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Internal memo

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To	Rod Williams (IOC), Callie Andrews (IOC)
CC	Mike Muggridge (IOC)
Reference	15212
Date	21 January 2015
Subject	**Technical Memorandum** **Evaluation of Potential Impacts to Beverley Lake** **IOC Wabush 3 Project**

Summary

Project Purpose

Rio Tinto Iron Ore Company of Canada (IOC) plans to develop Wabush 3; a new mine pit that would be located south of Luce pit (see Figure 1). The Wabush 3 pit and associated waste rock dumps and overburden stockpile are located within the catchments of a number of lakes including Dumbell Lake, the nominated back-up water supply for the Town of Labrador City, Leg Lake, and White Lake/Luce pit. The overburden stockpile is also close to the catchment of Beverley Lake, the current municipal water supply for Labrador City. The Wabush 3 life of mine (LOM) is planned to extend until 2063 when the pit reaches its maximum depth at an elevation of about 430 meters above mean sea level (m amsl).

IOC is currently in the process of obtaining environmental permits for the Wabush 3 expansion project, which include an Environmental Impact Statement (EIS). As part of the EIS, possible impacts must be identified and mitigation of potential impacts must be proposed. As part of this evaluation, a hydrology study of the area was conducted that is documented in *Wabush 3 Hydrology Technical Report* (Golder Associates, 2014). Additionally, Rio Tinto Technology and Innovation (TI) conducted a groundwater modeling study to evaluate potential impacts to Dumbell Lake and Leg Lake, documented in *Groundwater Modeling Predictive Results for IOC Wabush 3 Project Technical Memorandum* (Rio Tinto TI, 2014), but did not evaluate potential impacts to Beverley Lake.

The City of Labrador is concerned that the Wabush 3 project may impact Dumbell Lake, the back-up water supply, but also Beverley Lake, Labrador City's primary water supply. At IOC's request, TI has conducted an evaluation of potential impacts to Beverley Lake to answer the following focussing question:

What are potential impacts to Beverley Lake as a result of Wabush 3 pit dewatering?

To answer this question, TI conducted groundwater modeling of Wabush 3 LOM and analysed the potential impacts to Beverley Lake (e.g., changes in groundwater flow to Beverley Lake).

Key Findings

The key findings from this work include:

1) Dewatering of the Wabush 3 pit is not predicted to have any impacts on Beverley Lake in terms of changes in groundwater flux to the lake. Furthermore, the Wabush 3 pit is not predicted to have any impact on groundwater levels adjacent to Beverley Lake.

2) Due to uncertainty regarding the hydrogeology in the area between the proposed Wabush 3 pit and Beverley Lake, a sensitivity run assuming a high hydraulic conductivity zone (e.g. a conductive fault) connecting the pit area to the lake was simulated and indicates that Wabush 3 dewatering could lead to a minor reduction in groundwater inflow to Beverley Lake (4 gpm decrease over the LOM predicted for this sensitivity simulation).

3) Surface water flows to Beverley Lake are not expected to be impacted by Wabush 3 pit dewatering because no part of the Wabush 3 pit is in the Beverley Lake watershed (surface water catchment).

Recommendations

Based on TI's analysis and results presented herein, IOC should:

1) Characterize the hydrogeology of the area between Wabush 3 and Beverley Lake and collect data to establish baseline conditions prior to construction and operation of Wabush 3.

2) Collect surface water stream gaging data on tributaries to Beverley Lake to establish baseline conditions prior to construction and operation of Wabush 3.

3) Revise the hydrogeological conceptual site model with data collected during the hydrogeological characterization effort as described above.

4) Revise and recalibrate the IOC South Area numerical groundwater model to incorporate the hydrogeological data collected and reflect any changes to hydrogeological conceptual site model. Perform predictive simulations with the recalibrated model.

Key Findings, Methodology, and Recommendations

Introduction

Rio Tinto Iron Ore Company of Canada (IOC) plans to develop Wabush 3, a new mine pit that would be located south of Luce pit (see Figure 1). The Wabush 3 pit and associated waste rock dumps and overburden stockpile are located within the catchments of a number of lakes including Dumbell Lake, the nominated back-up water supply for the Town of Labrador City, Leg Lake, and White Lake/Luce pit. The overburden stockpile is also close to the catchment of Beverley Lake, the current municipal water supply for Labrador City. The Wabush 3 life of mine (LOM) is planned to extend until 2063 when the pit reaches its maximum depth at an elevation of about 430 meters above mean sea level (m amsl).

IOC is currently in the process of obtaining environmental permits for the Wabush 3 expansion project, which include an Environmental Impact Statement (EIS). As part of the EIS, possible impacts must be identified and mitigation of potential impacts must be proposed. As part of this evaluation, a hydrology study of the area was conducted and is documented in *Wabush 3 Hydrology Technical Report* (Golder Associates, 2014). Additionally, Rio Tinto Technology and Innovation (TI) conducted a groundwater modeling study to evaluate potential impacts to Dumbell Lake and Leg Lake, which is documented in *Groundwater Modeling Predictive Results for IOC Wabush 3 Project Technical Memorandum* (Rio Tinto TI, 2014). This study did not evaluate potential impacts to Beverley Lake.

The City of Labrador is concerned that the Wabush 3 project may impact Dumbell Lake, the back-up water supply, but also Beverley Lake, Labrador City's primary water supply. At IOC's request, TI has conducted an evaluation of potential impacts to Beverley Lake to answer the following focussing question:

What are potential impacts to Beverley Lake as a result of Wabush 3 pit dewatering?

To answer this question, TI conducted groundwater modeling of Wabush 3 LOM and analysed the potential impacts to Beverley Lake (e.g., changes in groundwater flow to Beverley Lake).

Key Findings

The key findings from this work are as follows:

1) Dewatering of the Wabush 3 pit is not predicted to have any significant or measurable impacts on Beverley Lake in terms of changes in groundwater flux to the lake. Beverley Lake remains a zone of groundwater discharge across all scenarios. There is a large low permeability quartzite ridge (on which Smokey Mountain ski hill is located) that separates Wabush 3 from Beverley Lake. While somewhat permeable, the quartzite has the lowest hydraulic conductivity of all rock types tested in both the Wabush 3 and Luce pit areas (based on geometric mean from packer tests). Given the low hydraulic conductivity of hydrogeologic units and distance between Wabush 3 and Beverley Lake, the elevation of Wabush 3 relative to Beverley Lake (Wabush 3 mine plan has the pit bottom above Beverley Lake until approximately 2047), impacts are expected to be minimal, as supported by the groundwater modeling results

2) The Wabush 3 pit is not predicted to have any impact on groundwater levels adjacent to the Beverley Lake as illustrated by piezometric maps of current conditions (Figure 2) and at the end of Wabush 3 LOM in 2063 (Figure 3) when the depth of dewatering is at a maximum).

3) The hydrogeology of the Wabush 3 area and the hydraulic conductivity between the pit and the surrounding lakes is still somewhat uncertain. While the calibrated model

did not predict any impacts to Beverley Lake, because of this uncertainty a sensitivity run in which the Wabush 3 pit area was connected to Beverley Lake via a narrow higher hydraulic conductivity (1.2×10^{-5} m/s) zone (simulating a possible conductive fault zone). This sensitivity simulation resulted in a 4 gpm decrease in groundwater inflow to Beverley Lake (from 51 gpm to 47 gpm) over the LOM, which represents a decline of approximately 8 percent. This is insignificant relative to the overall flow budget for Beverley Lake, which is greater than 2,500 gpm (the average amount pumped from Beverley Lake in 2010 for Labrador City water supply). The magnitude of impacts to Beverley Lake, in the case of a conductive zone connecting the lake and the Wabush 3 pit, would be highly dependent on the effective hydraulic conductivity and geometry of this zone.

4) Surface water flows to Beverley Lake are not expected to be impacted by Wabush 3 pit dewatering because no part of the Wabush 3 pit is in the Beverley Lake watershed (surface water catchment). However, Wabush 3 *is* within the groundwater catchment of Beverley Lake, but Dumbell Lake is between the two, and is predicted to maintain the water table at a constant level upgradient of Beverley Lake. Wabush 3 is not expected to significantly affect Dumbell Lake (Dumbell Lake is expected to act as a constant head source) so groundwater flow between Dumbell Lake and Beverley Lake is not expected to change.

Methodology

The groundwater flow model used for predictions of potential impacts to Beverley Lake is the same model as was used to predict impacts to Dumbell Lake as described in *Groundwater Modeling Predictive Results for IOC Wabush 3 Project* (Rio Tinto TI, 2014). This model was based on the conceptual groundwater model (*IOC Site-wide Conceptual Groundwater Model,* Rio Tinto TI, 2012a) on which the numerical groundwater flow model (*IOC South Groundwater Flow Model and Updated Luce Pit Dewatering Prediction*, Rio Tinto TI, 2012b) was based; however, the model was modified to incorporate the data collected in the Wabush 3 area in 2011-2013 (AMEC, 2012a; AMEC, 2012b; Golder Associates, 2011; Rio Tinto IOC, 2013). The groundwater flow model was used to predict flows (minimum necessary dewatering rates) to Wabush 3 and Luce pits for the planned LOM through 2063. As was done for Dumbell Lake (Rio Tinto TI, 2014), impacts to Beverley Lake were evaluated by comparing simulated groundwater inflow and outflow rates to the lake during the LOM.

The re-calibrated South Area groundwater model (Rio Tinto TI, 2014) was used to predict groundwater levels and flows for the proposed Wabush 3 pit over the LOM (through 2063). These simulations also incorporated the Luce pit LOM (through 2053). Pits were incorporated into the model as transient seepage face (drain) boundary conditions to determine the induced outflow of groundwater (flow to the pits) as the pits are deepened through time. Pit shell elevations were obtained from IOC mine planners on 5-year intervals. Elevations were then interpolated linearly on one year intervals for input to the model. Note that detailed mine plans were not simulated in these predictions.

The hydrogeology of the area between Beverley Lake and Wabush 3 is largely unknown because there are no piezometers or monitoring wells in the area and no drilling or hydraulic testing has been conducted in this area. Because there are no water level data in the Beverley Lake area, the model is uncalibrated and conceptual in nature.

Model-predicted water levels for current conditions (2013) are shown on Figure 3. These are from the calibrated model illustrating baseline conditions (pre-Wabush 3 mining, but with Luce pit dewatered to 540 m amsl). Groundwater in the Wabush 3 area flows toward Leg Lake, Dumbell Lake and Luce pit. Figure 4 shows the predicted water table elevation contours at the end of LOM in 2063 with Wabush 3 dewatered to about 430 m amsl and Luce pit dewatered to 320 m amsl (the end of LOM for Luce pit is planned for 2053, but for simplicity in the model dewatering of Luce pit was assumed to extend through 2063).

Based on the groundwater model simulations of the Wabush 3 LOM, groundwater inflow to the Wabush 3 pit was predicted to increase through time reaching about 450 gpm by the year 2033 and then remaining between 450-500 gpm through 2063. Predicted flows to the Wabush 3 pit are relatively low compared to flows to Luce pit (approximately 8,000 gpm). This is primarily because the proposed Wabush 3 pit is not directly hydraulically connected to any lakes in the way that Luce pit is connected to Luce Lake. Geologic data collected to date and the structural models developed for the site do not indicate a direct connection from the Wabush 3 pit to any surrounding lakes (Leg Lake, Dumbell Lake, White Lake) via high hydraulic conductivity features (e.g., large fault zones, shear zones, or leached zones). The Wabush 3 pit is also higher in elevation reaching a minimum elevation of approximately 430 m amsl, while the final depth of Luce pit is 110 meters deeper (pit floor at approximately 320 m amsl). Note that these predicted flow rates are based on simulating the pit shell as a seepage face, and actual dewatering rates necessary to keep water levels below the pit floor and pore pressures in the pit walls low may need to be somewhat higher than these predicted flows.

To assess impacts to Beverley Lake as a result of Wabush 3 dewatering, flow budgets for the general head boundary cells representing these lakes were predicted through time from 2013 to 2063.

The hydrogeology of the area between the Wabush 3 pit and Beverley Lake is uncertain, and therefore a sensitivity run was performed in which the pit and the lake were connected via a narrow zone of higher hydraulic conductivity (1.2×10^{-5} m/s). Impacts to Beverley Lake are predicted to be less than impacts to Dumbell Lake because Beverley Lake (elevation ~531 m amsl) is lower than Dumbell Lake (elevation ~575 m amsl) and farther from Wabush 3.

Recommendations

Based on TI's analysis and results presented herein, IOC should:

1) Characterize the hydrogeology of the area between Wabush 3 and Beverley Lake. This work should include drilling, aquifer testing (packer tests and slug tests), installation of monitoring wells and measurement of water levels and water quality to establish baseline conditions prior to construction and operation of Wabush 3. Wells could be installed along the road to Smokey Mountain ski hill.

2) Collect surface water stream gaging data on tributaries to Beverley Lake to establish baseline conditions prior to construction and operation of Wabush 3. Flow data also should be compared to predicted groundwater fluxes. Permanent gaging stations should be established on tributaries immediately upstream of Beverley Lake. Gaging of discharge from Beverley Lake also should be measured. Flows should be measured through time to monitor high-flow, low-flow, and average-flow conditions.

3) Revise the hydrogeological conceptual site model with data collected during the hydrogeological characterization effort as described above. The focus should be on the area between Beverley Lake and Wabush 3, particularly identifying preferential pathways and barriers to flow.

4) Revise and recalibrate the IOC South Area numerical groundwater model to incorporate the hydrogeological data collected as part of the studies described above and reflect any changes to hydrogeological conceptual site model. Following recalibration, perform predictive simulations to evaluate if there are any potential impacts to Beverley Lake and Dumbell Lake as a result of Wabush 3 pit dewatering.

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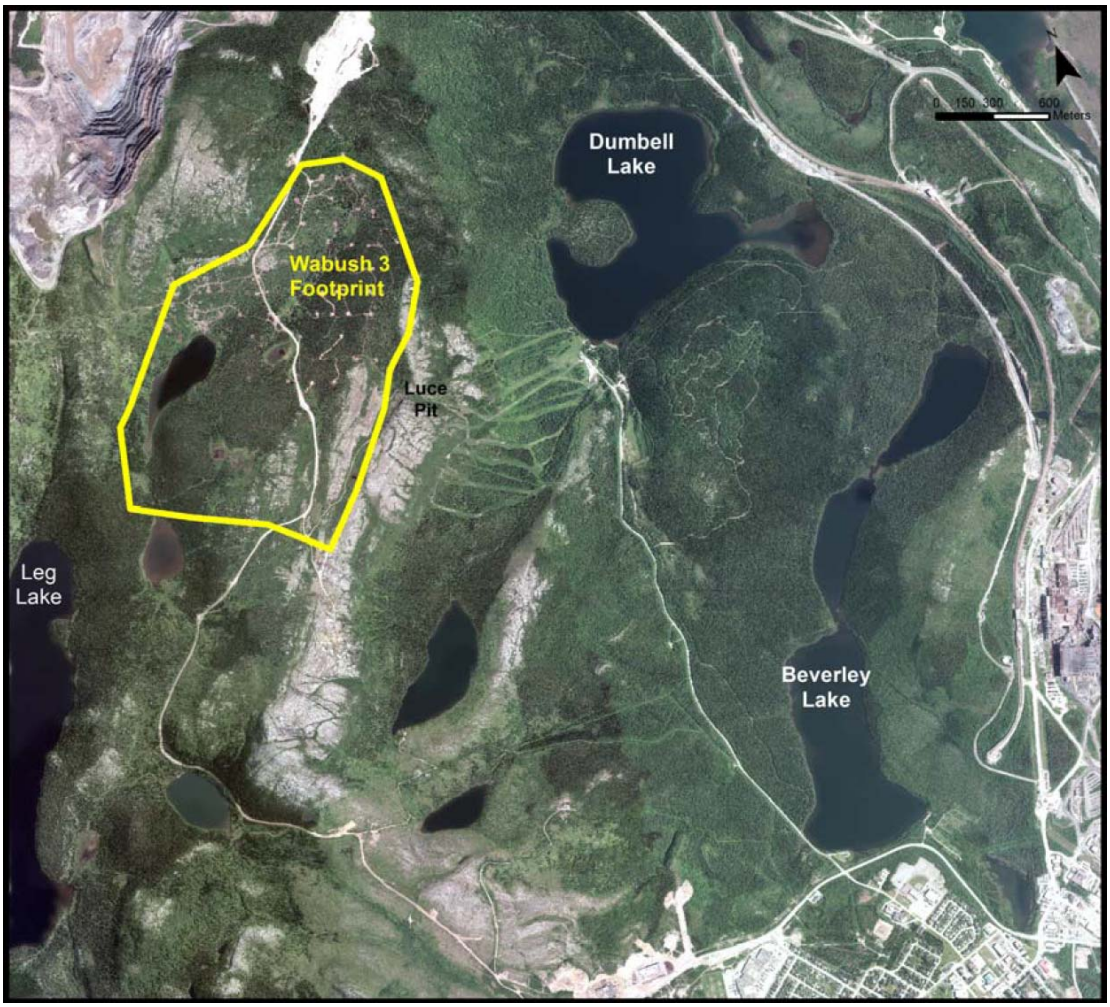

Figure 1. Wabush 3 Area Site Map with Dumbell Lake and Beverley Lake.

Figure 2. Model-predicted water table elevation contours for current (2013) baseline conditions prior to Wabush 3 mining (Luce pit dewatered to 540 m amsl).

Figure 3. Model-predicted water table elevation contours at the end of Wabush 3 LOM in 2063 (simulation also includes Luce pit dewatering to 2063).