Information Request 14

Responses to Information Request 14

IR 14 –Tailings Storage Facility Seepage - Mitigation

References:

EIS Guidelines, Sections 2.7.1.1 and 2.7.2.1
EIS, Sections 2.7.2.4 and 2.8.2.12
EIS Appendix 2.2.4-D (Report on the Preliminary Design of the Tailings Storage Facility)
EIS Appendix 2.6.1.4 D-A (Baseline Groundwater Hydrology Assessment)
EIS Appendix 2.7.2.4 A-B (Water Management Report)
EIS Appendix 2.7.2.4 A-C (Numerical Hydrogeologic Analysis)

Related Comments:

CEAR # 292 (Environment Canada)
CEAR # 276 (BC Ministry of Mines, Energy and Natural Gas)
CEAR # 272 (Natural Resources Canada)
CEAR # 290 (Tsilhqot'in National Government)

Rationale:

The EIS Guidelines state that the assessment shall describe the environmental effects of the Project, the proposed mitigation measures and an assessment of the effectiveness and any areas of uncertainty associated with the measures.

The EIS Guidelines also require, where mitigation measures are proposed and there is little experience or uncertainty as to their effectiveness, a description of the potential risks to the environment and the means to address them.

The Proponent describes mitigation measures for seepage recovery that will prevent seepage from the main embankment of the TSF from reaching the surrounding watershed. The combined efficiency of these seepage recovery measures was determined to be 93% (Appendix 2.2.4-D, p. B-4). Natural Resources Canada (NRCan) believes that: "the Proponent's overall estimate of seepage mitigation efficiency is over-optimistic given the highly heterogeneous nature of overburden units beneath the TSF and the potential for rapid contaminant transport along preferential groundwater flow paths that bypass interception wells (Appendix 2.2.4-C)". Without mitigation measures, the Proponent estimates that undiluted tailings pore water would reach Fish Lake tributaries by year 50 (Appendix 2.7.2.4 A-C, p.28).

There appears to be inconsistencies in the EIS regarding the proposed mitigation measures to control and capture seepage from the TSF. For example, the Proponent states (p. 599) that any water from the groundwater depressurization and seepage recovery wells would continue to be pumped back to the Main Embankment seepage ponds and the Main Embankment seepage pond water would continue to be pumped to the open pit until year 47, while elsewhere in the EIS (Appendix 2.7.2.4A-C, p.28). The same mitigation is proposed beyond year 47. Furthermore, the Proponent states (p.1391) that if deemed necessary groundwater recovery wells may be installed with water being pumped to the TSF. It is therefore unclear if the proposed mitigation measures are planned to operate in perpetuity.

No discussion is apparent in the EIS to evaluate the effectiveness of these measures to control potential effects on downstream water quality from seepage under temporary or early closure scenarios as required in the EIS Guidelines, Section 2.7.2.4.2.

Information requested:

Given the heterogeneous nature of overburden units beneath the TSF and the potential for contaminant transport along preferential groundwater flow paths that bypass interception wells the Panel requests that Taseko:

a. Provide the basis for estimates presented for the effectiveness of measures that would be implemented to control and collect seepage from the TSF.

b. Provide evidence through further analysis to support estimates of TSF seepage recovery efficiencies for the various mitigation measures that are proposed to protect water quality in Fish Lake.

c. Provide an assessment of the effectiveness of water management measures proposed for temporary or early closure scenarios to control potential effects on water quality in Fish Lake, Wasp Lake, and Big Onion Lake.

The Panel requests that Taseko:

d. Provide additional information regarding the proposed seepage collection and recycle ponds, the depressurization wells and the groundwater recovery wells. Taseko is requested to provide information at a level of detail that will facilitate a better understanding of the proposed measures, specifically:
    i. The number of groundwater recovery wells the Proponent anticipates installing;
    ii. An approximate indication of where the groundwater recovery wells would be installed;
    iii. Where the groundwater recovery wells would be finished (*e.g.* bedrock, the basalt, overlying unconsolidated overburden); and
    iv. If any groundwater recovery wells would be installed below the south embankment.

Information Request #14a

Given the heterogeneous nature of overburden units beneath the TSF and the potential for contaminant transport along preferential groundwater flow paths that bypass interception wells the Panel requests that Taseko provide the basis for estimates presented for the effectiveness of measures that would be implemented to control and collect seepage from the TSF.

Summary Response

The estimates that have been utilized for the effectiveness to control and collect seepage from the TSF are considered reasonable for this level of design of the TSF. As the project progresses, additional studies will be completed to refine the location, size and aspect of the various mitigation measures that have been proposed. Beyond those measures identified, additional mitigation measures may be implemented, if required, such as additional seepage interception wells. Furthermore, the potential for preferential groundwater pathways is a risk that can be managed. A reference for a peer reviewed survey method for identifying such groundwater pathways is included below.

The control of seepage water from the TSF occurs through many aspects of the design, including the glacial till basin liner, the embankment core/filter zones, the tailings mass, the depressurization wells, the seepage collection ponds and the groundwater pump back wells. The optimization of each of these measures occurs during detailed design, as well as throughout the project life based on information collected in the monitoring program. The basis for estimates for seepage control and collection measures is discussed in greater detail in the responses to IR12a, IR12b and IR14b.

Discussion

The management of contact water from the TSF is interwoven throughout the design. The naturally occurring and low-permeable glacial till liner is one key aspect to controlling contact water from within the TSF. As identified in the Preliminary Design Report of the TSF (EIS Appendix 2.2.4-D, Ref: VA101-266/27-3), for areas where insufficient glacial till exists to meet the seepage criteria, it will be borrowed, placed and compacted, if necessary. Sufficient overburden materials are shown to exist both within the TSF, and within the area of the open pit that must be removed during the construction period. The practice of conducting more detailed site investigations and augmenting basin soil liners, if required, is common practice in the construction of tailings management facilities.

The embankment design itself is also a measure to control seepage, where it contains a low-permeable, compacted glacial till core, with associated filters, which controls and directs seepage to the seepage collection ponds. Prior to the embankment, however, is the tailings mass itself. That is, the tailings solids acts as a primary barrier to contact water leaving the TSF, by keeping the supernatant pond away from the embankments, thereby decreasing the phreatic surface and the volume of seepage water.

After the glacial till basin liner, the embankment core/filters and the tailings mass itself, additional measures to control and collect seepage contact water have been input to the design. Depressurization wells related to the embankment shell zone will assist in increasing the capture rate of seepage water flowing through the embankment section. Further downstream, the seepage collection ponds will capture both surface contact water from the downstream shell of the embankment, as well as captured seepage water from the filters and depressurization wells, and a portion of the seepage water flowing through the foundation of the embankment (see response to IR14b). Beyond these measures, groundwater recovery wells have been allowed for, downstream of the seepage collection ponds, to capture still more seepage water that bypasses the seepage collection ponds, embankment filters and depressurization wells.

The 2D Seepage Model (EIS Appendix 2.2.4-D, Ref: VA101-266/27-3, Appendix B) presented the basis for and estimates of seepage from the TSF at the scale of the embankments. The 3D numerical groundwater model (EIS Appendix 2.7.2.4A-C) presented the basis for seepage recovery in the groundwater pump back wells located downstream of the seepage collection ponds. The response for IR14b presents a write-up summarizing the basis for the mitigation measures to control and collect seepage from the TSF. The response to IR 12a and 12b provide the basis for estimates related to the hydraulic conductivity of glacial till and tailings and TSF seepage estimates.

The potential for preferential groundwater pathways is a risk that can be managed. As a hypothetical example, if unexpected water quality results are encountered in the monitoring wells or the receiving environment, analysis to identify sources would be completed. To confirm the source and location of groundwater pathways a survey of the preferred groundwater pathways would be completed, any pathways bypassing the interception wells would be targeted by seepage interception wells to intercept the preferred groundwater pathway. An example of a peer reviewed survey method for the location of preferred groundwater pathways is described in the paper by Kofoed. V. O., et al. Unique applications of MMR to track preferential groundwater flow paths in dams, mines, environmental sites and leach fields. The Society of Exploration Geophysicists., Vol. 30 No. 2, Feb 2011.

References

Taseko Mines Limited (2012). *New Prosperity Gold-Copper Mine Project Environmental Impact Statement*.

Information Request #14b

Provide evidence through further analysis to support estimates of TSF seepage recovery efficiencies for the various mitigation measures that are proposed to protect water quality in Fish Lake.

Response Summary

The estimates of seepage recovery are considered reasonable assumptions for this level of design of the TSF. During the detailed design phase, additional studies will be conducted to refine the estimates, including: specific design measures to achieve or exceed the required seepage system collection efficiency (well screen interval, well diameter, well spacing, etc.), definition of the exact location of seepage management system features (wells, ponds, pumps), and sizing and operating methodology for the seepage collection system.

The 2D Seepage Model was used as the basis for estimating seepage recovery rates through the embankment, where the majority of seepage will leave the TSF. This estimate is considered conservative, as it did not account for the depressurization wells that will be a part of the embankment design. Hence, a greater percentage of seepage is expected to flow through the embankment and, by extension, the recovery will increase. The basis for estimating recovery of seepage that is not captured by the embankment filters and depressurization wells is based on predicted hydraulic flow paths within the materials of the foundation and downstream of the embankment, as well as other project experience where seepage recovery systems are in place. Finally, the basis for estimating recovery of seepage that bypasses the filters, depressurization wells and the seepage collection ponds is derived from the 3D numerical groundwater flow model.

Discussion

The 2D Seepage Model (EIS Appendix 2.2.4-D, Ref: VA101-266/27-3, Appendix B) presented the estimates of seepage from the TSF at the scale of the embankments. Figure 2.7.2.4A-10 from the EIS, reproduced here as Figure 14B-1 shows the estimated percentages for all the seepage flow paths, which were inputs to the water balance, and ultimately the water quality model for assessing water quality changes for Fish Lake and the greater receiving environment.

The basis for the estimate of seepage being directed through the embankment and recovered (65%) versus that which is assumed to not be captured immediately by the embankment filters (35%) is derived from the 2D Seepage Model listed above. While this model identified the need to install depressurization wells as part of the TSF design, the depressurization wells were not specifically a part of the seepage model results. Hence, there is a level of conservatism built into the basis for 65% flow through the embankment, as it would only increase with inclusion of the depressurization wells. In other words, greater flow of seepage will be directed through the embankment filters and therefore be recovered by the depressurization wells and the seepage collection ponds, than is shown above and included within the EIS.

The basis for the estimate of the total 35% flow that will be captured by the seepage collection ponds (50%) and that which will bypass the ponds (50%) relates the expected flow paths within the various materials in the foundation and downstream of the embankment, as well as additional project experience relating to seepage recovery from tailings facilities. Optimization of the seepage recovery ponds will occur during the detailed design phase of the project, which could lead to greater recovery of that seepage presently assumed to bypass the seepage collection ponds.

Within the 3D model, a conceptual groundwater seepage recovery system was implemented into the telescoping refined model (TRM) downstream of the main embankment. These wells were implemented as drain boundaries with the drain elevation set near the bottom of the upper bedrock unit (model Layer 2) about 100 m-bgl, the grid block dimensions in this part of the telescoping refined model were 25 x 25 m. The wells were assumed to be screened across their entire extent by assigning the grid blocks belonging to the wells' elevated values of hydraulic conductivity, two orders of magnitude higher than the adjacent cells. This representation allows the model to predict potential dewatering rates based on generated hydraulic gradients and hydraulic parameters rather than specifying well intake rates a priori which is useful for model convergence.

Through several model iterations, the drain elevation and number of drain cells required was optimized to determine the smallest number of drains required and the shallowest drain depth which could capture the majority of potential groundwater seepage downstream from the main embankment.

References

Taseko Mines Limited (2012). *New Prosperity Gold-Copper Mine Project Environmental Impact Statement*.

SEEPAGE FLOW PATHWAYS IN POST-CLOSURE

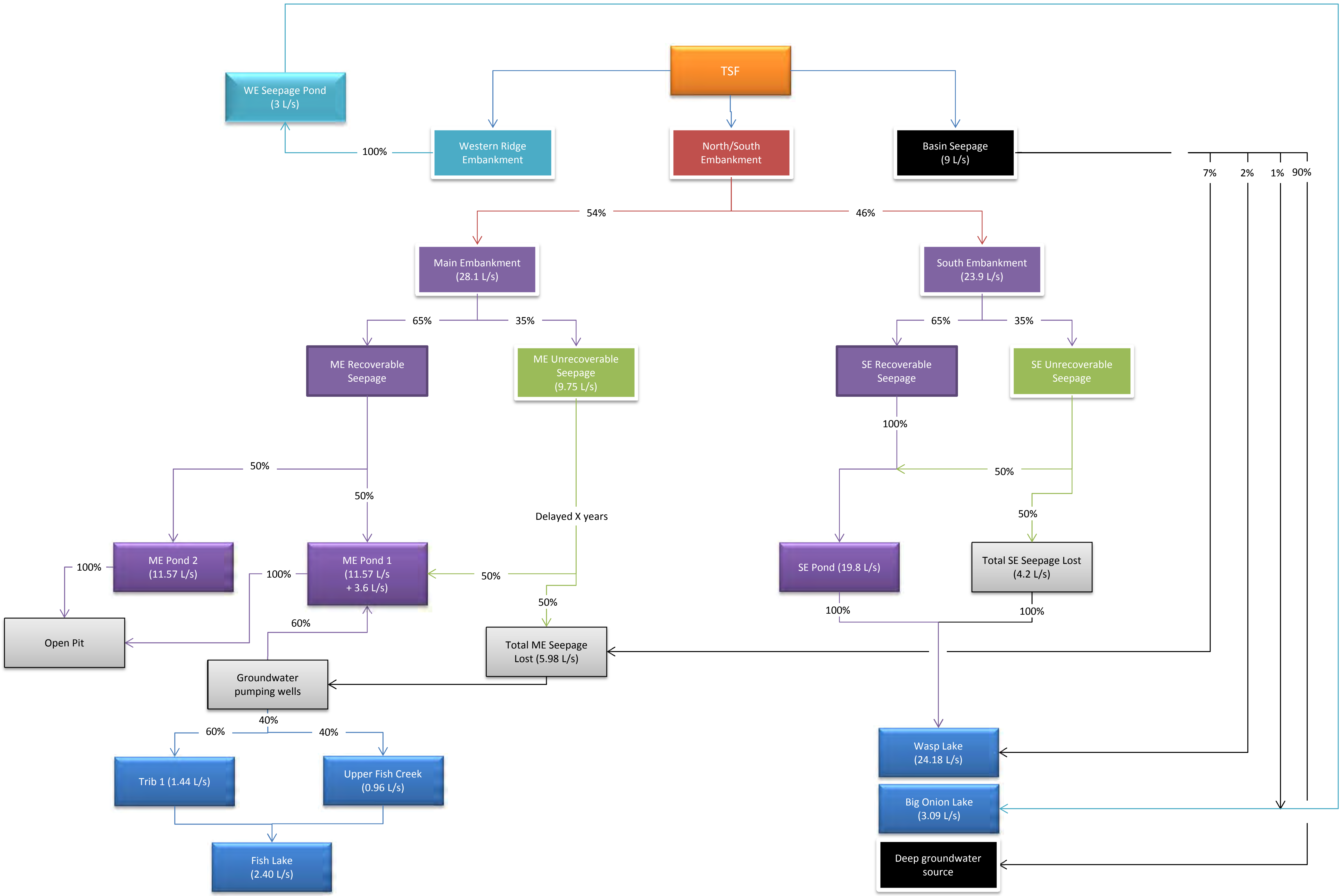

FIGURE 14B-1
TSF SEEPAGE FLOW CHART FOR END OF YEAR OPERATIONS (YEAR 17)

Information Request #14c

Provide an assessment of the effectiveness of water management measures proposed for temporary or early closure scenarios to control potential effects on water quality in Fish Lake, Wasp Lake, and Big Onion Lake.

Response Summary

The water management system will be established and in operation prior to the operations period. As a result the infrastructure required in the event of temporary closure or in the very unlikely event of premature permanent closure would be in place prior to these hypothetical events. The water management measures are virtually identical to those for scheduled closure. As a result, the effectiveness is the same, or better, depending upon when such closure commences in the mine life. Furthermore, potential effects on water quality in Fish Lake, Wasp Lake and Big Onion Lake will be the same, or reduced.

Discussion

The effectiveness of water management measures proposed for temporary or premature permanent closure does not differ greatly from that for full closure. The depressurization wells, seepage collection ponds, groundwater seepage pump back wells, collection ditches, diversion ditches and pumping systems will be established and in operation prior to the operations period. The water management measures are virtually identical to those for scheduled closure.

Less power will be required for pumping from the seepage collection ponds to the TSF, as the embankment would not be as high. However, the infrastructure would remain the same. The contact water collection ditches, and the non-contact water diversion ditches would continue to function in the same manner and effectiveness as for scheduled closure. Water from the TSF that would either be transferred to the open pit, or if water quality is suitable, released to the inlets of Fish Lake, would be reduced in volume but similar in character. A greater volume of non-contact water may be available due to a smaller TSF impoundment footprint, depending upon when temporary or premature closure occurs in the mine life.

Should temporary or premature closure occur before the west embankment is constructed, then there will be no seepage collection pond required for that embankment, and therefore no measure of effectiveness compared to scheduled closure would apply. Should temporary or premature closure occur after the west embankment is constructed, less potential for effects on water quality in Big Onion Lake could be assumed, as there would be less un-captured seepage flowing in that direction, due to a lower tailings pond elevation. As for the south embankment, and potential effects on water quality in Wasp Lake, no change in effectiveness of the water management measures related to that embankment would be predicted for temporary or premature closure. The catchment areas for non-contact water would remain the same, with only a reduction in uncaptured contact water seepage due to the lower tailings pond elevation resulting in a reduced potential for effects to Wasp Lake.

References

Taseko Mines Limited (2012). *New Prosperity Gold-Copper Mine Project Environmental Impact Statement*.

Information Request #14d

Provide additional information regarding the proposed seepage collection and recycle ponds, the depressurization wells and the groundwater recovery wells. Taseko is requested to provide information at a level of detail that will facilitate a better understanding of the proposed measures, specifically:

i. The number of groundwater recovery wells the Proponent anticipates installing;

ii. An approximate indication of where the groundwater recovery wells would be installed;

iii. Where the groundwater recovery wells would be finished (e.g. bedrock, the basalt, overlying unconsolidated overburden); and

iv. If any groundwater recovery wells would be installed below the south embankment.

Response Summary

Utilizing the 3D numerical groundwater model, a conceptual groundwater seepage recovery system was identified. Through this model, ten groundwater seepage recovery wells would be installed approximately 100 – 150 m downstream of the main embankment, to depths of about 100 m and spaced about 300 m apart. No groundwater recovery wells have been stipulated for the south embankment, but are a contingency mitigation measure subject to ground water monitoring in that area.

Discussion

Within the 3D model, a conceptual groundwater seepage recovery system was implemented into the telescoping refined model (TRM) downstream of the main embankment. These wells were implemented as drain boundaries with the drain elevation set near the bottom of the upper bedrock unit (model Layer 2) about 100 m-bgl, the grid block dimensions in this part of the telescoping refined model were 25 x 25 m. The wells were assumed to be screened across their entire extent by assigning the grid blocks belonging to the wells' elevated values of hydraulic conductivity, two orders of magnitude higher than the adjacent cells. This representation allows the model to predict potential dewatering rates based on generated hydraulic gradients and hydraulic parameters rather than specifying well intake rates a priori which is useful for model convergence.

Through several model iterations, the drain elevation and number of drain cells required was optimized to determine the smallest number of drains required and the shallowest drain depth which could capture the majority of potential groundwater seepage downstream from the main embankment.

The optimized results showed that approximately 10 groundwater seepage recovery wells installed 100 – 150 m downstream of the main embankment to depths of about 100 m and spaced about 300 m apart would be required. These results predict that the total flow to the 10 wells would be 1400 m^3/day (260 USgpm) or about 140 m^3/day (26 USgpm) per well. The wells will target permeable horizons such as inter-bedded sands and gravels, weathered basalts, and rock fractures.

Groundwater recovery wells have not been specified below the south embankment. However, they could be installed as an additional mitigation measure, if deemed necessary.

References

Taseko Mines Limited (2012). *New Prosperity Gold-Copper Mine Project Environmental Impact Statement*.