Water Management Plan

Doris North Gold Mine

Nunavut

Submitted by:

Miramar Hope Bay Limited

North Vancouver, British Columbia

October 2006

TABLE OF CONTENTS

Page

LIST OF TABLES

1.0 INTRODUCTION

Miramar Hope Bay Limited has developed a water management plan for the Doris North Project. It is a component of the site's Environmental Protection Plan.

This plan outlines the management strategy and procedures to be used to manage:

- All storm water that comes in contact with the mine facilities and thus can become contaminated; and
- All water to be released from the Tail Lake tailings containment system.

This Plan is a "living document" and will be reviewed and updated periodically during the mine life to ensure that site experience with water management procedures is captured and shared amongst all operating staff (adaptive management).

2.0 STORM WATER MANAGEMENT

The mill/camp pads will be graded nominally to ensure that water will drain from the pads. Surface run-off from process and work areas will be directed towards and collected in a sump. The sump will be designed to contain a 1:100 year recurrence interval, 24-hr duration storm subject to a 6-hour pumping cycle. If time permits, water quality testing will be used to determine whether the water is uncontaminated and be discharged to the tundra. If testing cannot be carried out in time, or if the water is considered contaminated it will pumped to the mill for circulation to Tail Lake.

Similarly, storm water from the temporary waste rock stockpile will be directed towards and collected in a sump and handled in the same manner.

3.0 GREY WATER TREATMENT AND DISPOSAL

All greywater from the construction camp will be collected and treated in a modular sewage treatment plant set up on site for this purpose. During the construction phase of the Project the treated wastewater from the sewage treatment plant will be pumped overland and discharged approximately 200 m to 500 m to the northwest of the camp in a direction away from Doris Lake.

During operations sewage will be treated in a modular packaged biological treatment with the treated effluent and sludge pumped to the tailings impoundment as part of the tailings feed stream.

4.0 SNOW MELT AND STORM WATER COLLECTED WITHIN FUEL CONTAINMENT

Surface run-off from work area of the fuel transfer station at Roberts Bay will be directed towards and collected in a sump. The sump and containment area of the fuel transfer station will have sufficient capacity to contain the 1:100 year, 24-hour duration storm event. At any time when water is contained in the sump it would be subjected to water quality testing, and if deemed uncontaminated it would be pumped out onto the tundra. If this water is contaminated it would be treated through a filtration system to remove hydrocarbons before discharge.

Similarly for the fuel tank farm facility at the plant site, the base of the containment area will be graded at 1% to a corner sump location that will be used to pump out uncontaminated storm water and snowmelt directly onto the tundra using a removable pump. Prior to pumping out storm water, the water will be subjected to water quality testing, and if the water is deemed contaminated it will be treated through a filtration system to remove hydrocarbons before discharge.

5.0 TAIL LAKE WATER MANAGEMENT

A water management strategy for the Tail Lake tailings containment system was developed by SRK Limited for MHBL and is a component of the *Water Quality Model, Doris North Project, Nunavut, Canada* report, prepared by SRK dated October 2006 (see Water License Application document – Supporting Document S6). The following management plan is drawn from this source.

3.1 Discussion of Potential Discharge Strategies

Two possible strategies for the management of the discharge system have been considered, as follows. In the first strategy, a fixed monthly flow rate, based on projected average monthly flow conditions and water quality in Doris Creek and water quality in Tail Lake, distributed according to the Doris Lake outflow hydrograph would be adopted.

In the second strategy, discharge flows would actively be controlled according to current real time measured; i) flow conditions in Doris Creek, and, ii) current water quality in Tail Lake and Doris Creek. In this strategy it should however be realized that, while flow rates in Doris Creek could be measured on a real time basis, there would always be a delay in obtaining water quality results.

For either strategy, the effectiveness of the approach will depend on how rapidly water quality is likely to change within Doris Creek (background) and in Tail Lake.

Monitoring results to date suggest that significant changes in the background water quality in Doris Creek occur over periods of weeks rather than days. Similarly, when the discharge volume of water from the mill (about 36,000 m^3 per month) is compared to the Tail Lake reservoir (typically about 2,200,000 m^3) it is apparent that rate of change of water quality in Tail Lake too will not be rapid. It is therefore possible that reasonable performance can be achieved by either control strategy. Nonetheless, the latter strategy would significantly reduce the risk of discharging water in excess of the target rate.

The first strategy would be the most simple to manage. Conceptually, a chart would be developed that would show correlations between water quality in Tail Lake and flow rates in Doris Creek for each month of the active discharge period. The discharge flow rate would be fixed for periods of up to a week and adjusted as required based on the performance. Monitoring would be undertaken downstream of the mixing zone in Doris Creek to determine the performance against the flow charts, and, if required, these charts may be adjusted to improve the performance. It would however be accepted that marginal exceedances of the target concentrations in Doris Creek are likely to occur from time to time.

The second strategy would provide significantly better control on discharge rates and target concentrations (i.e. CCME guidelines) are likely to be achieved consistently throughout the open water season. It is therefore recommended that the latter strategy be adopted.

The key management and control components of the proposed discharge strategy will comprise:

- Real-time monitoring of flows in Doris Creek.
- Monitoring of water quality in Doris Creek and Tail Lake on a frequent basis.
- Managing the decant intake in Tail Lake to minimise suspended solids release.
- Use of the water quality results to determine allowable discharge rates.
- Controlling the discharge flow rate on a real-time basis.

The description and details of the water discharge management strategy is provided in the next section.

3.2 Water Management

3.2.1 Objectives

The primary objective of the Tail Lake water management strategy will be to meet CCME guidelines (Canadian Water Quality Guidelines) for parameters of concern to protect freshwater aquatic life in Doris Creek, downstream of the waterfall, with the possible exception of nitrite.

The following sections provide descriptions of the discharge system, sampling and analytical requirements, data management requirements, calculation of allowable discharge flow rates, and, operational and post operational water management activities.

3.2.2 Water Quality Monitoring and Locations

Approved water sampling protocols will be adopted. Water sampling and monitoring for the management of Tail lake water will be as follows.

3.2.2.1 Tail Lake

The intake to the discharge pipeline will be located on a floating barge system within the northern part of Tail Lake, about 1.5 m below the water surface. Three water samples will be obtained from the barge at depths of 1.0 m, 1.5 m and at 2.0 m to represent the intake water quality. The monitoring will initially be undertaken every second day, but may be reduced to weekly or less should the data indicate that the rate of change in water quality is small. Similarly, if the samples taken at different depths are shown to vary little, then sampling may be reduced to duplicate samples at the pipe intake depth.

3.2.2.2 End of Pipe Discharge

The frequency of sampling and analysis is specified in the MMER to be weekly, at least initially, for regulated parameters. However, there is provision to reduce the frequency of analysis for some parameters based on the results obtained. These results will be correlated with the intake water quality results for further confirmation that the intake monitoring results reasonably reflect actual discharge water quality.

3.2.2.3 Doris Creek Upstream of Weir

The upstream water quality samples for Doris Creek will be obtained upstream of the flow monitoring point, as dictated by site conditions. Sampling will initially be undertaken every second day to coincide with the intake monitoring samples. As for the intake sampling, the frequency may be reduced to weekly should the data indicate that the rate of change in water quality is small.

3.2.2.4 Doris Creek Downstream of Waterfall

Doris Creek downstream of the waterfall will be monitored only during periods of active discharge. The sample location will be established approximately 30 to 50 m downstream of the waterfall, as dictated by site conditions, to ensure that complete mixing of Tail Lake discharge and Doris Creek had occurred. Sampling will initially be undertaken every second day. As the discharge control strategy is refined and proven to meet discharge objectives, the frequency of sampling may be reduced.

3.2.2.5 Dam Seepage

If evident, toe seepage at the North and South Dams will be sampled and monitored on a weekly basis. If flows become significant, the seepage will be collected and pumped back to Tail Lake.

3.2.2.6 Mill Effluent

Mill tailings discharge water will be monitored at a location after all of the effluent streams have been combined into a single flow. Initially the water quality will be sampled daily and composited over a two day period. Depending on the variability in the tailings effluent water quality, the composite period may be increased and the frequency of analysis reduced.

3.2.3 Water Quality Analyses

3.2.3.1 Onsite Laboratory

A low level detection environmental laboratory will be established on site. For convenience the laboratory will be sited near the camp complex, but sufficiently removed from the mill site to prevent contamination. The laboratory will be established prior to commencement of any discharges from Tail Lake.

Suitably qualified personnel familiar with the operation and maintenance of a low level environmental laboratory will be retained to operate the laboratory. Documented standard operating procedures (SOPs) will be used.

The laboratory will be equipped with a low level inductively coupled plasma (ICP) mass spectrophotometer (MS) to enable low level detection analyses of metals. Details of the operation of the laboratory setup and technical information for the ICP-MS are provided in Appendix J of the SRK Water Quality Model.

MHBL will seek laboratory accreditation with the Canadian Association for Environmental Analytical Laboratories (CAEAL). The requirements include a well-documented quality assurance/quality control (QA/QC) program, as well as demonstrated proficiency in analysis of performance evaluation (PE) samples. The assessment and accreditation will be updated every two years.

A documented internal quality control program will be implemented which will include items such as calibration schedules, use of quality control samples, established control specifications with corrective actions if specifications are not met, data validation, equipment maintenance, and staff training and evaluation programs.

Quality control samples will include:

- blanks – analysis of de-ionized water to ensure that there is no contamination due to laboratory procedure;
- duplicates – a replicate analysis of a homogeneous sample to show method precision;
- spikes – a replicate sample spiked with a known amount of stock standard solution to show both method precision and accuracy and to check for any interferences; and
- reference materials – a National Institute of Standards and Technology (NIST) or other suitable certified reference material to show method accuracy.

All of the above laboratory QC samples will be run regularly. Results will be compared to Data Quality Objectives (DQOs) and be used to flag sample results where DQOs are not met. Control samples will be run at a minimum frequency of 10% of the samples for analysis. Quality records will be kept and will be available for inspection.

3.2.3.2 Water Quality Parameters

The parameters that will be monitored regularly, and intermittently, at the site are summarised in Table 3.1. Not all of the parameters will necessarily be measured on-site. Non-critical parameters such as dissolved and total organic carbon would be measured off-site on a less frequent basis.

Table 3.1: Parameters to be measured for effluent characterization and water quality monitoring

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

Notes:

1. List of parameters regulated (deleterious substances and pH) as per Schedule 3 of the MMER; concentration limits specified in the regulation (Schedule 4).
2. All concentrations are total values; dissolved concentrations may also be reported; effluent loading (Section 20 of MMER) will also be calculated and reported.
3. List of parameters required for effluent characterization and water quality monitoring as per Schedule 5 of the MMER Analysis of mercury may be discontinued if the concentration of total mercury in effluent is less than 0.10 µg/L in 12 consecutive samples of effluent.
4. In situ measured parameters only for water quality monitoring (in receiving waters).
5. These other parameters are potential contaminants or supporting parameters; analysis is optional and may be added based on site specific historical monitoring data or geochemistry data.

3.2.4 Third Party Verification

Upon the commencement of operations, MHBL will ensure that an independent, third party laboratory carry out monitoring of Tail Lake and Doris Creek water quality, above and below the waterfall, three times annually during active discharge to provide verification of MHBL's monitoring results. MHBL will provide the sampling and delivery of samples to the independent, third party laboratory, with copies of the results directly to the NWB and NIRB's Monitoring Officer.

3.2.5 Doris Creek Flow Monitoring

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

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

3.2.6 Data Management

Monitoring information that will be collected will include:

The name of the person(s) who performed the sampling or took measurements;

Date, time, and place of sampling or measurement;

Date of analysis;

Name of the person who performed the analysis;

Analytical methods or techniques used; and

Results of any analysis.

The results and records of any monitoring, data, or analysis shall be kept for a minimum of the life of the project including closure and post closure monitoring. This time period will be extended if requested by NIRB, DFO, EC or the NWB.

MHBL will set up and maintain a Laboratory Information Management System (LIMS) to record and manage all the water quality monitoring results. MHBL will consult with NIRB’s Monitoring Officer for guidance on presentation of monitoring results and records.

3.2.7 Determination of the Discharge Rate

The discharge rate will be determined in two steps. In the first step, the Allowable Discharge Volume Ratio (ADVR) is calculated as follows:

$$ADVR(Cu) = (CCME_{Cu} - [Cu]_{DC}) / ([Cu]_{TL} - CCME_{Cu})$$

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

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

$CCME_{Cu}$ = CCME Freshwater Aquatic Guideline or site specific objective for copper (mg/L).

The ADVR for other key parameters would then be calculated on the same basis. The lowest ADVR ($ADVR_{MIN}$) is then selected as the controlling ADVR.

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

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

Where *TDR* = target discharge rate (m^3/s), and

$ADVR_{MIN}$ = lowest allowable discharge ratio.

The factor 0.8 is a factor of safety that will ensure that the discharge contaminant loading remains at or below 80 percent of the CCME guideline in Doris Creek. This conservatism is applied to allow for potential upset conditions in flows or analytical results.

3.2.8 Discharge Control

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

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

The discharge to Doris Creek will be located sufficiently downstream from the flow monitoring location to ensure that the discharge will not interfere with flow measurements in Doris Creek, but sufficiently upstream of the waterfall to ensure complete mixing with Doris Creek water. The outlet would be placed such that the discharge flow would not lead to erosion or degradation of the creek bed. The approximate discharge location is shown in Dwg G-02 (SRK 2006a).

3.2.9 Operational Strategy

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

- Prior to commencement of milling, the laboratory will be set-up and analytical procedures developed, documented and verified. Sampling protocols will also be documented and verified.
- Two weeks prior to commencement of operations (assuming a spring start-up), water quality in Tail Lake and Doris Creek will be monitored every second day to establish baseline conditions.
- Real-time monitoring of the flows in Doris Creek will commence as soon as practical during the open water season. The pressure transducer would be

connected to a programmable logic controller (PLC) that would record flows in Doris Creek and be used to control the discharge flow rate.

- Commencing with the start of tailings deposition, Tail Lake will be monitored for an additional two weeks every second day. As the dynamics of the system, i.e. rate of change in water quality, becomes better understood, the frequency of monitoring could be reduced.
- Before any discharge would commence, Tail Lake water would be submitted for toxicity testing and metals analysis. Only if the water meets MMER criteria will discharge from Tail Lake commence. The flow ratio would be calculated for each sampling event and adjusted as necessary. The discharge flow would be controlled by the automated flow control system which would use the real time flow monitoring in Doris Creek to control the discharge flow rate. Flow rates would automatically be logged by the flow control system.

In subsequent years, it is anticipated that at the start of the open water season the analytical turnaround time will likely prevent discharge for the first few days. The downstream together with the upstream and Tail Lake water quality monitoring results will be used to verify the performance of the discharge system at regular intervals and to make flow control adjustments as appropriate.

As part of the control strategy, the actual water quality in Tail Lake will regularly be compared with the predicted water quality to assess the accuracy of the model. If necessary, the model may be recalibrated to the actual water quality observed in Tail Lake. The model would then be rerun to assess potential implications on the discharge strategy and to determine future operational requirements.

3.3 Contingency Discharge Strategy

As demonstrated in Section 4 of the SRK Water Quality Model report, Tail Lake can be operated successfully at several lower than optimum discharge rates. In the event that maximum allowable discharge flow rates are lower than estimated herein, the proposed control system will automatically adjust to the lower flow rates.

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

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