Klohn Crippen Berger

September 7, 2007

Deloitte & Touche
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Mr. Doug Sedgwick

Dear Doug:

Rose Creek Tailings Facility, Faro Mine
PMF Flood Handling
Phase 1 – Concepts for Passing the PMF over the Intermediate Impoundment

In a letter dated July 6, 2007, SRK requested that Klohn Crippen Berger Ltd. (KCB) prepare a proposal to develop and cost a scheme which allows floods greater than the 1 in 500 year event to pass over tailings in the Intermediate Impoundment and through a spillway around the Intermediate Dam. In our letter dated July 11, 2007, we proposed that the work be carried out in two phases:

Phase 1 – review of available data, site visit and assessment of the viability of the concept of passing flows over the tailings.

Phase 2 – assuming the concept is viable; preliminary design, cost estimating and reporting.

The Phase 1 study was authorized by Doug Sedgwick of Deloitte and Touche via email on July 13, 2007.

Mr. Bryan Watts, P.Eng, Dr. Thava Thavaraj, P.Eng, and Dr. Ernest Portfors, P.Eng of KCB visited the Faro mine site on July 21 and 22, 2007. At Faro, we were met by Mr. John Brodie, P.Eng of Brodie Consulting and Mr. Daryl Hockley, P.Eng of SRK. Mr. Watts and Dr. Thavaraj undertook observations related to KCB's dam safety assessment while Dr. Portfors toured the surface water management facilities with Messrs. Brodie and Hockley. Numerous photographs of the water management facilities were taken which aided in subsequent office assessment of water management issues.

This letter report includes some general observation on water management issues at the Faro mine in addition to an assessment of the viability of passing the Rose Creek PMF over the Intermediate Impoundment.

Our draft report was issued on August 10, 2007 and comments received from Mr. Brodie and Mr. C. Scott, P.Eng of SRK were discussed in a telephone conversation on August 20, 2007.

1. General Water Management Observations

Observations pertinent to consideration of the Rose Creek Diversion Channel (RCDC) options were:

- **Vangorda/Grum Haul Road North Fork Rose Creek Crossing**

Currently, the Vangorda/Grum haul road crosses North Fork Rose Creek over a large fill. The haul road contains a rock drain which was constructed by pushing large boulders into the creek bed. North Fork Rose Creek flows through the rock drain and although there is a small pond on the upstream side of the fill, there is no evidence of significant ponding during high flows.

John Brodie advised that the current mine closure plans are to remove this road fill. The road fill and rock drain could, however, provide useful attenuation of North Fork flood waters and so reduce the required size of the Rose Creek Diversion Channel.

From visual observations of the North Fork valley upstream from the waste dumps (from the Vangorda/Grum haul road and access road above the waste dumps and Faro Pit), it appears that there may be an opportunity to construct a properly designed flood retention dam upstream of the waste dumps to provide storage and some flood attenuation. This concept is outside our current scope and has not been developed further.

- **Faro Creek Diversion**

Faro Creek is diverted upstream from the Faro pit and discharges into North Fork Rose Creek.

The current PMF flood estimates prepared by Water Management Consultants (WMC) (Rose Creek Probable Maximum Flood, May 2006) assume that Faro Creek Diversion remains in service during the PMF and diverts the entire Faro Creek flow into North Fork Rose Creek.

In its current condition, the diversion ditch has inadequate capacity to carry the Faro Creek PMF. In addition, we have been advised that other studies have concluded that the Faro pit wall will continue to fail and ultimately reach the location where the original Faro Creek is diverted.

SRK have reported (Options for Closure of the Anvil Range Mining Complex, draft, June 2007) that the recommended options will include upgrading Faro Creek to pass the 1 in 500 year flood. Assuming that this upgrading occurs, during the PMF it can be assumed that the Faro Creek Diversion will fail and flows will discharge into Faro Pit. The Faro Pit will provide some attenuation of the flood peak even if the Pit is full at the start of the PMF. Thus WMC's assumptions for Faro Creek should be considered conservative.

- **Guardhouse Creek and other North Slope Streams**

Guardhouse Creek and other drainages along the North Slope of the tailings impoundment are currently diverted downstream of the Intermediate Dam. In the event of a PMF, these diversions will undoubtedly be overtopped and fail. Consequently, it should be assumed that all the PMF flow from the North Slope enters the tailings pond.

- **Design of RCDC to pass the PMF**

Northwest Hydraulic Consultants (nhc) have prepared a design for upgrading RCDC to pass the PMF (Rose Creek Diversion Channel, Hydrotechnical Closure Design, draft, November 2006). This design assumes that 30% of the diversion channel is blocked with ice or debris prior to the PMF. We agree with assuming channel blockage prior to the PMF, however, blockage of more than 30% is conceivable for two reasons.

First, the PMP, which produces the PMF, is very large and undoubtedly will cause significant surface erosion and slides in the South Slope above the RCDC. nhc have analyzed a condition of some channel blockage and concluded that the PMF velocities would quickly erode any deposited material. However there is a risk that these deposits could completely block the RCDC resulting in overtopping the channel dyke between the RCDC and the Intermediate Impoundment.

Second, if it is assumed that the PMF occurs many years in the future, minor slope failures and vegetation could significantly clog the channel unless regular maintenance is carried out.

We understand that the mine closure plan includes the requirement for on-going water treatment, consequently personnel will be present at site to ensure that RCDC is maintained. However we do consider there is a risk that the RCDC is not maintained and that RCDC is not operational at the time a PMF occurs.

2. Diversion of Rose Creek over the Intermediate Tailings Impoundment

A concept of allowing Rose Creek flows greater than the current diversion channel capacity of approximately 135m^3/s (estimated to be the 1:500 year flood) to flow over the Intermediate Impoundment has been developed.

The upper portion of the Rose Creek Diversion Channel to the location of the current fuse plug would be upgraded to pass the PMF. The fuse plug currently contains some large rock and would be re-built to ensure failure when flows exceeded 135m^3/s. We have assumed that the fuse plug would completely fail at 135m^3/s and that the remainder of the PMF hydrograph would flow into the Intermediate Impoundment. Based on the PMF hydrograph (WMC May 2006), the fuse plug would fail at about hour 8 of the flood. As a refinement, it may be feasible to design an overflow section at the existing fuse plug location such that only flows above 135m^3/s would flow into the Intermediate Impoundment while the existing RCDC would continue to carry 135m^3/s.

We understand that the tailings will be covered with a layer of waste rock and soil with a total thickness of 1.5 to 2m. We have also been advised that it is anticipated that a large seismic event would result in localized tailings liquefaction and sand boils, but not general destruction of the cover.

Because of the liquefaction potential, it will not be possible to construct dikes across the tailings surface to completely contain the flood discharge. Therefore, we have anticipated that the flood discharge would enter the Intermediate Impoundment from the fuse plug location and spread over the entire tailings cover surface. As the water level in the Impoundment rose, flow would discharge over a spillway constructed around the Intermediate Dam.

There are two major design issues.

First, as the flood is routed through the Impoundment, water is temporarily stored in the Impoundment over the tailings cover and the flood peak is attenuated. There is a balance between the size of the spillway and the amount of water level rise over the tailings cover. We assumed that the tailings would be leveled to El. 1050.0 and that the top of the waste rock and soil cover would be at El.1051.5. Immediately upstream of the Intermediate Dam, the tailings level is appreciably lower and a pond currently exists with water surface at El.1047.3. As a first approximation, we have assumed that this pond would be in-filled with the top of the tailings cover at 1051.5. The current top of the Intermediate Dam is approximately 1049.9 and the current crest of the RCDC dyke at the Intermediate Dam location is 1054.4.

Table 1 shows the approximate maximum pond water level and corresponding maximum outflow discharge for various spillway widths. Spillway crest elevations were set at 1051.5, level with the top of the tailings cover, and at 1052.5, 1m above the tailings cover to initially form a pond and reduce flow velocities over the tailings.

Table 1

Top of Tailings Cover (m)	Spillway Invert Elevation (m)	Spillway Bottom Width (m)	Peak Outflow (m^3/s)	Max. Pond Water Level Elevation (m)
1051.5	1051.5	25	351	1056.2
		40	432	1055.4
		75	507	1055.0
		100	589	1054.1
1051.5	1052.5	25	291	1056.6
		40	386	1056.1
		75	482	1055.3
		100	504	1054.8

Raising the Intermediate Dam will be required as the current crest is lower than the assumed level of the rock and soil tailings cover. Overtopping of the Intermediate Dam would probably result in breaching the dam and release of tailings downstream. Consequently, we assumed that 2m of freeboard above the maximum flood level on the dam would be necessary.

If we assume that the pond water level is allowed to rise to the top of the existing RCDC dike at 1054.4, Table 1 shows that a spillway width of about 100m would be required and the Intermediate Dam crest and adjoining RCDC dike would be raised to about 1056.5. A 100 m wide spillway is probably not practical given the topography at either dam abutment; consequently the RCDC dyke and Intermediate Dam would require additional raising.

The second important issue is the velocity of the flood water as it enters and flows across the tailings cover in the Intermediate Impoundment.

When the fuse plug fails, $135m^3/s$ will initially flow through the natural channel that exists between the toe of the Secondary Dam and the RCDC dike.

The initial portion of this channel is approximately 25m wide for a length of about 325m and drops from the RCDC invert of 1053.7 to the top of the tailings cover at 1051.5. Over the next 500m the Impoundment widens to about 250m. After this point, the main Impoundment widens rapidly to about 600m.

The initial flow of $135m^3/s$ will have a velocity of about 3.5m/s in the 25m wide channel. This portion of the channel would be protected with rock riprap.

When the channel widens, the flow will spread and the velocity will reduce; however, we expect that unless the entire tailings cover is protected by riprap, local channelization will occur and the tailings cover will locally be eroded. In some areas, this erosion will probably expose tailings.

An option is to construct a shallow swale, say 1m deep, protected by riprap to carry flow into the main Impoundment area where flow would spread over the swale banks onto the tailings cover surface. Perhaps a series of flow distribution swales would help in distributing flow over the tailings cover.

As the flood discharge increases, water level in the Impoundment will rise rapidly and at the time when the peak flood of $692m^3/s$ occurs, water in the Impoundment will be approximately 3m deep. Velocities in the narrow initial portion of the channel near the entrance will be about 4m/s, but this will drop to below 1m/s over most of the tailings cover. Assuming the cover has been re-vegetated, only local erosion should occur. By providing rock riprap on the initial entrance channel and on a shallow swale (or swales) across the tailings cover, erosion of the soil cover should be limited.

3. Intermediate Dam Spillway

The spillway in competent rock around the Intermediate Dam and for a significant distance in the abutment downstream from the dam presents the lowest risk to avoid the possibility of spillway flows eroding the Intermediate Dam.

Other designs have assumed that a reinforced concrete control structure buried for frost protection could be provided as a grade control structure. The risk inherent with this approach is that unless maintenance can be guaranteed, a flood greater than $135m^3/s$ but less than the PMF could erode the soil frost protection, leaving the concrete to weather and potentially fail when the PMF did occur. Failure of the control structure could then lead to erosion and failure of the Intermediate Dam.

During the July field visit, a small outcrop of bedrock was observed on the right abutment just downstream from the existing spillway. The remainder of the abutment consists of easily erodable soils. Competent bedrock must be confirmed in order to locate a spillway on the right abutment.

On the left abutment, there is an outcrop of competent bedrock in the RCDC at the Intermediate Dam axis. A spillway could be located on the left abutment, however, to do so the RCDC would require re-routing to the left into the South Slope. This would require a significant excavation.

4. Conclusions

We believe that the concept of passing the PMF over the Intermediate Impoundment is viable providing that a spillway in competent bedrock can be located in the Intermediate Dam abutment. During the PMF, localized erosion of the tailings waste rock and soil cover would occur and probably expose tailings, but providing a series of low, riprapped swales across the tailings cover should minimize erosion.

A spillway in competent bedrock is the lowest risk option. The right abutment of the Intermediate Dam is preferred because of topography; however, bedrock may not be found in this area. Locating a spillway in bedrock on the left abutment is more probable; however, substantial shifting of the Rose Creek Diversion Channel into the South Slope would be required.

5. Recommendations

a) Undertake a site field investigation program to identify rock location and quality along the Intermediate Dam centerline and for a distance of 200m downstream on both right and left dam abutments.

b) Assuming (a) above is successful, undertake Phase 2 studies which will include: design a fuse plug, inlet channel and distribution swales over the tailings cover (this will require unsteady flow hydrotechnical math modeling); design the spillway and Intermediate Dam raising; prepare cost estimates.

We would be pleased to discuss this Phase 1 report with you at your convenience.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Ernest Portfors, Ph.D., P.Eng
Principal

Cc: John Brodie – Brodie Consulting Ltd.
Cam Scott – SRK Consulting
Bryan Watts – Klohn Crippen Berger Ltd.