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MEMORANDUM

DATE: May 21, 2008

TO: Stephen Mead, Faro TAT

FROM: John Brodie, P. Eng., Dan Mackie (SRK)

SUBJECT: S Wells Groundwater Capture Proposal

This memo discusses the current issues with water quality in North Fork Rose Creek (NFRC) in the S Well areas. Options for mitigation are described and a recommended option is presented along with estimated costs to complete.

Background

Water quality in NFRC is monitored under the Water Licence at X2. It is also assessed through the Adaptive Management Plan (AMP) – Event 5, Degraded Water Quality in NFRC.

Monitoring of the water quality in NFRC has indicated that the AMP threshold for zinc has been exceeded in 2006, 2007 and 2008 during the low flow period, typically from October to May. The magnitude of the exceedance has increased each year.

The report "Options for Closure of the Faro Mine Complex" (Options for Closure report) identifies groundwater capture as a key part of the overall closure strategy. An adaptive management approach is described as necessary, but the only component of that approach which is identified is to raise NFRC into a lined channel to isolate it from contaminated groundwater.

Adaptive management options for groundwater capture are described in more detail in SRK/RGC 2006, "2005 Seepage Investigation at the S Cluster Area below the Faro Waste Rock Dump". In that report, the following adaptive management strategies are identified:

- Pumping wells,
- Cut-off walls,

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- Shallow sumps and trenches,
- Permeable reactive barriers, and
- Stream isolation.

SRK/RGC suggest that a combination of measures will be required to attain the desired performance in groundwater capture. Initial efforts should be focused on known areas of high contamination.

An April 22 meeting involving the Faro TAT and select IPRP members concluded:

- Some of the S-Wells monitoring wells have concentrations up to 500 ppm zinc
- There is a measurable increase in zinc in NFRC from U/S to D/S of the S-Wells area.
- The rationale for proceeding with GW collection in this area should be well documented. This work should be flagged as "interim" with the recognition that it may become part of the long-term solution
- Pumping wells installed into weathered bedrock are required.

Discussion

In follow-up meetings, two key questions have arisen:

1. Is the zinc increase in NFRC a critical issue?
2. Is year round collection of the contaminated groundwater necessary?

Answering these questions helps to justify what is an appropriate initial program of groundwater capture that will address the current situation and, if possible, also form part of the long-term adaptive management strategy.

Data from surface water and groundwater monitoring provide a basis for addressing these questions. The zinc concentration in the NFRC rose to about 0.1 mg/l, which is higher than CCME criteria. The measured concentration is about 50% of the anticipated site specific water quality objective after consideration of hardness.

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Based on data presented in the 2005 S-Cluster seepage investigation report (SRK, 2006), two scenarios concerning the observed trends of groundwater seepage could be argued:

A. Most of the recent (last few years) increase in zinc in the NFRC is associated with the near surface seepage. The deep groundwater will likely eventually impact the NFRC, if it is not already, probably further downstream from the S-Wells. The gradients and likely seepage velocity of the near surface flow suggest that the highly contaminated groundwater is currently reaching the creek along discreet flow-paths. Consequently, the current loading of zinc is being adequately diluted and is not likely to get materially worse in the short-term (although as noted above, the trend is increasing zinc concentration).
B. The current levels of zinc in NFRC represent the leading edge of a contaminated plume. A "step-wise" increase in the loading to the NFRC will occur relatively soon (probably less than 2 years), once the highly contaminated material reaches the creek.

At this stage, the data is not sufficient to definitively state which of the above two scenarios is the case. Therefore, zinc in the NFRC is not currently considered critical, but it is likely that it will become critical.. Three general options for the area could be considered:

1. Continue or expand the current program of monitoring to determine with more certainty as to when critical impacts would necessitate some mitigative action.
2. Conduct additional investigations (e.g., more drilling) to compliment option 1.
3. Provide means to protect NFRC by either isolating the interval in the vicinity of the S Wells or install phase one of an adaptive groundwater capture system.

Some over-arching considerations to help identify the appropriate strategy going forward are:

- The Water Licence requirement to ensure protection of aquatic resources.
- A requirement of YG and INAC to demonstrate the capacity to responsibly manage the Faro site.
- Best management practices as might be applied at other mine sites.
- The cautious and risk-adverse approach that has been taken by INAC on other northern contaminated sites.

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In light of the above, it does not seem reasonable to advocate options 1 or 2. However, the short-term risk does not seem to warrant an elaborate and complex interception system at this time. Therefore, it is recommended that Option 3 be implemented, incorporating a limited scope year-round seepage collection system.

The scope and associated cost for isolating NFRC past the S Wells area has not been evaluated. However, such work would require an amendment to the Water Licence. Obtaining an amendment would preclude this approach, at least for 2008. Therefore, we recommend that a Phase 1 groundwater collection system be installed, which would include the following components (also shown on Figure 1):

- Four 6-inch pumping wells completed in weathered bedrock and overburden materials, located up gradient from the NFRC, near the original S-wells. Further discussion on the location of these wells (upstream or downstream of the anticipated cut-off wall) is pending.
- Pumps, riser pipes and, probably, pitless wellhead adaptors would be installed at each well.
- Each pumping well would be developed and the system tested with a series of pumping tests (3-hour step tests; 72-hour simultaneous, constant rate test; recovery).
- All pumping wells would have automatic on/off controls and be wired to an appropriate central junction.
- A shallow groundwater collection system comprised of a collection sump with radial french drain-type collectors or a long trench with a central sump.
- The sump would act as the central collection point for all captured groundwater. The sump would be housed in an enclosed, heated shelter.
- From the sump, water would be pumped by a separate booster pump to the final treatment/storage location.

Options for disposal of the collected water are:

1. Pump to the Faro Pit
2. Pump to the Zone II pit.
3. Pump to the ETA
4. Pump to the Original Impoundment.

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Options 2, 3, and 4 would all require re-pumping the water later so it could be treated, and options 3 and 4 could result in additional aquifer contamination.

Option1, pump to the Faro pit appears to be the preferred option. This would involve discharge via a single, insulated and heat-traced, small diameter pipeline up the face of the Intermediate Dump. The pump would have to be capable of lifting the water to the top of the Intermediate Dump, from which point water could gravity drain to the Faro pit.

Consideration was given to installation of small treatment system operating in the vicinity of the S Wells as an alternative to pumping the water for storage until it could be treated. Such an approach would almost certainly invoke an amendment to the Water Licence, and therefore this option was not considered further.

Additional monitoring wells would be installed as part of the program. Three nested monitoring wells, with completions in weathered bedrock and overburden, would be completed to compliment the existing monitoring network. These monitoring wells would provide both data for assessing pumping performance and baseline water quality from down gradient of the existing monitoring network.

Work in the S-well area will also include continued refinement of the final seepage interception system (SIS) design, as concieved in the SRK, 2006 assessment report. Tasks related to this component would include:

- Re-interpretation of the existing 2004 seismic survey data with drillhole logs to provide better information regarding bedrock topography for the proposed SIS alignment.
- Installation of two bedrock monitoring wells along the SIS alignment for bedrock characterization (note that there is almost no bedrock data for the entire site and none in this area).
- Detailed design of the final SIS

All work in the S-well area would be summarised and described, with design drawings and as-builts for appropriate components, in a final report.

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The following table provides estimated costs for the general tasks that will be required. In the event that budget, schedule or other site logistical issues require a reduction it the scope of work, then, one or more of the following elements could be delayed for a year:

- Installation of the additional monitoring wells (the main monitoring approach is water quality in NFRC).
- Construction of only the surface sump without the radial or trench components. Ideally situated and operated with a low water level will tend to draw most of the near surface contaminated water.
- Final design of the SIS could be conducted after completion of the phase 1 work envisioned here.

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Task	Est. Time (hrs)	Consultant Fees	Consultant Disbursements	Driller or Contractor Cost
Program Design and Planning	80	$11,500		
Phase 1 Groundwater Collection System				
OB MW Drilling & Completion	75	$10,000	$3,500	$60,000
OB MW Test/Sample	30	$4,000	$4,500	
PW Drilling & Completions	144	$20,000	$4,800	$100,000
PW Pump Install & Testing	96	$13,000	$5,000	$65,000
Shallow Sump Design	24	$3,500		
Continued SIS Design				
Seismic Re-interpretation				$4,000
BR MW Drilling & Completion	75	$10,000	$3,500	$60,000
SIS Detailed Engineering	120	$17,400	$5,000	
Final Reporting	100	$14,500	$1,000	
Senior Review	55	$10,175		
Project Management	78	$12,000		
Task Sub-Totals		**$126,075**	**$27,300**	**$289,000**
Misc. Equipment and Materials (10%)				$31,630
3% Communications Charge on Fees		$3,782		
Split of Drill/Equipment Mob				$70,000
Component Sub-Total				**$547,787**

Construction-related Costs	Est. Time (hrs)	Consultant Fees	Consultant Disbursements	Driller or Contractor Cost
Upgrade access road to S Wells	allowance			$5000
Shallow Sump Construction	96	$13,000	$3,500	$40,000
Supply power (cables/transformers/install)				$50,000
Component Sub-Total				**$115,000**

Water Handling Options				
Pipeline	1200 m @ $100/m (2002 est.)			$120,000
System electric control				$25,000
Component Max Sub-Total				**$145,000**

Combined Max Sub-Total			**$804,287**
Contingency (10%)			$80,429
Estimated Max Total			**$884,715**

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