

## Memo

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<b>To:</b>	Chris Hanks Tom Logan	<b>Date:</b>	October 6, 2008
<b>cc:</b>	Maritz Rykaart Lowell Wade	<b>From:</b>	Kelly Sexsmith
<b>Subject:</b>	Doris -Windy All Weather Road: Geochemical Monitoring of Quarry Rock	<b>Project #:</b>	1CH005.000, Task 300.

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### 1 Introduction

As part of the Doris-Windy all-weather road construction, three new rock quarries are proposed for development. The proposed quarries are located a regionally extensive Mg-theolite basalt unit that had previously been identified as suitable for construction. Geochemical testing of the quarry rock was completed in July 2008, and results of the characterization program were presented in “*Geochemical Characterization of Quarry Materials for the Doris-Windy All Weather Road, Hope Bay Project*” (SRK 2008). The results indicated that samples in all three quarries were consistently non-acid generating and that the potential for metal leaching was low.

A field verification and monitoring program was proposed to ensure that the quarry development remains within the expected Mg-theolite basalt rock unit and that any rock with anomalously high sulphide content is managed appropriately. Details of the proposed verification program described in SRK 2008 are provided as follows:

*Monitoring of placed quarry rock will verify the ML/ARD characteristics determined in this study. The plan is based on the Doris North quarry monitoring plan from MHL (2007) and consists of the following:*

- 1. Visual monitoring of quarry rock by field geologist during excavation to confirm that the expected rock types and disseminated sulphides (e.g. not veins) are being exposed.*
- 2. Obtaining a total of five samples of blasted material (one per quarry) for acid-base accounting (ABA) confirmatory test work. The objective would be to confirm results and also assess the ARD potential of the fine fraction, which tends to concentrate sulphide minerals. For each sample, ABA would be conducted on the fines and the whole sample, for a total of ten ABA analyses.*
- 3. Post-construction monitoring of seepage and runoff of rock fill to confirm that environmentally-significant levels of metal leaching are not occurring. Specifically, annual seep surveys should be conducted during the spring freshet for the first two years after the major earthworks construction of the Doris-Windy all-weather road. Using a field meter, pH will be determined for rock fill*

*seepage and a water quality sample submitted for the analysis of pH, total sulphate, total ammonia, nitrate, alkalinity and an ICP metal scan. The objective is to verify that rock used in construction is non-acid generating and not leaching metals.*

SRK has subsequently revised this monitoring plan to provide more specific details, and to better reflect some of the practical limitations related to winter construction and safety issues.

## **2 Item 1: Visual Inspections**

### **2.1 Issues and Approach**

Construction of the Doris-Windy all-weather road is expected to commence in October 2008. Winter conditions are expected during most of the construction period. Although periodic inspections of the quarry may be possible, there are many safety issues associated with working in an active quarry, including unstable ground, traffic issues, and working around explosives. Additionally, white-out conditions and poor light will make it difficult to visually characterize the rock during the winter months. For these reasons, it is considered unrealistic to rely on regular inspections of the quarry rock to verify the geological characteristics of the rock during construction.

As an alternative to regular inspections of the quarry, SRK is proposing to complete a more thorough inspection of final quarry surface, and of rock fill in both the road after construction has been completed. In the unlikely event that any unsuitable materials are found during these inspections, mitigation measures, including additional testing and/or relocation of the rock fill will be implemented. The inspections would be completed in the spring of 2009, as soon as the road surface is snow free. Details of the inspections and proposed mitigation measures are provided below.

Given the high degree of consistency in the geochemical test data, and the degree of geological continuity expected within the quarry areas, the risk of inadvertently using other rock units or of encountering significant quantities of sulphides is considered to be very low.

### **2.2 Geochemical Inspection Methods**

The geochemical inspections will be completed by a qualified geologist or geochemist. The inspections will be completed in the spring of 2009, as soon as the rock fill is clear of snow. This is likely to be in late May or early June.

Prior to the inspections, site personnel will develop a traffic control plan to ensure that it is safe to work alongside the road, and will inform any vehicle operators as to the location and timing of the inspection work.

The inspectors will walk along one side of the road, examining both the surface and the exposed bedding material along the side of the road for any anomalous rock types (i.e. other than Mg-theolite basalts) or significant amounts of sulphide. If present, these materials will be examined, described, and located on a map. In addition, at regular 100 metre intervals, the inspector will stop and complete a close inspection of the rocks, breaking open several rock clasts and describing what they see.

Once the inspections are complete, anomalous rock types will either be sampled and submitted for static tests (ABA, metals, and extraction tests) to determine whether mitigation measures are warranted, or, if there are any obvious geochemical concerns such as significant quantities of sulphide minerals, the mitigation measures will be implemented without sampling and testing.

The number of samples will depend on the size and variability of the anomalous rock and the frequency at which this material occurs over the full length of the road. Once testing is complete, the data will be evaluated by a qualified geochemist. A conservative approach will be used in the interpretation of the testing results. Specifically, mitigation will be recommended if any of the following results are found:

- S(T) content of greater than 0.1% and NP to AP ratios of less than 3.
- S(T) content greater than 0.01% and NP/AP ratios of less than 1.
- paste pH less than 5

It is expected that results of the static testing would be available by September 2009, and remedial measures, if required, could be implemented by November 2009.

The results of the inspections and testing, and, if applicable, a description of the mitigation measures will be documented in a format that is suitable for regulatory review.

## **2.3 Mitigation Measures**

Any rock fill that is identified as being unsuitable for construction will be excavated and hauled back to one of the mined-out quarries. The rock fill would be placed within the quarry and covered with a minimum of 2 metres of the more typical Mg-theolite basalt that was approved for use in the road. Permafrost is expected to slowly aggrade into the rock fill, slowing the rates of sulphide oxidation substantially, and eventually shutting off seepage pathways. The clean rock cover would act as a thermal blanket to keep the active freeze/thaw zone away from the more reactive rock.

## **3 Confirmatory Sampling**

The original monitoring plan for the road construction specified collection of one sample per quarry area, with static testing on both the fine fraction of the sample and on the whole sample. Winter conditions are expected to complicate the sampling process, and SRK are now proposing to collect all of the samples during the visual inspection work in the spring of 2009.

Samples would be collected at regular intervals along the road. A total of five samples would be collected, and would include both a whole sample and a sample sieved to pass a -2 mm screen. The sample locations would be pre-determined to ensure that they reflect a random selection of the rock fill.

The samples will be submitted for acid base accounting tests and metal assays. Results will be compared to the pre-development test results and will be documented in a format that is suitable for regulatory review.

## **4 Seep Surveys**

Annual seep surveys will be conducted during the spring freshet, the first year after construction of the Doris-Windy all-weather road. A second survey will be completed either the following spring or fall (2010), depending on conditions observed at the time of the survey.

The main objective of the seep surveys is to gain a better understanding of the rates of metal leaching from this material. Ideally, the seeps will be smaller flows moving down through and interacting directly with the rock fill. These types of seeps generally occur during and immediately following snow melt or rain fall events. Seep surveys along road corridors are particularly challenging because there is relatively little storage and attenuation of these internal flows, and this shortens the window of time during which these ideal seeps can be collected. In addition, there will be numerous larger flows that move laterally through the base of the road or through culverts. Due to the relatively low rock to water ratio of these lateral flows, these seeps tend to be highly diluted, and they are not

particularly useful for understanding rates of metal leaching. The seep survey will therefore focus on smaller flows that appear to originate from within the rock fill.

Seeps will be located by walking along the downstream side of the road and infrastructure areas and looking and listening for signs of flowing water. In low lying areas where the direction of surface water flow is not evident, both sides of the structure will be inspected.

Where surface flows are identified, the upstream side will be inspected to determine whether the flow originates from the upstream side or whether it is likely to originate from within the rock fill material. Most samples will target this latter, more ideal type of seep. However, a modest number (maximum of one location every two km of road) will be collected at locations where there is moderate upstream flow component. In these cases, samples will be collected from both upstream and downstream of the road.

At each sample location, a survey stake will be installed to mark the location of the seep, and the location will be surveyed using a GPS. Photographs of the seep will be taken, and a complete description of the flow pattern, and magnitude of flow will be recorded. Field pH, conductivity, Eh and temperature readings will be taken, and samples will be collected for laboratory testing of pH, TDS, acidity and/or alkalinity, sulphate, total ammonia, nitrate, and a full suite of metals by ICP-MS.

Results will be presented in a format that is suitable for regulatory review.

## **5 References**

SRK Consulting, 2008. Geochemical Characterization of Quarry Materials for the Doris-Windy All Weather Road, Hope Bay Project. Report prepared for Newmont, August 2008.