the Manager, and shall, in conjunction with the Safety Department, review the plan on a regular basis and update as needed. The plan will also be reviewed periodically by the mine Occupational Health and Safety Committee.

The purpose of the emergency response component of this document is to act as a general resource for each member of Management and all employees to enable them to react to emergencies at the Doris North site. The plan will act as a guidance tool to ensure immediate and effective handling of any emergency. Prompt, effective and organized Emergency Response by the company will ensure safety of the employees, minimize the affect on the environment and maintain effective communication with the regulatory agencies.

Recognizing that spills or leaks of petroleum products and chemical substances have the potential of posing a variety of hazards, and can endanger both short or long term public health and the environment, MHBL has developed a Spill Response Plan to address accidental releases of hazardous substances. Hazards that may exist at Doris North include the release of toxic vapors, fire, spills, and explosions.

The principal objectives of the Spill Response Plan component of this plan are:

- To provide information to cleanup crews, employees, contractors, KIA, and government agencies in the event of a spill;
- To promote the safe and effective recovery of spilled materials; and
- To minimize the negative impacts of spills on the receiving environment (water/ice and/or land).

The spill response component of this plan addresses the organization of the Doris North Project spill response and related emergency measures. Alerting and notification procedures and cleanup strategies are outlined along with the duties and responsibilities of key spill response personnel.

4.2 Air Quality Management Plan

Miramar Hope Bay Ltd. has developed an air quality management program as part of the Doris North Project permitting phase.⁶³ The following is a summary of the key elements of the Air Quality Management Plan:

- control measures that will be established to mitigate combustion and fugitive emissions from the Project;
- a monitoring plan to collect on-site air quality and meteorological data to allow for an adaptive approach to air quality management at the Doris North Project.

4.3 Noise Abatement Plan

Miramar Hope Bay Ltd. has developed a Noise Abatement Plan.⁶⁴ The following is a summary of the key elements of the Noise Abatement Plan.

This Plan is designed to provide information on monitoring and mitigating noise as required under Condition 3 of the Doris North Project Certificate. The intent of this plan is to detail the monitoring and control program for environmental noise, as well as outline the requirements for occupational noise monitoring, control and worker protection.

The environmental noise follow-up monitoring program described in the Plan indicates location, duration, timing and type of noise monitoring to be conducted, as well as provides a description of noise control methods that can be employed should mitigation be required.

Occupational related noise management program included in the Plan will be an integral part of the on-site health and safety program. This section of the Plan describes the commitments and philosophy for noise control in relation to employee health as a

⁶³ The Air Quality Management Plan forms a component of the Environmental Protection Plan for the Project and is attached as Supporting Document S10b to the Revised Water License Application Support Document, April 2007.

⁶⁴ The Noise Abatement Plan forms a component of the Environmental Protection Plan and is attached as Supporting Document S10c to the Revised Water License Application Support Document, April 2007.

reference for the Occupational Health and Safety Program that has been developed for construction and operation activities at Doris North.

4.4 Waste Rock Management Plan

MHBL has developed a Waste Rock Management Plan for the Doris North Project.⁶⁵ The following is a summary of the key elements of the Waste Rock Management Plan.

MHBL does not plan to use any of the underground waste rock for construction of the site roads, building pads, laydown areas, tailings dams or other site infrastructure to ensure that only non-acid generating rock is used in such construction. Under the mining plan, it is expected that all development waste rock will be used internally as backfill within the mine workings. All of the underground waste rock brought to surface will be placed onto the temporary waste rock stockpile to be returned into the underground mine during the mine life. All waste rock brought to surface through the development of the underground mine will be placed into storage in a temporary waste rock pile to be constructed immediately to the south of the ore stockpile and portal access road. The pile will be constructed within a berm designed to contain and direct all runoff from the pile into a dedicated runoff collection pond. Berms will also direct clean runoff away from the waste rock pile. The water collected in the runoff collection pond will be pumped to the tailings impoundment area via the mill pump box.

In the event that during the mine life, MHBL wishes to use some of the underground waste rock for use on surface for some unspecified purpose such as cover material in the non-hazardous landfill area then the following procedures will be used to demonstrate that such rock is suitable for such use:

- Only waste rock that has been demonstrated through confirmatory test work to be non-acid generating and non-metal leaching will be allowed for use on surface;
- Acid Base Accounting test work will be used to demonstrate that underground waste rock is suitable for use on surface. Typically one ABA test for every 5,000 tonnes of rock to be used will be needed to meet this requirement assuming that the 5,000 tonnes is all from one rock lithology and location; and
- The NPR value derived from the ABA test must exceed 3.0 to meet the threshold of being classified as non-acid generating for this purpose.

4.5 Hazardous Materials Management Plan

MHBL has developed a Hazardous Materials Management Plan for the Doris North Project.⁶⁶ The following is a summary of the key elements of the Hazardous Materials Management Plan.

⁶⁵ The Waste Rock Management Plan forms a component of the Environmental Protection Plan for the Project and is attached as a Supporting Document S10d to the Revised Water License Application Support Document, April 2007.

⁶⁶ The Hazardous Materials Management Plan forms a component of the Environmental Protection Plan for the Project and is attached as a Supporting Document S10e to the Revised Water License Application Support Document, April 2007.

The purpose of this document is to provide a consolidated summary of information on the safe and environmentally sound transportation, storage, and handling of the major hazardous products to be used at the Doris North Project both during the construction and operational phases. These procedures are an integral component of the overall Environmental Protection Plan (EPP) for the proposed Doris North Project, and will be periodically reviewed and updated as the Doris North Project moves through environmental permitting, construction, operations, and final closure and reclamation. It should be noted that many of the hazardous materials discussed in these procedures are to be used in the extraction of gold in the mill, and consequently, will not be shipped to or used on site until the beginning of the operational phase (shipped on the second construction sea lift in the summer of 2008).

A hazardous material is one that, as a result of its physical, chemical, or other properties, poses a potential hazard to human health or the environment when it is improperly handled, used, stored, disposed of, spilled or otherwise managed. In combination with MHBL's "Emergency Response and Contingency Plan" the Hazardous Materials Management Plan (HMMP) provide instruction on the prevention, detection, containment, response, and mitigation of accidents that could result from handling of hazardous materials at the proposed Doris North Project.

The Doris North Project will use the following types of hazardous materials in the day to day operation of the underground mine, and in the extraction of gold from the ore mined:

- Fuel and Lubricants – diesel fuel, oils, greases, anti-freeze, and solvents for power generation, building heating, equipment operation and maintenance;
- Process Plant/Milling Reagents/Consumables – Potassium Amyl Xanthate flotation collector, Aerophine 3418 Flotation Promoter, methyl isobutyl carbinol (MIBC) flotation frother, sodium cyanide for gold leaching, activated for gold recovery in the Carbon-in-Leach circuit, caustic soda, hydrogen peroxide for effluent treatment, sulphuric acid for effluent treatment, copper sulphate for effluent treatment, sodium matabisulphite for effluent treatment and borax, sodium nitrate, silica sand for bullion refining;
- Explosives – ammonium nitrate and high explosives used for blasting in the mine;
- Laboratory chemicals – small volumes of various chemicals in the on-site analytical laboratory to analyze rock and water samples for grade control, to monitor metallurgical performance and to monitor environmental performance.

The procedures contained within the Hazardous Materials Management Plan are based on the following principles for best practice management of hazardous materials:

- Purchasing controls – control of shipping methods, appropriate packaging, shipping schedules, etc.
- Shipment Tracking procedures;
- Inventory controls on site – periodic inventory of materials in storage on site to determine usage and to identify and manage any unexpected loss;

- Maintenance of current safe handling and storage procedures – MSDS, WHMIS, TDG data and labelling – made available to those in contact throughout the operational site;
- Characterization of potential environmental hazards posed by these materials through the Environmental Management System;
- Allocation of clear responsibility for managing shipment, storage, handling and use of potentially hazardous materials;
- Defined methods for transport, storage, handling, and use;
- Identification of disposal methods for potentially hazardous waste generated from use of these products;
- Preparation of contingency and emergency response plans;
- Adequate type and delivery of training for management, workers, and contractors whose responsibilities include handling potentially hazardous materials;
- Maintenance and review of records of hazardous material consumption and incidents in order to anticipate and avoid impacts on personal health and the environment; and
- Procedures to track and manage wastes generated through use of these products, including regular shipments of potentially hazardous waste to appropriate licensed disposal facilities following all relevant regulatory requirements (packaging, labelling, inventory tracking and waste manifesting).

MHBL requires that the transportation, storage, handling and use of hydrocarbon based products, ammonium nitrate, and all other chemicals to be used at the proposed Doris North Project be conducted in a safe and efficient manner. Prevention, detection, containment, response, and mitigation are the key elements in the management of hazardous materials. MHBL is committed to minimizing the potential for adverse environmental effects on terrestrial and aquatic biota and ecosystems that may result from accidental release. The first step in accomplishing this is to apply consistent practices towards the management of hazardous materials site-wide. MHBL will incorporate proper hazardous material management procedures into its environmental management plans and systems for the proposed Doris North Project to reduce risk of accidental release.

All hazardous materials to be used at the Doris North operation will be manufactured, delivered, stored, and handled in compliance with all applicable federal and territorial regulations, as well as ISO 9001 Quality Standards.. MHBL is committed to preventing, to the greatest extent possible, both inadvertent release of these substances to the environment and accidents resulting from mishandling or mishap. MHBL will institute programs for employee training, facility inspection, periodic drills to test systems, and procedural review to address deficiencies, accountability, and continuous improvement objectives.

MHBL will actively work towards minimizing the generation of hazardous wastes by investigating alternatives to the use of hazardous materials, by recycling products and containers wherever feasible, and by treating wastes using state-of-the-art technologies before any release to the environment.

As with all other aspects of health and safety policy at the Doris North Project, all employees will be expected to comply with all applicable precautions and handling procedures with regard to hazardous materials. Employees are also expected to report any concerns to their supervisors, the Health and Safety Committee, or senior site management. All staff are encouraged to bring forward suggestions for improvements that can be incorporated into procedure revisions as appropriate.

4.6 Explosives Management Plan

MHBL has developed an Explosives Management Plan for the Doris North Project.⁶⁷ The following is a summary of the key elements of the Explosives Management Plan.

The Explosives Management Plan for the Doris North Project provides pre-construction information on explosives transport, storage and handling at the site. It is intended to provide MHBL staff with an overview of how explosives are to be stored and managed at the Doris North site to ensure protection of the surrounding environment.

Explosives will be used at Doris North for blasting of the underground mine development headings and for production stope blasts. Explosives will also be used during the construction phase of the Project to extract broken rock from the four quarry sites for construction of the site facilities (roads, airstrip, building pads, jetty, tailings dams, etc.).

The plan covers procedures for explosives handling and environmental management to minimize negative effects from explosives use. Doris North will be an underground mine and the quantity of explosives on hand and used on an annual basis will be relatively small (approximately 700 tonnes of ammonium nitrate manufactured into ANFO on site, and 38 tonnes of packaged high explosives). All explosives (and other bulk supplies) will be delivered annually in a marine sealift to Roberts Bay. Explosives and other hazardous supplies will be shipped in sea-can containers. Sea-can containers will be offloaded from the barges and trucked to their storage locations at the mine site.

Manufacture of ANFO will be contracted out by the Mine to a qualified blasting contractor who will mix ammonium nitrate and fuel oil (ANFO) in a contractor-supplied mixing building, and deliver the ANFO underground for use by certified mine personnel in mine development.

MHBL's use of explosives must be compliant with all pertinent regulations, including the Canadian Explosives Act, the Explosives Use Act (Nunavut) and the Mine Health and Safety Act and associated regulations (Nunavut). MHBL requires that all employees act in a manner to ensure this compliance. MHBL will provide appropriate training to all employees who will come into contact or who will use explosives on site, to ensure that these requirements are understood and met. MHBL will conduct weekly inspections of its explosives handling facilities to audit compliance with these requirements. MHBL will conduct monthly inventory checks of explosive use on site of in an approved acceptable manner following consultation with the land owner, regulatory agencies and the

⁶⁷ The Explosives Management Plan forms a component of the Environmental Protection Plan for the Project and is attached as a Supporting Document S10f to the Revised Water License Application Support Document, April 2007.

explosives supplier to manage usage and minimize waste. All spills of explosives will be cleaned up immediately, logged, and reported on the Nunavut spill line.

At the cessation of further mining activity on site, all unused explosives will be removed from site or disposed.

4.7 Landfill Management Plan

MHBL has developed a Landfill Management Plan for the Doris North Project.⁶⁸ The following is a summary of the key elements of the Landfill Management Plan.

The Landfill Management Plan provides information on how inert industrial wastes will be handled in a safe and environmentally sound manner at the Doris North Project.

All solid non-combustible, non-hazardous waste will be disposed of in a portion of the rock quarry (Quarry 2) immediately west of the camp. An area approximately 100 m x 100 m will be dedicated to landfill operations. The final quarry configuration will consist of a flat surface, graded in the down slope direction. Uncontaminated storm and melt water will be diverted away from the landfill by small rockfill berms constructed along the upslope edges of the quarry excavation. Snow melt and precipitation falling on the landfill area will be contained within the landfill area by small rockfill berms constructed along the down slope edges of the quarry excavation. This water will be collected in a pollution control sump located in the southeast corner of the landfill area, and discharged by land application onto the adjoining tundra if measured water quality complies with the discharge limits contained within the water license. Water that does not comply with these limits will be transferred by tank truck to the tailings containment area.

Upon closure, the landfill disposal site will receive a final cover of non-acid generating rock, the surface will be re-graded to blend in with the surrounding terrain, and surface drainage will be directed away from the site.

4.8 Landfarm Management Plan

MHBL has developed a Landfarm Management Plan for the Doris North Project.⁶⁹ The following is a summary of the key elements of the Landfarm Management Plan.

The Landfarm Management Plan provides information on contaminated soil and snow handling in a safe and environmentally sound manner at the Doris North Project. Landfarming is a form of bioremediation that uses naturally occurring micro-organisms contained within the soil (yeast, fungi or bacteria) to metabolize or break down petroleum hydrocarbons. Natural processes include volatilization, aeration, biodegradation and photolysis. End products are micro-organism protein, carbon dioxide and water. Stimulation of microbial growth and activity for hydrocarbon removal is accomplished

⁶⁸ The Landfill Management Plan forms a component of the Environmental Protection Plan for the Project and is attached as a Supporting Document S10g to the Revised Water License Application Support Document, April 2007.

⁶⁹ The Landfarm Management Plan forms a component of the Environmental Protection Plan for the Project and is attached as a Supporting Document S10h to the Revised Water License Application Support Document, April 2007.

primarily through the addition of air and nutrients (metabolism of hydrocarbons is mediated predominantly through aerobic microbes).

The proposed landfarm will be approximately 50 m by 25 m constructed within Quarry 2, and thus, will be within a controlled drainage area (i.e., built on top of the bedrock floor in the quarry). The landfarm will be bermed and underlain by a geomembrane to prevent leachate flows out of the facility. No hazardous wastes other than petroleum-stained soil and snow will be placed in the landfarm. Operation of the landfarm will be monitored and soils tested annually. Once remediated in accordance with the Nunavut Environmental Guidelines for Soil Remediation (Industrial Standard), as verified by laboratory analysis, soils will be used for progressive site reclamation in an opportunistic fashion.

On final closure, any contaminated soil that has not yet been remediated that remains within the landfarm facility will be placed underground and encapsulated in permafrost.

4.9 Tailings Management Plan

MHBL has developed a Tailings Management Plan for the Doris North Project.⁷⁰ The purpose of this document is to provide a consolidated source of information on the strategy to be applied at the Doris North Project to manage the deposition and containment of mill tailings. The tailings management strategies for the Doris North Project have been previously described in Section 3.6, and consequently, have not been repeated here.

4.10 Water Management Plan

MHBL has developed a Water Management Plan for the Doris North Project.⁷¹ The purpose of this document is to provide a consolidated source of information on the strategy to be applied at the Doris North Project to manage:

- The containment, monitoring and release of snowmelt and rainwater that comes in contact with the Doris North plant site area; and
- The containment and release of excess water from the Tail Lake tailings containment system.

The water management strategies for the Doris North Project have been previously described in Sections 3.5, 3.6 and 3.7, and consequently, have not been repeated here.

⁷⁰ The Tailings Management Plan forms a component of the Environmental Protection Plan for the Project and is attached as a Supporting Document S10i to the Revised Water License Application Support Document, April 2007.

⁷¹ The Water Management Plan forms a component of the Environmental Protection Plan for the Project and is attached as a Supporting Document S10j to the Revised Water License Application Support Document, April 2007.

4.11 Quality Assurance/Quality Control Program

MHBL has developed a Quality Assurance/Quality Control Plan for the Doris North Project.⁷² This plan is intended to ensure sound QA/QC practices are followed, where applicable, for all environmental sampling and monitoring.

This QA/QC Plan was developed prior to the start of project construction, and is intended to provide a framework and general guidance for quality assurance/quality control practices at the Doris North Project site both during the construction and operational phases of the project. Quality assurance (QA) and Quality Control (QC) are important components of the environmental management program for this project. This QA/QC Plan has been prepared in accordance with "QA/QC Guidelines for use by Class "A" Licensees in Meeting Surveillance Network Program Requirements and for Submission of a QA/QC Plan" published in July 1996 by the Water Resources Division of the Department of Indian and Northern Affairs and the Northwest Territories Water Board.

Through implementation of the Quality Assurance and Quality Control (QA/QC) Plan, MHBL will ensure that sampling methods and analytical data are of the highest calibre. Proven scientific management practices are to be employed throughout the sampling program. All samples are currently being delivered to an accredited external environmental laboratory for analysis. This will continue until the on-site environmental lab is functional and generating results that have been checked against the outside lab. Analysis of compliance samples will continue to be sent to an accredited external lab.

This document describes the procedures to be used by MHBL personnel when conducting environmental water samples. Minimum criteria for sample collection, preservation, documentation, transportation, and data management are established and applied to samples from the Doris North Project. These procedures have been developed from literature and guidelines intended to promote good practices in field sampling and sample handling, which will provide assurance of the quality of the resulting data. This document will be reviewed on a regular basis with the intent to continually improve environmental performances.

The QA/QC Plan is primarily intended to be read, understood, and implemented by company personnel involved in water quality monitoring. The procedures are applied to all environmental water samples, whether analyzed for the purpose of regulatory compliance monitoring, or for the purpose of environmental management on site.

MHBL has a Quality Assurance/Quality Program in place that was developed for the current exploration water licenses for the Windy and Boston Exploration sites. It has been adapted for use at the Doris North Project and covers all environmental monitoring sampling procedures. This Plan will be updated to reflect the on-site laboratory sample handling and analytical procedures specific to the Doris North Project prior to the start of

⁷² The Quality Assurance/Quality Control Plan forms a component of the Environmental Protection Plan for the Project and is attached as a Supporting Document S10k to the Revised Water License Application Support Document, April 2007.

milling operations at the end of 2008. MHBL will register and seek accreditation of its on-site laboratory under the Canadian Association of Environmental Analytical Laboratories (CAEAL) and will work to maintain certification for the key water license discharge parameters during the mine's life.

In the intervening period, Quality Assurance/Quality Control standards covering baseline data collection have been implemented by the consultants collecting data on behalf of MHBL, specifically Golder Associates. Typically these procedures are summarized as follows:

- **Field Protocol:** To check on the precision of the samples collected, periodic duplicate water samples are submitted for testing. A duplicate sample requires that the sample collector fill two sampling sets (group of bottles from two different samples at the same depth). Since sampling takes place over three seasons, no spatial bias towards any specific site or temporal bias towards any season is incorporated into the sampling program. The sampling program will also submit blind duplicates for analysis (i.e., duplicate samples not labeled with the location).

To ascertain whether contamination has reached the samples, field blanks are incorporated into the sampling process. A field blank is a set of bottles filled with demineralized, de-ionized water (supplied by the lab) and processed in the same manner as a collected water sample. These blanks are used for each sampling session. All blanks are filled in the field to ensure that they undergo the same conditions and procedures as the water samples. One field blank is processed for each sample collection period.

The third level of quality control is a check on the laboratory's precision and accuracy by preparing a split sample in the field. A split sample is a discrete water sample separated into two identical tests. The water sample is collected at one time and at a specific depth. In theory, the same results should be achieved when analyzed by the laboratory. Typically one split is processed for each sample collection period.

- **Laboratory Protocol:** Laboratory quality assurance/quality control (QA/QC) measures typically consist of a routine program to check the accuracy and precision of the analyses and to ensure that laboratory contamination will not contribute to the results. These programs are typically conducted in-house by the laboratory. It involves checking every 20 to 25% of the total number of samples being analyzed. It also includes triplicate, blank and split samples collected in the field.

These quality assurance/quality control procedures will be carried forward by MHBL and will become part of the QA/QC Plan for the Mine before the on-site laboratory is commissioned.

The sampling protocols described in the QA/QC Plan have already been implemented by MHBL to ensure consistency in the sampling technique for each parameter tested.

4.12 Mine Closure and Reclamation Plan

MHBL has developed a Mine Closure and Reclamation Plan for the Doris North Project.⁷³ The Closure and Reclamation Plan is intended to outline how the Doris North Project will be closed and reclaimed should construction proceed. This exercise is intended to ensure that issues associated with the effective closure and reclamation of the site are considered in sufficient detail at the earliest possible stage in the mine development process thereby influencing mine design to take into account environmental issues related to mine closure and reclamation.

The Closure Plan is considered to be a “living” document. It is anticipated that the Plan will undergo further revision over the next three years. It will continue to be updated and refined as the Doris North Project moves through the Water License permitting process, construction, commissioning, into operation and approaches final closure in 2010. The level of detail of closure and reclamation planning contained within the Plan will continue to increase with subsequent revisions. Those revisions will incorporate the lessons learned at each phase of the mine development process. Moreover, the revisions will also reflect the input from the Kitikmeot Inuit Association as representative of the land owner (the Inuit), local communities, NTI and other stakeholders who have an interest in how the Doris North Project is ultimately reclaimed. This document provides a basis for continuing discussions with stakeholders regarding closure and reclamation that were initiated during the Environmental Assessment process.

Mining is considered to be a temporary use of the land. At closure, the mine site and the land affected by the mining operations are to be reclaimed to achieve the following objectives (listed in order of priority):

- Protection of public health and safety through the use of safe and responsible reclamation practices;
- Reduction or elimination of environmental effects once the mine ceases operation;
- Re-establish conditions that permit the land to return to a similar pre-mining land use; and
- Reduce the need for long-term monitoring and maintenance by establishing physical and chemical stability of disturbed areas.

The targeted post-closure land use for the Doris North Project is wildlife habitat. This end land use is a reflection of the current use of the tundra area surrounding the Project site by wildlife (both resident and migratory). It is acknowledged that local communities and First Nations make use of the surrounding area for traditional activities, and reclamation of the Doris North Project will target leaving a reclaimed site that is protective of the surrounding water, air and land to enable such traditional activities to continue.

⁷³ The Mine Closure and Reclamation Plan forms a component of the Environmental Protection Plan for the Project and is attached as a Supporting Document S10I to the Revised Water License Application Support Document, April 2007.

It is also recognized that aesthetics (how a reclaimed site looks) is of concern to the Inuit, local communities, and other stakeholders. This concern is acknowledged by MHL, and aesthetics have been considered in the design of the specific reclamation activities to be applied at the Doris North site. The first and foremost approach in this respect is to leave a "clean" site. In other words, all remaining potentially hazardous materials (chemicals, reagents, hydrocarbons, explosives, etc.) will be removed from the site after mining ceases. These products will be transported south for use elsewhere (recycling) or for appropriate disposal in a licensed disposal facility. All non-hazardous materials, such as buildings, demolition debris, steel, vehicles, general garbage and debris, will be removed from the surface and disposed of in the appropriate non-hazardous landfill sites to be constructed within Quarry 2. This landfill will then be closed out and covered with a "clean" cap of quarried rock. It is expected that permafrost will become established within the closed out landfill in a short time frame after closure. Precipitation runoff will be directed away from the reclaimed landfill by a series of upslope berms. All building foundations and above ground concrete structures will be demolished and removed so that only rock fill pads remain as evidence of the existing use of the site as a mine. There will be visual changes to the pre-development landscape primarily associated with the remaining remnants of the airstrip, site roads and building and laydown rock fill pads. Roads will be reclaimed to allow restoration of natural drainage pathways in a low maintenance fashion (i.e., no culverts, bridges or berms) but the gravels used to construct the roads, airstrip and building pads will largely remain in place and be evident for many years before natural processes obliterate or disguise their presence.

The Tail Lake tailings impoundment will be reclaimed as a lake similar in appearance to the pre-development lake; however, the South Dam and remnants of the North Dam will remain although they will no longer hold back any water (i.e., they will no longer function as dams). Tail Lake will return to its predevelopment water level, with drainage flowing back through the original outflow channel into Doris Lake. The impounded tailings solids will be under a 4 m cover of water, and thus, not visible on surface. Water quality will return to levels close to background. The water will not be harmful to aquatic life, wildlife or human consumption after reclamation. The lake will ultimately be able to support a fish population but it will take many years for sediment to cover the stored tailings and for benthic organisms and vegetation to re-establish on the lake bottom, both pre-conditions for the re-establishment of a fish population within the lake.

4.13 Monitoring and Follow-Up Plan

MHL has developed a Monitoring and Follow-Up Plan for the Doris North Project.⁷⁴ The purpose of the Monitoring and Follow-Up Plan is to provide a consolidated summary of the monitoring and follow-up programs committed to by Miramar Hope Bay Ltd. at the Doris North Project. These programs are intended to collect high quality data to:

⁷⁴ The Monitoring and Follow-Up Plan forms a component of the Environmental Protection Plan for the Project and is attached as a Supporting Document S10m to the Revised Water License Application Support Document, April 2007.

- Enable MHL to monitor and report on performance compliance with all environmental legislation, regulations, Licenses, Permits, Leases and/or Authorizations applicable to ongoing operation of the Doris North Project;
- Enable MHL to obtain good quality data on environmental conditions at and around the mine to facilitate appropriate management of MHL's activities and facilities at the Doris North Project;
- Allow MHL to check the validity of the assumptions that were made during the design phase of the project, and provide the data needed to adaptively manage its activities if such assumptions are shown to be incorrect; and
- Allow MHL to check the validity of the environmental impact assessment predictions made during the environmental assessment process and modify its activities if measured impacts are worse than predicted.

These monitoring and follow-up programs are part of corporate commitments, regulatory approval conditions (e.g., Project Certificate from the Nunavut Impact Review Board) and as a result of stakeholder consultation. This Plan summarizes the environmental monitoring and follow-up programs to be implemented at the Doris North Project.

A follow-up monitoring program is used to verify the accuracy of the environmental assessment and/or to determine the effectiveness of mitigation. Typically, follow-up programs are focused on issues associated with potentially significant adverse environmental effects or negotiated mitigations, such as fisheries compensation to replace productive capacity of lost fisheries habitat due to the project. Monitoring data will be analyzed to help determine if there are any undesirable environmental effects as a result of project activities.

In general, adaptive management is triggered when effects to the receptor exceed predictions determined in the Environmental Impact Statement (EIS).

All environmental monitoring programs are designed by qualified scientists using widely-accepted scientific standards. The monitoring and follow-up programs will be conducted by qualified and experienced professionals or technicians, with assistance, where practical, of Inuit hired from the region.

The monitoring and Follow-up programs summarized in the Monitoring and Follow-Up Plan are:

- Air Quality and Climate Monitoring;
- Noise Monitoring;
- Hydrology Monitoring;
- Site Water Quality Monitoring;
- Tailings Geotechnical Monitoring;
- Waste Rock Characterization;
- Aquatic Effects Monitoring;
- Fish Monitoring;
- Vegetation and Soil Quality Monitoring; and
- Wildlife Monitoring.

4.14 Wildlife Monitoring and Mitigation Plan

MHBL has developed a Wildlife Monitoring and Mitigation Plan (WMMP) for the Doris North Project. This Plan forms a component of the Environmental Protection Plan for the Project and was submitted to NIRB in December of 2006.

The overall purpose of this WMMP is to comply with the relevant sections of the Nunavut Land Claim Agreement (NLCA), and the relevant directives as outlined in the EIS Guidelines provided by the NIRB (2002). Although a final Land Use Plan (LUP) for the West Kitikmeot Region has not yet been approved, and therefore a conformity screening of the Project by the Nunavut Planning Commission (NPC) was not required, the WMMP submitted by MHBL is expected to link to such regional initiatives, as was suggested in Subsection 4.6 of the EIS Guidelines (NIRB 2002) and subsequently recommended by NIRB in its Final Hearing Report (NIRB 2004).

One directive of the NPC is to support the Canadian Biodiversity Strategy which includes conserving biological diversity, promoting sustainable use of biological resources, improving our understanding of ecosystems, and increasing resource management capacity. Through monitoring the Valued Environmental Components (VECs) and other wildlife species, potential effects to the biodiversity of the Hope Bay Greenstone Belt (HBGB) will also be measured, and more understanding of the regional ecosystem will be acquired. Evaluation of the mitigation measures will also help determine the most effective methods for limiting and managing impacts to wildlife resources.

Specific objectives of the WMMP are:

- To verify the accuracy of wildlife impact predictions made in the EIS, and identify unanticipated effects;
- To design and implement a WMMP that can be applied to potential future developments associated with MHBL's mineral activities in the HBGB;
- To implement a wildlife mitigation and management plan designed to reduce the risks and disturbance to VECs, and other wildlife species and habitats;
- To determine the effectiveness of the wildlife mitigation and management plan;
- To consider and incorporate, where possible, IQ into the WMMP;
- To propose action levels or adaptive management triggers that can be used as early warning signs for reviewing and implementing wildlife management and mitigation measures;
- To design studies and data collection protocols that are consistent with other monitoring programs in the Arctic (e.g., at the BHP Ekati Diamond Mine; at the Diavik Diamond Mine; and/or at the De Beers Snap Lake Mine), and can be used to understand and manage regional cumulative effects, and participate in regional and/or collaborative programs (e.g., Cumulative Effects Assessment and Management Strategy and Framework, West Kitikmeot LUP);
- To develop and review the WMMP in collaboration with the Government of Nunavut, (Department of Environment), EC, and the Kitikmeot Inuit Association; and,

- To provide an annual report that will satisfy all interested and concerned stakeholders, and will provide the opportunity for feedback from communities, governments, and the public.

The WMMP represents an adaptive approach to understanding the effects of the Project on the landscape and the species that live there. In this context, the WMMP is considered as a continually evolving process that relies not only on the efficiency of data collection and analytical results, but is also dependent on feedback from the communities, government, and the public.

Having an adaptive and flexible program allows for appropriate and necessary changes to the design of monitoring studies, and the mitigation and management plans. Some changes may come about through the observation of unanticipated effects or inadequacies in the sampling methods to detect measurable effects. Other changes may result from ecological knowledge acquired through working with aboriginal community members, and discussions with elders holding IQ both in the field and through workshops.

MHBL is committed to considering and incorporating traditional knowledge, or more specifically, IQ, into the WMMP. The incorporation of IQ will occur throughout all stages of the WMMP, including identification of mitigation measures, monitoring study design, data collection, and follow-up programs to obtain feedback. As for all aspects of the WMMP, the incorporation of IQ will be a continuously evolving process.

IQ has been incorporated into this WMMP. For example, information documented during a project specific workshop on IQ contributed to the selection of VECs for mitigation and monitoring. As well, specific mitigation measures suggested by elders at the workshop have been included in the WMMP (e.g., use of incinerators to avoid attracting bears, reduce noise through the use of mufflers, minimum altitude for aircraft). Local Inuit have and will continue to contribute to monitoring study design. For example, knowledge of wolverine behaviour on the tundra obtained from a Kugluktuk hunter was used to identify habitat associations for wolverine, as part of the study design for wolverine monitoring.

Inuit, particularly those familiar with the Hope Bay area, will be invited to participate in all data collection programs. This includes specific species monitoring programs (e.g., caribou and muskox aerial surveys, habitat use by grizzly bears, wolverine snow track surveys). The involvement of Inuit in field data collection is expected to contribute to overall efficiency as well as provide feedback and ideas which can be incorporated on a day to day basis. For example, sampling methods may be changed based on knowledge of wildlife behaviour or ecology provided by Inuit participants during the field programs. Where appropriate, elders will be invited to site to further contribute to field monitoring programs.

Following each annual monitoring program, a workshop will be held to provide information back to communities and the general public, and to obtain feedback. A separate annual workshop will be provided for elders, if desired. The workshops will be an additional forum to exchange information, and to refine the monitoring studies, and mitigation and management plans based on local input, knowledge, and IQ.

4.15 Heritage Protection Plan

MHBL has developed a Heritage Protection Plan for the Doris North Project. This Plan forms a component of the Environmental Protection Plan for the Project, and was incorporated with the first Doris North Environmental Impact Statement submitted to NIRB in 2003.

“The archaeological record of the Nunavut Settlement Area is of spiritual, cultural, religious and educational importance to Inuit. Accordingly, the identification, protection and conservation of archaeological sites and specimens and the interpretation of the archaeological record is of primary importance to Inuit” (Nunavut Land Claims Agreement Article 33, Section 2.2)

MHBL has made a commitment to maintain sound environmental practices in all of its activities. With respect to heritage resources, this means that all efforts will be made to identify the possible impacts to archaeological sites, both known and unknown, and procedures will be followed to ensure that sites are avoided, where possible, or all pertinent cultural information will be gathered prior to impact, where sites cannot be avoided.

The purpose of the Heritage Protection Plan is to provide a framework for the management and protection of heritage resources associated with the Doris North Project within the scope of relevant regulations. Heritage resources are protected under Articles 33 and 34 of the Nunavut Land Claims Agreement, which are further clarified under Nunavut Archaeological and Palaeontological Sites Regulations (2001). Section 3(1) of these regulations states that:

“no person shall possess or sell an archaeological artifact that was removed from an archaeological site on or after June 15, 2001”

“No person shall excavate, alter or otherwise disturb an archaeological site, or remove an archaeological artifact from an archaeological site, without a Class 2 permit”

These regulations define an archaeological artifact as:

“any tangible evidence of human activity that is more than 50 years old and in respect of which an unbroken chain of possession or regular pattern of usage cannot be demonstrated ”

and an archaeological site is defined as:

“a site where an archaeological artifact is found” (Section 1)

Under Article 33 of the Nunavut Land Claims Agreement, an archaeological site means:

“a site or work within the Nunavut Settlement Area of archaeological, ethnological or historical importance, interest or significance or a place where an archaeological specimen is found, and includes explorers’ cairns”
(Section 33.1.1)

Archaeological sites and artifacts are tangible objects, as defined above. Traditional knowledge is information held within the memories of local people who have used or know of past uses of an area. As such, traditional knowledge does not have a physical component itself, but it can lead to locations of archaeological sites and artifacts, in areas where past human activities have occurred over a long period of time.

There are several types of impacts that may occur. Direct impact is the actual physical disturbance of the location of an archaeological site or artifact caused by an activity associated with construction or development. Indirect impact is disturbance caused by some peripheral activity, or simply by the proximity of the development. An example is the presence of higher numbers of people living and working in a confined area which can increase the potential for disturbance of sites at some distance from the actual development zone. Impacts to archaeological resources are generally immediate. The immediate effect of ground disturbance on specific archaeological resources is, of course, negative, since the location is disturbed or destroyed. However, positive effects do occur prior to the actual disturbance. These can be seen in the fact that many sites are now being recorded and investigated largely because of potential development. This provides the opportunity to add to the scientific and cultural knowledge of a region.

This Plan describes how specific aspects of the Doris North Project and other activities in the Hope Bay Belt might affect heritage resources, both in general terms as well as with respect to specific known sites and areas. The archaeological sites recorded and archaeological investigations conducted to date are identified. This data is then used to present guidelines for protection and mitigation of heritage resources.

5.0 WATER WITHDRAWAL

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The Doris North Project will obtain its fresh water from Doris Lake from a pump house to be constructed at the north end of Doris Lake adjacent to the proposed float plane dock. Water will be drawn into the pump house wet well through a 100 mm (4") diameter HDPE pipe laid on the bottom of Doris Lake.

5.1 Potable Water

During the construction phase potable water for the construction camp will be obtained from Doris Lake using the same pumping facilities that will be in place for the operational phase. Potable water will be chlorinated and stored within the camp.

For the operational phase of the project, potable water, fire suppression water and up to 50% of the mill water (the remaining 50% coming from water recycled from Tail Lake) will be supplied from Doris Lake. The recycle of water from Tail Lake will be maximized where practical to reduce freshwater use in the milling process. A 100 mm diameter insulated and heat traced HDPE line will pump water from the lake to storage tanks at the mill and camp sites. Potable water will be treated in a packaged plant installed in a container, and will consist of sand filtration followed by ultra violet light and/or chlorination treatment.

The Project's potable water consumption is projected to be 30,000 cubic metres per year (daily average potable water consumption of 68.6 cubic metres per day plus a contingency of 17%). The daily consumption estimates is based on a 175 person camp with a per person consumption of 0.04 cubic metres (40 liters) per person per day.

5.2 Fresh Water Consumption

Mill process water requirements are projected to average 970 m³/day, with a maximum mill process water requirement of 1,183 m³/ day. This maximum value has been used in the water quality model to ensure that the model reflects the most conservative assumptions with respect to the volume of water reporting to the tailings containment area with the mill tailings streams.

Water use underground is expected to be minimal. A brine solution will be mixed in the mill and piped underground for use in drilling and dust suppression. This brine solution will be recirculated through an underground sump. Development and production drilling will use this brine solution to stop drills from freezing in the permafrost. Total requirements are estimated at approximately 0.1 m³/h. As mining is expected to be within the permafrost zones, groundwater is anticipated to be minimal. Any water encountered will be pumped from underground and discharged into the tailings line to Tail Lake.

Consequently, the maximum projected freshwater use for non-potable water uses (process water) at the Doris North Project is estimated at 450,000 cubic metres per year (estimated daily average consumption of 1,183 cubic metres per day plus a 16% contingency allowance). This assumes no recycle of water from Tail Lake.

5.3 Reclaim and Recycle Water Use in the Milling Process

MHBL plans to reclaim water from Tail Lake for use in the milling process and to recycle water within the milling process to minimize the Project's use of freshwater from Tail Lake to the greatest practical extent, and to minimize the volume of water that subsequently has to be discharged from the tailings containment area (TCA) to the receiving environment.

5.3.1 Use of Reclaim Water from the Tailings Containment Area (Tail Lake)

It is MHBL's intent to maximize, to the greatest practical extent, the use of recycle water from the tailings containment area. However, there is a possibility that the water may not be able to clarify sufficiently during the winter period when lake ice reduces the volume in Tail Lake (especially during the first winter). During summer months (June through September), process water will be taken from Tail Lake by a pump mounted on a floating pump house barge located near the north end of the lake. Make up freshwater for use in the mill will be drawn from the freshwater holding tank only in case of a shortage of suitable water from Tail Lake.

The projected volume of water recycled from Tail Lake as mill process water is 145,000 cubic metres per year (based on 1,183 cubic metres per day for four months). MHBL will attempt to increase the volume of water recycled from Tail Lake, as this will improve its overall Tail Lake water management strategy.

5.3.2 Recycle of Water within the Milling Process

There will be three internal recycle water streams within the milling flowsheet (see Figure 3.3):

- Overflow from the regrind circuit thickener where the reground flotation concentrate will be thickened ahead of the leach circuit, with the thickener overflow recycled back to the mill process water tank;
- Leach residue from the carbon-in-leach (CIL) circuit will be thickened ahead of the cyanide destruction circuit, with the thickener overflow solution recycled to the head end of the CIL circuit; and
- The discharge slurry from the cyanide destruction circuit will be thickened and then filtered on a belt filter to produce a relatively dry residue that will be trucked underground as backfill. Approximately 70% of the thickener overflow and filtrate from the belt filter will be recycled to the head end of the cyanide

destruction circuit ($79 \text{ m}^3/\text{day}$). The remaining 30% ($31.4 \text{ m}^3/\text{day}$) will be bled off and co-disposed with the flotation tailing in the Tail Lake TCA.

The volume of these three internal recycle water streams has been accounted for in the mill process water consumption totals presented in the preceding sections.

6.0 DISCHARGE STANDARDS FOR WATER RELEASES FROM THE DORIS NORTH MINE

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6.1 Tail Lake Discharge Standards

A water management strategy for the Tail Lake tailings containment system was developed by SRK Consulting (Canada) Inc. for MHL, and is a component of the Water Quality Model and the Water Management Plan.⁷⁵ The following management plan is drawn from this source.

The primary objective of the Tail Lake water management strategy is to meet CCME guidelines (Canadian Water Quality Guidelines) for parameters of concern (see Table 6.1)⁷⁶ to protect freshwater aquatic life in Doris Creek, downstream of the waterfall. These guidelines were established by the Canadian Council of the Ministers of Environment, and represent a vigorous determination of levels for each parameter that are protective of aquatic life within fresh waters in Canada. These are guidelines not regulated limits, and incorporate a highly conservative approach in determining from scientific research world wide at what level of each parameter are harmful effects noted on aquatic life. Consequently, they provide guidance as to levels of each parameter in receiving waters below which there is assurance of “low to no” risk of adverse effect on aquatic life. It should be noted that quite often natural levels of parameters within Canadian freshwaters may already exceed the CCME Guideline values. Consequently, by meeting the CCME Guidelines in the receiving water, MHBL is striving to ensure that there will be no adverse effects on aquatic life downstream of its discharge point.

⁷⁵ Sections 5.2 and 6.0, Water Quality Model, Supporting Document S6 and the Water Management Plan, Supporting Document S10j to the Revised Water License Application Support Document, April 2007.

76 MHLB expects to meet all CCME Guideline values for the parameters of concern listed in Table 6.1 (where CCME Guidelines exist) at the monitoring point downstream of the waterfall within Doris Creek with the possible exception of nitrite. The predicted levels of nitrite are only marginally above CCME Guideline values (see Table 4.2 in Water Quality Model, Supporting Document S6 to the Revised Water License Application Support Document, April 2007) and will only occur for a very short duration as nitrite will quickly convert to nitrate in the receiving waters.

Table 6.1: Parameters of concern for effluent and water quality monitoring

Deleterious substances and pH ^{1,2}	Required Effluent Characterization and Water Quality Monitoring Parameters ^{2,3:}	Required Additional Water Quality Monitoring Parameters	Site-Specific Parameters ⁶
Arsenic	Aluminium	Dissolved oxygen ⁵	Chromium
Copper	Cadmium	Temperature ⁵	Manganese
Lead	Iron		Selenium
Nickel	Mercury ⁴		Total phosphorus
Zinc	Molybdenum		Nitrite ⁷
Radium 226	Ammonia		Conductivity
Total cyanide	Nitrate		Calcium
Total suspended solids	Alkalinity		Chloride
pH	Total hardness		Magnesium
			Potassium
			Sodium
			Sulphate
			Dissolved organic carbon ⁵ Total organic carbon ⁵

Notes:

1. List of parameters regulated (deleterious substances and pH) as per Schedule 3 of the MMER; concentration limits specified in the regulation (Schedule 4).
2. All concentrations are total values; dissolved concentrations may also be reported; effluent loading (Section 20 of MMER) will also be calculated and reported.
3. List of parameters required for effluent characterization and water quality monitoring as per Schedule 5 of the MMER.
4. Analysis of mercury may be discontinued if the concentration of total mercury in effluent is less than 0.10 µg/L in 12 consecutive samples of effluent.
5. In situ measured parameters only for water quality monitoring (in receiving waters).
6. These other parameters are potential contaminants or supporting parameters; analysis is optional and may be added based on site specific historical monitoring data or geochemistry data.
7. Nitrite will not be considered as a controlling parameter for the calculation of the ADVR and TDR unless actual concentrations significantly exceed the predicted values.

MHBL chose to meet these CCME Guideline values at a point immediately downstream of a 4.3 m waterfall in the Doris Creek, as this is the closest point at which Arctic char can come into contact with the water released from the TCA. This waterfall acts as natural barrier to the migration of Arctic char and other downstream fish species up into Doris Lake.

Technology does not exist that will allow MHBL to treat the water to be released from Tail Lake to these CCME Guideline values; consequently, MHBL acknowledges that it cannot achieve the CCME Guidelines at the end of the discharge pipe from Tail Lake. MHBL's discharge strategy relies on metering the amount of water released from Tail Lake so that the combined outflow water from Doris Lake meet CCME Guideline values below the waterfall. The end of the discharge pipe was placed immediately upstream of

this waterfall to protect aquatic life upstream of the discharge point within Doris Lake and the upper reaches of the Doris Creek. In other words the proposed end of pipe discharge point was selected to minimize, to the greatest extent possible, the amount of Doris Creek that could be exposed to the end of pipe discharge before it mixes completely with the receiving water as it goes over the waterfall.

CCME Guidelines⁷⁷ are to be used for guidance purposes only and are thus not incorporated into regulated discharge standards. The Federal discharge standards that apply to the Canadian mining industry are set out in Schedule 4 of the Metal Mining Regulation under the Fisheries Act. These are based on best-practical-available-technology for water treatment, and not necessarily meant to be protective of aquatic life. In most regulatory jurisdictions, these end of pipe discharge standards are assessed on a case by case basis to determine acceptable levels of impact once mixed in the receiving waters. In other words, the setting of discharge limits typically relies upon a natural mixing zone within the receiving waters. Under the MMER, by law, the end-of-pipe discharge from Tail Lake must meet the MMER discharge limits (see Table 6.2) and pass the LC₅₀ fish toxicity test.

MHBL, however, recognizes that indiscriminate discharge of water from Tail Lake at these limits would not necessarily result in water quality meeting CCME guidelines in Doris Creek below the waterfall. Consequently, MHBL devised a discharge strategy that allows for the load (kilograms per time) of contaminants discharged from Tail Lake to be varied in proportion to the background flow and load in the Doris Creek, so that concentrations consistently remain at or below CCME guideline values in Doris Creek below the waterfall. To be successful this approach departs from the traditional fixed end of pipe discharge limit and discharge rate normally contained in water licenses, and replaces it with a fixed allowable concentration in the receiving water.

Table 6.2: Discharge Limits under MMER

Parameter	Units	Maximum Monthly Mean	Maximum in a Composite	Maximum Grab Sample
Arsenic (As)	ug/L	500	750	1000
Copper (Cu)	ug/L	300	450	600
Lead (Pb)	ug/L	200	300	400
Nickel (Ni)	ug/L	500	750	1000
Zinc (Zn)	ug/L	500	750	1000
Total Suspended Solids	mg/L	15	22.5	30
Total CN	mg/L	1.0	1.5	2.0

⁷⁷ As set out in the Canadian Water Quality Guidelines, published by the Canadian Council of Ministers of the Environment.

6.1.1 Discharge Strategy & Adaptive Management

The water management strategy for the Project entails an active managed discharge from Tail Lake beginning in Year 1 of operations, and continuing until it can be shown that there is no adverse impact on downstream aquatic life from an unregulated discharge from Tail Lake. At the end of Year 9 (seven years after mining ceases) water quality in Tail Lake is predicted to be within the CCME Guidelines, thereby allowing for a complete “walk-away” closure scenario.

During the mine’s operating life (two years), and for an additional three years after mining and milling ceases, the volume of water to be released from Tail Lake will exceed the natural inflow into Tail Lake. By the third year following the cessation of mining and milling the amount of water that needs to be released from Tail Lake is predicted to be equal to the natural inflow. However, water will continue to be pumped from Tail Lake on a managed annual basis until the water level within Tail Lake has been drawn down to the pre-development water level of 28.3 m above sea level. Prior to this time, MHBL will commission a human health and ecological risk assessment to determine at what point water can be released in an unregulated fashion through the former Tail Lake outflow into Doris Lake, without resulting in an adverse impact to aquatic life downstream. This assessment will be based on prevailing water quality within Tail Lake at the time.

MHBL will continue to actively manage the annual discharge from Tail Lake by pumping this water to the discharge point in Doris Creek upstream of the waterfall until it can be demonstrated that no adverse impact on downstream aquatic life will occur with an unregulated discharge. At that time, the North Dam will be breached and the outflow from Tail Lake will be restored to the pre-mine outflow channel into Doris Lake. Under this scenario no further management of water releases from Tail Lake will be required however monitoring will continue for a minimum of one more year to verify that water quality continues to meet CCME Guidelines.

The active management strategy means that Tail Lake can be operated successfully at several lower than optimum discharge rates. In the event that maximum allowable discharge flow rates are lower than estimated within the water quality model, the proposed control system will automatically adjust to the lower flow rates.

In the event that contaminant of concern concentrations in water samples upstream of the discharge location meet CCME guideline values, and concentrations in water as sampled immediately downstream of the waterfall do not meet the CCME Guideline values, MHBL personnel are to take the following actions:

- Immediately discontinue the discharge of water from Tail Lake by turning off the discharge pump;
- Obtain new analytical data from the monitoring points within Tail Lake and within Doris Creek upstream of the discharge point, and then re-calculate the allowable discharge rate (using the process set out in Section 9.3 of the Water Management Plan – Supporting document S10j);

- Adjust the allowable discharge rate in the PLC controller and re-start the Tail Lake discharge pump;
- Re-sample the water in Doris Creek at the monitoring point downstream of the waterfall, and have it analyzed to verify that CCME Guideline values are being met for the parameters of concern.

In the unlikely event that CCME Guideline⁷⁸ values cannot be met downstream of the waterfall for any discharge rate from Tail Lake, then the discharge system will be shut down and no water discharged until the reason can be assessed by MHL's environmental team.⁷⁹

Tail Lake has sufficient capacity to store water for several years after operations cease. During this time, it will be possible to monitor changes in water quality in Tail Lake, and either commence active discharge if suitable conditions develop, or project water quality into the future to the time that the full supply level (FSL) will be reached. The effects of natural discharge would be re-assessed for that time, and if acceptable for natural discharge, Tail Lake would be allowed to fill to its FSL and then allowed to overflow naturally until solute concentrations approach CCME guidelines to enable discharge of excess water contained in Tail Lake, and allow breaching of the North Dam. This represents the first contingency strategy.

A second contingency is available for the management of the water contained in Tail Lake. The water quality monitoring undertaken in the early stages of the 'holding' period will identify the solutes that may be of concern at the time the FSL is reached. This will provide ample time to identify water treatment requirements, if any, that may be applied to enable discharge of excess water when the FSL is reached. Construction and commissioning of a water treatment plant would represent a second level contingency; however, it is unlikely that this contingency would ever have to be developed.

6.1.2 Receiving Water Quality Estimates

In summary, the water quality modeling results (see supporting document S6 – SRK 2006e Water Quality Model, Doris North Project – Section 4) and discharge scenario evaluations indicate that:

- Water management strategies are available that will not cause exceedance of CCME guidelines in Doris Creek;
- Alternative strategies are also available that may cause marginal exceedances of CCME guidelines in Doris Creek; however, such exceedances would be of short duration and will significantly reduce the requirements (time and management) for active operation; and,

⁷⁸ For those contaminants of concern with concentrations that are below their CCME guideline values in the background water draining from Doris Lake.

⁷⁹ The contingency management strategies in such an event are presented in Section 5.3, Water Quality Model, Supporting Document S6 to the Revised Water License Application Support Document, April 2007.

- The range of discharge conditions that remain protective of the receiving environment indicate that there is significant flexibility available to manage Tail Lake water to still meet CCME guidelines in Doris Creek.

The results indicate that adaptive management of the water in Tail Lake is possible. This means that while one strategy might be selected as a preferred strategy, it is not the only strategy that will be protective of the receiving environment. More importantly, if conditions or actual water quality in Tail Lake deviate from those predicted in the water quality modeling, then it will be possible to switch to an alternate strategy that would remain protective of the receiving environment without compromising the tailings deposition and overall water management for the site.

The discharge strategy selected by MHBL would see the discharge of up to 1,200,000 m³ per year starting in Year 1 of operations. The maximum concentrations both in Tail Lake and in the receiving environment in Doris Creek immediately downstream of the point of discharge based on an average runoff flow yield of 180 mm/year are presented in Table 6.3.

Table 6.3: Predicted Water Quality in the Receiving Environment

Parameter Max. Occurs In	Units	MMER	CCME ¹	Tail Lake Year 2	Maximum in Doris Creek		Doris Creek	
					Upstream	Downstream Year 2	Increase above Background %	Fraction of CCME (%)
pH			6.5 to 9	7 to 8	7.6	7 to 8		
TSS	mg/L	15		1.9	4.0	3.8		
Free CN	mg/L		0.005	0.0005		0.00004		1%
Total CN	mg/L	1.0		0.008	0.001	0.001		
Total Ammonia-N ³	mg/L		1.27	0.45	0.02	0.045	197%	4%
Nitrate-N ³	mg/L		2.9	6.5	0.006	0.58	9641%	20%
Nitrite-N ^{3, 4}	mg/L		0.197	0.30	0.0020	0.023	0%	12%
Total Metals								
Aluminium Al ¹	mg/L		0.1	0.045	0.08	0.0768	0%	77%
Arsenic As	mg/L	0.5	0.005	0.0021	0.00047	0.0006		11%
Cadmium Cd	mg/L		0.000017	0.00006	0.000002	0.000007	240%	43%
Chromium Cr ²	mg/L		0.001	0.0028	0.0003	0.000	46%	46%
Copper Cu ¹	mg/L	0.3	0.002	0.006	0.0014	0.0018	24%	89%
Iron Fe	mg/L		0.3	0.11	0.11	0.11	0%	38%
Lead Pb	mg/L	0.2	0.001	0.00043	0.00012	0.00013		13%
Mercury Hg	ug/L		0.026	0.0050	0.0006	0.0009		4%
Molybdenum Mo	mg/L		0.073	0.0062	0.0001	0.00059		1%
Nickel Ni	mg/L	0.5	0.025	0.008	0.001	0.0011		4%
Selenium Se	mg/L		0.001	0.00065	0.0011	0.0011	0%	112%
Silver Ag	mg/L		0.0001	0.00007	0.00000	0.0000080	474%	8%
Thallium Tl	mg/L		0.0008	0.000032	0.000022	0.000022	3%	3%
Zinc Zn	mg/L	0.5	0.03	0.011	0.003	0.0032	14%	11%

Notes:

1. Where CCME Guideline is dependent on other water quality values, the mean values of these parameters were used to calculate the guideline for the Doris North Project. Al is dependent on pH and hardness and thus this guideline value is a calculated value.
2. The guideline for chromium is for Cr(VI+) and not total chromium;
3. Ammonia, nitrate and nitrite are in units of nitrogen equivalency
4. The CCME Guideline for Nitrite was updated in December 2006 (Update 6.0.1) to reflect Nitrite measured Nitrite-nitrogen which is equivalent to 0.197 mg/L Total Nitrite.
5. Shaded numbers exceed CCME guideline values;

Under this strategy, water quality downstream of the discharge point in Doris Creek would be consistently below CCME guidelines for the protection of freshwater aquatic life with the following exception:

Selenium - The selenium concentration exceeds its guideline intermittently due to elevated concentrations in background water upstream of the discharge location. Since the selenium concentration in Tail Lake is predicted to be below the concentrations in Doris Creek, the discharge of Tail Lake water will actually lower the selenium concentration below the background level.

6.1.3 Proposed Discharge Limits

The proposed Tail Lake discharge strategy presents a conundrum for regulators, in that it requires a departure from the convention of only establishing an end-of-pipe discharge standard that must be met in a regulatory instrument such as a water license. Under the proposed Tail Lake discharge strategy, MHBL suggests that the water license contain a two component discharge standard, as follows:

Component 1: End-of-Pipe Compliance Discharge Standard

All water discharged from Tail Lake must meet the following MMER Standard (Table 6.4):

Table 6.4: End-of-Pipe Discharge Standard for all discharges from Tail Lake

Parameter	Units	MMER Criteria	Maximum Average Allowable Concentration at the Tail Lake Discharge End-of-Pipe	Maximum Allowable Concentration in a grab sample at the Tail Lake Discharge End-of-Pipe
TSS	mg/L	15	15.00	30.00
Total CN	mg/L	1	1.00	2.00
Total Metals				
Arsenic As	mg/L	0.5	0.50	1.00
Copper Cu	mg/L	0.3	0.30	0.60
Lead Pb	mg/L	0.2	0.20	0.40
Nickel Ni	mg/L	0.5	0.50	1.00
Zinc Zn	mg/L	0.5	0.50	1.00
Radium 226	Bq/L	0.37	0.37	1.11

Notes: All concentrations are in total values

1. MMER defines average allowable concentration as a monthly average of all samples taken during the reporting month.

Component 2: - Compliance Standard in the Receiving Water at the SNP point below the waterfall in Doris Creek.

The water license would require that, provided the background water quality in Doris Creek upstream of the discharge location is below the CCME Guideline, whenever water is being discharged from Tail Lake, water quality at the SNP point below the waterfall in Doris Creek meet the following water quality standard (Table 6.5):

Table 6.5: Proposed WQ Standard in Doris Creek at SNP Point below the waterfall

Parameter	Units	MMER Criteria	CCME Guidelines	Average Allowable Concentration at the SNP Point in the Doris Outflow Creek below the waterfall whenever water is being discharged from Tail Lake	Maximum Allowable Concentration in any Grab Sample at the SNP Point in the Doris Outflow Creek below the waterfall whenever water is being discharged from Tail Lake
pH			6 to 9	6 to 9	6 to 9
TSS	mg/L	15		15	15
Free CN	mg/L		0.0050	0.005	0.005
Total CN	mg/L	1		0.010	0.010
Total Ammonia-N ^{1,3,4}	mg/L		1.54 at pH 7.5 and Temperature of 20 ⁰ C ¹	1.54 at pH 7.5 and Temperature of 20 ⁰ C ¹	1.54 at pH 7.5 and Temperature of 20 ⁰ C ¹
Nitrate-N ³	mg/L		2.94	2.94	2.94
Nitrite-N ³	mg/L		0.06	0.06	0.06
Total Metals					
Aluminium Al ⁴	mg/L		0.10	0.10	0.10
Arsenic As	mg/L	0.5	0.005	0.005	0.005
Cadmium Cd	mg/L		0.000017	0.000017	0.000017
Chromium Cr ²	mg/L		0.0010	0.0010	0.0010
Copper Cu ⁴	mg/L	0.3	0.0020 to 0.0040 ²	0.002	0.002
Iron Fe	mg/L		0.30	0.30	0.30
Lead Pb	mg/L	0.2	0.0010	0.001	0.001
Mercury Hg	mg/L		0.000000026	0.000000026	0.000000026
Molybdenum Mo	mg/L		0.073	0.073	0.073
Nickel Ni	mg/L	0.5	0.025	0.025	0.025
Selenium - Se	mg/L		0.0010	0.0010	0.0010
Silver - Ag	mg/L		0.0001	0.0001	0.0001
Thalium - Tl	mg/L		0.0008	0.0008	0.0008
Zinc Zn	mg/L	0.5	0.030	0.03	0.03

Notes:

1) Total Ammonia concentration discharge standard to vary with pH and temperature as follows

2) The guideline for chromium is for Cr(VI³) and not total chromium.

3) Ammonia, Nitrate and Nitrite are in units of nitrogen equivalency.

4) Where CCME Guideline is dependent on other water quality values, the mean values of these parameters were used to calculate the guideline for the Doris North Project

Temp (°C)	pH							
	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5
0	23.1	73.0	23.1	7.32	2.33	0.749	0.250	0.042
5	153	48.3	15.3	4.84	1.54	0.502	0.172	0.034
10	102	32.4	10.3	3.26	1.04	0.343	0.121	0.029
15	69.7	22.0	6.98	2.22	0.715	0.239	0.089	0.026
20	48.0	15.2	4.82	1.54	0.499	0.171	0.067	0.024
25	33.5	10.6	3.37	1.08	0.354	0.125	0.053	0.022
30	23.7	7.50	2.39	0.767	0.256	0.094	0.043	0.021

All reported total ammonia concentrations are reported in mg/L NH₃; measurements of total ammonia in the aquatic environment are often also expressed as mg/L total ammonia-N. The present guideline values (mg/L NH₃) can be converted to mg/L total ammonia-N by multiplying the corresponding guideline value by 0.8

Note:

- MHBL proposes that average allowable concentration be calculated as a monthly average of all samples taken during the reporting month. Given that MHBL has proposed that the maximum allowable concentration in any grab sample be set at the same value as the average allowable value, this is a mute point for this discharge point

In the event that the concentration of any contaminant of concern in the background water in Doris Creek above the discharge location is above the CCME Guideline value, and its concentration in Tail Lake is below that in Doris Creek, then that contaminant of concern is eliminated from consideration and will not preclude discharge to Doris Creek.

Both components must be met to achieve compliance with the water license. In this way, water quality in the receiving environment is protected at a point downstream of the waterfall in the Doris Creek.

6.1.4 Adaptive Management

MHBL recognizes that regular monitoring of water quality within Tail Lake will be necessary to provide early warning of potential water quality problems. MHBL proposes regular monitoring of water quality within Tail Lake and comparing the analytical results against the predictions made in the water quality model for Tail Lake. This comparison will provide MHBL with an early warning of significant departures from the predicted levels and potential water quality problems in the coming discharge seasons, thereby allowing for the discharge strategy to be adaptively modified.

As part of the control strategy, the actual water quality in Tail Lake will be compared with the predicted water quality on a monthly basis to assess the accuracy of the model. If significant deviation is noted, then the model will be recalibrated to the actual water quality observed in Tail Lake. The model will be rerun if there is a more than 20% deviation above the predicted concentrations for any of the critical or significant parameters (MMER, CCME). The model will then be rerun to assess potential implications on the discharge strategy, and to determine future operational requirements. This comparison of actual water quality to predicted water quality in Tail Lake will be communicated to the NWB for inclusion in the public registry as part of the monthly Surveillance Network Program reporting. Model calibration would be required only if the model significantly underestimates solute concentrations in Tail Lake AND it is shown to potentially have a significant impact on the water management strategy.

The water quality modeling was undertaken with the explicit purpose of establishing the limitations on the potential for discharging water from the TCA. Therefore, measured water quality will be compared to the predicted water quality. The parameters will include MMER criteria as well as the CCME parameters of concern, and will include nutrients. If the predictions over-estimate actual concentrations, no additional assessment will be undertaken. In the event that actual concentrations significantly exceed predicted concentrations, the source streams will be analyzed and compared to the assumptions that were adopted in the water quality model. The source loadings will accordingly be adjusted in the water quality model to assess future constraints on the discharge strategy. If the modeling shows that there will be no significant impacts on the discharge strategy, the progress of water quality will be tracked to ensure that the conclusion holds. In the event that the predictions show a significant constraint on achieving the water management strategy, then measures to contain or limit that source will be investigated. Should it not be possible to control the source, then the implications with respect to the discharge strategy/holding time will be assessed. It may then be possible, through adaptive management, to revise the discharge strategy. In the event that the

discharge strategy cannot be revised to accommodate the changes in water quality, water treatment requirements will be established. Because of the long holding time available, it will be possible to design and implement a suitable water treatment system to continue to meet the project objectives of meeting CCME Guidelines in the receiving environment.

6.2 Storm Water Discharge Standards

Storm water includes precipitation runoff and snowmelt. MHBL will intercept, collect and manage storm water from those areas of the mine site where the risk of contamination pick up is significant, specifically from:

- The camp and mill pad area where most of the surface mine related activities will occur;
- The lined fuel transfer station, the fuel tank farm and the landfarm facility;
- The non-hazardous landfill facility

6.2.1 Camp and Mill Pad Sedimentation Pond

During the Spring melt, the water collected in the camp and mill sedimentation pond will be sampled by the on-site environmental personnel, and analyzed for pH, TSS, Total Ammonia, Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, Al, As, Cu, Fe, Pb, Ni, and Zn.

Water will be pumped from the sedimentation pond onto the tundra and be land applied, as long as it meets the proposed discharge standards as set out in Table 6.6. The water will be discharged to the area immediately to the south of the pond where it will have a ~500 m cross country flow path before reaching Doris Lake. Pumping from the sedimentation pond will only start once water in the pond has been verified as meeting the proposed discharge standards.

Table 6.6: Proposed Discharge Standards for the Camp/Mill Pad Sedimentation Pond

Parameter Being Monitored	Proposed Discharge Standard (mg/L) ^{1, 2}
pH	5.0 to 9.0
TSS	15
Total Ammonia	2
Total CN	1
Total Oil and Grease	5.0 and no visible sheen on pond
Total Metals	
Aluminium - Al	1
Total Arsenic - As	0.05
Total Copper - Cu	0.02
Total Iron - Fe	0.3
Total Lead - Pb	0.01
Total Nickel - Ni	0.05
Total Zinc - Zn	0.01

1. Based on a review of discharge limits used at other mine sites in the NWT for small volume discharges into freshwater
2. MHBL proposes that average allowable concentration be calculated as a monthly average of all samples taken during the reporting month.

Once pumping starts the discharge from the pond will be sampled for the above parameters daily for each day of pump operation.

MHBL looked at discharge limits established in other water licenses for relatively new mine sites in the North to determine what discharge standards were being used to protect the freshwater aquatic environment for small volume discharges from surface runoff ponds and fuel containment facilities. Only limited information could be found. The results of the MHBL review are presented in Table 6.7. At Doris North the water released from the mill and camp pad sedimentation pond will be land applied onto the tundra at a site approximately 500 m upstream of Doris Lake. The tundra will play a significant role in attenuating contaminants contained in this release. The large dilution available in Doris Lake will further attenuate these contaminants. The proposed discharge limits for the release of water from this sedimentation pond (Table 6.6) were drawn from the data in Table 6.7. These levels have been selected by the regulatory agencies managing water in the N.W.T. as being protective of water quality in the receiving environment in similar settings.

Table 6.7: Comparison of Water License Discharge Standards for Small Volume Releases at Other Mining Operation in the North

Mine Site	Ekati - Sable, Beartooth, and Pigeon Pits		Diavik Diamond Mines		Snap Lake		Boston		MMER	
Water License #	MV2001L2-0008		N7L2-1645 amended May 2004		MV2001L2-0002 Apr 15 2004		NWB1BOS0106 Oct 5 2001			
Type of Discharge Limit	Discharge from Waste Rock piles, Sedimentation Ponds, Surface Runoff		All Discharges to Lac de Gras from WTP - last point of control		All Discharges to Snap Lake		All Minewater discharged from minewater pond			
	Maximum Average Concentration	Maximum Concentration of Any Grab Sample	Maximum Average Concentration	Maximum Concentration of Any Grab Sample	Maximum Average Concentration	Maximum Concentration of Any Grab Sample	Maximum Average Concentration	Maximum Concentration of Any Grab Sample	Maximum Authorized Monthly Mean Concentration	Maximum Authorized Concentration in any Grab Sample
Total Ammonia mg/L	2.0	4.0	N/A	20.0	N/A	20.0				
Total Aluminum mg/L	1.0	2.0	1.5	3.0	1.0	2.0				
Total Arsenic mg/L	0.050	0.1	0.05	0.10	0.02	0.04	0.50	1.00	0.50	1.00
Total Copper mg/L	0.02	0.04	0.02	0.04	0.01	0.02	0.30	0.60	0.30	0.60
Total Cadmium mg/L	0.0015	0.003	0.0015	0.003	0.001	0.002				
Total Chromium mg/L	0.02	0.04	0.02	0.04	0.02	0.04				
Total Lead mg/L	0.01	0.02	0.01	0.02	0.005	0.009	0.20	0.40	0.20	0.40
Total Zinc mg/L	0.01	0.02	0.01	0.02	0.01	0.02	0.50	1.00		
Total Nickel mg/L	0.05	0.1	0.05	0.10	0.05	0.1	0.50	1.00	0.50	1.00
Nitrate mg/L					28	56			0.50	1.00
Nitrite mg/L	1.0	2.0	1.0	2.0	1.0	2.0				
Total Suspended Solids mg/L	15	25	15.0	25.0	7	14	25	50	15.00	30.00
Total Cyanide mg/L									1.00	2.00
Turbidity NTU	10	15	10	15						
Oil and Grease mg/L							No Visible Sheen			
Extractable Petroleum Hydrocarbons - F1					4.6					
Extractable Petroleum Hydrocarbons - F2					2.1					
Total Phosphorous mg/L	0.2	0.4								
pH - all discharges to environment	6.0 to 9.0		6.0 to 8.4		6.0 to 9.0		6.0 to 9.5			
pH - surface runoff	5.0 to 9.0		5.0 to 8.4		5.0 to 9.0					
Sewage Treatment Plant Discharge										
Oil and Grease mg/L *	3.0		3.0	5.0	5.0		No Visible Sheen			
Total Suspended Solids mg/L			10.0	20.0	35.0		100			
BOD mg/L			15.0	25.0	30		80			
Faecal Coliforms CFU/100ml			10	20	1000		10000			
Surface Runoff During Cnstruction										
Total Suspended Solids mg/L	50	100	50	100	50	100				

* At Colomac Oily Water Separator is discharged to sewage lagoon. MV2000L2-0001 limits oil and grease in lagoon discharge to 5.0 mg/L

6.2.2 Temporary Waste Rock Stockpile Pollution Control Pond

The water that accumulates within the Temporary Waste Rock Pile Pollution Control Pond is to be pumped to the tailings pump box within the mill so that it can be transferred to the tailings containment area. No water is to be discharged onto the surrounding tundra without the authorization of the Nunavut Water Board. The water that accumulates within the Temporary Waste Rock Pile Pollution Control Pond is to be sampled monthly during periods of open water, and sent for analysis (pH, TSS, Total Ammonia, Total Sulphate, Total CN, Total Oil and Grease, Al, As, Cu, Fe, Pb, Ni, and Zn). The results are to be reported to the Nunavut Water Board under the Surveillance Network Program (SNP) contained within the water license.

6.2.3 Discharge of Storm water and Snow Melt from the Fuel Tank Farm, Roberts Bay Fuel Transfer Station and Landfarm Lined Containment Areas

The precipitation runoff and snowmelt collected in the sumps at the fuel transfer station, the fuel tank farm and within the landfarm facility will be treated by passing this water through an F1 “Flow and Plug” Oil Adsorption System (Model F11-C-180-TM-Cx2 as supplied by Terry Ruddy Sales of Edmonton Alberta). This is a portable unit set up on standard pallets so that they can be moved to the fuel transfer station, the fuel tank farm and the landfarm facility as and when needed.

All precipitation runoff and snowmelt from these three facilities will be treated through the Oil Adsorption System, with the treated water then directed onto the nearby tundra to be land applied in a method that prevents erosion at the point of application. The discharge from the Oil Adsorption System will be sampled and analyzed on a once per day basis whenever the system is in operation. The sample will be taken from the discharge of the oil adsorption system prior to this water being land applied onto the tundra. The samples will be analyzed for pH, Total Suspended Solids, Total Oil and Grease and Total Ammonia (Total Ammonia only at the landfarm as it is not expected to be present at the other two facilities).

MHBL recommends that the standard that must be achieved for discharge be as set out in Table 6.8:

Table 6.8: Proposed Discharge Standards for Water Discharged from the Lined Fuel Transfer Station, Fuel Tank Farm and Landfarm Facilities

Parameter Being Monitored	Proposed Discharge Standard (mg/L) ^{1, 3}
pH	5.0 to 9.0
TSS	15
Total Oil and Grease	5
Total Ammonia ²	2

Notes:

1. Based on a review of discharge limits used at other mine sites in the NWT for small volume discharges into freshwater
2. Total Ammonia standard is only for the landfarm facility where nitrogen based nutrients are added to aid soil remediation
3. MHBL proposes that average allowable concentration be calculated as a monthly average of all samples taken during the reporting month.

At Doris North, the treated water released from the fuel transfer station, the fuel tank farm and landfarm will be land applied onto the tundra. The tundra will play a significant role in attenuating contaminants contained in this release. The large dilution available in Doris Lake and Roberts Bay will further attenuate these contaminants. The proposed discharge limits for the release of treated water from these facilities (Table 6.8) were drawn from the data in Table 6.7. These levels have been selected by the regulatory agencies managing water in the N.W.T. as being protective of water quality in the receiving environment in similar settings.

6.2.4 Discharge of Storm Water and Snow Melt from the Non-Hazardous Material Landfill Pollution Control Sump

Non-combustible and non-hazardous waste will be disposed of in a landfill that will be constructed in a portion of the rock quarry immediately west of the camp (Quarry 2). The landfill will be isolated from the surrounding watershed via a set of containment and barrier berms. The landfill surface will be graded towards a single sump to allow pump out of clean water directly onto the tundra, or contaminated water to a tanker and then on to Tail Lake. The landfill will be fenced and access will be via a lockable vehicle gate.

Uncontaminated precipitation runoff will be directed away from the landfill area by small rockfill berms located along the upslope edge of the quarry excavation. Similar rockfill berms constructed along the down slope edge of the quarry excavation will retain precipitation runoff and snowmelt within the landfill footprint. The floor of the quarry is founded on bedrock, and will be sloped gently to drain into an excavated sump located at the south-east corner of the landfill area.

During spring melt, the water collected in this sump will be sampled by the on-site environmental personnel, and will be analyzed for pH, TSS, Total Ammonia, Total Sulphate, Total CN, Total Oil and Grease, Al, As, Cu, Fe, Pb, Ni, and Zn.

Water will be pumped from the sump onto the tundra and be land applied, as long as it meets the proposed discharge standards as set out in Table 6.6 (the same discharge standard as proposed for the mill and camp pad sedimentation pond). Pumping from the landfill pollution control sump will only start once water in the sump has been verified as meeting the proposed discharge standards.

Once pumping starts the discharge from the sump will be sampled for the above parameters daily for each day of pump operation.

The water will be discharged to an area immediately to the east of Quarry 2 where it will have a long cross country flow path before reaching Doris Lake.

If water quality does not meet the proposed discharge standards, then the water contained in the landfill pollution control sump will be pumped into a truck mounted tank and transferred to the tailings containment facility at Tail Lake. This transfer of water will continue until sampling verifies that the landfill pollution control sump water complies with the proposed discharge standards.

7.0 MONITORING PROGRAMS

Taotutit Atogakhat

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MHBL has developed a Monitoring and Follow-up Plan for the Doris North Project. This Plan forms a component of the Environmental Protection Plan for the Project and is attached as a sub-component of supporting document S10 to this application (S10m).

The purpose of the Monitoring and Follow-Up Plan is to provide a consolidated summary of the monitoring and follow-up programs committed to by Miramar Hope Bay Ltd. at the Doris North Project in Nunavut. These programs are intended to collect high quality data to:

- Enable MHBL to monitor and report on performance compliance with all environmental legislation, regulations, Licenses, Permits, Leases and/or Authorizations applicable to ongoing operation of the Doris North Mine;
- Enable MHBL to obtain good quality data on environmental conditions at and around the mine to facilitate appropriate management of MHBL's activities and facilities at the Doris North Mine;
- Allow MHBL to check the validity of the assumptions that were made during the design phase of the project, and provide the data needed to adaptively manage its activities if such assumptions are shown to be incorrect; and
- Allow MHBL to check the validity of the environmental impact assessment predictions made during the environmental assessment process and modify its activities if measured impacts are worse than predicted.

These monitoring and follow-up programs were developed as part of corporate commitments, regulatory approval conditions (e.g., Project Certificate from the Nunavut Impact Review Board) and as a result of stakeholder consultation.

A follow-up monitoring program is used to verify the accuracy of the environmental assessment and/or to determine the effectiveness of mitigation. Typically, follow-up programs are focused on issues associated with potentially significant adverse environmental effects or negotiated mitigations, such as fisheries compensation to replace productive capacity of lost fisheries habitat due to the project. Monitoring data will be analyzed to help determine if there are any undesirable environmental effects as a result of project activities.

Monitoring programs have been developed in each of the following areas for the purpose of monitoring the ongoing environmental performance of the Doris North Mine and to verify the impact predictions made during the environmental assessment of the project; these include the following:

- Climate;
- Hydrology;

- Air quality;
- Noise;
- Vegetation and soil quality;
- Site water quality;
- Tailings geotechnical;
- Waste rock characterization;
- Aquatic effects;
- Fish; and
- Wildlife.

In general, adaptive management is triggered when effects to the receptor exceed predictions determined in the Environmental Impact Statement (EIS). The following is a summary of the key elements of the Monitoring and Follow-Up Plan. The results from these monitoring programs will be used to manage ongoing operations at the mine; adjust and/or modify methods, procedures and/or equipment to mitigate any sub-standard performance, and to prevent adverse environmental impacts associated with any such sub-standard performance from continuing.

All environmental monitoring programs are designed by qualified scientists using widely-accepted scientific standards. The monitoring and follow-up programs will be conducted by qualified and experienced professionals or technicians, with assistance, where practical, of Inuit hired from the region.

The following supporting documents contain detailed information regarding the monitoring programs summarized in the Monitoring and Follow-Up Plan:

- Water Quality Model⁸⁰
- Geochemical Characterization of Quarry Materials⁸¹
- Air Quality Management Plan⁸²
- Waste Rock Management Plan⁸³
- Noise Abatement Plan⁸⁴
- Water Management Plan⁸⁵
- Aquatic Effects Monitoring Program⁸⁶ =
- Doris North Project No Net Loss Plan – Revision 5 (Golder 2005a)

Table 7.1 provides an overview summary of the monitoring parameters, sampling location, and sampling frequency for each proposed follow-up monitoring program.

⁸⁰ Section 5.2, Water Quality Model, Supporting Document S6 to the Revised Water License Application Support Document, April 2007.

⁸¹ Section 4.3, Geochemical Characterization of Quarry Materials, Supporting Document S7 to the Revised Water License Application Support Document, April 2007.

⁸² Section 3.2, Air Quality Management Plan, Supporting Document S10b to the Revised Water License Application Support Document, April 2007.

⁸³ Section 2.7, Waste Rock Management Plan, Supporting Document S10d to the Revised Water License Application Support Document, April 2007.

⁸⁴ Sections 2 and 3, Noise Abatement Plan, Supporting Document S10d to the Revised Water License Application Support Document, April 2007.

⁸⁵ Sections 6 and 9.6, Water Management Plan, Supporting Document S10j to the Revised Water License Application Support Document, April 2007.

⁸⁶ Final Report on Effluent and Aquatic Monitoring Study Design, Supporting Document S11 to the Revised Water License Application Support Document, April 2007.

Table 7.1: Monitoring Program Summary

Category	Parameter	Location	Frequency	Mining Phase
Air Quality and Climate				
Doris North	Wind speed @ 3 m	Mill Site	Continuous	Construction, Operation, Closure, Post-closure
	Wind direction @ 3 m	Mill Site	Continuous	Construction, Operation, Closure, Post-closure
	Temperature @ 2 m	Mill Site	Continuous	Construction, Operation, Closure, Post-closure
	Relative humidity @ 2 m	Mill Site	Continuous	Construction, Operation, Closure, Post-closure
	Solar radiation @ 2.5 m	Mill Site	Continuous	Construction, Operation, Closure, Post-closure
	Precipitation (tipping bucket; summer)	Mill Site	Summer continuous	Construction, Operation, Closure, Post-closure
	Passive monitoring for SO ₂ , NO ₂ and O ₃	Mill Site	Monthly	Construction, Operation, Closure
	Particulate matter (TSP, PM ₁₀ , PM _{2.5}) PLANNED	Mill Site	Every 6 th day	Construction, Operation, Closure

Category	Parameter	Location	Frequency	Mining Phase
Boston	Wind speed @ 10 m	Above the Portal	Continuous	Construction, Operation, Closure, Post-closure
	Wind direction @ 10 m	Above the Portal	Continuous	Construction, Operation, Closure, Post-closure
	Temperature @ 2 m	Above the Portal	Continuous	Construction, Operation, Closure, Post-closure
	Relative humidity @ 2 m	Above the Portal	Continuous	Construction, Operation, Closure, Post-closure
	Solar radiation @ 2.5 m	Above the Portal	Continuous	Construction, Operation, Closure, Post-closure
	Snow Depth	Above the Portal	Continuous	Construction, Operation, Closure, Post-closure
	Precipitation (tipping bucket; summer)	Above the Portal	Summer continuous	Construction, Operation, Closure
	Passive monitoring for SO ₂ , NO ₂ and O ₃	Above the Portal	Monthly	Construction, Operation, Closure
Soil and Vegetation Sampling	Metal concentrations in lichens ¹	Project site locations and reference locations throughout the Hope Bay Region	Once during Construction, annually during Operation and once during Closure	Construction, Operation, Closure
	Metal concentrations in plants and berries ¹	Project site locations and reference locations throughout the Hope Bay Region	Once during Construction, annually during Operation and once during Closure	Construction, Operation, Closure

Category	Parameter	Location	Frequency	Mining Phase
	Metal concentrations in soils ¹	Project site locations and reference locations throughout the Hope Bay Region	Once during Construction, annually during Operation and once during Closure	Construction, Operation, Closure
Noise				
Environmental Noise	LA _{eq} , LAF _{min} , LAF _{max} , LC _{eq} , and 1/3 band octave data.	At NM1 – Jetty and Quarry 1 area, NM2: Camp and Plant area; NM3: Quarry #2 and NM4: Tailings Area Caribou Crossing.	3 to 4 times in each project phase commencing in the summer of 2007.	Construction, Operation, Closure
Occupational Noise Monitoring	Hearing Levels Workplace Noise Levels		Pre-employment medicals and annual audiometric testing for employees working in high exposure areas or occupations UG Mine, Mill, Mtce Shop, Heavy Equipment Operators, Employees working around aircraft, other areas where noise level is 80 dBA or greater	Operations Operations
Hydrology				
	Water quantity (water level and/or discharge)	Tail Lake	Continuous	Construction, Operation, Closure, and Post-closure to end of treated tailings effluent discharge
		Doris Lake	Continuous	
		Tail Lake Outflow (upper)	Continuous during open water season including during discharge of tailings effluent	
		Doris Lake Outflow (upper)		
		Doris Lake Outflow (lower)		

Category	Parameter	Location	Frequency	Mining Phase
		Roberts Lake Outflow	Continuous during open water season	Construction, Operation through verification of fisheries No Net Loss mitigation measures
		Little Roberts Lake Outflow		
	Snow course surveys	Doris Lake watershed	Annual in late winter	Construction, Operation, Closure and Post-closure to end of treated tailings effluent discharge
	Lake Evaporation	Doris Lake Watershed (calculated)	Continuous	Construction, Operation, Closure and Post-Closure to end of treated tailings effluent discharge
Site Water Quality				
Environmental Management during construction and at closure	Total suspended sediment/Turbidity	Roberts Bay jetty Doris Lake boat launch Doris Lake water intake	Hourly to daily during in-water construction activity	Construction, Closure
Environmental Management during construction and at closure	Total suspended sediment/Turbidity	All construction sites	Daily visual inspections for all construction activity during spring freshet and during and after rain events, with sampling of runoff/seepage where turbidity appears to be high	Construction, Operation

Category	Parameter	Location	Frequency	Mining Phase
Site Compliance Monitoring	Water quality and quantity	Tail Lake end of discharge pipe to Doris Creek Doris Creek Outflow both upstream and downstream of discharge point	Weekly as per MMER during annual discharge period Every second day for two weeks prior to discharge and for two weeks after discharge, then reducing to once per week during the annual discharge period	Operation, Closure, Post Closure (for up to nine years after cessation of mining)
Site Compliance Monitoring	Water quality and quantity	Water Quality within Tail Lake – Reclaim water	Every second day for two weeks prior to discharge and for two weeks after discharge, then reducing to once per week during annual the discharge period Monthly at all other times during operational phase Monthly during closure phase only during open water period	Operation, Closure, Post Closure (for up to nine years after cessation of mining)
Site Water Quality				
Site Compliance Monitoring	Water quality and quantity Tailings Solids Backfill Solids – quality and quantity	Combined Tailings discharged to Tail Lake– water component Tailings solids discharged to Tail Lake Filtered Cyanide Leach Residue	Daily initially, reduced to weekly after 3 months of operation Composited monthly Composited monthly	Operation

Category	Parameter	Location	Frequency	Mining Phase
Site Compliance Monitoring	Water quality and quantity	Temporary Waste Rock Pollution Control Pond	Monthly (during open water season)	Operation, Closure
Site Compliance Monitoring	Water quality and quantity	Plant site storm water management pond	Once before any planned discharge, daily when discharging onto the tundra	Operation, Closure
Site Compliance Monitoring	Water quality	Fuel tank farm collection sump	Daily when discharging onto the tundra	Operation, Closure
Site Water Quality				
Site Compliance Monitoring	Water quality	Roberts Bay Fuel tank transfer facility collection sump	Daily when discharging onto the tundra	Operation, Closure
Site Compliance Monitoring	Water quality	Landfarm collection sump	Daily when discharging onto the tundra	Operation, Closure
Site Compliance Monitoring	Water quality	Landfill collection sump	Once before any planned water is discharged to the tundra (land applied) Daily whenever the sump is being pumped to discharge onto the tundra	Operation, Closure
Seepage Monitoring of quarried rockfill along roads and pads	Water Quality – field pH	After construction is complete a survey of seep points along the site roads, airstrip and building pads will be conducted targeting ~ 100 points	An initial survey in the Spring freshet of 2008 Follow-up survey in the Spring of 2009 and 2010	Construction, Operation

Category	Parameter	Location	Frequency	Mining Phase
Seepage Monitoring of quarried rockfill along roads and pads	Water Quality – Sulphate and Metals	Seepage points where the field pH is measured as being either below 6.0 or higher than 8.0 will be analyzed for sulphate and metals	An initial survey in the Spring freshet of 2008 Follow-up survey in the Spring of 2009 and 2010	Construction, Operation
Site Water Quality				
Site Environmental Management	Water quality	Doris Lake at freshwater pump intake	Monthly	Operation, Closure
Site Environmental Management	Water quality	Potable Water – taken at different spots each month	Monthly	Operation, Closure
Site Environmental Management	Water quality	Sewage Treatment Plant Effluent to Mill pump box	Monthly	Operation, Closure
Effluent Treatment Process Control	Water quality and quantity	Barren bleed solution	Every two hours	Operation
Site Geotechnical				
Thermal Monitoring	Ground Temperature	Thermistor strings at jetty, fuel transfer station, airstrip, camp pad, pollution control pond, sedimentation pond, float plane dock laydown area, roads – 5 thermistor strings, and bridge abutments	Monthly	Operation
Visual Inspections	Settlement of fill materials	All surface infrastructure pads and roads and the jetty	Monthly	Operation

Category	Parameter	Location	Frequency	Mining Phase
Tailings Geotechnical				
Thermal Monitoring	Ground Temperature	Thermistor strings at tailings dams, around Tail Lake shoreline	Monthly	Operation, Closure
Visual Inspections	Tailings containment system performance	Tailings and reclaim pipelines, dump catch basins, tailings discharge point, reclaim water pump, north and south dams and discharge system	Daily	Operation, Closure
Geotechnical Inspections	Tailings containment system performance and dam stability	Inspection by a qualified geotechnical engineer of all structures including the dams and Tail Lake shoreline	Annually during early summer	Operation, Closure, Post- Closure
Tail Lake Bathymetry	Tail Lake bathymetry to facilitate tailings deposition management	Survey of Tail Lake bathymetry	Annually during early summer	Operation
Waste Rock Characterization				
Quarried Rock Material	ABA Characterization	Check sampling of rock quarried for use in infrastructure (jetty, roads, airstrip, building pads, dams, etc.) to verify characterization ABA characterization work completed on quarry rock sources in 2006	Approximately 100 samples spread over construction quarrying	Construction

Category	Parameter	Location	Frequency	Mining Phase
Underground Waste Rock	ABA Characterization	ABA characterization of any non-acid generating waste rock to be permanently left on surface to verify that such rock is non-acid generating	As required – contingent measure	Construction, Operations
Aquatic Effects				
Regional Water Quality	Water Quality	Doris Creek at confluence with Little Roberts Lake	Monthly during annual discharge period	Operations, Closure, Post-closure
Regional Water Quality	Water Quality	Little Roberts Lake Outflow	Monthly during annual discharge period	Operations, Closure, Post-closure
MMER Effluent Monitoring	pH, MMER deleterious substances	Tail Lake end of Discharge pipe to Doris Creek	Weekly during annual discharge period	Operations, Closure, Post-closure
	Acute Lethality Testing on rainbow trout and <i>Daphnia magna</i>	Tail Lake end of Discharge pipe to Doris Creek	Monthly during annual discharge period	Operations, Closure, Post-closure
EEM Effluent Characterization	pH, MMER deleterious substances	Tail Lake end of Discharge pipe to Doris Creek	Four times per year during EEM cycle	Operations, Closure, Post-closure
EEM Receiving Water Chemistry	pH, dissolved oxygen, temperature, MMER deleterious substances	Doris Creek Outflow both upstream and downstream of discharge point	Four times per year during EEM cycle	Operations, Closure, Post-closure
Aquatic Effects				
EEM Fish Population Survey	Fish survival, growth, condition and reproduction	Two control streams, two control lakes, one exposure lake and two exposure streams (near-field and far-field)	Monitoring frequency is dependent on results of previous cycle (minimum of two cycles)	Operations, Closure, Post-closure
EEM Fish Tissue Survey	Tissue mercury concentration			

Category	Parameter	Location	Frequency	Mining Phase
EEM Benthic Invertebrate Community survey	Invertebrate density, taxa richness, diversity and similarity of community structure			
Fish				
Rearing habitat in Doris L.	Periphyton, benthos, and fish	Doris Lake sites and two reference sites	Annually during operation; plus Year-1 and Year-5 from decommissioning.	Operation, Closure and Post-closure.
Jetty fish habitat structures	Periphyton, benthos, and fish	Jetty structure sites and two reference sites	Summer following jetty construction, plus Year-2 of operation and Year-2 of active post-closure (year prior to jetty lowering to below water)	Construction, Operation and Post-closure.
Rearing habitat in tributary to Roberts Lake	Use of habitat by fish (Arctic char, lake trout)	Tributary to Roberts Lake	Annually during operation; plus Year1 and Year-5 from decommissioning.	Operation, Closure and Post-closure.
Enhancement of stream channel in Roberts Creek,	Success of upstream Arctic Char movement into Roberts Lake	Roberts Creek above and below enhancement area	Once in a low to moderate flow year during early years of operations or closure and again in Year-9 or Year-10 (depending on flow conditions) after decommissioning	Operation/Closure and Post-closure
	Arctic char smolt out-migration	Roberts Creek below Little Roberts Lake	Annually beginning in 2006 for 10 year period	Pre-construction, Construction, Operation, Closure, and Post-closure
	Arctic char and lake trout abundance (catch-per-unit-effort)	Roberts Lake and selected tributaries	Annually beginning in 2006 for 10 year period	Pre-construction, Construction, Closure, and Post-closure

Category	Parameter	Location	Frequency	Mining Phase
Willow Habitat along Doris Lake at entrance of Tail Creek	Distribution of shoreline willow habitat	Doris Lake at entrance of Tail Creek	Once in summer of 2007 (pre-construction), once during operation and once during closure	Pre-construction, Construction, Closure
Tail Lake Fish Tissue Analyses	Metal contaminant levels in lake trout	Tail Lake	Once prior to conducting fish-out of Tail Lake	Construction
Wildlife				
VECS include: • wildlife habitat; • caribou; • muskoxen; • grizzly bears; • wolverines; • upland breeding birds; • waterfowl; and • raptors.	Habitat loss from Project footprint	Project footprint	Once during each mining phase	Construction, Operation, Closure
	Survey observations (individuals, density, species richness and sign) for all VECs	Wildlife Study Area	Annually according to species survey protocol	Construction, Operation, Closure and Post-closure
	Sightings log and encounters	Hope Bay Region	Annual summary of observations	Construction, Operation, Closure

¹ Metal concentrations in soils, lichens, plants and berries include analyses for the following metals: Arsenic, Silver, Aluminum, Barium, Beryllium, Cadmium, Cobalt, Chromium, Copper, Molybdenum, Nickel, Lead, Antimony, Tin, Strontium, Thallium, Vanadium, Zinc, Calcium, Potassium, Magnesium, Sodium, Iron, Manganese, Phosphorus, Selenium, Titanium and Mercury.

The following sections provide a summary of the monitoring programs discussed in the Monitoring and Follow-Up Plan.⁸⁷

7.1 Climate Monitoring

The climate monitoring program, or meteorological monitoring program, will continue as part of the air quality monitoring program, and addresses NIRB Project Certificate Commitment #8 for the Doris North Project. A meteorological station was installed on the north shore of Doris Lake in May 2003, and measures hourly values of temperature, wind speed, wind direction, relative humidity, solar radiation and rainfall. The program will continue through all phases of the Doris North Project, and is used to support the air quality monitoring program and hydrology monitoring programs, among others. Further details on the air quality monitoring program can be found in Supporting Document S10b.

7.2 Hydrology Monitoring

The existing hydrology monitoring program will continue and be modified to meet regulatory requirements. The program will include annual snow course surveys, water level monitoring on Doris and Tail lakes, and discharge monitoring on Doris, Roberts, Little Roberts and Tail lake outflows. An additional station will be added on Doris Lake outflow to record discharges below the treated tailings discharge point (below the falls). Annual lake evaporation will continue to be calculated using data from the Doris Lake meteorological station.

Monitoring will continue as long as required to assess project effects and mitigation. Real time monitoring will be provided where required to meet operational requirements. Further details on the hydrology monitoring program can be found in Supporting Document S10m.

7.3 Air Quality Monitoring

The air quality monitoring program will continue to measure baseline air quality conditions. The air quality monitoring program currently includes monitoring of total suspended particulates (TSP), dustfall, sulphur dioxide (SO₂), nitrogen dioxide (NO₂) and ozone (O₃), and is designed to address NIRB Project Certificate Commitment #30 for the Doris North Project. In addition, in the summer of 2007 the meteorological station will have the capability to measure ambient concentrations of particulate matter (PM), including PM₁₀ and PM_{2.5}. This monitoring program is designed to determine the effects of the Project on air quality parameters, such as TSP, dustfall, NO₂, SO₂, O₃, PM₁₀ and PM_{2.5}. Further details on the air quality monitoring program can be found in Supporting Document S10b.

⁸⁷ Monitoring and Follow-Up Plan, Supporting Document S10m to the Revised Water License Application Support Document, April 2007.

7.4 Noise Monitoring

The Noise Abatement Plan⁸⁸ is designed to provide information on monitoring and mitigating noise, as required under the NIRB Doris North Project Certificate Condition #29. Noise monitoring programs will be conducted three to four times in each of the following project stages: pre-construction (baseline), construction, operation and reclamation. Although some construction operations are scheduled to start in early 2007 (April to mid July), additional baseline monitoring will be conducted in the summer and fall of 2007 away from the area of activity, or during periods of inactivity at the site. A Noise Abatement Plan is provided as a basis for discussion with government regulators. Monitoring periods and dates will be determined, in consultation with government regulatory agencies, based on the Valued Ecosystem Components that may be affected. The following factors will be used to finalize the scheduling of noise monitoring for baseline, construction, operations and reclamation phases:

- season;
- caribou migration;
- bird migration;
- the month before bear hibernation; and
- times when major wildlife events occur.

Locations for monitoring were selected based on the results of noise modelling for the EIA, location of project noise sources and infrastructure, and VEC factors. Type I or Type II integrating noise level meters capable of logging L_{eq} , L_{max} and L_{min} in both dBA and dBC units will be used for long term monitoring. In addition, sound recordings will be made in order to identify noise events and sources being measured. The abatement plan will also identify work procedures that Miramar can implement to control noise from the site, and action that will be taken if noise is not in compliance with criteria. The final noise abatement plan was submitted to NIRB in March 2007, as required as a condition of the Project Certificate.

7.5 Vegetation and Soil Quality Monitoring

Monitoring of vegetation quality (i.e., collection of vegetation samples for chemical analysis) will be included as part of the environmental monitoring program for the Doris North Project. The purpose of the sample collection is to determine whether dust from the site is depositing onto nearby plants, and whether the plants are taking up metals (i.e., components of dust) as a result. Information on plants concentrations can then be used to judge the quality of food for wildlife in the area. Further details on the vegetation and soil quality monitoring program can be found in the Monitoring and Follow-up Plan.⁸⁹

⁸⁸ Noise Abatement Plan, Supporting Document S10c to the Revised Water License Application Support Document, April 2007.

⁸⁹ Monitoring and Follow-Up Plan, Supporting Document S10m to the Revised Water License Application Support Document, April 2007.

7.6 Site Water Quality Monitoring

Site water quality monitoring will be conducted for several purposes:

- Site Compliance Monitoring – sampling sites expected to be included within the Surveillance Network Program (SNP) that is expected to be included in the water license for the Doris North Project. These sites are to be sampled to allow MHL mine site personnel to determine whether water from the mine facilities meets standards for discharge, how much water can be discharged and to verify compliance with the discharge standards set under the water license and by the MMER. Table 7.2 presents MHL's suggested Water License SNP points, sampling frequency and analytical parameters for each of these SNP points.⁹⁰ The proposed SNP sampling locations are shown in Figure 7.1 ;
- Site Environmental Management Sampling – samples expected to be collected by MHL to facilitate management of the site water management facilities and to provide data needed by mine operational staff to make operational decisions. This will not be scheduled sampling but represents sampling carried out on an as needed basis by site personnel to allow them to assess and manage environmental performance at the site. The sample locations will vary in response to events going on on site and to respond to internal data needs. These samples are not intended to be part of the SNP;
- Effluent Treatment Process Control – samples taken within the mill to provide data to MHL operating personnel that will tell them how the mill effluent treatment circuit is performing and to trigger adjustment of operational controls accordingly to optimize treatment performance;

Environmental Effects Monitoring of water quality in the downstream aquatic receiving environment to meet obligations under the MMER to monitor for potential mine related effects and to facilitate adaptive management programs to mitigate when adverse effects are found⁹¹ (see Summary on Table 7.1).

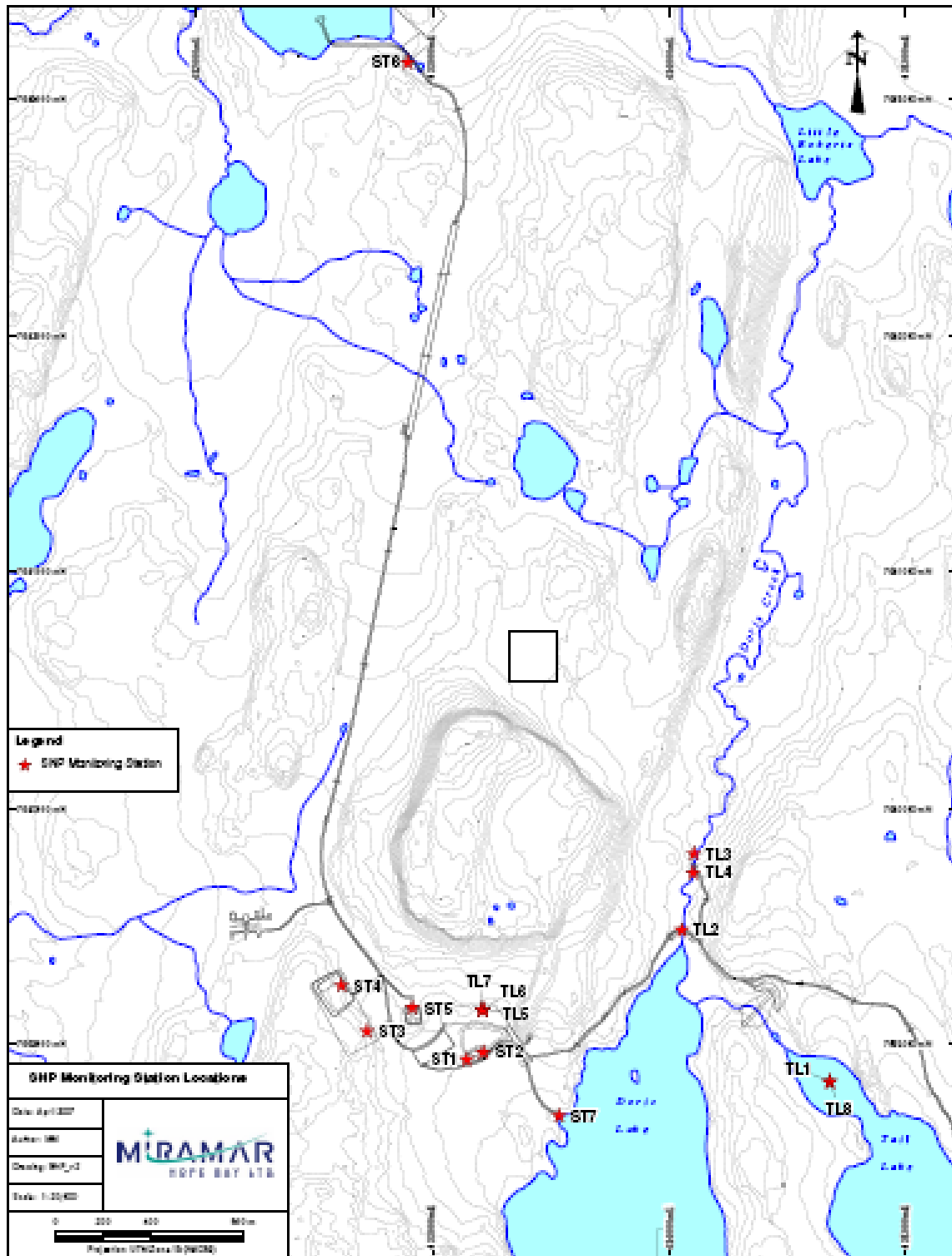
⁹⁰ For specific information on the sampling at each of the proposed SNP stations, see Sections 6 and 9.6, Water Management Plan, Supporting Document S10j and Section 5, Monitoring and Follow-Up Plan, Supporting Document S10m to the Revised Water License Application Support Document, April 2007.

⁹¹ Covered in Section 8, Monitoring and Follow-Up Plan, Supporting Document S10m to the Revised Water License Application Support Document, April 2007.

Table 7.2: Proposed SNP Stations, Sampling Frequency & Parameters

SNP MONITORING STATIONS			
SNP #	Description	Frequency	Monitoring Parameters
TL1	Tail Lake at the Reclaim Pump Barge - depth of 1.5 m below surface	Every second day for two weeks prior to discharge and for two weeks after discharge then reducing to once per week during remainder of annual discharge period	pH, TSS, Free CN, Total CN, Total Ammonia-N, Nitrate, Nitrite, Orthophosphate-P, Total Phosphate-P, Total Al, As, Cd, Cr, Cu, Fe, Pb, Hg, Mo, Ni, Se and Zn
TL2	Doris Outflow Creek - upstream (at the flow monitoring station adjacent to the bridge)	Every second day for two weeks prior to discharge and for two weeks after discharge then reducing to once per week during remainder of annual discharge period	pH, TSS, Free CN, Total CN, Total Ammonia-N, Nitrate, Nitrite, Orthophosphate-P, Total Phosphate-P, Total Al, As, Cd, Cr, Cu, Fe, Pb, Hg, Mo, Ni, Se and Zn
TL3	Doris Outflow Creek - down stream (~100 m downstream of the base of the waterfall)	Every second day for two weeks prior to discharge and for two weeks after discharge then reducing to once per week during remainder of annual discharge period	pH, TSS, Free CN, Total CN, Total Ammonia-N, Nitrate, Nitrite, Orthophosphate-P, Total Phosphate-P, Total Al, As, Cd, Cr, Cu, Fe, Pb, Hg, Mo, Ni, Se and Zn
TL4	Tail Lake Discharge End-of-Pipe - taken at a valve at the discharge end of the transfer pump pipeline	Weekly during periods of discharge	pH, TSS, Free CN, Total CN, Total Ammonia-N, Nitrate, Nitrite, Total Al, As, Cd, Cr, Cu, Fe, Pb, Hg, Mo, Ni, Se and Zn and Volume
TL5	Combined Tailings Discharged into Tail Lake (Water Component) - taken from a valve at the discharge end of the mill tailings pumps	Daily initially, reduced to weekly after 3 months of operation	pH, TSS, Free CN, Total CN, Total Ammonia-N, Nitrate, Nitrite, Total Al, As, Cd, Cr, Cu, Fe, Pb, Hg, Mo, Ni, Se and Zn and Volume
TL6	Combined Tailings Discharged into Tail Lake (Solid Component) - taken from a valve at the discharge end of the mill tailings pumps	Monthly on a composite sample taken from the TL6 weekly samples	Total Al, As, Cd, Cr, Cu, Fe, Pb, Hg, Mo, Ni, Se and Zn and Tonnage
TL7	Filtered Cyanide Leach Residue sent UG as backfill	Monthly	Tonnage
TL8	Reclaim water pumped from Tail Lake to Mill Process water tank taken from a valve at the discharge end of the reclaim water pump	Monthly	pH, TSS, Free CN, Total CN, Total Ammonia-N, Nitrate, Nitrite, Total Al, As, Cd, Cr, Cu, Fe, Pb, Hg, Mo, Ni, Se and Zn
ST1	Discharge from Camp/Mill pad sedimentation pond taken from the pond at a depth of ~0.25 m	Once before any discharge, daily when discharging onto the tundra	pH, TSS, Total Ammonia, Total Sulphate, Total CN, Total Oil and Grease, Al, As, Cu, Fe, Pb, Ni, and Zn
ST2	Discharge from Temporary Waste Rock Stockpile Pollution Control Pond taken from a depth of ~0.25 m	Monthly during open water season	pH, TSS, Total Ammonia, Total Sulphate, Total CN, Total Oil and Grease, Alkalinity, Chloride, Al, As, Cu, Fe, Pb, Ni, and Zn
ST3	Discharge from Non-hazardous landfill pollution control sump taken from discharge of pump used to land apply this water	Daily when discharging onto the tundra	pH, TSS, Total Ammonia, Total Sulphate, Total CN, Total Oil and Grease, Al, As, Cu, Fe, Pb, Ni, and Zn
ST4	Discharge from the landfarm sump taken from discharge of oil adsorption system	Daily when discharging onto the tundra	pH, Total Suspended Solids, Total Oil and Grease, Benzene, Toluene, Ethyl benzene and Total Ammonia
ST5	Discharge from the fuel tank farm sump taken from discharge of oil adsorption system	Daily when discharging onto the tundra	pH, Total Suspended Solids, Total Oil and Grease, Benzene, Toluene, and Ethyl benzene.
ST6	Discharge from the Roberts Bay fuel transfer station sump taken from discharge of oil adsorption system	Daily when discharging onto the tundra	pH, Total Suspended Solids, Total Oil and Grease, Benzene, Toluene, and Ethyl benzene.
ST7	Freshwater pumped from Doris Lake taken from a valve on the discharge end of the fresh water pump	Monthly	pH, TSS, Free CN, Total CN, Total Ammonia-N, Nitrate, Nitrite, Total Al, As, Cd, Cr, Cu, Fe, Pb, Hg, Mo, Ni, Se and Zn

Figure 7.1: Suggested Water Quality Monitoring Sites



The primary objective of the Tail Lake water management strategy will be to meet CCME guidelines (Canadian Water Quality Guidelines) for parameters of concern to protect freshwater aquatic life in Doris Creek, downstream of the waterfall.

Monitoring of total suspended sediment (TSS) will be conducted during the construction of the water intake structure and boat dock in Doris Lake, the tailings dams, and the jetty in Roberts Bay. This will provide a review of the effectiveness of sediment control efforts and ensure compliance with regulatory requirements. Several site water quality commitments (Commitment #9, #10, #11, #12 and #13, among others) are outlined in the NIRB Project Certificate for the Doris North Project, and the proposed monitoring program addresses these commitments. The program will consist of periodic monitoring of TSS, or its surrogate, turbidity, at reference and test stations in the vicinity of the construction activities. The monitoring results will be compared to regulatory guidelines for protection of aquatic life (CCME), and if guidelines are being exceeded, appropriate mitigation measures will be implemented to reduce the input of suspended sediment into the water.

7.7 Surface and Tailings Geotechnical Monitoring

A geotechnical monitoring program has been included in the final tailings dam design report.⁹² The following is a summary of the proposed geotechnical monitoring and Follow-up for the surface infrastructure and tailings containment areas.

The surface infrastructure components of the Doris North Project will require two types of geotechnical monitoring:

- **Visual monitoring** – physical inspection of all fill surfaces taking special care to identify any areas that may have undergone settlement.
- **Thermal monitoring** – to evaluate the depth of the active zone, such that advance warning of potential settlement can be determined.

A total of 8 thermistors have been installed in locations where surface infrastructure is to be constructed.⁹³ Where possible, these installations will be retained through construction. In addition, new thermistors are to be installed at the following locations as part of the fill construction:

- Jetty - two strings
- Fuel transfer station - one string
- Airstrip - three strings
- Camp pad - two strings

⁹² Section 11, Design of the Tailings Containment Area, Supporting Document S1 and Section 7, Design of the Surface Infrastructure Components, Supporting Document S2 to the Revised Water License Application Support Document, April 2007.

⁹³ See Thermistors and Geotechnical Drill Hole Plan and Details, Drawing G-04, Engineering Drawings for Surface Infrastructure Components and Tailings Containment Area, Supporting Document S4 to the Revised Water License Application Support Document, April 2007.

- Pollution control pond - one string
- Sedimentation pond - one string
- Float plane dock laydown area - one string
- Roads - five strings
- Bridge abutments - two strings

Each of these stings will have at least three beads measuring between depths of 0.3 m and 3 m below natural ground surface. The thermistor strings need not have data loggers, but monitoring frequency of manual readings on all stings must be completed at least once a month. If warming trends are observed, this frequency should be increased as appropriate. These data will be reviewed by a qualified geotechnical engineer at least once a year to assist in making appropriate maintenance recommendations.

The proposed tailings containment geotechnical monitoring program includes monitoring of the thermal regime, deformation, and seepage. The level of monitoring will be intensive during the early stages of operations, since it is during this period that the dam performance against the design assumptions will be confirmed.

Given the importance of the frozen core for the performance of the dam, the ground temperature inside the dam will be monitored. The ground temperature measurements will determine the extent of the frozen region in the dam, and should provide information on the rate of thawing or freezing fronts. Temperature sensors are located in sensitive areas, such as the upstream zone of the dam, the outer shell that will be subject to the fluctuations of the active zone, as well as the abutments. Temperature sensors will be installed both horizontally and vertically, and as much as possible, will be installed as the dams are being constructed.

Monthly readings will be manually taken from these sensors to depict the thermal regime in the dams; however, data loggers will be installed to collect continuous data at key locations. This frequency will be maintained until the dam reaches pseudo-steady state conditions. The frequency will then be reduced thereafter, but the frequency will have to coincide with the peaks of the annual climatic cycles (i.e. low and high temperatures).

Settlement will be monitored by installing monuments along the crest and sloped faces of the dam. The monuments will be installed during the construction of the dam, and will be surveyed on a regular basis to monitor the movement of the dam, both horizontally and vertically. The deformation will be monitored using settlement plates (or similar devices) and, possibly, inclinometers. The frequency of measurements will be higher during the initial stage of the operations, and will be based on the rate at which the talik is developing along the upstream side of the dams. The frequency of the measurements may be decreased as the rate of deformation decreases.

Climatic data will be collected during the operation of the mine. The climatic data will include ambient air temperature, precipitation (rain and snow), wind speed and wind direction as a minimum. Surveys of snow cover would also be performed to complement the assessment of the thermal regime at the dams.

The dams will be inspected on a regular basis (weekly) to detect damage, deformation or any other anomalies. It is important that the inspections be frequent during the period the lake level is rising and the talik developing. The water level of Tail Lake will also be monitored as part of those regular inspections. Observations of potential seepage will be incorporated in the dam inspection requirements.

The data collected from the monitoring program will be compiled and assessed as part of the Annual Monitoring Program for the tailings containment area. The compiled data will be made available to the regulatory agencies, as well as other parties that may have interest in such data. The frequency of reporting will be on an annual basis.

Annual Geotechnical Site Inspection

In addition to the regular site inspections of the tailings containment area, a suitably qualified professional engineer registered in the Nunavut Territory will make an annual inspection of the tailings dams each summer. The subsequent inspection report will summarize the observations and the review of the available monitoring data (described above). The report will be filed in a timely manner so that, if required, mitigation measures to these structures can be implemented prior to the next freshet.

Maintenance

The dams may require maintenance as the talik develops on the upstream face of the dams. The talik will induce settlements along the upstream face of the dams. The central frozen core is expected to remain frozen and is unlikely to be subject to significant settlement. The final design includes provisions to reduce or minimize these potential settlements along the upstream faces. Regardless of the outcome of the final design, the maintenance program should include placement of additional fill on the upstream face of the dams as settlement develops. The frequency of the maintenance should decrease over time as the thermal regime gradually reaches equilibrium. Regular inspection of the dams will identify any other maintenance issues.

7.8 Waste Rock Characterization Monitoring

Quarried Construction Rock Material

The proposed construction rock quarries have been characterized as having low acid generating and metal leaching potential. However, there is always a small chance that some unexpected change in rock type will be encountered as the quarries are developed. To ensure that any such change is detected, the quarry faces will be inspected by MHBL's field geologists as they are exposed, and if sulphide mineralization is encountered, quarrying will stop until additional testing is completed and the implications assessed. The objective is to ensure that no potentially acid generating rock is used in site construction.

In addition, a program of check ABA (acid base accounting) testing will be conducted on the quarried rock used in site construction to verify that all rock used is non-acid generating. A target of collecting 100 samples spread equally over the approximately 1 million tonnes of rock to be quarried has been established for this Follow-up program.

During construction samples of quarried rockfill will be collected from the various road and pad construction sites and sent to an accredited external lab for acid base accounting analysis. The following information will be collected for each sample collected:

- Location of sample point
- GPS coordinates of sample point
- Name of quarry from which the rockfill came from
- Date rockfill was placed
- The name of the person who performed the sampling
- Date and time of sampling
- Date of analysis
- Name of person who performed the analysis
- Analytical method or techniques used
- Results of analysis

The data will be cross-referenced to a site infrastructure map. The objective is to collect ~100 samples from across the site (spread to capture a representative cross-section of all rockfill used in site construction) to verify that the rock used in construction is non-acid generating.

In the unlikely event that potentially acid generating rock is identified at any of these sample locations, a more intensive sampling program will be conducted around the spot where the rock was discovered. Construction records will be checked to find any other locations where rock from that same quarry on the same date could have been placed. These will also be sampled. Any potentially acid generating rock located by this means will be tagged for removal and replacement during the next winter season. The material removed will be moved to the temporary waste rock stockpile to ultimately be placed underground.

A seep survey will be conducted in the first spring freshet following the major earthworks construction (spring of 2008) along the roadways and beside the pads to measure pH levels in the precipitation runoff and snowmelt that comes in contact with this rock. The pH of each seep will be measured using a field pH meter with the following data recorded:

- Location of sample point
- GPS coordinates of sample point
- The name of the person who performed the sampling
- Date and time of sampling
- Date of analysis
- Name of person who performed the analysis

- Analytical method or techniques used
- Results of analysis

The data will be cross-referenced to a site infrastructure map. The objective is to collect ~100 samples from across the site (spread to capture a representative cross-section of all rockfill used in site construction) to verify that the rock used in construction is non-acid generating. In any location where the field pH is measured to be below 5.0 or above 8.0, a water sample will be collected and submitted for analysis for pH, Total Sulphate, Total Ammonia, Nitrate, Alkalinity, Dissolved Al, As, Cd, Cu, Pb, Ni, and Zn.

Any potentially acid generating rock located by this means will be tagged for removal and replacement during the next winter season. The material removed will be moved to the temporary waste rock stockpile to ultimately be placed underground.

This seep survey will be repeated in the spring freshet of 2009 and 2010.

Underground Waste Rock

MHBL does not plan to use any of the underground waste rock for construction of the site roads, building pads, laydown areas, tailings dams or other site infrastructure to ensure that only non-acid generating rock is used in such construction. Under the mining plan it is expected that all development waste rock will be used internally as backfill within the mine workings.

7.9 Aquatic Effects Monitoring

The aquatic effects monitoring program follows the Metal Mining Effluent Regulations and addresses NIRB Project Certificate Commitments #15, #16 and #17 for the Doris North Project. The objective of the metal mining Environmental Effects Monitoring (EEM) is to evaluate the effects of mine effluent on fish, fish habitat, and the use of fisheries resources. The monitoring program includes sampling fish populations and tissues, benthic invertebrate communities, and effluent and water quality monitoring. The aquatic EEM consists of a series of monitoring and interpretation cycles, with the requirements of each cycle dependent upon the findings of the previous cycle, such that adaptive management strategies can be implemented. Further details on the aquatic effects monitoring program can be found in the Monitoring and Follow-up Plan.⁹⁴

7.10 Fish Monitoring

The fish monitoring portion of the overall aquatic monitoring program includes the monitoring and assessment of the fisheries compensation plan, and fish tissue sampling prior to removal of fish from Tail Lake. The fisheries compensation program consists of the following:

- creation of rearing habitat in Doris Lake;

⁹⁴ Section 8, Monitoring and Follow-Up Plan, Supporting Document S10m to the Revised Water License Application Support Document, April 2007.

- creation of additional reef habitat in the vicinity of the Jetty in Roberts Bay;
- creation of rearing habitat in a tributary to Roberts Lake; and
- enhancement of the stream channel to facilitate fish migration in Roberts Outflow.

The performance of habitat creation measures will be determined by the establishment of primary and secondary productivity on the created habitat, and comparing these measures to reference (natural) areas. In addition, the use of these structures as rearing and feeding habitat for fish will also be used to determine success. The success measure of rearing habitat in the tributary to Roberts Lake will be determined by assessing the use of the tributary by Arctic char through electrofishing surveys. The success of the enhancement measures in Roberts Outflow will be determined through monitoring of smolt out migration from Roberts Lake, as well as by assessing the provision of nearly unrestricted passage of Arctic char into Roberts Lake. Further details on the determination of the efficacy of fish habitat compensation measures can be found in the Monitoring and Follow-up Plan.

In addition to the follow-up programs associated with the fisheries compensation program, MHBL has agreed to assess potential changes to shoreline habitats along Doris Lake due to dewatering of Tail Lake outflow. The effects of dewatering may alter the natural plant community, and therefore, affect ninespine stickleback habitat. Detailed mapping of the outflow will be conducted in 2007, and re-measured periodically throughout the operations and closure phase of the project. Further details on the Tail Lake outflow monitoring program can be found in Monitoring and Follow-Up Plan. Fish tissue sampling will be conducted for lake trout in Tail Lake prior to the deposition of tailings. This sampling will commence prior to operation as part of the fish-out procedure.⁹⁵

7.11 Wildlife Monitoring

Monitoring of wildlife will be implemented to determine the direct and indirect effects of the Doris North Project on the following wildlife VECs:

- wildlife habitat
- caribou
- muskoxen
- grizzly bears
- wolverines
- upland breeding birds
- waterfowl
- raptors

⁹⁵ Further details on the fish tissue sampling program can be found in Section 9, Monitoring and Follow-Up Plan, Supporting Document S10m to the Revised Water License Application Support Document, April 2007.

MHBL submitted a revised Wildlife Mitigation and Monitoring Report⁹⁶ for the Doris North Project to the Nunavut Impact Review Board in December of 2006 in response to Project Certificate Conditions 22 and 25. The Wildlife Mitigation and Monitoring Program (WMMP) is designed to determine the direct and indirect effects of the Doris North Project on wildlife and wildlife habitat. Direct effects include habitat loss from project infrastructure and direct mortality from encounters with on-site staff. Indirect effects include a reduction in habitat effectiveness through habitat avoidance near the project site as a result of human presence and sensory disturbance. Alternatively, some species (e.g., wolverine and grizzly bear) may be attracted to the project site due to human presence and camp smells. The area of avoidance or attraction is referred to as a Zone of Influence (ZOI).

Specific details can be found in the Wildlife Mitigation and Monitoring Program (WMMP) as per NIRB Project Certificate Commitment #27 for the Doris North Project. Consultation with regulatory authorities including Environment Canada and the GN DoE, and with the KIA have been incorporated into the final WMMP as per NIRB Project Certificate Commitments #22 and #26. Data will be collected through appropriate field methods to determine if the Project infrastructure has any effect on wildlife distribution and relative abundance during all phases of operations as per Project Certificate Commitments #25. Information from the wildlife monitoring program can be used as a feedback loop into the adaptive management framework.

⁹⁶ Final Report on Wildlife Mitigation and Monitoring Program for the Doris North Gold Mine Project, dated December 2006, prepared by Golder Associates Ltd. For Miramar Hope Bay Ltd.

8.0 CLOSURE AND RECLAMATION

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MHBL has developed a detailed Mine Closure and Reclamation Plan for the Doris North Project.⁹⁷ The following is a summary of the key elements of the Mine Closure and Reclamation Plan.

This plan has been prepared using the guidance provided in the 2006 “Mine Site Reclamation Guidelines for the Northwest Territories” issued by Indian and Northern Affairs Canada. Additional detail can be found through reference to the Closure Plan. The cost of reclamation and post-closure monitoring and maintenance is estimated at \$11.6 Million.

MHBL is committed to a program of progressive reclamation at the Doris North Project site. Consequently, MHBL intends to manage its reclamation liability at Doris North by initiating reclamation work at an early point in the mine life, where practical, thereby limiting the expansion of overall liability over time.

The following sections provide a summary of reclamation activity proposed for each of the project components.

8.1 Jetty

The jetty will remain in operation for two years after mining ceases to support ongoing reclamation activity. At that time, all mooring hardware will be dismantled and removed from the jetty. The jetty will then be partially removed. Partial removal will entail lowering the jetty surface to 30 cm below the LLWL (lower low water level - 50 cm below the mean water level). Complete removal is not possible without removal of a substantial volume of natural marine sediments. After reclamation, there will be no above water evidence of the jetty.

8.2 Underground Mine

All potentially hazardous materials will be removed from the underground workings and shipped off site for recycle and/or disposal at a licensed disposal facility. The portal entrance to the underground mine will be filled with a rock-fill plug and sealed with a welded steel cover to ensure the underground workings remain inaccessible to people and large animals, in compliance with mine safety requirements. The raises will either be backfilled or covered over (capped) with a vented reinforced concrete cap to similarly prevent access into the mine. The underground workings are in permafrost, and thus, there is no local groundwater and the mine is not expected to flood. Consequently the mine walls are expected to remain frozen over the long-term.

⁹⁷ The Mine Closure and Reclamation Plan forms a component of the Environmental Protection Plan and is attached as Supporting Document S10I to the Revised Water License Application Support Document, April 2007.

8.3 Surface Infrastructure and Facilities

All potentially hazardous materials will be removed from the buildings, packaged and shipped off site for recycle and/or disposal at an appropriate facility. The buildings will then be dismantled with the demolition materials disposed of in the site landfill in Quarry 2. Any economically salvageable equipment will be removed prior to demolition and shipped off site to the point of sale. All above grade concrete floors and foundations will be broken up and removed to the non-hazardous landfill. The rock-fill building pads will remain in place. Any berms on the pads will be breached, and any areas that may collect surface water will be graded to allow free drainage off the pads.

A program of test pitting and sampling will be conducted after closure at all points where ground contamination may be present based on mine operating history. Any contaminated pad surfaces identified through this program will be excavated, treated where appropriate through land farming techniques and/or disposed in the underground mine or at the landfill site in Quarry 2. The selected option will be determined on the specific nature of the contaminant and following consultation with the KIA and GN DOE. In some circumstances contaminated material may have to be shipped off site for secure disposal.

The Environmental Protection Service of the Nunavut Department of Sustainable Development has published an "Environmental Guideline for Soil Remediation" that provides guidance as to acceptable levels for the remediation of hydrocarbon contaminated soils in Nunavut. These guidelines are derived from the CCME 1991 Interim Criteria and the CCME 1997 Recommended Soil Quality Guidelines.

MHBL will use the industrial remediation guideline as set out in Table 8.1 to determine when soil has been remediated to a level acceptable for removal from the landfarm facility for use in site remediation.

Table 8.1: Nunavut Environmental Guidelines for Soil Remediation

Remediation Guidelines for Soil				
	Agricultural	Residential/ Parkland	Commercial	Industrial
Benzene	0.05	0.5	5	5
Toluene	0.1	0.8	0.8	0.8
Ethylbenzene	0.1	1.2	20	20
Xylene	0.1	1	17	20
Total Petroleum Hydrocarbons (TPH)*	-	500**	2500**	2500**
Lead	70	140	260	400
Polychlorinated biphenyl	0.5***	5***	50***	50***

Note: All values are in µg/g or parts per million (ppm). These are the more commonly required parameters. The type of contamination at the site may require analysis for additional CCME parameters.

* Total petroleum hydrocarbons (includes total purgeable and total extractable hydrocarbons).

** The TPH guidelines were developed by the Government of the Northwest Territories (GNWT)

*** CCME 1991 Interim Criteria (note: 1998 PCB Soil Quality Guidelines are currently under development).

The fuel tanks will be emptied, the tanks cleaned and dismantled, with the demolition debris disposed of in the solid waste landfill site in Quarry 2. The hydrocarbon sludge from cleaning of the tanks will be burned on site where possible, or shipped off site for disposal at an appropriate facility where burning is not possible. The containment berms will be breached and recontoured to encourage natural drainage. The finely crushed rockfill material placed on top of the HDPE liner to protect the liner will be sampled for hydrocarbon contamination. Material above the GN industrial criteria will be recovered and placed into the underground mine. At this point in time, it is thought that this material would be end dumped into the ventilation raises prior to capping. Material that meets compliance with the GN standard will be used as cover material at the landfill site. The HDPE liner will be brushed clean and then cut up, removed and disposed of in the landfill.

Waste oil will be burned on site in a dedicated waste oil burner specifically designed for that purpose. Unused explosives will be removed from site or burned on site (ANFO already mixed and stick powder) under the control and direction of a qualified person. Unused chemicals, as well as any other hazardous waste material, will be removed from site for recycle and/or disposal at an appropriate disposal facility in the south.

The permanent explosives storage magazines will be removed from site, along with the explosives mixing plant. The safety berms will be graded level. The storage pads will be tested for contaminated soil. Any identified contaminated pad material will be assessed on a site specific basis using risk management techniques to determine whether the damage to the underlying tundra from removing the rockfill material is worth the potential consequence of leaving the rockfill in place. Each identified site will be remediated following consultation with the land owner and applicable regulatory agencies, taking into account the site specific risk assessments for each area.

The remaining rock fill pads and roads will be scarified and seeded with a native seed mix (if available) to promote re-establishment of native vegetation over the long term. The culverts in the access road will be removed, and the edges of the excavation back-bladed and armoured with coarse rock to allow for passage of natural drainage with minimal risk of future erosion.

The floating wood boat and plane dock on Doris Lake will be removed. The pontoon structures will be removed and disposed of in the site landfill. The mooring bollards will be cut flush at the bottom of the lake and removed. About 0.1 m of clean rockfill will be placed over the bollards left imbedded in the bottom of the lake. The rock fill approach ramp and laydown area will be reclaimed in the same manner as the site roads. Prior to final grading, all anchor points, attached cables, wood cribbing, etc. will be removed.

The walls in the rock quarries will be stabilized at the end of the construction phase of the operation by ensuring that the final quarry wall slopes are cut back to geotechnically stable angles as part of the final quarrying activity. All stockpiled rock material left within the quarries will be spread out or removed for use in closing out other facilities, such as the landfill site. The quarry floors will be channeled to allow precipitation runoff to drain onto the surrounding tundra.

8.4 Tailings Management System

The final closure for the Tail Lake tailings impoundment is a permanent water cover of 4.0 m above the highest tailings elevation in the impoundment. For the full design tailings volume over two years, the tailings surface is expected to be below 24.3 m, which implies that the minimum final water elevation in Tail Lake must be at 28.3 m. In actual fact, the existing (*i.e.*, pre-mining elevation of Tail Lake is 28.3 m, which implies that once the water quality in Tail Lake returns to background concentrations, the North Dam can be breached to allow Tail Lake to return to its pre-mining elevation. Under this condition, there will be a 4.0 m water cover over the tailings. At that time, the North Dam will be breached, and the outflow from Tail Lake will be restored to the pre-mine outflow channel (Tail Lake Outflow) into Doris Lake.

A shoreline survey indicated that approximately 5,100 m of Tail Lake shore may contain permafrost that could be thawed by a rise in the water elevation. Consequently there is a risk that slumping of the shoreline could occur as the Tail Lake water level is dropped during reclamation (once the North Dam is breached). MHBL has proposed armouring 20% of the most high risk shoreline (mostly at the north end of Tail Lake) at the time of construction by placement of geotextile and armouring rock and has allowed sufficient quarried rock to be set aside from the commencement of operations to armour an additional 20% of the most high risk shoreline during the mine life on an as needed basis in response to visual settlement monitoring (adaptive management). The closure and reclamation plan includes a contingency allowance for the placement of geotextile and rock armouring over the remaining 60% of the shoreline considered vulnerable to erosion.

8.5 Roads and Airstrip

The all-weather roads and the airstrip will remain in place after closure. Peripheral equipment like lighting and signposting will be removed. Where culverts have been installed underneath the roads or runway, the roadway or runway will be breached, the culvert removed and the breached opening sloped and appropriately armoured with rock to ensure that natural drainage can pass through with no requirement for maintenance over the long term.

8.6 Landfill and Landfarm

Upon closure, the non-hazardous solid waste disposal site will receive a final cover of non-PAG rock (minimum of 1 m), the surface will be re-graded to blend in with the surrounding terrain, and surface drainage will be directed away from the site. While it is expected that permafrost will form within the capped landfill within a short term, the closure or long term stability of the landfill does not depend upon or require the presence of permafrost within the landfill. Precipitation runoff will be directed away from the landfill by upslope berms. The landfill will not contain hazardous waste materials. The volume of seepage from the landfill will be small, and is not expected to be of poor quality.

Upon closure, hydrocarbon contaminated soils within the landfarm will be tested. Soils that do not meet the GN remediation industrial standard will be removed and placed in the underground mine, where they will be permanently stored within the permafrost. Soils that have been remediated to meet the GN remediation standard will also be removed and used to establish as a vegetative medium over reclaimed areas at the plant site. The underlying HDPE liner will then be brushed clean, cut into pieces and disposed of within the site landfill. The underlying rockfill base and berms will be tested for hydrocarbon contamination, and if within the GN remediation standard removed and used to help close out the landfill site. Rockfill that does not meet the remediation standard will be placed in the underground mine within the permafrost to isolate the material from surface and groundwater.

8.7 Post Closure Water Management

The water management strategy for the Project entails an active managed discharge from Tail Lake beginning in Year 1 of operations and continuing until it can be shown that there is no adverse impact on downstream aquatic life from an unregulated discharge from Tail Lake. At the end of Year 9 (seven years after mining ceases), water quality in Tail Lake is predicted to be within the CCME Guidelines, allowing for a complete “walk-away” closure scenario.

During the mine’s operating life (two years) and for an additional three years after mining and milling ceases, the volume of water to be released from Tail Lake will exceed the natural inflow into Tail Lake. By the third year following the cessation of mining and milling, the water level in Tail Lake will reach the pre-development level of 28.3 m above sea level and the amount of water that needs to be released from Tail Lake is predicted to be equal to the natural inflow. In the year prior to this point in time (i.e., during the 2nd year following the cessation of mining and milling), MHBL will commission a human health and ecological risk assessment to determine if the quality of the water contained in Tail Lake is suitable for release in an unregulated fashion through the former Tail Lake outflow into Doris Lake without resulting in an adverse impact to aquatic life downstream. In the event that the risks are shown to be unacceptable, MHBL will continue to actively manage the annual discharge from Tail Lake by pumping this water to the discharge point in Doris Creek upstream of the waterfall. Pumping would only cease if it can be demonstrated that no adverse impact on downstream aquatic life will occur with an unregulated discharge. At that time, the North Dam will be breached and the outflow from Tail Lake will be restored to the pre-mine outflow channel (Tail Lake Outflow) into Doris Lake. Under this scenario, no further management of water releases from Tail Lake will be required, although monitoring will continue for a minimum of one more year to verify that water quality remains acceptable for discharge.

Under the water management strategy for the discharge of water from Tail Lake, neither the primary (proposed strategy) nor the contingent strategies involve a requirement to treat the water in Tail Lake prior to discharge. It should be pointed out that the proposed management strategy involves treatment of the cyanide leach barren bleed solution residue through an effluent treatment circuit within the mill prior to the tailings being released into Tail Lake. This effluent treatment plant oxidizes cyanide and removes metal contaminants from the liquid fraction of this tailings stream (cyanide barren bleed

solution). The Tail Lake water management strategy includes a primary contingent measure that involves holding and managing water over an extended period of time within Tail Lake until water quality reaches suitable concentrations for discharge. Tail Lake has capacity to accommodate this contingent strategy.

During the two year active reclamation period, site storm water will continue to be managed as it was during the mine's operating life. At the plant site, all runoff will be directed to the storm water sump, tested and if contaminated, transferred into Tail Lake. Water quality monitoring will continue throughout this period.

After reclamation is complete and all sources of contamination have been removed or otherwise mitigated, storm water will be re-directed onto the surrounding tundra from the site roads, airstrip and plant site. Water quality monitoring will continue in summer months until it can be demonstrated that the storm water draining from the reclaimed facilities is consistently meeting water license discharge standards.

8.8 Post Closure Water Quality

During reclamation, all mine related sources of contamination will be removed or mitigated so that within two years all storm water draining from the site is expected to be within water license discharge standards, thereby requiring no ongoing active management.

The annual discharge of water from Tail Lake will continue to be managed each summer for a period of nine years after cessation of mining, that is, through 2019. Water quality modeling indicates that water quality within Tail Lake will have naturally returned to levels consistent with current CCME guidelines for protection of freshwater aquatic life by 2020. At this point in time, no further active management of the release of water from Tail Lake will be required.

8.9 Post Closure Monitoring

The Mine Closure and Reclamation Plan includes MHBL's commitment to ongoing environmental monitoring and maintenance of the Doris North Project site until it can be demonstrated that reclamation objectives have been achieved, and that the site will not have any significant effects on the receiving environment into the future. A cost estimate and schedule for this post closure monitoring is included in the Plan. The responsibility for implementing and paying for post closure monitoring and maintenance lies with MHBL, and would be transferred to any new owner unless alternate arrangements were made that were acceptable to the land owner and other applicable regulatory agencies.

It is anticipated that a Surveillance Network Program (SNP) will be established as part of the water license conditions for the project (see proposed SNP in Section 7.6 – Table 7.2). MHBL will continue monitoring at the same applicable SNP stations into the post closure period, but at a decreasing frequency. Allowance has been included in the reclamation cost estimate for continuing SNP monitoring at a frequency of four times per year from 2011 through 2016, with the frequency decreasing to twice per year through 2018 and then once per year through 2020.

During the closure period, monitoring programs will continue in the following specific areas:

- Compliance Monitoring - monitoring to demonstrate compliance with all regulatory requirements and standards during the closure and reclamation period;
- Biophysical Monitoring - monitoring to ensure that the project is not resulting in adverse impacts to water, air, and environmental health (fish, wildlife, humans);
- Socio-economic Monitoring - socio-economic data relating to mine expenditures, worker health and recruitment will be made available to the appropriate agencies, with appropriate proprietary considerations. MHBL will assist KIA and government agencies by providing mine-related information. If socio-economic variables related to the IIBA are required, this information will be provided to the appropriate parties, as agreed. Information sharing with possible future projects and activities in Nunavut will also be conducted with appropriate proprietary considerations; and
- Compliance with MHBL Policies and Standards - Hiring, training and termination will be undertaken with consideration for Inuit peoples, residents in adjacent communities, and gender equity.

MHBL will initiate programs at closure to help Inuit and other local people in obtaining new jobs and filling vacancies that may be created through other mining developments in Nunavut or elsewhere.

Physical reclamation of the project facilities is expected to be complete within two years of plant shutdown (closure period). Management of the annual release of supernatant from Tail Lake would continue for an additional seven years during the open water season (i.e., with a crew of two people camping on site during the annual release window each summer) (post-closure period). Other on site activity will be minimal during this time. Environmental monitoring would continue. The level of monitoring required will be a function of environmental performance at the site. It has been assumed that post-closure environmental monitoring will continue for 10 years (2011 through 2020), with lesser degrees of effort required as it can be demonstrated that reclamation actions have achieved the stated objectives of preventing any ongoing degradation of the surrounding environment.

The types of environmental monitoring anticipated include:

- Monitoring of water quality in Doris Lake, Tail Lake, Tail Lake outflow and in Doris Creek below Tail Lake;
- Monitoring of surface runoff from the reclaimed plant area, fuel tank farm, closed out landfill and from the reclaimed fuel transfer areas;

- Program of aquatic effects monitoring, including sediment, benthos and fisheries studies to assess cumulative effects of the project on the aquatic environment; and
- Annual inspection by a qualified professional geotechnical engineer of the Tail Lake containment dam.

It is anticipated that water quality and other data will demonstrate that environmental conditions have essentially stabilized by the end of 2015, and that a reduction in frequency of environmental monitoring can be justified. The assumed changes for post closure Years 6 through 10 are summarized as follows:

- Sampling of remaining applicable SNP stations, with the sampling visits scheduled during open water periods;
- Monitoring of surface runoff from reclaimed site facilities, with the sampling visit scheduled during open water periods;
- Annual inspection by a qualified professional geotechnical engineer of the Tail Lake containment dams.

Stabilization of environmental conditions by the end of Year 10 is assumed to be sufficient to justify the cessation of further monitoring requirements by the end of 2020. However, this assumption will be revisited, assessed and modified as necessary based on measured environmental performance at that time.

8.10 Reclamation Schedule

With the completion of mining and ore processing (projected to be at the end of 2010), the mill and all processing circuits will be washed to recover the remaining gold and to remove any material containing cyanide and other milling reagents. All wash down water will be directed through the cyanide detoxification circuit prior to being discharged to Tail Lake.

The site will then be secured and held on a “care and maintenance” basis lasting for approximately five months (January to June) to await outdoor working temperatures more suitable for site disassembly. Over the following two summers (2011 and 2012), all buildings will be dismantled and the roads, building pads and other infrastructure remediated. Salvageable equipment and building material will be transported to the lay down area at Roberts Bay and shipped from site the year following closure (2011). Non-salvageable equipment and material will be cleaned of potentially hazardous material and then disposed of in the on-site landfill disposal area in Quarry 2. Given the remote location of the Doris North Project, it has been assumed that most equipment, buildings and materials will have no economic salvage value, and will thus be demolished and disposed of on-site. Estimates of reclamation liability were made on this basis.

Part of the camp and other support facilities such as the sewage and potable water treatment plants and the shop, will remain in place during most of the Closure Phase; a short period of approximately two years to provide support to the crews conducting the physical reclamation of the Doris North site. These facilities will be decommissioned and removed during the second year of reclamation (2012). The annual release of supernatant from Tail Lake will have to be actively managed for a period of nine years following the cessation of milling (through 2019). In the fall of 2019, the North Dam will be breached so that water can naturally flow from Tail Lake through the former Tail Lake discharge channel beginning with the spring freshet in 2020. At that time water quality in Tail Lake is predicted to be suitable for uncontrolled release.

In the seven year period (2013 through 2019), a two person team will be mobilized to site each summer to manage the pumped release of water from Tail Lake during the open water season. This crew will be housed in a two man exploration camp mobilized each year for this purpose.

The reclamation plan assumes the worst case scenario specifically that at the end of the Doris North reserve there is no ongoing exploration or mining activity on the remainder of the Hope Bay belt. In the more optimistic scenario, MHL will continue to develop additional reserves on the Belt, which would continue the life of the Doris North site. MHL has indicated that where possible from a practical and economic standpoint, the Doris North mill and camp would continue to be used as the centre for processing other reserves found on the belt. In this case, the reclamation plan will be adjusted as needed to accommodate the extended facility life. MHL will remove all of the Doris North buildings and facilities once all further activity on the Hope Bay Belt was completed.

8.11 Reclamation Security

MHL is committed to providing suitable financial security and assurance to cover the cost of full reclamation of the Doris North project. MHL expects that the estimates contained within the Mine Closure and Reclamation Plan will form the basis for future discussions between the NWB, KIA, DIAND and MHL in establishing the appropriate level and form of financial security to be posted for the project. MHL acknowledges the stated principles covering financial security enunciated in the Mine Site Reclamation Policy for Nunavut. It is MHL's intent to enter into discussions with the responsible authorities to reach agreement on an appropriate form and amount of security to be posted for the project.

At this time, MHL has not developed or indicated any preference towards a specific format for the posting of security against reclamation liability. MHL remains open to consideration of a wide range of options, including but not limited to the creation of a reclamation trust, cash, letter of credit, insurance bond or a combination of these mechanisms and others that may arise as a result of future discussions with the authorities.

9.0 LAND LEASES

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9.1 Confirmation of Ownership

The Doris North Project and components of the supporting infrastructure (other than the marine jetty on federal land) will be constructed on Inuit Owned Lands Parcel BB-60. Mineral rights for the Doris North Project area are administered by Nunavut Tunngavik Inc. (“NTI”) on behalf of Inuit.

The Doris North Project is wholly within Exploration Agreement BB60-00-01, known as Tok 1, held between Miramar Hope Bay Ltd (“MHBL”) and NTI. MHBL has exclusive rights to explore for minerals on TOK 1. MHBL and NTI are currently in negotiations for a Production Lease for the Doris North Project.

9.2 Surface Leases

Surface access rights for the Doris North Project area (other than the marine jetty on federal land) are administered by the Kitikmeot Inuit Association (“KIA”). MHBL intends to submit a lease application to the KIA in early 2007, and hopes to finalize the lease with KIA once the regulatory process has been completed.

9.3 Foreshore Lease at Jetty Site

An application for lease of Federal Crown Land was submitted to Indian and Northern Affairs Canada (“INAC”) in March, 2003, record number 77A/3-1, for the land immediately surrounding the proposed marine jetty at Roberts Bay. MHBL hopes to receive this lease from INAC when the regulatory process is near completion.

10.0 COMPENSATION

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10.1 Inuit Impact Benefits Agreement

In September of 2006, the KIA and MHBL signed an Inuit Impact Benefits Agreement (IIBA) for the Doris North Project at a community ceremony held in Cambridge Bay. While the full text of the IIBA is confidential, the following is a summary of the IIBA contents:

10.1.1 Implementation Committee

- MHBL and KIA will establish an Implementation Committee to monitor and implement the IIBA 30 days after execution of the Agreement. A first meeting of this committee took place in October at Edmonton;
- Committee comprises four members: two from KIA and two from MHBL;
- Committee will meet regularly, at least twice annually face to face;
- Committee reports annually and evaluate progress under the Agreement.

10.1.2 MHBL-KIA Liaison

- MHBL will appoint a Liaison who will be the primary contact for KIA on issues relating to implementation issues (*e.g.*, training, employment, contracts, *etc.*).

10.1.3 IIBA Coordinator

- KIA will hire and/or appoint an IIBA Coordinator who will be responsible for ensuring provisions of the IIBA are implemented.

10.1.4 Training and Education Opportunities

- MHBL will provide KIA funding for training and education initiatives that KIA may enter into with partners.

10.1.5 Employment Opportunities

- All positions at the Doris North Project shall be open to Inuit;
- Work rotation will generally be two weeks in, two weeks out;
- Points of Hire include: Kugluktuk, Cambridge Bay, Gjoa Haven, Taloyoak, and Kugaaruk;
- MHBL will provide Inuit employees free air transportation to and from the Point of Hire;
- Contractors and Subcontractors subject to provisions of the IIBA;

- Inuit who do not speak English will be provided reasonable opportunities for employment where lack of English language does not compromise safety of employee, safety of others or job performance;
- MHBL will take steps to establish an Employee and Family Assistance Program;
- MHBL will serve country food that meets government inspection standards;
- MHBL will prohibit possession and consumption of alcohol and illegal drugs at the Doris North Project; and
- MHBL will make summer employment opportunities available to eligible Inuit students.

10.1.6 Business and Contracting Opportunities

- For contracts covered by the IIBA, MHBL will make a 'bid adjustment' for Inuit content in order to provide preference for businesses achieving high levels of Inuit participation. The Inuit content factors include: Head Office in the Kitikmeot Region; Degree of Inuit Ownership; Degree of Inuit Employment; Proportion of Wages Accruing to Inuit; and Total Purchases/Inputs from Kitikmeot Based Businesses;
- Awarding of contracts will be monitored by the Implementation Committee and actual contract awards will be reviewed to track Inuit content;
- Large contracts will be broken down to encourage participation of Inuit; and
- Bonding requirements are not imposed until a successful contractor is selected.

10.1.7 Access to Facilities and Roads

- MHBL will provide to KIA access to those parts of the Doris North Project and its facilities that are on Inuit Owned surface lands upon reasonable notice;
- MHBL will establish operating practices and procedures relating to safety for those persons accessing leases held by MHBL; and
- MHBL will cooperate with KIA and Kitikmeot communities in search and rescue efforts in the Doris North Project area.

10.1.8 Closure and Reclamation

- MHBL recognizes KIA will issue surface leases and other land tenures for the Doris North Project, and these authorizations and tenures contain provisions for progressive reclamation.

10.1.9 Inuit Benefits

- MHBL will contribute funds to KIA over the life of the Doris North Project. KIA may at its sole discretion use the funding to establish programs or projects that the KIA deem necessary or desirable (e.g., culture and/or community development initiatives).

The Doris North Project IIBA will mitigate the impacts of the Doris North development on Kitikmeot Inuit. It also sets in place a collaborative framework through which benefits will be provided to Inuit.

10.1.10 Inuit Water Rights Compensation

The IIBA also contains a water rights compensation agreement with the main points summarized as follows:

- The IIBA applies to the effects of the Doris North Project and addresses KIA's right of compensation under legislation and Article 20 of the NLCA;
- Compensation payments made address loss or damage to quality, quantity or flow of water in, on or flowing through IOL, for damage to Tail Lake and to Inuit values that result from the Doris North Project; and
- The IIBA does not relieve MHBL of any liability for the effects of its Doris North Project on IOL which are not related to compensation for KIA rights under Article 20 of the NLCA or under the Nunavut Waters and Nunavut Surface Rights Act.

10.2 Fish Habitat Not Net Loss Plan

MHBL submitted a Doris North Project "No Net Loss" Plan Revision 5 (Golder Associates Ltd. 2005; EIS Supporting Document F4), which outlines the proposed fisheries mitigation and compensation developed in discussion with Department of Fisheries and Oceans and KIA. The fisheries compensation program for the Doris North Project has been designed to ensure that "No Net Loss" in fish habitat productive capacity is achieved as it relates to the DFO policy for the management of fish habitat. The compensation program consists of four main components; these are as follows:

- creation of rearing habitat in Doris Lake;
- creation of additional reef habitat in the vicinity of the Jetty in Roberts Bay;
- creation of rearing habitat in a tributary to Roberts Lake; and,
- enhancement of the stream channel to facilitate fish migration in Roberts Outflow.

The fisheries compensation "No Net Loss Plan" is currently being updated to include detailed design drawings for the proposed compensation program as part of permitting requirements under the Fisheries Act.

11.0 WATER FEES

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MHBL has submitted the \$30.00 application fee associated with a water license application of this nature in September of 2003 together with the Water License Application Form and Questionnaire.

Future water use fees are based on the Northwest Territories Waters Regulation (Section 9(1)(b) of the NWTWR), for the first 2,000 m³ per day that is authorized by the license, \$1 for each 100 m³ per day”.

The projected consumption of water from Doris Lake for both potable and process water use at the Doris North Project is 480,000 m³ per year (maximum) or 1,315 m³ per day. On this basis the annual water fees would be in the order of \$13.15 per day (\$4,800 per year) due on the final issue of the water use license, and annually on the anniversary date of the license.

GLOSSARY

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Terms and Acronyms	Definition
ABA	Acid base accounting – a testing method to determine whether a rock, soil material may generate acidic water at some point in the future
Archaeology	The scientific study of the material remains of the cultures of historical or pre-historical peoples.
ARD	Acid rock drainage – acidic (and possibly metal containing) water resulting from the chemical weathering of rock or soil material primarily caused by the oxidation of sulphide minerals
Bioaccumulation	The uptake and retention of contaminants by an organism from its environment.
Biodiversity	A measure of the variety of plants and animals in a particular habitat or ecosystem.
Borrow pit	A pit from which material is taken for building roads and for similar activities.
CCME	Canadian Council for the Ministers of Environment. CCME is an organization that sets common guidelines for environmental protection across Canada. CCME is often used to refer to specific environmental protection guidelines such as the Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life
CWQG	Canadian Water Quality Guidelines
Cumulative effects	The effects of a development taken in combination with the effects of other past, current, or reasonably foreseeable future developments.
Demand	A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. The greater the biochemical oxygen demand, the greater the degree of pollution.
DIAND	Department of Indian Affairs and Northern Development
DIO	Designated Inuit Organization
Ecosystem	The organisms of a natural community together with their environment.
EIS	Environmental Impact Statement
EMS	Environmental management system
Esker	A winding ridge made of sand and gravel deposited by a melting glacier.

Terms and Acronyms	Definition
Geochemistry	The study of the chemical composition of the earth and the physical and chemical processes responsible for it.
Geology	The study of Earth in terms of its development as a planet. Commonly thought of as the study of rocks.
Geomorphology	The scientific discipline that studies the surface features of the Earth, including land forms.
Gradient	The angle of a slope, or its steepness.
HSS	Health and Social Services
Hydrology	The science that deals with the occurrence, circulation, distribution, and properties of the waters of the Earth, including their reactions with the environment.
IIBA	Inuit Impact and Benefit Agreement.
INAC	Department of Indian and Northern Affairs Canada (formerly DIAND).
KIA	Kitikmeot Inuit Association
Leaching	The process by which a liquid (e.g., water) passes through a substance, picking up some of the material and carrying it to other places. Can occur underground in soil and rock, or above ground through piles of material.
Lithology	The description of the physical characteristics of a rock, often based on its colour, structure, mineral components, and grain size.
LSA	Local Study Area – local spatial boundaries determined for each VEC based on their respective characteristics and interactions with project components.
MAE-TSE	Miramar Mining Corporation
MHBL	Miramar Hope Bay Ltd.
MPA	Maximum potential acidity
NIRB	Nunavut Impact Review Board
Nitrate	A compound containing nitrogen that can exist in the atmosphere or as a dissolved gas in water, and that can have harmful effects on humans and animals.
Nitrite	A chemical compound produced when ammonia in wastewater is oxidized by bacterial or chemical reactions and ultimately becomes nitrate.
NLCA	Nunavut Land Claims Agreement.
NPC	Nunavut Planning Commission
NPR	Neutralization potential ratio, $NPR = \text{ratio of NP/MPA}$. The ratio of measured neutralization potential to maximum acid generating potential.

Terms and Acronyms	Definition
NTI	Nunavut Tunngavik
Nunavummiut	The indigenous inhabitants of Nunavut
NWB	Nunavut Water Board
Ore	A rock or mineral that contains a valuable constituent, such as diamonds or a metal, for which it is mined and processed.
Overburden	Material that must be removed to allow access to an ore body, particularly in a surface mining operation.
Permafrost	Permanently frozen ground.
Post-closure	The period of time, considered to be up to 30 years, following the shut-down of a mine or other facility, during which monitoring of its effects should be continued.
Proponent	The individual or organization that wishes to carry out a development project.
Raptor	A bird that hunts by snatching its prey.
Riparian	Living or located on a riverbank.
RSA	Regional Study Area – regional spatial boundaries determined for each VEC based on their respective characteristics and interactions with project components.
Sulphur dioxide	A gas formed when sulphur burns in the presence of oxygen, as for example in the burning of gasoline or diesel fuel in a vehicle engine. It is a major air pollutant that is corrosive and harmful to plants and animals, especially trees.
Talik	Permanently unfrozen ground in regions of permafrost. Usually applies to a layer that lies above the permafrost but below the active layer.
TSS	Total suspended solids.
VECs	Valued Ecosystem Components.

Miramar Hope Bay Ltd.
Revised Water License Application
Doris North Project, Nunavut
April 2007

This report, "Revised Water License Application Support Document, Doris North Project, Nunavut, April 2007", has been prepared by Miramar Hope Bay Ltd.

Prepared By

Lawrence J. Connell, P.Eng.
General Manager, Environment

15. MHBL 2007 S10i. Tailings Management Plan, prepared by Miramar Hope Bay Ltd., April 2007 – S10i
16. MHBL 2007 S10j. Water Management Plan, prepared by Miramar Hope Bay Ltd., April 2007 – S10j
17. MHBL 2007 S10k. Quality Assurance/Quality Control Plan, prepared by Miramar Hope Bay Ltd., April 2007 – S10k
18. MHBL 2007 S10l. Mine Closure and Reclamation Plan, prepared by Miramar Hope Bay Ltd., April 2007 – S10l
19. MHBL 2007 S10m. Monitoring and Follow-up Plan, prepared by Miramar Hope Bay Ltd., April 2007 – S10m
20. SRK 2007a. Design of the Tailings Containment Area, Doris North Project, prepared by SRK Consulting (Canada) Inc., March 2007 - S1
21. SRK 2007b. Design of the Surface Infrastructure Components, Doris North Project, prepared by SRK Consulting (Canada) Inc., March 2007 – S2
22. SRK 2007c. Technical Specification for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, prepared by SRK Consulting (Canada) Inc., March 2007 – S3
23. SRK 2007d. Engineering Drawings for Tailings Containment Area and Surface Infrastructure Components, Doris North Project, prepared by SRK Consulting (Canada) Inc., March 2007 – S4
24. SRK 2007e. Water Quality Model, Doris North Project, prepared by SRK Consulting (Canada) Inc., March 2007 – S6
25. SRK 2007f. Geochemical Characterization of Quarry Materials, Doris North Project, prepared by SRK Consulting (Canada) Inc., March 2007 – S7
26. SRK 2007g. Geochemical Characterization of Portal Development Rock, Doris North Project, prepared by SRK Consulting (Canada) Inc., March 2007 – S8

**Appendix A: Water License Application Form and the Water License Application
Supplementary Questionnaire for Mine Development**

P.O. Box 119
GJOA HAVEN, NU X0E 1J0
TEL: (867) 360-6338
Fax: (867) 360-6369
KATIMAYINGI

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NUNAVUT WATER BOARD
NUNAVUT IMALIRIYIN

WATER LICENCE APPLICATION FORM

Application for: (check one)

XX New ☐ Amendment ☐ Renewal ☐ Assignment

1. NAME AND MAILING ADDRESS OF APPLICANT/LICENSEE Hope Bay Joint Venture (Miramar Hope Bay Ltd./Hope Bay Gold Corp.) 311 West First Street North Vancouver, BC V7M 1B5 Phone: 604-985-2572 Fax: 604-980-0731 Cell: 780-975-2550 e-mail: hwilson@miramarmining.com hugh_r.Wilson@hotmail.com		2. ADDRESS OF CORPORATE OFFICE IN CANADA (if applicable) SAME AS # 1 Phone: _____ Fax: _____ e-mail: _____							
3. LOCATION OF UNDERTAKING (describe and attach a topographical map, indicating the main components of the Undertaking) Doris Lake, Hope Bay belt Latitude: 68 degrees 09 Minutes North Longitude: 106 degrees 40 Minutes West NTS Map No. <u>77A/3</u> Scale									
4. DESCRIPTION OF UNDERTAKING (attach plans and drawings) To develop and operate a small gold mine that will mine and process approximately 475,000 tonnes of ore and produce approximately 270,000 ounces of gold over a 30 month period.									
5. TYPE OF UNDERTAKING (A supplementary questionnaire <u>must</u> be submitted with the application for undertakings listed in A bold@) <table><tr><td>☐ Industrial</td><td>☐ Remote/Tourism Camps</td></tr><tr><td>XX Mine Development</td><td>☐ Municipal</td></tr><tr><td>☐ Advanced Exploration</td><td>☐ Power</td></tr><tr><td>☐ Exploratory Drilling</td><td>☐ Other (describe): _____</td></tr></table>		☐ Industrial	☐ Remote/Tourism Camps	XX Mine Development	☐ Municipal	☐ Advanced Exploration	☐ Power	☐ Exploratory Drilling	☐ Other (describe): _____
☐ Industrial	☐ Remote/Tourism Camps								
XX Mine Development	☐ Municipal								
☐ Advanced Exploration	☐ Power								
☐ Exploratory Drilling	☐ Other (describe): _____								

6. **WATER USE**

XX To obtain water

☐ To modify the bed or bank of a watercourse

☐ To alter the flow of, or store, water

XX To cross a watercourse

☐ To divert a watercourse

☐ Flood control

XX Other (describe): To manage the water in a tailings containment area

7. **QUANTITY OF WATER INVOLVED** (litres per second, litres per day or cubic metres per year, including both quantity to be used and quality to be returned to source)

Subject to final engineering and design:

- Potable water needs will be approximately 17,500 cubic meters / year
- Net process water demand will be approximately 400,000 cubic meters / year

8. **WASTE** (for each type of waste describe: composition, quantity, methods of treatment and disposal, etc.)

XX Sewage

XX Solid Waste

☐ Hazardous

XX Bulky Items/Scrap Metal

XX Waste oil

XX Greywater

XX Sludges

☐ Other (describe): _____

**SEE QUESTIONNAIRE AND PRELIMINARY
PROJECT DESCRIPTION FOR DETAILS**

9. **PERSONS OR PROPERTIES AFFECTED BY THIS UNDERTAKING** (give name, mailing address and location; attach if necessary)

The Doris Hinge Project activities are located entirely on Inuit Owned Surface and Sub-surface Land (IOL block BB60.)

DIAND ☐ Yes ☐ No If no, date expected _____

Regional Inuit Association ☐ Yes ☐ No If no, date expected _____

Commissioner ☐ Yes ☐ No If no, date expected _____

10. **PREDICTED ENVIRONMENTAL IMPACTS OF UNDERTAKING AND PROPOSED MITIGATION MEASURES** (direct, indirect, cumulative impacts, etc.)

Please see Preliminary Project Description provided.

11 **INUIT WATER RIGHTS**

Will the project or activity substantially affect the quality, quantity, or flow of water flowing through Inuit Owned Lands and the rights of Inuit under Article 20 of the Nunavut Land Claims Agreement?

The Project is located on Inuit Owned Lands and so the use of water will be subject to Article 20 of the NLCA (Inuit Water Rights). Please see Preliminary Project Description provided.

12. CONTRACTORS AND SUB-CONTRACTORS (name, address and functions)

This will be provided with a final Project Description

13. STUDIES UNDERTAKEN TO DATE (list and attach copies of studies, reports, research, etc.)

Please see Appendix 3 in Preliminary Project Description provided.

14. THE FOLLOWING DOCUMENTS MUST BE INCLUDED WITH THE APPLICATION FOR THE REGULATORY PROCESS TO BEGIN

Supplementary Questionnaire (where applicable: see section 5) ☒ Yes ___ No If no, date expected

Inuktitut/English Summary of Project ☒ Yes ___ No If no, date expected Please see Preliminary Project Description provided.

Application fee \$30.00 (c/o of Receiver General for Canada) ☒ Yes ___ No If no, date expected

15. PROPOSED TIME SCHEDULE

___ Annual (or) ☒ Multi Year

Start Date: September 1, 2003

Completion Date: September 30, 2007

Hugh R. Wilson

Manager, Environmental Affairs

Name (Print)

Title (Print)


Signature

March 20, 2002

Date



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NUNAVUT WATER BOARD
NUNAVUT IMALIRIYIN KATIMAYINGI

**Water Licence Application
Supplementary Questionnaire
for Mine Development**

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SECTION 1 :

GENERAL

1. Applicant

Hope Bay Joint Venture
(Miramar Hope Bay Ltd./Hope Bay Gold Corp.)
311 West First Street
North Vancouver, BC V7M 1B5

Phone: 604-985-2572 Fax: 604-980-0731
e-mail: hwilson@miramarmining.com
hugh r Wilson@hotmail.com

Corporate Address (if different from above):

(Corporate Office address)

(Telephone number)

(Fax)

(E-Mail)

Project Name **DORIS HINGE PROJECT**

Location

Closest Community **Umingmaktok**

Latitude/Longitude **68 deg. 09 min N 106 deg 40 min W**

Show the location of the project on a general location map (eg: 1:1,000,000)

2. Environmental Manager **Hugh R. Wilson** **604 985 2572**
(Name) (Telephone No.)

or Project Manager _____
(Title)

3. Indicate the status of the mine or mill on the date of application. (Check the appropriate space.) Indicate schedule or time table of project activities.

Design _____

Under construction	_____
In operation	_____
Suspended	_____
Care and Maintenance	_____
Abandoned	_____

4. If a change in the status of the mine or mill is expected, indicate the nature and anticipated date of such change.

Doris Hinge Project is in the feasibility study stage.

5. Indicate the proposed schedule for the Mine/Mill operating schedule.

Hours per week	<u>168</u>
Days per week	<u>7</u>
Weeks per year	<u>52</u>
Number of employees	<u>70-80</u>
Number of Inuit employees	<u>as many as possible who are trained and capable of performing the necessary duties</u>

6. How will the project effect the traditional uses on Inuit Owned Lands?

No effect

7. Have the Elders been consulted on effects to the traditional use on Inuit Owned Land? If so, list them. If not, why not?

Consultation with Bathurst Inlet, Umingmaktok and Cambridge Bay has been undertaken in 2000 and 2001 and will continue as the project proceeds to production.

8. Has the proponent consulted Inuit Organization in the Area? If so, list them.

The Doris Hinge Project is located on Inuit Owned Lands. Consultation has been ongoing with KIA, NTI, NWB, NIRB, NPC, CLARC'S and KHTA.

9. Has the proponent consulted surrounding communities on traditional water use areas? If so, list them. If not, why not?

This has been part of ongoing consultations, visits to Bathurst Inlet and Umingmaktok are carried out annually. Project updates with KIA Board at their annual Board meetings.

10. Attach a detailed location map (1:50,000) drawn to scale showing all on site and off site facilities and activities. Show the relative locations of the (proposed) locations of the

mine, mill, water treatment facilities, sewage and solid waste facilities, and tailings containment areas. The plan should include the water intake and pumphouse, fuel and chemical storage facilities, any existing or proposed concentrate, ore and waste rock storage piles, any existing and proposed drainage controls, piping distribution systems, gas, electric and water utility route locations, and transportation access routes around the site. The map also should include elevation contours, water bodies and an indication of drainage patterns for the area.

Please see Preliminary Project Description provided.

11. If applicable, provide a brief history of property development which took place before the present company gained control of the site. Include shafts, adits, mills (give rated capacity, etc.) waste dumps, chemical storage areas, tailings disposal areas and effluent discharge locations. Make references to the detailed map.

Please see Preliminary Project Description provided.

12. Give a short description of the proposed or current freshwater intake facility, the type and operating capacity of the pumps used, and the intake screen size.

Final design and engineering will be done after the feasibility study has been completed, however; it is expected that the pumphouse and intakes would be consistent with other installations in the belt or at other similar operations in the West Kitikmeot region.

13. At the rate of intended water usage for the exploration activity, explain water balance inputs and outputs in terms of estimated maximum draw down and recharge capability of the water source from fresh water will be drawn.

Please see Figure 8 in Preliminary Project Description for water balance.

14. Will any work be done that penetrates regions of permafrost ?
Yes X No

15. If "YES" above, is the permafrost continuous or discontinuous ?

continuous

16. Were (or will) any old workings or water bodies (be) dewatered in order to conduct the exploration activity ?
Yes _____ No X

17. If "YES" above, indicate the name of the water body, the total volume of water to be discharged and the chemical characteristics of the water. Also included should be the receiving water body and expected schedule of the dewatering.

18. Was (or will) the above discharge (be) treated chemically ?
Yes _____ No NOT APPLICABLE AS #16 WAS "NO"

19. If "YES" above, describe the applied treatment.

NOT APPLICABLE AS #16 WAS "NO"

SECTION 2 :

GEOLOGY AND MINERALOGY

20. Physiography; Provide an analysis and interpretation of the geologic and hydrologic environment in the immediate vicinity of the mine or plant. The investigation should extend from ground surface downward to the base of the glacial drift. Include large scale topographic map(s) covering the area where the mine, mill and waste disposal basin are (or were to be)located. The map(s) should provide information on groundwater patterns and permafrost variations in the area.

Please refer to the Preliminary Project Description provided.

21. Briefly describe the physical nature of the orebody, including known dimensions and approximate shape.

This is somewhat explained in the Preliminary Project Description and will be updated at the conclusion of feasibility study.

22. Briefly describe the host rock in the general vicinity of the orebody (from the surface to the mineralized zone.)

Please see Preliminary Project Description provided.

23. Provide a geological description of the ore minerals of the deposit.(If possible, include the percentage of metals.)

Please see Preliminary Project Description provided.

24. Describe the geochemical tests which have been (or will be) performed on the ore, host rock, and waste rock to determine their relative acid generation and contaminant leaching potential. Outline methods used (or to be used) and provide test results in an attached report (ie. Static, Kinetic tests.)

Please see Preliminary Project Description provided.

SECTION 3:

THE MINE

25. Indicate the type of mining method to be used on the property:

Open Pit _____ **X**
Underground _____ **X**
Strip mining
Other mining activity
Explain:

Please see Preliminary Project Description provided.

26. Outline any possible operational changes and when that might occur. (Eg. Open pit to underground)

Please see Preliminary Project Description provided.

27. Describe the type(s) of explosives to be used in mining operations.

Premixed ANFO that will arrive on an annual sealift.

28. Indicate the number of shafts or other openings that are presently on the property. Signify whether or not the openings are presently in use. (Submit measurement in metres)
Indicate if used seasonally.

n/a

29. Are any entrances to shafts, adits, etc. below ground water level.

n/a

30. Are permafrost conditions expected?

Yes

31. Indicate the expected life of the mine.

30 months as described in the Preliminary Project Description

32. Indicate the present average rate of production from all ore sources on the property.

NO PRODUCTION AT THE SITE AT THIS TIME.

33. Indicate the expected maximum rate of production from all ore sources on the property.

Production is expected to be 600 tonnes per day as described in the attached Preliminary Project Description

34. Outline all water usage in the mine. Indicating the source and volume of water for each use.

Please see Preliminary Project Description provided.

35. Indicate the volume of natural ground water presently gaining access to the mine workings.

n/a m³/day

36. Outline methods used (planned) underground to decrease minewater flow. (For example: recycling)

No mine water flow is expected.

37. Indicate the average daily volume of water to be discharged from the mine during normal operations.

No discharge from the mine is expected, however, should it occur, water would be pumped to surface and either used in the process (if metallurgically acceptable), or pumped to the tailings containment area.

38. If a mill will be operating on the property in conjunction with mining, will all minewater (underground, open pit, etc.) be directed to the mill for reuse?

See # 37 above

39. If not, indicate the proposed point and volume of discharge for the minewater.

n/a

40. What are the chemical and physical characteristics of the preceding minewater?
n/a
41. Are there any treatment plans for minewater and will any chemicals be used in such treatment? Explain.
n/a

SECTION 4:

THE MILL (PROCESSING PLANT)

42. Attach a copy of the (proposed) mill flow sheet., Indicate the points of addition of all the various reagents (chemicals) that are (or will be) used.
43. If milling is in progress on the property at the present time, indicate the rate of milling.
X not applicable (check) OR _____ tonnes/day
44. What is the present (or proposed) maximum capacity of the mill?
600 tonnes per day
45. List the types and quantities of all reagent used in the mill process (in kg/tonne ore milled.)
To be provided on conclusion of feasibility study in Project EIS.
46. Is the (proposed) milling circuit based on autogenous grinding?
Yes _____ No **X** Partially
47. Indicate the amount(s) of concentrate(s) produced in the mill.
n/a
48. Will fresh water undergo treatment prior to use in the mill process? Explain.
n/a
49. Indicate all uses of water in the mill. Include the quantity and source of the water for each use

Please see Figure 8 in Preliminary Project Description provided.

Use	Source	Volume m ³ /day

50. Indicate the total volume of water discharged from the mill.

900-1000 cubic meters per day.

51. Of the preceding volume, what quantity is (will be) recycled to other areas on the property (mine, mill, etc.)? Indicate location of use and quantity.

All make-up water will be pumped from Tail Lake which is the tailings containment area.

52. Based on yearly production, indicate the average quantity of tailings (Dry weight) discharged from the mill.

approximately 240 000 tonnes

53. What is the average liquid-solid ratio of tailings leaving the mill?

By weight: 1:2 By volume: 2:1
Liquid: Solid Liquid: Solid

54. If applicable, identify any chemical treatment applied to the liquid phase before being discharged to the tailings area. (Attach flow sheet if available.)

All tailings containing cyanide will be processed through the cyanide destruction circuit.

55. Based on present production or bench test results, describe the chemical and physical characteristics of liquid mill wastes directed to the tailings area.

will be provided on conclusion of Feasibility Study and Project EIS

56. Provide a geochemical description of the solid fraction of the tailings.

will be provided on conclusion of Feasibility Study and Project EIS

57. Identify the current source of power production.

n/a; (3.2 mw diesel electric plant to be installed for operations)

58. At present, is the mill handling custom lots of ore from other properties (or will the mill be handling any in the future)?

n/a

59. If so, specify ore characteristics and describe any mill processes which will change as a result.

n/a

60. If tailings are being recovered in the mill or elsewhere for use as backfill etc.), indicate the quantity of solid tails (tonnes/day) recovered from the mill process.

n/a

61. Will exits be bermed to prevent spills from escaping the mill?

Please see Preliminary Project Description provided.

62. Will all sumps for process tanks have the required 110% holding capacity of the largest tank?

Yes

SECTION 5:

THE CONTAINMENT AREAS

63. Is the tailings containment area (being) designed for total containment?

Total containment of solids with reclaim water being pumped back to the mill process. It is expected that there will be an annual discharge of tailings pond water to the receiving environment.

64. Attach detailed scale plan drawings of the proposed (or present) tailings area. The drawings must include the following:

Please refer to the attached Preliminary Project Description.

- a. details of pond size and elevation;
- b. precise details of all retaining structures (length, width, height, materials of construction, etc.);

- c. details of the drainage basin, and existing and proposed drainage modification;
- d. details of all decant, siphon mechanisms etc., including water treatment plant facilities;
- e. the plan for tailings deposition and final tailings configuration;
- f. details with regard to the direction and route followed by the flow of wastes and/or waters from the ore; and
- g. indication of the distance to nearby major watercourses.

Note: Individual detailed large scale drawings of any facility (dam, decant system, ditch, dike, water treatment plant, etc.) (to be) constructed must be attached. Specific details with regard to the methods of construction, materials (to be) used, etc., are required.

65. Explain your choice of location for the tailings pond design by rationalizing rejection of other options. Consider the following criteria in your comparisons; subsurface strata, permeability, abandonment of tailings, recycling/reclaiming waters, and assessment of runoff into basins. Attach a brief summation.

Tail Lake is a small isolated lake with a correspondingly small watershed and is located close to the proposed processing facility. The watershed area of the proposed tailing containment area is 440 ha. The average depth of Tail Lake is +/- 3 metres.

66. The total area for the existing tailings basin in hectares and for any proposed tailings area is n/a; see #65 Hectares.
67. The average depth of the tailings basin is n/a; see # 65 metres.
68. Indicate the total capacity for the existing tailings area by using water balance and stage volume calculation and curves. (Attach a description of inputs and outputs along with volume calculations.)

Final engineering will be done on conclusion of Feasibility Study and will be included in Project EIS.

69. Indicate the total capacity for the proposed tailings area using water balance and stage volume calculation and curves. (Attach a description of inputs and outputs along with volume calculations.)

Final engineering will be done on conclusion of Feasibility Study and will be included in Project EIS.

70. Will the present tailings area contain the entire production from the mine-mill complex for the life of the project?

Yes

71. If "NO" above, or if production output increases tailings volumes. Indicate what plans have been made for future tailings disposal on the property.

72. Has any land in the immediate area been identified as native or crown land or withdrawn pending native claim settlement?

All lands required for the Project are Inuit Owned Lands (Block BB60)

73. Do the tailings area and all related treatment facilities lie on company held claims?

Yes

74. If not, indicate mine claim boundaries (and owners) on tailings area plan map. Also, attach a copy of all pertinent agreements signed with the owners of the claims not held by the company.

n/a

75. Will the proposed tailings area engulf or otherwise disturb any existing watercourse?

No

76. If "YES", attach all pertinent details (name of watercourse, present average flow, direction of flow, proposed diversions, etc.).

77. If any natural watercourse will gain access to the proposed tailings area, What methods will be used to decrease the amount of runoff water entering the containment area? Indicate the volume of water which will enter the tailings area from the source(s) in question and attach all pertinent details of proposed diversions.

Please see Preliminary Project Description provided.

78. Indicate on the tailings area plan drawing all sources of seepage presently encountered in the vicinity of the tailing area, the volume of each seepage flow (m3/day), and the direction of each flow.

Water balance of Tail Lake watershed to be provided in Project EIS.

79. Are the seepage flows from the property presently being treated chemically? _____ If so, describe how.

n/a

80. If NOT, explain.

n/a

81. Please attach a conceptual abandonment and restoration plan for all tailings areas being developed. Describe the measures that have been (or will be) taken to contain and stabilize the tailings area(s) against leaching and seepage after operations on the property cease.

Please see Preliminary Project Description provided.

82. Describe the proposed or present operation, maintenance and monitoring of the tailings area.

Please see Preliminary Project Description provided.

SECTION 6:

WATER TREATMENT

83. Describe the methods of chemical treatment that are presently being used and/or will be used to control the quality of the tailings effluent. Attach engineering drawings where applicable and a process flow chart. If a pilot test has been conducted please attach description of methodology and results.

Please see Preliminary Project Description provided.

84. List the names of chemicals to be used in the water treatment process.

This is subject to final engineering and will be provided in Project EIS.

85. What is the proposed or present average rate of effluent treatment of the plant (if applicable)?

This is subject to final engineering and will be provided in Project EIS.

86. What is the proposed or present maximum effluent treatment capacity of the plant (if applicable)?

This is subject to final engineering and will be provided in Project EIS.

87. Will treated effluent be discharged directly to a natural water body or will polishing or settling ponds be employed? Describe location control structures and process of water retention and transfer. Attach any relevant design drawings.

This is subject to final engineering and will be provided in Project EIS.

88. Name the first major watercourse the discharge flow enters after it leaves the area of company operations.

Doris Creek; Please see Preliminary Project Description provided.

89. In terms of rate of effluent release and volume and flushing rate of the receiving watercourse, estimate the extent of the mixing zone within the receiving waters and where background levels of constituents for that watercourse will be attained.

This is subject to final engineering and will be provided in Project EIS.

90. Describe the present (proposed from pilot tests) chemical and physical characteristics of the tailings effluent (Decant).

This is subject to final engineering and will be provided in Project EIS.

SECTION 7:

ENVIRONMENTAL MONITORING PROGRAM

91. Have elders been consulted in the establishment of the monitoring program?

This will be part of ongoing Project consultations program.

92. Has Traditional Knowledge of the area been considered?

Will be included in Project EIS.

93. Has any baseline data been collected for the main water bodies in the area prior to development?

Yes; these data will be reviewed in Project EIS.

94. If "YES" include all data gathered on the physical, biotic and chemical characteristics at each sampling location. Identify sampling location on a map.

Please see Appendix 2 in Preliminary Project Description provided.

95. Provide an inventory of hazardous materials on the property and storage locations. (Attach separate Map)

This is subject to final engineering and will be provided in Project EIS.

96. Attach the present or proposed contingency plan which describes course of action, mitigative measures and equipment available for use in the event of system failures and spills or hazardous materials.

Contingency plans will be provided with Project EIS, however; the NWB do have contingency plans on file as they relate to the current activities in the belt.

97. Provide a conceptual abandonment and restoration plan for the site, detailing the costs to carry out the plan, and a proposal for a financial assurance which covers the costs to carry out the plan.

Please see Preliminary Project Description provided.

98. Provide a detailed emergency response plan for the project.

Will be developed with Project contingency Plans and submitted in support of Project EIS.

99. Provide a description of the pollution control systems and environmental management procedures.

Will be developed with Project contingency Plans and submitted in support of Project EIS.

SECTION 8:

ENVIRONMENTAL ASSESSMENT AND SCREENING

100. Has this project ever undergone an initial environmental review, including previous owners.

No

101. Has any baseline data collection and evaluation been undertaken with respect to the various biophysical components of the environment potentially affected by the project (e.g. wildlife, soils, air quality), i.e. in addition to water related information requested in this questionnaire?

Please see Preliminary Project Description provided. Project EIS will be developed to comply with EIS guidelines expected from NIRB.

102. Describe any cumulative impacts the project may create?

**Please see Preliminary Project Description provided;
Also to be included in Project EIS**

103. Has any meteorological data been collected at or near the site? (E.g. precipitation, evaporation, snow, wind).

- a) If so, please include the data and attach copies of reports or site titles, authors and dates.

Please see Figures 9 and 10 in Preliminary Project Description provided.

104. If no, are such studies being planned? Briefly describe the proposals.

Please see Preliminary Project Description Appendix 2 for studies completed to date that will be reviewed in preparation of Project EIS.

105. Has authorization been obtained or sought from the department of fisheries and oceans for dewatering or using any water bodies for containment of waste?

Application to DFO submitted; copy attached.

106. Please attach an outline briefly describing any options or alternatives considered or reflected for the various mine components outlined in this questionnaire (e.g. mill site, water supply sources, location for ore and waste piles).

107. Has a socio-economic impact assessment or evaluation of this project been undertaken? (This would include a review of any public concerns, and water and cultural uses of the area, implication of land claims, compensation, local employment opportunities, etc.)

Please see Preliminary Project Description provided.

108. If yes, please describe the proposal briefly.

It is expected that these issues will be negotiated in an Inuit Impact and Benefit Agreement, and it is the intention of the proponent to initiate these discussions with KIA in due course.

109. If no, is such a study being planned? Yes _____ (When) OR No

110. Does the project alter the quantity or quality or flow of waters through Inuit Owned Lands?

No

111. If yes, has the applicant entered into an agreement with the Designated Inuit Organization to pay compensation for any loss or damage that may be caused by the alteration.

112. If no compensation arrangement has been made, how will compensation be determined?



Miramar Hope Bay Ltd.

300 – 889 Harbourside Drive, North Vancouver, BC V7P 3S1
604-985-2572 fax 604-980-0731

February 8, 2005

Phillippe di Pizzo
Chief Executive Officer
Nunavut Water Board
P.O. Box 119
Gjoa Haven, Nunavut
X0B 1J0

Dear Mr. di Pizzo:

Re: Doris North Project

In March of 2002 Miramar Hope Bay Ltd. ("Miramar") made an application (the "Application") to the Nunavut Water Board ("NWB") for a water licence for the Doris North Project in Nunavut (the "Project"). The NWB subsequently referred the Project to the Nunavut Impact Review Board (NIRB) for environmental assessment pursuant to Article 12 of the Nunavut Land Claim Agreement ("NLCA"). NIRB conducted this environmental assessment in 2003 - 2004, culminating in a series of public hearings held in the communities in July, 2004.

In its final report, NIRB indicated that Miramar had failed to provide sufficient information for the Board to complete their assessment process. NIRB indicated that there were five key deficiencies and that if these deficiencies were adequately addressed then it would be proper for Miramar to reapply to NIRB to have the environmental assessment of the Doris North Project reconsidered. Over the past months Miramar has initiated work to address each of the deficient areas identified by NIRB and is ready to re-enter the environmental assessment process. To this end Miramar has completed an updated Preliminary Project Description for its Doris North Project. The Project as described is essentially the same Project that was being reviewed by NIRB in the summer of 2004, however the proposed project schedule has been altered from that initially proposed to reflect the events of the past year and to recognize the time needed for completion of the upcoming assessment and permitting process. Other items such as the type of tailings dam construction proposed have been changed to reflect the concerns raised by NIRB in their earlier review.

As the March 2002 Water License application to the NWB remains open and in order to have NIRB proceed with a new environmental assessment, Miramar would ask that the Nunavut Water Board please formally refer the Doris North Project to NIRB for screening in accordance with Article 12 of the NLCA.

The updated Preliminary Project Description for the Doris North Project was submitted to the NIRB on February 1st. A copy will also be made available to the NWB through an FTP link to accompany this letter. If there is anything that you need from Miramar to refer the Project to NIRB or to address any other concerns respecting the Project, please do not hesitate to contact me at 1-800-663-8780.

Yours truly,

Miramar Hope Bay Ltd.
(original signed) A. David Long
Per: A. David Long
Vice President Legal
Miramar Mining Corporation

cc. Ms. Stephanie Briscoe, Executive Director, NIRB

**Water Licence Application
Supplementary Questionnaire
for Mine Development**

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SECTION 1:

GENERAL

1. Applicant

Miramar Hope Bay Limited
300 – 895 Harbourside Drive
North Vancouver, BC
Canada V7P 3S1

Phone: 604-985-2572
Fax: 604-980-0731
Email: dlong@miramarmining.com

Corporate Address (if different from above):

(Corporate Office address)

(Telephone number) (Fax)

(Email)

Project Name: **DORIS NORTH PROJECT**

Location:

Closest Community: **Umingmaktok**

Latitude/Longitude: 68 deg. 09 min N 106 deg. 40 min W

Show the location of the project on a general location map (eg: 1:1,000,000)

2. Environmental Manager: **David Long** **604-985-2572**
(Name) (Telephone No.)

or Project Manager **Vice President Legal, Miramar Mining Corp.**
(Title)
3. Indicate the status of the mine or mill on the date of application. (Check the appropriate space.) Indicate schedule or time table of project activities.

Design ✓

Under construction	_____
In operation	_____
Suspended	_____
Care and Maintenance	_____
Abandoned	_____

4. If a change in the status of the mine or mill is expected, indicate the nature and anticipated date of such change.

Doris North Project is in the feasibility and design engineering stage

5. Indicate the proposed schedule for the Mine/Mill operating schedule:

Hours per week	<u>168</u>
Days per week	<u>7</u>
Weeks per year	<u>52</u>
Number of employees	<u>150</u>
Number of Inuit employees	<u>as many as possible who are trained and capable of performing the necessary duties</u>

6. How will the project affect the traditional uses on Inuit Owned Lands:

No effects identified to date.

7. Have the Elders been consulted on effects to the traditional use on Inuit Owned Land? If so, list them. If not, why not?

Consultation with Bathurst Inlet, Umingmaktok and Cambridge Bay was undertaken in 2000, 2001, 2002 and 2003, and will continue as the project proceeds to production.

Elders were consulted at a 3-day TK knowledge workshop held in Cambridge Bay on September of 2003 at which time the Doris North Project was the subject of discussion.

8. Has the proponent consulted Inuit Organization in the Area? If so, list them.

The Doris Hinge Project is located on Inuit Owned Lands. Consultation has been ongoing with KIA, NTI, NWB, NIRB, NPC, CLARC'S and KHTA.

9. Has the proponent consulted surrounding communities on traditional water use areas? If so, list them. If not, why not?

This has been part of ongoing consultations, visits to Bathurst Inlet and Umingmaktok are carried out annually. Project updates with KIA Board at their annual Board meetings.

A Memorandum of Agreement covering compensation for Inuit water rights was negotiated between Miramar and the KIA for the Doris North Project.

10. Attach a detailed location map (1:50,000) drawn to scale showing all on site and off site facilities and activities. Show the relative locations of the (proposed) locations of the mine, mill, water treatment facilities, sewage and solid waste facilities, and tailings containment areas. The plan should include the water intake and pumphouse, fuel and chemical storage facilities, any existing or proposed concentrate, ore and waste rock storage piles, any existing and proposed drainage controls, piping distribution systems, gas, electric and water utility route locations, and transportation access routes around the site. The map also should include elevation contours, water bodies and an indication of drainage patterns for the area.

Please see preliminary Project Description provided.

11. If applicable, provide a brief history of property development which took place before the present company gained control of the site. Include shafts, adits, mills (give rated capacity, etc.) waste dumps, chemical storage areas, tailings disposal areas and effluent discharge locations. Make references to the detailed map.

Please see Preliminary Project Description provided.

12. Give a short description of the proposed or current freshwater intake facility, the type and operating capacity of the pumps used, and the intake screen size.

Final design and engineering will be done after the feasibility study has been completed, however; it is expected that the pumphouse and intakes would be consistent with similar operations in the West Kitikmeot region.

13. At the rate of intended water usage for the exploration activity, explain water balance inputs and outputs in terms of estimated maximum drawdown and recharge capability of the water source from fresh water will be drawn.

Please see Supporting Document F4 to the November 2003 Final Environmental Impact Statement for the Doris North Project submitted to NIRB in November 2003, entitled "Doris Lake Water Level Impact Analysis".

14. Will any work be done that penetrates regions of permafrost?

Yes X No

15. If "YES" above, is the permafrost continuous or discontinuous?

continuous

16. Were (or will) any old workings or water bodies (be) dewatered in order to conduct the exploration activity?

Yes No X

17. If "YES" above, indicate the name of the water body, the total volume of water to be discharged and the chemical characteristics of the water. Also included should be the receiving water body and expected schedule of the dewatering.

18. Was (or will) the above discharge (be) treated chemically?

Yes No NOT APPLICABLE

19. If "YES" above, describe the applied treatment.

NOT APPLICABLE

SECTION 2:

GEOLOGY AND MINERALOGY

20. Physiography: Provide an analysis and interpretation of the geologic and hydrologic environment in the immediate vicinity of the mine or plant. The investigation should extend from ground surface downward to the base of the glacial drift. Include large scale topographic map(s) covering the area where the mine, mill and waste disposal basin are (or were to be) located. The map(s) should provide information on groundwater patterns and permafrost variations in the area.

Please refer to the Preliminary Project Description provided.

21. Briefly describe the physical nature of the orebody, including known dimensions and approximate shape.

Please see the Preliminary Project Description provided.

22. Briefly describe the host rock in the general vicinity of the orebody (from the surface to the mineralized zone).

Please see Preliminary Project Description provided.

23. Provide a geological description of the ore minerals of the deposit. (If possible, include the percentage of metals).

Please see Preliminary Project Description provided.

24. Describe the geochemical tests which have been (or will be) performed on the ore, host rock, and waste rock to determine their relative acid generation and contaminant leaching potential. Outline methods used (or to be used) and provide test results in an attached report (i.e. Static, Kinetic tests).

Please see Preliminary Project Description provided.

SECTION 3

25. Indicate the type of mining method to be used on the property.

Open pit	_____
Underground	_____X_____
Strip Mining	_____
Other mining activity	_____
Explain:	

Please see Preliminary Project Description provided.

26. Outline any possible operational changes and when that might occur (e.g. open pit to underground).

Please see Preliminary Project Description provided.

27. Describe the type(s) of explosives to be used in mining operations.

Premixed ANFO that will arrive on an annual sealift.

28. Indicate the number of shafts or other openings that are presently on the property. Signify whether or not the openings are presently in use. (Submit measurement in metres). Indicate if used seasonally.

n/a

29. Are any entrances to shafts, adits, etc. below ground water level?

n/a

30. Are permafrost conditions expected?

Yes

31. Indicate the expected life of the mine.

24 months as described in the Preliminary Project Description.

32. Indicate the present average rate of production from all ore sources on the property.

NO PRODUCTION AT THE SITE AT THIS TIME.

33. Indicate the expected maximum rate of production from all ore sources on the property.

Production is expected to be 800 tonnes per day as described in the attached Preliminary Project Description.

34. Outline all water usage in the mine indicating the source and volume of water for each use.

Please see Preliminary Project Description provided.

35. Indicate the volume of natural ground water presently gaining access to the mine workings.

 n/a m³/day

36. Outline methods used (planned) underground to decrease minewater flow. (For example: recycling).

No mine water flow is expected.

37. Indicate the average daily volume of water to be discharged from the mine during normal operations.

No discharge from the mine is expected; however, should it occur, water would be pumped to surface and either used in the process (if metallurgically acceptable), or pumped to the tailings containment area.

38. If a mill will be operating on the property in conjunction with mining, will all minewater (underground, open pit, etc.) be directed to the mill for reuse?

See #37 above.

39. If not, indicate the proposed point and volume of discharge for the minewater.

n/a

40. What are the chemical and physical characteristics of the preceding minewater?

n/a

41. Are there any treatment plans for minewater and will any chemicals be used in such treatment? Explain.

n/a

SECTION 4:

THE MILL (PROCESSING PLANT)

42. Attach a copy of the (proposed) mill flow sheet. Indicate the points of addition of all the various reagents (chemicals) that are (or will be) used.

See attached Project Description.

43. If milling is in progress on the property at the present time, indicate the rate of milling.

 X not applicable (check) OR _____ tonnes/day

44. What is the present (or proposed) maximum capacity of the mill?

800 tonnes per day

45. List the types and quantities of all reagent used in the mill process (in kg/tonne ore milled).

List of reagents provided in updated Project Description. Quantities being refined but available upon request.

46. Is the (proposed) milling circuit based on autogenous grinding?

Yes _____ No. _____ Partially X

SAG mill

47. Indicate the amount(s) of concentrate(s) produced in the mill.

80 TPD

48. Will fresh water undergo treatment prior to use in the mill process? Explain.

No

49. Indicate all uses of water in the mill. Include the quantity and source of the water for each use.

See Figure 2.6 in the attached updated Project Description.

Please see Figure 8 in the Preliminary Project Description provided.

Use	Source	Volume m ³ /day

50. Indicate the total volume of water discharged from the mill.

2040 cubic metres per day.

51. Of the preceding volume, what quantity is (will be) recycled to other areas on the property (mine, mill, etc.)? Indicate location of use and quantity.

Minimum of 33%. All to the mill for use in the process. Miramar hopes to increase this recycle rate.

52. Based on yearly production, indicate the average quantity of tailings (dry weight) discharged from the mill.

Approximately 240,000 tonnes

53. What is the average liquid-solid ratio of tailings leaving the mill?

By weight: $\frac{1.2}{\text{Liquid: Solid}}$ By volume: $\frac{2.1}{\text{Liquid: Solid}}$

54. If applicable, identify any chemical treatment applied to the liquid phase before being discharged to the tailings area. (Attach flow sheet if available).

All tailings containing cyanide will be processed through the cyanide destruction circuit. See Figure 2.6 in the updated Project Description.

55. Based on present production or bench test results, describe the chemical and physical characteristics of liquid mill wastes directed to the tailings area.

See updated Project Description.

56. Provide a geochemical description of the solid fraction of the tailings.

See updated Project Description.

57. Identify the current source of power production.

n/a; (4.0 mw diesel electric plant to be installed for operations)

58. At present, is the mill handling custom lots of ore from other properties (or will the mill be handling any in the future)?

n/a

59. If so, specify ore characteristics and describe any mill processes which will change as a result.

n/a

60. If tailings are being recovered in the mill or elsewhere for use as backfill, etc.) indicate the quantity of solid tails (tonnes/day) recovered from the mill process.

n/a

61. Will exits be bermed to prevent spills from escaping the mill?

Please see Preliminary Project Description provided.

62. Will all sumps for process tanks have the required 110% holding capacity of the largest tank?

Yes

SECTION 5:

THE CONTAINMENT AREAS:

63. Is the tailings containment area (being) designed for total containment?

Total containment of solids with reclaim water being pumped back to the mill process. It is expected that there will be an annual discharge of tailings pond water to the receiving environment.

64. Attach detailed scale plan drawings of the proposed (or present) tailings area. The drawings must include the following:

Please refer to the attached Preliminary Project Description.

- a. details of pond size and elevation;
 - b. precise details of all retaining structures (length, width, height, materials of construction, etc.);
 - c. details of the drainage basin, and existing and proposed drainage modification;
 - d. details of all decant, siphon mechanisms etc., including water treatment plant facilities;
 - e. the plan for tailings deposition and final tailings configuration;
 - f. details with regard to the direction and route followed by the flow of wastes and/or waters from the ore; and
 - g. indication of the distance to nearby major watercourses.
65. Explain your choice of location for the tailings pond design by rationalizing rejection of other options. Consider the following criteria in the comparisons; subsurface strata, permeability, abandonment of tailings, recycling/reclaiming waters, and assessment of runoff into basins. Attach a brief summation.

Tail Lake is a small isolated lake with a correspondingly small watershed and is located close to the proposed processing facility. The watershed area of the proposed tailing containment area is 440 ha. The average depth of Tail Lake is +/-3 metres.

66. The total area for the existing tailings basin in hectares and for any proposed tailings area is n/a; see #65 hectares.
67. The average depth of the tailings basin is n/a; see #65 metres.
68. Indicate the total capacity for the existing tailings area by using water balance and stage volume calculation and curves. (Attach a description of inputs and outputs along with volume calculations).

Final engineering will be done on conclusion of Feasibility Study and will be included in Project EIS.

69. Indicate the total capacity for the proposed tailings area using water balance and stage volume calculation and curves. (Attach a description of inputs and outputs along with volume calculations).
70. Will the present tailings area contain the entire production from the mine-mill complex for the life of the project?

Yes

71. If "NO" above, or if production output increases tailings volumes. Indicate what plans have been made for future tailings disposal on the property.
72. Has any land in the immediate area been identified as native or crown land or withdrawn pending native claim settlement?

All lands required for the Project are Inuit Owned Lands (Block BB60)

73. Do the tailings area and all related treatment facilities lie on company held claims?

Yes

74. If not, indicate mine claim boundaries (and owners) on tailings area plan map. Also, attach a copy of all pertinent agreements signed with the owners of the claims not held by the company.

n/a

75. Will the proposed tailings area engulf or otherwise disturb any existing watercourse?

No

76. If "YES", attach all pertinent details (name of watercourse, present average flow, direction of flow, proposed diversions, etc.).
77. If any natural watercourse will gain access to the proposed tailings area, what methods will be used to decrease the amount of runoff water entering the containment area? Indicate the volume of water which will enter the tailings area from the source(s) in question and attach all pertinent details of proposed diversions.

Please see Preliminary Project Description provided.

78. Indicate on the tailings area plan drawing all sources of seepage presently encountered in the vicinity of the tailing area, the volume of each seepage flow (m^3/day), and the direction of each flow.

Water balance of Tail Lake watershed to be provided in Project EIS.

79. Are the seepage flows from the property presently being treated chemically? _____ If so, describe how.

n/a

80. If NOT, explain.

n/a

81. Please attach a conceptual abandonment and restoration plan for all tailings areas being developed. Describe the measures that have been (or will be) taken to contain and stabilize the tailings area(s) against leaching and seepage after operations on the property cease.

Please see Preliminary Project Description provided.

82. Describe the proposed or present operation, maintenance and monitoring of the tailings area.

Please see Preliminary Project Description provided.

SECTION 6:

83. Describe the methods of chemical treatment that are presently being used and/or will be used to control the quality of the tailings effluent. Attach an engineering drawings where applicable and a process flow chart. If a pilot test has been conducted please attach description of methodology and results.

Please see Preliminary Project Description provided.

84. List the names of chemicals to be used in the water treatment process.

**Sulphuric Acid
Hydrogen Peroxide
Copper Sulphate**

85. What is the proposed or present average rate of effluent treatment of the plant (if applicable)?

Treatment of all cyanide-bearing mill tailings slurry, which is expected to be 12.6m³/hr.

86. What is the proposed or present maximum effluent treatment capacity of the plant (if applicable)?

This is subject to final engineering and will be provided in Project EIS.

87. Will treated effluent be discharged directly to a natural water body or will polishing or settling ponds be employed? Describe location control structures and process of water retention and transfer. Attach any relevant design drawings.

Treatment will take place in the mill. The tailings pond will act as a secondary treatment stage through settling of precipitants.

88. Name the first major watercourse the discharge flow enters after it leaves the area of company operations.

Doris Creek; Please see Preliminary Project Description provided.

89. In terms of rate of effluent release and volume and flushing rate of the receiving watercourse, estimate the extent of the mixing zone within the receiving waters and where background levels of constituents for that watercourse will be attained.

Mixing zone is estimated to be within 400 m which is defined by a waterfall in Doris Creek. Background levels should be attained below the waterfall.

90. Describe the present (proposed from pilot tests) chemical and physical characteristics of the tailings effluent (Decant).

See Section 2.6.1.2. of the updated Project Description.

SECTION 7:

ENVIRONMENTAL MONITORING PROGRAM

91. Have elders been consulted in the establishment of the monitoring program?

92. Has Traditional Knowledge of the area been considered?

Yes

93. Has any baseline data been collected for the main water bodies in the area prior to development?

Yes, these data will be reviewed in Project EIS. See attached Project Description.

94. If "YES" include all data gathered on the physical, biotic and chemical characteristics at each sampling location. Identify sampling location on a map.

Please see Preliminary Project Description provided by a short summary.

95. Provide an inventory of hazardous materials on the property and storage locations. (Attach separate Map).

No such materials currently stored on site.

96. Attach the present or proposed contingency plan which describes course of action, mitigative measures and equipment available for use in the event of system failures and spills or hazardous materials.

Contingency plans will be provided with Project EIS, however; the NWB do have contingency plans on file as they relate to the current activities in the belt.

97. Provide a conceptual abandonment and restoration plan for the site, detailing the costs to carry out the plan, and a proposal for a financial assurance which covers the costs to carry out the plan.

Please see Preliminary Project Description provided.

98. Provide a detailed emergency response plan for the project.

Will be developed with Project contingency plans and submitted in support of Project EIS.

99. Provide a description of the pollution control systems and environmental management procedures.

Will be developed with Project contingency plans and submitted in support of Project EIS.

SECTION 8:

ENVIRONMENTAL ASSESSMENT AND SCREENING

100. Has this project ever undergone an initial environmental review, including previous owners.

Yes

101. Has any baseline data collection and evaluation been undertaken with respect to the various biophysical components of the environment potentially affected by the project (e.g. wildlife, soils, air quality), i.e. in addition to water related information requested in this questionnaire?

Please see Preliminary Project Description provided. Project EIS will be developed to comply with EIS guidelines expected from NIRB.

102. Describe any cumulative impacts the project may create.

Please see Preliminary Project Description provided; also to be included in Project EIS.

103. Has any meteorological data been collected at or near the site? (e.g. precipitation, evaporation, snow, wind).

Yes

a) If so, please include the data and attach copies of reports or site titles, authors and dates.

Please see the Final EIS submitted to NIRB in November 2003 for best summary of available meteorological data.

104. If no, are such studies being planned? Briefly describe the proposals.

A new site weather station was established in 2004 and will continue to operate.

105. Has authorization been obtained or sought from the Department of Fisheries and Oceans for dewatering or using any water bodies for containment of waste?

Application to DFO submitted.

106. Please attach an outline briefly describing any options or alternatives considered or reflected for the various mine components outlined in this questionnaire (e.g. mill site, water supply sources, location for ore and waste piles).

107. Has a socio-economic impact assessment or evaluation of this project been undertaken? (This would include a review of any public concerns, and water and cultural uses of the area, implication of land claims, compensation, local employment opportunities, etc.).

Yes, an SEIA was completed as part of the November 2003 EIS. A new SEIA study was undertaken in 2004 and will be submitted to NIRB in early 2005.

108. If yes, please describe the proposal briefly.

A Memorandum of Understanding covering an Inuit Impact Benefits Agreement for the Doris North Project was negotiated in 2004 between Miramar Mining and the KIA. The IIBA address socio-economic benefits to Inuit residents of the West Kitikmeot.

109. If no, is such a study being planned? Yes _____ (When) OR No

110. Does the project alter the quantity of quality of flow of waters through Inuit Owned Lands?

No

111. If yes, has the applicant entered into an agreement with the Designated Inuit Organization to pay compensation for any loss or damage that may be caused by the alteration.

A Memorandum of Agreement has been negotiated in 2004 between Miramar and the KIA covering Inuit water rights compensation issues.

112. If no compensation arrangement has been made, how will compensation be determined?



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NUNAVUT WATER BOARD
NUNAVUT IMALIRIYIN KATIMAYINGI

February 28, 2005

One Page via Email

Mr. David Long
Vice-President, Legal
Miramar Mining Corporation
300 – 889 Harbourside Drive
North Vancouver, BC V7P 3S1

Subject: Doris North Project - Application for a Water Licence
NWB File # NWB1DOR

Dear Mr. Long:

I acknowledge receipt of your February 8, 2005 letter and updated Preliminary Project Description ("PPD") for the *Doris North Project* ("Project") in Nunavut. Your submission has been placed in the Nunavut Water Board's ("NWB") Public Registry and is available to the public upon request or from the NWB FTP site.

On March 20, 2002, the *Hope Bay Joint Venture* ("HBJV"), a joint venture between *Miramar Hope Bay Limited* and *Hope Bay Gold Corporation*, filed an application for a water licence for the construction, operation and decommissioning of the *Doris Hinge Project* ("Application"). The NWB referred the Application to the Nunavut Impact Review Board ("NIRB") for environmental assessment pursuant to Article 12 of the Nunavut Land Claim Agreement ("NLCA"). In its final report, NIRB indicated that *Miramar* had not provided sufficient information for the Board to complete their assessment process. NIRB indicated that there were five key deficiencies and that if these deficiencies were adequately addressed then *Miramar* could reapply to NIRB to have the environmental assessment of that project reconsidered.

The NWB Public Registry indicates that the Application is pending and has not been withdrawn. In light of your February 8, 2005 submission, we have reviewed the updated PPD versus the Application. We conclude that the Project as described is fundamentally the same undertaking submitted in March 2002 and subsequently reviewed by NIRB, aside from adjustments to the proposed schedule and other items such as the preliminary details of the construction of the tailings dam, which in themselves do not change the scope and nature of the Application already on file. We note however that the name of the applicant on the Application is the Hope Bay Joint Venture ("HBJV"). We also note that the name of the project on both the Application and the March 2002 PPD is referred to as the *Doris Hinge Project*, whereas your most recent submission refers to the *Doris North Project*. For greater clarity, please let the NWB know whether the name of the applicant and the name of the project as officially recorded in the Application should be changed.

Meanwhile, **by copy of this letter to the NIRB**, we are asking our sister-board to resume its environmental assessment of the Application pursuant to Article 12 of the NLCA.

Please contact me if you have any question.

Sincerely,

Original signed by:

Philippe di Pizzo
Executive Director

c.c. Stephanie Briscoe, NIRB
 Distribution List

Appendix B: Curriculum Vitae

Larry Connell, P.Eng.

General Manager, Environmental
Miramar Mining Corporation Limited

Professional summary

Mr. Connell is an environmental manager and metallurgist with more than 30 years operating experience in the mining industry in the fields of environmental engineering, mineral processing and operations management. He has had extensive involvement in environmental assessment, environmental permitting, acid rock drainage, mine closure and reclamation planning, rehabilitation and effluent treatment in gold and base metal mining. Prior to joining Miramar Mining Corporation, Mr. Connell held senior operating positions with Viceroy Minerals Corporation, Royal Oak Mines Inc., BP Resources Canada Ltd., Giant Yellowknife Mines Ltd., and Falconbridge Ltd. And as a consulting engineer a AMEC Earth & Environmental and Knight Piesold Ltd.

Professional qualifications

Professional Engineer in British Columbia, Ontario, and the Yukon:

- British Columbia – License # 23696
- Ontario – License # 9099508
- NWT/NU – License # L1720

Education

B.Sc. (Hon) Mining Engineering (Mineral Processing Option), Queen's University, Ontario, 1975

Summary of core skills

ARD-Metal Leaching Characterization

Mr. Connell has a strong background in acid rock drainage and metal leaching characterization and has conducted waste characterization studies for a number of clients across Canada. He has developed waste rock management plans for several mines in British Columbia, the N.W.T., Nunavut and the Yukon and has been involved in developing management plans for both reactive tailings and waste rock.

Waste Management

Mr. Connell has experience in the development and implementation of management plans for a number of different categories of mine waste materials, including waste rock, mill tailings, hazardous waste materials such as waste oils, greases, solvents, etc., PCB's, contaminated soils, asbestos containing products and landfill materials. This experience extends to remediation of contaminated soils, development of remediation options, recycling programs.

Environmental Management

Mr. Connell has over 25 years experience as an environmental manager in the Canadian mining industry. He has headed up environmental management teams at a number of operating mines across Canada and at the corporate level. He has assisted a number of clients in assessing the current status of their environmental programs and developing means to ensure on-going environmental compliance including development and implementation of environmental management systems. He has participated in a number of due diligence audits for various clients both in Canada and the US and is familiar with environmental regulations in these respective jurisdictions.

Larry Connell, P.Eng.

Permitting

Mr. Connell has been involved in the permitting process for mining operations in Newfoundland, Ontario, British Columbia, the Northwest Territories, Nunavut, the Yukon, Montana, Nevada and Alaska. He has developed and led the team in implanting permitting strategies for a number of new mining operations. He has also been involved in amending permits for a number of existing mining operations.

Environmental Impact Assessment

Mr. Connell has a strong background in environmental impact assessment and has led teams in the preparation of EIA for both small and large-scale mining operations. This experience encompasses preparation of EIA's under the requirements of the Canadian Environmental Assessment Act and the British Columbia Environmental Assessment Act. Mr. Connell is well versed with both the US NEPA process and the World Bank standards covering the EIA process.

Mine Closure and Reclamation Planning

Mr. Connell has extensive experience in the planning and preparation of closure plans for mining operations throughout Canada and the US. He has been involved in the reclamation of several abandoned mine sites, from initial site investigation through to the design and implementation stage. He has prepared closure plans in Newfoundland, Ontario, Manitoba, British Columbia, the Northwest Territories, Nunavut, the Yukon and Alaska. He has conducted formal reviews of mine closure plans in Montana and Nevada.

Reclamation Cost Estimating

Mr. Connell has developed cost estimates for mine closure plans for both active and dormant mine properties in both Canada and the US. He is well versed with the reclamation costing spreadsheet programs used in Northern Canada, in British Columbia and in South Dakota. He has participated in mine closure-bonding negotiations for clients in both Canada and the US and has extensive experience in developing closure cost estimates.

Selected Project Experience (from past 4 Years)

Barrick Gold, Inc. Nickel Plate Mine, Hedley, BC. Project Manager – Mine Closure Studies. Review of current data, assessment of data gaps and development of studies to assist in the selection and assessment of closure options to support ongoing preparation of an updated closure plan for the closed out Nickel Plate Mine. Project involves the geochemical assessment of mine waste rock and tailings and development of long term management of these wastes at this site.

De Beers Canada, Snap Lake Diamond Project, NT. Managed the preparation of the Mine Closure and Reclamation Plan including cost estimate for the Snap Lake underground diamond mine.

Larry Connell, P.Eng.

De Beers Canada, Gahcho Kué Diamond Project, NT. Managing the ongoing geochemical assessment program and conceptual mine closure and reclamation planning for the environmental assessment of the Gahcho Kué diamond project.

bcMetals Corporation, Red Chris Project. Managed the preparation of the environmental impact assessment (Application Report to the BC Environmental Assessment Office) for the proposed Red Chris copper/gold project in north-western British Columbia and worked with bcMetals to obtain the Project Development Certificate for this Project.

Miramar Hope Bay Ltd, Doris North Project. Assisted in the preparation of the EIS and Mine Closure and Reclamation Plan (including reclamation cost estimate) for the proposed Doris North gold mine in the West Kitikmeot region of Nunavut. Managed the geochemical assessment and assisted in the design and assessment of waste management facilities for this underground mine project.

INCO Ltd., Thompson Mine, Manitoba. Project engineer on the preparation of the conceptual level reclamation and closure plan for the Thompson mine and metallurgical site to meet regulatory requirements in Manitoba.

Indian and Northern Affairs Canada, Giant Mine Arsenic Management Project. Member of the Independent Peer Review Panel providing DIAND with technical review of the project work being undertaken to develop alternatives for the long-term management of arsenic trioxide baghouse dust stored underground at the Giant Mine in Yellowknife, NT.

Goldcorp Inc., Red Lake Mine. Environmental audit of the Red Lake Mine for the Board of Directors and due diligence assessment for the merger between Wheaton River Minerals and Goldcorp.

Ivanhoe Mines Mongolia Inc. Oyu Tolgoi Project, Mongolia, Conceptual mine closure and reclamation planning with reclamation cost estimate for the Oyu Tolgoi copper/gold project in Mongolia.

Placer Dome Canada Ltd., Campbell Red Lake Mine, ON. Review of mine permitting process and required baseline data to develop strategy and timelines for the permitting of several satellite mines to supply ore to the Campbell Red Lake mill.

Past Work Experience

AMEC Earth & Environmental – Senior Mining Environmental Consultant. Provision of environmental consulting services to mining client's worldwide on waste management, mine reclamation, environmental assessment and permitting.

Knight Piesold Ltd. – Senior Mining Environmental Consultant. Provision of environmental consulting services to mining client's worldwide on waste management, mine reclamation, environmental assessment and permitting.

Royal Oak Mines - Corporate Manager of Environmental Services. Primary responsibility for the provision of environmental support services to Royal Oak Mines Inc.'s operating gold and copper mines (Hope Brook, Pamour, Giant, Colomac and Kemess South). Communication and coordination on all environmental issues with government regulatory agencies. Responsible for the development and monitoring of environmental control programs at the company's operating and inactive properties. Responsible for the development and implementation of corporate procedures to maintain compliance with regulatory environmental standards. Responsible for the preparation and implementation of mine

Larry Connell, P.Eng.

closure and reclamation plans for the companies mining properties. Primary direction of new mine environmental assessment and permitting activities (Kemess South Mine in BC), renewal of mine permits in the NWT, Newfoundland and Montana.

Royal Oak Mines - Corporate Manager of Environmental and Metallurgical Services. In addition to the activities listed above Mr. Connell had responsibility for auditing and optimizing the metallurgical performance of the Company's operating mineral processing plants. This position was divided into two separate functions in early 1995 reflecting the growth of the company and its subsidiaries.

BP Resources Canada – Operations Superintendent - Hope Brook Gold Mine, Newfoundland. Primary responsibility for the operation of a 3,500 TPD conventional CIP gold mill and associated heap leaching facility including maintenance, metallurgical and environmental control services. Key involvement in solving critical environmental control problems resulting from complex copper-cyanide chemistry including liaison with both Federal and Provincial regulatory agencies.

Dickenson Mines Ltd. – Mill Superintendent - Arthur W. White Mine, Red Lake, Ontario. Primary responsibility for the operation of a 700 TPD gold mill processing both conventional and refractory ore. Responsible for environmental and occupational health programs. Briefing Officer for the 1985 Ontario Provincial Underground Mine Rescue championship team.

Giant Mine, Yellowknife, NWT – Asst. Mill Superintendent. Responsible for all metallurgical and technical services including environmental control for a 1,250 TPD gold mill processing refractory ores.

Falconbridge Mine, Sudbury, Ontario - Metallurgist. Employed as a junior metallurgist at the Fecunis and Strathcona concentrators and the nickel smelter. Worked as a quality control engineer in the nickel smelter as a research associate in the Falconbridge Sudbury Research and Development facility.

Employment history

2006 – Present	Miramar Mining Corporation
2002 - 2006	AMEC Earth & Environmental Limited
2000 - 2002	Knight Piésold Ltd.
1999 – 2000	Viceroy Minerals Ltd. – Brewery Creek Mine
1991 - 1999	Royal Oak Mines Inc.
1987 - 1991	BP Resources Canada Ltd.
1981 - 1986	Dickenson Mines Limited (now Goldcorp)
1977 - 1981	Giant Yellowknife Mines Ltd.
1975 - 1977	Falconbridge Nickel Mines Ltd.

Maritz E. Rykaart

Senior Geotechnical Engineer



Profession	Geotechnical Engineer
Education	B.Eng. (Civil), Rand Afrikaans University, South Africa, 1991. M.Eng. (Civil), Rand Afrikaans University, South Africa, 1993. Ph.D. Geotechnical Engineering, University of Saskatchewan, Canada, 2001.
Registrations/ Affiliations	P.Eng., (BC, SK, YT, NWT/NT), Canada Pr. Eng., ECSA, South Africa Member Canadian Geotechnical Society

Specialisation

Unsaturated soil hydrology; soil cover design and construction; design and construction of mine water pollution control systems; design and construction of mine waste containment systems; surface flux boundary numerical modeling.

Expertise

- Unsaturated flow hydrology
- Waste rock, heap leach and tailings impoundment cover design, performance monitoring and surface flux boundary modeling, including senior review of designs
- Design and implement geotechnical investigation programs to locate and test soils and mine waste for cover suitability
- Design and installation of cover performance monitoring equipment for mine waste facilities
- Develop closure plans for mine waste facilities
- Feasibility studies, conceptual and detailed designs of new mine waste facilities
- Design of surface mine infrastructure components for new mines
- Design of polluted mine water management systems, including surface water diversion structures, earth embankment dams, spillways, storm water channels etc.
- Teaching short courses on cover design and surface flux boundary modeling

Employment Record

2001 – Present	SRK Consulting (Canada) Inc. Senior Geotechnical Engineer, Vancouver, Canada.
1998 – 2001	University of Saskatchewan Ph.D. Candidate & Research Assistant, Saskatoon, Canada.
1996 – 1998	Wates, Meiring & Barnard (Pty) Ltd. Geotechnical/Civil Engineer, Midrand, South Africa.
1996	Thuthuka Project Managers (Pty) Ltd. Site Engineer and Project Manager, Springs, South Africa.
1993 – 1995	Wates, Meiring & Barnard (Pty) Ltd. Geotechnical/Civil Engineer, Midrand, South Africa.
1992 – 1993	Rand Afrikaans University M.Eng. Candidate & Research Assistant, South Africa.

Languages

English, Afrikaans

Maritz E. Rykaart

Senior Geotechnical Engineer

Publications

1. Rykaart, M, Boyce, S. (2005). From Numerical Modeling to Practice: Cover Performance Data for Five Heap Leach Pads. Paper presented at Heap Leach and Waste Rock Facility Closure Workshop, Elko, Nevada, USA, June 21-22, 2005 (presentation only).
2. Rykaart, M, Hockley, D., Noel, M. (2005). Results of International Review of Design and Construction Practices for Soil Covers Used in Mine Waste Closure. Paper presented at CIM Toronto 2005, Toronto, Ontario, Canada, April 24-27, 2005 (presentation only).
3. Rykaart, M., Hockley, D., Noel, M., Paul, M., Jahn, S. (2004). International Review of Soil Cover Design and Construction Practices. Paper presented at the 11th Annual British Columbia ML/ARD Workshop, Vancouver, British Columbia, Canada. December 1-2, 2004 (presentation only).
4. Hockley, D., Rykaart, M., Noel, M. (2004). Soil Covers in the Canadian North. Paper presented at the 11th Annual British Columbia ML/ARD Workshop, Vancouver, British Columbia, Canada. December 1-2, 2004 (presentation only).
5. Rykaart, M., Noël, M. (2004). Comparative Surface Flux Boundary Modeling as Applied to the Design of Soil Covers. Paper presented at the 2004 SME Annual Meeting & Exhibit, Denver, Colorado, USA, February 23-25 (presentation only).
6. Wilson, G.W., Williams, D.J., Rykaart, E.M. (2003). The Integrity of Cover Systems – An Update. The AusIMM Bulletin. Journal of the Australian Institute of Mining and Metallurgy. Pages 63-69, November/December 2003.
7. Rykaart, E.M., M. Noël (2003). “Comparative Study of Surface Flux Boundary Models to Design Soil Covers for Mine Waste Facilities”. Proceedings of the 6th International Conference on Acid Rock Drainage (ICARD), Cairns, Australia, 12-18 July, 2003.
8. Rykaart, E.M., G.W. Wilson (2003). Methodology for Calculating the Closure water Balance for an Acid Generating Tailings Dam. Proceedings of the 6th International Conference on Acid Rock Drainage (ICARD), Cairns, Australia, 12-18 July, 2003.
9. Rykaart, E.M., G.W. Wilson, N. Currey, P. Ritchie, (2003). Case Study: Final Closure of a Tailings Dam Using Direct Vegetation. Proceedings of the 6th International Conference on Acid Rock Drainage (ICARD), Cairns, Australia, 12-18 July, 2003.
10. Hockley, D.E., M. Noel, E.M. Rykaart, S. Jahn, M. Paul (2003). Testing of Soil Covers for Waste Rock in the Ronneburg WISMUT Mine Closure. Proceedings of the 6th International Conference on Acid Rock Drainage (ICARD), Cairns, Australia, 12-18 July, 2003.
11. Wilson, G.W., D. Williams, M. Rykaart (2003). The Integrity of Cover Systems. Proceedings of the 6th International Conference on Acid Rock Drainage (ICARD), Cairns, Australia, 12-18 July, 2003.
12. Parshley, J., Buffington, R., Rykaart, M. (2003). Lessons Learned from the Closure of the Yankee Heap Leach Pad, Bald Mountain Mine, Nevada. Paper Presented at the Heap Leach Closure Workshop, Elko, Nevada, USA, March 25-26. (presentation only).

Maritz E. Rykaart

Senior Geotechnical Engineer

13. Rykaart, E.M., G.W Wilson, D.G. Fredlund (2002). Spatial Surface Flux Boundary Model for Tailings Impoundments. Proceedings of the Tailings and Mine Waste Conference 2002, Fort Collins, Colorado, USA, January 28-29, pp. 283-291.
14. Rykaart, E.M. (2002). A Methodology to Describe Spatial Surface Flux Boundary Conditions for Solving Tailings Impoundment Water Problems. Ph.D. Thesis, Department of Civil Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.
15. Fredlund, M., J. Stianson, M. Rykaart (2002). Applications of Automatic Mesh Refinement in the SVFlux and ChemFlux Software Packages. Proceedings of the 55th Canadian Geotechnical Conference. Calgary, Niagara, Ontario, Canada. October 20-23.
16. Rykaart, M., M. Fredlund, J. Stianson (2002). Modeling tailings dam flux boundary conditions with 3-D seepage software. Ground Engineering, Vol. 35, No. 7, July, pp. 28-30.
17. Rykaart, M., M. Fredlund, J. Stianson (2001). Solving tailings impoundment water balance problems with 3-D seepage software. Geotechnical News, Vol. 19, No. 4, December, pp. 50-54.
18. Rykaart, E.M., G.W. Wilson, D. Fredlund, N.A. Currey (2001). A Spatial Flux Boundary Model for Tailings Dams. Proceedings of the 54th Canadian Geotechnical Conference. Calgary, Alberta, Canada. 16-19 September. Volume 2, pp. 1102-1109.
19. Wates, J.A., E.M. Rykaart (1999). The performance of natural soil covers in rehabilitating opencast mines and waste dumps in South Africa. Water Research Commission Report No. 575/1/99.
20. Rykaart, E.M. (1997). Modeling the Performance of Soil Covers. Pre-Conference Workshop: Groundwater Impact Assessment and Management. Sandton, South Africa. 24 June, 1997.
21. Rykaart, E.M. (1996). Experiments on Recharge through Soil Covers to Coal Spoils. Proceedings of One-Day Course on Hydrology of Made Ground. Fourways, South Africa. 9 October 1996.
22. Rykaart, E.M., J.A. Wates (1996). Prioritizing Impact Mitigation Measures at Collieries: Case Study. Proceedings of Second National Conference on Environmental Management Technology and Development. Fourways, South Africa. 7-8 October.
23. Wates, J.A., E.M. Rykaart (1996). Development of a Groundwater Quality Management Plan for the Middle Steelpoort. Proceedings of Second National Conference on Environmental Management Technology and Development. Fourways, South Africa. 7-8 October 1996.
24. Rykaart, E.M. (1996). Using Soil Covers as a Barrier Against AMD: A Review. Proceedings of the Young Water, Environmental and Geotechnical Engineers Festival. Botha's Hill, Kwa-Zulu Natal, South Africa. 17-19 July.
25. Rykaart, E.M., J. Haarhoff (1995). Die Verfyning van Inspuitnossels vir Opgeloste-Lug Flottasie (The Refining of Air-Injection Nozzles in Dissolved Air Flotation). Water Research Commission Report No. 448/1/95, ISBN 1868451682.
26. Rykaart, E.M., J. Haarhoff (1995). Behaviour of Air Injection Nozzles in Dissolved Air Flotation. Water Science and Technology. 31(3-4), pp. 25-35.

Maritz E. Rykaart
Senior Geotechnical Engineer

27. Haarhoff, J., E.M. Rykaart (1995). Rational Design of Packed Saturators. Water Science and Technology. 31(3-4), pp. 179-190.
28. Rykaart, E.M., J. Haarhoff (1995). Behaviour of Air Injection Nozzles in Dissolved Air Flotation. Proceedings of Specialist Conference on Flotation Processes in Water and Sludge Treatment. Orlando, Florida, U.S.A. 26-28 April.
29. Haarhoff, J., E.M. Rykaart (1995). Rational Design of Packed Saturators. Proceedings of Specialist Conference on Flotation Processes in Water and Sludge Treatment. Orlando, Florida, U.S.A. 26-28 April.
30. Wates, J.A., E.M. Rykaart (1994). Design of Soil Covers for Control of Infiltration. Proceedings of First National Conference on Environmental Management Technology and Development. Fourways, South Africa. 7-8 March.
31. Rykaart, E.M. (1993). Die Verfyning van Inspuitnossels vir Opgeloste-Lug Flottasie (The Refining of Air-Injection Nozzles in Dissolved Air Flotation). Thesis for fulfillment of Masters Degree Program in Civil Engineering, Rand Afrikaans University, Johannesburg, South Africa.

Maritz E. Rykaart

Senior Geotechnical Engineer

Key Experience: Mine Closure

GLOBAL

- International review of waste rock pile cover design and construction practices, involving approximately 200 sites in 26 countries
- Review of cover design and construction principles specifically related to cold climates, i.e. Canadian arctic, and high altitude areas

CANADA

Deloro Mine, Ontario Ministry of Environment (CH2MHill), Ontario

- Red Mud tailings dam geotechnical investigation and stability assessment
- Recommendations with respect to final Red Mud tailings impoundment cover designs to ensure dam stability

Beaverlodge Mine, Cameco, Saskatchewan

- Review of annual piezometer data to evaluate integrity of tailings impoundment soil cover
- Review of cover construction specifications and QA/QC procedures

Key Lake, Cameco, Saskatchewan

- Final closure design for Gaertner waste rock pile, including landscaping design, re-vegetation plan, infiltration modelling and stability assessment. Work includes earthworks quantities estimation for use in tender documents

Syncrude Oil Sands Mine, Syncrude, Fort McMurray, Alberta

- Design, programming and installation of waste rock dump cover performance instrumentation (thermistor strings, thermal conductivity matric suction sensors, TDR volumetric moisture content probes and automated weather and Bowen ratio stations)

Equity Silver, Placer Dome, British Columbia

- Tailings impoundment soil cover performance numerical modelling
- Mine closure feasibility study

Union Bay, Seacor, Vancouver Island, British Columbia

- Scoping level cover assessment for coal waste processing dump
- Reconnaissance level borrow source investigation for cover soils
- Assistance in permitting of cover design

Brule Coal, Western Canadian Coal, British Columbia

- Scoping level cover assessment for waste rock pile

Faro Mine, Deloitte & Touché, Yukon

- Design and evaluation of conceptual cover alternatives for waste rock piles and tailings impoundments, including numerical modeling
- Design, construction and monitoring of two large scale tailings cover test pads
- Design, construction and monitoring of six large scale waste rock cover trials. This includes the installation of detailed monitoring instrumentation
- Desk study investigation into relocation of tailings

Maritz E. Rykaart

Senior Geotechnical Engineer

Giant Mine, INAC, Northwest Territories

- Design and evaluation of cover options for four tailings impoundments and two sludge ponds
- Preliminary cover design
- Design of field trials to test cover design

Colomac Mine, DIAND, Northwest Territories

- Assessment of tailings rehabilitation options, including design of soil covers

Doris North Mine, Miramar, Nunavut

- Conceptual cover designs for tailings impoundment

Nanasivik Mine, DIAND, Nunavut

- Final closure cost estimate in RECLAIM format

UNITED STATES OF AMERICA

Golden Sunlight Mine, Placer Dome, Montana

- Installation of thermal conductivity matric suction sensors and continuous data logging equipment into waste rock dump and tailings covers dams

San Manuel Mine, BHP Billiton, Arizona

- Numerical modelling to design closure soil cover for heap leach pad and waste rock piles
- Design of field and laboratory testing program to obtain numerical modelling inputs

Coral Gold Mine, Nevada

- Site investigation and numerical modelling of final cover for heap leach pad

Elder Creek Mine, Nevada

- Heap leach pad cover design for final closure, including numerical modeling

Florida Canyon Mine, Nevada

- Review of closure cover design and numerical modelling report

Glamis Marigold Mine, Nevada

- Review of closure cover design and numerical modelling report
- Comparative numerical modelling, comparing results of different surface flux boundary models
- Inputs into EIS with respect to cover designs

Bald Mountain Mine, Placer Dome, Nevada

- Review of infiltration modelling for final cover design closure plan for the Yankee heap leach pad
- Review of draindown modelling, and development of new draindown model for Yankee heap leach pad cover
- Development of a site investigation plan to characterize the Mooney heap leach pad
- Review of the Casino/Winrock heap leach pad final closure water balance

Cortez Gold Mine, Crescent Valley, Nevada

- Review of final heap leach pad closure water balance, including heap draindown and cover assessment

Maritz E. Rykaart

Senior Geotechnical Engineer

Newmont Mining Company, Nevada

- Closure plan for tailings dam

Norse Windfall Mine, BLM, Nevada

- Development of material testing program for gathering of data for use in numerical modeling of heap leach pad and waste rock cover design

Atlanta Gold Mine, Idaho

- Development of material testing characterization program for heap leach pad and waste rock cover materials
- Heap leach pad and waste rock dump cover design and numerical modeling
- Feasibility study for land application disposal system (LAD)
- Modeling of drawdown for a 310 ft high agglomerated heap leach pad

Ridgeway Gold Mine, Kennecott Minerals, South Carolina

- Design of waste rock dump sampling protocol, sampling and in-situ physical testing of waste rock

Holden Mine, Washington

- Geotechnical testing of tailings and potential cover soils with a view to designing a soil cover for closure

AUSTRALASIA

Kidston Gold Mine, Placer Dome, Queensland, Australia

- Design and installation of cover performance monitoring equipment (thermal conductivity matric suction sensors, in-situ physical and hydraulic testing, surface water flow measurement, automated weather and Bowen ratio stations)
- Development of a closure water balance for tailings impoundment to illustrate feasibility of using direct vegetation as a final closure alternative

Olympic Dam, WMC, South Australia

- Preliminary cover design for tailings impoundment
- Design of field characterization and testing plan to confirm cover suitability

INCO Goro, New Caledonia

- Lysimeter design for tailings dam cover performance monitoring

EUROPE

WISMUT, Lichtenberg Pit, Ronneburg, Germany

- Review of annual monitoring data for four test covers on a waste rock dump, including predictive numerical modeling and recommendations as to further testing requirements to accurately evaluate the cover performance

Maritz E. Rykaart

Senior Geotechnical Engineer

SOUTH AMERICA

Quiruvilca, Pan American Silver, Chile

- Scoping level cover assessment for tailings impoundments

Rio Paracatu, Rio Tinto, Brazil

- Scoping level cover assessment for mine area, tailings impoundment and high sulphide cells
- Design, installation and monitoring of cover trials

Minas da Fortaleza, Rio Tinto, Brazil

- Scoping level cover assessment for waste rock dumps and tailings impoundment

Mauro Tunnel, Chile

- Scoping level cover assessment for acid generating waste rock from the tunnel construction

Tatasi Mine, Bolivia

- Evaluate soil cover alternatives for final closure of tailings dam
- Develop current and closure water balance for mine site with emphasis on impacts of reduction of the waste load from the site

Pascua Lama Mine

- Review on proposed tailings dam soil cover for closure purposes

SOUTH AFRICA

Water Research Commission, Pretoria, South Africa

- Calibration of numerical models for the design of soil covers for opencast mine and waste dumps in South Africa

Department of Water Affairs & Forestry, Pretoria, South Africa

- Waste Dump rehabilitation experiment (5 years), leading to development of a design guideline for natural soil covers for rehabilitating coal waste dumps

West Driefontein Mine, Carltonville, South Africa

- Tailings dam closure and rehabilitation design

RMP Properties, Johannesburg, South Africa

- Feasibility study and concept design for rehabilitation of gold mining sand dump at Fennel Road

Tweefontein Colliery, Witbank, South Africa

- Waste dump rehabilitation feasibility study

Maritz E. Rykaart

Senior Geotechnical Engineer

Key Experience: Geotechnical and Hydraulic Design

Miramar Hope Bay Limited, Nunavut, Canada

- Design of four field drilling and soil characterization programs to investigate permafrost conditions
- Tailings dam design (frozen core)
- Preliminary design of mine surface infrastructure including roads, explosives magazine, mill pads, causeway and airstrip
- Pre-feasibility Study
- Bankable feasibility Study

De Beers (Canada), Victor Kimberlite Project, Ontario, Canada

- Geotechnical soil characterization for deep (200 m) overburden drilling

Colomac Mine, Northwest Territories, Canada

- Geotechnical investigations to assess seepage problems in a tailings dam
- Borrow source investigation
- Design of seepage remediation measures for tailings dam
- Detailed design and construction of 8 km diversion ditches around tailings lake perimeter

Britannia Mine, British Columbia, Canada

- Preliminary design of surface water diversion structures to limit surface water inflow into collapsed mine adits and glory holes

Giant Mine, Northwest Territories, Canada

- Site investigation into the integrity of existing stream diversion
- Conceptual design of Secure Landfills
- Costing and conceptual designs for preserving permafrost over frozen arsenic chambers areas

Red Mountain Mine, British Columbia

- Review of tailings dam design and feasibility study of new tailings dam locations

Goedgevonden Colliery, Witbank, South Africa

- River diversion: Feasibility study, concept design, contract documentation and permit application

Vlaklaagte Colliery, Witbank, South Africa

- River diversion: Feasibility study, concept design and permit application

Greenside Colliery, Witbank, South Africa

- River diversion and stormwater control channel: Detailed design, contract documentation and permit application
- Pollution control dams: Detailed design and contract documentation
- Stormwater return dam: Detailed design and contract documentation

Heidelberg Colliery, Hayford Colliery, Witbank, South Africa

- Stream diversion design and Section 20 Permit application

Water Research Commission, Pretoria, South Africa

- Potable water treatment
- Design and testing of injection nozzles for dissolved air flotation

Maritz E. Rykaart

Senior Geotechnical Engineer

H2O Groundwater Systems, California, USA

- Developed mathematical model for an air stripper used for groundwater contamination cleanup

Kriel Colliery, South Africa

- Feasibility study into flooding the underground workings with excess polluted water

Krugersdorp Municipality, South Africa

- Feasibility study into new municipal waste site

Alpha Colliery, Natal, South Africa

- Geohydrological assessment for surface water aspects

Sappi Ngodwana, Nelspruit, South Africa

- Dewatering of river front: Feasibility study and concept design
- Dewatering of river front: Detailed design, contract documentation and site supervision

Tweefontein Colliery, Witbank, South Africa

- Environmental management program report

Hayford Colliery, Witbank, South Africa

- Environmental audit. AECI

Department of Water Affairs & Forestry, Pretoria, South Africa

- Middle Steelpoort Groundwater Management Plan
- Wapadskloof Vanadium toxicity investigation

West Driefontein Mine, Carltonville, South Africa

- Rehabilitation of breach on slimes dam: Design and site supervision
- Modeling maximum rate of rise for gold tailings dam using SIGMA/W software

Sappi Enstra, Springs, South Africa

- Construction supervision and management of a turnkey project for an upgrade to a pulp and paper mill water treatment plant

John T. Chapman

Principal Engineer

Profession	Chemical Engineer
Education	B.Sc. Chemical Engineering, University of Pretoria, 1984 M.Sc. Chemical Engineering, University of Cape Town, 1989
Registrations/ Affiliations	P.Eng. Association of Professional Engineers and Geoscientists of British Columbia P.Eng. Association of Professional Engineers and Geoscientists of Yukon GradIEAus. Institution of Engineers, Australia

Specialisation	Contaminant hydrogeochemistry, geochemistry characterization and management of mine wastes, mine closure.

Expertise	Contaminant hydrogeochemistry modelling, water treatment evaluation, mine waste characterization and developing mine waste management strategies. ARD site assessments, mine closure studies, water treatment assessment and due diligence studies for financial institutions. Geochemical data review and interpretation, and design, set-up and supervision of mine drainage prediction testing programs.

Employment Record

2002 – present	SRK Consulting (Canada) Inc., Vancouver, BC Principal Engineer
1998 - 2002	SRK Consulting (Australasia), Brisbane, Australia Principal Environmental Engineer
1991 - 1998	SRK Consulting (Canada) Inc., Vancouver, BC Associate Consultant
1988 - 1991	Coastech Research Inc., Vancouver, BC Senior Engineer
1985 - 1988	Council for Mineral Technology (MINTEK), Minerals Engineering Division, South Africa, Chemical Engineer
1985	Department of Chemical Engineering, University of Cape Town, South Africa, Researcher

Publications	See attached

Languages	English and Afrikaans

John T. Chapman

Principal Engineer

Publications

1. Chapman J., D. Hockley, K. Sexsmith, B. Arthur and S. Donohue (2003). "Testing Acid Generation in Patse Backfill Tailings". Proceedings of the Sixth International Tailings and Mine Waste Conference, Cairns, Australia, July 13 to 17, 2003.
2. Chapman J., W. Coedy, T. Mudder, M. Botz, M. Nahir and O. Melo (2003). "Enhanced Natural Degradation Of Cyanide And Related Compounds in an Abandoned Tailings Lake Using Mono-Ammonium Phosphate (MAP)". Proceedings of ARCSACC Conference, May 2003, Edmonton Canada.
3. Sexsmith, K.S., D.E. Hockley, J.T. Chapman, N. McKay, G.W. Sevick and K. Black (2003). "Mineralogical examination of carbonates in the Crandon tailings". Minerals and Metallurgical Processing, (SME), May 2003, Vol. 20, No. 2, pp98-101.
4. Sevick, G.W., J.B. Hutcheson, J. Murphy and J. Chapman (1998). "Engineered Open Pit Mine Backfilling". Proceedings of the Fifth International Tailings and Mine Waste Conference, Fort Collins, Colorado, 1998.
5. Hockley, D., J. Chapman, G. Sevick and D. Moe (1998). "Estimating Contaminant Concentrations in a Re-Flooded Underground Mine". Tailings and Mine Waste, Denver, Colorado, January 1998.
6. Delaney, T.A., D.E. Hockley, J.T. Chapman and N. Holl. "Geochemical Characterization of Tailings from the McArthur River Mine, Saskatchewan". Tailings and Mine Waste, Denver, Colorado, January 1998.
7. Chapman, J., D. Hockley, G. Sevick, R. Dakel and M. Paul. "Pit Backfilling on Two Continents, Comparison of Recent Experience in the Wismut and Flambeau Projects". Tailings and Mine Waste, Denver, Colorado, January 1998.
8. Hockley, D.E., M. Paul, J. Chapman, S. Jahn and W. Weise. "Relocation of Waste Rock to the Lichtenberg Pit near Ronneburg Germany". Fourth International Conference on Acid Rock Drainage, Vancouver, B.C., June 1997.
9. Chapman J., M. Paul, S. Jahn and D.E. Hockley (1997). "Sulfide and Carbonate Availability and Geochemical Controls Established from Long Term Column Tests". Fifth International Conference on Acid Rock Drainage, Denver, Colorado, Publ. by Soc. For Mining and Metallurgy and Exploration Inc., Vol. 1, p. 581, June 1997.
10. Hockley, D.E. and J.T. Chapman. "Waste Rock Remediation Activities in the Ronneburg Mining District". Fourth Annual B.C. ARD Symposium, Vancouver, B.C., November 1996.
11. Connelly, R.J., K.J. Harcourt, J. Chapman and D. Williams (1994). "Approach to Remediation of Ferruginous Discharges in the South Wales Coalfield". 5th International Mine Water Congress, Nottingham, (U.K.), September 1994.
12. Chapman, J., D. Hockley, Dr. A. MacG. Robertson and L. Broughton (1993). "Rock Pile Water Quality Modelling – The Q-ROCK Mathematical Model". Presented at the Environmental Management for Mining Conference, Saskatoon, Oct. 27-29, 1993.
13. Brodie, M.J. and J.T. Chapman (1993). "Development of Rehabilitation Plans for Acid Drainage Control at Two Closed Underground Mines". 17th Annual Mine Reclamation Symposium, Port Hardy, B.C., May 4-7 1993.
14. Chapman, J.T., P.B. Marchant, R.W. Lawrence and R. Knopp (1993). "Bio-oxidation of a Refractory Gold Bearing Sulphide Concentrate: A Pilot Study". FEMS Microbiology Reviews 11(1993) 243-252.
15. Warkentin, D., J. Chapman, P.B. Marchant and A. Sadeghbari (1990). "Biological Sulphate Reduction – Process Update". CIM District 6 Meeting, Kamloops, B.C., Sept. 1990.
16. Pinches, A., J.T. Chapman, W.A.M. Te Riele and M. Van Staden (1988). "The performance of Bacterial Leach Reactors for the Pre-Oxidation of Gold Bearing Sulfide Concentrates". In Biohydrometallurgy, Proc. Int'l. Symposium, Warrick. Eds. Norris, P.R. and D.P. Kelly, Science and Technology Letters, 1988, p329.

John T. Chapman

Principal Engineer

Technical Articles

1. Chapman, J. (1999). "Mine Contamination". Published in the journal of Mining Environmental Management, Vol.7, No. 4, July 1999.
2. Chapman, J. (1999). "Pit Backfilling with Mine Waste". Published in the journal of Mining Environmental Management, Vol.7, No. 4, July 1999.

John T. Chapman

Principal Engineer

Key Experience: Selected recent Project experience

Holden Mine Site – URS Corp

- Geochemical characterization of tailings and modelling study to evaluate the long term geochemical performance of sulphide tailings and predict the release of metal loads to surface water.

Faro Mine Site – Deloitte and Touche

- Scoping study to assess water treatment requirements for the Faro Mine site. Developed preliminary water balance to assess closure requirements and minimise post closure treatment requirements. Developed capital and operating costs for preferred water treatment system.

Island Copper Mine - BHP-Billiton

- Assessed alternative water treatment options for the Island Copper Mine site to treat ARD before discharge to the flooded pit. Developed capital and operating estimates which were incorporated into the post closure management strategy.

Colomac Mine - Public Works Canada

- Colomac Mine Closure Study, North West Territories, Canada (Expert Geochemist). Completed site assessment, tailings and waste rock sampling programs and laboratory testing programs. Completed long term water quality predictions for developing mine closure options. Assessed in-pit and tailings lake enhanced natural treatment for cyanide removal.

Codelco – Andina Division, Chile

- Closure study for Tailings Storage Areas at the Andina Mine, Chile (Expert Geochemist) Activities included site assessment, water quality prediction and closure option evaluation.

Pt Indo Muro Kenkana, Indonesia

- Environmental Closure Study for the Mt Muro Project, Indonesia (Project Manager / Expert Geochemist). Managed a multidisciplinary team from Australia, Canada and the USA. Completed mine waste assessment, waste water impact evaluation and developed mine closure plan. Assisted in risk assessment.

Mt Leyshon Mine, Charters Towers, Qld. Australia - Newmont Mining

- Mine Closure Study for the Mt Leyshon Mine, Qld. Australia (Expert Geochemist/Project Manager). Completed a detailed review of proposed closure plan and developed and alternate optimised strategy. Designed post closure monitoring program and supervised installation of monitoring lysimeters.

INCO – Goro Project, New Caledonia

- INCO Goro Project Bankable Feasibility Study, New Caledonia (Expert Geochemist) Designed mine waste sampling and characterization program. Supervised laboratory testing program and interpreted test results. Developed long term water quality predictions and proposed waste management strategies and mine closure options.

Lepanto Mine (Phillipines), Principal Engineer

- Review of ARD assessment and mine closure strategy. Developed tailings characterization work plans.

Normandy Woodcutters Mine (Northern Territory, Australia) Principal Engineer

- Principal Technical Reviewer, waste rock characterization and development of decommissioning plan for the Woodcutters base metal mine.

John T. Chapman

Principal Engineer

Foth and Van Dyke (Wisconsin), Crandon Mine

- Senior Engineer, characterization of sulphidic tailings and modelling of oxygen entry, tailings oxidation, and solute release from the tailings impoundment at the proposed Crandon massive sulphide copper-zinc mine.
- Senior Engineer, prediction of solute release from underground wall rock and tailings backfill at the proposed Crandon Mine.
- Senior Engineer, characterization of waste rock and development of procedures for backfilling the Flambeau Mine open pit with limestone amended waste rock.
- Senior Engineer, modeling of oxygen transport and alkalinity requirements in waste rock backfill at the Flambeau Mine.

WISMUT GmbH, (former East Germany)

- Principal Engineer, cost estimates and assessment of remediation alternatives for Nordhalde waste rock pile.
- Project Manager, installation of oxygen monitoring equipment in waste rock, and review of data to predict future trends in water quality.
- Project Manager, review and testing of in situ remediation measures for acidic waste rock.
- Senior Reviewer, block modelling of waste rock piles.
- Project Engineer, development of laboratory and field protocols for evaluation of waste rock, and control of waste rock backfilling operations.
- Project Engineer, assessment of physical barriers and geochemical remediation methods for the Ronneburg uranium mine complex.

CH2M Gore & Storrie, Ontario Ministry of Environment (Ontario)

- Senior Engineer, remediation of tailings and mine areas at the Deloro Mine site, an abandoned gold mine, cobalt smelter, and arsenic production facility.

Public Works and Government Services Canada (Yukon)

- Reviewer, assessment of potential for acid rock drainage at fifteen abandoned mine sites in the Yukon.

CAMECO Corporation (Saskatchewan)

- Project Engineer, tailings characterization and review hearings for proposed McArthur River mine.
- Project Engineer, prediction of contaminant fluxes from waste rock piles at the Key Lake and Rabbit Lake uranium mines.
- Project Engineer, laboratory investigations and mathematical modelling to estimate uranium, radium, lead, nickel and arsenic release from Key Lake and McArthur River tailings.

Stephen J. Day

Principal Geochemist



Profession Professional Geoscientist

Education M.Sc, Geochemistry, University of British Columbia 1988.
B.Sc., Geology, University of British Columbia 1985.

**Registrations/
Affiliations** Professional Geoscientist (BC) No. 18,467.
Professional Geologist (Northwest Territories and Nunavut) No L1283.
Association of Professional Engineers and Geoscientists of B.C.
Fellow of the Geological Association of Canada.
Fellow, The Association of Applied Geochemists.

Specialisation

Stephen Day is Principal Geochemist at SRK's Vancouver office. He is an experienced specialist in the development of waste management plans to address acid rock drainage and leaching of mine wastes in general. He has particular expertise in the development of prediction methods for mine planning and modeling of leachate chemistry. His project experience includes development of innovative approaches to management of potentially acid generating wastes at new mines, assessment of existing waste disposal facilities at operating and abandoned mines to determine options for reduction or elimination of contaminated drainage, and environmental audits of mines.

Certification

Occupational Safety and Health Administration (OSHA).
Hazardous Wastes Operations and Emergency Response (OSHA 29 CFR 1910)
40-hour course.

Employment Record

1998 – Present	SRK Consulting (Canada) Inc. , Principal Geochemist
1992 – 1998	Dames & Moore , Senior Geochemist/Manager, Geosciences
1989 – 1992	Norecol Environmental Consultants Ltd. , Geochemist
1987 – 1989	British Columbia Geological Survey , Geochemist

Publications

Fifteen technical papers on acid rock drainage studies, stream sediment sampling, formation of placer deposits, mineral exploration in glacial terrains.

Key Experience: Mine Closure Planning

Barrick Gold, Nickel Plate Mine (2005)

- Geochemical characterization for closure planning of waste rock, mine workings and tailings from open pit gold mine.

Teck Cominco, Pine Point Mine (2006)

- Evaluation of monitoring requirements for tailings discharge.

Stephen J. Day

Principal Geochemist

Teck Cominco Alaska, Red Dog Mine (2003-Current)

- Water quality predictions for mine closure planning

Deloitte & Touche, Faro Mine (2002-Current)

- Design and implementation of geochemical studies for closure planning

BHP Billiton, Island Copper Mine (2001-2005)

- Geochemical studies for closure planning
- Chemical load modelling

Hudson Bay Mining and Smelting, Flin Flon Operations (2005)

- Input to estimation of closure costs.

Teck Cominco, HB Mine (2005)

- Review of geochemical issues for tailings.

Viceroy Resources, Brewery Creek Mine (2002-2004)

- Evaluation of water quality aspects related to closure.
- Assessment of selenium leaching.

Inmet, Samatosum Mine (2003)

- Environmental audit of former open pit copper-silver mine.

BHP Billiton, Confidential Internal Reviews (2002)

- Reviewed geochemical aspects of closure plans for two mines

BHP Billiton, Robinson Mine, Nevada (2001-2002)

- Geological and geochemical characterization of waste rock as part of closure planning for a large open pit copper mine
- Operation of a field laboratory for determination of leachable metal concentrations

British Columbia Ministry of Water Land and Air Protection, Britannia Mine, British Columbia (2001-Current)

- Evaluation of the effects of the use of mine workings for storage of contaminated mine water prior to treatment

Highland Valley Copper, Highmont Mine, BC (2000-2001)

- Geochemical assessment of tailings for closure planning

Dupont Canada, Baker Mine, B.C. (1999-Current)

- Evaluation of long term drainage quality for an inactive underground gold and silver mine
- Closure Planning

TeckCominco Ltd., Sa Dena Hes Mine, Yukon Territory (1999-Current)

- Assessment of geochemical characteristics of underground lead-zinc mines, waste rock and tailings, and downstream loading and impact assessment

Environment Canada, Mount Washington Mine, B.C. (1999-2000)

- Assessment of geochemistry as part of closure planning for a inactive open-pit copper mine

Holden Mine, Washington State (1998-Current)

Stephen J. Day

Principal Geochemist

- Support for Feasibility Study for closure of underground mine, waste rock and tailings
- Development of a site geochemical model to support selection of closure measures for a disused underground copper and zinc mine

Westmin Resources, Premier Gold Mine, B.C. (1998-2002)

- Prediction of long term geochemical behaviour of waste rock and tailings at an open pit gold mine

Homestake, Snip Mine, B.C. (1998)

- Prediction of post-closure impacts due to leaching of mine wastes at underground gold mine

Confidential Client (1996)

- Evaluated leaching of mercury from a former mercury mine as part of decommissioning

COMIBOL, Bolivia (1996-1997)

- Assessment of environmental issues for operating and closed mines as part of due diligence review

Weldwood Canada, Various Properties, B.C. (1996)

- Environmental evaluation of large area of former coal mining to assess remediation measures and potential costs

Stronsay, B.C. and Sa Dena Hes, Y.T. projects (1993)

- Initial assessment of potential environment liabilities

Kinross Gold, QR Gold Mine, B.C (1993, 1998-2000)

- Predictions of post-closure impacts due to long term leaching of waste rock and pit walls at open pit gold mine

Cominco, Sullivan Mine, B.C. (1992-1998)

- Evaluation of metal leaching from oxidized waste rock and tailings as part of closure planning. Geochemical interpretation of regional groundwater chemistry downgradient of tailings facility. Modelling of dry cover materials for acid generating tailings

Cominco, Pinchi Lake Mine (1994-1995)

- Evaluation of mercury distribution and leaching from mine wastes as part of closure planning

Survey of Abandoned Mines (1991)

- Compiled data relating to acid generation potential at more than 1000 abandoned mines in British Columbia. Assessed five coal and metal mine sites

Key Experience: New Mine Approvals and Permitting

Taseko Mines, Prosperity Project (2006)

- Geochemical assessment of waste rock and tailings for proposed open pit copper-gold mine.

Niblack Mining, Niblack Project (2006)

- Review of geochemical aspects for permitting of underground exploration development.

Teck Cominco, Morelos Project (2006)

- Geochemical assessment of waste rock and tailings for proposed open pit gold mine.

Miramar, Doris North Project (2006).

- Geochemical characterization of quarry rock

Stephen J. Day

Principal Geochemist

AES Wapiti Coal Project, Hillsborough Resources (2006)

- Geochemical characterization of waste rock and coal for proposed drag line coal mine.

Horizon Project, Hillsborough Resources (2006)

- Geochemical characterization of waste rock and coal processing products for proposed underground and open pit coal project.

Barrick Gold, Donlin Creek Project (2006)

- Geochemical characterization of waste rock and tailings for proposed open pit gold mine.

Westhawk Development Corp., Coal Creek Project (2006).

- Geochemical characterization of waste rock and proposed small coal mine.

Crowflight Minerals, Bucko Mine (2005)

- Geochemical characterization of rock and tailings for proposed underground nickel mine.

Doublestar Resources, Catface Project

- Geochemical characterization of rock and tailings for proposed open pit copper mine.

Novagold Corporation, Galore Creek Project (2004-current)

- Geochemical characterization
- Prediction of water quality impacts and recommendations for waste handling at a proposed open pit copper-gold mine

Northern Dynasty Minerals, Pebble Project (2004-Current)

- Geochemical characterization.
- Prediction of water quality impacts and recommendations for waste handling at a proposed open pit copper-gold-molybdenum mine

bcMetals Corporation, Red Chris Project (2003-Current)

- Geochemical characterization
- Prediction of water quality impacts and recommendations for waste handling at a proposed open pit copper-gold mine

Brule Project, Western Canadian Coal (2004-Current)

- Geochemical characterization, water chemistry predictions and input to waste management planning for a coal mine

Dillon Mine, Western Canadian Coal (2004)

- Geochemical characterization, water chemistry predictions and input to waste management planning for small coal mine

Doublestar Resources Limited, Sustut Copper Project (2001-2003)

- Assessment of geochemical issues for proposed copper mine
- General permitting assistance under the BC Environmental Assessment Process

Barrick Gold Corp, Pascua Project, Chile/Argentina (1999-2001)

- Assessment of waste rock and tailings geochemistry and prediction of drainage quality

Stephen J. Day

Principal Geochemist

Alaska Department of Natural Resources, True North Project (2000-2002)

- Review of expansion proposals for the Fort Knox Mine

BHP Billiton Diamonds, Ekati Diamond MineTM, Northwest Territories (2001-Current)

- Characterization of waste rock and prediction of water quality for the Sable, Pigeon and Beartooth Pipes
- Compilation of Waste Rock Management Plans

Crystal Graphite Corporation, Black Crystal Graphite Project, British Columbia (2001-2002)

- Geochemical characterization of waste rock and tailings for a proposed graphite mine

Teck Corp, Pogo Project, Alaska (1996-2004)

- Geochemical characterization
- Prediction of water quality impacts and recommendations for waste handling at a proposed underground gold mine

Indian and Northern Affairs Canada, Northwest Territories (1999-2001)

- Review of geochemical aspects of Diavik Diamond Mines

Coeur d'Alene Mines, San Bartolome Project, Bolivia (2001-2002)

- Geochemical characterization of waste rock and tailings for a proposed silver mine

PolyMet Mining Corp., Northmet Project, Minnesota (1999-2001, 2004-current)

- Development and implementation of geochemical test program for proposed open pit PGM, nickel and copper mine

Manalta Coal, Telkwa Coal Project, B.C. (1991-2000)

- Development of waste management plan to address acid drainage potential

Sutton Resources, Bulyanhulu Project, Tanzania (1997-1998)

- Waste management planning and prediction of impacts for proposed underground gold mine

Teck Corp, Marte Lobo Project, Chile (1997)

- Assessment of potential impacts to groundwater due to waste rock leaching at proposed open pit gold mine

Pine Valley Coal, Willow Creek Coal Project, B.C. (1996-1997)

- Baseline evaluation of acid generation potential and water quality for proposed coal mine

Teck Corp, Petaquilla Project, Panama (1996-1997)

- Prediction of potential impacts due to leaching of waste rock at proposed open pit copper mine

Cominco, Kudz-Ze-Kaya project, YT (1996)

- Retained to address acid generation issues in waste management plan for proposed zinc-copper-lead mine

Termopacifico, Colombia (1994)

- Assessment of existing waste management for small coal mines as part of proposed thermal power plant

Manhattan Minerals, Moris Mine, Mexico (1993)

- Developed closure plan for proposed heap leach gold mine. Also addressed acid generation issues

Stephen J. Day

Principal Geochemist

TVI, Canatuan Project, Philippines (1993)

- Development of waste management plan for proposed gold mine

El Condor, Kemess South Project, B.C. (1992)

- Evaluated natural weathering of rock and soil in support of waste management plan for proposed copper mine

Brewery Creek (1991)

- Soil and vegetation geochemistry study

Galore Creek Project (1991)

- Conducted initial assessment of acid generation at proposed large porphyry copper mine

Snip Mine (1991)

- Developed cyanide degradation model for tailings pond

Berg Project (1990)

- Investigated acid generation in waste rock and proposed waste handling approach for porphyry copper mine

Taiwan Limestone Project (1990)

- Conducted environmental assessment of proposed limestone quarry

Geddes Resources, Windy Craggy Project, B.C. (1989-1991)

- Investigated acid generation in waste rock, tailings, and underground workings and developed waste management plan for proposed massive sulphide copper mine

Cinola Project (1989-1990)

- Development of waste rock and tailings management plan for proposed epithermal gold mine

Cheni Gold Mines (1989)

- Developed waste rock handling plan for potentially acid generating rock at gold vein mine

Silver Butte Mine (1989)

- Interpreted acid generation data for waste rock and underground development for proposed massive sulphide base metal mine

Confidential Client

- Due diligence audit for a proposed porphyry copper mine
- Prediction of impacts due to rock and tailings leaching and recommendation of waste management strategies

Key Experience: Operating Mines

Imperial Metals, Moun Polley Mine (2004-Current)

- Geochemical characterization and water quality predictions for mine expansion.
- Water quality predictions for closure of copper heap leach.

Inmet, Troilus Mine (2005)

- Development of an approach for waste rock segregation at open pit copper gold mine.

Stephen J. Day

Principal Geochemist

BHP Billiton, Mina Tintaya (2005-2006)

- Evaluation of selenium sources in waste rock and downstream attenuation and transport.
- Geochemical characterization for closure planning.

TeckCominco, Elkview Coal Mine (2003)

- Detailed assessment of occurrence and release of selenium from mine facilities, and recommendations for management approaches

Cominco, Red Dog Mine, Alaska (1997-Current)

- Development of innovative methods for characterization of the geochemical behaviour of waste rock
- Ongoing geochemical advice and interpretation

Thompson Creek Mining, Endako Mine (1999-2000)

- Assessment of waste rock geochemistry

Huckleberry Mines Limited (1996-current)

- Ongoing advice to operating open pit copper and molybdenum on waste management and prediction of long term water quality impacts

TeckCominco, Luscar Ltd., Fording Coal, Elk Valley Coal Mines, British Columbia (1999-2002)

- Technical review of university research on the occurrence and release of selenium from waste rock

Hudson Bay Mining and Smelting (1998)

- Environmental audit of more than ten massive sulphide copper and zinc mines, mills and associated smelter

Confidential, Colombia (1997)

- Assessment of existing environmental liabilities and scoping of environmental impact assessment for an operating coal mine as part of due diligence review

Cominco Trail Operations, B.C. (1993)

- Developed slag pile leachate model for proposed slag disposal site

Gold Mine Yellowknife, NWT (1993)

- Environmental assessment of operating gold mine as part of due diligence

Macrae Mining, New Zealand (1993)

- Presented arguments on acid generation thresholds in tailings. Evaluated reports on arsenic leaching from waste rock and tailings

Equity Silver Mines (1991)

- Developed water quality model for an acid generating open pit to address disposal of water treatment sludge in pit

Tanco Mining company (1991)

- Environmental audit of tantalum mine and mill

Endako Mines (1990)

- Evaluated acid generation potential of waste rock and tailings at molybdenum mine

Key Experience: Government Projects

U.S. Trade and Development Agency, Dominican Republic (2002)

Stephen J. Day

Principal Geochemist

- Delivered part of a short course to federal government personnel on acid rock drainage assessment and remediation

State of Alaska (2001)

- Workshop on mine site geochemical assessment

Canadian International Development Agency, Peru (2000-2001)

- Preparation of guidelines for inspection of mines

MEND Program (2000-2001)

- Managed and co-authored preparation of report titled Acidic Rock Drainage and Technology Gap Analysis

MEND Program (1996-2000)

- Co-author of technology manual on acid rock drainage prediction, control and treatment

MEND Program (1998)

- Reviewed and assisted with selection section of Procedures for Assessing the Subaqueous Stability of Oxidized Waste Rock

MEND Program (1997)

- Co-authored Blending and Layering Waste Rock to Delay, Mitigate or Prevent Acid Generation

MEND Program (1996)

- Co-authored Guide for predicting water geochemistry from waste rock piles

Japan International Cooperation Agency, Brazil (1995-1996)

- Part of a multi-disciplinary team led by Mitsubishi that evaluated remediation of coal mines in the State of Santa Catarina

Indian and Northern Affairs (1994)

- Prepared a long range research plan for acid rock drainage

Mine Environment Neutral Drainage Program, Cinola Project, B.C. (1994)

- Assessed long term potential for acid generation in waste rock and evaluated limestone addition to prevent acid release from waste rock

QA/QC for Acid Generation Studies (1990)

- Prepared manual for BC Acid Mine Drainage Task Force

Review of Acid Generation Determination Methods (1990)

- Assessed methods and recommended new approaches to testing for Energy, Mines and Resources Canada

Acid Rock Drainage Technical Guide (1989)

- Co-authored state-of-the-art manual covering prediction and monitoring of acid mine drainage

Stephen J. Day

Principal Geochemist

Key Experience: Contaminated Sites and Other Projects

Ministry of Health

- Directed sampling of 240 wells to assess potential pesticide contamination

Fullerton Lumber

- Assessed soil contamination and potential approaches to on-site processing and soil remediation

Fisheries and Oceans Canada

- Assessed soil, sediment and water contamination at a marine repair station. Developed and costed remediation options

Fisheries and Oceans Canada

- Assessed contaminated woodfill on Crown lands. Developed and costed remediation options

Western Steel

- Interpretation of arsenic sludge chemistry.

Grand Metropolitan

- Assessment and management of several hydrocarbon underground storage tanks

Transport Canada

- Senior review of project to assess liabilities associated with underground fuel storage tanks at 28 remote beacon sites

Dylan MacGregor

Senior Geologist



Profession Education

Geologist

M.A.Sc., University of British Columbia (2002)

Department of Civil Engineering, Geoenvironmental program

- Research and coursework on the chemistry, mineralogy and origins of soil and its interactions with contaminants, with an emphasis on mine drainage - soil interaction.
- Thesis project: Natural attenuation of aqueous zinc in shallow soils over permafrost downslope of Galkeno 300 mine adit, United Keno Hill Mines, central Yukon.

B.Sc., Simon Fraser University (1998)

Honours: Physical Geography Minor: Earth Science

Geoscientist-in-Training, Association of Professional Engineers and Geoscientists of British Columbia

Registrations/ Affiliations

Expertise

Dylan has six years' experience related to mine waste characterization, mine drainage, and mine permitting and closure. Includes two years of graduate research into natural geochemical removal of metals from mine drainage.

Employment Record

2002 – Present

SRK Consulting (Canada) Inc., Geoenvironmental Group, Vancouver, BC
Staff Geologist. Mine waste characterization and waste management planning
Geochemical evaluation of aspects of closure options at abandoned mines
Field investigation for mine development and mine closure projects.

1999 – 2002

University of British Columbia, Geoenvironmental Program, Department of Civil Engineering, Vancouver, BC: Teaching and Research Assistant. Laboratory evaluation of interaction of heavy metals and soils, supervision of undergraduate soil mechanics laboratory, marking and exam invigilation.

Summer 1996, 1997, 1998

Yukon Territorial Government, Yukon Geology Program, Faro and Mayo, Yukon Territory, Geological Assistant. Geological mapping, geochemical sampling, interpretation of aerial photography.

Publications

1. MacGregor, D., (2002). "Natural attenuation of zinc occurring in shallow soils downslope of Galkeno 300 adit, Keno Hill mining district, central Yukon Territory, and the implications of residual zinc accumulation". In Proceedings of the Northern Latitudes Mining Reclamation Workshop, Whitehorse, YT, October 1-3, 2001.
2. MacGregor, D. and Li, L.Y., (2001). "Natural attenuation of mine drainage-borne zinc in shallow subsurface soils over permafrost, central Yukon, Canada". In Proceedings of the 3rd British Geotechnical Association Geoenvironmental Engineering Conference, Edinburgh, Scotland, September 17-19, 2001.
3. MacGregor, D., (2000). "Possible mechanisms of natural attenuation of metal-bearing waters in soils in northern climates". Mining Environment Research Group Open File 2000-6, Yukon Territorial Government.

Languages

English

Dylan MacGregor

Senior Geologist

Key Experience:

Recent project experience includes:

Anvil Range Mining Complex, Faro, YT – Deloitte & Touche (2002-2007)

- Installation, maintenance and monitoring of waste rock instrumentation. Duties included drill supervision, logging and collection of geochemical samples, installation of multi-level pore gas and thermal monitoring instrumentation.
- Monitoring of waste rock seepage. Duties included surveying and collecting waste dump seepage samples; evaluation of monitoring results; preparation of monitoring reports.
- Geotechnical investigation of Grum Dump seepage options. Duties included supervision of excavator during test pit excavation; logging of materials and collection of geotechnical samples; preliminary design of elements of seepage collection system; preparation of preliminary design report.
- Pit lake water quality prediction. Duties included geochemical characterization of pit walls and bench talus; sampling of in-pit groundwater seeps and wall rock runoff; updating water and load balance for 3 pits and estimating short- and long-term pit lake water quality.
- Development of water and load balance for Grum Dump. Duties included sampling of surface water and groundwater seepage downgradient of Grum Dump; incorporating hydrological data into a dump water balance; estimating current loadings from waste dump to receiving environment; proposing additional monitoring of and potential collection systems for contaminated drainage.
- Evaluation of attenuation of zinc in natural soils below 55 Mt tailings facility in Rose Creek value. Duties included planning; drill supervision and core logging; sample collection; monitoring well installation; field contact testing; supervision of laboratory testing, including detailed mineralogy; data interpretation and report preparation.

Doris North Project, Hope Bay, NU – Miramar Mining Corporation (2002-2007)

- Managing summer and winter geotechnical drilling programs. Duties included planning and logistics for drilling and instrumentation; geotechnical logging and sampling of overburden material and rock core; hydraulic (packer) testing of bedrock and overburden; installation, maintenance and monitoring of thermistors.
- Preliminary design of surface infrastructure. Duties included siting roads and infrastructure facilities; developing cost estimates for infrastructure components; developing preliminary designs for infrastructure components including roads, airstrips, fuel tank farms, explosives magazines, and foundations for processing plant, camp and other components.
- Evaluation of geochemical characteristics of proposed construction rock and mine development rock. Duties included review and interpretation of static geochemical data; review and interpretation of quantitative mineralogical data to identify carbonate mineral species present and the relative proportions of these carbonate mineral species.

Giant Mine, Yellowknife NWT – DIAND (2003-2004)

- Managing winter geotechnical drilling program investigating crown pillars and contents of arsenic trioxide chambers. Duties included drill supervision; health and safety plan implementation and monitoring; geotechnical logging of rock core; sampling of arsenic trioxide; decontamination of sampling equipment, drill staff and supervisory staff; hydraulic (packer) testing of bedrock and overburden; carrying out cone penetrometer testing of arsenic trioxide dust; supervision of chamber cavity monitoring using down-hole laser technology; installation and monitoring of thermistors and vibrating wire piezometers.
- Maintenance, monitoring and sampling of multi-level groundwater wells. Duties included monitoring water pressures using Westbay MP system; collection of water samples for geochemical analysis.

Dylan MacGregor

Senior Geologist

Red Mountain Exploration Site, Stewart BC– Seabridge Gold Incorporated (2003-2007)

- Annual monitoring and inspection. Duties included sampling of underground mine pool; sampling of waste dump seepage and downgradient surface water; sampling of waste rock for geochemical assessment of weathering progress; installation of instrumentation for year-round monitoring of underground mine pool elevation; inspecting condition of site, including fuel storage facilities and site infrastructure; supervising mechanical inspections of mobile heavy equipment; preparation of annual monitoring and inspection reports for submission to regulatory authorities.
- Development of reclamation plan. Duties included assessment of reclamation requirements; development of cost estimate and schedule for reclamation work; preparation of reclamation plan for submission to regulator authorities.
- Planning and coordination of a general site cleanup in 2005, including offsite removal of waste hydrocarbons and hazardous materials.

Jericho Project, NU – Tahera Diamond Corporation (2003-2006)

- Managing summer geotechnical drilling program. Duties included supervision of drilling, using chilled brine and triple tube core system; geotechnical logging and sampling of overburden material and rock core; hydraulic (packer) testing of bedrock and overburden; installation, maintenance and monitoring of thermistors.
- Review of 2006 waste rock seepage monitoring results and preparation of 2006 waste rock seepage monitoring report.

Colomac Mine, NWT – DIAND (2002-2003)

- Compilation of available information on permafrost conditions. Duties included review and compilation of available drill logs; review and compilation of available hydrologic data related to tailings management facility.
- Preparation of closure options. Duties included supervision of preparation of figures outlining options for closing portions of the site; estimation of volumes for various earth-moving options.

Britannia Mine, Britannia Beach BC – BC Ministry of Water, Lands, Air and Parks (2003-2004)

- Assessment of potential for surface diversions. Duties included field mapping of potential routes for diversion of surface water from open pits draining into underground workings; supervision of surveying of potential diversion routes; preliminary design of surface water diversions, and preparation of preliminary design report.
- Collection of water quality samples from underground mine discharges and downgradient surface water flow paths.

Pebble Project, Iliamna AK– Northern Dynasty Minerals (2004-2006)

- Selection of samples for geochemical testing. Duties included reviewing geological model and assay database; identifying available core intervals required for geochemical testing; logging of selected samples for quality assurance purposes once sample collection had occurred.
- Field reconnaissance of potential seepage sampling locations; collection of field pH and conductivity measurements to provide a basis for screening potential sampling sites; selection of sites to be sampled to provide information on natural seepage water quality from mineralized areas.

Dylan MacGregor

Senior Geologist

Former United Keno Hill Mines, Yukon Territory- Els Reclamation and Development Company (2005-2007)

- Assessment of over 70 sites in former silver mining district to establish baseline physical and chemical conditions to facilitate transfer of property from government to private sector interests. Duties included evaluation of geochemical condition of waste rock, tailings, and mine drainages; evaluation of physical stability of structures and mine workings; audit of existing records to assess gaps in understanding of present and potential future liabilities.
- Preparation of a baseline environmental report to document physical and chemical conditions at the various individual sites; included identification and discussion of trends or phenomena that were only evident when viewed at a scale incorporating several individual sites (e.g. evolution of water quality along drainage paths, potential for area-wide contamination from airborne particulate).

Prosperity Project, southeast Chilcotin region, BC– Taseko Mines Ltd. (2006-2007)

- Planning and supervision of geochemical testing program to support a mine permit application. Duties included review of existing information to identify data gaps; development of a testing program to address deficiencies; supervision of testing and analytical laboratories.
- Providing input to mine planning team relating to potential waste management strategies. Duties included review of geochemical data to assess potential for segregation of reactive and non-reactive waste rock; input into development of a reactive/ non-reactive waste rock model; input into siting of mine facilities, including ore and low grade ore stockpiles.

Alvin Tong

Geotechnical Engineer



Profession Geotechnical Engineer

Education B.A. Sc., Geological Engineering, Geotechnical Option,
University of British Columbia, 2002

**Registrations/
Affiliations** Engineer-In-Training, British Columbia, Reg. No. 132605

Specialisation Site investigation and construction management.

Expertise Alvin Tong is a Geotechnical Staff Engineer with experience in geotechnical investigations, sensitivity analysis and design, construction inspection and management. He has worked on large, civil construction and mining developments and has been directly responsible for QA/QC activities and monitoring the workmanship of the geosynthetic installations by the Contractor for several projects.

Employment Record

Oct 2005 – Feb 2006	Kensington Project , Resident Engineer Alaska, USA.
Jun 2005 – Oct 2005	Brule Feasibility Study , Field Engineer Tumble Ridge, B.C.
Oct 2004 – May 2005	Mount Polley Tailing Storage Facility 2004 Expansion , Field Engineer Williams Lake, B.C.
Apr 2004 – Oct 2004	Hertzler Tailings Impoundment Stage 2 Construction , Field Engineer Montana, USA
Oct 2003 – Mar 2004	Pebble Project , Engineer, Alaska, USA
Sep – Oct 2003	Red Chris Project , Field Engineer, Smithers, B.C.
Aug – Sep 2003	Kemess North Project , Field Engineer, Central, B.C.
Apr – Aug 2003	Pend Oreille Project , Liner Inspector, Washington, USA

Languages English, Cantonese

Alvin Tong

Geotechnical Engineer

Key Experience: Recent project experience includes:

Kensington Project, Resident Engineer

Alaska, USA

- Responsible on site geotechnical support and quality assurance
- Provide geotechnical recommendations, construction monitoring, oversaw soil laboratory testing, contractor and client liaison, construction and technical support
- Geotechnical support and monitoring including road and mill site foundation, fill material control, and surface hydrology
- Report writing included drafting of Technical Specifications and Operation Manual as a part the proposal documents.

Brule Feasibility Study, Field Engineer

Tumble Ridge, B.C.

- Responsible for setting up and carry out site investigation program including testpitting, production water well drilling and terrain mapping
- Soil logging and sampling, monitoring well pump testing, identifying geomorphic features, on-site geotechnical support, soil laboratory testing, stability analysis, design and construction recommendations
- Report writing included presenting and summarizing data to provide design and construction recommendations.

Mount Polley Tailing Storage Facility 2004 Expansion, Field Engineer

Williams Lake, B.C.

- Responsible for monitoring QA/QC activities during the expansion constructions
- Provide on-site technical support for the client and liaison with the office
- Providing works including quantity trekking, construction methods, instrumentation data analysis, sensitivity analysis
- General construction management support, and final construction report writing

Hertzler Tailings Impoundment Stage 2 Construction, Field Engineer

Montana, USA

- Responsible for monitoring QA/QC activities during geosynthetic liner installation
- Provided construction observation, inspection work, project control, construction method, foundation construction monitoring
- Technical direction for the geosynthetic clay liner and HDPE geomembrane installations

Pebble Project, Staff Engineer

Alaska, USA

- Completed tailings storage facility site alternatives and sensitivity studies for a proposed mine development in Alaska

Red Chris Project, Field Engineer

Stikine, B.C.

- Responsible for data collection, instrument installations, client and office support, data analysis, design and construction recommendations, and report writing
- The data collection includes geotechnical core logging and packer testing
- Instrumentations include monitoring wells, piezometer and sampling Waterra

Alvin Tong

Geotechnical Engineer

- Client and office support includes relaying information from site to office and provide client with supports as requested

Kemess North Project, Field Engineer

Prince George, B.C.

- Responsible for data collection, instrument installations, client and office support, data manipulation, design recommendations, report writing
- Data manipulation includes DIPS analysis and design support includes SLOPE-W and SEEP-W analysis of the pit wall
- Report writing included presenting and summarizing the data and providing design limitations and construction recommendations

Pend Oreille Project, Liner Inspector

Washington, USA

- Responsible for QA/QC of the lining process, subgrade preparation, and to provide client and office support
- QA/QC includes numerous tests like air test, vacuum box test, destructive test, spark test and overall visual inspects
- Client and office support include providing information for government inspectors, contractors, mine project managers and senior engineers in the office

Gary R. Ash

Education B.Sc. (Honours) Zoology, University of Alberta, Canada, 1972
 M.Sc. (Biology), University of Alberta, Canada, 1974

Affiliations American Fisheries Society
 Alberta Society of Professional Biologists
 Canadian Society of Environmental Biologists

Experience

2001 to date	Golder Associates Ltd. Edmonton, Alberta <i>Principal and Senior Fisheries Biologist</i> Aquatic resources specialist involved with research and environmental assessment of fish and habitat resources, and impact assessment with a focus on mining, hydroelectric, oil and gas, and linear development projects. Services provided include study design and management, collection and reporting of field investigations, input to multidisciplinary environmental impact assessments, preparation of environmental monitoring plans, development of mitigation and fish habitat compensation programs to meet client and regulatory needs. Recent projects include environmental assessments relating to a potential mining development in Nunavut and the Mackenzie Valley Gas Pipeline.
1977-2001	R.L.&L. Environmental Services Ltd. Edmonton, Alberta <i>Principal and Co-founder</i> Conducted fisheries and aquatic environmental investigations throughout western and northern Canada for 25 years. Completed field studies and an aquatic impact assessment for part of an Initial Environmental Assessment relating to a proposed base metals mine site at Izok Lake, Northwest Territories. Provided input to the study design for the baseline studies for Echo Bay's Ulu Project in the Northwest Territories, and directed the baseline data collection for the AEC Bitumen Production Project (Cold Lake Air Weapons Range, Alberta) and the Meliadine West Gold Exploration Project near Rankin Inlet, Northwest Territories. Involved in several environmental protection and planning studies, with input to an environmental monitoring and waste compliance program for the Lupin Project gold mine (Contwoyto Lake, Northwest Territories), a fisheries habitat inventory for a large number of lakes in central Alberta (Alberta Fish and Wildlife Division), and prepared a five-year strategic plan for the fisheries component of the Mica Dam Compensation Program for BC Hydro. Managed and wrote the fisheries and aquatic sections of the environmental information review and data gap analysis of both the upper and lower Columbia River projects for BC Hydro's water use planning process. Conducted fisheries and baseline studies for the Mackenzie Delta Producers proposed pipeline down the Mackenzie valley.
1977-1979	BC Hydro Vancouver, BC <i>Fisheries Biologist</i> Involved in the preparation of terms of reference for environmental impact studies for proposed hydro and thermal power generating stations. Other duties included monitoring consultants' work, conducting in-house field studies, and providing input to EIAs.
1974-1977	Renewable Resources Consulting Services Ltd. Edmonton, Alberta <i>Fisheries Biologist</i> Undertook numerous aquatic research programs entailing environmental evaluations of proposed energy developments such as hydroelectric dams (Peace Canyon Dam, Peace Site C, and the Marsh Lake Northwest Territories dam); river dredging (Mackenzie River); flood control, oil sands development, and pipeline construction (environmental code for the Mackenzie Valley pipeline).

PROJECT RELATED EXPERIENCE - POWER

**Environmental Overview Assessment of the Implications of
Locating the Site C Dam Upstream of the Moberly River**

British Columbia

An overview assessment of the implications of locating the Site C Dam on the Peace River to upstream of the Moberly River on the fish and aquatic resources, wildlife and historic resources.

**Site C Environmental Impact Statement Indicating Effects
Pertinent to the Dunvegan Hydroelectric Proposal**

British Columbia

An environmental assessment of potential cumulative effects of the proposed Site C hydroelectric development in BC in combination with the proposed Dunvegan Project in Alberta. The assessment included implications on ice formation, hydrology, fisheries resources, wildlife, agriculture, soils, forestry, socio-economic and First Nations.

**Keenleyside Powerplant Project Cumulative Environmental
Effects Assessment: Fisheries and Aquatic Habitats.**

British Columbia

An assessment of the cumulative environmental effects of the installation and operation of the proposed Keenleyside Powerplant on the Columbia River near Castlegar, B.C. Impacts are discussed for hydraulic effects, entrainment, total dissolved gas pressure (TGP), load/flow shaping, and habitat losses to aquatic resources, particularly fisheries.

**Environmental Information Review and Gap Analysis
Water Use Planning – Keenleyside, Mica, Revelstoke**

British Columbia

A comprehensive review was prepared of all documented literature and file information on fish, wildlife and recreation within the Columbia River Basin that may be affected by operations of the Mica, Revelstoke and Keenleyside facilities, and possible interactions between these environmental resources and facility operations. A summary of potential operation-related effects on fish, wildlife and recreation in the context of current facility operations, as well as potential cumulative effects caused by other existing projects in the Columbia Basin was completed; information deficiencies that hamper evaluating the nature and significance of these impacts were identified; and recommendations provided for future environmental studies to address.

**Keenleyside Powerplant Project: Assessment of Potential Biological
Effects of Water Temperature Changes.**

Castlegar, BC

An assessment of the biological effects of the potential changes in the thermal regime was conducted to better understand the implications of the potential temperature changes associated with the powerplant.

Mica Dam Unit 5 Project

British Columbia

Existing biological information on limnology, fish and habitat resources, and the uses of these resources, was summarized for the project area (Mica Reservoir, the upper Columbia River and its tributaries, and Revelstoke Reservoir). Potential impacts on the aquatic habitat and fisheries, including the magnitude and duration of the impacts were detailed. In addition, possible mitigation measures and recommendations for further study were identified. A short discussion of the potential incremental or cumulative impacts associated with additional units planned for Revelstoke and Mica was also provided.

Gary R. Ash

GMS Tailrace Weir Excavation Project: Fish habitat Assessment British Columbia

An assessment was provided of the impacts of reservoir drawdown on fish habitat and tributary access. Habitat values associated with a proposed excavation project in the GMS tailrace area were also assessed and habitat mitigation/compensation/enhancement options associated with the proposed excavation project provided.

Environmental Monitoring and Support Services Alberta

Director for a project requiring continuous sediment monitoring during emergency dredging of the North Saskatchewan River. Maintained regulatory agency liaison and mitigation planning to comply with water quality objectives. Developed fish habitat compensation strategies and satisfied reporting commitments on behalf of TransAlta.

Lake Whitefish Spawning Success

An assessment was conducted of the impact of the Wabamun Power Plant thermal plume on lake whitefish spawning success in Wabamun Lake, Alberta.

Water and Sediment Sampling Wabamun Lake

Project Director for study on total metal concentrations in water and sediment in the Ash Lagoon, Wabamun Lake and watershed, and reference areas.

Socio-Economic Effects Of Changes In Traditional Resource

Availability In The Athabasca River Delta – Fisheries Component

An evaluation was conducted of how changes from the construction and operation of the WAC Bennett Dam in the upper Peace River may have affected use of traditional fisheries resources by the ACFN.

Libby Coordination Agreement Assessment British Columbia

An overview report was prepared which discussed the impacts associated with Libby Coordination Agreement operations on fish, fish habitat, and fish use in the Kootenay and Columbia River systems.

Fish Mortality Study Alberta

Expertise was provided to resolve fish mortality in the inlet and outlet canals at the Wabamun Plant. On-site monitoring of fish collection from the intake screens was conducted in the vicinity of the Wabamun plant intake, to assist with determining the possible causes of fish mortality. Electrofishing was conducted to remove fish from the outlet canal. Intake canal velocities were also measured at the Wabamun Plant.

Waneta Powerplant Columbia River, BC

A preliminary scoping document and discussion paper was prepared regarding the impacts of construction and operation on white sturgeon populations

Peace River Site C Hydroelectric Development: British Columbia Pre-construction fisheries studies

This project was conducted to assess fisheries resources and utilization in the development area of a proposed hydroelectric project on the Peace River, near Fort St. John, B.C. Information collected was used to create a pre-development database to facilitate impact assessment and the identification of potential mitigation and compensation options.

Gary R. Ash

Lower Columbia River Fisheries Inventory

British Columbia

Fisheries studies were conducted to increase the pre-development database of information relating to the fisheries resource, and to identify feasible mitigation and enhancement opportunities that exist in the development area of seven proposed hydroelectric facilities within the Lower Columbia River basin. A detailed inventory was conducted of existing fish populations and movement patterns within the Lower Columbia Development study area. In addition, an assessment was completed of the use of the mainstem Columbia River and tributaries for spawning, rearing and feeding by sportfish and non-sportfish species and an assessment of the extent of gas bubble trauma in fish, resulting from the high total dissolved gas levels below Hugh Keenleyside Dam.

Load/Flow Shaping: A Review of Environmental Effects

British Columbia

This study was conducted to provide a review of the environmental effects of hydroelectric powerplant operations on biological communities. Emphasis was placed on species in the Columbia River below Keenleyside Dam to the Canada-U.S. border. The information was used to predict the impacts of several hydroelectric projects and to assist in developing mitigation and compensation programs to reduce the impacts of existing and planned developments on the lower Columbia River basin.

PROJECT RELATED EXPERIENCE – ENVIRONMENTAL IMPACT ASSESSMENT

Imperial Oil Cold Lake Expansion Project

Cold Lake, Alberta

Aquatic studies of the fish community, fish habitat, lower trophic levels, and water quality for completion of the environmental impact assessment for Imperial Oil Resource Ltd.'s Mahihkan North and Nabiye developments near Cold Lake, Alberta. The development used Cyclic Steam Stimulation (CSS) technology to recover bitumen from deep formations.

Pre-Development Aquatic Studies: Meliadine West Project

Nunavut, Canada

Participated in the collection of baseline information of fish populations and aquatic nonvertebrate communities in the area of Rankin Inlet, Nunavut. In addition, fish tissues and water quality samples were collected from selected waterbodies in the study area. An assessment was conducted of waterbodies and fish populations that may be impacted by the development. Radio transmitters were implanted in selected sportfish species (Arctic char, Arctic grayling and lake trout) to determine the extent of overwintering and spawning migrations.

Ulu Project - Aquatic Studies Program

Nunavut, Canada

A detailed survey of the aquatic biological community was undertaken as part of a baseline environmental study within the area of the ULU deposit, located approximately 155 km north of the Lupin gold mine. The purpose of the study was to provide accurate pre-development baseline data on the aquatic environment of waterbodies that may be impacted by mining activities. Aspects of the study included fish and fish habitat investigations, water quality and sediment collections.

Gary R. Ash

AEC Bitumen Production Project, Air Weapons Range: Baseline Studies - Fish and Aquatic Habitat Component

Cold Lake, AB

Alberta Energy Company (AEC) plans to develop a commercial scale bitumen production project from its Oil Sands Development Leases located in the Cold Lake Air Weapons Range. As a result, a baseline inventory of the aquatic biota in the vicinity of the project area was undertaken. The objectives of the 1997 baseline studies program was to inventory fish populations and aquatic habitats in waterbodies in the vicinity and immediately downstream of the development area and assess the importance of these waterbodies to these fish populations.

Keenleyside Powerplant Project Cumulative Environmental Effects Assessment: Fisheries and Aquatic Habitats.

British Columbia

An assessment of the cumulative environmental effects of the installation and operation of the proposed Keenleyside Powerplant on the Columbia River near Castlegar, B.C. Impacts are discussed for hydraulic effects, entrainment, total dissolved gas pressure (TGP), load/flow shaping, and habitat losses to aquatic resources, particularly fisheries.

Fisheries assessment in the ULU Project Area

Nunavut, Canada

Four proposed winter road routes were evaluated on the basis of engineering and environmental criteria. The aquatic habitat at each stream crossing along the proposed winter road routes as well as the fish use of these streams was assessed. In addition, preliminary limnological and fisheries surveys of four lakes were conducted.

Waneta Powerplant

Columbia River, BC

A preliminary scoping document and discussion paper was prepared regarding the impacts of construction and operation on white sturgeon populations

PROJECT RELATED EXPERIENCE – MINING

Miramar Hope Bay Ltd. Doris North Project

Nunavut, Canada

Designed and directed aquatic baseline studies for the proposed Doris North Gold Project located south of Cambridge Bay, NU. The project also included participation in a multi-disciplinary team to prepare an Environmental Impact Statement (EIS) that was submitted to the Nunavut Impact Review Board. This involvement included identification of mitigation options and preparation of a fisheries compensation program to offset losses to the fisheries resources. Participated in NIRB pre-hearing conferences in four northern communities and attended the NIRB hearings on behalf of the client as an expert witness relating to the aquatic disciplines.

Pre-Development Aquatic Studies: Izok Mining Project (Port Site)

Nunavut, Canada

Aquatic sampling programs were conducted to collect baseline information from an initial Environmental Impact Assessment. Fisheries programs, habitat evaluations, water and sediment quality sampling, and bathymetry were undertaken at Izok Lake and on the Arctic coast (port site). Fish tissues and sediment samples were analyzed to determine background levels of heavy metals.

Gary R. Ash

Pre-Development Aquatic Studies: Meliadine West Project

Nunavut, Canada

Baseline inventory study of fish populations and aquatic non-vertebrate communities in the area of Rankin Inlet, Nunavut. In addition, fish tissues and water quality samples were collected from selected waterbodies in the study area. An assessment was conducted of waterbodies and fish populations that may be impacted by the development. Radio transmitters were implanted in selected sportfish species (Arctic char, Arctic grayling and lake trout) to determine the extent of overwintering and spawning migrations.

Ulu Project - Aquatic Studies Program

Nunavut, Canada

A detailed survey of the aquatic biological community was undertaken as part of a baseline environmental study within the area of the ULU deposit, located approximately 155 km north of the Lupin gold mine. The purpose of the study was to provide accurate pre-development baseline data on the aquatic environment of waterbodies that may be impacted by mining activities. Aspects of the study included fish and fish habitat investigations, water quality and sediment collections.

Fisheries Investigations at the Lupin Gold Mine

Contwoyto Lake, N.W.T.

Environmental monitoring was conducted at the Lupin Mine site to determine if there had been any major changes in metal concentrations in fish tissue in the vicinity of the decant pathway.

Hope Bay Fish Integrated Report

Hope Bay, Nunavut

Aquatic environmental baseline information area was consolidated and synthesized from previous projects within the Doris Hinge project area. The consolidated report is intended to be used in support of an environmental impact assessment and will form the basis for future monitoring programs.

Hope Bay Aquatic Studies

Hope Bay, Nunavut

This project is designed to address data gaps in our current understanding of the aquatic habitat and fish populations in the study area. A brief field survey was conducted during spring to document Arctic grayling spawning locations and stream habitat conditions. During late summer and early fall, a fish fence will be installed in Roberts Creek to enumerate Arctic char migrants returning from the sea. Tissue samples will be collected from 60 fish to be analyzed for metal concentrations. In addition, sediment samples will be collected in Roberts Bay and Roberts Lake to determine the present concentrations of metals and organic contaminants. The collected data will be used in the preparation of an environmental impact assessment and will form a baseline for future monitoring activities.

Miramar Hope Bay Project – Fisheries

Compensation Program

Hope Bay, Nunavut

Involved development of a fisheries compensation plan, in consultation with DFO, to enhance fish production in the Doris North project area to replace lost fish production due to the mining development. The proposed compensation plan included facilitating access of Arctic char and other species to spawning and overwintering habitats in Roberts Lake, construction of rearing habitat in Doris Lake and Roberts Bay, and enhancement of a tributary to Roberts Lake to enhance Arctic char rearing habitat.

Miramar Hope Bay Project – Input to EIS and Expert Witness Testimony

Hope Bay, Nunavut

Involved coordination and input of the biological components to the Miramar Doris North Project Final Environmental Impact Statement submitted to the Nunavut Impact Review Board. It also included appearing on behalf of the proponent as an expert witness at the NIRB regulatory hearings.

Gary R. Ash

PROJECT RELATED EXPERIENCE – TOTAL GAS PRESSURE (TGP) INVESTIGATIONS

Total Dissolved Gas Analysis at Boundary Dam

Washington State, USA

The objective of the program was to evaluate total dissolved gas loadings from Boundary Dam on the Pend d'Oreille River downstream through the Canadian portion of the river, past the Seven Mile and Waneta hydro projects, to the Columbia River back at the Canada-USA border. An empirical model was developed to provide mass balance estimates of total dissolved gas contributed by Boundary Dam to the total loadings in the Columbia River at the border.

Revelstoke Dam TGP Investigations

British Columbia, Canada

Monitoring of TGP levels downstream of Revelstoke Dam during specific operations and reducing the confounding effects of rapidly changing operations.

Williston and Peace Canyon Dams

British Columbia, Canada

This project, conducted jointly with B.C. Hydro staff, involved a sampling program to collect total gas pressure data at two Peace River hydroelectric facilities. This was part of B.C. Hydro's ongoing program to monitor TGP production at their major facilities.

TDG Monitoring at Brilliant and Waneta Dams

British Columbia, Canada

This involved a monitoring program, initiated in conjunction with B.C. Hydro studies, to document TGP levels at the Brilliant and Waneta hydroelectric projects. The studies also involved conducting TGP monitoring during operation of selected spillway gates at these facilities to determine any differences in TGP production relating to their use.

Surveys in the Columbia River Basin

British Columbia, Canada

Investigations of the seasonal changes in TGP production associated with both Mica and Revelstoke dams, Keenleyside Forebay, Robson, Birchbank, Seven Mile Dam, Waneta Dam, Duncan Dam, Kootenay Canal Plant, and Kootenay River (above Kootenay Lake) in relation to various seasonal and operational parameters.

Input of Fisheries Information for the Columbia River

British Columbia, Canada

Fisheries habitat and use information for the Columbia River was provided for use and input into the "Columbia Total Gas Pressure and Fisheries Analyses Computer Model" developed by Aspen Applied Sciences Ltd. This model is useful for predicting TGP levels associated with specific dam operations and flows, and identifies potential problems relating to impacted fish habitats located downstream of the dams.

TDG Sampling Protocol and Equipment Review

British Columbia, Canada

Establishment of sampling protocol and appropriate electronic sampling equipment used to gather information on total gas pressure (TGP) and temperature parameters.

TDG Survey in the Columbia River Basin

British Columbia, Canada

A survey along the Columbia, Kootenay and Pend d'Oreille rivers was undertaken during the summer of 1993 to document the dissolved gas and temperatures differences along the drainages and to identify potential factors that may cause these fluctuations.

Gary R. Ash

Keenleyside Dam (TGP) Reduction Study

British Columbia, Canada

Total gas pressure monitoring was conducted at three locations (Keenleyside forebay, Robson, and Birchbank) during 1993 and 1994 to provide data input to an interdisciplinary study including R.L. & L. Environmental Services Ltd., Klohn-Crippen Integ, Aspen Applied Sciences Ltd., and B.C. Hydro. This study resulted in changes being implemented to the operating orders for Keenleyside Dam, thus helping to reduce downstream dissolved gas concentrations during some periods of the year.

PROJECT RELATED EXPERIENCE – HYDROACOUSTIC ASSESSMENTS

Aquatic Assessment of Barge Route Options for the Mackenzie Gas Project

Nunavut, Canada

Hydroacoustic data were collected during 2004 as part of the Barge Route Options of the Mackenzie Gas Project. A BioSonics Inc. Model DT-X scientific hydroacoustic echosounder was used to identify fish targets, conduct bathymetric surveys and undertake bottom substrate surveys at various locations within the Mackenzie River Delta. Bathymetric and substrate surveys were conducted to aid in determining the barge route and determining the extent of dredging, if required. Fish sampling was conducted using conventional, passive sampling methods (i.e., gill netting) and active sampling methods (i.e., hydroacoustics). Using an active sampling method, such as the BioSonics echosounder, allowed for a greater sampling area with considerably less sampling effort. The BioSonics unit recorded the geo-referenced location of each fish target and the target strength, which can be converted to the size of the fish target. Thus for each study site, estimates of fish density (fish/m²) were calculated, as well as the size distribution of fish encountered.

Bathymetric Assessment of Forestburg Reservoir

Alberta, Canada

A BioSonics DT-X scientific hydroacoustic system was used to measure bathymetry in a thermal power plant cooling reservoir in central Alberta. The reservoir was surveyed using a GPS navigation system to follow a 50 m x 50 m grid pattern. The reservoir had extensive growths of macrophytes, which provided challenges in detecting the bottom for bathymetric calculations.

Doris North Gold Project Fisheries Baseline Surveys

Nunavut, Canada

A BioSonics DT-X scientific hydroacoustic system was used to provide baseline information on bathymetry, substrate composition, and fish distribution and densities in three lakes in the vicinity of the proposed Doris North Gold Project, located approximately 150 km south of Cambridge Bay, Nunavut. Species of fish present in the waterbodies included Arctic charr, lake trout (charr), lake whitefish, cisco, least cisco, and ninespine stickleback.

Assessment of Fish Entrainment at Keenleyside Dam

BC, Canada

A BioSonics Model 101 scientific hydroacoustic system with a single beam transducer was used to assess fish entrainment on a seasonal basis at the Hugh Keenleyside Dam near Castlegar BC. The fixed aspect survey was conducted both during day and night to assess diel differences in fish entrainment rates. Ground truthing of fish species composition and sizes was conducted using gill nets and drift nets set in the forebay above the dam.

Gary R. Ash

PROJECT RELATED EXPERIENCE – OIL AND GAS

Imperial Oil Cold Lake Expansion Project

Cold Lake, Alberta

Aquatic studies of the fish community, fish habitat, lower trophic levels, and water quality for completion of the environmental impact assessment for Imperial Oil Resource Ltd.'s Mahihkan North and Nabiye developments near Cold Lake, Alberta. The development used Cyclic Steam Stimulation (CSS) technology to recover bitumen from deep formations.

AEC Bitumen Production Project, Air Weapons Range:

Cold Lake, AB

Baseline Studies - Fish and Aquatic Habitat Component

Alberta Energy Company (AEC) plans to develop a commercial scale bitumen production project from its Oil Sands Development Leases located in the Cold Lake Air Weapons Range. As a result, a baseline inventory of the aquatic biota in the vicinity of the project area was undertaken. The objectives of the 1997 baseline studies program was to inventory fish populations and aquatic habitats in waterbodies in the vicinity and immediately downstream of the development area and assess the importance of these waterbodies to these fish populations.

Mackenzie Valley Producers Gas Pipeline

NWT and AB

Co-manager of the aquatics component of the Mackenzie Gas Project. Initial reconnaissance surveys followed by detailed baseline assessments were conducted to evaluate fish resources along the proposed pipeline route. Results of the initial findings from spring, summer and fall were presented in a report and will be followed by a comprehensive EIA in the up-coming year. This project involves the development of the natural gas reserves in the Mackenzie River Delta and construction of a pipeline from the new production field down the Mackenzie River valley to Alberta.

Gary R. Ash

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Candace Bell, M.Sc.

Education M.Sc. (Atmospheric Science) McGill University, 2000
 B.Sc (Meteorology) University of Alberta, 1996

Affiliations Member of the Canadian Meteorological and Oceanographic Society

Certificates & Courses

CALPUFF Training Course (Earth Tech Inc.), Victoria, BC, 2002
Golder U – Client Services, 2003
Golder U – Project Management, 2004
Golder U – Contracts and Liability, 2005
Golder U – Health and Safety, 2005

Experience

2000 to date	Golder Associates	Calgary, Alberta
	<i>Air Quality Meteorologist</i>	
	Ms. Bell is an air quality meteorologist specialized in the areas of meteorology, air dispersion modelling and environment impact assessments. Her responsibilities include management and coordination of air quality and impact assessments, development of meteorological data sets for use in air dispersion models (CALPUFF, ISC3, AERMOD), and report preparation.	

Candace Bell, M.Sc.

PROJECT RELATED EXPERIENCE

OPTI Canada/ Nexen Canada Air Quality Modelling Course **Calgary, Alberta**

Through the Golder Institute, Golder prepared a comprehensive 2-day course designed to introduce the concepts of dispersion modelling and air quality assessment in the Oil Sands Region. The course comprised 8 modules ranging in topic from oil sands history to hands on modelling exercises using SCREEN3 and CALPUFF. Responsibilities included preparation of course materials.

Miramar Mining Corporation **Bathurst Inlet, Nunavut** **Doris North Gold Project EIS**

Golder Associates prepared an air quality and noise assessment for the Miramar Doris North Gold Project located near Bathurst Inlet, Nunavut. The assessment was prepared to support the Environmental Impact Study for submission to the Nunavut Impact Review Board. Responsibilities included preparation of meteorological data set for dispersion modelling, coordination of air dispersion modelling and report preparation.

Quesnel Waste Quesnel Incinerator **Quesnel, British Columbia**

Golder was retained to conduct an air quality assessment of Particulate Matter (PM) from a proposed wood waste incinerator in the town of Quesnel, B.C., as part of a Phase II assessment. The PM emissions were modelled with a regional set of emissions and 3-D CALMET data set. Responsibilities included air dispersion modelling.

Greater Vancouver Regional District **Ashcroft Ranch, British Columbia** **Ashcroft Ranch Landfill EIA**

Golder was retained by the Greater Vancouver Regional District to provide technical support for the development of the proposed Ashcroft Ranch Landfill. The support included site design engineering and an environmental impact assessment including a comprehensive air quality and noise assessment. The air assessment included a climate and meteorological data summary, reporting of air monitoring data, assessment of criteria air pollutants, dustfall and odour assessment, as well as green house gas emission estimates. The noise assessment included a field baseline survey and model predictions of continuous and impulsive noise sources. Responsibilities included developing a 3-D meteorological data set required for dispersion modelling and analyzing meteorological and climate data.

Pangea Minerals Tuluwaka Gold Mine EIA **Tanzania, Africa**

Conducted an air quality assessment to estimate the ambient air concentrations of criteria air compounds resulting from the operation of the Tuluwaka Gold Project in Tanzania, Africa. Responsibilities included analysis of on-site meteorological data and preparation of meteorological data set for dispersion modelling.

Cogema Resources Inc. **Saskatchewan, Canada** **Monitoring Data Review and Analysis**

Golder Associates was retained to conduct a review and analysis of the ambient air quality data collected in the vicinity of the Cogema McLean uranium mine. Responsibilities included review and analysis of meteorological data and report preparation.

Candace Bell, M.Sc.

PROJECT RELATED EXPERIENCE (continued)

OPTI Canada Inc. Long Lake Project EIA and Project Update Anzac, Alberta

Golder was responsible for the preparation of the Environmental Impact Assessment (EIA) and subsequent project update for the Long Lake Project, which includes an integrated Steam Assisted Gravity Drainage (SAGD) facility and upgrading complex. The air quality assessment included an evaluation of the cumulative air pollutant concentrations and acid deposition using the CALPUFF dispersion model (3-D mode). The project update made use of the Golder regional emissions and 3-D meteorological data sets, covering the area from Fort Chipewyan to south of the Cold Lake area. The use of these data sets made the update predictions consistent with the assessment approaches used on the majority of applications filed in the Oil Sands Region, as well as the work being conducted for the NO_x-SO_x Management Working Group (NSMWG). In addition, the use of the large study area and greater number of sources were effective in addressing all of the concerns raised by Saskatchewan Environment. Responsibilities included air dispersion modelling and report preparation.

Paramount Resources Ltd. Cameron Hills, Northwest Territories **Cameron Hills Project**

The Cameron Hills project is a gas development that straddles the Alberta/NWT border. An air quality, noise and greenhouse gas assessment was submitted to the government of the NWT and the National Energy Board (NEB). This assessment was part of a comprehensive EIA completed for the application process. The assessment included the preparation of a facility emissions inventory, development of a meteorological data set, and the completion of refined dispersion modelling to determine regional and local air pollutant concentrations. Responsibilities included air dispersion modelling and preparation of the meteorological data set.

Lehigh Inland Cement Limited Substitution Fuel Project Edmonton, Alberta

Golder Associates were retained to prepare the Environmental Protection and Enhancement Act (EPEA) application for the proposed conversion of the Lehigh Inland Cement facility in Edmonton to allow the use of coal as a primary fuel. The project involved a detailed review of the facility emissions, estimation of resulting off-site concentrations, evaluation of current operations, and recommendations for future mitigation. Liaison with regulators during the application process formed an integral part of the air quality assessment. Responsibilities included preparation of meteorological data sets and air dispersion modelling.

Petro-Canada Oil and Gas Meadow Creek Project EIA Fort McMurray, Alberta

Golder was responsible for the completion of the Environmental Impact Assessment (EIA) and application to develop a Steam-Assisted Gravity Drainage (SAGD) project in the Athabasca Oil Sands Region. The air quality component of the project evaluated acid deposition in the region as well as local and regional concentrations of sulphur dioxide, nitrogen dioxide, particulate matter, secondary particulates, carbon monoxide, reduced sulphurs, volatile organic compounds, trace metals and polycyclic aromatic hydrocarbons. The CALPUFF model (3-D mode) was used for this assessment. Responsibilities included air dispersion modelling, preparation of 3-D meteorological data set, report preparation and hearing support.

Candace Bell, M.Sc.

PROJECT RELATED EXPERIENCE (continued)

Canadian Natural Resources Limited (CNRL) Kirby Project EIA

Lac La Biche, Alberta

Golder was responsible for the completion of the Environmental Impact Assessment (EIA) and project application for the development of this Steam-Assisted Gravity Drainage (SAGD) project on the northern edge of the Cold Lake Air Weapons Range. The air quality assessment completed for the EIA evaluated local and regional concentrations of sulphur dioxide, nitrogen dioxide, particulate matter, secondary particulates, carbon monoxide, reduced sulphurs, volatile organic compounds, trace metals and polycyclic aromatic hydrocarbons using the 3-D CALPUFF model. The assessment also evaluated the cumulative acid deposition in the region and assessed possible impacts on the receiving environment. Responsibilities included air dispersion modelling, preparation of a 3-D meteorological data set and report preparation.

Paramount Resources Ltd. Air Quality EIA-Cameron Hills Development

Cameron Hills, Northwest Territories

This project is a gas development that straddles the Alberta/NWT border. An air quality evaluation was submitted to the government of the NWT and the National Energy Board (NEB) as part of a comprehensive EIA completed for the application process. The assessment included the preparation of a facility emissions inventory, development of a meteorological data set, and the completion of refined dispersion modelling to determine regional and local air pollutant concentrations. Responsibilities included air dispersion modelling and preparation of the meteorological data set.

DeBeers Canada Mining Inc. Diamond Mine EIA

Snap Lake, Northwest Territories

An air quality assessment was completed as part of a comprehensive Environmental Impact Assessment (EIA) for a proposed diamond mine northeast of Yellowknife, NWT. The project involved the evaluation and selection of dispersion models, quantification of the current and future air emissions for the construction, operation and closing phases of the project. Additional support was provided to the client in response to stakeholders questions and concerns for the technical hearing. Responsibilities included coordination of air dispersion modelling and preparation of the meteorological data set and report preparation.

CNRL Horizon Project

Fort McMurray, Alberta

Golder Associates was responsible for the completion of the Environmental Impact Assessment (EIA) for the Canadian Natural Resources Limited (CNRL) Horizon integrated oil sands mine and upgrading project. The air quality sections of the EIA evaluated cumulative air pollutant concentrations and acid deposition across the Oil Sands Region, using the CALPUFF dispersion model (3-D mode). The EIA made use of Golder's regional emissions database and 3-D meteorological data set, which covers the area from Fort Chipewyan in the north to the Cold Lake area in the south. Responsibilities included coordination of air dispersion modelling, development of 3-D meteorological data set and report writing.

Candace Bell, M.Sc.

PROJECT RELATED EXPERIENCE (continued)

Shell Canada Ltd. Jackpine Mine-Phase 1 EIA

Fort McMurray, Alberta

Golder was responsible for the completion of the recent Environmental Impact Assessment (EIA) of the Jackpine Mine – Phase 1 Oil Sands mine for Shell Canada Limited. As part of the EIA, Golder was responsible for the completion of the air quality components of the project, which included the use of the Golder's regional emissions database and 3-D meteorological data set. The air quality assessment evaluated air concentrations and acid deposition resulting from cumulative emissions sources across the Oil Sands Region, spanning from Fort Chipewyan in the north to the Cold Lake area in the south. Air quality predictions were made using the CALPUFF dispersion model, run in the 3-D mode. Responsibilities included air dispersion modelling, development of 3-D meteorological data set and report preparation.

OPTI Canada Inc./Nexen Canada Ltd.

Anzac, Alberta

Long Lake Project EIA Support

Golder provided support to OPTI Canada Inc. and partner Nexen Canada Ltd. in their application to Alberta Environment and the Energy and Utilities Board to construct and operate the Long Lake commercial SAGD project. Work included re-assessment of facility emissions and an update to the EIA that was submitted in November 2000. Responsibilities included air dispersion modelling and report preparation.

Northwest Territories Power Corporation

Various, Northwest Territories

Air Quality Assessment

An air quality assessment of 21 power generating stations in the Northwest Territories was completed for NTPC. The work involved a preliminary screening of all sites, followed up by detailed evaluation of sites with possible health risks, as identified in the screening analysis. The detailed evaluation involved refined emissions calculations and dispersion modelling to predict ground-level impacts of selected compounds. Responsibilities included coordination of air dispersion modelling and report writing.

Saputo Dairy

Calgary, Alberta

Environmental Workplan and Remedial Action Plan

Performed an air quality assessment of atmospheric emissions from a soil remediation project at a dairy processing facility in Calgary, Alberta. The ISC3ST dispersion model was used to predict ground-level concentrations of BTEX compounds released from a vapour recovery unit. Responsibilities included coordination of air dispersion modelling.

Lehigh Inland Cement Limited

Edmonton, Alberta

Substitution Fuel Project, Appeal Board Hearings

Golder was retained by the proponent to provide expert witness testimony in the Environmental Appeals Board hearing of the Lehigh Inland Cement substitution fuel project approval. The work included the completion of supplementary responses and hearing preparation for the air quality component of the hearing. Specific responsibilities included the preparation of affidavits, review of appellant affidavits, hearing preparation and participation as a panel member during the hearing. Responsibilities included hearing support.

Candace Bell, M.Sc.

PROJECT RELATED EXPERIENCE (continued)

NO_x-SO_x Management Working Group (NSWMG) Northeastern Alberta, Canada NO_x/SO_x Sensitivity Mapping Project

Golder was responsible for a project to map receptors sensitive to acid deposition in the Oil Sands Region. The project made use of acid deposition predictions made using the CALPUFF dispersion model (3-D mode) to update earlier studies highlighting soils and water bodies that might be affected by emissions from the existing and planned developments in the region. A significant component of the study involved the integration of air quality predictions and mapping of sensitive soils into a GIS model for the Oil Sands Region. Responsibilities included air dispersion modelling and development of 3-D meteorological data set.

Candace Bell, M.Sc.

PUBLICATIONS & PRESENTATIONS

Bell, Candace. 2004. *Air Dispersion Modelling Evolution in the Athabasca Oil Sands Region*. Science and Experience: Using High Resolution Mesoscale Model Output with CALPUFF, Presentation Feb. 3 & 4, Lacey, WA

Carolyn Decock

Education B.Sc., University of Calgary, 1999

Affiliations Arctic Institute of North America (AINA)
Canadian Acoustical Association (CAA)

Courses Wellsite Production: Introduction to the Petroleum Industry, SAIT, Calgary, AB 2002
Bylot Island Weather, Climate & Snow Study, University of Calgary, Calgary, AB 2004
Health and Safety, Golder U, 2002
Radio Operator, Aeronautical, Industry Canada 2000
Sprouse Fire & Safety, 2002
Tower Climbing and Electrical Awareness, ENMAX, 2002
Fire Extinguisher Use Training, EHP, 2003
ATV Training Course, Canadian Safety Council, 2004
Bear Awareness, 2004
H₂S Alive, Petroleum Industry Training Service, 2005
Level A CPR, St. John Ambulance Emergency First Aid, 2005
Argo Training, 2005
Defensive Driving, 2005

Experience

2001 to date	Golder Associates Calgary, Alberta <i>Environmental Noise Scientist</i> Responsibilities include all aspects of environmental noise assessments. This includes coordinating and conducting noise baseline monitoring programs, assessing noise emissions, data analysis, propagation and prediction modelling and reporting for noise impact assessments and environmental impact assessments. Responsibilities in the past have included aiding the air quality team in environmental air quality assessments. Other volunteer tasks include being a member of the emergency response team and the health and safety committee.
2000 to 2001	Excel Geophysics Inc. High River, Alberta <i>Project Leader</i> Organized daily field operations for gravity exploration surveys. Duties included obtaining land permission, managing crews and equipment, preparing customs documentation (between Canada and the United States) and collecting and processing gravity and GPS data.
2000	Alberta Land and Forestry Service Edmonton, Alberta <i>Wildland Fire Fighter</i> One of 400 people selected for the specialized Rapattack Wildland Fire Fighting Unit. One of 14 selected individuals out of 70, for initial attack on fires in Montana, U.S.A. during the out of control fire season in August 2000. Responsibilities included repelling from a helicopter to extinguish wild-land fires at a moments notice.

Carolyn Decock

Experience (continued)

1999

University of Calgary

Calgary, Alberta

Research Assistant

Assisted in the collection and processing of field data for study on glacial hydrology and snow pollution. In 2004, completed an independent study called "Bylot Island Weather, Climate and Snow Study" that included a full lab and data analysis of the samples collected in 1999.

Carolyn Decock

PROJECT RELATED EXPERIENCE - OIL SANDS

EnCana Oil and Gas Partnership

Christina Lake Thermal Project Phase 1B Expansion Fort McMurray, Alberta

EnCana Oil & Gas Partnership operates an in-situ Steam Assisted Gravity Drainage (SAGD) extraction facility for the recovery of crude bitumen from the McMurray Deposit at Christina Lake, Alberta. Golder was retained to prepare an amendment to their operating approvals from AENV and AEUB in order to expand the facility capacity and modify the facility design. The noise component of the work included conduct of a noise impact assessment according to AEUB requirements. Responsibilities included reporting baseline measurements of an in-situ facility, noise modelling, and sound emissions determination.

Petro-Canada Oil and Gas

Meadow Creek Project EIA Fort McMurray, Alberta

Golder was responsible for the completion of the environmental impact assessment (EIA) and application to develop a Steam-Assisted Gravity Drainage (SAGD) project in the Athabasca Oil Sands Region. Responsibilities included an ambient noise survey for the proposed project and presented the results using an in house model to provide facility. Also aided with air dispersion modelling on three phases of the project and summarised results.

Canadian Natural Resources Limited

Kirby Project EIA Lac La Biche, Alberta

Golder was responsible for the completion of the environmental impact assessment (EIA) and project application for the development of this Steam-Assisted Gravity Drainage (SAGD) project on the northern edge of the Cold Lake Air Weapons Range. Responsibilities included aiding with the air dispersion modelling and conducting an ambient noise survey for the proposed project.

OPTI Canada Inc.

OPTI Long Lake Pilot Project Anzac, Alberta

Golder was responsible for the preparation of an air quality assessment for the Long Lake Pilot Project, which is a scaled down version of the Long Lake Commercial Project. This project includes a small-scale integrated Steam-Assisted Gravity Drainage (SAGD) facility and upgrading complex. Responsibilities included assisting with air emission calculations, modelling and reporting.

Canadian Natural Resources Limited

Primrose East Oil Sands Project Fort McMurray, Alberta

Golder was retained to prepare an EIA for the Canadian Natural Primrose East Oil Sands Project. This SAGD project is an expansion of the existing Canadian Natural Primrose and Wolf Lake development. Responsibilities included organizing and conducting noise monitoring, noise emissions prediction modelling and reporting.

Encana

Foster Creek Phase 1D/E Fort McMurray, Alberta

Golder has been retained by EnCana to complete work related to various aspects of the Foster Creek SAGD facility. This work also includes application and amendment assessments as expansion continues at the facility. Responsibilities for this on-going work include noise emission and noise modelling for a noise impact assessment.

Carolyn Decock

PROJECT RELATED EXPERIENCE - OIL SANDS (continued)

Suncor Energy Inc.

Fort McMurray, Alberta

Firebag In-Situ Project C&E and Stage 3 Expansion Projects

Golder was retained by Suncor Energy Inc. to aid in the preparation of the application for a modification and expansion of the Firebag In-Situ Project. The work was completed for two stages: C&E, a co-generation facility, and Stage 3, a production expansion. The applications included a noise impact assessment based on AEUB requirements. Responsibilities included emissions determination, modelling and reporting.

Suncor

Firebag Stage 4 to 6

Fort McMurray, Alberta

Suncor is planning further development at their Firebag SAGD facility. Golder prepared the AENV and EUB approval amendment applications for Stages 4 to 6 of the development, including an EIA-level air assessment and the EUB application noise assessment. Responsibilities included organizing and conducting noise monitoring emissions, modelling and reporting.

Rio Alto Exploration Ltd.

Kirby Thermal Pilot Project

Kirby Lake, Alberta

This project involved the preparation of the air quality and noise sections for a thermal heavy oil pilot project in the Christina Lake region. Field responsibilities included conducting a 24-hour ambient noise survey at site and equipment noise measurements of the facility. The results were presented in an Environmental Assessment report.

Imperial Oil Resources

Kearl Project

Fort McMurray, Alberta

Golder was responsible for the completion of the EIA of the Kearl Oil Sands Project for Imperial Oil Resources. As part of the EIA, Golder was responsible for the completion of the noise component of the project. The noise assessment included establishing baseline noise levels, conducting a noise prediction study and completion of the assessment to AENV and EUB requirements. Responsibilities included conducting baseline noise measurements, baseline reporting, emissions calculations, prediction modelling and impact reporting .

Suncor Energy Inc.

Suncor Voyageur Upgrader Project

Fort McMurray, Alberta

Golder was responsible for the completion of the recent environmental impact assessment (EIA) of the Suncor Voyageur Upgrader Project for Suncor Energy Inc. As part of the EIA, Golder was responsible for the completion of the noise component of the project. The noise assessment included establishing baseline noise levels, conducting a noise prediction study and completion of the assessment to AENV and EUB requirements. Responsibilities included conducting a baseline monitoring program consisting of three 24-hour measurements, emission measurements, prediction modelling and reporting.

Carolyn Decock

PROJECT RELATED EXPERIENCE - OIL SANDS (continued)

Shell Canada Limited

Muskeg River Mine Expansion

Fort McMurray, Alberta

Golder was responsible for the completion of the recent environmental impact assessment (EIA) of the Muskeg River Mine Expansion project for Shell Canada Limited. As part of the EIA, Golder was responsible for the completion of the noise component of the project. The noise assessment included conducting a noise prediction study and completion of the assessment to AENV and EUB requirements. Responsibilities included emissions determination, modelling, and EIA report preparation.

Canadian Natural Resources Limited

Horizon Project

Fort McMurray, Alberta

Golder Associates was responsible for the completion of the environmental impact assessment (EIA) for the Canadian Natural Resources Limited (CNRL) Horizon integrated oil sands mine and upgrading project. Responsibilities included conducting the noise field program, creating noise models, analyzing predictions for traffic and facility noise issues and creating figures and tables for use in the noise section of the EIA. Also aided the team in air dispersion modelling and creating figures and tables for reports.

Shell Canada Ltd.

Jackpine Mine-Phase 1 EIA

Fort McMurray, Alberta

Golder was responsible for the completion of the recent environmental impact assessment (EIA) of the Jackpine Mine – Phase 1 Oil Sands mine for Shell Canada Limited. Responsibilities included calculating noise emissions, prediction modelling, and reporting.

Carolyn Decock

PROJECT RELATED EXPERIENCE - OIL AND GAS

TransCanada Pipelines Ltd

Cacouna Energy Project

St. Georges-de-Cacouna, Québec

TransCanada Pipelines is proposing to develop and construct a liquefied natural gas (LNG) import terminal in the Parish of St. Georges-de-Cacouna, Québec, on the south shore of the St. Lawrence River. The primary purpose of the Cacouna Energy Project is to import natural gas produced in overseas locations to meet long-term energy requirements in Central Canada (Québec and Ontario) and the northeastern United States. Golder was retained to conduct the environmental impact study and assist the client through the Québec and Federal regulatory process. Responsibilities included helping with emission identification and monitoring emission, calculations, noise modelling, report preparation and writing.

Husky Canada Ltd.

Noise Assessment

Southern Saskatchewan

Golder Associates was retained by Husky Canada Ltd. to perform noise monitoring and prepare a noise assessment for a proposed natural gas compressor located in a farming community in southern Saskatchewan. Responsibilities included conducting the baseline noise measurements, data analysis, emissions calculation, prediction modelling, and report writing.

Chevron Canada Resources

K-29 Well Site Flaring Assessment

Fort Liard, Northwest Territories

A well-test flaring assessment was completed for a proposed gas processing facility near Ft. Liard, NWT. The project involved the estimation of facility emissions and a dispersion modelling analysis of the SO₂ emissions from a flare. Responsibilities included organizing the emission calculations, using the ISC to obtain air quality predictions and analyzing the results. These results were put into figures and presented in a report.

Plains Marketing

Joarcam Truck Terminal

Edmonton, Alberta

Plains Marketing applied to construct a truck terminal facility located on a 5 hectare site east of Leduc, AB. The facility is required to provide a delivery point for Plains-owned and locally-produced crude oil for co-mingling with other crude oil and shipment on the Joarcam Pipeline system to markets in Edmonton and elsewhere. Golder was retained to provide technical input to Plains Marketing for the EUB permit application. Responsibilities included organizing and conducting noise monitoring and baseline reporting.

Carolyn Decock

PROJECT RELATED EXPERIENCE - POWER

Suncor Energy Inc.

Chin Chute Power Project

Taber, Alberta

Golder was retained by Suncor to prepare the Alberta Energy and Utility Board application and CEAA environmental impact assessment (EIA) for a proposed 30 MW wind farm near Taber, Alberta. The application and EIA included a baseline noise survey and detailed noise predictions, including octave band issues. Responsibilities included conducting a baseline monitoring program that consisted of six 24-hour measurements followed with a baseline report.

FortisBC

Bell Station Expansion Noise Baseline

Kelowna, British Columbia

FortisBC expanded their primary power substation in Kelowna, BC. Prior to putting the expansion in service, Golder was retained to conduct a baseline noise survey to address any potential public noise concerns. Responsibilities included conducting a baseline monitoring program consisting of three 24-hour measurements, emissions measurements and report writing.

Okanagan Biofuels

Kelowna Biofuel Plant

Kelowna, British Columbia

Golder was retained to identify potential noise and air quality impacts due to an ethanol production plant at a former distillery in Kelowna, BC. The project consisted of completion of a CEAA Screening and follow-up studies for baseline noise, noise impacts and air quality. Responsibilities included conducting a baseline noise monitoring program, emissions measurements (including rail units) and report writing.

Carolyn Decock

PROJECT RELATED EXPERIENCE - TRAFFIC

Noel Covey and Associates Palmview Sanctuary

Queensland, Australia

Worked with the Golder office in Brisbane to complete a traffic noise assessment in Queensland, Australia. The project consisted of a proposed land development area being constructed along-side an existing highway with a high traffic volume. A model was developed and barrier attenuation was calculated. Responsibilities included working with our international offices to complete a noise assessment for the client. This included noise emission and barrier calculations, modelling and reporting.

Carolyn Decock

PROJECT RELATED EXPERIENCE -MINING

DeBeers Canada Mining Inc.

Diamond Mine EIA

Snap Lake, Northwest Territories

An air quality assessment was completed as part of a comprehensive EIA for a proposed diamond mine northeast of Yellowknife, NWT. Responsibilities included assisting in air emission calculations, model input parameters and post processing dispersion modelling results.

Barrick Gold

Gold Mine EIA

Tanzania

Golder has been retained to conduct an Environmental Impact Assessment for a proposed gold mine in north-western Tanzania. Responsibilities include completing the noise baseline report, assisting with emissions calculation and prediction modelling.

Dynatec

Ambatovy Project EIA

Madagascar

Golder was retained by Dynatec Corporation to complete an EIA of a nickel/cobalt mine in Madagascar. The EIA included assessments of air quality and noise for the open pit mine, slurry pipeline, processing plant, tailings facility and port expansion. Responsibilities included completing a noise baseline report.

Carolyn Decock

PROJECT RELATED EXPERIENCE - OTHER

AMEC Americas

Canadian Natural Horizon Project Noise Study

Fort McMurray, Alberta

Golder was retained to conduct a detailed noise prediction study of the Canadian Natural Horizon Project Extraction Plant for the AMEC America engineering design team. The noise study was used to determine if additional noise controls were required for environmental and safety requirements the facility based on the final design specifications. Responsibilities included determination of sound emissions, noise modelling and reporting.

Canadian Natural Resources Ltd.

Airport Noise Assessment

Fort McMurray, Alberta

Golder Associates was retained to conduct a noise assessment of a proposed airport on the Canadian Natural Horizon Project site. The noise assessment was part of an application for a License of Occupation and included assessing long-term and short-term noise levels from air traffic at the site. EUB guidelines for long-term (24-hour) noise levels and WHO criteria for short-term noise levels (1-hour hour) were used as noise targets. The CadnaA AzB noise model was used for modelling data. Responsibilities included aiding in the noise modelling, data analysis and report writing.

Greater Vancouver Regional District

Ashcroft Ranch Landfill EIA

Ashcroft Ranch, British Columbia

Golder was retained by the Greater Vancouver Regional District to provide technical support for the development of the proposed Ashcroft Ranch Landfill. The support included site design engineering and an environmental impact assessment including a comprehensive air quality and noise assessment. The noise assessment included a field baseline survey and model predictions of continuous and impulsive noise sources. Responsibilities included conducting the noise field program, noise modelling, data analysis and report writing.

Riverside Forest Products Ltd.

National Pollutant Release Inventory

Various Locations, British Columbia

Completed 2002 and 2003 National Pollutant Release Inventory reporting for five wood processing facilities throughout British Columbia. Responsibilities included data input and reviewing MSDS forms.

Lehigh Inland Cement Limited

Substitution Fuel Project, Appeal Board Hearings

Edmonton, Alberta

Golder was retained by Lehigh Inland Cement Ltd. to provide expert witness testimony in the Environmental Appeals Board hearing of the substitution fuel project approval in Edmonton. The work included the completion of supplementary responses and hearing preparation for the air quality component of the hearing. Responsibilities included assistance in organizing and completing hearing preparation as well as providing hearing support from the office during the hearing.

Teresa A. Drew

Education B.Sc. Physics, St. Mary's University, 1999
 Environmental Noise Assessment, Technical University of Nova Scotia, 1995
 Advanced Traffic Noise Modelling, Vanderbilt University, 1993
 Mineral Technology Diploma, University College of Cape Breton, 1987

Certificates and Courses

Health and Safety, Golder U, 2004
 Contracts and Liability, Golder U, 2004

Affiliations Canadian Acoustical Association
 Acoustic Society of America

Experience

2004 to date	Golder Associates <i>Senior Noise Specialist</i> Responsibilities include the management of and participation in noise and air quality assessments. Focus is on regulatory compliance, environmental impact assessment, environmental noise modelling, ambient noise monitoring, industrial impact assessment, roadway impact assessment, airport impact assessment, source characterization and mitigation selection.	Calgary, Alberta
1998 to 2004	Jacques Whitford Environment Limited <i>Scientist, Environmental Sciences Division</i> Duties included the management of and participation in environmental noise work. Focus was on environmental impact assessment, complaint investigation, source characterization and mitigation selection. Technical work included indoor air quality assessments, mold assessments and industrial hygiene testing. Responsibilities also included contract management of large projects, supervision of technical staff and business management of the Air/Noise/Health and Safety group.	Dartmouth, Nova Scotia
1993 to 1998	Jacques Whitford Environment Limited <i>Senior Technologist, Environmental Sciences Division</i> Duties included the participation in air quality and environmental noise work. Focus was on environmental impact assessment, noise modelling, complaint investigation, source characterization and mitigation selection. Technical work included assisting in ambient air dispersion modelling, indoor air quality assessments, mold assessments and industrial hygiene testing.	Dartmouth, Nova Scotia
1987 to 1993	Jacques Whitford and Associates Limited <i>Senior Technologist, Mining Division</i> Duties included participating in mine feasibility studies, mine permitting, mine engineering and design work. Focus was on confirmation of ore reserve estimates, ore body mapping, obtaining operational permits, slope stability calculations and roof support/mine subsidence studies.	Dartmouth, Nova Scotia

Teresa A. Drew

Experience (continued)

1986 to 1987 **Nova Scotia Department of Mines and Energy Halifax, Nova Scotia**
Data Technician (Summer), Geochemistry Section, Mineral Resources Division
Conducted data entry and mapping of geologic and lake sediment geochemistry sampling. Also performed database management during the conversion of storage to a new system.

Teresa A. Drew

PROJECT EXPERIENCE -- ENVIRONMENTAL ANALYSIS AND IMPACT ASSESSMENT

TransCanada Pipelines Ltd. Cacouna Energy Project

Québec

TransCanada Pipelines is proposing to develop and construct a liquefied natural gas (LNG) import terminal in the Parish of St. Georges-de-Cacouna, Québec, Canada on the south shore of the St. Lawrence River. The primary purpose of the Cacouna Energy Project is to import of natural gas produced in overseas locations to meet long-term energy requirements in Central Canada (Québec and Ontario) and the northeastern United States. Golder was retained to conduct the environmental impact study and assist the client through the Québec and Federal regulatory process. Responsibilities for this project included: component lead for the acoustic component, noise prediction studies, baseline report review, technical consultation on acoustics, report writing and hearing participation.

Suncor Energy Inc. Chin Chute Power Project

Taber, Alberta

Golder was retained by Suncor to prepare the Alberta Energy and Utility Board application and CEAA Environmental Impact Assessment (EIA) for a proposed 30 MW wind farm near Taber, Alberta. The application and EIA included a baseline noise survey and detailed noise predictions, including octave band or tonal issues. Responsibilities included management and review of the baseline noise survey, conduct of noise predictions, writing of the application and assessment documents and component management.

Imperial Oil Resources Kearl Project

Fort McMurray, Alberta

Golder was responsible for the completion of the EIA of the Kearl Oil Sands Project for Imperial Oil Resources. As part of the EIA, Golder was responsible for the completion of the noise component of the project. The noise assessment included establishing baseline noise levels, conducting a noise prediction study and completion of the assessment to AENV and EUB requirements. Responsibilities included management and review of the baseline noise survey, conduct of noise predictions, writing of the assessment document, hearing preparation and component management.

Okanogan Biofuels Kelowna Biofuel Plant

Kelowna, British Columbia

Okanogan Biofuels is planning to develop an ethanol production plant on the site of a former distillery in Kelowna, BC. The project underwent a CEAA Screening by Golder which identified potential impacts due to noise and air quality. The project consisted of completion of the CEAA Screening and follow-up studies for baseline noise, noise impacts and air quality. Responsibilities include writing the CEAA screening document, management and review of the baseline noise survey, conduct of noise impact assessment and component management.

Fortis BC Bell Station Expansion Noise Baseline

Kelowna, British Columbia

Fortis BC has just finished a major expansion of the primary power substation in Kelowna BC. Prior to putting the expansion in service Golder was retained to conduct a baseline noise survey in order to be able to address any future public noise concerns, should they arise. Responsibilities include review of the baseline noise survey and project management.

Teresa A. Drew

PROJECT EXPERIENCE - ENVIRONMENTAL ANALYSIS AND IMPACT ASSESSMENT (continued)

EnCana Oil and Gas Partnership

Fort McMurray, Alberta

Christina Lake Thermal Project Phase 1B Expansion

EnCana Oil & Gas Partnership (EnCana) operates an in-situ Steam Assisted Gravity Drainage (SAGD) extraction facility for the recovery of crude bitumen from the McMurray Deposit at Christina Lake, Alberta. Golder was retained to prepare an amendment to their operating approvals from AENV and AEUB in order to expand the facility capacity and modify the facility design. The noise component of the work included conduct of a noise impact assessment according to AEUB requirements. Responsibilities included management and review of the existing noise source survey, conduct of noise predictions, writing of the amendment document, and component management.

AMEC America

Fort McMurray, Alberta

Canadian Natural Horizon Project Noise Study

Golder was retained to conduct a detailed noise prediction study of the Canadian Natural Horizon Project Extraction Plant for the AMEC America engineering design team. The noise study was used to determine if additional noise controls were required for environmental and safety requirements the facility based on the final design specifications. Responsibilities included conduct of noise predictions, writing of the assessment document, and component management.

Suncor Energy Inc.

Fort McMurray, Alberta

Suncor Voyageur Upgrader Project

Golder was responsible for the completion of the recent environmental impact assessment (EIA) of the Suncor Voyageur Upgrader Project for Suncor Energy Inc. As part of the EIA, Golder was responsible for the completion of the noise component of the project. The noise assessment included establishing baseline noise levels, conducting a noise prediction study and completion of the assessment to AENV and EUB requirements. Responsibilities included management and review of the baseline noise survey, conduct of noise predictions, writing of the assessment document, hearing preparation and component management.

Shell Canada Limited

Fort McMurray, Alberta

Muskeg River Mine Expansion

Golder was responsible for the completion of the recent environmental impact assessment (EIA) of the Muskeg River Mine Expansion project for Shell Canada Limited. As part of the EIA, Golder was responsible for the completion of the noise component of the project. The noise assessment included conducting a noise prediction study and completion of the assessment to AENV and EUB requirements. Responsibilities included conduct of noise predictions, writing of the assessment document, hearing preparation and component management.

Suncor Energy Inc.

Fort McMurray, Alberta

Firebag In-Situ Project C&E and Stage 3 Expansion Projects

Golder was retained by Suncor Energy Inc. to aid in the preparation of the application for a modification and expansion of the Firebag In-Situ Project. The work was completed for two stages: C&E, a co-generation facility, and Stage 3, a production expansion. The applications included a noise impact assessment based on AEUB requirements. Responsibilities include establishing permissible sound levels, noise prediction modelling, report writing and component management.

Teresa A. Drew

PROJECT EXPERIENCE - ENVIRONMENTAL ANALYSIS AND IMPACT ASSESSMENT (continued)

Greater Vancouver Regional District Ashcroft Ranch Landfill EIA

Ashcroft Ranch, British Columbia

Golder was retained by the Greater Vancouver Regional District to provide technical support for the development of the proposed Ashcroft Ranch Landfill. The support included site design engineering and an environmental impact assessment, including a comprehensive air quality and noise assessment. The air assessment included a climate and meteorological data summary, reporting of air monitoring data, assessment of criteria air pollutants, dustfall and odour assessment, as well as green house gas emission estimates. The noise assessment included a field baseline survey and model predictions of continuous and impulsive noise sources. Responsibilities included component management and report writing.

Canadian Natural Resources Ltd. Airport Noise Assessment

Fort McMurray, Alberta

Golder Associates was retained to conduct a noise assessment of a proposed airport on the Canadian Natural Horizon Project site. The noise assessment was part of an application for a License of Occupation and included assessing long-term and short-term noise levels from air traffic at the site. EUB guidelines for long-term (24-hour) noise levels and WHO criteria for short-term noise levels (1-hour) were used as noise targets. The CadnaA AzB noise model was used for the assessment. Responsibilities included senior review.

World Bank Shanghai Inner Ring Road EIA

Shanghai, China

The client contracted the company to provide senior technical review of the EIA prepared in China for this World Bank funded project. Tasks regarding environmental noise and air quality included reviewing the technical support documents, reviewing the assessment in relation to local criteria and internationally accepted methods, assessing the mitigation recommendations and providing training/technology transfer to the Shanghai EIA team. Responsibilities included technical support and report preparation.

World Bank Quangzhou Inner Ring Road

Quangzhou, China

The client contracted the company to provide senior technical review of the EIA, prepared in China, for this World Bank funded project. Tasks regarding environmental noise and air quality included reviewing the technical support documents, reviewing the assessment in relation to local criteria and internationally accepted methods and assessing the mitigation recommendations. Responsibilities included technical support and report preparation.

Voisey's Bay Nickel Company Voisey's Bay Nickel Mine Development EIA

Nain, Newfoundland and Labrador

The company was contacted to perform baseline environmental studies, environmental monitoring of the site exploration activities and developing the Environmental Impact Assessment. The air quality component of the work consisted of baseline monitoring for dust, SO₂ and NO_x as well as the ambient air modelling and impact analysis of the proposed mine site, camp, processing and port facilities. The noise component of the work consisted of a noise prediction study to determine impacts of operational noise on the accommodations section of the site. Responsibilities included technical support and report writing.

Teresa A. Drew

PROJECT EXPERIENCE - ENVIRONMENTAL ANALYSIS AND IMPACT ASSESSMENT (continued)

Parmalat Canada Inc.

Montreal, Québec

West Montreal Distribution Facility Expansion

Subsequent to finishing an environmental approval process, Parmalat requested the company assist with the resolution of environmental noise issues regarding the proposed project. The work included verifying baseline noise levels, reviewing the impact assessment previously submitted, modelling potential noise impacts and developing mitigation options to allow the project to meet stringent environmental noise objectives. Responsibilities included component management, technical support and report preparation.

Nova Scotia Power Inc.

Dartmouth, Nova Scotia

Tufts Cove Expansion Air Quality and Noise Review

Prior to starting the formal environmental approvals process, the client wished to assess air quality (AQ) and noise effects from the proposed addition of two, 5 MW turbines on the plant site. This allowed for AQ and noise controls to be included at the design stage and potential community issues to be identified and addressed before entering a formal process. Responsibilities included component management, technical support and report preparation.

Nova Scotia Power Inc.

Sydney, Nova Scotia

Sydney Stand-By Plant Stack Replacement

The client wished to document any changes in noise levels at their property boundary due to the change in stack design at their Sydney backup generating station. The project included establishing baseline/existing sound levels generated by the plant, including the frequency analysis and conducting post retrofit monitoring of the same parameters to characterize the Pre- and Post-retro fit noise levels. Responsibilities included component management, technical support and report preparation.

Duke Energy Bayside Power Project

Saint John, New Brunswick

Environmental Effects Monitoring

The Bayside Power project is a 265 MW natural gas power plant near Saint John New Brunswick that started operations in 2001. Environmental protection and consultation continued through the construction of the facility. The noise component of the project construction focused on the design specifications of the turbines at the facility. Commitments had been made for the turbines to meet specific noise criteria. The company was responsible for establishing baseline values, verifying the design sound emission levels (using ANSI standards) and verifying noise levels at distance from the plant. Responsibilities included technical support and report review.

Sable Offshore Energy Inc.

Goldboro, Nova Scotia

Sable Project Environmental Effects Monitoring

The project consisted of environmental baseline and effects monitoring from 1999 to 2001 for the Sable Offshore Energy Inc. land based facilities in Goldboro and Point Tupper, Nova Scotia. The work included noise, air quality, terrestrial, aquatic and heritage resources. Responsibilities included component management for noise, technical support for noise and air quality and report preparation.

Teresa A. Drew

PROJECT EXPERIENCE - ENVIRONMENTAL ANALYSIS AND IMPACT ASSESSMENT (continued)

Maritimes and Northeast Pipeline Ltd. Halifax Lateral EIA

Nova Scotia

The company was responsible for the completion of the environmental impact assessment (EIA) and the environmental portions of the project application for a 117 km natural gas pipeline from the existing line to downtown Halifax. The noise assessment conducted for the EIA included establishing baseline values for the various levels of development along the route and impact assessment from construction and operation activity. Responsibilities included component management, technical support and report preparation.

Sable Offshore Energy Inc. Point Tupper Lateral EIA

Point Tupper, Nova Scotia

The company was responsible for the completion of the environmental impact assessment (EIA) and the environmental portions of the project application for a 40 km natural gas pipeline from the Goldboro Gas Plant to the NGL Fractionation facility in Point Tupper, NS. The noise assessment conducted for the EIA included impact assessment from construction and operation activity. Responsibilities included component management, technical support and report preparation.

Nova Scotia Dept. of Transportation and Public Works Beaver Bank By-Pass EIA

Halifax, Nova Scotia

The company was responsible for the completion of the environmental impact assessment (EIA) of a proposed highway by-pass through communities near Halifax. The noise assessment for the EIA included a baseline study, modelling and impact analysis for noise levels for construction and operation phases of the project. Responsibilities included component management, technical support and report preparation.

Nova Scotia Dept. of Transportation and Public Works New Minas By-Pass EIA

New Minas, Nova Scotia

The company was responsible for the completion of the environmental impact assessment (EIA) of a proposed highway by-pass in the town of New Minas, Nova Scotia. The noise assessment for the EIA included a baseline study, modelling and impact analysis for noise levels for construction and operation phases of the project. Responsibilities included component management, technical support and report preparation.

Nova Scotia Dept. of Transportation and Public Works Highway 101 Realignment, Digby EIA

Digby, Nova Scotia

The company was responsible for the completion of the environmental impact assessment (EIA) of a new highway alignment near the town of Digby, Nova Scotia. The noise assessment for the EIA included a baseline study, modelling and impact analysis for noise levels for construction and operation phases of the project. Responsibilities included component management, technical support and report preparation.

Nova Scotia Dept. of Transportation and Public Works Salt Spring Barrier Re-Design

Salt Springs, Nova Scotia

The client requested assistance in re-assessing the specifications of a highway noise barrier to ensure it met the commitments in the EIA. Responsibilities included technical support and report preparation.

Teresa A. Drew

PROJECT EXPERIENCE - ENVIRONMENTAL ANALYSIS AND IMPACT ASSESSMENT (continued)

Michelin Canada Inc.

Bridgewater, Nova Scotia

Wireline Room Noise Assessment

The client had one production room where noise levels were high enough to require hearing protection at all times. The client wanted to know the source of the noise and how to reduce the source levels so that less protective equipment was required. Sound levels in the room were measured and characterized (through octave band analysis), specific sources of sound identified and recommendations made for reducing sound levels in the area. Responsibilities included project management, technical support and report preparation.

Strait Crossing Development Inc.

Borden, Prince Edward Island

Confederation Bridge Environmental Effects Monitoring

The company was contracted to conduct environmental effects monitoring during the construction of the Confederation Bridge in PEI. One of the environmental concerns to be monitored was the effects of construction noise on wetland birds in the nearby marshes through measurement of noise during bird surveys. Responsibilities included technical support on noise measurements and data correlation, with associated report writing.

Nova Scotia Dept. of Transportation and Public Works

Masstown, Nova Scotia

Highway 104 Twinning, Masstown EIA

The company was responsible for the completion of the environmental impact assessment (EIA) of the twinning of the Trans-Canada Highway near Masstown, Nova Scotia. The noise assessment for the EIA included a baseline study, modelling and impact analysis for noise levels for construction and operation phases of the project. Responsibilities included component management, technical support and report preparation.

Nova Scotia Dept. of Transportation and Public Works

Antigonish, Nova Scotia

Highway 104 Twinning, Antigonish EIA

The company was responsible for the completion of the environmental impact assessment (EIA) of the twinning of the Trans-Canada Highway near Antigonish, Nova Scotia. The noise assessment for the EIA included a baseline study, modelling and impact analysis for noise levels for construction and operation phases of the project. Responsibilities included component management, technical support and report preparation.

Nova Scotia Dept. of Transportation and Public Works

New Glasgow, Nova Scotia

Highway 104 Twinning, New Glasgow EIA

The company was responsible for the completion of the environmental impact assessment (EIA) of the twinning of the Trans-Canada Highway near New Glasgow, Nova Scotia. The noise assessment for the EIA included a baseline study, modelling and impact analysis for noise levels for construction and operation phases of the project. Responsibilities included component management, technical support and report preparation.

Teresa A. Drew

**PROJECT EXPERIENCE - ENVIRONMENTAL ANALYSIS AND IMPACT
ASSESSMENT (continued)**

Nova Scotia Dept. of Transportation and Public Works Amherst, Nova Scotia
Highway 104 Construction Noise Assessment

The project was to assess the potential impact of highway construction noise on waterfowl in a nearby Ducks Unlimited wetland. A baseline noise survey, noise prediction calculations and an interpretation of the possible effects on wetland birds was performed. Responsibilities included technical support for baseline survey and prediction calculations with the associated report preparation.

Teresa A. Drew

PROJECT EXPERIENCE - COMPLAINT INVESTIGATION

Universal Properties

Halifax, Nova Scotia

Penninsula Place Complaint Investigation

The client requested assistance addressing the complaints of excess noise and air pollution from idling engines on tracks adjacent to the building. The building was newly erected adjacent to a rail yard that had been in operation for 50+ years. The work required providing an overview of regulatory requirements, sampling of air quality in affected apartments, measurement and characterization of noise levels in affected apartments and recommendations for possible mitigation measures or courses of action that may be pursued to resolve the issue. Responsibilities included project management, technical support and report preparation.

Canadian National Railway

Halifax, Nova Scotia

Halifax Yards Complaint Investigation

The client requested assistance addressing the complaints of excess noise and air pollution from the idling of engines at the Joseph Howe Drive engine maintenance facility. The work required mediation between home owners and the client, sampling and characterization of particulate deposition at private residences, sampling and characterization of emissions from diesel engines and measurement of noise levels near the homes in question. Responsibilities included conduct of all measurement programs, data analysis and reporting.

Nova Learning Ltd.

Mahone Bay, Nova Scotia

Queens Middle School Complaint Investigation

The client requested assistance addressing the complaints of excess noise from the air system at a newly constructed school. The work required the characterization of noise at the location of complaint, source evaluation and recommendation of mitigation options for outdoor effects of HVAC systems. Responsibilities included project management, technical support and report preparation.

Nova Learning Ltd.

Kingston, Nova Scotia

Kingston Middle School Complaint Investigation

The client requested existing condition and follow-up monitoring for noise at a school where mitigation for HVAC noise was being installed. The work required characterization of noise at the location of complaint before and after installation. Subsequent concerns expressed by school neighbours resulted in the work being expanded to include the assessment of noise from the HVAC system and development of further mitigation options. Responsibilities included project management, technical support and report preparation.

Deniso Leibel Limited

Scotsburn, Nova Scotia

Scotsburn Mill Complaint Investigation

The client requested assistance addressing the complaints by neighboring residents of excess noise from their facility. Responsibilities included project management, technical support and report preparation.

Teresa A. Drew

PROJECT MANAGEMENT AND COORDINATION

EnCana Corporation Deep Panuke DPA

Halifax, Nova Scotia

The company was contracted to manage all aspects of the National Energy Board/Canada-Nova Scotia Offshore Petroleum Board application to proceed with development of the Deep Panuke Field off Nova Scotia. The project consisted of coordinating the economic, engineering and environmental aspects of the application as well as conducting the environment impact assessment. This was a multi-discipline project teaming the company with more than five sub-consultants and specialists. Responsibilities for this project included project controller (including scheduling, activity reporting and budget control) with weekly client reporting and technical support and report writing for the noise component of the project.

Sable Offshore Energy Inc.

Nova Scotia

The company was conducting a number of environmental impact assessments, monitoring projects and regulator discussions for this client. Coordination of the various projects was required to ensure consistency and quality of product, as well as timely response to client needs. Responsibilities for this client included project scheduling, activity reporting and budget control.

Nova Scotia Department of Transportation and Public Works Muggah Creek Remediation Project

Sydney, Nova Scotia

In 2000, the province of Nova Scotia re-started efforts to clean up the Sydney Tar Pond site. The initial stage of the work consisted of Phase II and III environmental site assessments and a Risk Assessment of the old industrial sites and surrounding community. This was a multi-discipline project teaming the company with more than four sub-consultants and specialists. Responsibilities for this project included project controller (including scheduling, activity reporting and budget control) with weekly client reporting.

Maritimes & Northeast Pipelines Ltd.

Nova Scotia

The company was conducting a number of environmental impact assessments, monitoring projects and regulator discussions for this client. Coordination of the various projects was required to ensure consistency and quality of product, as well as timely response to client needs. Responsibilities for this client included project scheduling, activity reporting and budget control.



Chris Madland, B.Sc.

Education Honours Graduate, Integrated Environmental Planning Technology, Selkirk College,
Castlegar, BC, 1999
B.Sc. Environmental Science, Royal Roads University (RRU), Victoria, BC, 2000

Affiliations Institute of Professional Environmental Practice

Certificates and Courses

Class 1 Driver's License with Air Brake Endorsement, 1994
Certified Crew Supervisor – Backpack Electro-shocking, 1999
Swift Water Rescue and Powerboat Safety Awareness, 1999
Wilderness First Aid, 2002
Construction Safety Training System, 2002
Class 1 First Aid with Transportation Endorsement, Alberta and BC, 2004

Experience

2000 to date	Golder Associates <i>Air Quality Scientist</i> Mr. Madland is an air quality scientist specializing in the areas of ambient air quality and meteorological monitoring, air emission inventories and environmental impact assessments.	Calgary, Alberta
2000 to 1998	British Columbia Hydro <i>Student Biologist</i> Participated in various reservoir and dam management programs, produced documents supporting BC Hydro's application for ISO 14001 certification.	Castlegar, British Columbia

Chris Madland, B.Sc.

PROJECT RELATED EXPERIENCE – AMBIENT MONITORING

Erco Worldwide

Saskatoon, Saskatchewan

Monitoring Data Review and Analysis

Golder Associates was retained to conduct a review and analysis of the ambient air quality data collected in the vicinity of the ERCO Worldwide chemical production facility located in Saskatoon, Saskatchewan. This review and analysis was completed as part of a comprehensive State of the Environment report. Mr. Madland's responsibilities included data review, analysis and report preparation.

Siksika Environmental Ltd.

Siksika Reservation, Alberta

Environmental Training

Golder was retained to provide technical training and job shadowing opportunities for selected employees of Siksika Environmental Ltd. Training was provided in the siting, operation and maintenance of ambient air monitoring equipment. Mr. Madland developed and delivered an introduction to air quality monitoring course.

Miramar Mining Corporation

Bathurst Inlet, Nunavut

Ambient Air Quality Monitoring

Miramar Mining Corporation is developing a gold mine near Cambridge Bay on Victoria Island, Nunavut. Golder was retained to provide background air quality and meteorological monitoring services in support of their permit application process. A Hi-Volume sampler and meteorological monitoring program was implemented during the summer months. Responsibilities included program development, instrument selection and procurement, installation and training of on-site staff in the maintenance of monitoring components. Mr. Madland was also responsible for data analysis and reporting for this project.

Cogema Resources Inc.

Saskatchewan, Canada

Monitoring Data Review and Analysis

Golder Associates was retained to conduct a review and analysis of the ambient air quality data collected in the vicinity of the Cogema McLean uranium mine. Responsibilities included the coordination of data acquisition and subsequent analysis, as well as report preparation.

Chevron Canada Ltd.

Fort Liard, Northwest Territories

M-25 Meteorological Monitoring

This project involved implementing and managing a meteorological monitoring program at the Chevron Canada Ltd. F-25 and K-29 wells near Ft. Liard in the Northwest Territories. The parameters monitored at each site included wind speed, wind direction temperature and solar radiation. Responsibilities included limited client liaison.

Chris Madland, B.Sc.

PROJECT RELATED EXPERIENCE – AMBIENT MONITORING (continued)

EnCana Energy

Christina Lake, Alberta

Christina Lake Environmental Management

Golder was responsible for the development of an air quality monitoring program for the Christina Lake Thermal Project in the Athabasca Oils Sands Region of Alberta. The ambient monitoring consisted of four static exposure stations and one continuous station. The program included options and recommendations for equipment purchase and monitoring station locations based on the requirements of the Alberta Monitoring Directive. Documentation was prepared to provide regulators with the information necessary to evaluate the suitability and effectiveness of the planned program. Mr. Madland was involved in the siting of the continuous and the static stations and oversaw the installation of the monitoring program hardware. He was also responsible for the ongoing coordination of the program, data quality assurance and reporting.

EnCana Energy

Christina Lake, Alberta

Christina Lake Thermal Project Monitoring Program: 2001

An air quality and meteorological monitoring plan and on-site assessment program were conducted to evaluate facility emissions from the Christina Lake Thermal Project. The project involved the establishment of an air quality and meteorology monitoring station, interpretation of data, and regular reporting and liaising with government officials on behalf of the client. Mr. Madland was involved in the siting of the continuous and the static stations and oversaw the installation of the monitoring program hardware. He was also responsible for the ongoing management of some components of the program, data quality assurance and reporting.

Norske Skog Inc.

Vancouver Island, British Columbia

Crofton Landfill

Golder Associates implemented a dust-fall and meteorological monitoring program at a water reservoir adjacent to the Norske Skog Inc. landfill in Crofton, B.C. The objective of the program was to assess the impact of dust emissions from the landfill on the water reservoir. The monitoring program consisted of monthly sampling of two dust-fall canisters, which were analyzed for dust-fall amounts and trace metal concentrations. Responsibilities included support for the field staff and siting process.

DeBeers Canada Mining Inc.

Snap Lake, Northwest Territories

Snap Lake Diamond Mine Monitoring Program

Provided ongoing support to DeBeers Canada for applications to the Government of the Northwest Territories to construct and operate an underground diamond mine in the vicinity of Snap Lake, NWT. The monitoring programs included siting, installing, maintaining and calibrating the equipment, as well as developing standard operating procedures for the collection of samples, and completing monitoring reports. Responsibilities included the siting, installation, calibration and maintenance of ambient air quality and meteorological monitoring stations in the vicinity of the plant site. Mr. Madland has also been responsible for annual ambient air quality and meteorological monitoring reporting and ongoing client support for the monitoring programs.

Chris Madland, B.Sc.

PROJECT RELATED EXPERIENCE – AMBIENT MONITORING (continued)

Lafarge Construction Material Limited

Calgary, Alberta

Ambient Air Quality Monitoring

Provided consulting services to Lafarge regarding a proposed gravel pit east of Calgary, Alberta. Work included the preparation of a monitoring plan and guidance to Lafarge on placement options for a particulate and meteorological monitoring system in the vicinity of the proposed operation. Mr. Madland contributed to the monitoring plan and proposal, coordinated the station siting process, procured all necessary monitoring hardware, installed and calibrated the requisite systems, and coordinated ongoing client support and reporting.

Domtar Canada Ltd.

Cochrane, Alberta

Particulate Monitoring

Conducted short-term particulate monitoring services to Domtar Canada Ltd. using hi-volume sampling devices. The objective of the work was to obtain estimates of airborne total suspended particulate (TSP) levels in the vicinity of an excavation site. Responsibilities included monitoring plan preparation equipment procurement, installation and calibration, and reporting.

Inmet Mining Corporation

Izok Lake, Nunavut

Izok Meteorological Monitoring

This project involved implementing and managing a meteorological monitoring program at the Izok Lake Project in Nunavut. The parameters monitored at each site included precipitation, wind speed, wind direction, temperature and solar radiation. The meteorological monitoring formed part of a comprehensive program designed to establish baseline hydrologic and climatic conditions at the proposed mine site. Mr. Madland travelled to the site and installed the meteorological station.

Chris Madland, B.Sc.

OTHER PROJECT RELATED EXPERIENCE

OPTI Canada/ Nexen Canada

Calgary, Alberta

Air Quality Modelling Course

Through the Golder Institute, Golder prepared a comprehensive two-day course designed to introduce the concepts of dispersion modelling and air quality assessment in the Oil Sands Region. The course comprised eight modules ranging in topic from oil sands history to hands-on modelling exercises using SCREEN3 and CALPUFF. Mr. Madland designed, constructed and demonstrated a scaled Plume Model.

Miramar Mining Corporation

Bathurst Inlet, Nunavut

Doris North Gold Project EIS

Golder Associates prepared an air quality and noise assessment for the Miramar Doris North Gold Project located near Bathurst Inlet, Nunavut. The assessment was prepared to support the Environmental Impact Study for submission to the Nunavut Impact Review Board. Responsibilities included contributing to the project emissions inventory and aiding in preparing supplementary regulatory responses.

Nimbus Projects Ltd.

Stettler, Alberta

Well Test Flaring Assessment

Nimbus Projects, acting on behalf of Tiverton Petroleum, retained Golder Associates to assess ambient SO₂ concentrations resulting from the expansion of an oil battery located northeast of Stettler, AB. The air quality assessment was prepared to support an approval application. Mr. Madland managed this project and prepared the final report.

OPTI Canada Inc.

Anzac, Alberta

Long Lake Project EIA and Project Update

Golder was responsible for the preparation of the environmental impact assessment (EIA) and subsequent project update for the Long Lake Project, which includes an integrated Steam Assisted Gravity Drainage (SAGD) facility and upgrading complex. The air quality assessment included an evaluation of the cumulative air pollutant concentrations and acid deposition using the CALPUFF dispersion model (3-D mode). The project update made use of the Golder regional emissions and 3-D meteorological data sets, covering the area from Fort Chipewyan to south of the Cold Lake area. The use of these data sets made the update predictions consistent with the assessment approaches used on the majority of applications filed in the Oil Sands Region, as well as the work being conducted for the NO_x-SO_x Management Working Group (NSMWG). In addition, the use of the large study area and greater number of sources were effective in addressing all of the concerns raised by Saskatchewan Environment. Responsibilities included ambient air quality data analysis and report preparation.

Lehigh Inland Cement Limited

Edmonton, Alberta

Substitution Fuel Project

Golder Associates were retained to prepare the Environmental Protection and Enhancement Act (EPEA) application for the proposed conversion of the Lehigh Inland Cement facility in Edmonton to allow the use of coal as a primary fuel. The project involved a detailed review of the facility emissions, estimation of resulting off-site concentrations, evaluation of current operations, and recommendations for future mitigation. Liaison with regulators during the application process formed an integral part of the air quality assessment. Responsibilities included calculation of fugitive emissions and report preparation.

Chris Madland, B.Sc.

OTHER PROJECT RELATED EXPERIENCE (continued)

Petro-Canada Oil and Gas Meadow Creek Project EIA

Fort McMurray, Alberta

Golder was responsible for the completion of the environmental impact assessment (EIA) and application to develop a Steam-Assisted Gravity Drainage (SAGD) project in the Athabasca Oil Sands Region. The air quality component of the project evaluated acid deposition in the region as well as local and regional concentrations of sulphur dioxide, nitrogen dioxide, particulate matter, secondary particulates, carbon monoxide, reduced sulphurs, volatile organic compounds, trace metals and polycyclic aromatic hydrocarbons. The CALPUFF model (3-D mode) was used for this assessment. Mr. Madland assisted with emissions calculations and with report preparation.

Chevron Canada Resources Air Quality Evaluation of the K-29 Facility

Ft. Liard, Northwest Territories

A well-test flaring assessment was completed for a proposed gas processing facility near Ft. Liard, NWT. The project involved the estimation of facility emissions and a dispersion modelling analysis of the SO₂ emissions from a flare. The site location was in very complex terrain and required the use of the CTSCREEN model to determine the necessary flare height that would result in no exceedances of the ambient SO₂ guidelines. Involvement in the project included client liaison.

DeBeers Canada Mining Inc. Diamond Mine EIA

Snap Lake, Northwest Territories

An air quality assessment was completed as part of a comprehensive EIA for a proposed diamond mine northeast of Yellowknife, NWT. The project involved the evaluation and selection of dispersion models, quantification of the current and future air emissions for the construction, operation and closing phases of the project. Additional support was provided to the client in response to stakeholders' questions and concerns for the technical hearing. Responsibilities were to calculate fugitive emissions from the project and assist in report preparation.

Shell Canada Ltd. Jackpine Mine-Phase 1 EIA

Fort McMurray, Alberta

Golder was responsible for the completion of the recent environmental impact assessment (EIA) of the Jackpine Mine – Phase 1 Oil Sands mine for Shell Canada Limited. As part of the EIA, Golder was responsible for the completion of the air quality components of the project, which included the use of the Golder's regional emissions database and 3-D meteorological data set. The air quality assessment evaluated air concentrations and acid deposition resulting from cumulative emissions sources across the Oil Sands Region, spanning from Fort Chipewyan in the north to the Cold Lake area in the south. Air quality predictions were made using the CALPUFF dispersion model, run in the 3-D mode. Responsibilities included calculation and summary of facility and regional emissions, and report preparation.

Lehigh Inland Cement Limited Substitution Fuel Project, Appeal Board Hearings

Edmonton, Alberta

Golder was retained by the proponent to provide expert witness testimony in the Environmental Appeals Board hearing of the Lehigh Inland Cement substitution fuel project approval. The work included the completion of supplementary responses and hearing preparation for the air quality component of the hearing. Responsibilities included technical support of the air quality team that attended the hearings.



Nathan Schmidt

Education: Ph.D., Civil Engineering (Fluid Mechanics), University of Canterbury, 1998
M.Sc., Civil Engineering (Water Resources), University of Alberta, 1992
B.Sc., Civil Engineering (Co-op Program, With Distinction), University of Alberta, 1990
Applied Fluvial Geomorphology, Dave Rosgen/Wildland Hydrology, 2001

Affiliations: Association of Professional Engineers, Geologists and Geophysicists of Alberta (P.Eng. and Environment Committee Chair) • Association of Professional Engineers and Geoscientists of British Columbia • Association of Professional Engineers, Geologists and Geophysicists of Northwest Territories • International Association for Hydraulic Research • Canadian Institute of Mining, Metallurgy and Petroleum (Environment Section) • Canadian Water Resources Association (Alberta Director) • Consulting Engineers of Alberta (Environment Committee Member)

Awards: Commonwealth Postgraduate Scholarship, 1993-1997 • NSERC Post-graduate Scholarship, 1992 • Leonard E. Gads Teaching Assistant Award, 1991 and 1992 • Engineers Collaborative J.R. Ogilvie Memorial Scholarship, 1990 • Walker, Newby & Associates Scholarship in Environmental Engineering, 1990 • Leonard E. Gads Memorial Scholarship, 1989 • Luscar Engineering Limited Bursary in Civil Engineering, 1986

Experience:

2002 - date	Golder Associates Ltd. <i>Associate, Senior Water Resources Engineer</i> Consultant and Project Manager on projects related to river engineering, hydrology, water management, and environmental impact assessment in the mining, water resources, power, forestry, and transportation market sectors.	Edmonton, AB
1997 - 2002	Golder Associates Ltd. <i>Senior Water Resources Engineer</i> Consultant and Project Manager on a variety of projects. Highlights included managing the climate and hydrology component of the Regional Aquatics Monitoring Program for five years, leading the surface water hydrology components of the CNRL Horizon Oil Sands Project EIA and Suncor Firebag In Situ Oil Sands Project EIA, and leading the Functional Design, Hydrology, and Hydraulics components of the Iron Ore Company Wabush Lake Tailings Management Project.	Calgary, AB
1993 - 1997	University of Canterbury <i>Research/Teaching Assistant, Fluid Mechanics</i>	Christchurch, New Zealand
1992 - 1993	Alberta Transportation & Utilities <i>Bridge Planning Engineer</i>	Edmonton, AB
1990 - 1992	University of Alberta <i>Research/Teaching Assistant, Water Resources Engineering</i>	Edmonton, AB
1990	Stanley Associates Engineering Ltd. <i>Hydrotechnical Engineer</i>	Edmonton, AB

Nathan Schmidt

PROJECT RELATED EXPERIENCE – INFRASTRUCTURE

Igloo Building Products

Parkland County, Alberta

Project manager for drainage design of an 80 ha parcel of land in the Acheson Industrial Park. The project included hydrological modeling and grading design to meet Province of Alberta and Parkland County regulations.

Golden West Homes

Parkland County, Alberta

Project manager for stormwater management permitting (Alberta *Water Act*) drainage design of an 11 ha parcel of land in Parkland County. The project included hydrological modeling to meet Province of Alberta and Parkland County regulations.

Cohos Evamy – Arcadia Creek BF 76478

Arcadia, Alberta

Project manager responsible for deriving design water surface elevations and flow velocities, as well as recommending scour protection measures for a replacement bridge on Arcadia Creek at Highway 2. This was an Alberta Infrastructure and Transportation project. Also responsible for coordinating environmental tasks.

CH2M Hill – Poplar Creek BF71019 and BF85038

Breton, Alberta

Project manager responsible for deriving design water surface elevations and flow velocities, as well as recommending scour protection measures for bridge on Poplar Creek and bridge-sized culvert on an adjacent tributary.

Big Island Lake Stabilization

Strathcona County, Alberta

Project manager responsible for establishing the pre-disturbance lake water level regime of a small prairie lake and performing feasibility-level design of a control structure to restore the lake level. The project included field surveys, hydrological and hydraulic modeling, environmental assessment and public consultation.

Syncrude Aurora Clean Groundwater Diversion

Fort McMurray, Alberta

Project manager for assessment of water quality and treatment alternatives for pumped groundwater from the basal aquifer, with the goal of achieving regulatory permitting for release to Stanley Creek or the Muskeg River. The project included sizing of a retention pond, specification of aeration requirements and participating in discussions with Alberta Environment.

Foothills Model Forest – Hardisty Creek Restoration

Hinton, Alberta

Project manager for fisheries and hydrologic assessment and development of remediation measures for stream restoration and fish passage. Responsible for addressing concerns of stakeholders including industry, regulatory agencies, municipalities and environmental groups.

Infrastructure Systems Ltd. – Henderson Creek BF 73982

Bonanza, Alberta

Project manager responsible for deriving design hydrology, water surface elevations and flow velocities, as well as recommending scour protection measures for a replacement bridge on Arcadia Creek at Highway 2. Responsible for checking Design Data drawing. This was an Alberta Infrastructure and Transportation project.

Nathan Schmidt

PROJECT RELATED EXPERIENCE – INFRASTRUCTURE (continued)

Infrastructure Systems Ltd. – Hines Creek Dell Bridge BF 72581 Fairview, Alberta

Project manager responsible for deriving design water surface elevations and flow velocities, as well as recommending scour protection measures for a single-span bridge on Hines Creek.

Infrastructure Systems Ltd. – Highway 28 Culvert BF 73146 Redwater, Alberta

Project manager responsible for deriving design discharge and culvert sizing for replacement of a culvert between two wetlands.

Jivko Engineering – Mackenzie River Bridge Ft. Providence, NWT

Contributed to environmental impact assessment, including study of effects of ferry crossing decommissioning on sediment deposition into the Mackenzie River and effects of bridge pier and approach causeway construction on physical habitat characteristics.

Canadian Natural Resources Ltd. – Tar River Crossings Ft. McMurray, Alberta

Project manager for hydraulic assessment, fish habitat assessment and erosion and sediment control planning for two bridge crossings on the Tar River at the CNRL Horizon Project. The results of the study were used for permit applications with Fisheries and Oceans Canada.

B.C. Rail Emergency Erosion Control Prince George, British Columbia

B.C. Rail retained Golder Associates to provide an emergency assessment of recent Fraser River bank erosion that jeopardized a section of their mainline, north of Prince George. In collaboration with a fisheries biologist, conducted a site visit and prepared a report assessing the likely cause of the erosion, outlining potential remedial measures, assessing such measures by economic, technical and environmental criteria, and discussing ways to incorporate fish habitat compensation measures into remedial measures. The report was used to support an application for an Authorization for Harmful Alteration, Disruption or Destruction (HADD) of fish habitat to Fisheries and Oceans Canada.

Anadarko Petroleum – East Liard Pipeline Fort Liard, Northwest Territories

Project manager for hydrology component of the project. Tasks included a field reconnaissance to identify stream crossing locations, field program to measure geomorphologic data, regional hydrology study and design of pipeline sagbend and burial depths.

Border Paving Ltd. – McLeod River Gravel Pit Edson, Alberta

Responsible for deriving water surface elevations for various flood events to support a regulatory application for gravel pit development to Fisheries and Oceans Canada.

Alberta Transportation BF 73687 and BF76856 Barrhead, Alberta

Project manager for the design of river protection works at two sites. The bridge providing access to Ft. Mackay was subject to pier scour and a remedial design was developed to repair the problem and prevent further damage. The Highway 32 bridge across Groat Creek, south of Whitecourt, was subject to severe upstream bank erosion. A riprap guidebank was designed to repair the channel and enhance bed load passage through the bridge opening. The works required an Authorization from DFO, including fish habitat compensation, and the compensation was negotiated and designed.

Nathan Schmidt

PROJECT RELATED EXPERIENCE – INFRASTRUCTURE (continued)

Canadian Natural Resources Ltd. – Access Road Crossings Ft. MacKay, Alberta

Performed hydraulic assessment of bridge crossings of the MacKay and Ells Rivers and Joslyn Creek and four culvert crossings to define flood inundation levels and fish passage velocities. The results of the study were used for permit applications with Fisheries and Oceans Canada.

Transportation Association of Canada Ottawa, Canada

Co-authored and compiled TAC's Synthesis of Practice on Transportation Construction and Maintenance and the Protection of Fish Habitat. This document discusses the integration of habitat issues into transportation and stream crossing planning, reviews regulatory approval requirements and presents best management practices for habitat protection, channel design, fish passage and erosion and sediment control.

Alberta Transportation & Utilities Edmonton, Alberta

Co-author of the AT&U Fish Habitat Manual: Guidelines and Procedures for Watercourse Crossings in Alberta. Wrote chapter on Erosion and Sediment Control Plan, including sample plans for bridge and culvert construction, and subsequently revised the chapter on Fish Passage. Prepared factsheets describing recommended mitigation procedures.

Alberta Infrastructure RPW Inspections Edmonton, Alberta

Undertook Level I hydrotechnical inspections at 28 bridge sites near Cochrane, Canmore, Sundre and the Forestry Trunk Road. Hydrotechnical and geomorphic observations were recorded during site visits. Measurements were supplemented with photographs and video footage. The condition of existing river protection works and the likelihood of lateral channel migration were assessed. Field observations were supplemented by airphoto analysis. Level II hydrotechnical inspections were undertaken at bridge sites on Lee Creek at Cardston and the Belly River near Glenwood. Detailed assessments of river behavior were presented and conceptual designs for river training works were developed. The results of each inspection, assessment and recommendations were presented in report format.

Suncor Firebag Project Access Corridor Ft. McMurray, Alberta

The access corridor to the Firebag In-Situ Oilsands Project required the replacement of three bridges and one culvert on Canterra Road and the construction of one bridge over the North Steepbank River. Developed Erosion and Sediment Control Plans for these five crossings to satisfy requirements for federal and provincial permit applications.

North Arm, Fraser River British Columbia, Canada

Assessed mechanisms responsible for river bank erosion at a site downstream of the Oak Street bridge in Vancouver. Prepared a feasibility-level report which reviewed options for bank protection and presented a conceptual design which accommodated the construction of a containment system for the contaminated site, which was under a remediation order. Prepared final design drawings and construction specifications for the bank protection works and inspected the work during construction.

Nathan Schmidt

PROJECT RELATED EXPERIENCE – INFRASTRUCTURE (continued)

South Thompson River

British Columbia, Canada

Assessed mechanisms responsible for river bank erosion at the Secwepemc Cultural Education Society site on the Kamloops Indian Reserve. Prepared a report which reviewed options for bank protection and presented a conceptual design which accommodated preservation of the unique cultural and archeological resources of the area. After consultations with the client and DFO, prepared final design drawings and construction specifications.

Sunpine Forest Products

Sundre, Alberta

Participated in the development of a GIS-based system for forestry road stream crossing design. Involved in the development of field data acquisition forms, regional hydrologic analyses for flood and fish passage events, and bridge waterway opening design.

Peterson Creek Park Erosion Control

Kamloops, British Columbia

Developed an erosion and sediment control plan for three eroded streams that were tributary to Peterson Creek. These streams had been subject to increased stormwater runoff due to urbanization of their catchment areas and this had caused streambed erosion of up to four metres. These streams were located in steeply sloped parkland, so erosion control treatments were designed to minimize use of heavy equipment and disturbance of natural areas. Treatments included installation of HDPE pipe with granular fill and construction of timber and rockfill erosion control structures. This project culminated in the production of tender documents, including detailed plans for construction.

Bow River near Canmore

Alberta, Canada

Prepared an Erosion and Sediment Control Plan for a pipeline crossing of the Bow River. This plan was used during open trench construction to minimize effects on fish and fish habitat in the crossing area and included components of fish habitat compensation.

Whispering Pines IR4

British Columbia, Canada

Responsible for writing a construction specification for emergency dyking on the North Thompson River, north of Kamloops. The specification was prepared for Indian and Northern Affairs Canada and the Whispering Pines/Clinton Indian Band to assist the band in raising existing dykes and constructing new dykes in advance of the spring freshet.

Quintette Coal – Babcock Window Haul Road

British Columbia, Canada

Prepared a water management plan for the Babcock Window haul road at Quintette Operating Corporation's mine near Tumbler Ridge. Performed an analysis of available climatic and hydrologic data to determine site runoff and designed a sedimentation pond in accord with provincial guidelines. Prepared quantity and cost estimates for construction.

Special Areas Water Supply Project

Alberta, Canada

Responsible for estimating bridge and culvert costs for 33 crossings of a water supply canal from Nevis to Sounding Creek. This involved performing hydraulic backwater calculations using WSPRO as well as a culvert flow program, sizing of culvert and bridge openings, clearances and gradeline modifications.

Nathan Schmidt

PROJECT RELATED EXPERIENCE – INFRASTRUCTURE (continued)

Various Rivers, Creeks and Canals in Alberta

Alberta, Canada

Performed assessments of 16 major bridge crossings of rivers, creeks and irrigation canals in Alberta as part of a highway bridge maintenance and construction program. Tasks included analysis of site hydrology and hydraulic conditions including backwater calculations, flood frequency determination, flood depth and bridge clearance determination and bank protection design.

Red Deer River near Drumheller

Alberta, Canada

Collected field data to be used in the design of river bank protection works. Relevant data included river stage and channel geometry.

Athabasca River near Fort McMurray

Alberta, Canada

Collected field data to be used in the design of a pipeline crossing. Relevant data included river stage and channel geometry as well as observations of ice scarring.

Nathan Schmidt

PROJECT RELATED EXPERIENCE – COASTAL ENGINEERING

Cameco Key Lake Mine

Saskatchewan, Canada

Used the U.S. Army Automated Coastal Engineering System (ACES) to perform wave hindcasting for an abandoned mine pit lake, based on Environment Canada wind data. ACES was then used to forecast erosion rates for the sandy shoreline at the pit.

North Arm, Fraser River

British Columbia, Canada

Assessed mechanisms responsible for river bank erosion at a site downstream of the Oak Street bridge in Vancouver. Prepared a feasibility-level report which reviewed options for bank protection and presented a conceptual design which accommodated the construction of a containment system for the contaminated site, which was under a remediation order. Prepared final design drawings and construction specifications for the bank protection works and inspected the work during construction.

South Thompson River

British Columbia, Canada

Assessed mechanisms responsible for river bank erosion at the Secwepemc Cultural Education Society site on the Kamloops Indian Reserve. Prepared a report which reviewed options for bank protection and presented a conceptual design which accommodated preservation of the unique cultural and archeological resources of the area. After consultations with the client and DFO, prepared final design drawings and construction specifications.

Avon - Heathcote Estuary

Christchurch, New Zealand

Observed and collected field data to measure the tidal response of McCormack's Bay, a portion of the estuary partially isolated by causeway construction. Relevant data included tidal stage, channel velocities and water surface area.

Akaroa and Lyttelton Harbors

Christchurch, New Zealand

Collected field data to be used in mixing studies to characterize flushing of the harbors due to tide-influenced mixing patterns. Slug and continuous releases of dye were used and dye concentrations along transects of the resulting plumes were measured.

Nathan Schmidt

PROJECT RELATED EXPERIENCE – EROSION AND SEDIMENT CONTROL

City of Edmonton – Whitemud Creek Erosion Study

Edmonton, Alberta

Project manager an assessment of existing erosion and evaluation of future erosion potential under urbanized conditions. The project involved intensive data collection for approximately 40 km of stream length on Whitemud and Blackmud Creeks within the City limits. It included assessments of stream hydrology, geomorphology and valley wall instability, with the objective of identifying and prioritizing areas for application of mitigation measures.

CN Rail – Trestle Replacement

Whitecourt, Alberta

This project involved the emergency construction of an earthfill embankment and culvert to replace a fire-damaged timber railway trestle. Provided advice to site personnel regarding sediment monitoring and specification of Best Management Practices for erosion and sediment control on this project.

City of Edmonton – Clover Bar Creek Restoration

Edmonton, Alberta

Project manager an assessment of existing erosion and evaluation of future erosion potential under urbanized conditions. Undertook an intensive site reconnaissance on 5 km of stream length, assessed erosion potential and developed recommendations for restoration of existing erosion and treatments to prevent erosion under the future, urbanized flow regime. The project included a comprehensive alternative evaluation and quantity and cost estimates for selected alternatives. Later participated in process to resolve dispute over funding responsibilities between two municipalities.

Various Clients

Various Locations

Senior review of Erosion and Sediment Control Plans for the following projects:

- John Hart Highway SDMP – Peters Bros. Construction, Dawson Creek, B.C.
- Farrell Creek Road #115 SDMP – Brocor Construction, Hudson's Hope, B.C.
- Lesser Slave River Bridge File 7460 ECO Plan – West Shore Constructors, Slave Lake, Alberta

Regional Municipality of Wood Buffalo

Fort McMurray, Alberta

Project manager and lead engineer on a project to revitalize the Snye, a waterbody located upstream of the confluence of the Athabasca and Clearwater rivers. The Athabasca end of the Snye was blocked by causeway construction in the late 1960's, resulting in siltation and stagnation. This project included field surveys, a hydrology study and development of a feasibility-level design for hydraulic structures to manage flow through the Snye to enhance water quality and maintain a self-scouring inlet for navigation at the Clearwater entrance.

Alberta Transportation – Red Willow River

Wembley, Alberta

Project director for river engineering, alternative assessment and environmental work on a reach of the river that was subject to accelerated erosion. Areas of interest included bank erosion downstream of a secondary highway bridge and at the downstream end of a cutoff channel that was constructed in the early 1970's. Undertook a field reconnaissance to kick off the project and provided guidance and review for the duration of the project.

Fisheries and Oceans Canada – Nulahugyuk Creek

Bernard Harbour, Nunavut

Undertook a field reconnaissance and provided hydrology and geomorphology input to a study of an Arctic stream, to determine reasons why the historic Arctic char spawning run has not occurred in recent years and to develop remedial measures.

Nathan Schmidt

Transportation Association of Canada

Ottawa, Canada

Primary author and project manager for development of the TAC National Guide to Erosion and Sediment Control on Roadway Projects. This document was developed with the TAC Project Steering Committee, with review by the TAC Environmental Issues Subcommittee, the TAC Environment Council and the TAC Chief Engineer's Council, and it was subject to review and comments by Fisheries and Oceans Canada (DFO) at the regional and national levels. The intent of the document was to address erosion and sediment control regulatory issues, physical theory and risk assessment, as well as provide methods for developing erosion and sediment control plans over the life cycle of a roadway project.

Foothills Model Forest – Hardisty Creek Restoration

Hinton, Alberta

Project manager for fisheries and hydrologic assessment and development of remediation measures for stream restoration and fish passage. Responsible for addressing concerns of stakeholders including industry, regulatory agencies, municipalities and environmental groups. The project included several phases, including assessment and design (2003-4), construction of stream restoration prescriptions (2004) and construction of a 1.8 m high riffle to backflood a culvert for fish passage (2005).

Alberta Transportation

Barrhead, Alberta

Project manager for the design of river protection works at two sites. The bridge providing access to Ft. Mackay was subject to pier scour and a remedial design was developed to repair the problem and prevent further damage. The Highway 32 bridge across Groat Creek, south of Whitecourt, was subject to severe upstream bank erosion. A riprap guidebank was designed to repair the channel and enhance bed load passage through the bridge opening. The works required an Authorization from DFO, including fish habitat compensation, and the compensation was negotiated and designed.

Talisman Resources Pipeline Crossing

Little Sundance Creek, Alberta

Analyzed hydrologic and geomorphic data for a proposed pipeline crossing. Used the data to complete a sagbend and burial depth design for a directionally drilled crossing. Wrote the engineering sections of an Alberta *Water Act* Code of Practice report for the pipeline crossing.

EOG Resources Pipeline Crossing

Christmas Creek, Alberta

Performed a site reconnaissance to collect stream geomorphology data at a proposed pipeline crossing. Used the data to complete a sagbend and burial depth design for a directionally drilled crossing. When site conditions prevented use of directional drill method, the crossing method was changed to an aerial crossing and a Navigable Waters Protection Act application drawing was prepared.

Peterson Creek Park Erosion Control

Kamloops, British Columbia

Developed an erosion and sediment control plan for three eroded streams that were tributary to Peterson Creek. These streams had been subject to increased stormwater runoff due to urbanization of their catchment areas and this had caused streambed erosion of up to four metres. These streams were located in steeply sloped parkland, so erosion control treatments were designed to minimize use of heavy equipment and disturbance of natural areas. Treatments included installation of HDPE pipe with granular fill and construction of timber and rockfill erosion control structures. This project culminated in the production of tender documents, including detailed plans for construction.

Sunpine Forest Products

Sundre, Alberta

Participated in the development of a GIS-based system for forestry road stream crossing design. Involved in the development of field data acquisition forms, regional hydrologic analyses for flood and fish passage events, and bridge waterway opening design.

Nathan Schmidt

Whispering Pines IR4

British Columbia, Canada

Responsible for writing a construction specification for emergency dyking on the North Thompson River, north of Kamloops. The specification was prepared for Indian and Northern Affairs Canada and the Whispering Pines/Clinton Indian Band to assist the band in raising existing dykes and constructing new dykes in advance of the spring freshet.

Transportation Association of Canada

Ottawa, Canada

Contributed to, and compiled, TAC's Synthesis of Practice for the Protection of Fish Habitat. This document discusses the integration of habitat issues into transportation and stream crossing planning, reviews regulatory approval requirements and presents best management practices for habitat protection, channel design, fish passage and erosion and sediment control.

Alberta Transportation & Utilities

Edmonton, Alberta

Involved in the preparation of the AT&U Fish Habitat Manual: Guidelines and Procedures for Watercourse Crossings in Alberta. Wrote chapter on Erosion and Sediment Control Plan, including sample plans for bridge and culvert construction and gravel mining. Prepared factsheets describing recommended mitigation procedures.

Quintette Coal – Babcock Window Pit

British Columbia, Canada

Prepared water management plans for the Babcock Window pit and haul road at Quintette Operating Corporation's mine near Tumbler Ridge. Performed an analysis of available climatic and hydrologic data to determine site runoff and designed a sedimentation pond in accord with Provincial guidelines. Prepared quantity and cost estimates for construction.

Bow River near Canmore

Alberta, Canada

Prepared an Erosion and Sediment Control Plan for a pipeline crossing of the Bow River. This plan was used during open trench construction to minimize effects on fish and fish habitat in the crossing area and included components of fish habitat compensation.

North Arm, Fraser River

British Columbia, Canada

Assessed mechanisms responsible for river bank erosion at a site downstream of the Oak Street bridge in Vancouver. Prepared a feasibility-level report which reviewed options for bank protection and presented a conceptual design which accommodated the construction of a containment system for the contaminated site, which was under a remediation order. Prepared final design drawings and construction specifications for the bank protection works and inspected the work during construction.

South Thompson River

British Columbia, Canada

Assessed mechanisms responsible for river bank erosion at the Secwepemc Cultural Education Society site on the Kamloops Indian Reserve. Prepared a report which reviewed options for bank protection and presented a conceptual design which accommodated preservation of the unique cultural and archeological resources of the area. After consultations with the client and DFO, prepared final design drawings and construction specifications.

Nathan Schmidt

PROJECT RELATED EXPERIENCE – MINE WATER MANAGEMENT

Fording Coal Ltd. – Greenhills Mine

Elkford, British Columbia

Preliminary site assessment of requirements for dam break inundation study component of Emergency Preparedness Plan for the main and west tailings dams.

Canadian Natural Resources Ltd. – Horizon Mine

Ft. McMurray, Alberta

Manager for development of operational water management plan, closure reclamation drainage plan and conceptual design of the Athabasca River water intake. The operational water management plan included development of design criteria consistent with best management practices for oil sands mining operations, design of site-specific surface drainage, dewatering and diversion systems, development of a basal aquifer dewatering plan, development of a mine water balance for closed-circuited areas and derivation of raw water supply requirements for mining operations. The closure reclamation drainage plan involved the development of a progressive drainage plan, incorporating hydrologic and geomorphic considerations to ensure sustainability of the drainage system and landscape.

Syncrude Canada Ltd. – Aurora North Mine

Ft. McMurray, Alberta

Project manager for evaluation of clean water diversion alternatives at the Aurora North mine, including outlets to Stanley Creek, the Muskeg River, Mills Creek, Fort Creek and the Athabasca River. The evaluation considered economic, environmental and technical/operational criteria to determine the best alternative. Served as project manager for the next phase of the project, which involved detailed design of ditch, pump and pipeline facilities for clean water diversion.

Syncrude Canada Ltd. – Aurora North Mine

Ft. McMurray, Alberta

Project manager for development of an operational water management plan for 10 years of mining activities, including a review of design criteria with specific application to Aurora North mine components, an assessment of surface water hydrology and drainage facilities at the mine, development of a muskeg and overburden dewatering plan and development of guidelines for sizing mine pit sumps and pumps.

Albian Sands Energy

Ft. McMurray, Alberta

Update of closure reclamation drainage plan for mine components addressed in the 10-year conservation and reclamation plan.

Quintette Coal – Deputy and Shikano Common Pits

British Columbia, Canada

Review of hydrologic studies for this area, including derivation of design discharges for closure planning. Design of closure drainage facilities for two catchments, including feasibility-level design of a stepped spillway in bedrock for the Shikano Common pit.

Iron Ore Company of Canada – Wabush Lake

Labrador, Canada

Responsible for the installation of flow monitoring stations on tributaries to Wabush Lake. Tasks included selection of station locations, data logger programming, station installation, training of Iron Ore Company of Canada staff in gauging techniques, and processing of data from the three stations. Other tasks included lake bathymetry, water quality profiling, sediment sampling and infiltration testing on terrestrial tailings deposits.

Nathan Schmidt

PROJECT RELATED EXPERIENCE – MINE WATER MANAGEMENT (continued)

Quintette Coal – Babcock Window Pit

British Columbia, Canada

Prepared water management plans for the Babcock Window pit and haul road at Quintette Operating Corporation's mine near Tumbler Ridge. Performed an analysis of available climatic and hydrologic data to determine site runoff and designed a sedimentation pond in accord with Provincial guidelines. Prepared quantity and cost estimates for construction.

Diavik Diamonds – Lac de Gras

Northwest Territories, Canada

Conducted an impact analysis to quantify the incremental hydrologic impacts of the Diavik Diamond Mine project and the cumulative impacts of the Diavik and BHP projects. Tasks included identifying changes in site hydrologic conditions and water balance as well as describing changes in sediment yields and suggesting procedures for mitigating any impact on the environment.

Syncrude – Beaver River Diversion

Ft. McMurray, Alberta

Prepared feasibility-level designs for several river diversion alternatives considered during closure planning for the Mildred Lake facility north of Ft. McMurray. Prepared quantity and cost estimates based on these designs and performed a net present value analysis to compare alternatives.

Nathan Schmidt

PROJECT RELATED EXPERIENCE – MANUALS AND GUIDELINES

Transportation Association of Canada

Ottawa, Canada

Primary author and project manager for development of the TAC National Guide to Erosion and Sediment Control on Roadway Projects. This document was developed with the TAC Project Steering Committee, with review by the TAC Environmental Issues Subcommittee, the TAC Environment Council and the TAC Chief Engineer's Council, and it was subject to review and comments by Fisheries and Oceans Canada (DFO) at the regional and national levels. The intent of the document was to address erosion and sediment control regulatory issues, physical theory and risk assessment, as well as provide methods for developing erosion and sediment control plans over the life cycle of a roadway project.

Ontario Ministry of Transport (MTO)

Toronto, Canada

Senior technical reviewer for the MTO Gravity Pipe Design Manual. This document considered round pipes of less than 3 m diameter, including life cycle costing and risk analysis for concrete, steel, PVC and polyethylene materials.

Transportation Association of Canada

Ottawa, Canada

Contributed to, and compiled, TAC's Synthesis of Practice for the Protection of Fish Habitat. This document discusses the integration of habitat issues into transportation and stream crossing planning, reviews regulatory approval requirements and presents best management practices for habitat protection, channel design, fish passage and erosion and sediment control.

Alberta Transportation & Utilities

Edmonton, Alberta

Co-author of the AT&U Fish Habitat Manual: Guidelines and Procedures for Watercourse Crossings in Alberta. Wrote chapter on Erosion and Sediment Control Plan, including sample plans for bridge and culvert construction, and subsequently revised the chapter on Fish Passage. Prepared factsheets describing recommended mitigation procedures.

Bed Load Sampling Manual

Alberta, Canada

Prepared a manual for the use of bed load sampling equipment. The manual addressed the concepts of bed load, sampling techniques and equipment, as well as use of the Helley-Smith bed load sampler and analysis of field data.

Nathan Schmidt

PROJECT RELATED EXPERIENCE – HYDROMETRIC MONITORING

North Saskatchewan River Hydrographics 2003-5

Sundance GS, Alberta

Project manager for hydrographic and terrestrial surveys to monitor erosion and sedimentation over a reach length of approximately 1.5 km. The project also included use of an Acoustic Doppler Current Profiler to measure the velocity structure of flows on ten cross-sections along the reach.

Syncrude Aurora East Pit Passage Instrumentation

Fort McMurray, Alberta

Project manager for design, procurement and installation of instrumentation to monitor and log flow rates on a pumped surface water disposal system.

Athabasca River Water Intake Construction Monitoring Fort McMurray, Alberta

Project director for provision of environmental monitoring services at the Canadian Natural Resources Ltd. Athabasca River water intake. This water intake will provide water supply to an oil sands mine and extraction plant with a capacity of 270,000 barrels per day of bitumen. The project used instream dykes to allow in-the-dry construction of the water intake structure. Golder monitored sediment and other water quality parameters to ensure compliance with regulatory approvals.

Dundee George & Goose Hydrologic Monitoring 2005

Nunavut, Canada

Managed the installation and operation of one continuous and two manual stream discharge and lake level monitoring stations at the Dundee Precious Metals George and Goose (Back River) Project. Tasks included manual stream gauging, development of stage-discharge rating curves and processing of data used to characterize the local hydrological regime.

Miramar Roberts and Doris Lake Hydrologic Monitoring 2004-5 Nunavut, Canada

Responsible for the installation and operation of six stream discharge and lake level monitoring stations at the Miramar Doris North Project. Tasks included manual stream gauging, development of stage-discharge rating curves and processing of data used to characterize the local hydrological regime. Additional tasks included spring snowcourse surveys to measure snow depths and snow water equivalents on the range of aspects and terrain present at the project.

Albian Sands Energy Snowcourse and River Monitoring

Alberta, Canada

Project manager responsible for stream gauging on the Athabasca River at the Albian Sands Energy raw water intake. Tasks included five discharge measurements under ice-covered conditions, refinement of ice-covered rating curve, data analysis and reporting. Snowcourse surveys included snow depth and snow water equivalent measurements over the spring snowmelt period at a reclamation material stockpile on the Muskeg River Mine site.

Miramar Roberts and Doris Lake Hydrologic Monitoring 2003

Nunavut, Canada

Responsible for the installation and operation of three stream discharge monitoring stations at the Miramar Doris Hinge Project. Tasks included manual stream gauging, development of stage-discharge rating curves and processing of data used to characterize flows for development of fish habitat compensation works and tailings water decant plans under Canadian Metal Mining Effluent Regulations.

Nathan Schmidt

Albian Sands Energy Athabasca River Monitoring

Alberta, Canada

Project manager responsible for installation and operation of a stream gauging station on the Athabasca River at the Albian Sands Energy raw water intake. Tasks included development of open-water and ice-covered rating curves, data analysis and reporting.

Oil Sands Climatic & Hydrologic Monitoring 1998 to 2002

Alberta, Canada

Managed the climate and hydrology component of the Regional Aquatics Monitoring Program. This ongoing study of various streams and lakes in the oil sands area which spans from Janvier in the south to the Firebag River in the north. It includes the Athabasca River, Muskeg River and tributaries, Birch Mountains drainages, Poplar Creek, Kearl, McClelland and Isadore's Lakes. Responsible for the collection of data from climatic monitoring stations in the area and for undertaking snow surveys in various study areas. Analysis included processing stream discharge and water level data, preparing stage-discharge rating curves and synthesizing hydrographs. All available local and regional data were compiled in a database for easy reference. Provided data support to RAMP funders and to authorized third parties, including regulatory agencies, consultants and contractors.

Suncor Hydrologic Monitoring

Alberta, Canada

Project manager for reporting climatic and hydrologic data collected at the Suncor Millennium mine in 2000. Analyzed data provided by Suncor and summarized in a report to be submitted to regulatory agencies. Advised on ongoing improvements to the monitoring program to meet regulatory requirements.

Snap Lake Hydrologic Monitoring

Northwest Territories, Canada

Responsible for the operation of three stream discharge monitoring stations and one lake level monitoring station at Snap Lake. Tasks included manual stream gauging, development of stage-discharge rating curves and processing of data for use in a hydrologic baseline study of the watershed.

Wabush Lake Hydrologic Monitoring

Labrador, Canada

Responsible for the installation of three stream discharge monitoring stations on tributaries to Wabush Lake. Tasks included selection of station locations, data logger programming, station installation, training of Iron Ore Company of Canada staff in gauging techniques, and processing of data from the three stations. Other tasks included lake bathymetry, water quality profiling, sediment sampling and infiltration testing on terrestrial tailings deposits.

Synenco Field Reconnaissance

Fort McMurray, Alberta

Led a field reconnaissance to identify potential locations for hydrometric monitoring activities to support baseline hydrological data collection. The study area was located in the Marguerite River watershed, approximately 100 km north of Fort McMurray.

Nathan Schmidt

PROJECT RELATED EXPERIENCE – HYDROMETRIC MONITORING (continued)

Skookumchuck Water Quality Monitoring

British Columbia, Canada

In collaboration with Crestbrook Forest Industries and the BC Ministry of Environment, Lands and Parks, four continuous water quality monitoring stations were installed in small drainage basins in the East Kootenays. These were installed to monitor water level, temperature, pH, conductivity and turbidity. Other tasks included surveys of stream geomorphology and culvert road crossings and periodic site visits for stream discharge measurements, datalogger downloads and equipment maintenance.

Bed Load Sampling Manual

Alberta, Canada

Prepared a manual for the use of bed load sampling equipment. The manual addressed the concepts of bed load, sampling techniques and equipment, as well as use of the Helley-Smith bed load sampler and analysis of field data.

Suncor Firebag River Field Reconnaissance

Alberta, Canada

Performed a field reconnaissance to determine the origin of base flow in small tributaries to the Steepbank, Muskeg and Firebag Rivers. The area was surveyed for the existence of streams fed by springs originating in the sand and gravel aquifer beneath Muskeg Mountain.

Lac de Gras Snow Survey

Northwest Territories, Canada

Analyzed climatic, snow survey and stream discharge data to characterize runoff coefficients from small watersheds on the east island and adjacent mainland.

Avon - Heathcote Estuary

Christchurch, New Zealand

Observed and collected field data to measure the tidal response of McCormack's Bay, a portion of the estuary partially isolated by causeway construction. Relevant data included tidal stage, channel velocities and water surface area.

Akaroa and Lyttelton Harbors

Christchurch, New Zealand

Collected field data to be used in mixing studies to characterize flushing of the harbors due to tide-influenced mixing patterns. Slug and continuous releases of dye were used and dye concentrations along transects of the resulting plumes were measured.

Red Deer River near Drumheller

Alberta, Canada

Collected field data to be used in the design of river bank protection works. Relevant data included river stage and channel geometry.

Mackenzie River near Fort Providence

Northwest Territories, Canada

Observed and collected field data during the period of ice breakup to be used in a study to identify factors influencing the date of river breakup. Relevant data included river stage, ice characteristics and Water temperatures.

Athabasca River near Fort McMurray

Alberta, Canada

Collected field data to be used in the design of a pipeline crossing. Relevant data included river stage and channel geometry as well as observations of ice scarring.

Nathan Schmidt

PROJECT RELATED EXPERIENCE - HYDROLOGIC ANALYSIS

Prairie Farm Rehabilitation Administration

Barrhead, Alberta

Golder was a subconsultant to Urban Systems Limited on this water supply study for Barrhead County, and was responsible for the surface water hydrology, hydrogeology and geographic information systems components of the project. Served as the Golder project manager and was responsible for the hydrology analysis. Long-term hydrometric data were used to determine water supply availability under mean and 10-year dry conditions, including an allowance for Instream Flow Needs. The GIS component included analysis of groundwater and surface water supply as well as the results of a public consultation.

Miramar Doris Hinge Fish Habitat Compensation

Nunavut, Canada

Using hydrologic data collected during the project baseline study and long-term regional climatic data, a model was developed to predict lake discharges based on long-term records of rainfall and runoff. The results of the analysis were used as the basis for the feasibility-level design of fish habitat structures at Roberts Lake outlet, which were a key component of the fisheries *No Net Loss* plan. Recommendations were presented for future hydrologic monitoring to verify the results of the analysis and refine the habitat structure designs.

Oil Sands Regional Hydrologic Modeling

Ft. McMurray, Alberta

Project manager for development of a regional hydrologic (HSPF) model of the oil sands region. This model has subsequently been used as the basis for several environmental impact assessment baseline reports. The model was also used as the basis for development of design runoff curves for mine operational water management.

Quintette Coal – Tumbler Ridge

British Columbia, Canada

Analysed available climatic and hydrologic data to prepare water management plans for pit development and closure planning for three open pits. Performed rainfall-runoff modelling for sedimentation pond sizing. Reviewed client's hydrologic studies, including derivation of design discharges.

Diavik Diamonds – Lac de Gras

Northwest Territories, Canada

Developed a water balance model, incorporating changes to site hydrologic conditions, to quantify the hydrologic impacts of the Diavik Diamond Mine project on Lac de Gras. Analysed snow survey and local stream gauging data to determine snowmelt and seasonal runoff coefficients for selected representative catchments in the Lac de Gras basin.

Oil Sands Climatic & Hydrologic Monitoring 1998 - 2002

Alberta, Canada

Managed the climate and hydrology component of the Regional Aquatics Monitoring Program. This ongoing study of various streams and lakes in the oil sands area which spans from Janvier in the south to the Firebag River in the north. It includes the Athabasca River, Muskeg River and tributaries, Birch Mountains drainages, Poplar Creek, Kearl, McClelland and Isadore's Lakes. Responsible for the collection of data from climatic monitoring stations in the area and for undertaking snow surveys in various study areas. Analysis included processing stream discharge and water level data, preparing stage-discharge rating curves and synthesizing hydrographs. All available local and regional data were compiled in a database for easy reference. Provided data support to RAMP funders and to authorized third parties, including regulatory agencies, consultants and contractors.

Nathan Schmidt

PROJECT RELATED EXPERIENCE - HYDROLOGIC ANALYSIS (continued)

Sunpine Forest Products

Sundre, Alberta

Performed regional hydrologic analyses of mountain and foothill areas comprising Sunpine's Forest Management Area for flood and fish passage events. These were used for bridge and culvert waterway opening design.

Fraser and Thompson Rivers

British Columbia, Canada

Analysed historical streamflow data from Water Survey of Canada gauging stations on the Fraser, North Thompson and South Thompson Rivers to derive discharges incorporated in the design criteria for river bank protection works at sites in Vancouver and Kamloops.

Iron Ore Company of Canada – Wabush Lake

Labrador, Canada

Responsible for the installation of flow monitoring stations on three tributaries to Wabush Lake. Tasks included siting and installation of stations, training of IOC staff in gauging techniques, developing stage-discharge rating curves and synthesizing hydrographs from continuous water level data.

Paramount Pipeline

High Level, Alberta

Performed a regional hydrologic analysis of Water Survey of Canada stream gauging data to derive design discharges for crossings of several ungauged streams in northwest Alberta.

Syncrude Canada Ltd. - Mildred Lake

Ft. McMurray, Alberta

Performed a regional hydrologic analysis of Environment Canada–Atmospheric Environment Service precipitation and evaporation data to derive inflows to approximately 70 lakes in the region. This information was used in an environmental impact study of airborne emissions on lake water quality.

Nathan Schmidt

PROJECT RELATED EXPERIENCE - MUNICIPAL SYSTEMS

City of Kamloops

British Columbia, Canada

As part of the Peterson Creek Park Erosion Control Project, designed storm sewers and outfalls to convey runoff through an urban park area downstream of a recently urbanized catchment. The areas being treated had been subject to erosion due to increased stormwater runoff, and new storm sewers were used in conjunction with timber and rockfill erosion control structures to restore and protect the park area. This project culminated in the production of tender documents, including detailed plans for construction.

City of Nepean

Ontario, Canada

Developed a hydraulic model of the water supply and sewer systems for several subdivisions in the City of Nepean as part of an ongoing infrastructure rehabilitation study. The project included processing recorded meteorological data and delineating subcatchments for model simplicity and accuracy.

City of Edmonton

Alberta, Canada

Modelled the hydraulic behaviour of the stormwater retention pond and drainage system in the Ormsby Farms subdivision of the City of Edmonton.

City of Edmonton

Alberta, Canada

Modelled the response of an overflow spillway in Edmonton's combined sewer system to extreme storm events to calculate spillage to the North Saskatchewan River and inflows to the Gold Bar wastewater treatment plant.

Nathan Schmidt

PROJECT RELATED EXPERIENCE - ENVIRONMENTAL IMPACT STUDIES

Miramar Mining Doris North Project

Nunavut, Canada

Responsible for the hydrology components of the Environmental Impact Statement for a proposed gold mine on the Hope Bay Belt. This included an assessment of effects on a local lake due to withdrawals for water supply, development of a hydrological design basis for a fisheries compensation (*No Net Loss*) plan, and provision of input data for a tailings facility water balance. This work was done in conjunction with supplemental climate and hydrology data collection.

Jivko Engineering – Mackenzie River Bridge

Ft. Providence, NWT

Contributed to environmental impact assessment, including study of effects of ferry crossing decommissioning on sediment deposition into the Mackenzie River and effects of bridge pier and approach causeway construction on physical habitat characteristics.

Canadian Natural Resources Ltd. – Horizon Mine

Alberta, Canada

Managed the surface water hydrology component of the impact analysis for the Horizon Mine project, located northwest of Ft. Mackay, Alberta. Tasks included preparation of a report detailing baseline climate, hydrology and geomorphology, identifying changes in site hydrologic conditions and sediment yields and impact on the Athabasca River due to the project and other planned developments. Managed the development of the operational water management plan, closure reclamation water management plan and Athabasca River water intake conceptual design.

Diavik Diamonds – Lac de Gras

Northwest Territories, Canada

Conducted an impact analysis to quantify the incremental hydrologic impacts of the Diavik Diamond Mine project and the cumulative impacts of the Diavik and BHP projects. Tasks included identifying changes in site hydrologic conditions and water balance as well as describing changes in sediment yields and suggesting procedures for mitigating any impact on the environment.

Winspear Resources - Snap Lake

Northwest Territories, Canada

Responsible for carrying out a baseline hydrology study, including acquisition and processing of local hydrologic data. Responsible for analysing the incremental impact of the Snap Lake Diamond Mine on the Snap Lake watershed.

Suncor Energy Inc. - Firebag In Situ Project

Alberta, Canada

Performed a field reconnaissance to determine the origin of base flow in small tributaries to the Steepbank, Muskeg and Firebag Rivers. The area was surveyed for the existence of streams fed by springs originating in the sand and gravel aquifer beneath Muskeg Mountain. Participated in public workshop to inform regulators and stakeholders about the baseline hydrology study and environmental impact study. Responsible for hydrologic components of the environmental impact study.

Ontario Hydro – Pickering NGS A Restart

Ontario, Canada

Reviewed existing data for a study climate, hydrology and lake circulation conditions at the Pickering Nuclear Generating Station. Responsible for characterizing baseline conditions for a study of the environmental impacts of restoring the 'A' generating station to operation.

Nathan Schmidt

PROJECT RELATED EXPERIENCE - WATER SUPPLY AND DRAINAGE

Government of Northwest Territories DOT

Sahtu Region, NT

Provided hydrological data collection and analysis for eighteen watercourses along the Mackenzie Valley Winter Road to assess their viability for winter water supply. These watercourses are used to supply water for winter road construction, and withdrawals during winter low flow are regulated by the Mackenzie Valley Water Board and Fisheries and Oceans Canada to prevent harm to aquatic life. The study considered site-specific data collected for the project and for previous studies, including the Mackenzie Gas Project (2002-2004) and Arctic Gas Project (1972-73), as well as long-term regional data collected by Environment Canada.

County of Vermilion River

Kitscoty, Alberta

Golder was a subconsultant to Urban Systems Limited on this water supply study for the County of Vermilion River, and was responsible for the surface water hydrology, hydrogeology and geographic information systems components of the project. Served as the Golder project manager and senior reviewer. Long-term hydrometric data were used to determine water supply availability under mean and 10-year dry conditions, including an allowance for Instream Flow Needs. The GIS component included analysis of groundwater and surface water supply as well as the results of a public consultation.

Prairie Farm Rehabilitation Administration

Barrhead, Alberta

Golder was a subconsultant to Urban Systems Limited on this water supply study for Barrhead County, and was responsible for the surface water hydrology, hydrogeology and geographic information systems components of the project. Served as the Golder project manager and was responsible for the hydrology analysis. Long-term hydrometric data were used to determine water supply availability under mean and 10-year dry conditions, including an allowance for Instream Flow Needs. The GIS component included analysis of groundwater and surface water supply as well as the results of a public consultation.

Special Areas Water Supply Project

Alberta, Canada

Responsible for estimating bridge and culvert costs for 33 crossings of a water supply canal from Nevis to Sounding Creek. This involved performing hydraulic backwater calculations using WSPRO as well as a culvert flow program, sizing of culvert and bridge openings, clearances and gradeline modifications.

Various Rivers, Creeks and Canals in Alberta

Alberta, Canada

Performed assessments of 16 major bridge crossings of rivers, creeks and irrigation canals in Alberta as part of a highway bridge maintenance and construction program. Tasks included analysis of site hydrology and hydraulic conditions including backwater calculations, flood frequency determination, flood depth and bridge clearance determination and bank protection design.

Nathan Schmidt

PROJECT RELATED EXPERIENCE – MINE SITE HYDROLOGY

Miramar Roberts and Doris Lake Hydrologic Monitoring **Nunavut, Canada**

Responsible for the installation and operation of three stream discharge monitoring stations at the Miramar Doris Hinge Project. Tasks included manual stream gauging, development of stage-discharge rating curves and processing of data used to characterize flows for development of fish habitat compensation works and tailings water decant plans under Canadian Metal Mining Effluent Regulations.

Oil Sands Regional Hydrologic Modeling **Ft. McMurray, Alberta**

Project manager for development of a regional hydrologic (HSPF) model of the oil sands region. This model has subsequently been used as the basis for several environmental impact assessment baseline reports. The model was also used as the basis for development of design runoff curves for mine operational water management.

Oil Sands Climatic & Hydrologic Monitoring 1998 - 2002 **Alberta, Canada**

Managed the climate and hydrology component of the Regional Aquatics Monitoring Program. This ongoing study of various streams and lakes in the oil sands area which spans from Janvier in the south to the Firebag River in the north. It includes the Athabasca River, Muskeg River and tributaries, Birch Mountains drainages, Poplar Creek, Kearl, McClelland and Isadore's Lakes. Responsible for the collection of data from climatic monitoring stations in the area and for undertaking snow surveys in various study areas. Analysis included processing stream discharge and water level data, preparing stage-discharge rating curves and synthesizing hydrographs. All available local and regional data were compiled in a database for easy reference. Provided data support to RAMP funders and to authorized third parties, including regulatory agencies, consultants and contractors.

De Beers Canada Mining Inc. - Snap Lake Project **Northwest Territories, Canada**

Managed the baseline hydrology study, including acquisition and processing of local snowpack, stream discharge and water level data. Responsible for the installation and operation of three stream discharge monitoring stations and one lake level monitoring station at Snap Lake. Tasks included manual stream gauging, development of stage-discharge rating curves and synthesis of hydrographs. Responsible for analysing the incremental and cumulative impacts of the Snap Lake Diamond Mine on the Snap Lake watershed and downstream areas.

Iron Ore Company of Canada – Wabush Lake Project **Labrador, Canada**

Task manager for hydrology and functional design components of this tailings management project. Responsible for the installation of five stream discharge and one lake level monitoring stations in the Wabush/Shabogamo Lake system. Hydrometric tasks included selection of station locations, data logger programming, station installation, training of Iron Ore Company of Canada staff in gauging techniques, developing stage-discharge rating curves and synthesizing hydrographs from continuous water level data. Responsible for hydrologic simulation model of the Wabush/Shabogamo Lake watershed, which was used to characterize baseline conditions and model the impacts of a tailings management system on the lake. Responsible for documenting and modeling ice conditions on the lake and assessing changes to the lake ice regime due to the tailings management system.

Nathan Schmidt

PROJECT RELATED EXPERIENCE – MINE SITE HYDROLOGY (Continued)

Suncor Energy Inc. - Firebag In Situ Project

Alberta, Canada

Managed the hydrology component of the Firebag In Situ Oilsands Project EIA. Performed a field reconnaissance to determine the origin of base flow in small tributaries to the Steepbank, Muskeg and Firebag Rivers. The area was surveyed for the existence of streams fed by springs originating in the sand and gravel aquifer beneath Muskeg Mountain. Responsible for writing the hydrology component of the EIA. Prepared erosion and sediment control plans for stream crossings on the Muskeg River, North Steepbank River, Muskeg Creek, Jackpine Creek and Wapasu Creek.

Diavik Diamonds Inc. – Lac de Gras Project

Northwest Territories, Canada

Project engineer responsible for developing a water balance model, calibrated to baseline site hydrologic conditions, to quantify changes to Lac de Gras caused by the Diavik Diamond Mine. Conducted an impact analysis to quantify the incremental hydrologic impacts of the Diavik Diamond Mine project and the cumulative impacts of the Diavik and BHP projects. Analysed climatic, snow survey and local stream gauging data to determine snowmelt and seasonal runoff coefficients from small watersheds on the east island and adjacent mainland in the Lac de Gras basin. Tasks included identifying changes in site hydrologic conditions and water balance as well as describing changes in sediment yields and suggesting procedures for mitigating any impact on the environment.

Quintette Coal – Tumbler Ridge Project

British Columbia, Canada

Project engineer responsible for analyzing existing climate and hydrology data from Quintette Operating Corporation's mine near Tumbler Ridge. Reviewed the client's hydrologic studies, including derivation of design discharges. Developed rainfall-runoff models to derive design discharges for various catchments. Prepared water management plans for the Babcock Window haul road, pit and sedimentation pond in accord with Provincial guidelines. Prepared quantity and cost estimates for construction. Prepared closure planning reports for the Deputy and Shikano Common Pits and the North Tailings Pond, including flow routing and feasibility-level spillway design.

CNRL – Primrose and Wolf Lake Expansion Project

Cold Lake, Alberta

Responsible for initial scoping of the climate and hydrology baseline study, including definition of the local and regional study areas and identification of existing sources of data. Responsible for recommendations and cost estimates for the local climate and hydrology monitoring program.

OPTI Canada Ltd. – Long Lake Project

Anzac, Alberta

Task manager for spring 2000 snow survey. Participated in initial scoping of the climate and hydrology baseline study, including identification of existing sources of data. Responsible for recommendations and cost estimates for the local climate and hydrology monitoring program.

Syncrude Canada Ltd.

Ft. McMurray, Alberta

As a project engineer on the Beaver River Diversion Project, prepared feasibility-level designs for several river diversion alternatives considered during closure planning for the Mildred Lake facility north of Ft. McMurray. Prepared quantity and cost estimates based on these designs and performed a net present value analysis to compare alternatives. During the Mildred Lake Upgrader Project, performed a regional hydrologic analysis of AES precipitation and evaporation data to derive inflows to approximately 70 lakes in the region. This information was used in an environmental impact study of airborne emissions on lake water quality.

Nathan Schmidt

PROJECT RELATED EXPERIENCE – MINE SITE HYDROLOGY (continued)

Skookumchuck Water Quality Monitoring

British Columbia, Canada

In collaboration with Crestbrook Forest Industries and the BC Ministry of Environment, Lands and Parks, four continuous water quality monitoring stations were installed in small drainage basins in the East Kootenays. These were installed to monitor water level, temperature, pH, conductivity and turbidity. Other tasks included surveys of stream geomorphology and culvert road crossings and periodic site visits for stream discharge measurements, datalogger downloads and equipment maintenance.

Sunpine Forest Products

Sundre, Alberta

Performed regional hydrologic analyses of mountain and foothill areas comprising Sunpine's Forest Management Area for flood and fish passage events. These were used for bridge and culvert waterway opening design.

Paramount Pipeline

High Level, Alberta

Performed a regional hydrologic analysis of Water Survey of Canada stream gauging data to derive design discharges for crossings of several ungauged streams in northwest Alberta.

Ontario Hydro – Pickering NGS A Restart

Ontario, Canada

Reviewed existing data for a study climate, hydrology and lake circulation conditions at the Pickering Nuclear Generating Station. Responsible for characterizing baseline conditions for a study of the environmental impacts of restoring the 'A' generating station to operation.

Nathan Schmidt

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- Schmidt, N., ed. 2005. Proceedings of the 17th Canadian Hydrotechnical Conference. Edmonton, Alberta, August 17-19, 2005, 1016 p.
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- Biftu, G., N.P. Schmidt, A. Beersing and L.F. Sawatsky. 2004. Consideration of Potential Effects of Climate Change and Resulting Hydrologic Impacts on Mine Developments. Canadian Institute of Mining, Metallurgy and Petroleum Mining North, Edmonton, 9-12 May, 2004, 8 p.
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- Mackenzie, I.B., G. Herasymuk, N. Schmidt, Z. Kovats and K. Clipperton. 2004. Environmental Impact Assessments in the Alberta Oil Sands Area. Western Canada Oil Sands Summit, Calgary, Alberta, 29-30 January 2004, 25 p.
- Schmidt, N.P. and R.H. Spigel. 2000. Second Mode Internal Solitary Waves I – Integral Properties. Fifth International Symposium on Stratified Flows, Vancouver, 10-13 July, 2000, 6 p.
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- Metikosh, S. and N. Schmidt. 2000. Developing and Implementing Effective Compensation Measures. Presented to Synergy for Prosperity: Consulting Engineers of Alberta, Alberta Transportation and Alberta Roadbuilders and Heavy Construction Association Annual Conference, Edmonton, March, 2000 (Presentation only).
- Bender, M., S. Metikosh, L. Sawatsky and N. Schmidt. 1999. Transportation Construction and Maintenance and the Protection of Fish Habitat, Transportation Association of Canada, Synthesis of Practice No. 5, Ottawa, 56 p + app.

Nathan Schmidt

- Bender, M., S. Metikosh, L. Sawatsky, N. Schmidt and D. Snider. 1999. Mitigation Strategies for Watercourse Habitats at New Road Crossings: Alberta Transportation and Utilities Fish Habitat Manual, Canadian Society for Civil Engineering Conference, Regina, SK, 10p.
- Alberta Transportation and Utilities 1999. Fish Habitat Manual: Guidelines and Procedures for Watercourse Crossings in Alberta. Co-author responsible for writing Chapter 9 – Erosion and Sediment Control Plans; Appendix I – Fish Habitat Mitigation Technique Factsheets; Appendix VII – Example Erosion and Sediment Control Plans; 2nd edition revision of Chapter 7 – Culvert Fish Facility Design, Edmonton, AB.
- Schmidt, N. 1997. Generation, Propagation and Dissipation of Second-Mode Internal Solitary Waves, Ph.D. Thesis presented to the University of Canterbury, Department of Civil Engineering, 400 p.
- Schmidt, N. 1992. Flow in Ice Covered Channels, M.Sc. Thesis presented to the University of Alberta, Department of Civil Engineering, 200 p.
- Schmidt, N., and R.H. Spigel. 1997. Advanced Flow Visualisation Techniques Used in Fluids Research, UC Research, University of Canterbury Research Committee, July 1997, pp 48-49.

Greg Unrau

Education M.Sc. Atmospheric Science, University of British Columbia, 1996
B.Sc. Atmospheric Science, University of British Columbia, 1992

Affiliations Air and Waste Management Association
American Meteorological Society

Certificates and Courses

CALPUFF Training Course, 1996
U.S. EPA Visibility Assessment Course, 2001
Campbell Scientific Corp. Monitoring / Data Acquisition Workshop, 2002
CALPUFF Advanced Topics, 2004

Experience

1998 to date	Golder Associates	Calgary, Alberta
	<i>Associate, Air Quality Meteorologist</i>	
	Air quality meteorologist specializing in atmospheric sciences; air quality assessment; atmospheric dispersion modelling; environmental assessments; transportation air quality impact assessments; air quality and meteorological monitoring programs; and the evaluation of air quality and odour impacts. Responsibilities include the day-to-day management of technical personnel and the management of numerous projects.	
1996 to 1998	SEACOR Environmental Eng. Inc.	Vancouver, British Columbia
	<i>Air Quality Meteorologist</i>	
	Managed and participated in a series of air quality projects across Canada. Involved in air dispersion modelling, regional air quality assessments, emissions inventories, ambient air quality monitoring and meteorological monitoring studies for oil and gas, agricultural, industrial and forest product companies. Specialized in atmospheric sciences; air quality assessments; atmospheric dispersion modelling; environmental assessments; transportation air quality impact assessments; air quality and meteorological monitoring programs; and the evaluation of air quality and odour impacts. Performed the day-to-day management of technical personnel and the management of numerous projects.	

Greg Unrau

PROJECT RELATED EXPERIENCE - OIL & GAS

Imperial Oil Resources Ventures Ltd.

Mackenzie Gas Project

Northwest Territories and Alberta

Air Quality and Climate Lead for the proposed Mackenzie Gas Project on behalf of Imperial Oil Resources Ventures Ltd., the Aboriginal Pipeline Group, ConocoPhillips Canada Ltd., Shell Canada Limited and ExxonMobil Canada Properties Ltd. The Project consists of three separate production fields in the Mackenzie Delta, gas gathering system and a 1200 km pipeline along the Mackenzie Valley from the Inuvik area to Northwest Alberta. Prepared baseline monitoring programs, data analysis, literature review, Air Quality Impact Assessments and reporting, as well as input into Project Permit Applications, Environmental Impact Statement components and Information Request responses. Also participated in the initial development of a Climate Change strategy for the purposes of the Environmental Impact Statement.

Nimbus Projects Ltd.

Well Test Flaring Assessment

Stettler, Alberta

Nimbus Projects, acting on behalf of Tiverton Petroleum, retained Golder Associates to assess ambient SO₂ concentrations resulting from the expansion of an oil battery located northeast of Stettler, AB. The air quality assessment was prepared to support an approval application. Provided client liaison and report review.

Chevron/Upside Engineering

Well Test Flaring Assessment

Fort Liard, Northwest Territories

Provided a dispersion modelling assessment of the F-25 well site and an associated gas dehydration facility. The well and processing facility were situated in a region of complex terrain in the Franklin Mountains of the Liard Range. Modelled various gas processing rates and facility locations to determine the optimal operating parameters that would maximize gas production while minimizing environmental impact. Provided project management, development of meteorology data for use in modelling, coordination of monitoring program, and analysis of modelling results.

Chevron Canada Resources

Well Test Flaring Assessment

Fort Liard, Northwest Territories

A well-test flaring assessment was completed for a proposed gas processing facility near Ft. Liard, NT. The project involved the estimation of facility emissions and a dispersion modelling analysis of the SO₂ emissions from a flare. The site location was in very complex terrain and required the use of the CTSCREEN model to determine the necessary flare height that would avoid ground level SO₂ concentrations above ambient guidelines. Provided project management, analysis, dispersion modelling, and results.

Trans Gas Ltd.

Pipeline Consequence Analysis

Saskatoon, Saskatchewan

An analysis to determine the extent of flammable clouds and heat risks resulting from a pipeline failure was conducted in a mixed rural-residential area of Saskatoon. The study combined the results of consequence models with local meteorological conditions to determine the likelihood of risk to people living in the area. Completed dispersion modelling and results analysis.

Greg Unrau

PROJECT RELATED EXPERIENCE - OIL & GAS (continued)

Pan Canadian Petroleum Ltd.

Ambient Air Quality Monitoring

Senlac, Saskatchewan

Golder compiled the ambient monitoring information collected in the vicinity of the company operations near Senlac, Saskatchewan. Golder also assisted with other aspects of the annual reporting for the facility. Completed data analysis and reporting.

Anadarko Canada Corporation

Well Test Flaring Assessment

Fort Liard, Northwest Territories

Conducted a well-test flaring assessment of the A-68 well near Ft. Liard, NT. The project involved the estimation of emissions from the well during the testing period and a dispersion modelling assessment to determine the resulting ground-level SO₂ concentrations. The well was located in complex terrain and the dispersion modelling was completed using the ISCST3 model. Developed meteorology data and conducted dispersion modelling.

Kick Energy Corporation

Well Test Flaring Assessment

Pembina, Alberta

Conducted a well test flaring assessment of the Pembina 10-7-48-10 W5M well. The project involved the estimation of emissions from the well during the testing period and a dispersion modelling assessment to determine the resulting ground-level SO₂ concentration in complex terrain. A management plan was developed to determine the optimal conditions and timeframe within which the well test could proceed with minimal environmental impacts. Completed meteorological review, conducted dispersion modelling and developed a flaring management plan.

Westcoast Energy Inc.

Taylor Gas Plant Dispersion Modelling

Taylor, British Columbia

Completed a detailed evaluation of the SO₂ impacts on the complex terrain surrounding the sour gas processing facility for this study. Developed pre- and post-processors (FORTRAN code and Excel spreadsheets) that were used to prepare meteorological data for input to plume dispersion models and to analyze model results. Also responsible for executing numerous CTDMPPLUS dispersion model runs using varying initial conditions.

Westcoast Energy Inc.

BC – NO_x Modelling

Taylor, British Columbia

Completed dispersion modelling of the NO_x emissions in the community of Taylor using a combination of the CTDMPPLUS and ISC3 dispersion models. Developed pre- and post-processing routines to prepare model inputs, to apply chemical transformations, and to analyze model results.

Westcoast Energy Inc.

CS-8 Compressor Station

Merritt, British Columbia

Conducted an air quality evaluation of NO_x emissions from the main-line compressor station in the vicinity of Merritt, British Columbia. The study used dispersion modelling techniques to determine the areas most likely to experience elevated NO_x and NO₂ concentrations in the complex terrain around the station. Developed meteorology data and conducted dispersion modelling.

Greg Unrau

PROJECT RELATED EXPERIENCE - OIL & GAS (continued)

Chevron Canada Ltd.

Odour Assessment of a Soil Remediation System

Oliver, British Columbia

Completed a dispersion modelling evaluation of the emissions from a soil remediation system in the heart of Oliver, BC. The study quantified the emissions from an extensive soil stripping system to establish the likelihood that odours would be detected in the homes within the community. As part of the study, an evaluation of the possible options for mitigating the air emissions was evaluated. Conducted dispersion modelling.

Consumers' Co-operative Refineries Ltd.

Air Quality Modelling

Regina, Saskatchewan

An air quality impact assessment was completed for the proposed expansion of the Consumer's Co-op Refineries Ltd. (CCRL) refinery and upgrading complex located in Regina, Saskatchewan. As part of the assessment, Golder conducted a review of the existing monitoring data and completed dispersion modelling for the existing facility and the expanded facility. To complete the modelling, both the ISCST3 and CALPUFF models were used. Developed meteorology, analysed data, and interpreted results.

TransGas Inc.

Saskatoon Pipeline Silencer Blowdown

Saskatoon, Saskatchewan

In order to mitigate possible noise concerns associated with the operation of pressure release valves along a pipeline, TransGas considered fitting valves with silencer devices. As part of the TransGas risk management program, Golder Associates conducted an analysis to estimate the physical characteristics of a gas plume as it exits the silencer device and then disperses into the air. The core analysis determined the temporal and spatial extent of the flammable regions of the plume under various meteorological conditions. Conducted dispersion modelling and analysed results.

Black Tusk Energy Inc.

Pine Creek Well Test Application

Pine Creek, Alberta

This project involved a dispersion modelling assessment of predicted SO₂ and H₂S impacts associated with a proposed well test. Results were compared to vegetation thresholds and ambient air quality guidelines to quantify potential environmental effects. Developed meteorology data, conducted dispersion modelling, and analysed results.

Paramount Resources Ltd.

Cameron Hills Project

Cameron Hills, Northwest Territories

The Cameron Hills project is a gas development that straddles the Alberta/NWT border. An air quality, noise and greenhouse gas assessment was submitted to the government of the NWT and the National Energy Board (NEB). This assessment was part of a comprehensive Environmental Impact Assessment (EIA) completed for the application process. The assessment included the preparation of a facility emissions inventory, development of a meteorological data set, and the completion of refined dispersion modelling to determine regional and local air pollutant concentrations. Developed meteorology.

Greg Unrau

PROJECT RELATED EXPERIENCE - OIL & GAS (continued)

Post Energy Ltd.

Well Test Application

Ponoka, Alberta

Conducted dispersion modelling of emissions from a sour gas well in Alberta. The assessment was completed to predict ground level SO₂ and H₂S concentrations and determine potential effects on vegetation and human health. This assessment was submitted to support an application to the EUB. Provided project management and results analysis.

Post Energy Ltd.

Well Test Application

Kaybob, Alberta

A dispersion modelling assessment of SO₂ and H₂S emissions was performed for a well test in Alberta. The study evaluated flare heights and the potential effect of ground-level SO₂ concentrations on vegetation. Provided project management and results analysis.

Equinox Engineering Ltd.

Purcell M-25 Dispersion Modelling

Fort Liard, Northwest Territories

Evaluated ground-level concentrations resulting from adding an additional well to an existing gas dehydration facility in the NWT. Dispersion modelling was performed using both worst-case screening meteorological data and five years of meteorological data from Fort Nelson, NWT. The evaluation recommended further assessment to refine predictions. Provided project management and results analysis.

Canadian Natural Resources Ltd.

C-31 Air Quality Assessment

Fort Liard, Northwest Territories

Conducted an air quality and noise assessment to address potential impacts resulting from the construction and operation of a gas dehydration facility in the NWT. Ground-level concentrations were predicted for normal operations and emergency flaring events. In addition, noise levels resulting from the facility were assessed and compared with Alberta Energy and Utilities Board (EUB) sound level limits. Greenhouse gas emissions were estimated and compared to national and provincial emissions. Finally, an impact assessment was completed on the residential effects of the project and the overall significance of each impact was discussed. Responsibilities included development of meteorology data.

Petro Canada Ltd.

7-17 Flare Stack Sizing

Hinton, Alberta

Conducted dispersion modelling for the Peppers 7-17-52-23 W5M sour gas well, located near Hinton. A number of emission scenarios were assessed using the SCREEN3 model. The capacity of the existing flare stack was determined as the maximum flow rate of gas to the stack where the SO₂ ground-level concentrations would be within the Alberta Ambient Air Quality Guidelines. Provided project management and results analysis.

Petro Canada Ltd.

5-25 Flare Stack Sizing

Hinton, Alberta

Conducted dispersion modelling for the 5-25-51-22 W5M sour gas well, located near Hinton. A number of emission scenarios were assessed using the SCREEN3 model. The capacity of the existing flare stack was determined as the maximum flow rate of gas to the stack where the SO₂ ground-level concentrations would be within the Alberta Ambient Air Quality Guidelines. Provided project management and results analysis.

Greg Unrau

PROJECT RELATED EXPERIENCE - OIL & GAS (continued)

Post Energy Ltd.

Well Test Application

Brazeau, Alberta

Conducted dispersion modelling for a well test in Alberta. The assessment considered ground-level SO₂ concentrations and presented maximums related to seasonal variability, atmospheric stability class, vegetation sensitivity and frequency of occurrence. Responsibilities included project management and results analysis.

Majestic Engineering Ltd. and Big Horn Resources

Sour Water Stripper Head Gas Flaring

Kaybob, Alberta

Conducted an air quality assessment to determine acceptable gas flow rates for flaring sour water stripper head gas. Various flow rates were calculated based on equipment specifications and ground-level SO₂ concentrations were predicted using the ISC3ST dispersion model. Recommendations were made regarding required volumes of fuel gas to achieve acceptable ground-level concentrations. Provided project management and results analysis.

Majestic Engineering Ltd. and Big Horn Resources

Dispersion Modelling of the Proposed Kaybob Well Test

Kaybob, Alberta

Performed an air quality assessment for a well test in Alberta. The AERMOD dispersion model was used to predict ground-level concentrations of SO₂, the frequency of exceeding the guideline and where these exceedances would occur. Project Manager.

Consumers' Co-operative Refineries Ltd.

Expansion Flare Stack Modelling

Regina, Saskatchewan

Conducted dispersion modelling of three upset flaring scenarios for a proposed expansion at the Consumers Co-operative Refineries Ltd. facility in Regina. This work was a follow-up to air quality assessments of a proposed facility expansion in 1999 and 2000. Developed meteorology data, conducted dispersion modelling and analysed results.

Anadarko Canada Corporation

Well Test Flaring Assessment

Fort Liard, Northwest Territories

Conducted a well-test flaring assessment of the P-16 well near Ft. Liard, NWT. The project involved the estimation of emissions from the well during the testing period and a dispersion modelling assessment to determine the resulting ground-level SO₂ concentrations. The well was located in complex terrain and the dispersion modelling was completed using the ISCST3 model. As a result of the dispersion modelling results, a management plan was developed to determine the optimal conditions and timeframe within which the well test could proceed with minimal environmental impacts. Provided project management and developed meteorology data.

Cimarron Engineering Ltd.

Well Test Flaring Assessment

Fort Liard, Northwest Territories

Performed an air quality assessment for a proposed well test and subsequent facility operations of the P-66B gas well. Facility emissions were quantified and dispersion modelling was conducted using the Industrial Source Complex (ISC3ST) model. Air quality predictions were compared to vegetation effects levels and ambient air quality guidelines. A flare management plan was also developed. Conducted dispersion modelling and developed a flare management plan.

Greg Unrau

PROJECT RELATED EXPERIENCE - OIL & GAS (continued)

Devlan Exploration

Well Test Flaring Assessment Gwich'in Settlement Region, Northwest Territories

Performed a dispersion modelling assessment of the ground level concentrations resulting from the flaring at four gas wells during deliverability testing. Provided project management and coordinated dispersion modelling assessment.

Marathon Canada Ltd.

Slave Lake System Expansion

Lubicon Lake, Alberta

Performed an air quality impact assessment to evaluate the maximum ground level concentrations resulting from the expansion of the existing Slave Lake gas gathering system. Additionally, calculation of facility emissions and refined dispersion modelling for the proposed construction of a compressor station and processing facility were conducted. Developed meteorology data, conducted dispersion modelling and analysed results.

Ranger Oil Ltd.

Fort Liard, Northwest Territories

Air and Noise Assessment of the P-66A Gas Dehydration Facility

Conducted an air quality and noise assessment for a gas dehydration facility. The project presented unique challenges due to the complex terrain adjacent to the site. The results of the air modelling and emissions evaluation were incorporated into the facility designs to ensure that operations could proceed without adversely affecting the local air quality. Developed meteorology and conducted dispersion modelling.

CEMIG

Pipeline Consequence Analysis

Brazil

Participated in the analysis of possible pipeline failures in residential areas of Brazil using a combination of consequence models with local meteorological conditions to determine the likelihood of risk to people living in the area. Conducted consequence modelling and analysed results.

Greg Unrau

PROJECT RELATED EXPERIENCE - OIL SANDS DEVELOPMENTS

OPTI Canada Inc./Nexen Canada Ltd.

Long Lake EIA Project Update

Anzac, Alberta

Provided support to OPTI Canada Inc. and partner Nexen Canada Ltd. in their application to Alberta Environment and the Energy and Utilities Board to construct and operate the Long Lake commercial SAGD project. Work included re-assessment of facility emissions and an update to the EIA that was submitted in November 2000. Provided project management, developed baseline monitoring plan, coordinated monitoring program, coordinated dispersion modelling assessment, and provided results analysis and results interpretation.

Synchrude Canada Ltd.

Modelling Assessment of FGD Options

Fort McMurray, Alberta

As part of the ongoing modifications and design considerations at the Syncrude Mildred Lake facility, Golder Associates was retained to provide an assessment of the Syncrude Emissions Reduction (SER) Project. This assessment involved modelling a variety of emission scenarios to determine the benefits associated with the installation of a Flue Gas Desulphurization (FGD) unit. Provided project management, coordinated emissions inventory, and provided dispersion modelling results analysis and results interpretation.

NO_x-SO_x Management Working Group (NSMWG)

Acid Deposition Management Options

Fort McMurray, Alberta

Golder was retained as part of an ongoing series of projects for the NSMWG committee reviewing possible air quality options for the Athabasca Oil Sands Region. The initial stage of the project involved conducting a regional analysis of possible soils impacts over various exposure times to estimate the areas of soils at risk from acid-forming emissions for each township in the region. The second stage of the project evaluated the cumulative effects of historic and future acid deposition on regional soils over a variety of time periods. As part of this project, it was necessary to develop an annual emissions profile for the region. Conducted dispersion modelling and presented results.

Canadian Natural Resources Ltd.

Airport Noise Assessment

Fort McMurray, Alberta

Golder Associates was retained to conduct a noise assessment of a proposed airport on the Canadian Natural Horizon Project site. The noise assessment was part of an application for a License of Occupation and included assessing long-term and short-term noise levels from air traffic at the site. EUB guidelines for long-term (24-hour) noise levels and WHO criteria for short-term noise levels (1 hour) were used as noise targets. The CadnaA AzB noise model was used for the assessment. Provided client liaison, project management and reporting.

OPTI Canada Inc./Nexen Canada Ltd.

Air Quality Modelling Course

Calgary, Alberta

Through the Golder Institute, Golder prepared a comprehensive 2-day course designed to introduce the concepts of dispersion modelling and air quality assessment in the Oil Sands Region. The course was comprised of 8 modules ranging in topic from oil sands history to hands on modelling exercises using SCREEN3 and CALPUFF. Prepared and delivered course materials.

Greg Unrau

PROJECT RELATED EXPERIENCE - OIL SANDS DEVELOPMENTS (continued)

Canadian Natural Resources Ltd.

SRU Stack Height Assessment

Fort McKay, Alberta

As part of the permitting and approval process for the CNRL Horizon Project, Golder conducted an assessment of ground-level SO₂ concentrations associated with stack height changes on the Sulphur Reduction Units (SRUs). Provided client liaison, project and data analysis.

Canadian Natural Resources Ltd.

Horizon Project EIA

Fort McMurray, Alberta

Golder Associates was responsible for the completion of the environmental impact assessment (EIA) for the Canadian Natural Resources Limited (CNRL) Horizon integrated oil sands mine and upgrading project. The air quality sections of the EIA evaluated cumulative air concentrations and acid deposition across the Oil Sands Region, using the CALPUFF dispersion model (3-D mode). The EIA made use of Golder's regional emissions database and 3-D meteorological data set, which covers the area from Fort Chipewyan in the north to the Cold Lake area in the south. Managed the air quality component of the assessment, liaised with clients and regulators, and provided input to the project engineering team for mitigation strategies.

Petro-Canada Oil and Gas

Meadow Creek Project EIA

Fort McMurray, Alberta

Golder was responsible for the completion of the environmental impact assessment (EIA) and application to develop a Steam-Assisted Gravity Drainage (SAGD) project in the Athabasca Oil Sands Region. The air quality component of the project evaluated acid deposition in the region as well as local and regional concentrations of sulphur dioxide, nitrogen dioxide, particulate matter, secondary particulates, carbon monoxide, reduced sulphurs, volatile organic compounds, trace metals and polycyclic aromatic hydrocarbons using the 3-D CALPUFF model. Provided project management, completed meteorological review, coordinated dispersion modelling assessment and analysed results.

OPTI Canada Inc./Nexen Canada Ltd.

Long Lake Project EIA and Project Update

Fort McMurray, Alberta

Golder was responsible for the preparation of the environmental impact assessment (EIA) and subsequent project update for the Long Lake Project, which includes an integrated Steam Assisted Gravity Drainage (SAGD) facility and upgrading complex. The air quality assessment included an evaluation of the cumulative air concentrations and acid deposition using the CALPUFF dispersion model (3-D mode). The project update made use of the Golder regional emissions and 3-D meteorological data sets, covering the area from Fort Chipewyan to south of the Cold Lake area. The use of these data sets made the update predictions consistent with the assessment approaches used on the majority of applications filed in the Oil Sands Region, as well as the work being conducted for the NO_x-SO_x Management Working Group (NSMWG). In addition, the use of the large study area and greater number of sources were effective in addressing all of the concerns raised by Saskatchewan Environment. Provided project management, completed meteorological review, coordinated dispersion modelling assessment, and analysed results.

Greg Unrau

PROJECT RELATED EXPERIENCE - OIL SANDS DEVELOPMENTS (continued)

Canadian Natural Resources Ltd.

Primrose and Wolf Lake Expansion (PAW) Project

Cold Lake, Alberta

An air quality assessment was completed to support the application for the expansion of the Primrose and Wolf Lake in-situ oil sands developments at the southern edge of the Cold Lake Air Weapons Range. The air quality assessment formed part of a comprehensive environmental impact assessment (EIA) for the project, and evaluated ground-level concentrations and acid deposition of project and cumulative regional emissions using the CALPUFF 2-D dispersion model. A noise assessment was also completed as part of the EIA, evaluating the facility and traffic noise levels likely to result from varying stages of project development. Conducting dispersion modelling, analysed results, and provided recommendations.

Shell Canada Ltd.

Jackpine Mine; Phase 1 EIA

Fort McMurray, Alberta

As part of the EIA, Golder was responsible for the completion of the air quality components of the project, which included the use of the Golder's regional emissions database and 3-D meteorological data set. The air quality assessment evaluated air concentrations and acid deposition resulting from cumulative emissions sources across the Oil Sands Region, spanning from Fort Chipewyan in the north to the Cold Lake area in the south. Air quality predictions were made using the CALPUFF dispersion model, run in the 3-D mode. Completed data review and results analysis.

Canadian Natural Resources Ltd.

Kirby Project EIA

Cold Lake, Alberta

Golder was responsible for the completion of the environmental impact assessment (EIA) and project application for the development of this Steam-Assisted Gravity Drainage (SAGD) project on the northern edge of the Cold Lake Air Weapons Range. The air quality assessment completed for the EIA evaluated local and regional concentrations of sulphur dioxide, nitrogen dioxide, particulate matter, secondary particulates, carbon monoxide, reduced sulphurs, volatile organic compounds, trace metals and polycyclic aromatic hydrocarbons using the 3-D CALPUFF model. The assessment also evaluated the cumulative acid deposition in the region and assessed possible impacts on the receiving environment. Completed analysis of results and meteorological review.

Suncor Energy Inc.

Firebag In-Situ Oil Sands Project

Fort McMurray, Alberta

Golder was responsible for the completion of the environmental impact assessment (EIA) and application to develop a Steam-Assisted Gravity Drainage (SAGD) project in the Athabasca Oil Sands Region. The project EIA included the evaluation of community and regional concentrations and regional acid deposition from cumulative activities in the area. The Firebag Project EIA represented the first application to use the CALPUFF 3-D dispersion model for simulating concentrations and acid deposition patterns. A key component of the project was addressing specific regulatory and stakeholder concerns early in the assessment process through consultation and project workshops. Developed 3-D Meteorology data, completed meteorological review, conducted dispersion modelling, provided analysis and results interpretation.

Greg Unrau

PROJECT RELATED EXPERIENCE - OIL SANDS DEVELOPMENTS (continued)

Suncor Energy Inc.

Project Millennium

Fort McMurray, Alberta

As part of the environmental impact assessment (EIA) and application for the Project Millennium expansion, Golder was responsible for the preparation of a comprehensive air quality assessment. The air assessment evaluated local and regional concentrations of selected compounds of concern, and evaluated acidic deposition impacts across the region. After the submission of the EIA, the bulk of the work involved the preparation of responses to supplemental requests from outside agencies. Interaction with local stakeholders and the communication of the assessment results was essential in the months prior to the hearings. Finally, the work required the participation in the project hearings as an expert witness on the environmental panel. Provided hearing support and data analysis.

Suncor Energy Inc.

Firebag ETS Pilot Project

Fort McMurray, Alberta

Golder was responsible for the environmental and air quality evaluation of the Enhanced Thermal Solvent pilot project, which is located adjacent to the Firebag commercial SAGD development. In addition to providing environmental support, Golder participated in the preparation of the Environmental Protection and Enhancement Act (EPEA) application for the project. Developed a monitoring plan, coordinated monitoring program and results analysis.

Cumulative Environmental Management Association

Sensitivity Mapping Project

Fort McMurray, Alberta

Golder was responsible for a detailed project to map receptor sensitivity to acid deposition in the Oil Sands Region for the Cumulative Environmental Management Association (CEMA). The project made use of acid deposition predictions made using the CALPUFF dispersion model (3-D mode) to update earlier studies highlighting soils and water bodies that might be affected by emissions from the existing and planned developments in the region. A significant component of the study involved the integration of air quality predictions and mapping of sensitive soils into a GIS model for the Oil Sands Region. Provided results analysis.

OPTI Canada Inc.

Bitumen Upgrader

Burnt Lake, Alberta

Golder prepared an air quality report that was included as part of two applications to the Alberta Environmental Protection agency and the Energy and Utilities Board (EUB) to construct an upgrading facility adjacent to a thermal oil extraction project in the Burnt Lake region of Alberta. The work involved determining the criteria pollutant emissions of SO₂ and NO_x from the facility; conducting a dispersion modelling analysis of the emissions with consideration given to Baseline, Application and Cumulative Effects impacts. Modelling was performed using both the ISCST3 model and CALPUFF for short range and long range transport respectively. Additional responsibilities included considerable client liaison and co-ordination of the report preparation. Provided client liaison, conducted dispersion modelling, and completed data analysis and interpretation.

Greg Unrau

PROJECT RELATED EXPERIENCE - OIL SANDS DEVELOPMENTS (continued)

Rio Alto Exploration Ltd.

Kirby Thermal Pilot Project

Kirby Lake, Alberta

This project involved the preparation of the air quality sections for a thermal heavy oil pilot project in the Christina Lake region. An air quality assessment of the Rio Alto Kirby Thermal Pilot Project was completed as part of the application for the project. The assessment included evaluating the existing air quality and meteorological conditions, estimating the emissions from the project and dispersion modelling using the ISC3 model to determine ground level concentrations. Conducted dispersion modelling.

Synchrude Canada Ltd.

Approval Amendment

Fort McMurray, Alberta

Golder Associates prepared an air quality assessment of the main stack at the Synchrude Canada Ltd. Mildred Lake facility in northeastern Alberta. The assessment considered five alternate emissions scenarios and predictions of ground level SO₂ and Potential Acid Input were completed for each scenario. The results of the assessment were used to evaluate environmental performance in response to changes in facility design. Provided client liaison, project management, results analysis and interpretation.

OPTI Canada Inc.

OPTI Long Lake Pilot Project

Anzac, Alberta

Golder was responsible for the preparation of an air quality assessment for the Long Lake Pilot Project, which is a scaled down version of the Long Lake commercial Project. This project includes a small-scale integrated Steam Assisted Gravity Drainage (SAGD) facility and upgrading complex. The air quality assessment included an evaluation of the cumulative air concentrations and acid deposition using the CALPUFF dispersion model (3-D mode). The project made use of the Golder regional emissions and 3-D meteorological data sets, covering the area from Fort Chipewyan to south of the Cold Lake area. Provided client liaison and project management, coordinated dispersion modelling results analysis and interpretation.

Synchrude Canada Ltd.

Episodic Modelling

Fort McMurray, Alberta

An air quality dispersion modelling assessment was conducted to evaluate the impact of upset emissions from the Synchrude Mildred Lake facility near Fort McMurray, Alberta. The project involved modelling variable hourly emissions data from sources in the region using the CALPUFF dispersion model. In addition, meteorological conditions during a brief period of high hydrogen sulphide concentrations were evaluated to determine potential impacts as well as the contribution of each source to the observed concentrations. Provided client liaison and project management, and coordinated assessment.

Greg Unrau

PROJECT RELATED EXPERIENCE - OIL SANDS DEVELOPMENTS (continued)

Syncrude Canada Ltd.

Main Stack SO₂ Animation

Fort McMurray, Alberta

Prepared an hourly animation of a dispersion modelling simulation of variable SO₂ emissions from the Main Stack at the Syncrude Canada Ltd. Oil Sands facility. The simulation was using a 3-D meteorological data set that was developed in-house. The objective of the work was to provide a realistic visual representation of the hour by hour variation in the dispersion of emissions and the extent of the plume in the Athabasca Valley. Provided project management and client liaison.

EnCana Energy

Christina Lake Thermal Project EIA

Christina Lake, Alberta

Golder was responsible for the preparation of the environmental impact assessment of the Christina Lake Thermal Project for PanCanadian Petroleum Limited, which have since merged with Alberta Energy Corporation to form EnCana Energy. The project involved the evaluation of a proposed Steam-Assisted Gravity Drainage (SAGD) project to recover heavy oil. The air quality components of the project assessed the local and regional pollutant concentrations resulting from project emissions. Completed data analysis and provided hearing support. Also helped develop an air quality and meteorology monitoring plan to fulfil the AENV permit requirements.

Imperial Oil Resources Ventures Limited

Kearl Oil Sands Project – Mine Development

Fort McMurray, Alberta

Golder was retained by Imperial Oil to aid in preparation of the environmental impact assessment for the Kearl Oil Sands Project. Provided technical support, supplemental response support, and hearing assistance.

Greg Unrau

PROJECT RELATED EXPERIENCE - MANUFACTURE

Erco Worldwide

Monitoring Data Review and Analysis

Saskatoon, Saskatchewan

Golder Associates was retained to conduct a review and analysis of the ambient air quality data collected in the vicinity of the ERCO Worldwide chemical production facility located in Saskatoon, Saskatchewan. This review and analysis was completed as part of a comprehensive State of the Environment report. Provided data collection, client liaison, and reporting.

Shermag Ltd.

Air Quality Assessment

Bishopton, Québec

Golder was retained to conduct an air quality assessment for a furniture manufacturing company in response to odour complaints. Dispersion modelling was conducted for a large array of volatile organic compounds (VOCs) to obtain ground level concentrations at receptors in the surrounding community. A Fortran program was developed to facilitate the calculation and statistical analysis of a large number of modelled compounds. Provided project management, dispersion modelling and reporting.

Greater Vancouver Regional District

Ashcroft Ranch Landfill EIA

Ashcroft Ranch, British Columbia

Golder was retained by the Greater Vancouver Regional District to provide technical support for the development of the proposed Ashcroft Ranch Landfill. The support included site design engineering and an environmental impact assessment including a comprehensive air quality and noise assessment. The air assessment included a climate and meteorological data summary, reporting of air monitoring data, assessment of criteria air pollutants, dustfall and odour assessment, as well as green house gas emission estimates. The noise assessment included a field baseline survey and model predictions of continuous and impulsive noise sources. Provided project management client liaison, technical guidance, results analysis and reporting.

Greg Unrau

PROJECT RELATED EXPERIENCE - MONITORING

EnCana Energy

Christina Lake, Alberta

Christina Lake Environmental Management

Golder was responsible for the development of an air quality monitoring program for the Christina Lake Thermal Project in the Athabasca Oils Sands Region of Alberta. The ambient monitoring consisted of four static exposure stations and one continuous station. The program included options and recommendations for equipment purchase and monitoring station locations based on the requirements of the Alberta Monitoring Directive. Documentation was prepared to provide regulators with the information necessary to evaluate the suitability and effectiveness of the planned program. Provided project management and data analysis, reporting, and client liaison.

OPTI Canada Inc.

Ambient Monitoring Program

Anzac, Alberta

Golder was responsible for commissioning an ambient air quality and meteorological monitoring station near the community of Anzac as part of the baseline air quality studies for the Long Lake Project. Provided station siting logistics, day to day management of the program, data analysis, and reporting.

Suncor Energy Inc.

Firebag Monitoring Program

Fort McMurray, Alberta

Golder was responsible for preparing the air monitoring plan for the Firebag In-Situ Oil Sands Project. The ambient monitoring plan was prepared in accordance with the requirements of the Alberta Monitoring Directive and identified monitoring locations and equipment necessary to meet the compliance requirements of the operating approval. Participated in monitoring plan development.

Murphy Oil Company Ltd.

Ambient Air Quality Monitoring

Haynes, Alberta

Compiled the ambient monitoring information collected in the vicinity of the company operations near Haynes, Alberta. Provided client liaison and reporting.

Chevron Canada Ltd.

M-25 Meteorological Monitoring

Fort Liard, Northwest Territories

This project involved implementing and managing a meteorological monitoring program at the Chevron Canada Ltd. F- 25 and K-29 wells near Ft. Liard in the Northwest Territories. The parameters monitored at each site included wind speed, wind direction temperature and solar radiation. Developed monitoring plan and coordinated monitoring program.

Domtar Canada Ltd.

Particulate Monitoring

Cochrane, Alberta

Conducted short-term particulate monitoring services to Domtar Canada Ltd. using hi-volume sampling devices. The objective of the work was to obtain estimates of airborne total suspended particulate (TSP) levels in the vicinity of an excavation site. Project manager.

Greg Unrau

PROJECT RELATED EXPERIENCE - MINING

Miramar Mining Corporation

Ambient Air Quality Monitoring

Bathurst Inlet, Nunavut

Miramar Mining Corporation is developing a gold mine near Cambridge Bay on Victoria Island in Nunavut. Golder was retained to provide background air quality and meteorological monitoring services in support of their permit application process. A Hi-Volume sampler and meteorological monitoring program was implemented during the summer months. Provided client liaison and program development.

DeBeers Canada Mining Inc.

Diamond Mine EIA

Snap Lake, Northwest Territories

An air quality assessment was completed as part of a comprehensive EIA for a proposed diamond mine northeast of Yellowknife, NWT. The project involved the evaluation and selection of dispersion models, quantification of the current and future air emissions for the construction, operation and closing phases of the project. Additional support was provided to the client in response to stake holder's questions and concerns for the technical hearing. Completed meteorological review, and provided hearing support and client liaison.

DeBeers Canada Mining Inc.

Diamond Mine Monitoring Program

Snap Lake, Northwest Territories

Provided ongoing support to DeBeers Canada for applications to the Government of the Northwest Territories to construct and operate an underground diamond mine in the vicinity of Snap Lake, NT. The monitoring programs included siting, installing, maintaining and calibrating the equipment, as well as developing standard operating procedures for the collection of samples, and completing monitoring reports. Developed monitoring plan, installed monitoring equipment, and coordinated monitoring program.

Golder, UK (GAUK)

Gold Mine Risk Assessment

Ovacik, Turkey

Golder Associates Calgary participated in a risk assessment of the Ovacik Gold Mine in Turkey. This project comprised the review and verification of risk assessment work done to characterize accidental and emergency releases. Project manager.

Inmet Mining Corporation

Izok Meteorological Monitoring

Izok Lake, Nunavut

This project involved implementing and managing a meteorological monitoring program at the Izok Lake Project in Nunavut. The parameters monitored at each site included precipitation, wind speed, wind direction, temperature and solar radiation. The meteorological monitoring formed part of a comprehensive program designed to establish baseline hydrologic and climatic conditions at the proposed mine site. Developed monitoring plan and provided project management.

Greg Unrau

PROJECT RELATED EXPERIENCE - FOREST PRODUCTS

Quesnel Incinerator

Proposed Wood Waste Incinerator

Quesnel, British Columbia

Golder was retained to conduct an air quality assessment of Particulate Matter (PM) from a proposed wood waste incinerator in the town of Quesnel, B.C., as part of a Phase II assessment. The PM emissions were modelled with a regional set of emissions and 3-D CALMET data set. Provided client liaison, results analysis and reporting.

Louisiana Pacific Canada Ltd.

Ambient Air Monitoring

Minitonas, Manitoba

Reduced and analysed meteorological and air quality data collected as part of an ambient monitoring program at an OSB facility. Also participated in project management, client liaison and proposal preparation for subsequent contract extensions.

Louisiana Pacific Canada Ltd.

Dispersion Modelling & Health Risk Assessment

Minitonas, Manitoba

Participated in a dispersion modelling and human health risk assessment of airborne emissions originating from a wood products facility. Prepared model input file, executed model, and prepared report, and provided management and client liaison.

Louisiana Pacific Canada Ltd.

Ambient Air Monitoring

Dawson Creek, British Columbia

Participated in the design of a meteorological and ambient air quality monitoring system in the vicinity of an OSB facility in the community of Dawson Creek. Provided program design, equipment procurement and client liaison.

Weyerhaeuser Canada Ltd.

Environmental Monitoring Program

Review Prince Albert, Saskatchewan

Conducted a review of air quality and meteorological monitoring data collected over a 10 year period at the Prince Albert pulp and paper facility. The review objective was to identify parameters that could be monitored less frequently or be eliminated from the program completely. Completed data analysis and report preparation.

Canadian Pulp & Paper Association

Dispersion Modelling of PM₁₀ and PM_{2.5}

Western Canada

Conducted a series of dispersion modelling analyses on the PM₁₀ and PM_{2.5} emissions from two Kraft pulp mills in Western Canada as part of an evaluation of the implications of the proposed Canada-Wide standards for fine particulate matter. At the conclusion of the analysis, a brief presentation was made to the members of the CPPA sub-committee dealing with the implications of the regulations on the Canadian pulp and paper industry. Conducted dispersion modelling, analysed results and completed reporting.

Greg Unrau

PROJECT RELATED EXPERIENCE - GOVERNMENT

National Emission Inventory Task Group

Road Dust Assessment

Vancouver, British Columbia

Participated in a study of fugitive dust emissions from urban roads as part of the National Pollutant Release Inventory (NPRI) program. Helped plan the sampling program, collected samples and analysed the results.

Municipality of Anchorage

Hazard Assessment

Anchorage, Alaska

Provided a risk assessment of the hazards associated with a potential petroleum tank spill in Anchorage, Alaska. The Automated Resource for Chemical Hazard Incident Evaluation (ARCHIE) model was used to determine the pool fire and ignition hazards associated with a vapour cloud originating at the spill location. Both Naptha and unleaded gasoline spills were considered for this assessment. Completed conducting hazard modelling and prepared report .

Alberta Agriculture, Food and Rural Development

Environmental Assessment of Intensive Agriculture

Alberta

Participated in the assessment of potential environmental effects associated with increasing the levels of intensive agricultural activity in the province. Several different provincial growth scenarios were considered. Provided client liaison and completed data analysis.

Greg Unrau

PROJECT RELATED EXPERIENCE - POWER AND INDUSTRIAL EXPERIENCE

Northwest Territories Power Corporation

Air Quality Assessment

Northwest Territories

An air quality assessment of 21 power generating stations in the Northwest Territories was completed for NTPC. The work involved a preliminary screening of all sites, followed up by detailed evaluation of sites with possible health risks, as identified in the screening analysis. The detailed evaluation involved refined emissions calculations and dispersion modelling to predict ground-level impacts of selected compounds. Provided client liaison, developed meteorology data, analysed results, and provided interpretation.

Lehigh Inland Cement Ltd.

Substitution Fuel Project

Edmonton, Alberta

Golder Associates were retained to prepare the Environmental Protection and Enhancement Act (EPEA) application for the proposed conversion of the Lehigh Inland Cement facility in Edmonton to allow the use of coal as a primary fuel. The project involved a detailed review of the facility emissions, estimation of resulting off-site concentrations, evaluation of current operations and recommendations for future mitigation. Liaison with regulators during the application process formed an integral part of the air quality assessment. Provided data analysis and client liaison.

Domtar Canada Ltd.

Particulate Monitoring

Cochrane, Alberta

Conducted short-term particulate monitoring services to Domtar Canada Ltd. using hi-volume sampling devices. The objective of the work was to obtain estimates of airborne total suspended particulate (TSP) levels in the vicinity of an excavation site. Project manager.

Greg Unrau

PRESENTATIONS AND PUBLICATIONS

Unrau, G.D., M.A. Rawlings, and W.E. Speller. 2002. *Air Quality Assessments in the Athabasca Oil Sands Region: An Airshed Approach*. The Resources 2 Reserves 2 Results Conference, Calgary, AB, November.

Unrau, G.D., M.A. Rawlings, and S.A. Scott-Longley. 1998. *Evaluation of Particulate Concentration in Hinton and Skookumchuck*. The Canadian Pulp and Paper Association, Air Quality Sub-Committee Meeting, Toronto, ON, November.

Unrau, G.D. and W.E. Speller. 2001. DeBeers poster session.