BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

LORAX ENVIRONMENTAL

WOLFDEN RESOURCES INC

ULU EXPLORATION PROJECT

ULU MINE WASTE ROCK AND ORE STORAGE PLAN

FINAL

PROJECT NO.: 0385-002-02
DATE: MARCH 21, 2005

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Project No. 0385-002-02
Date: March 21, 2005

Mr. Dave Stevenson, P.Geo.
Project Manager
Wolfden Resources Inc.
309 South Court Street
Thunder Bay, ON
P7B 2Y1

Re: Ulu Mine Waste Rock and Ore Storage Plan

Dear Dave:

Please find attached four hard copies of our above referenced final report dated March 21, 2005. As requested, an electronic PDF version of this report has been forwarded to you as well. This report has been revised to include the comments received from Wolfden Resources Inc. on the draft report dated February 25, 2005 and teleconference discussion held on March 3, 2005.

Should you have any questions or comments, please do not hesitate to contact me at the number listed above.

Yours truly,

BGC Engineering Inc.
per:

REGISTERED PROFESSIONAL ENGINEER
March 23/05
H. H. HARTMAIER
LICENSEE
N.W.T.

Holger Hartmaier, M.Eng., P.Eng.
Senior Geotechnical Engineer

Lorax Environmental Services Ltd.
per:

Bruce Mattson, M.Sc., P.Geo.
Senior Environmental Geoscientist

HHH/sf

PERMIT TO PRACTICE
BGC ENGINEERING INC.
Signature
Date March 23, 2005
PERMIT NUMBER: P 285
The Association of Professional Engineers, Geologists and Geophysicists of the Northwest Territories

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LIMITATIONS OF REPORT

This report was prepared by BGC Engineering Inc. (BGC) and Lorax Environmental Services Inc. (Lorax) for the account of ***Wolfden Resources Inc.*** The material in it reflects the judgement of BGC/Lorax staff in light of the information available to BGC/Lorax at the time of report preparation. Any use which a Third Party makes of this report or any reliance on decisions to be based on it are the responsibility of such Third Parties. BGC Engineering Inc. and Lorax Environmental Services Inc. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

As a mutual protection to our client, the public, and ourselves, all reports and drawings are submitted for the confidential information of our client for a specific project and authorization for use and / or publication of data, statements, conclusions or abstracts from or regarding our reports and drawings is reserved pending our written approval.

1.0 INTRODUCTION

Wolfden Resources Inc. (WRI) are currently undertaking an advanced exploration program at the Ulu Mine site, located in Nunavut at longitude 110^o 58' W and latitude 66^o 54' N, on NTS map sheets 76 L/14 and 15 (Figure 1).

On March 23, 2004, the Nunavut Water Board (NWB) authorized the transfer of water license NWB1ULU0008 from Echo Bay Mines (EBM), a subsidiary of Kinross Gold Corporation (Kinross), the former licensee, to WRI (NWB, 2004). The expiry date of this license is June 30, 2008. The license entitles WRI to use water and dispose of waste for the purposes of advanced exploration, subject to the restrictions and conditions contained within the license. Under Part D of the license (Conditions Applying to Waste Disposal), Item 11 states the following:

The Licensee shall submit to the Board for approval … a Waste Rock and Ore Storage Plan to address the management of all drainage from ore and waste rock storage areas, both permanent and temporary, over the term of the Licence. The plan shall include, but not be limited to the following:

- *a. A site map to scale, identifying the ore and waste rock storage areas, the settling pond(s) and downstream receiving areas;*
- *b. A schedule of ore stockpiling, non-hazardous waste generation, coarse tailings and waste rock production by rock type, tonnage and destination over the term of the Licence;*
- *c. A complete description, including site maps to scale, each of proposed ore and waste rock storage facility or area:*
- *d. An identification of all potential sources of mine drainage from each storage site and the distance to the downstream receiving environment;*
- *e. Detailed proposals for management of each flow, including water quality monitoring, collection, treatment, rerouting and final disposal;*
- *f. Detailed dump construction plans and drainage management on rock types that may be identified as problematic through ARD testing, including contingency plans for controlling runoff and seepage water chemistry; and*
- *g. Temperature analysis of all waste rock storage areas having ARD potential to include the effect of oxidation reactions on predicted ARD generation rates.*
- *h. Intermittent ARD testing of waste rock used in construction and/or stockpile areas.*

The waste rock and ore storage plan provided herein, addresses both permanent and temporary storage over the term of the existing Water Licence for advanced exploration use only, until June 30, 2008 at the Ulu Mine site. A new water licence would be required to cover the potential full-scale mining phase of the project.

2.0 SCOPE OF WORK

BGC Engineering Inc. (BGC), in combination with Lorax Environmental Services Ltd. (Lorax), undertook the following scope of work to prepare this plan:

- Acid rock drainage (ARD) and metals leaching issues were assessed by Lorax, including:
  - Review of water quality baseline report, existing geochemical reports and metals database (existence of significant concentrations of arsenic and sulphur in the low sulphur waste rock.).
  - Review of geological model relative to planned exploration development work.
  - Preparation of the exploration ARD sampling protocol and waste storage considerations.
  - Preparation of mass balance environmental tolerance model for East Lake system.

- BGC undertook the following technical tasks with respect to plan development:
  - Preparation of detailed site map including mine waste storage areas and elements of the downstream receiving water system.
  - Preparation of a schedule of ore and waste rock production by tonnage and lithology, as directed by WRI.
  - Obtained watershed areas for East Lake and West Lake and derived simple water balance resulting from upslope run-off for input to Lorax mass balance model.
  - Developed a storage capacity curve for East Lake.
  - Formulated conceptual dump construction plans and drainage management details, as dictated by the nature of the potential run-off and the assimilative capacity of the downstream receiving water.
  - Obtained technical input on current water quality based on 2004 sampling program as well as future monitoring and collection requirements.

Gartner Lee Limited (GLL) provided preliminary baseline water quality data for the Ulu Mine site, based on the 2004 baseline environmental studies that were conducted as part of the overall Ulu-High Lake project,

This plan, provided herein, addresses the requirements of Part D, Item 11 of the Water Licence.

3.0 PROPOSED EXPLORATION AND DEVELOPMENT PROGRAM

Figure 2 presents an overall plan of the existing Ulu Mine site. Figure 3 is an oblique aerial view of the Ulu Mine site showing the location of the existing ore and waste storage pads, with respect to the major mine infrastructure. Figure 4 is an isometric section showing the existing underground development and the proposed underground extension work to be carried out over the next two years.

The underground workings were developed by EBM to the 155 level. Portal excavation commenced in August 1996 and 632 metres of ramp (to just above the 75 metre level access) and lateral development were completed by year end. In 1997, the ramp was extended to the 155 metre level. Level accesses were developed on the 75, 95, 115 and 135 levels, as well as an escape way raise (temporary fresh air supply raise) from surface to the 135 metre level. Diamond drill platforms were developed on 100 and 120 levels. The project was shut down due to low gold prices in August 1997 (EBM, 1997). A small amount of waste rock is currently stored on the waste pad immediately outside the portal. Approximately 2200 tonnes of ore was recovered as a bulk sample during the 1996-97 development program and is currently stockpiled on the ore storage pad.

The proposed extension will follow the original EBM plan to extend the ramp down to the 315 level. This program will be carried out over the next two years. EBM originally estimated there would be about 253,800 tonnes of waste rock generated during the development down to the 315 level (Wolfden, 2004 and BGC, 2003). Presumably, about one-half of this amount (126,900 tonnes) is already on the surface. Therefore, another 126,900 tonnes of waste rock will be produced during the exploration program.

Previously, the waste rock was used to construct the existing camp pad, sections of the existing road network and to build the existing waste rock and ore storage pads. Approximately 1500 tonnes of waste rock was placed into the portal area to seal the underground workings when the mine was closed in 1997. This material will have to be removed and stockpiled on the waste rock pad in order to regain access underground.

The 2005 exploration and development program by WRI will consist of establishing, or extending, ore zone access cross-cuts on the 25, 50, 75, 95, 115, and 155 levels. Drifting and raising within the ore will also be performed on these levels. Concurrent with this development, 20,000 m of exploratory and definition drilling will be conducted to confirm grade and continuity of the deposit at various levels.

The 2006 exploration and development program, if warranted, would extend the ramp to just below the 315 m level. Ore zone access cross-cuts would be driven off the ramp at the 155, 175, 215, 235, 255, 275, 295 and 315 levels. Alimak chambers and the excavation of Alimak fresh air raises will be driven on 135 and 275 levels. Ore drifting will be carried out from the ore access cross-cuts on the 135, 175 and 235 levels. Drifting will also cross-cut the ore zones on the 275 and 315 levels.

During this exploration and development phase of the project, all ore and waste rock will be brought to the surface and stored on the existing storage pads until mine production starts. Table 1 presents a schedule of the estimated volumes and tonnages of material to be placed at surface, based on the original EBM development plan. The amount of ore to be brought to surface during the exploration program will depend on the details of the ore delineation work required, but will not exceed 106,000 tonnes over the two years of this program. This would include the small volume of ore that was brought to the surface in 1997 and is currently stockpiled on the existing ore storage pad.

Table 1- Exploration Phase Schedule of Ore and Waste Rock Production

YEAR	ORE		WASTE	
	Volume (m^3)	**Tonnes**	**Volume (m^3)**	**Tonnes**
1 (2005)	17,667	53,000*	36,333	109,000
2 (2006)	17,667	53,000	5,967	17,900
Sub-total exploration phase	**35,334**	**106,000**	**42,300**	**126,900**

*Includes ore already at surface.

Deposition of waste rock at the surface is only anticipated to occur during the first two years of exploration development. Waste rock transported to the surface will be stored on the waste rock storage pad and will not be used for construction at the project site. Once the mine has been approved for production, WRI intends on using this waste rock to backfill the mined out underground openings.

The intent of this storage plan is to minimize potential environmental impacts, primarily related to the generation of acid rock drainage (ARD) or the leaching of metals from the waste rock and/or ore, during the period of the advanced exploration program only, which covers the remaining term of the existing water licence. The subsequent production phase of the operation, will be covered under the terms and conditions of a new water licence.

4.0 ORE AND WASTE ROCK CHARACTERIZATION

4.1 Background Information

As part of this assessment, Mehling Environmental Management Inc. (MEMI) undertook a review of the previous kinetic test work done by Klohn-Crippen (KC) in 1998 (See Appendix I) for Kinross, as well as the field column test work performed by EBM (MEMI, 2004 in Appendix II). In 2003, BGC prepared a waste rock and ore storage technical report, based on a review of existing project documents dating back to 1991. This report provided technical input into the design and planning of the storage plan, including an assessment of various options for the management of waste rock and ore at Ulu (BGC, 2003). The reader is referred to the above reports for details concerning the assessments carried out. The following sections will summarize the pertinent findings with respect to the current ore and waste rock storage plan.

Management of ore and waste rock is based on two geochemical issues, ARD and metal leaching.

4.2 Acid Rock Drainage

Acid-base accounting (ABA) measures the acid potential (AP) and neutralizing potential (NP) of a sample. A ratio of the two determinations (NP/AP) is referred to as the Net Potential Ratio (NPR), which is generally used to predict if a sample is potentially acid generating (PAG) or non-acid generating (NAG).

4.2.1 Net Potential Ratio (NPR)

Based on the humidity cell (kinetic) and field column tests data, Klohn (1998) determined that material with an NPR<3 is classified as PAG. Although Klohn suggested material having a NPR between 3 and 7 may also be PAG based on low temperature kinetic testing, MEMI (2004), noted that the high rinse volumes of the laboratory tests would not measure the true rate of carbonate depletion. Due to the laboratory effect of high volumes of deionized water relative to the amount of sample solids, a disproportionate amount of NP is rinsed from these samples at the low rates of sulphide oxidation measured in the low temperature laboratory tests. The underlying assumption when evaluating the relative depletion of NP and sulphide is that the calcium and magnesium are released from carbonate mineral dissolution in direct response to the acidity produced from sulphide oxidation. However, laboratory artefacts overwhelm this process for materials that have relatively low sulphide oxidation rates. Under these conditions, carbonate dissolution is predominately in response to the volume of deionised water added to the cell rather than in direct response to the neutralization of acidity produced from sulphide oxidation. Due to the disproportionately high water to solids ratio used during humidity cell testing, relative to the amount of water infiltrating through a mine waste storage facility, the effect of carbonate dissolution under field conditions was not accurately reflected by the Ulu laboratory kinetic tests. The Ulu humidity cells had sulphate release rates <5 mg/Kg/cycle. Typically, a sulphate release rate of 10 to 20 mg/Kg/cycle is required for the primary carbonate dissolution process to be the neutralization of acid produced from sulphide oxidation.

Given the available kinetic test results, Ulu material with a NPR <3 should be classified as PAG. In the future, following determination of the carbonate mineralogy and further kinetic testing a NPR criterion of 2 may be deemed more appropriate to differentiate between PAG and NAG materials.

Figure 5 is a plot of Total Sulphur content versus NPR by rock type (MEMI, 2004). The plot indicates that lithology alone cannot be used to segregate the NAG material as illustrated by samples of the same rock type having NPR values both greater than and less than the PAG criterion of 3.0. Section 6.1 provides a recommended protocol to be followed during the advanced exploration program to differentiate PAG and NAG waste rock.

4.2.2 Total Sulphur Content

The AP of the Ulu samples was calculated from the total sulphur content by multiplying $\%S_{Tot}$ by 31.25 to convert to Kg $CaCO_3$ / tonne of waste rock (Klohn, 1998 and MEMI, 2004). The existing Ulu ABA database indicates that materials with a total sulphur content > 0.2% have an NPR < 3 and could be considered PAG (MEMI, 2004).

4.2.3 Ore

Acid rock drainage assessment test work conducted to date on ore samples from the Ulu project includes:

- Static testing on whole ore samples (Rescan, 1991, Klohn, 1996 and 1998);
- Kinetic testing (Klohn, 1998), comprising:
  - Coarse ore (>1.5 mm fraction) humidity cell at 22^{o} C;
  - Same coarse ore (>1.5 mm fraction) humidity cell @ 4^{o} C;
  - Fine ore (<1.5 mm fraction- called tailings), humidity cell @ 22^{o} C;
  - Field column testing (Klohn, 1998, EBM, 2002) on the same coarse ore sample (>1.5 mm fraction).

The characteristics of ore samples collected to date, along with deposit mineralogy, suggests that all ore will likely have a NPR <3. Therefore, all ore should be classified as PAG (MEMI, 2004). The pre-test total sulphur content of the coarse ore sample (> 1.5 mm) and the fine ore sample (<1.5 mm) used in the humidity cell test were determined to be 1.14% and 1.63% respectively (Klohn, 1998). The sulphur content of ten samples tested in the database ranged from 0.15% to 2.24% (MEMI, 2004).

Compared to kinetic test results from other sites, the reactivity of the Ulu ore in terms of neutralization potential (NP) and sulphur leaching rates are low (MEMI, 2004). The coarse ore field column did not produce acidic drainage in five years of testing. Lag times to produce acidic drainage, even for relatively high-sulphide samples (i.e. 1.2 to 1.5% total sulphur) and fine grain sizes (<1.5 mm), are likely to be on the order of decades. Given the characteristics of the coarse ore and fine ore or tailings samples used in the kinetic tests relative to the current sample database, the humidity cell and field tests appear to provide reasonable worst case results, rather than average or expected results from ore materials (MEMI, 2004).

4.2.4 Waste Rock

In addition to reviewing previous static acid-base accounting (ABA) test work, Klohn (1998) carried out humidity cell tests on a waste rock composite sample at 4°C and 22°C (i.e. room temperature). The pre-test sulphur content of waste rock used in the humidity cell test was determined to be 1.17% (Klohn, 1998). The mean sulphur value for the 37 waste rock samples in Klohn (1996) was 0.68%, indicating that a significant portion (approximately 50%) of the waste rock may have sulphur levels above 0.2%. The sulphur content of 37 samples in the database ranged from 0.01% to 3.91% (MEMI, 2004), suggesting that a portion of the waste rock may be more reactive than the tested samples (MEMI, 2004). Based on the ABA database of 37 samples compiled to date, and a threshold NPR of 3 for separating PAG and NAG material:

- gabbro and diabase material for the most part are likely to be NAG;
- greywacke may be PAG or NAG depending on the sulphur content;
- mafic volcanics are likely to be PAG;
- basalt material is highly variable, but generally PAG.
- The altered material associated with the ore is also PAG.

As noted in Figure 5, lithology alone cannot be used as a criterion for segregating PAG and NAG waste rock.

4.3 Metal Leaching

4.3.1 General

The results of the kinetic test program undertaken by Klohn (1998) were also used to evaluate the metal leaching potential of the waste rock and ore. The solid phase concentrations of the field column samples are compared with the Ulu solid phase database in Figure 6. The database includes exploration drill hole assays from over 2800 samples. It is apparent from the figure that the coarse ore sample that was included in the B1 humidity cell and both field columns has an arsenic concentration greater than any other sample in the database. Similarly, even greater arsenic concentrations were measured in the fine ore sample (<1.5 mm size fraction) that was placed in the B3 humidity cell. The coarse ore sample from the B1 humidity cell and field columns was used to predict the potential worst-case for metal leaching from prospective ore produced from the Ulu deposit. Thus, the arsenic drainage concentrations from these materials should be viewed as extreme and predictions of arsenic drainage chemistry from these test materials account for this.

4.3.2 Ore

Two coarse ore and one fine ore samples were run in humidity cells for approximately 40 weeks (MEMI, 2004). Arsenic and zinc leaching were found to be a concern at neutral pH. Arsenic leaching from ore samples at neutral pH appears to occur rapidly under field conditions and may exceed the federal Metal Mine Effluent Regulations (MMER) maximum allowable values (MEMI, 2004). Based on the discharge standards presented in the Ulu water licence (Part D, Item 4), arsenic levels are likely to be elevated at the site. Zinc concentrations, although elevated, are likely to be below the discharge standards.

4.3.3 Waste Rock

Klohn (1998) did not consider metal leaching to be a potential problem for waste rock, based on kinetic test results and the geological description of the ore deposit. The current database however is limited (MEMI, 2004) and metal content may be elevated in portions of the waste rock, especially close to the orebody where there is a potential for significant arsenopyrite mineralization, which may leach problematic levels of arsenic. Field column tests were not conducted on the waste rock. However, arsenic release from the room temperature waste rock humidity cell was typically less than the detection limit of 0.05 mg/L, which was an order of magnitude less than the concentrations measured in the ore humidity cell.

Metal leaching was not assessed under acidic conditions, as acidic conditions are not predicted to occur for decades. If acidic conditions eventually develop, leaching rates of other metals, such as copper are expected to increase.

4.4 Summary

Based on the results of the kinetic test program, ARD from ore and waste rock is not anticipated to occur during the advanced exploration program due to the lag time (i.e. decades) to the onset of acid generation. Upon completion of the advanced exploration program, the ore will stay on the storage pad until a full-scale mine is permitted. If the full-scale mine is approved, then WRI will truck the ore over a winter road to a mill to be constructed at High Lake. If the Ulu-High Lake project is shut-down during the exploration stage, then the ore may stay on the pad, or be put back underground for closure, depending on WRI’s future project plans. Alternative closure plans for the ore and waste rock stockpiles may include covering the rock with an insulating layer of clean rockfill or sand and gravel from the Ulu esker deposit, so that the stockpiles freeze in place, thereby preventing further metal leaching.

The waste rock produced during the advanced exploration program will be monitored to assess if it is PAG or NAG to confirm waste rock management practices. WRI intends to use the waste rock as backfill during the full-scale mining, particularly the PAG material. The NAG material could be used as backfill or as construction material on surface. This would be based on the results of the sampling and monitoring protocols described in Section 6.

Drainage waters from the ore pile have the potential to exceed the water licence discharge criterion of 0.5 mg/L for total arsenic (Part D,. Item 4). The ore stockpiled from the exploration development work will have to be stored at surface until it is trucked away for processing or mitigated for closure. Therefore, management of runoff from the ore storage pad will be required during the exploration program.

Metal leaching is not anticipated to be a concern for the waste rock during the advanced exploration program or following closure, provided the waste rock does not become acid generating. This is discussed in more detail in Section 5.

5.0 IMPACT ASSESSMENT

The onset of acidic conditions and/or predicted metal leaching may not necessarily result in adverse affects on the environment (MEMI, 2004). This section presents an impact assessment for the storage of ore and waste rock at the Ulu site, taking into account the mass of the material, the state of the material (frozen versus unfrozen), its volume, site temperatures and the volume of runoff and leachate that may contact the stockpile materials. The impact assessments were done for site specific conditions to define potential impacts associated with temporary and/or permanent storage of ore and waste rock on site. The water quality of East Lake, which is located adjacent to the ore and waste rock storage areas, was assessed to determine the sensitivity of the receiving environment to the predicted metal loadings.

The parameters used in this assessment include the following:

- Volume and surface area of ore and waste rock piles;
- Annual volume of precipitation;
- Source concentrations of metals from ore and waste rock piles; and
- Receiving water quality.

The following sections describe the details of each of these parameters and the assumptions made in the assessment.

5.1 Volume and Surface Area of Ore and Waste Rock Piles

5.1.1 Existing Site Conditions

According to the original EBM estimates (BGC, 2003), the total amount of waste rock expected to be produced for ramp development down to the 315 level was 253,800 tonnes or an in-situ volume of 84,600 m^3. Since the ramp was developed only to the 155 level, it was assumed that approximately 50% of this volume was brought to the surface, or approximately 126,900 tonnes or 42,300 m^3. This material was used to construct the camp pad, sections of the existing road network and to build the existing waste rock and ore storage pads. A small amount of waste rock is currently stored on the waste pad immediately outside the portal, visually estimated to be about 150 m^3. An estimated 500 m^3 of waste rock was used to plug the portal entrance. This material will be removed and placed on the waste rock storage pad at the start of development.

In addition, a stockpile of 2,227 tonnes of ore, grading at 13.82 g/t gold is stored on the ore storage pad (EBM, 1997). Assuming a specific gravity of 3.0, this represents an in-situ volume of 742 m^3.

The entire site lies within the drainage basin of Ulu Lake (Figure 7). With respect to the mine site area, the Ulu Lake drainage basin was subdivided into the portions draining towards Ulu Lake, West Lake and East Lake (Figure 8).

Table 2 gives a breakdown of the estimated volumes and surface areas of the existing ore and waste rocks at site. The surface areas were calculated using a planimeter from the available topography and site plans. Areas were calculated for the portion of the pads in each of the three drainage areas (West Lake, East Lake and Ulu Lake). The volumes of the existing pad material in each area were estimated based on assuming a 1.2 m average thickness of material under the ore and waste rock pads. The balance of the material was assumed to be in the camp pad. Note that because the camp pad volume is a derived value, the average thickness works out to be only 0.16 m from the data in Table 2. This is because it was not possible to discriminate in detail, the actual extent of pad fills within the overall camp footprint.

Table 2- Summary of Estimated Ore and Waste Rock Presently on Site

ROCK TYPE (Drainage basin)	ESTIMATED VOLUME (m^3)	SURFACE AREA (m^2)
ORE (stockpiled) (East Lake)	**742**	**260**
WASTE ROCK:		
Camp Pad (Ulu Lake)	6,575	40,693
Camp Pad (East Lake)	8,345	51,649
Camp Pad (Sub-total)	**14,920**	**92,342**
Ore Pad (West Lake)	3,756	3,130
Ore Pad (East Lake)	15,401	12,834
Ore Pad (Sub-total)	**19,157**	**15,964**
Waste Pad (East Lake)	**7,573**	**6,311**
Waste Rock Stockpile (East Lake)	**150**	**Included in waste pad**
Portal Plug (East Lake)	**500**	**Currently underground**
Waste Rock Total	**42,300**	**114,617**
Ore Total	**742**	**260**

5.1.2 Exploration and Development Stage

Table 1 summarizes the estimated in-situ (underground) volumes and mass of ore and waste rock to be produced during the proposed exploration and development program. The schedule was based on the original EBM plan, assuming that about 126,900 tonnes of waste rock had already been mined. The remaining 126,900 tonnes from the proposed ramp extension was assumed to be excavated over a two year period and will have to be stored on the existing waste rock pad. Assuming the mine goes into production after Year 2, any additional waste rock will be used as backfill underground and will not be brought to surface. As discussed in the previous sections, at least 50% of the waste rock volume is expected to be PAG. Since lithology alone cannot be used to discriminate NAG rock from PAG rock, no attempt was made to estimate the volumes of the various rock types expected to be encountered during the exploration and development mining. At the time of preparation of this report, WRI were in the process of updating the geological and ore reserve model for the Ulu deposit. Once this work is completed, it may be possible to generate a breakdown of the various rock types expected to be excavated during the development work, which may aid in waste rock management, as discussed further in Section 6.

The ore production schedule shown in Table 1 indicates that about a maximum of 35,334 m^3 (106,000 tonnes) could be produced over the 2-year exploration program. It was assumed that some of this ore has already been brought to surface and is currently stored on the ore storage pad.

5.2 Annual Volume of Precipitation and Evaporation

Rainfall data for the site is not available. BGC (2003) presented weather data for Kugluktuk Extended (includes Coppermine Station from 1930 to 1976 and Kugluktuk Station from 1977 to present) and Lupin Extended (including Contwoyto Station from 1959 to 1981 and Lupin Station from 1982 to present). The mean annual precipitation based on Lupin Extended data was 270 mm. The Kugluktuk Extended data indicated 240 mm. The site is located in semi-arid tundra. Rescan (1991) estimated the mean annual precipitation to be less than 200 mm.

Since baseline climatic data for the Ulu site was not available at the time of writing of this report, a mean annual precipitation of 207 mm was used based on recent work done on the Doris North project by Miramar (SRK, 2003 and AMEC, 2003). This value was derived from data obtained from both the Lupin extended data as well as data from Cambridge Bay, and is considered to be representative of conditions at Ulu (NHC, 2005). The mean monthly distribution of rainfall was calculated using the data from the Kugluktuk station to the 207 mm total average annual precipitation at the site as summarized in Table 3. Kugluktuk average monthly precipitation data are from the period 1978 to 2004 and the prorated distribution is assumed to represent current and future conditions for the site.

Annual evaporation is based on data from Lupin (Gibson, 2002). These data compared well with monthly evaporation rates from Finnis (2005), which were based on the ERA-40 data for the Mackenzie River Basin. ERA-40 data are from the European Centre for Medium-Range Weather Forecasts (ECMWF) forty-year reanalysis project (ERA-40). It should be noted however, that the quality of evaporation data and forecasts over the arctic is unknown (Finnis, 2005). Table 3 includes the monthly distribution of evaporation derived from the Mackenzie River Basin (Finnis, 2005) for the entire year, although evaporation was applied to the surface of East Lake only during the ice-free months, which are assumed to be from the beginning of June through to the end of September.

Table 3- Estimated Ulu Site Climate Data

	Kugluktuk Precipitation	Kugluktuk Precipitation normalized to Ulu	*Runoff Precipitation	**Evaporation Rates (mm)
Jan	10.9	9.2	0.0	2.0
Feb	9.0	7.6	0.0	2.0
Mar	10.2	8.6	0.0	10.0
Apr	12.3	10.3	0.0	20.0
May	20.6	17.3	37.1	38.0
Jun	14.9	12.5	71.8	50.0
Jul	36.3	30.5	30.5	52.0
Aug	43.3	36.4	36.4	42.0
Sep	37.6	31.6	31.6	32.0
Oct	27.0	22.7	0.0	15.0
Nov	13.3	11.2	0.0	5.0
Dec	11.5	9.7	0.0	2.0
Totals	**246.9**	**207.3**	**207.3**	**270.0**

*Snowmelt is assumed to occur in May (25%) and June (75%).
**Monthly evaporation rates estimated from the Mackenzie River Basin data (Finnis, 2005)

5.3 Watershed Data and Water Balance Model

5.3.1 Runoff

Figures 7 and 8 show the drainage areas for Ulu Lake, West Lake and East Lake. The areas of the existing ore and waste pads within each drainage were also determined (Table 2). These values were used in conjunction with the precipitation data given in Section 5.2 to estimate the source concentrations of zinc and arsenic from the existing pads and stockpiles. Runoff into East Lake was calculated as the product of surface area, precipitation and runoff coefficient. Surface areas and runoff coefficients are provided in Table 4.

Table 4 - Existing Watershed Characteristics for East Lake

	Surface Area (m^2)	*Runoff Coefficient	Future Surface Area (m^2)
Waste Rock Pad	6,311	0.75	6,311
Camp Pad	51,649	0.75	51,649
Ore Pad	12,834	0.75	15,694
Natural Watershed	550,248	0.65	547,118
Total	**621,042**	**-**	**621,042**

*From Déry et al. (2004).

The runoff coefficient for the unaltered or natural watershed draining into East Lake was estimated from Déry et al. (2004). Déry calculated regional runoff coefficients for the Upper Kuparuk Basin (North Slope of Alaska) ranging from 0.65 to 0.70. The waste rock surfaces were assumed to have a higher runoff coefficient due to enhanced infiltration and reduced sublimation and evaporation.

5.3.2 Evaporation

Evaporation from East Lake primarily occurs during the summer months when the lake is near its capacity elevation of 410 m. The surface area of East Lake at this elevation is 18,155 m^2.

5.3.3 Groundwater

The water balance does not include active layer groundwater input to East Lake from the storage pads or the natural watershed. This assumption is deemed valid during the October through May period when seasonal frost would prevent runoff water from infiltrating into the subsurface. The seasonal active layer could transmit water to East Lake during summer and fall months and will be evaluated further during exploration. Silt and clay materials would provide an excellent attenuation mechanism of stripping arsenic from groundwater through sorption onto the clay surface. However, to remain conservative, both the water balance and mass balance models do not include a groundwater component discharging to East Lake.

A groundwater discharge component from East Lake was included in the water balance to account for water discharging through sand and gravels from the mouth of East Lake toward Ulu Lake. Lateral outflow from East Lake was modeled as groundwater flow within a narrow (~25 m wide) zone toward Ulu Lake through the shallow active layer (~2 m depth). The average gradient from East Lake to Ulu Lake is 0.05. Regional permafrost was assumed to be thick and pervasive, thereby limiting deep groundwater movement (Gibson, 2002).

Groundwater seepage from East Lake was estimated using Darcy's Law:

$$Q\ (m^3/s) = KiA$$

where K = hydraulic conductivity, i = gradient, and A = cross-sectional area.

Hydraulic conductivity is the largest uncertainty in this equation. It was assumed that the channel leading to Ulu Lake was a sand or sand-gravel with an elevated hydraulic conductivity on the order of 2×10^{-4} m/s.

The resulting monthly flow emanating from East Lake is approximately 1,300 m^3. Due to permafrost conditions typical for this region, it is assumed that this shallow groundwater flow does not occur from October to May. The seasonal distributions for the water balance parameters for the current ore and waste pad configurations are listed in Table 5.

Table 5 - Water Balance Results for East Lake

INPUTS						LOSSES					
Month	Waste Rock Pad Input (m^3)	Camp Pad Input (m^3)	Ore Pad Input (m^3)	Natural Watershed Input (m^3)	Total Input (m^3)	Evaporation Loss (m^3)	Groundwater Loss (m^3)	Net Output (m^3)	Lake Storage (m^3)	East Lake Surface Water Outflow (m^3)	Total Outflow (m^3)
1 (J)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40900	0.0	0.0
2 (F)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40900	0.0	0.0
3 (M)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40900	0.0	0.0
4 (A)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40900	0.0	0.0
5 (M)	175	1436	357	13191	15160	2890	1296	13174	40900	13174	14470
6 (J)	340	2782	691	25561	29375	3803	1296	27171	40900	27171	28467
7 (J)	144	1181	293	10846	12464	3955	1296	10224	40900	10224	11520
8 (A)	172	1408	350	12937	14868	3195	1296	12809	40900	12809	14105
9 (S)	149	1223	304	11234	12911	2434	1296	11034	40900	11034	12330
10 (O)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40900	0.0	0.0
11 (N)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40900	0.0	0.0
12 (D)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40900	0.0	0.0

The first time step begins in July under the assumption that the lake is full, with a volume of 40,900 m^3, following spring runoff. Subsequent time-steps balance lake volume as the sum of the lake volume from the previous time-step and the Net Output from the current time-step. Note, however, that estimates indicate that the lake level does not drop below the outflow elevation for an average year. Figure 9 illustrates the monthly time-series for East Lake surface water outflow, total outflow and storage volume based on data in Table 5. The total outflow is composed of both surface water and groundwater flow estimates emanating from East Lake.

Monthly flow estimates for the waste rock pads are illustrated in Figure 10. The monthly runoff or hydrograph for these catchments mimics the water balance for East Lake, as the timing for delivery of runoff has not been changed. Although infiltration into the waste rock may delay runoff to East Lake, the waste rock pad depths are shallow (approximately 1.2 m). Delay of runoff is assumed to be less than the resolution of this model (monthly time-step) and therefore has not been taken into account.

5.4 Source Concentrations from Existing Pads and Stockpiles

Source concentrations of pH-neutral drainage from the waste rock and ore storage pads were initially predicted from the combined results of the field columns and humidity cell testing. Parameters included in the existing Ulu Water Licence, pH, sulphate, arsenic, copper, lead, nickel and zinc, were evaluated. Waste rock field columns were not initiated on-site, thus, the relative loading observed between the ore and waste humidity cells was used to predict the relative concentrations from waste rock. These waste rock drainage concentrations were subsequently modified using the East Lake mass balance model to calibrate to the measured baseline water sampling. This section describes the derivation of the ore and waste rock drainage chemistry using the kinetic test data. The predicted waste rock drainage chemistry was subsequently modified using the mass balance approach with existing water quality sampling from East Lake.

Those concentration values initially predicted for waste rock drainage from the ore field columns are presented in Table 6. Comparison of humidity cell metal loadings between B1 ore sample and the B2 waste rock samples at room temperature indicated that sulphate and zinc loading from the ore and waste rock is comparable (MEMI, 2004) and these values were applied directly to waste rock. However, arsenic loading from the B1 ore humidity cell sample is at least five times to an order of magnitude greater than from the B2 waste rock sample, which consistently released arsenic below the detection limit. Thus, predicted arsenic concentrations from waste rock were reduced by an order of magnitude from those observed from the ore field columns. The average concentrations from the field columns for copper, lead and nickel were initially applied to both ore and waste rock. The relative loadings of these parameters could not be determined from the humidity cells because both the ore and waste rock room temperature humidity cells released these metals at rates below their respective detection limits (Klohn, 1998).

Table 6 – Initial Waste Rock Source Concentrations Predicted from Kinetic Test Data and On-Site Mass Balance

	Waste Rock Drainage Concentrations Prorated From Column Data (mg/L)		Revised Waste Rock Concentrations from Mass Balance (mg/L)	
	Years 1-3	Year 4 +	Years 1-3	Year 4 +
pH	7.5	7.5	7.5	7.5
SO4	152	418	152	200
As	0.028	0.057	0.0028	0.0057
Cu	0.013	0.016	0.007	0.005
Pb	0.001	0.001	0.00001	0.0001
Ni	0.006	0.006	0.03	0.02
Zn	0.057	0.034	0.06	0.01

The predicted waste rock drainage concentration values were used in the mass balance model and calibrated to the existing East Lake baseline water quality. Revised waste rock concentrations were applied to all the existing pads at the site including the waste rock pad, camp pad and ore storage pad. The revised waste rock concentrations based on the calibration are listed in Table 6. A comparison of the initial and calibrated East Lake water quality using the existing mine configuration and baseline water quality is illustrated in Appendix III.

The rationale for calibrating drainage chemistry predictions using the mass balance model is that the waste rock pad, ore storage pad and camp pad have been exposed in the East Lake drainage basin since 1996 – 1997 when the exploration programs were being conducted. These facilities are predominately composed of waste rock that has been exposed to site climatic conditions and leaching metals into East Lake. Although a small volume of ore is currently stored on surface, all material is assumed to be waste rock, which provides a degree of conservatism to the waste rock drainage chemistry prediction. Determining the concentration of drainage from this existing mass of waste rock exposed at surface provides the most reliable method of predicting the impact of future accumulations of waste rock associated with the Ulu exploration project. Unlike kinetic test methods, drainage from the existing material into East Lake accounts for climatic conditions, particle size considerations and provides a more representative sample given its large volume. Given the small volume of ore currently stored at surface, this calibration process only applies to drainage water quality predictions from waste rock.

The mass balance model calibration was conducted with the assumption that the chemical constituents are conserved in the aqueous phase through the entire East Lake system. That is to say that each mg of metal released from the waste rock pad, camp pad or ore pad is accounted for in the mass storage within East Lake or discharges toward Ulu Lake. This assumption is likely appropriate for chemical constituents such as sulphate and zinc that typically remain mobile in freshwater systems. However, the net concentrations of copper and lead are quite likely affected via sorption to organic matter and arsenic sorption to iron oxides and clay minerals could also be a factor in discharge from the storage areas toward East Lake. Sorption of arsenic is particularly favoured in aquatic systems that have low alkalinity such as shield lakes and shallow groundwater systems in the arctic.

The mass balance calibration process indicated that the initial waste rock drainage predictions using the kinetic test data for sulphate, arsenic, copper, lead and zinc concentrations were inappropriately high and when applied to the mass balance model did not reproduce the concentrations currently observed in East Lake. Thus, the loading concentrations of these metals were adjusted to provide a more realistic prediction of metal loading concentrations. Zinc and arsenic concentrations were decreased by one and two orders of magnitude, respectively. Sulphate and copper concentrations were decreased by a factor of two to three times. Conversely, nickel concentrations were increased by a factor of two to three (Table 6).

5.5 Source Concentrations from Proposed Exploration Development Pads and Stockpiles

Figures 11 and 12 show the proposed modifications to the existing pads and stockpiles to accommodate the volumes of ore and waste estimated to be produced over the next three years. Details of these modifications are discussed in Section 6.2.

To minimize metal loading from the stockpiles, the surface area of the pile must be minimized in order to minimize the volume of infiltration. WRI intend to use a stacking conveyor system to maximize the height of the piles. This system eliminates the compaction associated with bulldozing the piles. The lower overall density of the stockpile makes it easier to recover the materials later on. Experience with the stacking conveyor system at the nearby Lupin Mine indicated that the stockpiles of ore and waste could be worked with a ripper, even if frozen (Wolfden, 2005). The ore pad was originally designed to store nine months of production or about 160,000 tonnes of ore (EBM, 1997).

The in-situ volumes of ore and waste to be stored on site were given in Section 5.1.2. In order to estimate the thickness of materials to be placed on each pad, the in-situ volume was multiplied by a bulking factor of 30% representing the bulked stockpiled volume. The side slopes of the stockpiles were assumed to be at the angle of repose (assumed to be 35^o). The source concentrations from the development ore and waste were estimated using the rainfall data given in Section 5.2, and the areas and thicknesses of the ore and waste stockpiles. The ore stockpile on the modified ore pad would be 3 to 4 m thick, if placed evenly over the entire pad. The waste rock would have a thickness of about 9 m, extending over the existing pad.

Source concentrations from the ore stock pile, waste rock stockpile and the camp pads are listed in Table 7. The predicted initial drainage chemistry during the first three years of exposure of the rock and the expected drainage concentrations over the longer term at pH-neutral conditions are compiled. The time-varying trends observed from the kinetic testing (when available) and the revised predicted values were applied to the waste rock pad and the camp pad. The average concentrations from the ore field columns were applied to the ore storage pad discharge. As stated previously, application of the arsenic concentrations from ore field column leachate to the ore pad discharge concentrations should be viewed as an extreme worst case due to the extremely high arsenic content measured in the ore field column samples.

Comparison of the predicted discharge concentrations from waste rock, ore and camp pads to the Ulu Water Licence discharge criteria indicates that the expected drainage chemistry will be well within the discharge criterion for copper, lead, nickel and zinc. Only the arsenic concentrations from the ore are predicted to approach or exceed the Water Licence criterion set for the maximum average arsenic concentration (0.50 mg/L).

Table 7 - Predicted Source Concentrations from Waste Rock, Camp and Ore Pads

	Water Licence Discharge Criteria		**Predicted Camp Pad Concentrations (mg/L)**	**Predicted Waste Rock Pad Concentrations (mg/L)**		**Predicted Ore Pad Concentrations (mg/L)**	
	Maximum Average Conc. (mg/L)	Maximum Grab Sample Conc. (mg/L)		Years 1-3	Year 4+	Years 1-3	Year 4 +
pH	6.0 – 9.5		7.5		7.5	7.5	7.2
SO_4	-	-	200	152	200	152	418
As	0.50	1.0	0.0057	.0028	0.0057	0.282	**0.569***
Cu	0.30	0.6	0.005	0.007	0.005	0.013	0.016
Pb	0.20	0.4	0.0001	0.00001	0.0001	0.001	0.001
Ni	0.50	1.0	0.02	0.03	0.02	0.006	0.006
Zn	0.50	1.0	0.01	0.06	0.01	0.057	0.034

***** Bold values indicate where concentrations exceed Water Licence discharge criteria.

5.6 Receiving Water Quality

A preliminary baseline water quality assessment for the Ulu mine site was prepared by Gartner Lee Limited (GLL, 2005), which is attached in Appendix IV. A full summary of the 2004 Baseline Water Quality Assessment is currently being prepared as part of the broader High Lake Project Environmental Baseline Assessment Program.

The 2004 sampling program was developed to build on previous work carried out at the site by RL&L Environmental Services Ltd. in 1996 and 1997. The following sections provide a summary of the results with respect to metals levels for Ulu Lake, West Lake and East Lake that may be impacted by the proposed mine development.

5.6.1 Ulu Lake

Ulu Lake was previously sampled in 1996 and 1997. A comparison of those results with the 2004 data indicated a marginal increase in total zinc from below detection to a median of 0.0056 mg/L in 2004. Generally, the metal levels were low and within the recommended CCME (Canadian Council of Ministers of the Environment) guidelines with the exception of aluminum and copper during under-ice conditions. Ulu Lake exhibited elevated concentrations of copper and nickel compared to the control lake.

5.6.2 West Lake

Generally, the metal levels were low and within recommended CCME guidelines with the exception of aluminum in August 2004 (due to a drop in pH< 6.5) and copper. Levels of copper were higher during under-ice conditions and above CCME in open water conditions. Aluminum, arsenic and zinc concentrations were similar to the control lake, while copper and nickel concentrations were generally higher. The only notable changes from the 1996 sampling program was a decrease in sodium and strontium concentrations, an increase in sulphate (8.6 mg/L in 1996 to a median in 2004 of 29.1 mg/L) and an apparent increase in total zinc from below detection (<0.0005 mg/L) to 0.007 mg/L. The elevated levels of strontium seen in 1996 were thought to have originated from past exploration activities in the area. During the summer season, the levels of copper in West Lake are similar to previous results.

5.6.3 East Lake

The metal levels were low and within the recommended CCME guidelines. Aluminum and zinc concentrations were within the range of those in the control lake, while arsenic, copper, iron and nickel concentrations were higher. East Lake was previously sampled in August 1997. Overall, there was a general decrease in metal levels, specifically aluminum, calcium, magnesium, nickel, sodium, strontium and zinc.

5.7 Impact Assessment

Impacts of the proposed configuration of the waste rock and ore stored on surface were evaluated with the mass balance model. Arsenic and copper are predicted to be the metals that have the potential to approach CCME Guidelines for the Protection of Aquatic Life in East Lake. The risk of arsenic concentrations approaching CCME Guidelines in East Lake is due to the potential for high arsenic loading from stockpile ore. Conversely, elevated copper loading from waste rock is not expected; however, existing concentrations in East Lake approach the 0.002 mg/L guideline.

The existing kinetic test data indicate that significant arsenic loads may be associated with stockpiled ore materials. The true extent of the loading is difficult to assess at this time due to the unrepresentative samples that were placed in the humidity cells and field leach columns. As stated in Section 4.3, the arsenic concentration of the ore material placed in the columns exceeded all arsenic concentrations from the exploration drill hole assay data base, which was comprised of >2,800 samples. Thus, the arsenic concentrations from the field column leachates should be viewed with caution and considered as extreme worst case drainage concentrations.

Arsenic has been identified as the metal that has the greatest potential to approach CCME guidelines. Thus, a brief discussion qualifying the environmental risk posed by arsenic and ways to evaluate site-specific risk in the East Lake system is provided below. In addition, operational considerations that will reduce the risk of long term loading are provided.

The user-based approach emphasized in regulatory frameworks states that water quality guidelines (WQG)s must "*protect the most sensitive designated use of water at a specified site*". The Canadian WQG for arsenic for the protection of aquatic life is 0.005 mg/L (Table 9). This value is based on the sensitivity of a species of phytoplankton (*Scenedesmus obliquus*), which has been shown to be growth-inhibited at an arsenic value of 0.05 mg/L (Figure 13). A safety factor of 0.1 was then applied to this number to obtain the 0.005 mg/L criterion (CCME, 1999). A second factor that may influence the toxicity of arsenic in the East Lake system is that arsenic is predominately in a As(V) oxidation state in oxic systems. However, the guidelines were developed from tests that spiked the test solutions with As(III), which is more toxic than As(V).

Table 8- Summary of Water Quality Guidelines for Arsenic

Designated Water Use	Water Quality Guideline (mg/L)
Drinking water	0.025
Aquatic Life	0.005
Irrigation	0.1
Livestock Watering	0.025

The appropriateness of the guideline in the East Lake system could be evaluated by determining if phytoplankton that are sensitive to arsenic inhabit the system and if arsenic that is present in the system is in the form of As(III) or As(V). In addition, water quality in East Lake is not predicted to be adversely affected by arsenic during the initial three years of development. During this time, the accuracy of the current arsenic loading predictions can be evaluated to determine if additional mitigation is required.

As documented above, the major source of arsenic loading to the mass balance model is the ore stockpile. However, the following operational factors will prevent long-term metal leaching from the ore stockpile:

- The ore stockpile from the exploration phase will be trucked off-site during the production phase, expected to be within a period of three years.
- Looking forward into the production phase, WRI intends to stockpile no more than about 9 months production (160,000 tonnes) and truck this material away for processing annually during the winter. As a result, each year's stockpile of ore will only be exposed to oxidation and leaching for a short period of time and will be removed from site before the metals can be flushed from the stockpile in the spring.
- The feasibility study has estimated the mine life to be about seven years. At closure, no ore or PAG waste rock stockpiles will be left at the surface based on current mine plans.
- Seepage and runoff from the ore and waste piles will be collected and released only if it meets regulatory criteria, as described in Section 6.

Should monitoring of site drainage indicate that arsenic concentrations from the ore storage pad are as high as predicted from the field columns and that additional mitigation is required, the contingency measures that will be implemented at the site during exploration are discussed in Section 6.2.

6.0 RECOMMENDED ORE AND WASTE ROCK STORAGE PLAN

The proposed ore and waste rock storage plan is designed to mitigate the potential impacts associated with ARD and metal leaching over the short term of this exploration project. The proposed plan includes waste rock and ore monitoring during underground mining; construction of diversion berms and collection ponds to capture and control the release of seepage and runoff from the storage pads; and water quality monitoring to ensure that the water released to the environment meets regulatory criteria. All information collected during the exploration phase will be compiled into a database for the proposed production phase.

6.1 Waste Rock / Ore Monitoring

Development plans indicate that both waste rock and ore will be mined during the 2005 exploration program. Previous ARD studies (Klohn, 1998 (Appendix I) and MEMI, 2004 (Appendix II)) have indicated that ore material is expected to be potentially acid generating. However, this material does contain a significant quantity of available neutralization potential that buffers infiltrating water at pH neutral conditions and delays the onset of acidic drainage for 10's to 100's of years. Thus, this material will be temporarily stored on the ore storage pad during the exploration program with minimal impact to the regional water quality under pH neutral conditions.

Previous studies (MEMI, 2004) have demonstrated that waste rock has variable acid generating potential. Although the waste rock samples are similar to the ore samples, in that waste rock typically contains NP ranging from 20 Kg$CaCO_3$/t to 50 Kg$CaCO_3$/t, the sulphide content varies by an order of magnitude from <0.1%S to 4.0 %S. Thus, waste rock with higher sulphide contents (>0.2%S to 0.3%S) is likely to be potentially acid generating (PAG). The occurrence of higher sulphide material is likely related to its proximity to mineralized quartz veins and the adjacent alteration halos. The sampling protocol should be adjusted as ore veins are approached in order to determine the extent of this halo.

Due to the operational advantages of leaving waste rock on surface during operation and closure and having construction materials available for future mine structures, an attempt to segregate PAG waste rock from NAG waste rock is proposed during the production of waste rock from the exploration ramp extension. The program will rely on geologic logging of quartz veining, associated alteration and sulphide mineralization on the working face.

As requested under Part D, Item 10 of the Water Licence, the following protocol will be followed during the development of exploration underground workings in waste materials.

- On-site project geologist will refer to geology model and survey data and prepare a table to record the round ID, coordinate of the round's centroid, ore/waste designation, rock type and geology information such as rock type, alteration or mineralization.
- The face and drill cuttings of each development round will be examined by the on-site project geologist and the degree of quartz veining, alteration and sulphide mineralization will be recorded with the date and round ID. (It should be noted that EBM (1997) assumed 1.3 rounds per day of ramp development advance.)
- Rounds that are documented to contain significant veining, alteration and sulphide mineralization will be designated as PAG and be placed on the PAG portion of the waste rock storage pad. Conversely, material derived from rounds designated as NAG will be stored in the clean waste rock portion of the storage pad. EBM (1997) noted that rocks containing less than 2.5% pyrrhotite or 2% pyrite or 4.5% arsenopyrite or their combined equivalents, were not acid generating.
- A representative sample will be collected from every second face and labelled with the round ID and submitted for ABA testing at an accredited laboratory.
- Continued field leaching testing of ore and waste rock over the next three years to establish long-term weathering trends.
- Kinetic test work on additional waste rock and ore samples to assess changes in ARD potential with depth and geology.

The data collected during the waste rock monitoring program will provide WRI and regulators with a record of the types of waste rock stored in the stockpiles. As the ramp is developed, segregation of PAG and NAG rock could be carried out as above. This will provide WRI with the option of leaving the NAG materials on the surface (subject to regulatory approval) and minimizing the volumes of waste rock that need to be hauled back underground as backfill.

6.2 Ore and Waste Storage Options

Figures 11 and 12 show the proposed modifications required to manage the exploration development ore and waste to be stored at surface at the Ulu mine site. The proposed modifications are based on the need to store all the development waste and ore at the surface prior to going into production. Based on the volumes given in Table 1 and assuming a 30% bulking factor, the average thickness of waste rock on the existing pad will be about 9 m. If all the ore is stored on existing ore pad, the thickness of the pile will be about 4m. A thicker stockpile minimizes the area of infiltration and hence, potential downstream contaminant loadings. It also creates conditions for permafrost to aggrade into the pile and underlying pad and foundation soils. The portion of the pile affected by permafrost will not be subject to metals leaching, thereby reducing the overall contaminant loading. The depth of thaw for the rock stockpiles was assumed to be in the range of 3-4 metres at Ulu. As a result, the proposed modifications include:

- Relocation of the portion of the ore pad located within the West Lake Drainage to the East Lake Drainage but maintaining the same overall area of pad.
- Construction of a perimeter berm and ditch around the northwest and south sides of the ore pad to direct runoff towards East Lake. The berm will be about 1.5 m high and about 230 m long, with an overall volume of about 1400 m^3.
- Construction of a seepage collection dike around the downhill toe of the ore pad to capture any seepage and runoff which may be contaminated by metals, for sampling and testing before discharging into East Lake. This dike has a maximum height of 4 m and an estimated volume of about 7600 m^3.
- Construction of a seepage collection berm and dike, similar to the one proposed around the ore pad, around the downhill toe of the waste rock stockpile to capture any seepage and runoff which may be contaminated by metals, for sampling and testing prior to discharging into East Lake. The total volume of berm is estimated to be about 1200 m^3.
- Construction of a small settling pond and containment dike between the waste rock pad and East Lake to hold contaminated runoff and seepage water collected from the ore and waste pads prior to discharge to East Lake. The dike has a maximum height of about 4 m and a volume of about 3900 m^3.
- Construction of discharge piping between the ore pad and waste pad seepage collection ponds to the settlement pond, and from the settlement pond to East Lake.

The water retention dikes used to collect the seepage and runoff from the pads will be constructed using the esker sand and gravel. A total of about 7,300 m^3 of material is estimated to be required. Further studies will be required to finalize the design, layout and heights of the water retention dikes, based on site hydrology and water quality criteria. Geocomposite liners will be installed as shown in Figure 12 to act as the water retaining element. Clean (NAG) waste rock or selectively screened esker materials will be required on the upstream side of the dikes and diversion berms for erosion protection.

The thickness of the waste pile means that there could be some permafrost aggradation into the bottom of the pile by the end of the development period. WRI may have to undertake a seasonal stripping of the ore pile and/or use ripping to recover this frozen portion of the ore pile.

For long term storage, permafrost helps to minimize the volume of ore and waste that is exposed to metal leaching. Therefore, raising the stockpiles to their maximum height could be considered an effective short-term mitigation for metals leaching or a long-term closure option. This assumes that the materials are capped with inert material so that the seasonal active zone does not penetrate into the problematic materials. A thermistor will be installed in each stockpile during the exploration program to measure the temperature in the piles and assess its affects on predicted ARD generation rates. These thermistors will be temporary as the ore and waste stockpiles will be removed once mining production begins.

The shortest distance between the proposed waste rock storage pad and East Lake is about 160 m. The closest point on the ore pad is about 280 m from East Lake. The water retention dikes and diversion berms will prevent direct runoff discharging into the lake. The greatest source of metal loading is expected to be drainage from the ore storage pad, thus mixing the ore storage pad drainage waters with waste pad drainage will reduce discharge concentrations. This measure provides a management contingency to meet water licence criteria if elevated concentrations are observed in ore pad drainage water. For this reason, the piping is laid out to provide the option of discharging the ore pad runoff into the waste rock storage pad settling pond prior to discharge to East Lake. Layout configuration of the piping is illustrated in Figure 11.

The following sections discuss the details of the contingency plans that could be implemented to the base case ore and waste pad configurations and the ability of these contingencies to reduce metal loadings to the East Lake system.

6.2.1 Increased Ore Stockpile Height Contingency

Increasing the height of the stockpile reduces the potential of metal loading via two processes. Firstly, a thicker stockpile minimizes the surface area of the ore pad that catches precipitation and snowfall. Thus, the reduced catchment area also reduces the volume of water that will infiltrate through the ore material, thereby reducing metal leaching from the pile. Secondly, increased stockpile height accentuates permafrost aggradation into the pile, similar to that documented in rock fill at other arctic mines. The formation of permafrost will essentially eliminate water infiltration through the center of the pile, thus, halting the transport mechanism that transfers metals from the center of the pile to the discharge waters. The expected depth of seasonal thaw for the rock stockpiles (3 – 4 m) is similar to the proposed ore stockpile height under the non-contingency scenario. Thus, metal-loading rates per unit area from a taller stockpile are expected to be equivalent to a stockpile of lesser depth.

Increasing the height of the ore stockpile from approximately 3.5 m to 8 m reduces the stockpile footprint by approximately ½ to 7,500 m^2. Although ore storage pad discharge concentrations are expected to be similar to those released from the base case, the smaller exposed surface area will reduce the volume of water that infiltrates through the ore pad and accumulates arsenic loads. The lower water volume reduces the overall loading from the ore stockpile to the East Lake system. The mass balance model indicates that this contingency will also reduce the expected arsenic concentrations in East Lake by one half. The highest concentrations are expected to be coincident with snowmelt that occurs in May and June.

6.2.2 Ore Stockpile Configuration Contingency

Mass loadings from the ore stockpile can be reduced further during the snowmelt period by preventing the accumulation of snow on the surface of the ore stockpile, thus, reducing the unit area runoff from this facility relative to the other portions of the East Lake watershed. Maintaining a smooth surface on the top and sides of the stockpile will allow wind swept conditions to prevail and prevent the accumulation of snow in drifts or hollows on the surface of the stockpile. Following completion of an ore stockpile lift, the top surface will be levelled to remove all humps and swales and a slight grade will be maintained to encourage runoff during peak runoff or extreme precipitation events. Regular side slopes will be constructed by periodically dressing the slopes with an excavator to prevent hollows, benches or swales where snow could accumulate. Active snow removal from the top of the ore stockpile could also be implemented just prior to the spring snowmelt if significant accumulations of snow are still observed at this time.

Approximately 40% of the annual precipitation occurs as snowfall during the October through April period when temperatures are below freezing. Snow accumulation is released in May or June, a period when peak metal loading and metal concentrations are predicted to occur in the East Lake system. Assuming that the snow management process effectively removes 75% of the accumulated snow, the total annual loading from the stockpile will be reduced by 30%. More importantly the metal loading reduction will occur at a time when peak concentrations are expected in East Lake. Thus, this management contingency would reduce the maximum observed concentrations in this system as well as reduce the total annual metal load.

6.3 Construction Materials

Options considered for construction materials include:

- NAG waste rock from the proposed underground development.
- Esker sand and gravel from the granular borrow area.
- Clean rockfill from a quarry.

As described in Section 6.1, waste rock monitoring will be carried out to segregate NAG and PAG rock in the waste stockpile. Since the water quality from the waste dumps has not yet been measured, it would be premature to consider using the NAG material for construction for this phase of the work. As required under Part G, Item 5 of the Water Licence, only tested waste rock with a low potential for acid generation will be used for construction.

WRI have obtained a permit to mine esker sand and gravel for construction purposes and intend on using this material for construction of the dikes.

Opening a separate quarry for construction material will increase the overall magnitude of site disturbance, as well as requiring an assessment of the ARD and metal leaching properties of the rock prior to construction. It would not be feasible or practical at this stage to consider this option. Hence, esker sand and gravel will be used for construction materials for the proposed exploration program.

6.4 Water Quality Monitoring Protocol

Water quality sampling will be performed to demonstrate the effectiveness of the control measures, and to ensure compliance with the Water Licence discharge criteria (Part D, Item 4). Additional parameters (metals, sulphate, nitrogen compounds, *etc.*) will also be monitored in order to quantify loadings of these parameters to the receiving environment. Data will be summarized and reported, following the requirements of the Water Licence.

Water quality sampling and testing will be carried out at the following locations:

- Ore pad diversion ditch during periods of spring runoff and active flow.
- Ore and waste pad seepage collection ponds to determine if stored water can be released to the environment.
- End of pipe discharge water quality during periods of discharge from the ore and waste pad seepage collection ponds.
- Outlet of East Lake during periods of open water flow conditions.
- East Lake under ice conditions during the winter (when the camp is open).

During the operational and development period, water quality observations will be carried out periodically as required to meet regulatory requirements and as part of a study to assess the ongoing ore and waste rock management program. The findings from these observations will be used to adapt site practices for the production phase.

The parameters that will be analysed and their respective detection limits are listed in Table 10. Following the initial sampling events, the listed detection limits may be revised to better suit the observed discharge water chemistry.

Table 9 - Water Quality Sample Parameters and Detection Limits

Parameter	Symbol	Detection Limit	Units
Physical Parameters			
Conductivity		2	µS/cm
Hardness		1	mg/L
Total Dissolved Solids	TDS	10	mg/L
pH	pH	0.01	pH
Total Suspended Solids	TSS	3	mg/L
Turbidity	NTU	1	NTU
Major Anions			
Alkalinity-Total	$CaCO_3$	1	mg/L
Bromide	Br	0.5	mg/L
Chloride	Cl	0.5	mg/L
Fluoride	F	0.02	mg/L
Sulphate	SO_4	1	mg/L
Nutrient Parameters			
Ammonia Nitrogen	N	0.005	mg/L
Nitrate Nitrogen	N	0.005	mg/L
Nitrite Nitrogen	N	0.001	mg/L
Dissolved Ortho-Phosphate	P	0.001	mg/L
Total Phosphate	P	0.002	mg/L
Organics			
Total Organic Carbon	TOC	0.5	mg/L
Total and Dissolved Trace Metals			
Aluminum	Al	0.001	mg/L
Antimony	Sb	0.00005	mg/L
Arsenic	As	0.0001	mg/L
Barium	Ba	0.00005	mg/L
Beryllium	Be	0.0005	mg/L
Bismuth	Bi	0.0005	mg/L
Boron	B	0.001	mg/L
Cadmium	Cd	0.00005	mg/L
Calcium	Ca	0.05	mg/L
Chromium	Cr	0.0005	mg/L
Cobalt	Co	0.0001	mg/L
Copper	Cu	0.0001	mg/L
Iron	Fe	0.03	mg/L
Lead	Pb	0.00005	mg/L
Lithium	Li	0.001	mg/L
Magnesium	Mg	0.1	mg/L
Manganese	Mn	0.00005	mg/L
Molybdenum	Mo	0.00005	mg/L
Nickel	Ni	0.0001	mg/L
Phosphorus	P	0.3	mg/L
Potassium	K	2	mg/L
Selenium	Se	0.0005	mg/L
Silicon	Si	0.05	mg/L

Table 9 Continued

Parameter	Symbol	Detection Limit	Units
Silver	Ag	0.00001	mg/L
Sodium	Na	2	mg/L
Strontium	Sr	0.0001	mg/L
Thallium	Tl	0.00005	mg/L
Tin	Sn	0.0005	mg/L
Titanium	Ti	0.01	mg/L
Uranium	U	0.00001	mg/L
Vanadium	V	0.001	mg/L
Zinc	Zn	0.001	mg/L

7.0 CONCLUSIONS

Within the remaining term of the water licence, WRI intends to complete the underground exploration and development program at the Ulu Mine site, as originally proposed by EBM. The proposed program will result in stockpiles of ore and waste being stored on site over the remaining terms of the existing water licence, until a production decision is reached. The estimate quantities of materials to be stockpiled are 106,400 tonnes (35,334 m^3) of ore and 126,900 tonnes (42,300 m^3) of waste rock.

ARD and metal leaching studies have indicated a low risk of ARD formation from both the ore and waste rock, but a high risk of metals leaching, particularly arsenic from the ore. As a result, the ore and waste rock storage program must address control and mitigation of seepage and runoff from the ore pad. Run off from the waste rock pad will also be collected and monitored, although metal leaching from the waste is not expected to be a problem.
The proposed ore and waste rock management plan consists of the following main components:

- A waste rock monitoring program that will segregate PAG and NAG rock during the exploration development, based on mineralogy and confirmatory static ABA testing.
- Construction of seepage and runoff diversion berms and collection ponds on the downstream side of both the ore and waste storage pads to prevent direct runoff into East Lake.
- Water quality sampling and testing to assess the quality of seepage and runoff water prior to releasing it into East Lake.
- Water quality sampling of East Lake to assess impacts.

The results of the above program will be used to modify site practices for the production phase.

8.0 RECOMMENDATIONS

As part of the overall ore and waste rock storage plan, WRI should consider setting up some field columns to measure leachate quality from representative samples of ore, NAG and PAG waste rock. Further kinetic test work is recommended in assessing the metal loadings that would occur from ore obtained from deeper levels of the mine during production and as a result of the seasonal stockpiling and removal of ore and waste. WRI should verify the quantities of ore and waste to be produced during the exploration program, once the geological model and ramp development has been finalized. The sampling protocol for the waste rock monitoring program must be adjusted as the ore veins are approached to determine the extent of the alteration halos.

Thermistors should be installed into the ore and waste rock stockpiles to monitor temperatures within the piles throughout the year. This temperature data will be useful for correlating with the water quality measurements and predicting future metals loading in the runoff and seepage water from the stockpiles. In conjunction with this aspect of the monitoring program, a site specific weather station should be erected to provide baseline climatic data for the project.

Additional work will be required to develop an appropriate water treatment methodology to remove arsenic as a backup plan, should this become problematical during the production phase.

Preparation of design and construction drawings for the seepage collection berms and dikes, as requested under Part G, Item 1 of the Water Licence will be carried out at a later date. The preliminary configuration presented in Figures 11 and 12 needs to be investigated in the field and final layouts confirmed. Detailed site surveys will be required to establish ground elevations along the structure footprints to allow establishment of final dike and berm crest heights to satisfy design flood storage and freeboard requirements. It is anticipated that the final engineering for the water management berms and dikes cannot begin until June 2005, when the site is free of snow and survey work can be carried out. These design drawings will be prepared by a qualified Geotechnical Engineer, registered in Nunavut and will be submitted to the NWB for approval. In the meantime, WRI will continue to monitor runoff from the site at the SNP stations, as required in Schedule 1 of the Water Licence and report the results to the NWB.

As-built drawings of the water management structures will be prepared after construction and submitted to the NWB, as required under Part G Item 3 of the Water Licence. WRI will operate and maintain the seepage collection berms, dikes and ponds in accordance with Part D of the Water Licence, and any other recommendations provided by their geotechnical engineer.

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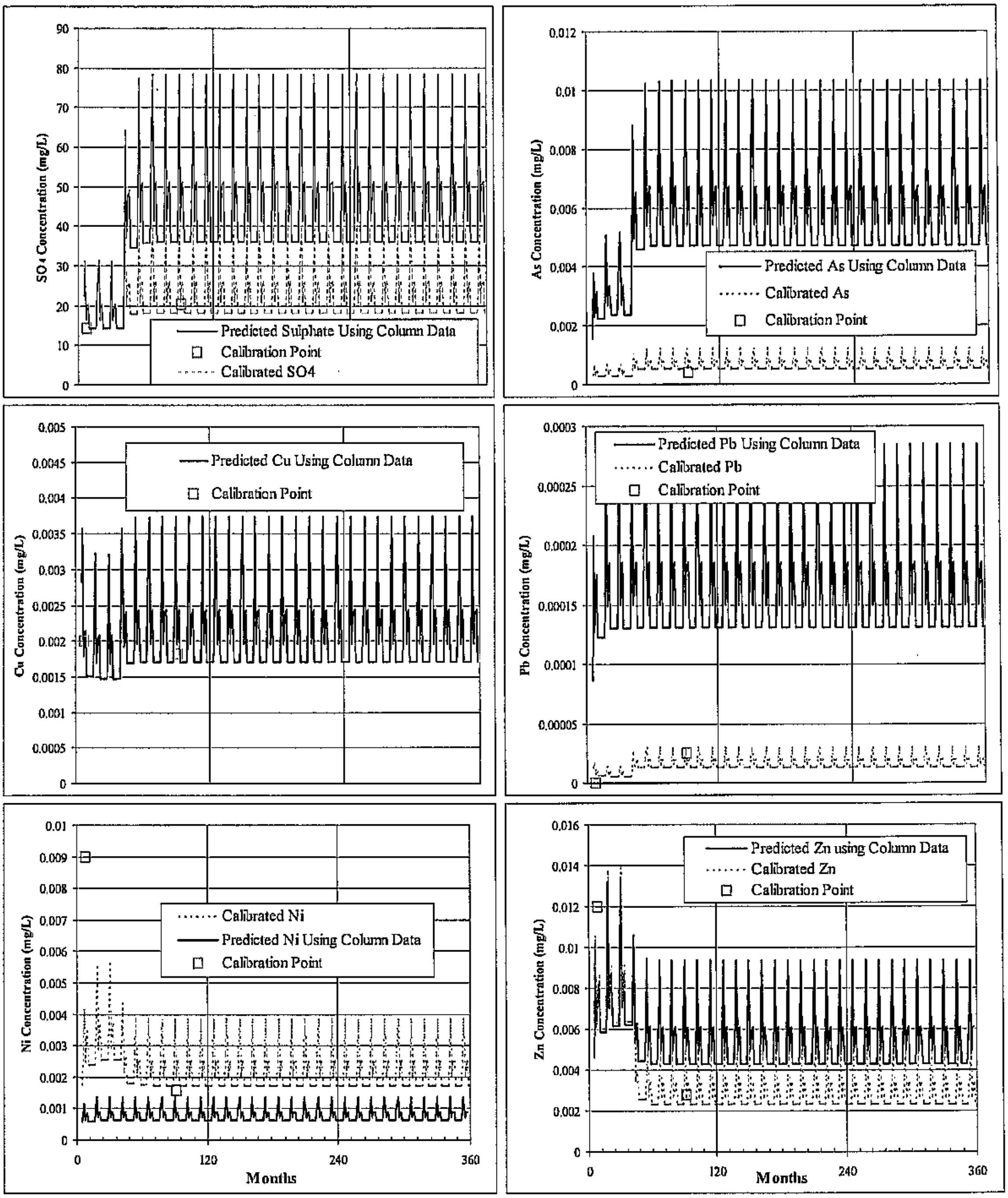
FIGURES

APPENDIX I
KINETIC TESTING OF SULFIDE-RICH MATERIAL FROM ULU

APPENDIX II
REVIEW OF FIELD COLUMN KINETIC TEST DATA

APPENDIX III
EAST LAKE- WATER QUALITY CALIBRATION



SO4 Concentration (mg/L)
Predicted Sulphate Using Column Data
Calibration Point
Calibrated SO4
As Concentration (mg/L)
Predicted As Using Column Data
Calibrated As
Calibration Point
Cu Concentration (mg/L)
Predicted Cu Using Column Data
Calibration Point
Pb Concentration (mg/L)
Predicted Pb Using Column Data
Calibrated Pb
Calibration Point
Ni Concentration (mg/L)
Calibrated Ni
Predicted Ni Using Column Data
Calibration Point
Zn Concentration (mg/L)
Predicted Zn using Column Data
Calibrated Zn
Calibration Point
Months
0
120
240
360

APPENDIX IV
PRELIMINARY BASELINE WATER QUALITY REPORT