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 $KgCaCO_3$/t to 50 $KgCaCO_3$/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

KLOHN-CRIPPEN

April 16, 1998

Echo Bay Mines Ltd.
Lupin Operation
c/o Echo Bay Mines Hanger
9818 Edmonton International Airport
Edmonton, Alberta
T5J 2T2

Mr. David B. Hohnstein
Manager, Environmental Affairs
Lupin, NWT

Dear Mr. Hohnstein:

Final Report on Kinetic Testing of Sulfide-rich Material from Ulu

Enclosed please find four copies of the final report on humidity-cell testing of ore and prospective mine waste for the Ulu Project. Incorporating the comments and suggestions you made on the draft report, we trust that this final version of the report will meet with your approval. We thank you for the opportunity to work on the interesting project and we look forward to providing you with our service again soon.

Yours truly,

KLOHN-CRIPPEN CONSULTANTS LTD.

Y.T. John Kwong, Ph.D.
Senior Environmental Scientist

for Peter J. Wheeler, P.Eng.
Manager, Calgary Mining Group

PM 7534 0201
980416

ECHO BAY MINES LTD.

ULU PROJECT

Kinetic Testing of Sulfide-Rich Material from Ulu

PM 7534 02

APRIL 1998

Klohn-Crippen

EXECUTIVE SUMMARY

To facilitate further mine development at the Ulu site, Echo Bay Mines Limited - Lupin Operation has retained Klohn-Crippen Consultants to design and conduct a kinetic test program to investigate the possibility of acid rock drainage (ARD) generation and metal leaching from stockpiling ore at Ulu for transport by winter-road to Lupin for processing. The test program involves humidity-cell testing of composites of an ore and a waste rock at both 4°C and 22°C, a prospective tailings sample at 22°C as well as field-column testing of two duplicate ore subsamples. Grain size effects, temperature control of reaction rates and the influence of flushing events on leachate chemistry are considered in the interpretation of test results.

From the weathering of the Ulu composites under different settings, it is evident that temperature affects the rate of sulfide oxidation more than that of depletion of neutralization potential (NP) in a sample. Since NP depletion has invariably occurred faster than sulfide oxidation, only materials with a neutralization potential ratio (NPR) of greater than 3 will not lead to net acid generation with prolonged weathering at 22°C. Under colder conditions, the NPR required to eliminate the possibility of ARD can be as high as 7. However, in the latter case, the amount of acid released on an annual basis is so low that it should not cause any significant impact.

A lower average reaction temperature and a lower frequency of flushing events account for the relatively low sulfide oxidation and metal leaching rates observed with the field-column testing of the Ulu ore compared to the humidity-cell testing results. Metal leaching with the Ulu waste rock is largely insignificant but variable amounts of As and Zn can be leached from the Ulu ore depending on the grain size of the test sample, the ambient temperature for reaction and the frequency of flushing. Based on the kinetic test results, it is estimated that stockpiling of coarse ore at the Ulu site up to 50 years will not lead to net acid generation or intense metal leaching. To avoid unnecessary metal leaching problems, however, it is recommended that ore temporarily stockpiled at the Ulu site should not be pulverized to less than 1.5 mm in diameter.

Further work recommended to complement the current investigation include: (1) a two-year extension of the field-testing to establish a long-term weathering trend; and (2) testing of samples collected from the deeper parts of the Ulu deposit to rectify the fact that all samples tested to date have been collected near the surface; the orebody and the associated waste rock may change in composition with depth.

TABLE OF CONTENTS

PAGE

TABLE OF CONTENTS
(continued)

TABLES

FIGURES

TABLE OF CONTENTS
(continued)

APPENDICES

1. INTRODUCTION

1.1 Project Background

The Ulu deposit is an Archean epigenetic lode-gold occurrence located within the High Lake greenstone belt of the north-central Slave Province. The Ulu property is located 45 km north of the Arctic Circle and 135 km north of the Lupin Mine in the Mackenzie Mining District, Northwest Territories (Figure 1). Echo Bay Mines - Lupin Operation (EBM-Lupin) acquired the property from BHP Minerals Canada Ltd. in 1995, intending to develop it to provide ore for milling at the Lupin Mine. The tentative mine plan involves stockpiling ore materials at the Ulu site year-round and transporting them to the Lupin Mine when winter roads are operational. Waste rock excavated to reach the orebody is to be used for the construction of ore pads for temporary ore storage and camp pads at the Ulu site.

At Ulu, gold mineralization is hosted by discordant quartz veins in mafic metavolcanics and, less commonly, also in metagabbro and metasediments. A preliminary acid rock drainage (ARD) assessment involving field reconnaissance and geochemical static testing led to two tentative conclusions (Klohn-Crippen Consultants Ltd., 1996):

1) Temporary stockpiling of ore on the surface at the Ulu site up to four years may not lead to net acid generation.
2) A less conservative neutralization potential ratio (NPR) than those recommended by the regulatory agencies (3 to 1 according to the United State Environmental Protection Agency and 4 to 1 according to the British Columbia Acid Rock Drainage Guidelines (Price and Errington, 1995)) may be applicable to discriminate potentially acid-generating from non-acid generating waste rock in the project area.