DRAFT

GROUNDWATER FLOW MODEL UPDATE

FOR

SNAP LAKE MINE

Prepared
for
De Beers Canada

Prepared
by
Itasca Denver, Inc.

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ITASCA™
Denver, Inc.

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LIST OF ABBREVIATIONS

3-D	three dimensional
BAD	bedrock above dyke
BBD	bedrock below dike
FW	foot wall
HW	hanging wall
K	hydraulic conductivity
K_h	horizontal hydraulic conductivity
K_v	vertical hydraulic conductivity
L/min	liters per minute
LOM	life of the mine
m	meters
m/day	meters per day
m^3	cubic meters
m^3/ day	cubic meters per day
mamsl	meters above mean sea level
mbgs	meters below ground surface
melev	mine elevation = mamsl + 5000
mg/L	milligram per liter
TDS	total dissolved solids

EXECUTIVE SUMMARY

DESCRIPTION OF GROUNDWATER FLOW MODEL UPDATE

1) Itasca compiled and analyzed hydrogeologic data provided by the engineers at Snap Lake mine.
2) Based on the analysis and input from the engineers at Snap Lake mine, Itasca updated the conceptual groundwater flow model and TDS calculation model.
3) The previous groundwater flow model developed by Hydrologic Consultants, Inc. (HCI) was updated with the new hydrogeologic data.
4) The updated groundwater flow model was calibrated to the measured mine inflow rates from 2004 to 2012.
5) Two volumetric mixing approaches were used to estimate the TDS concentrations in the mine water for comparison with the measured TDS concentrations.
6) The calibrated groundwater flow model was used to predict future mine inflow rates based on the future mine plans provided by the engineers at Snap Lake mine.
7) Three sensitivity runs were conducted to evaluate the sensitivity of the simulated inflow rates on the spatial extent and hydraulic conductivity of the structural zones.
8) The volumetric mixing approaches were used to estimate TDS concentrations of future mine water.

FINDINGS AND CONCLUSIONS

Based on the data analysis and model simulations, the following conclusions can be made from the current update of the groundwater flow model:

- The updated groundwater flow model is reasonably calibrated to the measured inflow rate from 2004 to 2012.
- The updated groundwater flow model predicts that the maximum inflow may be approximately 66,000 m^3/day based on future mine plans and the existing geologic model.
- The measured inflow rate is directly affected by the mined area.
- Most of water inflow to the mine workings occurs in the excavated ore zone. Snap Lake is the major source of inflow water.
- The predicted inflow rate is sensitive to the spatial extents and hydraulic conductivity of the structural zones.

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- There is a strong correlation between the measured TDS concentrations and the ratio of simulated inflow to the waste/haulage drifts over the inflow to the excavated ore area.
- The maximum TDS concentration is predicted to range from 1,000 to 2,000 mg/L depending on the assumed TDS concentration distributions in the footwall and the hanging wall rocks.

Based on our understanding of data and site conditions, Itasca recommends the following work to be conducted under the following categories:

Inflow Rate and TDS

- Monitor inflow rates and TDS concentrations to both the excavated ore area and the waste/haulage drifts in order to better understand the hydrogeologic conditions of the rock above and below the dyke.
- Monitor flow rates and TDS concentrations of water hits to refine the spatial extent of the structural zones.
- Monitor inflow rates to different pumping zones. These data can be used to further understand the permeable nature of the structural zones.
- Monitor inflow rates and TDS concentrations over entire mine and the backfilled area before and after backfilling.

Groundwater Head and TDS in Underground Workings

- Install long-term underground shut-in holes at selected locations in the hanging wall and the footwall to monitor groundwater heads over time. The measured groundwater heads are critical for understanding the transient groundwater flow conditions during mining and for the model calibration.
- Measure TDS concentrations from these monitoring points to determine any change in TDS concentrations over time. Analysis of the measured TDS concentrations over time can lead to an understanding of the spatial distribution of the TDS, and increase the confidence level in the estimated TDS.

Hydraulic Testing in Underground Workings

- Use the long-term underground shut-in holes to conduct single-hole or cross-hole flow and shut-in tests.

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- Monitor both groundwater heads and TDS concentrations during the flow and shut-in tests.

Structural Zones and Faults

- Continue mapping the faults and structural zones.
- Update the geologic structural model when data become available.

Mine Plan

- Develop a mine plan to minimize the ratio of inflow to the waste/haulage drifts over the inflow to the ore area to reduce TDS concentrations.

Monitoring of Lake

- Monitor the TDS concentrations in Snap Lake.
- Monitor the TDS concentrations in the mine water discharge to Snap Lake.
- Monitor the discharge rates of mine water to Snap Lake.
- Continue to monitor the inflow and outflow of Snap Lake from the existing monitoring locations.

Update of Groundwater Flow Model

- Update the groundwater flow model based on the data obtained from the above recommended programs.

1.0 INTRODUCTION

This report summarizes the current update of the groundwater flow model of Snap Lake mine which was previously developed by Itasca Denver, Inc. (Itasca) while operating under its former name, Hydrologic Consultants, Inc. (HCI). This current update was based on data provided by engineers at Snap Lake mine between July and November 2012. The objectives of the current model update are to:

- compile and analyze the existing data,
- update the conceptual hydrogeologic model,
- update hydrogeologic settings simulated in the existing groundwater flow model previously developed by HCI (2005a, 2005b, 2005c, 2006a, 2006b),
- calibrate the groundwater flow model to measured mine inflow rates,
- predict total groundwater inflow to the mine workings over the life of mine (LOM), and
- estimate the concentration of total dissolved solids (TDS) of the inflow water.

A preliminary finite-element groundwater flow model was developed by HCI using the *MINEDW* code (HCI 2001). The model was updated by HCI between 2002 and 2006 (HCI 2005a; 2005b; 2006a). From 2007 to 2011, Fracflow Constultants Inc. (Fracflow) developed a groundwater flow model using the *FEFLOW* code (Fracflow 2011a). Fracflow also used the solute transport feature of the *FEFLOW* code to predict TDS loading in the mine water (Fracflow 2011a).

Itasca has not been involved in the hydrogeologic work and groundwater flow model of Snap Lake mine since 2006. Since then, various hydrogeologic investigations have been conducted at the mine site, and groundwater inflow and TDS concentrations have been monitored. Therefore, prior to the current groundwater flow model update, Itasca compiled and analyzed data collected since 2006 and updated the conceptual hydrogeologic model.

2.0 MAJOR HYDROSTRATIGRAPHIC UNITS

The description of hydrostratigrapic units is provided in HCI (2005a; 2006a; 2006b). Figure 1 was developed by HCI (2005c) and is used here for reference and discussion in this report. Figure 1 also serves as an illustration of the conceptual hydrogeologic model. From shallowest to deepest, the major geologic units are:

- Lakebed Sediments - a relatively thin veneer of till, possibly glacial outwash, and post-glacial organic materials on the bottom of Snap Lake.
- Exfoliation Zone - the uppermost portion of the crystalline bedrock where post-glacial unloading has resulted in tensile fractures, primarily with horizontal orientation.
- Permafrost - the soil at or below the freezing point of water over time; it is a low-permeability unit.
- Bedrock Above Dyke (BAD) - this unit includes all of the bedrock below the exfoliation zone (or permafrost below the land) and above the kimberlite dyke.
- Upper Contact Zone - in the previous models, this unit is assumed to be about 10 meters (m) thick and was assumed to be less permeable than the overlying bedrock (HCI 2005a,b,c; 2006a,b). In the updated model, this unit was not simulated.
- Kimberlite Dyke - the kimberlite dyke layer is about 2 m thick throughout the model domain and has a relatively low hydraulic conductivity.
- Lower Contact Zone - in previous models, this unit is assumed to be about 10 m thick and was assumed to be less permeable than underlying bedrock (HCI 2005a,b,c; 2006a,b). In the updated model, this unit was not simulated.
- Bedrock Below Dyke (BBD) - is massive bedrock or country rock beneath the kimberlite dyke.

3.0 DATA ANALYSIS AND THEIR APPLICATIONS IN THE MODEL UPDATE

At the initial stage of the project, Itasca received the following categories of data provided by the mine which is listed in Table 1 and are described in the following sections:

- Investigation reports, including structural geology, geochemical tests, and lake sediment investigations
- Groundwater flow modeling reports
- Monitoring data, including water inflow rates to the mine, total dissolved solids (TDS) concentrations in the mine water, water levels of limited piezometers
- Measured horizontal (K_h) and vertical (K_v) hydraulic conductivity values
- AutoCAD drawings related to the updated geology (kimberlite dyke surface, faults, and structural zones), existing mined area, and the future mine plan

The following sections describe the analysis of these data and their usage in the model update.

3.1 UPDATE OF GEOLOGIC SETTINGS AND STRUCTURES

3.1.1 Lakebed Sediments

Based on Fracflow (2011a), there is an approximately 3 to 8 m thick layer of lake sediment overlying the bedrock In addition, the measured water level in one piezometer completed at the bottom of Snap Lake showed a hydraulic head difference across the lakebed sediment layers (Fracflow 2011a,b). Both data suggest that the lakebed sediment may act as a less-permeability unit that prevents the direct connection between the lake and the exfoliated bedrock.

3.1.2 Kimberlite

The extent of the kimberlite dyke surface was defined by the mine. As shown in Figure 2, the identified extent of the kimberlite dyke covers an approximately 10 km^2 area. The elevation of the dyke surface ranges from 4387.4 mine elevation to over 5440 mine elevation. In Snap Lake mine, mine elevation (melev) is defined as the elevation in meters above mean sea level (mamsl) plus

5,000. In general, the dyke is close to the ground surface on the southwest corner and extends deeper to the northeast direction. For the model prediction, Itasca assumed that the dyke will extend to the model boundary following the same strikes and dipping angle, as labelled as "assumed extent" in Figure 2.

3.1.3 Contact Zone

HCI's previous model assumed that a 10-m contact zone exists immediately above and below the kimberlite dyke (HCI 2005a). This contact zone also was simulated in Fracflow's model (Fracflow 2011a); however, engineers at Snap Lake mine suggested that, based on the observation from the mining operations, there is no evidence indicating the existence of the low-permeability contact zone (Teleconference, September 2012; Meeting at Itasca, November 2012). Therefore, the contact zone as shown in Figure 1 is not simulated in the updated model.

3.1.4 Faults and Structural Zones

The inflow to the Snap Lake mine area is mainly controlled by faults and their associated structural zones. Figure 3 shows the locations of traces of identified faults provided by the engineers at Snap Lake mine. The dip information for each of the selected 14 major faults is summarized in Table 2. The hydrogeologic natures of some of these faults are summarized below:

- HCI (2001) reviewed the results of the investigation report prior to 2001 and noted that the Snap and Crackle Faults are the two main faults in the mine area.
- In 2005, HCI analyzed data collected in the P1PP and AEP test panels and found that the K_v values of the rock above the kimberlite dyke derived from shut-in pressure tests varies by five orders of magnitude. From these investigations, it was concluded that the orebody area is intersected by a number of identified faults including the Snap Fault, and Crackle Fault, and several other northwest-southeast trending faults (HCI 2006c; Adrian Brown 2006).
- SRK (2007) correlated the aeromagnetic data with underground mapping (SRK 2007) and stated that the major features are evidenced in the aeromagnetic data.

- In 2011, Fracflow collected core log data from three inclined boreholes and conducted packer injection tests to determine the hydraulic conductivity values (*K*) of selected borehole intervals (Fracflow 2012). All three geotechnical boreholes were drilled from the land and intersected approximately 150 to 200 m of permafrost and drilled to approximately 50 m below the known orebody. The data suggest that fractures become less developed with the depth. The testing also found that fractured zones and faults are generally more permeable than the in situ rock.
- In September 2012, engineers at Snap Lake mine provided a comprehensive geologic delineation of faults in the mine area and specified that the Snap Fault, the Crackle Fault, and the 45 Degree Fault are the major water producing faults.

Figure 3 also shows the assumed extent of faults outside of the mining area. Based on discussion with engineers at Snap Lake mine, it was decided that the Central Fault, the Crackle Fault, and the Snap Fault most likely extend to the northeastern part of the model boundary.

Given the presence of the extensive fault network in the mining area, HCI (2006a,b) simulated faults as structural zones that are more permeable than the in situ rock. This approach of simulating the extensive fault network is also used in the updated model. As shown in Figure 3, there is a total of six defined structural zones based on the locations of faults, the amount of water inflow encountered during mining, and the input from engineers at Snap Lake mine. Following are brief descriptions of these zones:

- Zone 2 covers the major areas of the 45 Degree Fault and its intersection with the Central, Gridline, and 505-490 faults.
- Zone 3 simulates the northwest part of the 45 Degree Fault and its intersection with the Snap Fault.
- Zone 4 is the largest structural zone and is likely to have the highest *K* based on water hit data. It exists in the area of a cluster of faults, including the Baby Snap, Central, Gravel, Snap, and Z -A11 faults.
- Zone 5 is located between Zone 3 and Zone 4 and covers the area where the Snap Fault and the Gridline Fault intersect.
- Zones 6 and 7 are new zones suggested by engineers at Snap Lake mine. These two structural zones were not simulated in previous models (HCI 2005a; 2006a). Large parts of the 401DR, 505-490, 515W, and Flank faults are within Zone 6.

- Zone 7 represents the intersections among the C10DR, C C10, CF Major, Gravel, Gridline, and Crackle Faults.
- Among these six structural zones, Zones 2, 4, and 7 are considered to be more permeable than the other three zones because of the observed higher flow rates encountered during mining operations.

Figure 3 also shows the assumed extent of the structural zones outside of the mining area. Similar to the assumptions in extending the faults, structures associated with the Central, Crackle, and Snap faults were assumed to extend to the northeastern model boundary.

3.2 HYDRAULIC CONDUCTIVITY

The K_h and K_v values were compiled from the following sources:

- HCI's September 2005 Model Update Report (HCI 2005a) where 115 K_v values from 23 boreholes and 15 K_h values from 12 boreholes (2 sub-vertical downholes and 10 upholes) were summarized
- HCI's June 2006 Technical memorandum (HCI 2006b) where a total of 211 measured K_v values were obtained from 43 boreholes.
- Fracflow's 2012 Report (Fracflow 2012) where a total of 70 measured K_h values were obtained from three boreholes.
- Additional 61 measured K_h and 238 measured K_v were provided by engineers at Snap Lake mine.

In total, 146 K_h values were measured from 35 holes (surface boreholes or underground drill holes) (Table 3) and 564 K_v values were measured from 37 holes (Table 4). Of these holes, the coordinates of 22 holes are not available at the time of this report preparation.

Figure 4a shows the correlation of the K_h values versus depth. The geometric mean of the K_h values by 50 m intervals are calculated and plotted in Figure 4a. These values are the basis for assigning K_h values to the hydrogeologic units in the model. As shown in Figure 4a, the measured K_h values show a trend of decreasing K_h with depth.

Figure 4b shows the correlation of K_v values versus depth. As shown in the figure, the K_v values were obtained in a limited depth interval. No trend can be observed between the measured K_v values versus depth.

3.3 MONITORING DATA

The on-going monitoring programs at the site monitor the total groundwater inflow to the mine workings, TDS concentrations in the mine discharge water, water levels from limited piezometers, and water hits in the mine workings.

Inflows to the mine have been measured from 2004 to 2012 on a daily basis. The total inflow rates are plotted as function of time as shown in Figure 5. By the end of 2012, the measured total inflow to the entire mine workings exceeded 30,000 m^3/day. There was no continuous monitoring of inflow to the waste/haulage drifts. Based on hydro mapping estimates from engineers at Snap Lake mine, the inflow to the waste/haulage drifts ranges from 2,500 to 3,700 m^3/day, which is approximately 10 percent of the total mine inflow. Figure 6 shows that the measured inflow rate depends on the mined area. It should be noted that the calculated "mined area" was based on the drifted area as shown in Figure 7. The calculated mined area did not include additional areas as the result of pillar slushing. Figure 6 indicates that, as the mining area increases, inflow to the mine will most likely increase.

Water hit areas have been recorded during mine operations. Grouting has been applied to selected inflow areas. The observed water hit locations are shown in Figure 7. Also shown in Figure 7 are the areas where the grouting was judged to be effective by engineers at Snap Lake mine. As discussed in Section 3.1.4, the observed water hit locations were used to define the structural zones and their associated *K* values.

Figure 8 shows the measured TDS concentrations in the mine water discharge from 2004 to 2012. The measurement intervals vary from daily to more than one month. As shown in Figure 8, the measured TDS concentrations fluctuate over time. The measured TDS concentrations from 2011 and 2012 mostly range from 400 to 600 mg/L.

Table 5 summarises the measured TDS concentrations based on the data provided by engineers at Snap Lake mine. Where the coordinates are available, the sampling locations are shown in Figure 2. The measured TDS concentrations were grouped according to their relative locations to the dyke. As shown in Table 5, 36 measured TDS values are above the dyke, and 37 TDS values are below the dyke. Figure 9a shows that there is no clear trend between the measured TDS concentrations above the dyke versus depth; however, Figure 9b shows that, except for a few points in the depth interval of 200 to 300 meters below ground surface (mbgs), the measured TDS concentrations below the dyke shows the increasing trend along depth. The average TDS concentrations above and below the dyke are approximately 200 and 4,400 mg/L, respectively.

Water levels were measured in limited locations of piezometers. The piezometers with available coordinates are shown in Figure 2. For the model update, engineers at Snap Lake and Itasca jointly decided to not use the measured water levels from these piezometers in the model calibrations because 1) these piezometers are clustered in a small area; and 2) the data need further verification and confirmation.

4.0 UPDATED CONCEPTUAL HYDROGEOLOGIC AND TDS MIGRATION MODELS

4.1 UPDATED CONCEPTUAL HYDROGEOLOGIC MODEL

Based on data compilation and analysis, the following updates were made to the conceptual hydrogeologic model previously developed by HCI (2005a) shown in Figure 1:

- The 2-m-thick lakebed sediments layer is considered to be less permeable than the underlying exfoliation zone.
- Exfoliation Zone – similar to HCI (2005a), this zone was considered to be more permeable than the deeper bedrock in the updated model.
- Permafrost – similar to HCI (2005a; 2006a), this zone was assumed to be 210 m thick and considered to be a low-permeability unit in the updated model.
- Bedrock Above Dyke – similar to HCI (2005a), the *K* value of this unit is assumed to decrease with depth in the updated model.
- Kimberlite Dyke – in the previous model (HCI 2005a, 2006a; Fracflow 2011a), the dyke was assumed to only exist within the ultimate mine area. In the current update, the dyke is assumed to extend to the eastern boundary of the model.
- Bedrock Below Dyke – Similar to the bedrock above the dyke, the hydraulic conductivity value of the bedrock beneath the kimberlite dyke is considered to decrease with depth in the updated model.
- Contact zone - unlike in the previous models (HCI 2005a, 2006a; Fracflow 2011a), both the upper and lower contact zones are assumed to not exist in the updated model.

Six structural zones were used to simulate the faults within the current mining area and future mine plan area. Two structural zones were assumed to extend to the northeastern model boundary as shown in Figure 3. The structural zones are assumed to be more permeable than the in situ bedrock. Furthermore, based on the model calibration (Section 5.6.1), the structural zones below the dyke are considered to be less permeable than those above dyke. These structural zones are believed to be the major "conduits" for water (both shallow groundwater and lake water) flowing to the mine workings.

4.2 UPDATED CONCEPTUAL TDS MIGRATION MODEL

There is not a sufficient amount of data (such as spatial distribution of TDS concentrations) to conduct a reliable 3-D solute transport model because its predicted concentrations are highly sensitive to the assigned initial TDS concentrations in the model. Itasca used the similar conceptual model for the TDS calculations developed by HCI (2006a) as shown in Figure 10a to calculate the TDS concentration in the mine discharge water. The TDS concentrations in the mine water are estimated through the volumetric mixing of inflow to the ore area and the waste/haulage drifts.

The conceptual model in Figure 10a shows that there are two main groundwater components contributing TDS to the mine water, one is from the HW with relatively low TDS concentrations and the other is from the FW with relatively high TDS concentrations. The TDS concentrations in the bedrocks above and below the dyke are determined by two different approaches.

The first approach (referred to as "Approach A" in this report) simply assumes groundwater in the HW and FW bedrock are two distinct groups as shown in Figure 10a. For the water from the FW, the TDS concentrations were initially assigned with an average measured TDS concentration based on Table 5 ("Initial Concentration"). Because the mine water with TDS is discharged to Snap Lake, the TDS concentrations in the lake may exceed the Initial Concentration. Therefore, during the model calibration and prediction, the TDS value in the HW is updated for each modeling time step (one month intervals) by comparing the Initial Concentration and the estimated TDS concentrations in the lake. The TDS concentrations of the lake are also updated at each modeling time step by mixing the mine water with the lake water. If the Initial Concentration is less than the TDS concentrations in the lake (C_L in Figure 10a), the estimated TDS concentrations in the lake are assigned to the HW groundwater to account for the fact that Snap Lake is the groundwater source of the HW.

The second approach (referred to as "Approach B" in this report) was initially proposed by Mr. Jessie Clark from Snap Lake mine (De Beers 2012) and slightly modified by Itasca. As shown in Figure 10b, the groundwater in the FW was divided into three groups, FW1, FW2, and FW3. The TDS concentrations of these groups are calculated with the following empirical formulae:

- TDS of FW1 = 2910 + 9*(5330 – HW Contact)
- TDS of FW2 = 3773 + 9*(5330 – HW Contact)
- TDS of FW3= 7940 +9*(5330 – HW Contact)

In the above formulae, TDS concentration is in mg/L, HW Contact is the mine elevation (melev) of the contact between the HW and the dyke.

Instead of using an empirical formula to calculate the TDS concentration in the HW as originally suggested by Mr. Clark, Itasca assumed that the TDS concentration in the HW was five percent (%) of the TDS concentration in the FW1 group. This slight modification ensures that the calculated TDS in the HW is within the 200 to 1000 mg/L concentration range of the measured TDS concentrations.

5.0 UPDATE OF GROUNDWATER FLOW MODEL

The updated groundwater flow model used the same code (*MINEDW*), model domain, and the same boundary conditions as the previous versions of the model (HCI 2005a; 2006a). This section describes the major updates to the previous groundwater flow model.

5.1 MODEL BOUNDARIES

The extent of the groundwater flow model and the boundary conditions are shown in Figure 11. The nodes associated with the lakes are assigned as constant heads with elevations of the lake elevations. Permafrost is assumed to exist in the area outside of the lakes. Below the permafrost and lakes, specified heads were assigned to the model boundary for the pre-mining condition. The specified heads were derived from water-level elevations in surrounding lakes. During mining, the boundary conditions in these layers are converted to variable-flux boundary conditions. This type of boundary condition, as it is incorporated in *MINEDW*, simulates infinite hydrogeologic units that have the same hydraulic properties as the units at the boundary. Using an analytical solution, the variable-flux boundary condition calculates the flow across the boundary as the result of calculated changes in groundwater levels at the boundary. The bottom boundary of the model is assigned as a no-flow boundary.

5.2 MODEL GRID AND DISCRETIZATION

In comparison to the previous models (HCI 2006a; 2006b), the updated groundwater flow model incorporated one additional model layer to simulate the lakebed sediments. In total, there are 14 model layers, 60,802 elements, and 32,790 nodes. The model domain encompasses approximately 105 km^2. Finer discretization with an element size of 50 x 50 m is utilized within the footprint of the ultimate mine, as shown in Figure 12. In addition, this updated model differs from previous models in the vertical discretization. Rather than assuming the geologic units being horizontal outside of the mining area as in the previous model, the updated model assumes that the geologic units follow the dip of the kimberlite dyke as shown in Figure 13.

5.3 SIMULATION OF HYDROSTRATIGRAPHIC UNITS

The major hydrostratigraphic units are simulated with hydrogeologic zones in the model. Figure 12 illustrates hydrogeologic zones used in Layer 6 of the groundwater flow model. The designation of each hydrogeologic zone in Figures 12 and 13 and its associated hydraulic parameters are summarized in Table 6.

As shown in the cross section in Figure 13, the model consists of 14 model layers. The model layer configuration generally follows the west-east dip of the geologic setting. Because permafrost, the dyke, and exfoliation zones do not exist over the entire model domain, the assignment of the hydrogeologic zones to the bedrock varies in the same model layer and with depth. The following summarizes the representation of the geologic setting in model.

The model area within the identified and assumed dyke footprint covers two distinct areas: the permafrost area and lake area. The representation of the hydrogeologic units under the permafrost area is as follows:

- Layers 1 - 5: permafrost units
- Layers 6 - 8: bedrock above the dyke with changing *K* values with depth
- Layer 9: kimberlite dyke
- Layers 10 - 12: bedrock below the dyke with changing *K* values along depth
- Layers 13 - 14: deep bedrock

The simulation of hydrogeologic units under the lake area is as follows*:*

- Layer 1: lakebed sediments
- Layer 2: upper exfoliated zone
- Layer 3: lower exfoliated zone
- Layers 4-8: bedrock above the kimberlite dyke with changing *K* values with depth
- Layer 9: kimberlite dyke
- Layers 10-12: bedrock below the dyke with changing *K* values with depth

- Layers 13 - 14: deep bedrock

For the model area outside of the dyke footprint, the configuration of the model layers is similar to the areas within the dyke footprint with the exception that the kimberlite dyke is not simulated.

To simulate the decreasing *K* values with depth, the bedrock above the kimberlite dyke (BAD) was simulated with six hydrogeologic zones whose *K* decreased with depth. The elevation intervals for these zones are summarized in Table 6. Similarly, four hydrogeologic zones with decreasing *K* values are used to simulate the bedrock below the dyke (BBD), as summarized in Table 6.

The rock between the extended structural zones associated with the Central, Crackle, and Snap faults is simulated with different hydrogeologic zones for the sensitivity analysis. The areal extent of this rock is highlighted in Figure 12 for reference. The discussion of the extended structural zones is presented in Section 3.1.4 and illustrated in Figure 3. In the base case simulation, the hydrogeologic zones for the rock between the extended structural zones are assumed to have the same hydraulic parameters as the in situ bedrock.

5.4 SIMULATION OF GEOLOGICAL STRUCTURAL ZONES

As described in Section 4.1, faults in this project area are simulated as structural zones due to 1) the complexity of the fault features and extensive intersections, and 2) the major water hits (i.e., flow rates > 500 L/min) often occur at the intersections of faults, as depicted in Figure 3.

As summarized in Table 6, the *K* values of all six structural zones were simulated to decrease with depth. Based on the model calibration discussed in Section 5.5, Structural Zones 3, 5, and 6 were determined to have the same hydraulic parameters. In addition, the *K* values above the dyke are generally greater than those below the dyke as summarized in Table 6.

5.5 SIMULATION OF MINING

The excavation of the ore area and ancillary ramps and drifts are simulated by 3,862 drain nodes in the model, including 1,287 nodes for the excavated ore area and waste/haulage drifts from May 2004 to December 2012 and 2,575 nodes for future mines.

The location and schedule of the existing excavated ore area and waste/haulage drifts provided by engineers at Snap Lake mine are shown in Figure 14. The depth of the current ore area varies from 100 mbgs in 2004 to 430 mbgs in 2012. Future ore excavation and waste/haulage drifts provided by engineers at Snap Lake mine in November 2012 are shown in Figure 15.

Drain nodes for ore areas are assigned along two nodal layers along the dyke (nodal layers 9 and 10). The drain nodes are "turned on" at the specified times when the ore areas are excavated. The purpose of assigning "paired" drain nodes above and below the dyke is to obtain the inflow above and below the dyke for TDS calculations.

For the waste/haulage drifts, drain nodes are specified along the drifts in nodal layer 12, which is approximately 30 m below the kimberlite dyke. A total of 238 drain nodes were assigned along the existing waste/haulage drifts, and 268 drain nodes were used to simulate future waste/haulage drifts.

For the effective grouting area shown in Figure 7, no drain nodes were assigned in the model. The model assumes that the effective grouting area does not produce any inflow. No effective grouting was simulated for future mining.

A large leakance factor (10 m^2/day) was assigned to drain nodes to ensure that there is no "barrier" due to the numerical set-up to prevent water inflow to the mine workings. By assigning a larger leakance factor to the drain nodes, the predicted inflow to the mine is mainly controlled by the *K* value and the head gradient of the in situ rock. Sensitivity tests show that the total inflow to the mine workings using this leakance factor is similar to the value derived from using model-calculated values based on the *K* values and size of the model elements.

At present, no backfilling has been implemented at the mine; therefore, the updated model does not consider the effects of the backfilling on the predicted inflow. According to engineers at Snap Lake mine, backfilling likely does not reduce mine inflow. Therefore, once a drain node is "turned on", it remains active throughout the remainder of the mine life.

5.6 MODEL CALIBRATION

5.6.1 Groundwater Flow Model Calibration

The groundwater flow model calibration is essential to ensure that the groundwater flow model realistically simulates the site's hydrogeologic and operational conditions. Generally, the groundwater flow model should be calibrated to both water-level data and flow (or discharge) data; however, water-level data are only available at several shallow piezometers within a limited area, as discussed in Section 3.3. Both engineers at Snap Lake mine and Itasca jointly decided that it is not meaningful to calibrate the groundwater flow model to the water-level data for this model update. Therefore, only measured inflow rates were used in the model calibration.

The groundwater flow model calibration was conducted by varying the *K* values of the bedrock and structural zones, and the areal extents of some structural zones. The *K* values derived from the groundwater flow model calibration are summarized in Table 6. Figure 16 shows the K_h values of different geologic units simulated in the model. Figure 17 shows that, using the *K* values in Table 6 and Figure 16, the simulated groundwater inflow rates generally agree with the measured total mine inflow rates.

Also shown in Figure 17 is the simulated inflow rate to the waste/haulage drifts. The simulated flow rate to the waste/haulage drifts in November 2012 was approximately 3,700 m^3/day, which is close to the estimated value based on hydro mapping as discussed in Section 3.3.

5.6.2 Calibration to Measured TDS Concentrations

As discussed in the previous section, there are no sufficient measured TDS concentrations from the monitoring locations to define the spatial TDS concentrations for conducting a robust 3-D solute transport model. By using the simple mixing calculations as described in Section 4.2, the calculated TDS concentrations were compared with the measured TDS concentrations in the mine discharge for the period of 2004 to 2012.

The data at the site indicates that the water from the FW contains higher TDS concentrations than in the HW. This pattern is also observed from the model simulations. As shown in Figure 18, there is a close correlation between the measured TDS concentrations and the ratio of predicted inflow to the waste/haulage drift and that to the excavated ore area. This figure indicates that the predicted TDS concentrations are sensitive to the inflow rate from the HW and the FW.

Figure 19 shows the calculated TDS concentrations using Approaches A and B (as described in Section 4.2). As shown in the figure, the calculated values from both approaches reasonably agree with the measured values; therefore, both approaches are applicable for estimating the TDS concentrations of the mine discharge for future mining.

6.0 PREDICTIVE SIMULATIONS WITH UPDATED GROUNDWATER MODEL

6.1 DISCUSSION OF KEY SIMPLIFICATIONS/ASSUMPTIONS IN THE MODEL PREDICTIONS

The following are key simplifications/assumptions regarding the model predictions:

- The predicted inflow rate is sensitive to structural zones. Two structural zones were assumed to extend to the model boundary (Figure 3). If there are more structural zones than the two assumed structural zones, the predicted inflow rate could be higher than the value presented in this report.
- Estimated TDS concentrations could be sensitive to the TDS concentrations in the in situ rock. In this updated model, there is very little data to delineate the spatial distribution of the TDS.

6.2 PREDICTED INFLOW TO MINE

Using the calibrated groundwater flow model, predicted inflow rates to Snap Lake mine is presented in Figure 20. Figure 20 suggests that:

- Total inflow to the entire mine will reach a maximum value of approximately 66,000 m^3/day in year 2030 based on the future mine plan.
- The maximum inflow to the waste/haulage drifts is approximately 7,000 m^3/day.
- Most of the total inflow occurs in the mined ore area.

Figure 20 also shows the instantaneous increase (or spike) of the predicted inflow rates. These "spikes" are the result of a combination of the following reasons:

- The mining was simulated on a monthly interval, and not a daily interval. As such, all the drain nodes for the planned mined area of the respective month are numerically "turned on" instantaneously. This will numerically introduce the excessive release of groundwater from storage which, in reality, would release gradually from the rock over the monthly intervals.
- The area of mining and development varies for different years, which leads to different incremental increases of the predicted inflow rates. Some of the "spikes" are related to the intersection of the mining area with the permeable structural zones.

Figure 21 shows that most of the inflow to the mine originates from the lakes. Among the three lakes within the model domain, Snap Lake contributes approximately 80% to the total inflow and the Northeast Lake contributes approximately 20% to the total inflow. The contribution from North Lake is insignificant in comparison to the two other lakes. As shown in Figure 3, Northeast Lake overlies the two extended structural zones, and consequently, has a larger contribution than North Lake even though it is slightly farther from the mine than North Lake.

6.3 PREDICTED TDS CONCENTRATIONS IN MINE WATER INFLOW

TDS concentrations of future mine inflows were calculated using the two approaches described in Section 4.2. As shown in Figure 22, the calculated TDS concentrations fluctuate during future mining, with a high concentration occurring in 2013 and during the period of 2019 to 2023. This fluctuation is mainly attributable to the excavation schedule of the waste/haulage drifts. When the larger area of the waste drift development occurs, the ratio of predicted inflow to the waste/haulage drift over the predicted inflow to the excavated ore area would increase, and so does the estimated TDS. On the contrary, when a large area of ore excavation occurs, the estimated TDS concentrations would be relatively low. Figure 22 provides a useful guidance to the mine planning. In order to reduce the TDS concentration in the mine water, a low ratio of the inflow to the waste/haulage drift over that to the mined ore area should be maintained.

Figure 22 also shows that the trends of the predicted TDS concentrations from both Approaches A and B are similar; however, the upper ranges of the TDS concentrations from Approach B is estimated to be 1.5 to 2 times higher than that from Approach A. The maximum estimated TDS concentration from Approaches A and B are approximately 1000 and 2000 mg/L, respectively. Because Approach B considers the change in the TDS concentrations with depth while Approach A assumes a constant TDS concentration, it is reasonable to expect that the estimated TDS concentrations from Approach B will be higher than those from Approach A.

6.4 SENSITIVITY ANALYSIS OF GROUNDWATER INFLOW

The predicted inflow rate in Section 6.2 is considered to be the Base Case scenario. In this scenario, the following geologic settings were assumed:

- The structural zones associated with the Crackle, Central, and Snap faults were assumed to extend to the northeastern model boundary, and
- the kimberlite dyke was assumed to extend to the northeastern model boundary.

The sensitivity of the simulated inflow rate to these assumed structural zones was assessed under the following simulation scenarios:

- Scenario 1: The assumed structural zones associated with the Crackle, Central, and Snap faults were only extended to the eastern ultimate mine footprint.
- Scenario 2: The *K* values of the rock between the assumed structural zones associated with the Central, Crackle, and Snap faults were assumed to be two times higher than those of the in situ rock (see location in Figure 12).
- Scenario 3: The *K* values of the assumed structural zones associated with the Central, Crackle, and Snap faults were assumed to be two times greater than those of the Base Case scenario.

The predicted inflow rates from these scenarios, along with the Base Case scenario, are presented in Figure 23. A comparison between each sensitivity scenario and the Base Case scenario shows the following:

- By limiting the structural zones within the mining foot print, the predicted maximum inflow is approximately 53,000 m^3/day, which is approximately 20% less than the inflow rate from Base Case scenario.
- The predicted inflow rate is not sensitive to doubling the *K* values of the bedrock between the extended structural zones associated with the Crackle, Central, and Snap faults. Even though the *K* values of the bedrock were assumed to be two times greater than the *K* values of the in situ bedrock, they are still lower than the *K* values of the structural zones, which contribute the majority of the inflow. Therefore, the predicted inflow in Scenario 2 is similar to the flow rate in Base Case scenario.

- By assuming the K values of the extended structural zones being two times greater than the Base Case scenario, the simulated maximum groundwater inflow to the mine is approximately 75,000 m^3/day, which is approximately 20% higher than the maximum flow predicted in the Base Case scenario.
- The predicted inflow is sensitive to the both the spatial extent of the structural zones and their K values as shown in Scenarios 1 and 3.

No sensitivity analysis was conducted on the estimated TDS concentrations because the estimated TDS concentrations from both Approaches A and B are essentially directly proportional to the assumed TDS concentrations in the HW and FW.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the data analysis and model simulations, the following conclusions can be made from the current update of the groundwater flow model:

- The updated groundwater flow model is reasonably calibrated to the measured inflow rate from 2004 to 2012.
- The updated groundwater flow model predicts that the maximum inflow could be approximately 66,000 m^3/day based on future mine plans and the existing geologic model.
- The measured inflow rate is directly affected by the mined area.
- Most of the water inflow to the mine workings occurs in the excavated ore zone. Snap Lake is the major source of inflow water.
- The predicted inflow rate is sensitive to the spatial extents and hydraulic conductivity of the structural zones.
- There is a strong correlation between the measured TDS concentrations and the ratio of simulated inflow to the waste/haulage drifts over the inflow to the excavated ore area.
- The maximum TDS concentration is predicted to range from 1,000 to 2,000 mg/L depending on the assumed TDS concentration distributions in the FW and HW rocks.

Based on our understanding of data and site conditions, Itasca recommends the following work to be conducted under the following categories:

Inflow Rate and TDS

- Monitor inflow rates and TDS concentrations to both the excavated ore area and the waste/haulage drifts in order to understand the hydrogeologic conditions of the rock above and below the dyke.
- Monitor inflow rates and TDS concentrations of water hits to refine the spatial extent of structural zones.
- Monitor inflow rates to different pumping zones. These data can be used to further understand the permeable nature of the structural zones.

- Monitor the effect of the backfilling on the inflow rates and TDS concentrations over entire mine and the backfilled area before and after the backfilling.

Groundwater Head and TDS in Underground Workings

- Install long-term underground shut-in holes at selected locations in the HW and FW to monitor groundwater heads over time. The measured groundwater heads are critical in understanding the transient groundwater flow conditions during mining and for the model calibration.
- Measure TDS concentrations from these monitoring points to determine any change in TDS concentration over time. Analysis of the measured TDS concentrations over time can lead to an understanding of the spatial distribution of the TDS, and increase the confidence level in the estimated TDS.

Hydraulic Testing in Underground Workings

- Use the long-term underground shut-in holes to conduct single-hole or cross-hole flow and shut-in tests.
- Monitor both groundwater heads and TDS concentrations during the flow and shut-in tests.

Structure Zones and Faults

- Continue mapping the faults and structural zones.
- Update the geologic structural model when data become available.

Mine Plan

- Develop a mine plan to minimize the ratio of the inflow to the waste/haulage drifts over the inflow to the ore area to reduce the TDS concentration.

Monitoring of Lake

- Monitor the TDS concentrations in Snap Lake.
- Monitor the TDS concentrations in the mine water discharge to Snap Lake.
- Monitor the discharge rates of the mine water to Snap Lake.
- Continue to monitor the inflow and outflow of Snap Lake from the existing monitoring locations.

Update of Groundwater Flow Model

- Update the groundwater flow model based on the data obtained from the above recommended programs.

8.0 REFERENCES

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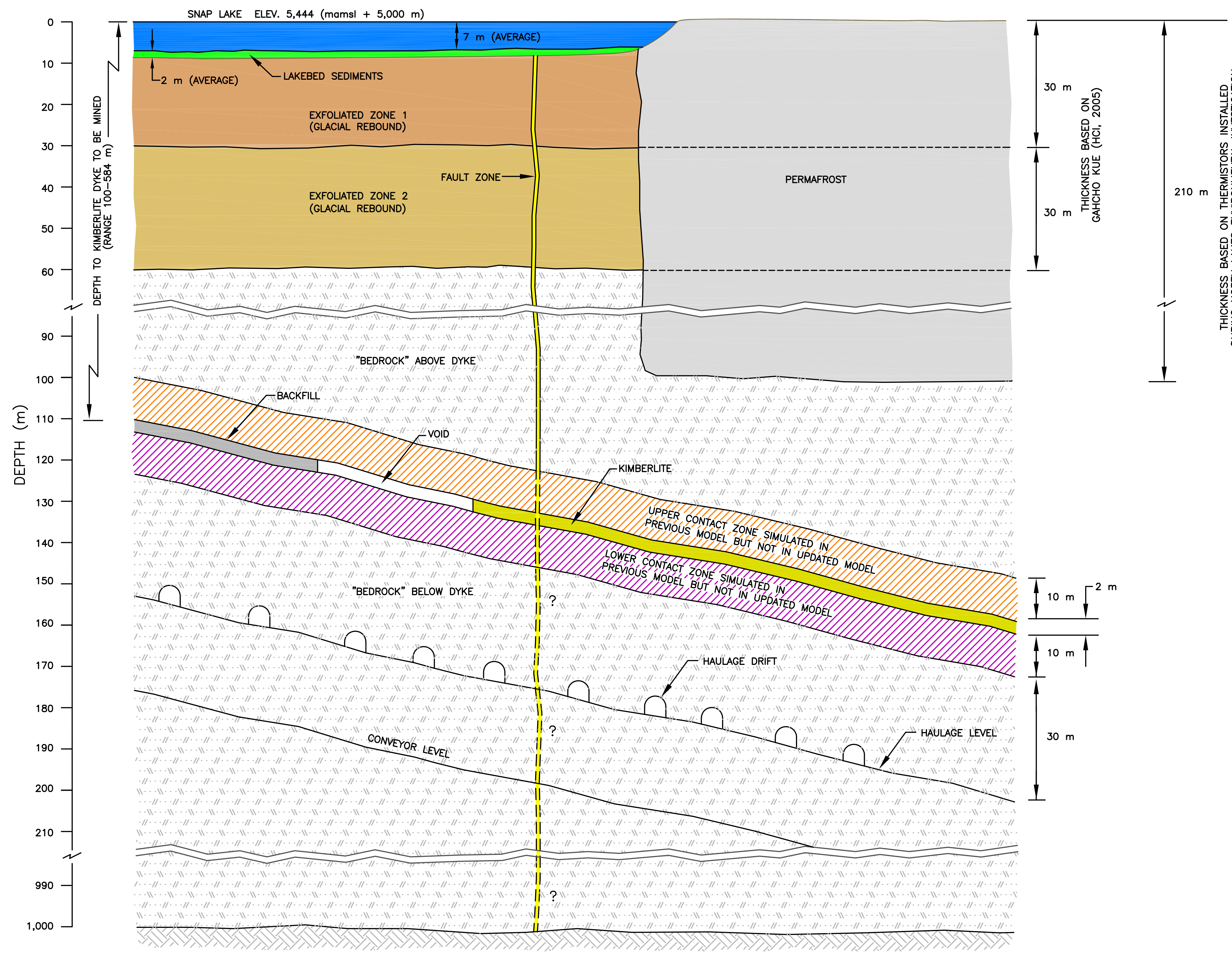

HYDRAULIC PROPERTIES OF VARIOUS HYDROGEOLOGIC UNITS ARE SUMMARISED IN TABLE 6.

NOT TO HORIZONTAL SCALE

PROJECT NO.	1780
BY	HL
CHECKED	--
DRAWN	SAC
DRAWING NAME	CONCEPTUAL-HG-MODEL
DRAWING DATE	10 DEC 2012
REVISION DATE	--

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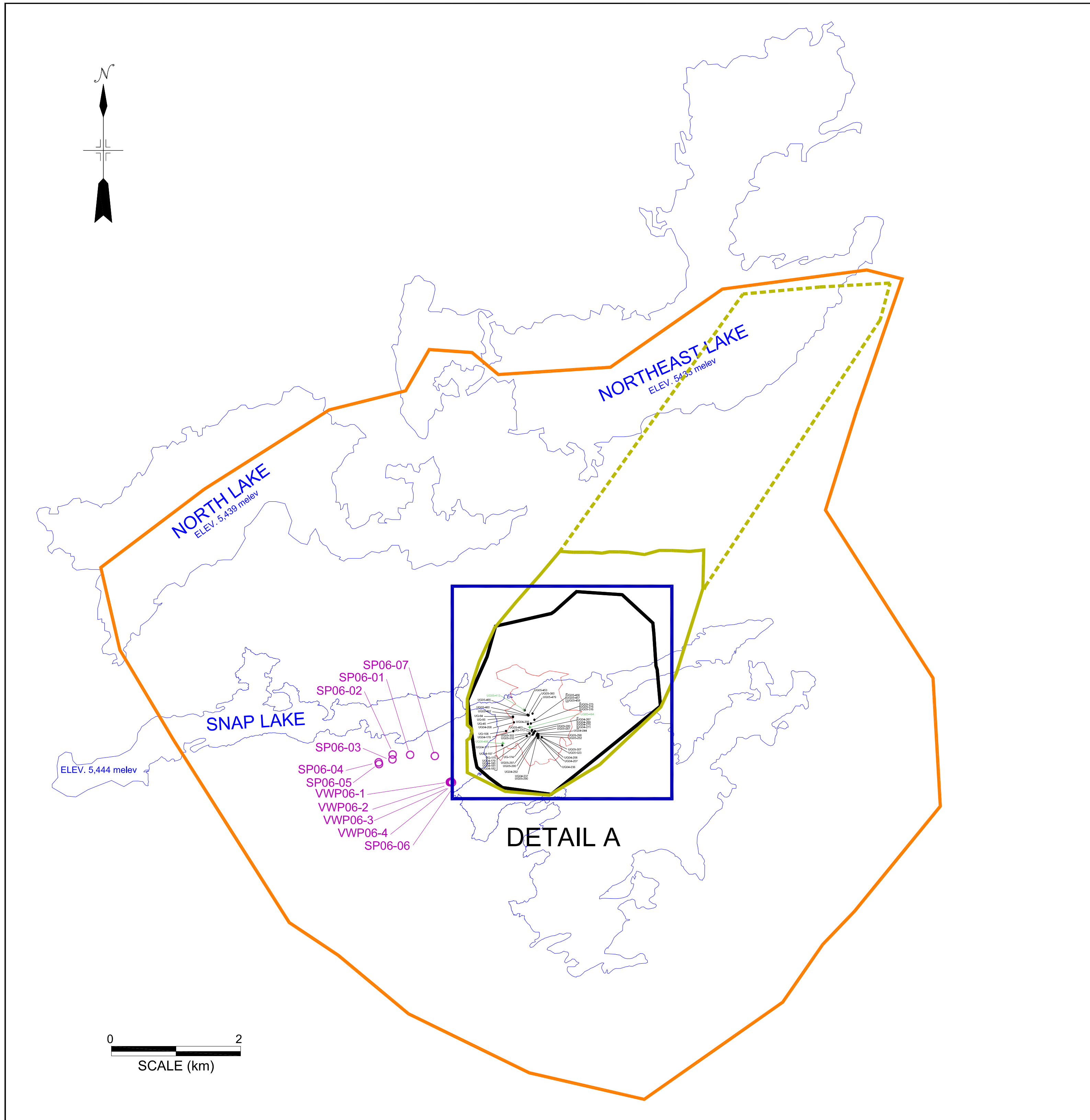
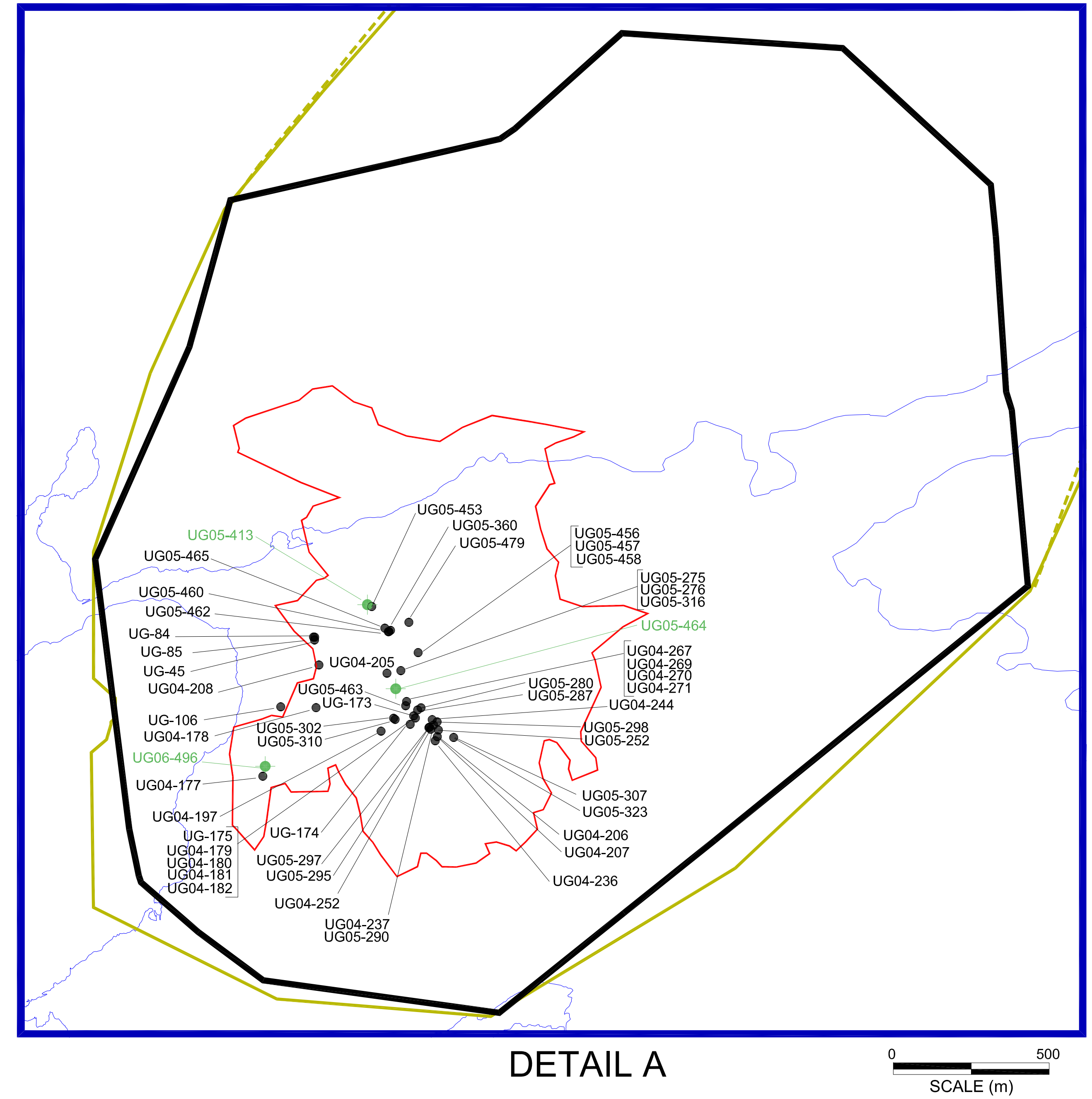
Conceptual Hydrogeologic Model of Planned Mine Area

CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 1

DRAFT





EXPLANATION

BOREHOLE USED FOR:

- SP06-06 WATER LEVEL MEASUREMENTS
- UG06-496 TDS MEASUREMENTS
- UG-106 HYDRAULIC TESTING

KIMBERLITE DYKES

- IDENTIFIED EXTENT
- ASSUMED EXTENT

MINING EXTENT

- EXISTING MINE
- FUTURE MINE

MODEL BOUNDARY

PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	BASEMAP
DRAWING DATE	10 DEC 2012
REVISION DATE	--

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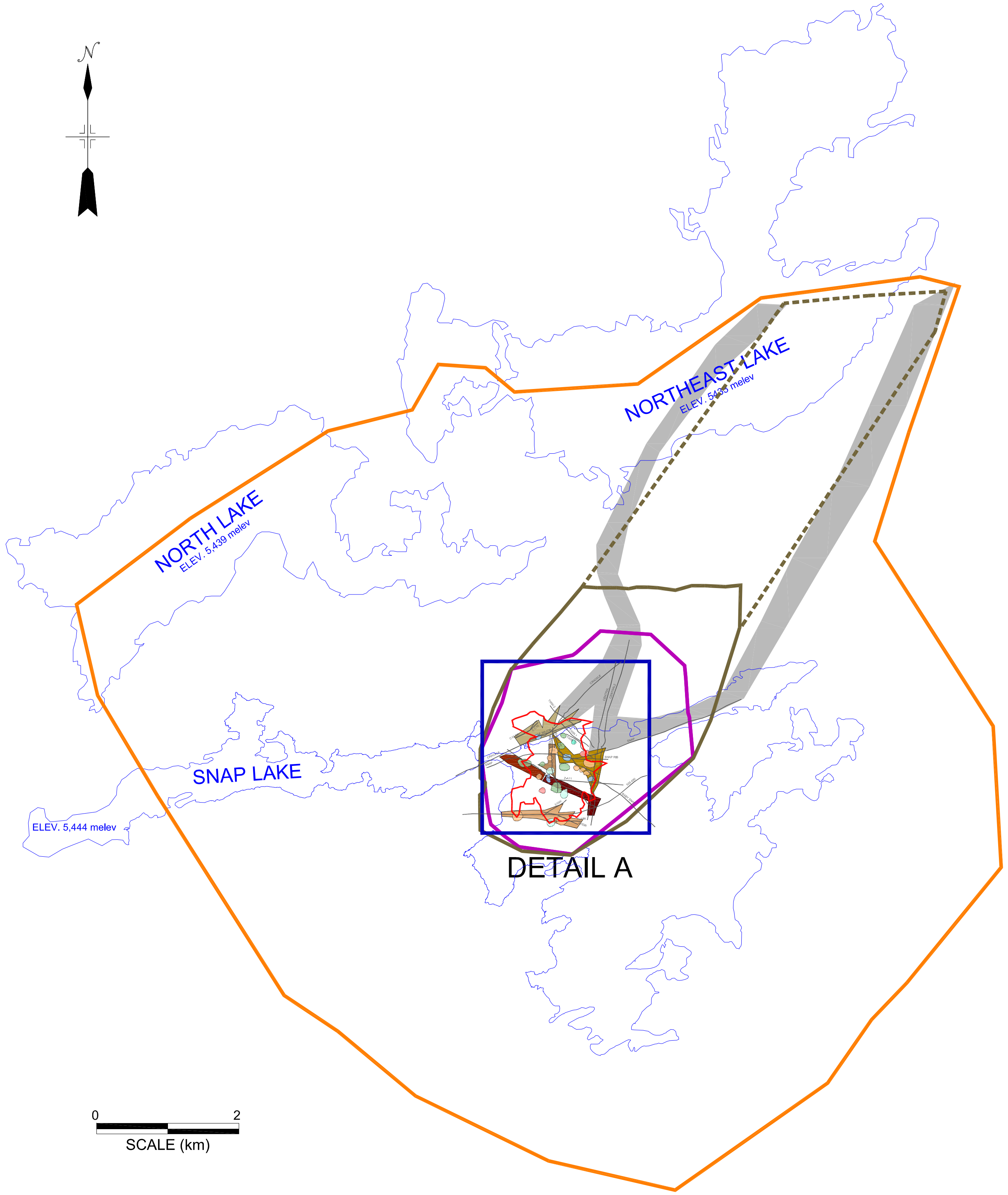
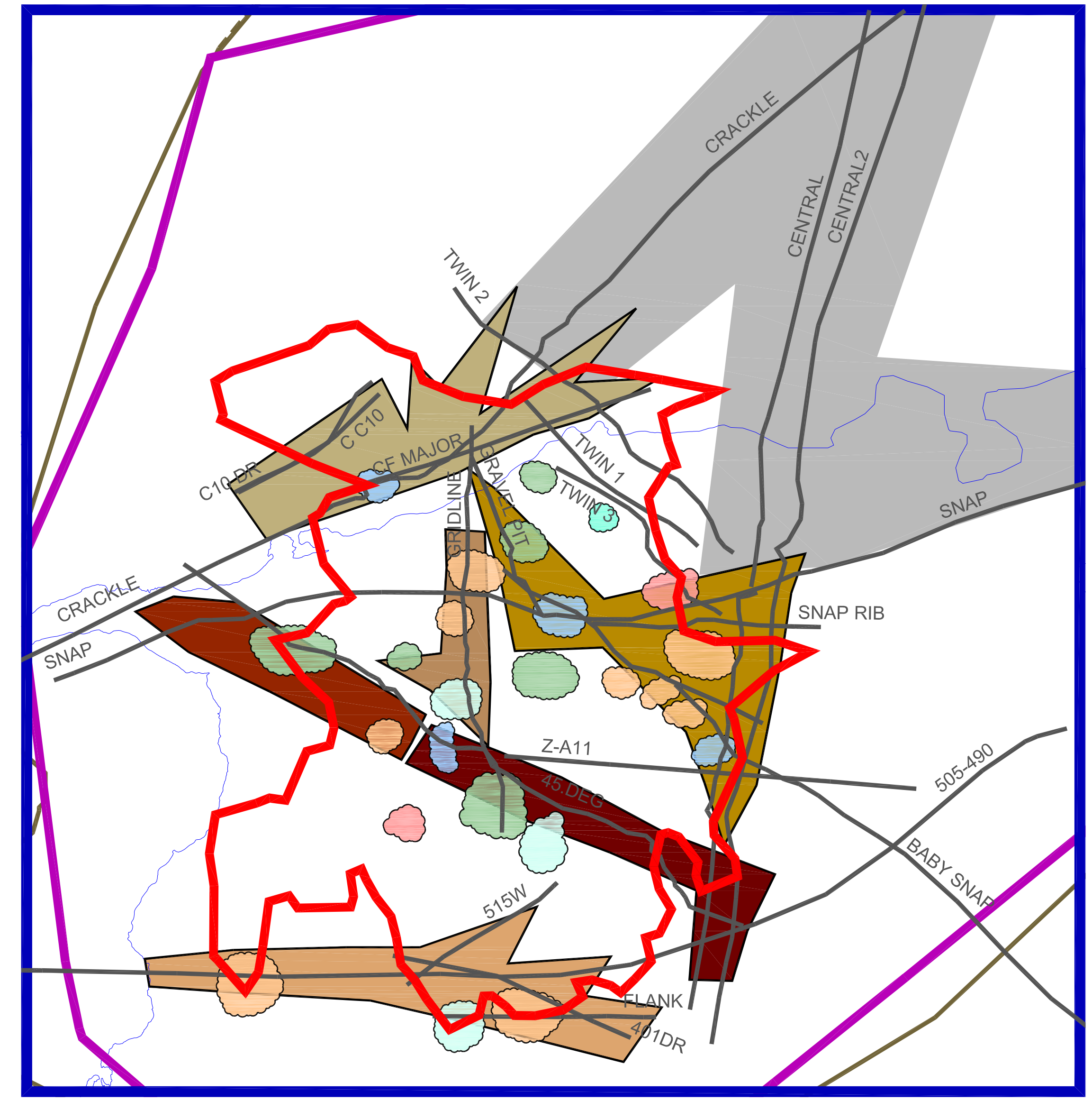
Base Map

CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 2

DRAFT





DETAIL A

0 400
SCALE (m)

EXPLANATION

KIMBERLITE DYKES
- IDENTIFIED EXTENT
- ASSUMED EXTENT

MINING EXTENT
- EXISTING MINE
- FUTURE MINE

- MODEL DOMAIN
- EXTENDED STRUCTURE ZONE
- FAULT

IDENTIFIED STRUCTURE ZONES
- ZONE 2
- ZONE 3
- ZONE 4
- ZONE 5
- ZONE 6
- ZONE 7

WATER HIT AREAS
FLOW RATE (L/min)
- <300
- 300 - 500
- 500 - 1,000
- 1,000 - 2,000
- >2,000

PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	FAULTS-STRUCTURES
DRAWING DATE	10 DEC 2012
REVISION DATE	--

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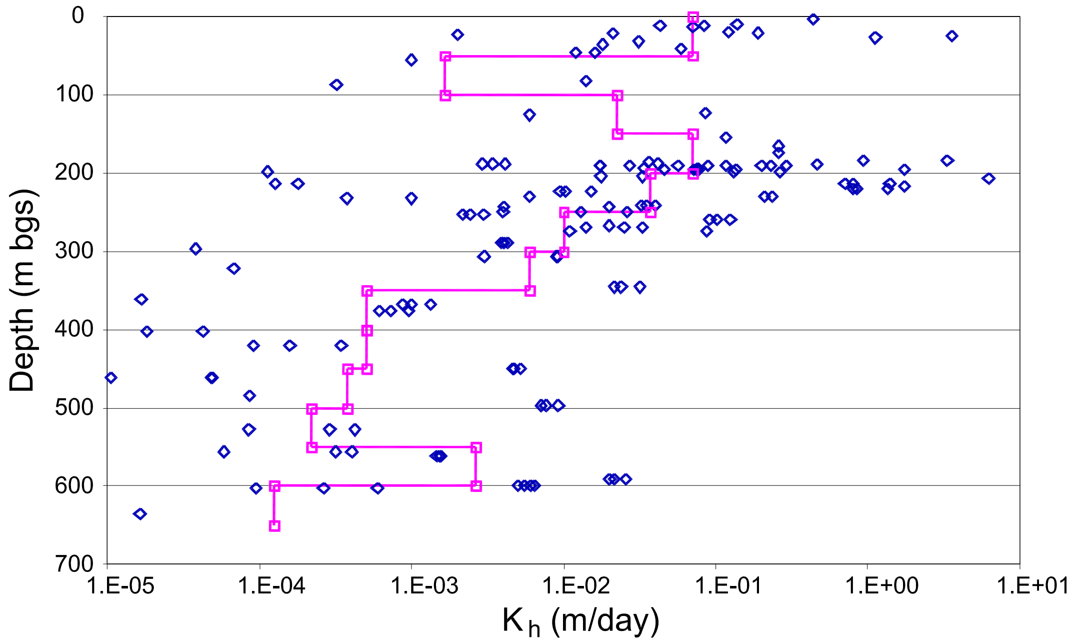
Faults and Structural Zones
in Mining Area and Model Domain

CLIENT:
De Beers Canada - Snap Lake Mine

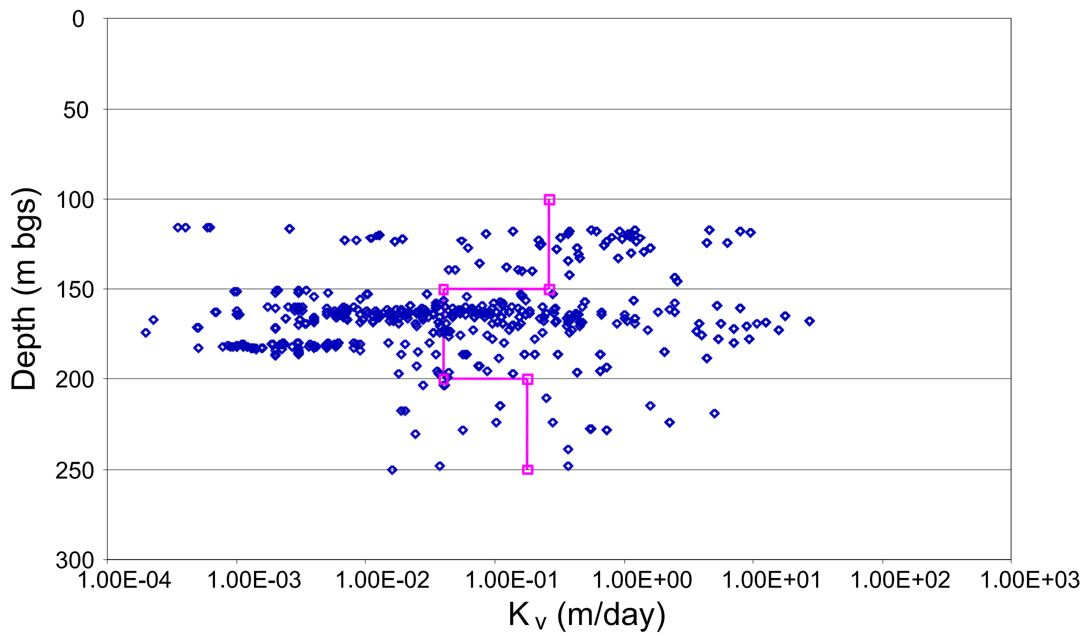
FIGURE NO.
3

DRAFT

a) Measured Horizontal Hydraulic Conductivity vs. Depth



b) Measured Vertical Hydraulic Conductivity vs. Depth



MEASURED VALUES

GEOMETRIC MEAN

PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	H–V–K–VS–DEPTH
DRAWING DATE	10 DEC 2012
REVISION DATE	––

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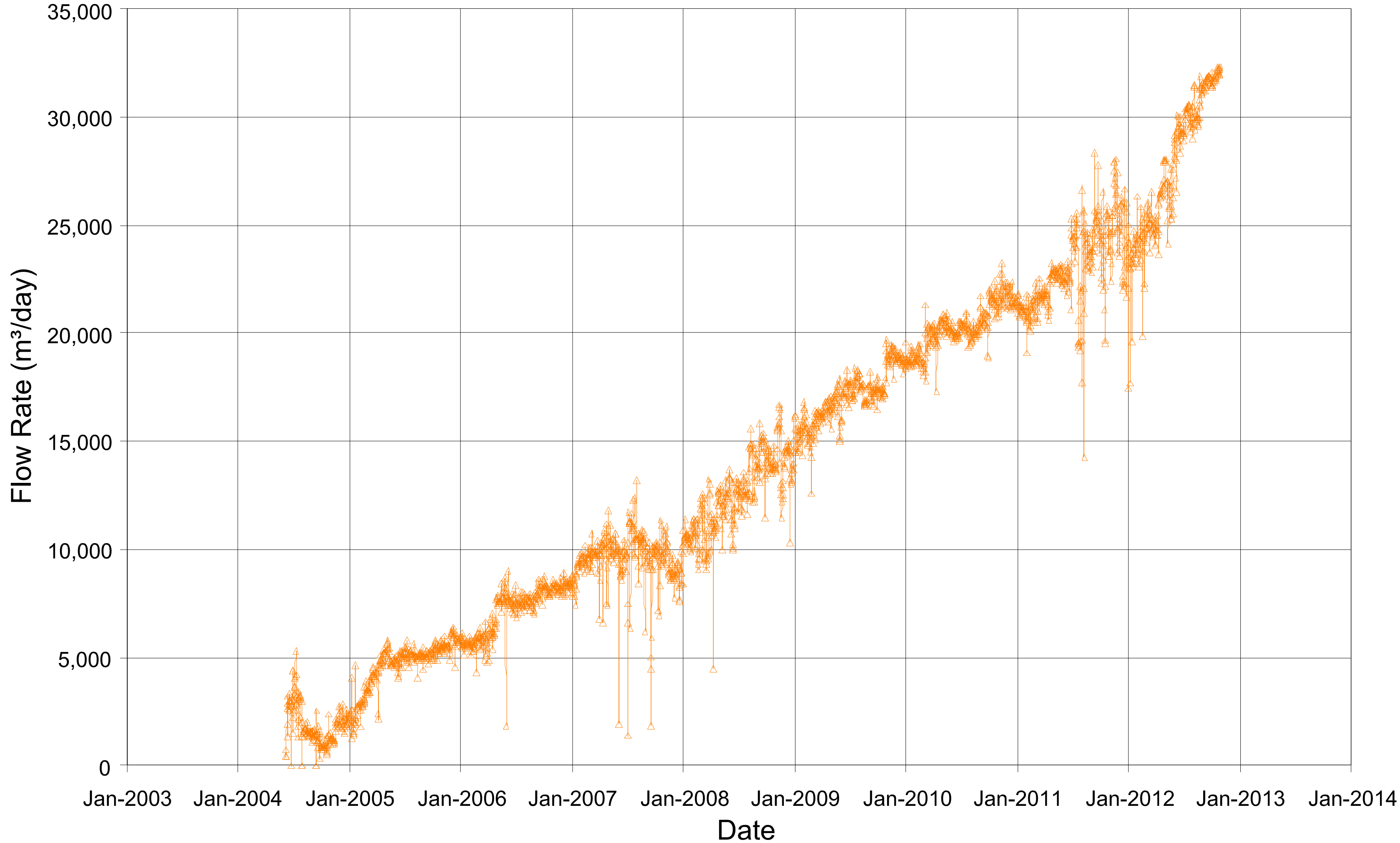
Measured Horizontal and Vertical Hydraulic Conductivity Values vs. Depth

CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 4

DRAFT



PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	MEAS-TOTAL-INFLOW
DRAWING DATE	10 DEC 2012
REVISION DATE	--

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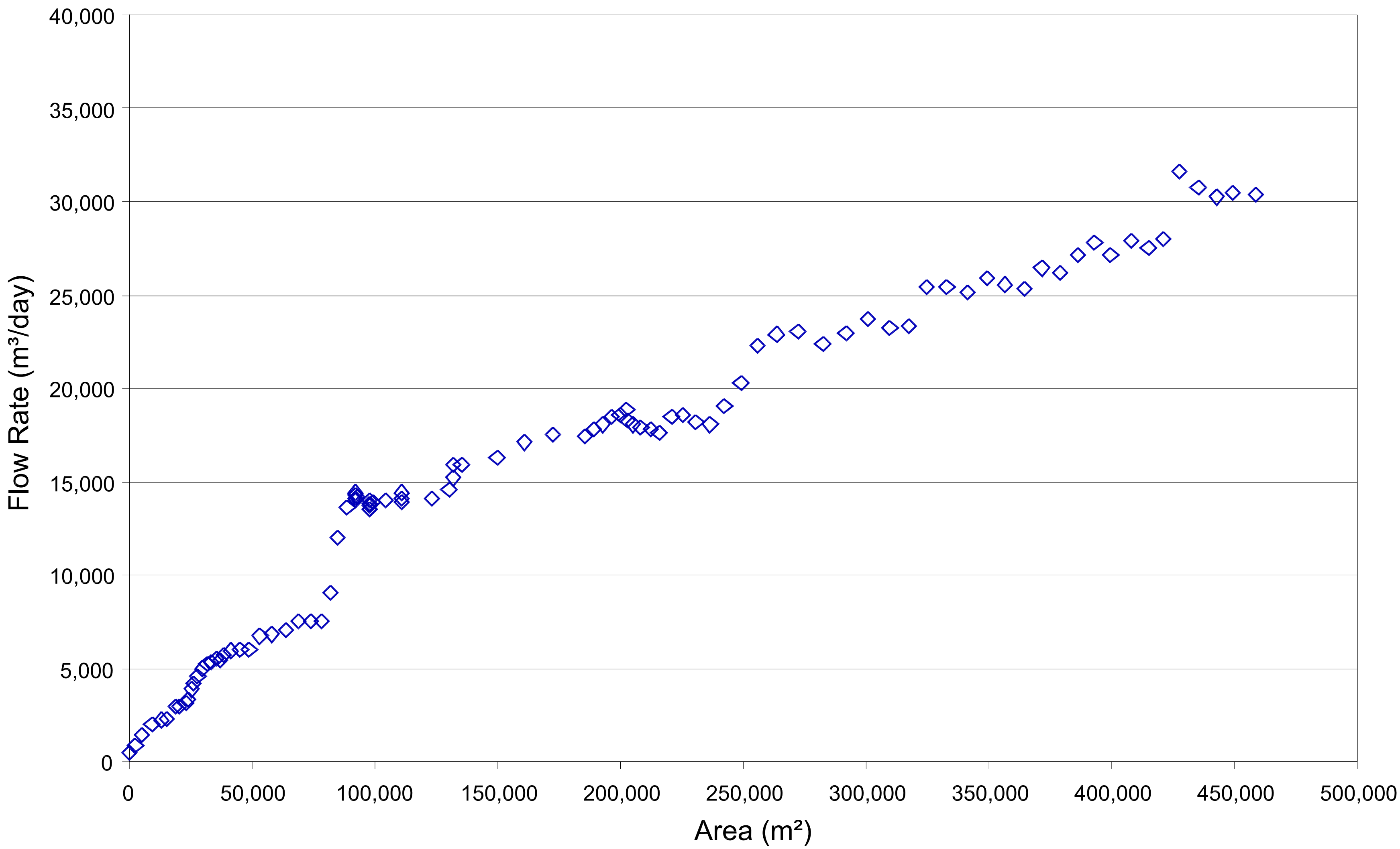
Measured Total Mine Inflow over Time

CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 5

DRAFT



PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	M–INFLOW–VS–M–AREA
DRAWING DATE	10 DEC 2012
REVISION DATE	––

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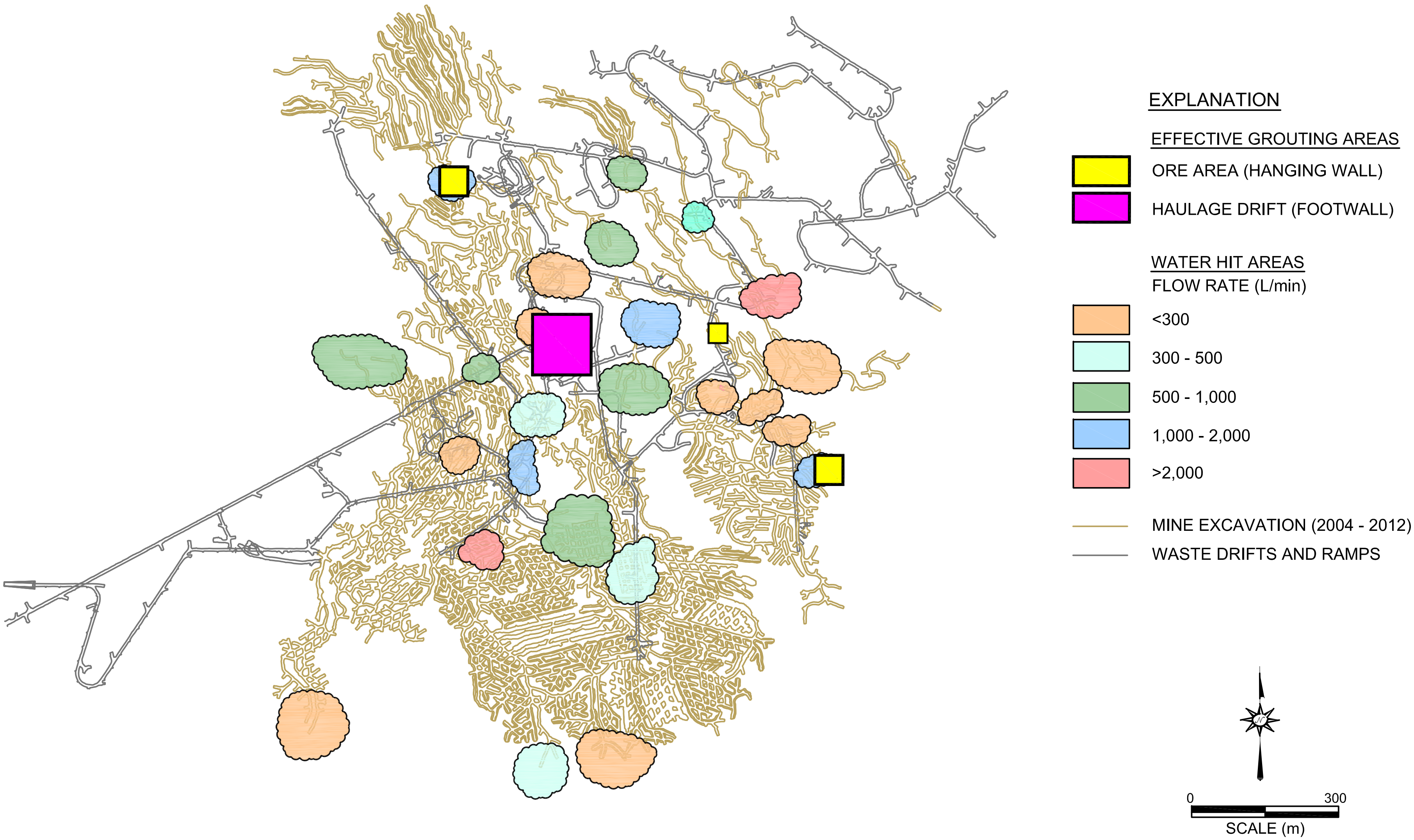
Measured Total Mine Inflow vs. Mined Area

CLIENT:
De Beers Canada - Snap Lake Mine

FIGURE NO.
6

DRAFT



PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	GROUTING
DRAWING DATE	10 DEC 2012
REVISION DATE	--

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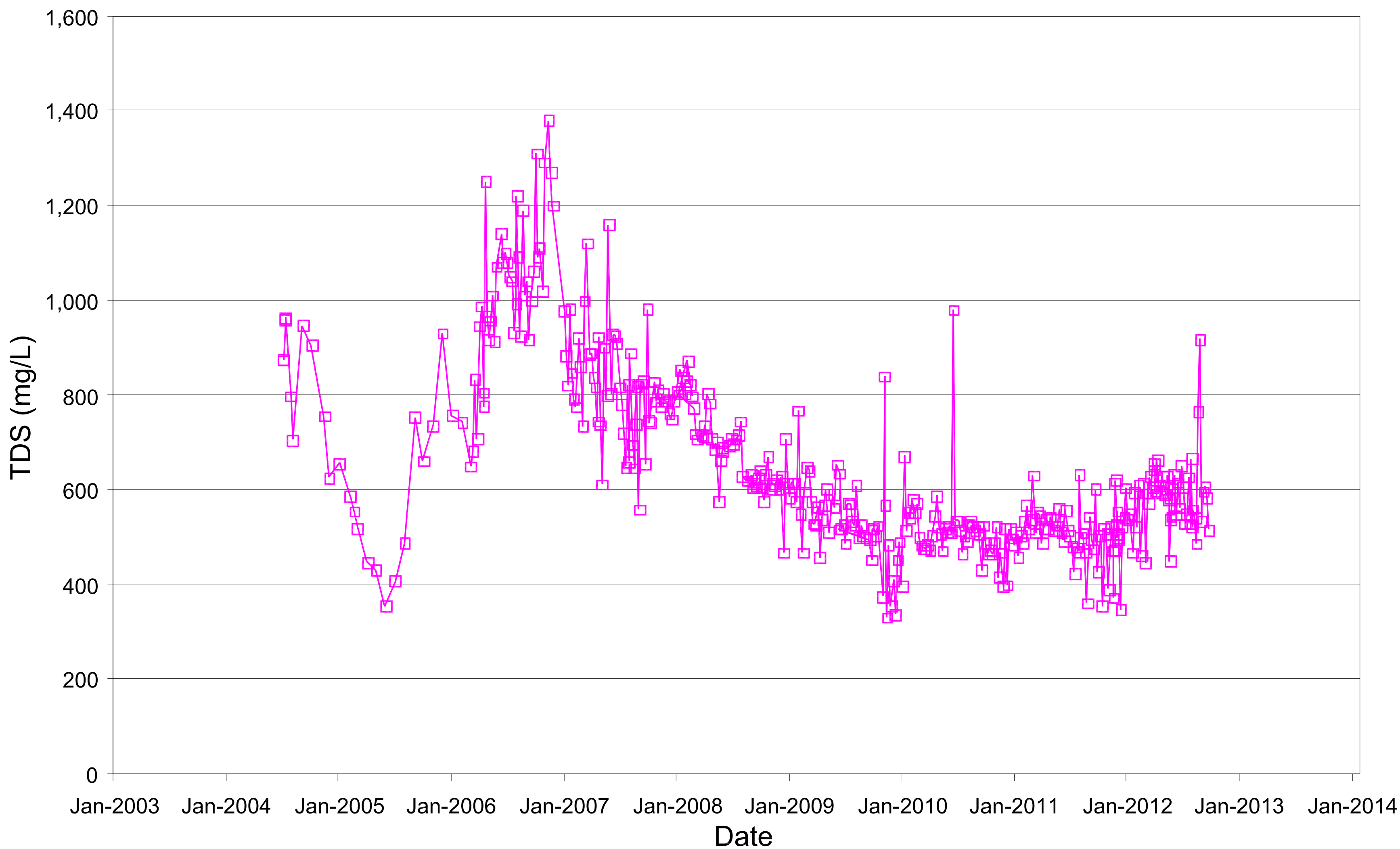
Areas of Water Hits and
Effective Grouting

CLIENT:
De Beers Canada - Snap Lake Mine

FIGURE NO.
7

DRAFT



PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	MEAS–TDS
DRAWING DATE	10 DEC 2012
REVISION DATE	––

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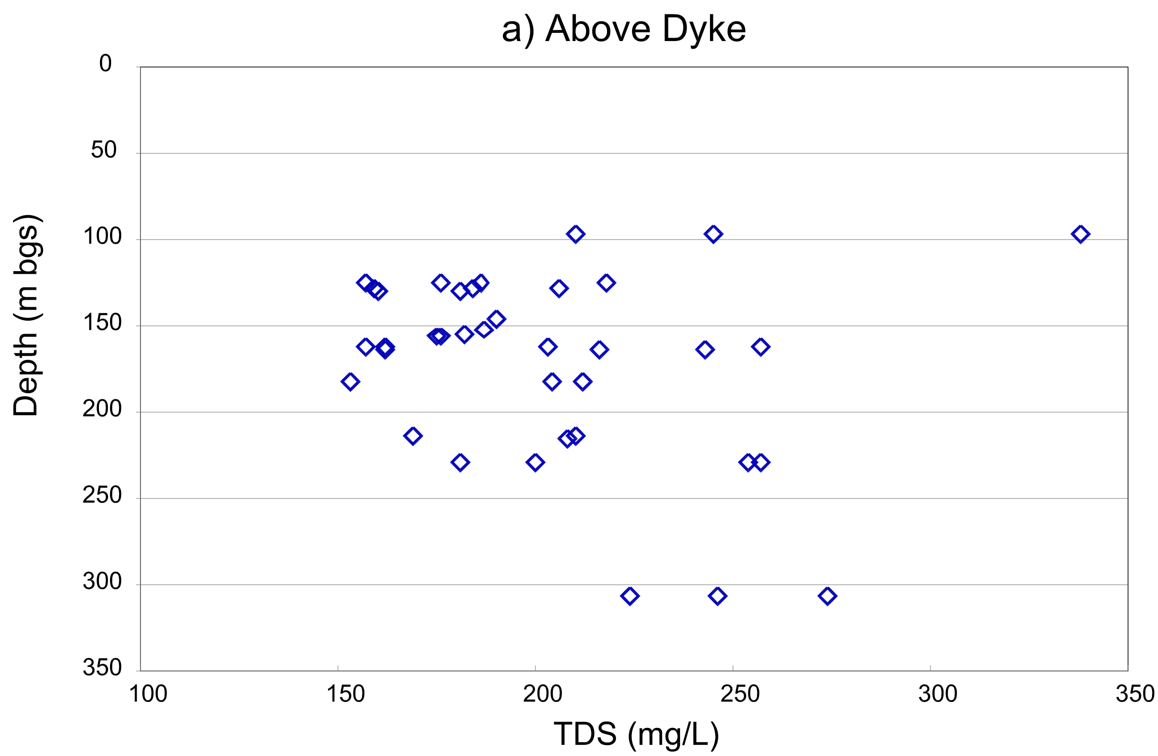
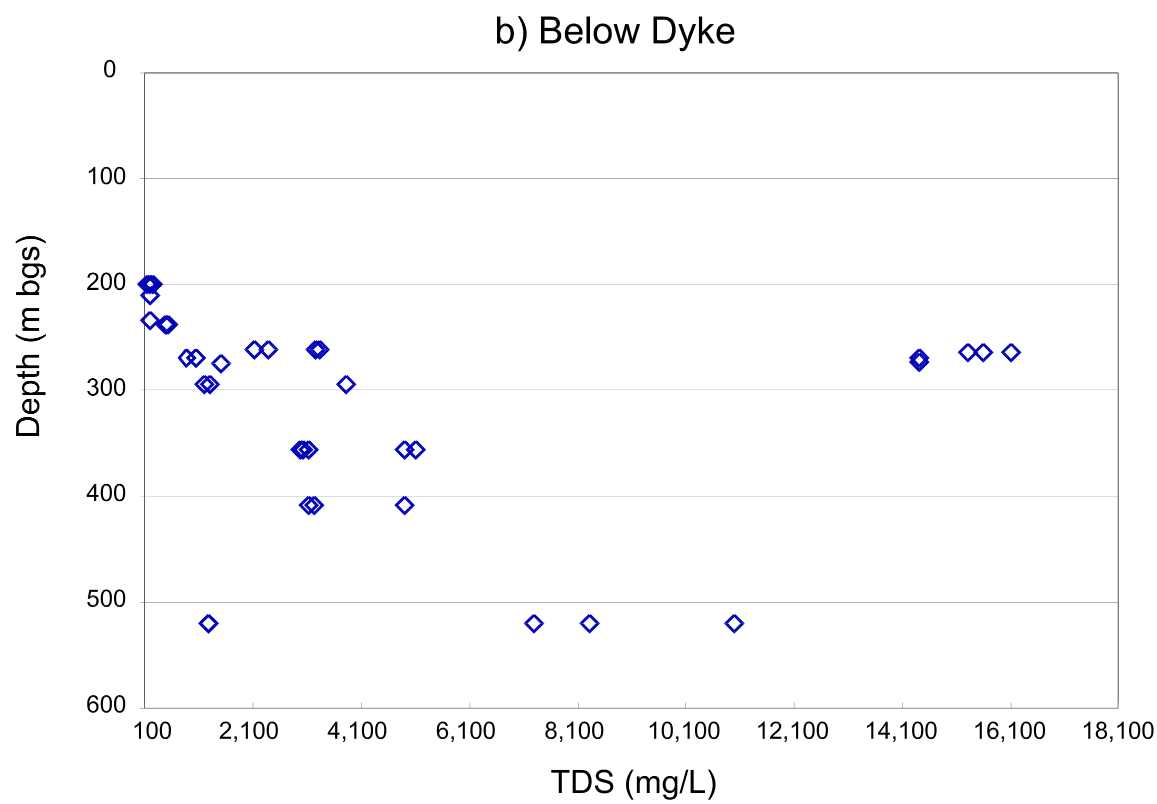
Measured TDS Concentrations
in Mine Discharge

CLIENT:
De Beers Canada - Snap Lake Mine

FIGURE NO.
8

DRAFT





PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	TDS–VS–DEPTH
DRAWING DATE	10 DEC 2012
REVISION DATE	––

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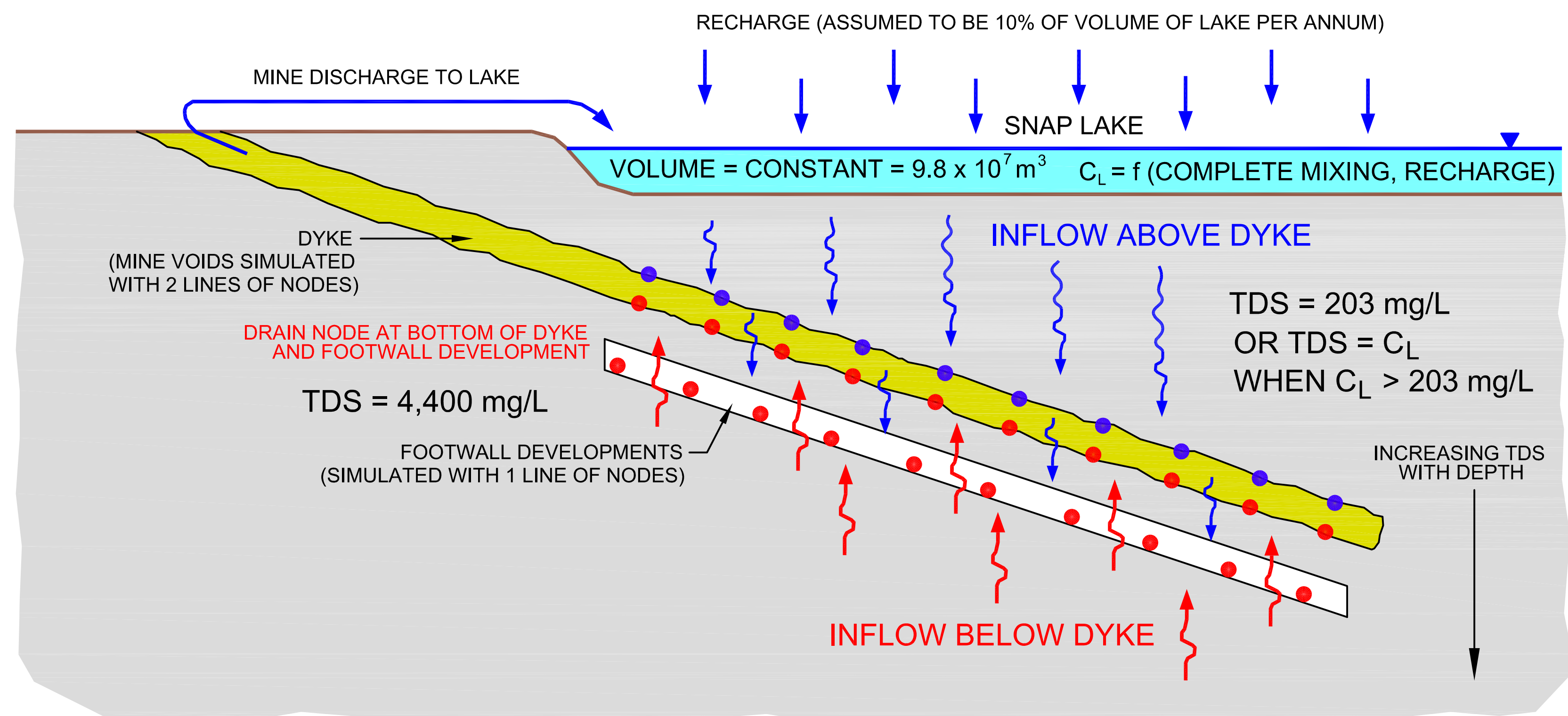
Measured TDS Concentrations vs. Depth

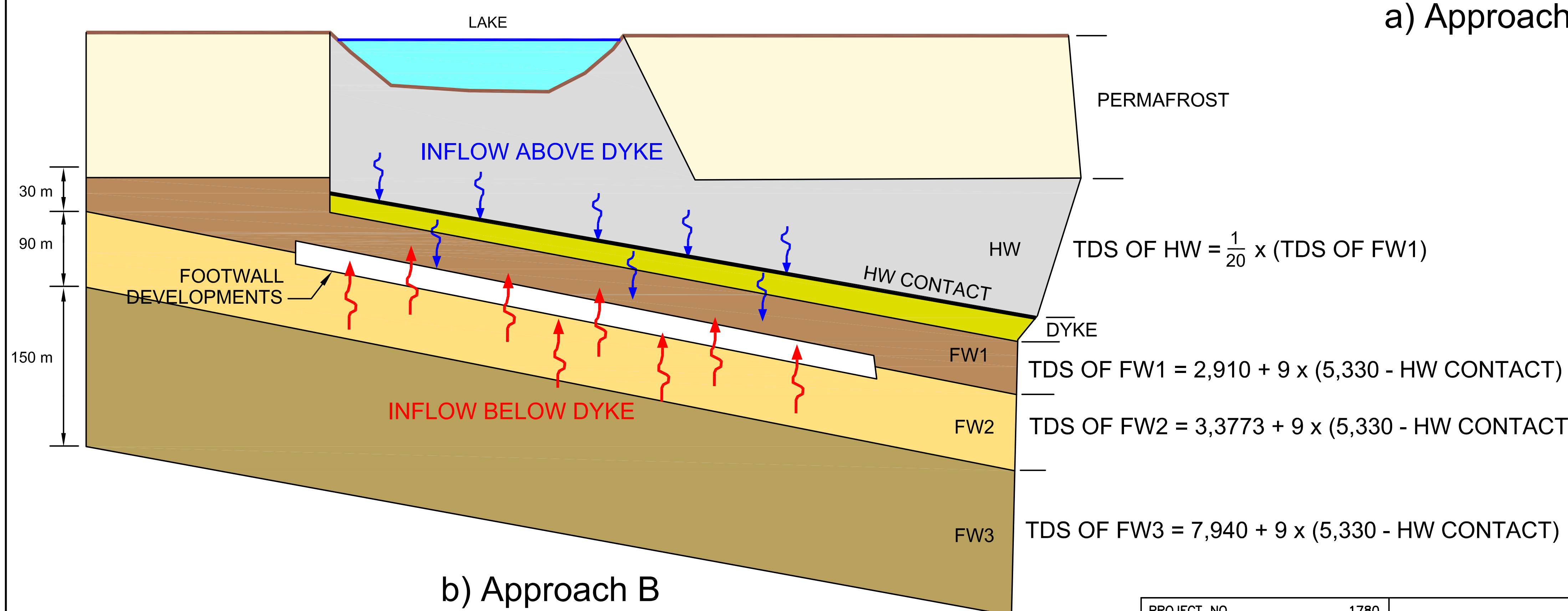
CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 9

DRAFT



a) Approach A



b) Approach B

NOTE: TDS CONCENTRATION IS IN mg/L -
HW CONTACT IS IN MINE ELEVATION (melev)

PROJECT NO.	1780
BY	OTHERS/DD
CHECKED	HL
DRAWN	OTHERS/SAC
DRAWING NAME	PREDICT–TDS
DRAWING DATE	10 DEC 2012
REVISION DATE	––

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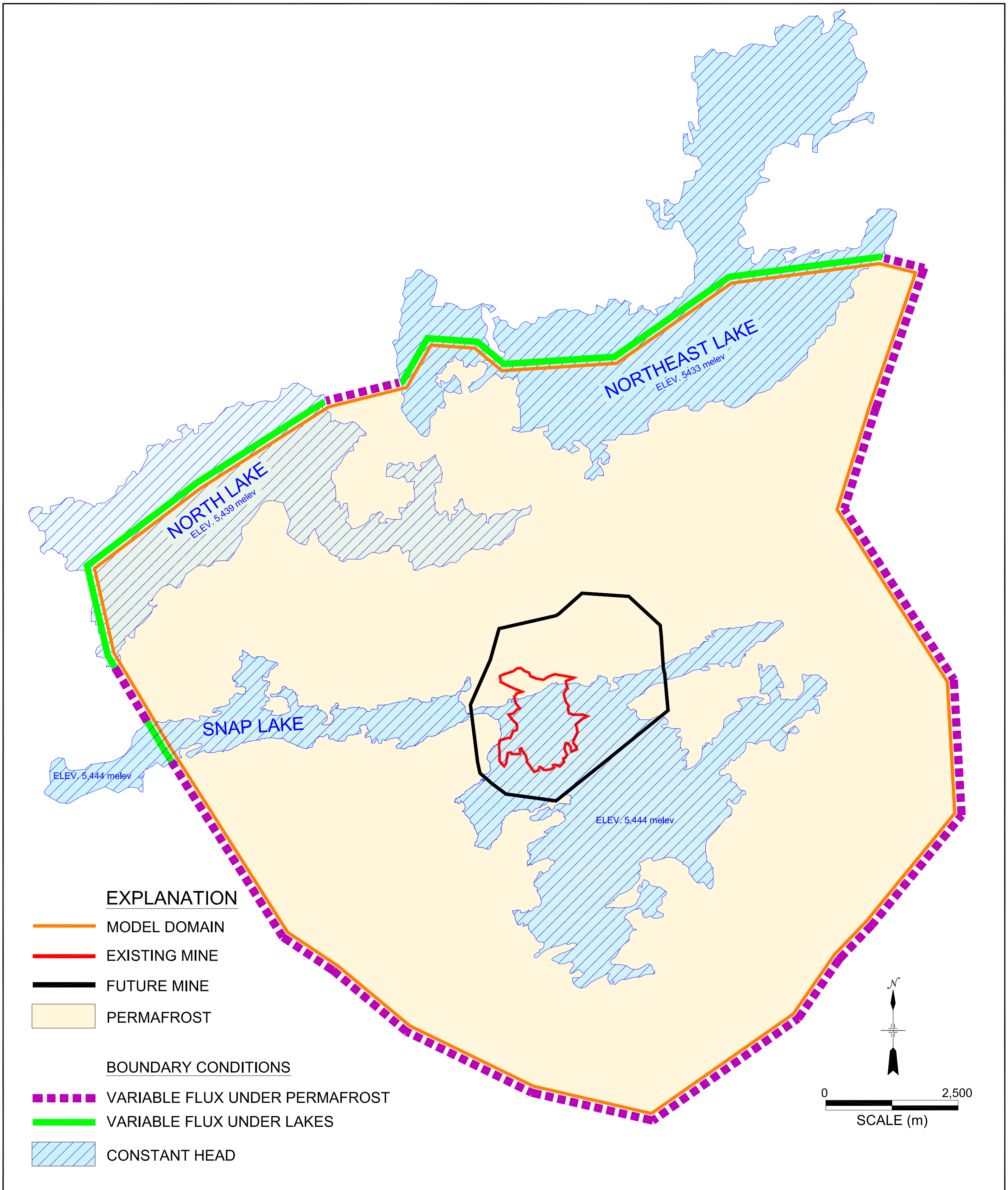
Conceptual Model for TDS Calculation

CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 10

DRAFT



PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	BOUND—COND
DRAWING DATE	10 DEC 2012
REVISION DATE	——

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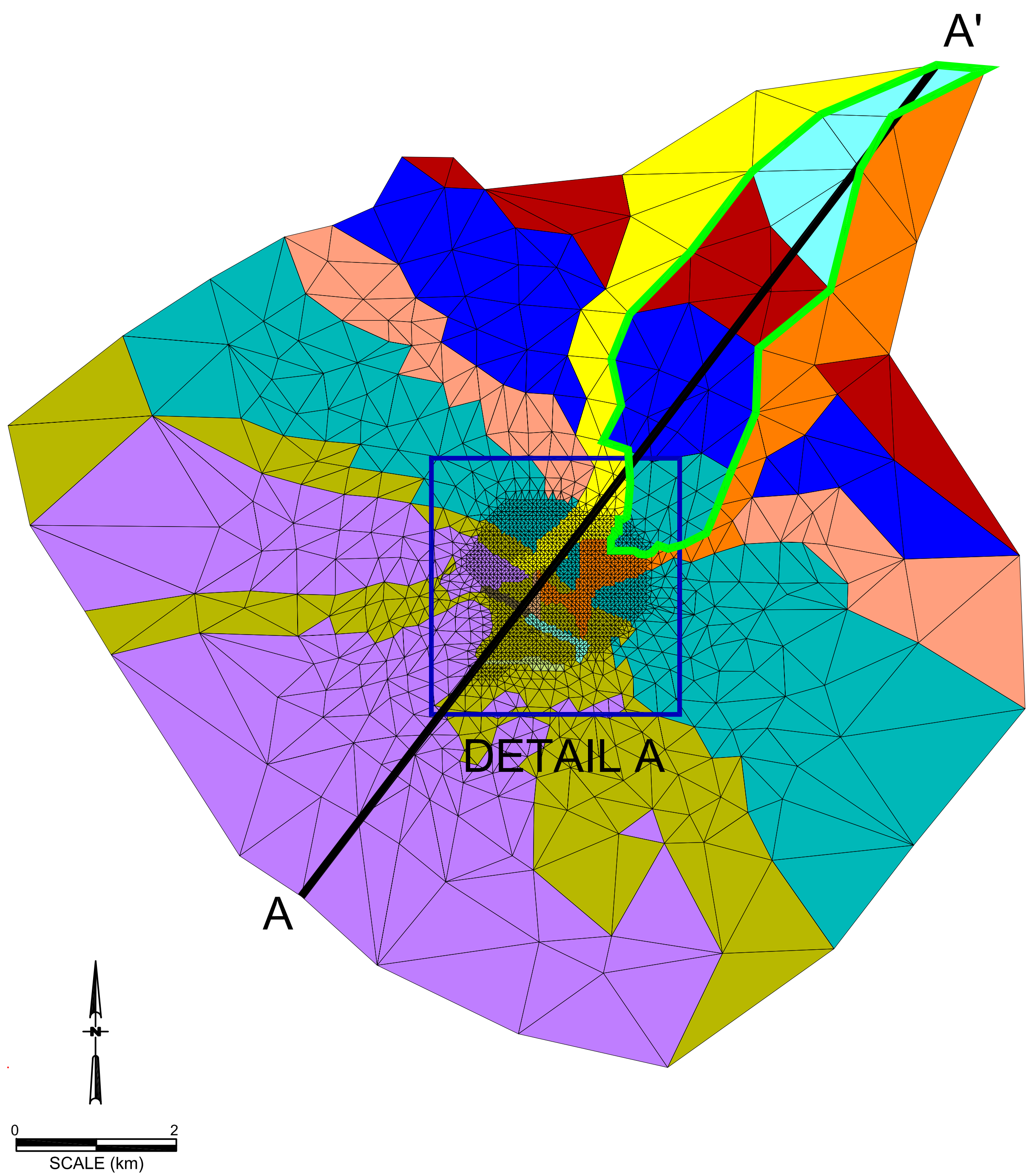
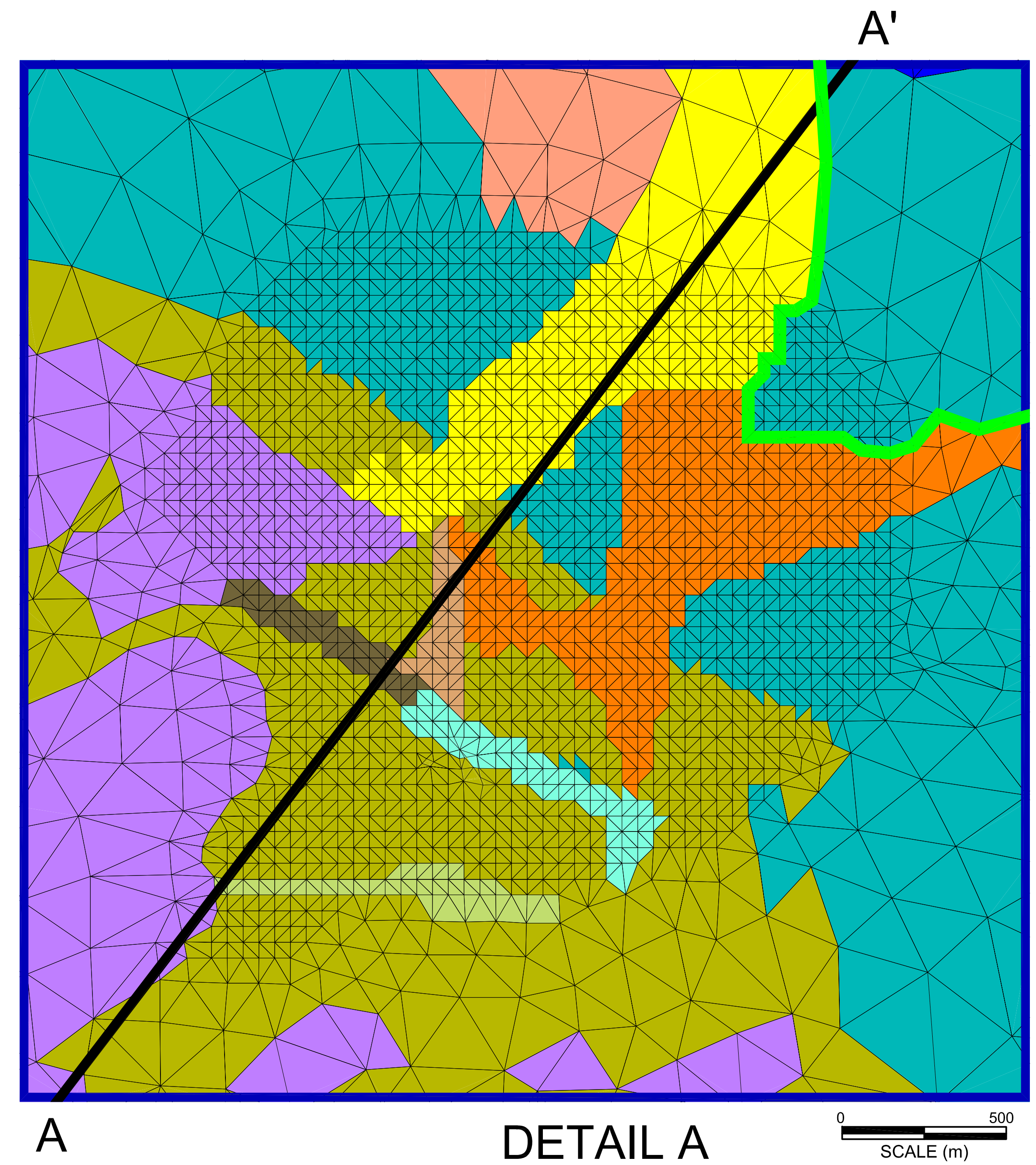
Model Domain and Boundary Conditions

CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 11

DRAFT





EXPLANATION

BEDROCK ABOVE DYKE (BAD)

- BAD1
- BAD2
- BAD3
- BAD4
- BAD5
- BAD6
- PERMAFROST

STRUCTURE ZONE ABOVE DYKE

- ZONE 2
- ZONE 3
- ZONE 4
- ZONE 5
- ZONE 6
- ZONE 7

ROCK BETWEEN EXTENDED ZONES FOR SENSITIVITY ANALYSIS

A——A' CROSS SECTION LOCATION (SEE FIGURE 13)

PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	LAYER6
DRAWING DATE	10 DEC 2012
REVISION DATE	--

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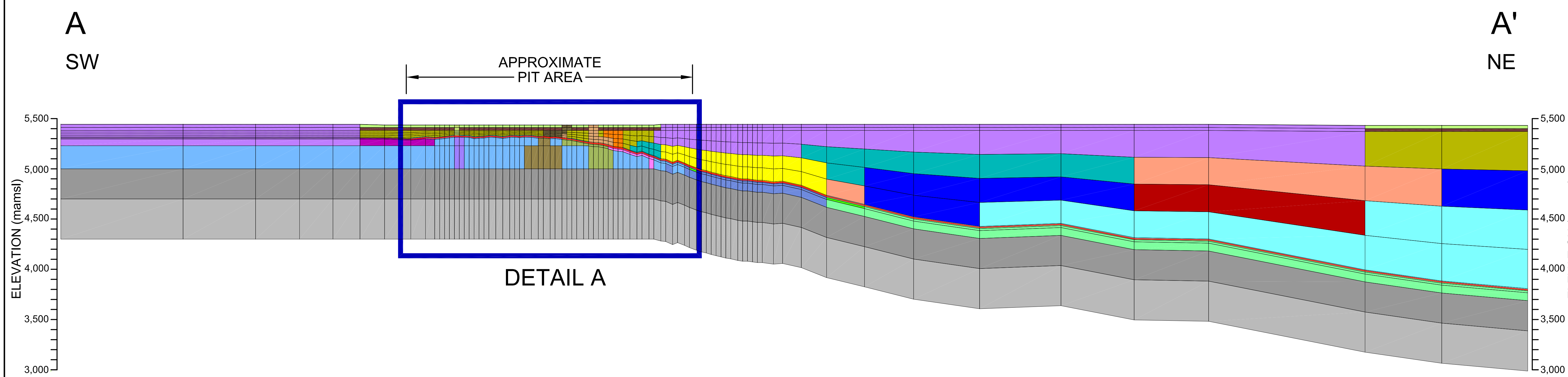
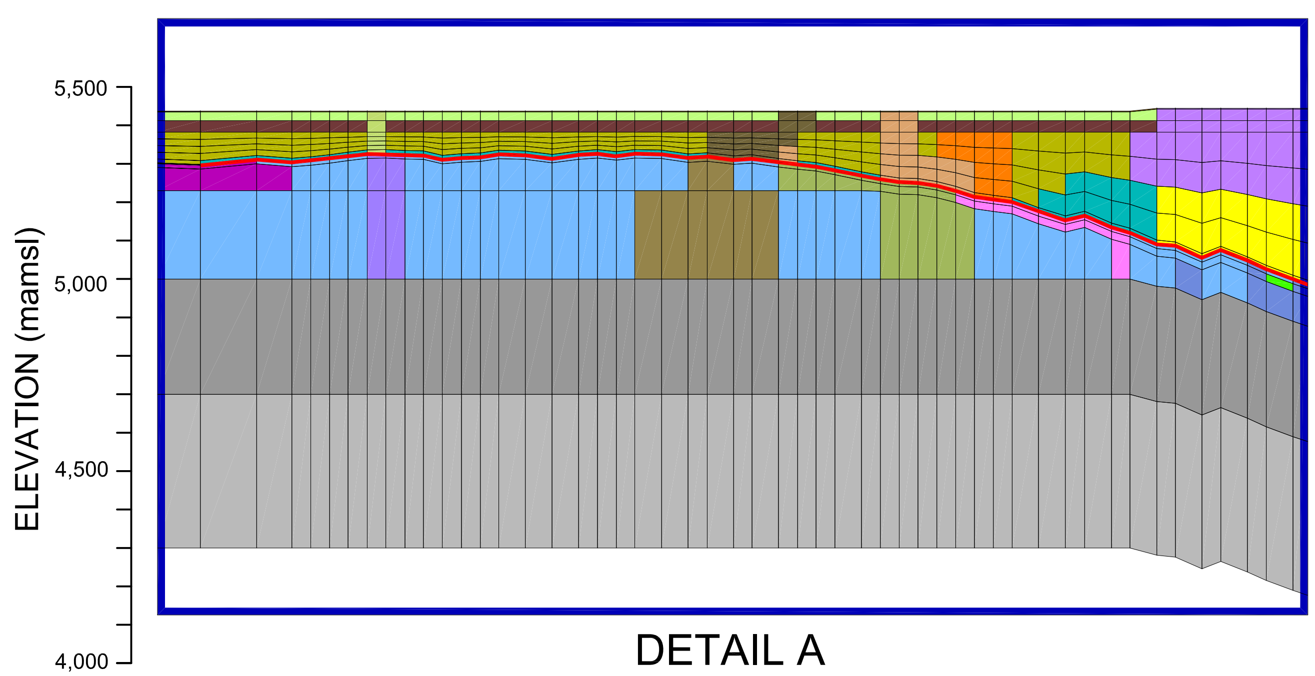
Mesh Configuration and Simulated Geology of Model Layer 6

CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 12

DRAFT





0 1,000
SCALE (m)

EXPLANATION

PERMAFROST
DEEP BEDROCK
LAKEBED SEDIMENT
COUNTRY BEDROCK
KIMBERLITE DYKE

BEDROCK ABOVE DYKE (BAD)
- BAD1
- BAD2
- BAD3
- BAD4
- BAD5
- BAD6

STRUCTURE ZONE ABOVE DYKE
- ZONE 3
- ZONE 4
- ZONE 5
- ZONE 6
- ZONE 7

BEDROCK BELOW DYKE (BBD)
- BBD1
- BBD2
- BBD3
- BBD4

STRUCTURE ZONE BELOW DYKE
- ZONE 3
- ZONE 4
- ZONE 5
- ZONE 6
- ZONE 7

EXFOLIATED BEDROCK
- EX1
- EX2

NOTE: SEE FIGURE 12 FOR CROSS SECTION LOCATION

PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	XSEC–AA
DRAWING DATE	10 DEC 2012
REVISION DATE	––

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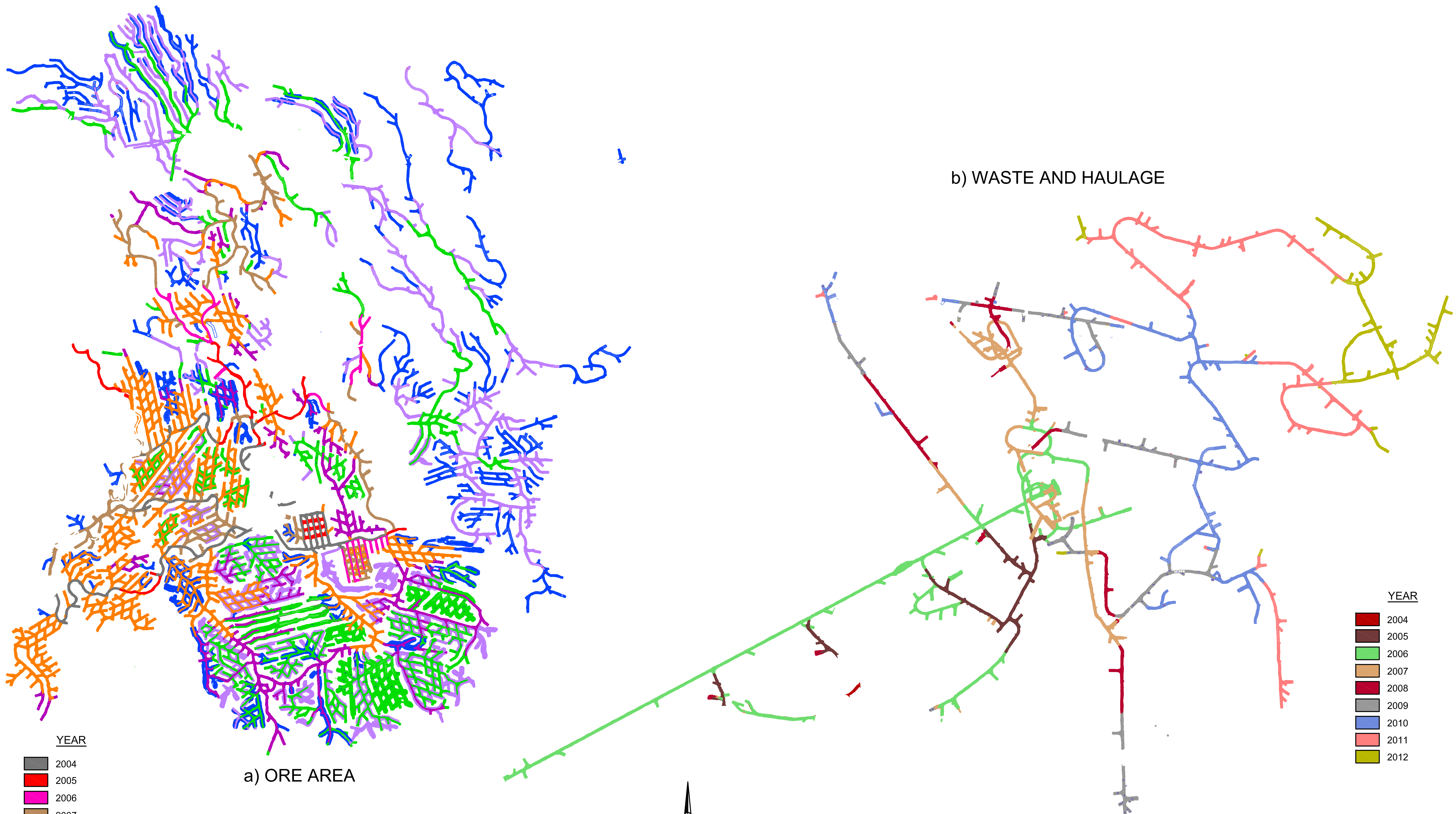
Simulated Geology along Cross Section A-A'

CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 13

DRAFT



PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	SIM–MINE–04–12
DRAWING DATE	10 DEC 2012
REVISION DATE	––

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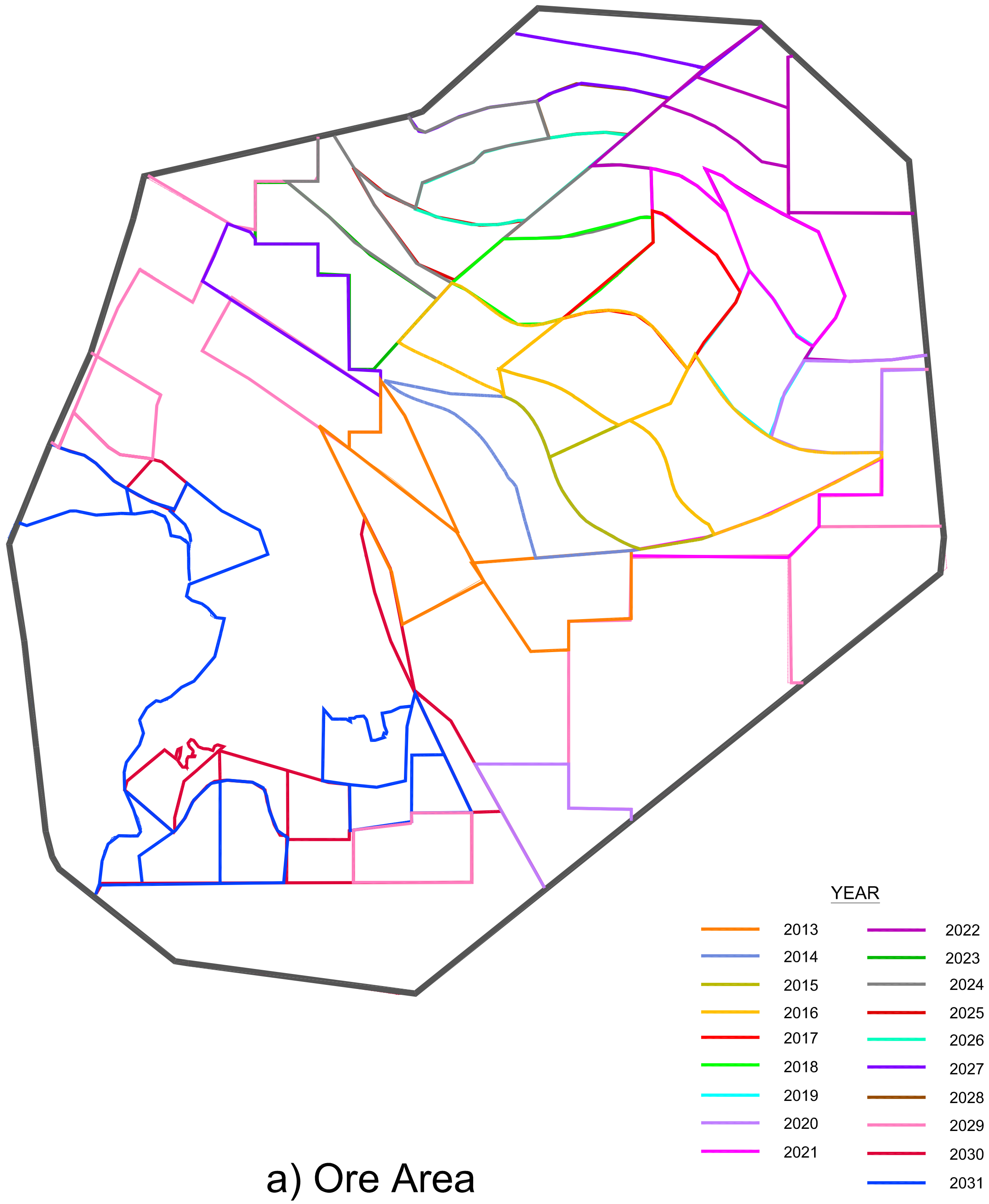
Simulated Mine Excavation from 2004 to 2012

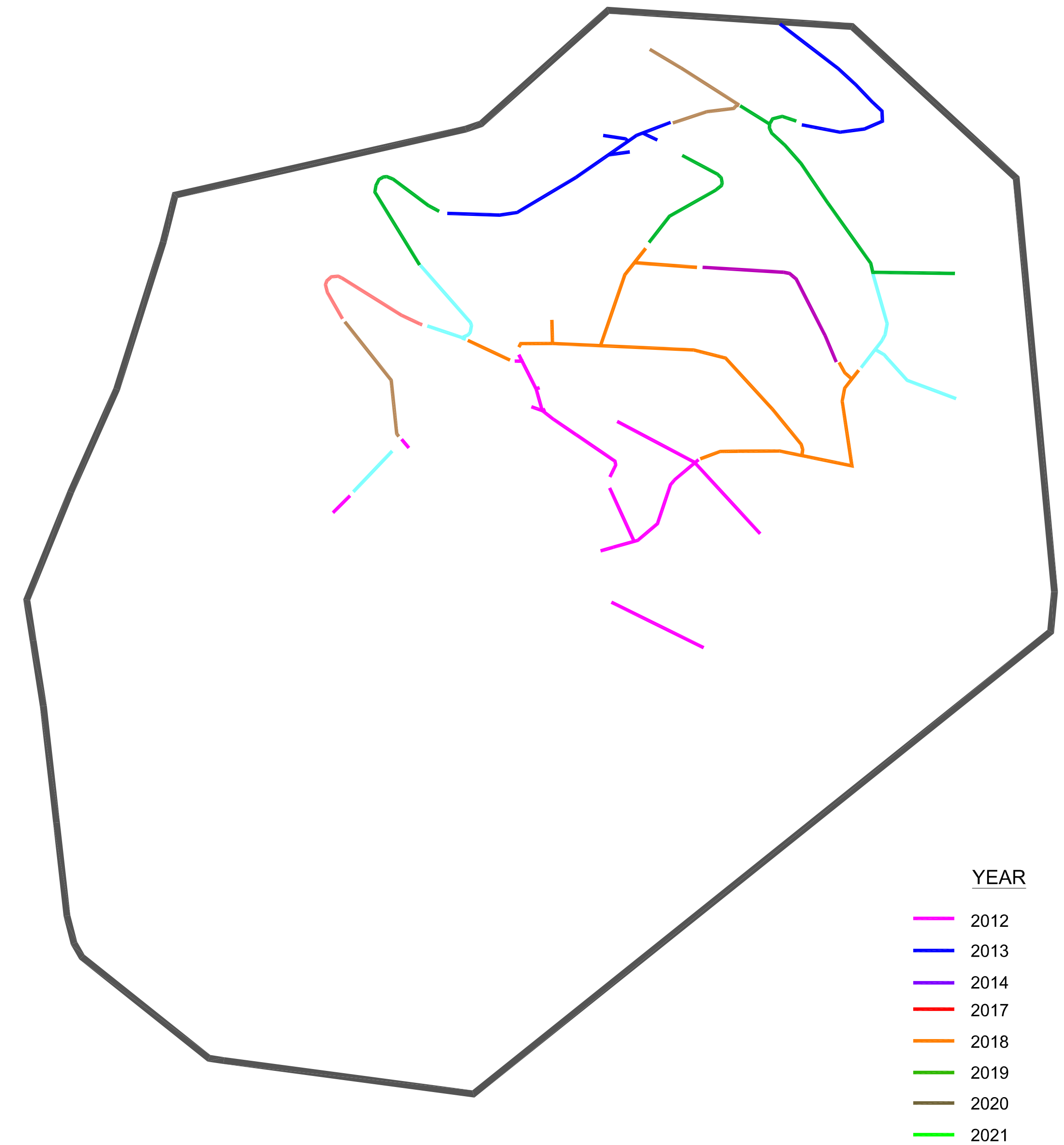
CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 14

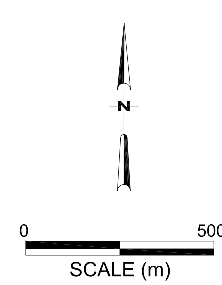
DRAFT



a) Ore Area



b) Waste and Haulage Drifts



PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	SIM-FUTURE-MINING
DRAWING DATE	10 DEC 2012
REVISION DATE	--

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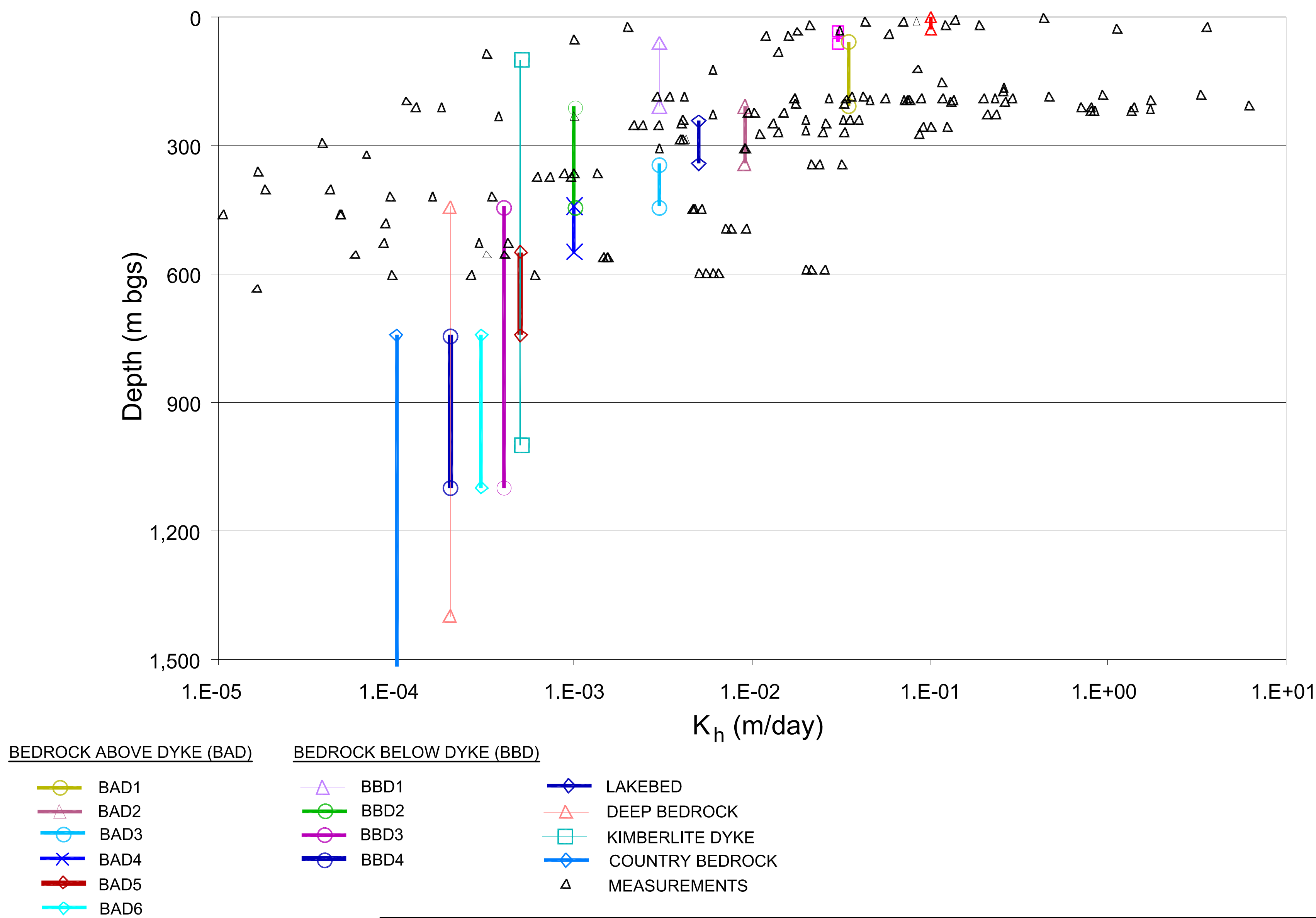
Simulated Future Mine Plan

CLIENT:
De Beers Canada - Snap Lake Mine

FIGURE NO.
15

DRAFT



EXFOLIATED BEDROCK

EX1

EX2

PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	HORIZ–K
DRAWING DATE	10 DEC 2012
REVISION DATE	––

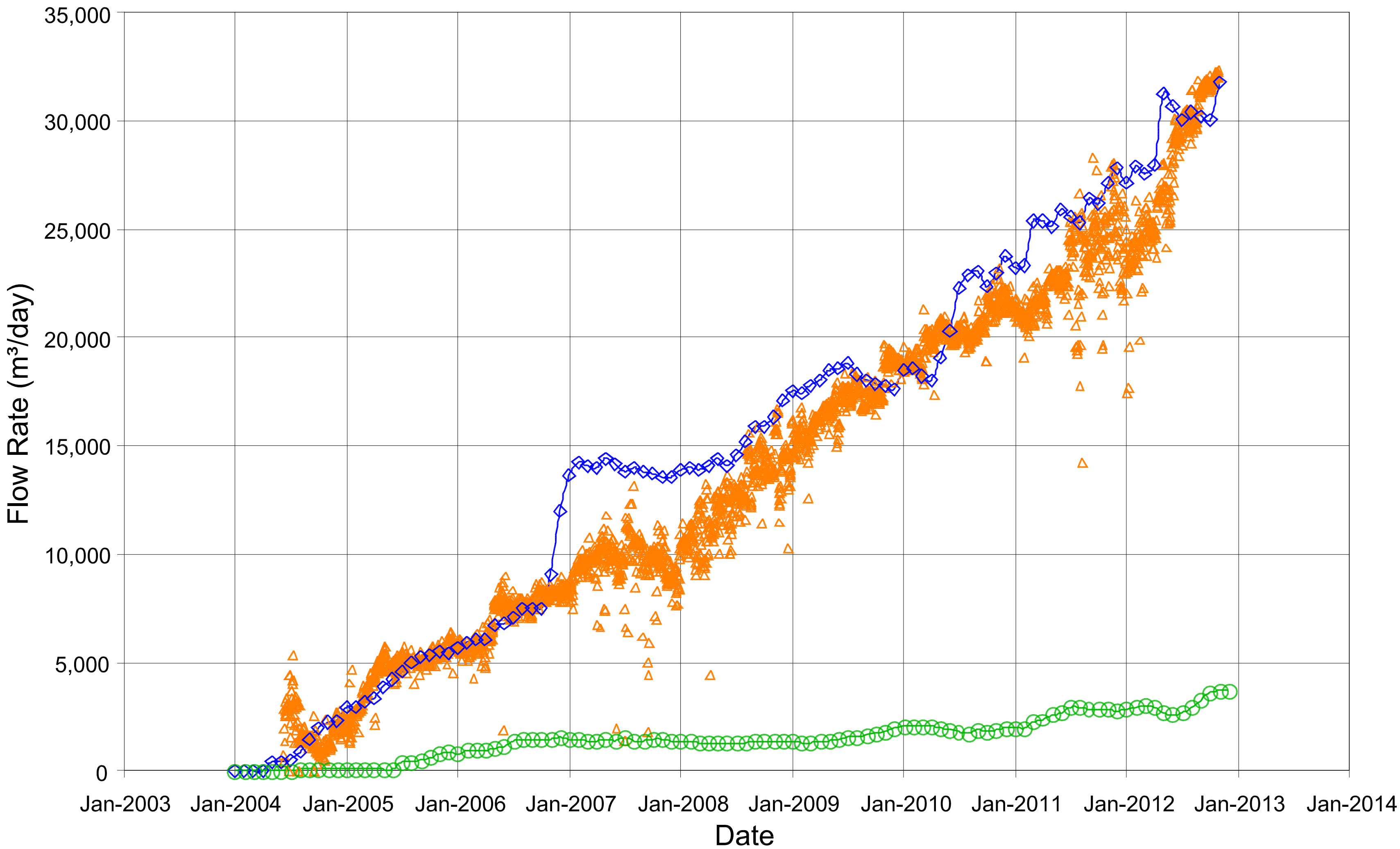
ITASCA™ Denver, Inc.

Horizontal Hydraulic Conductivity Values in Groundwater Flow Model

CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 16

DRAFT



Measured

Simulated Inflow

Entire mine

Waste drift

PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	SIM–MEAS–04–12
DRAWING DATE	10 DEC 2012
REVISION DATE	––

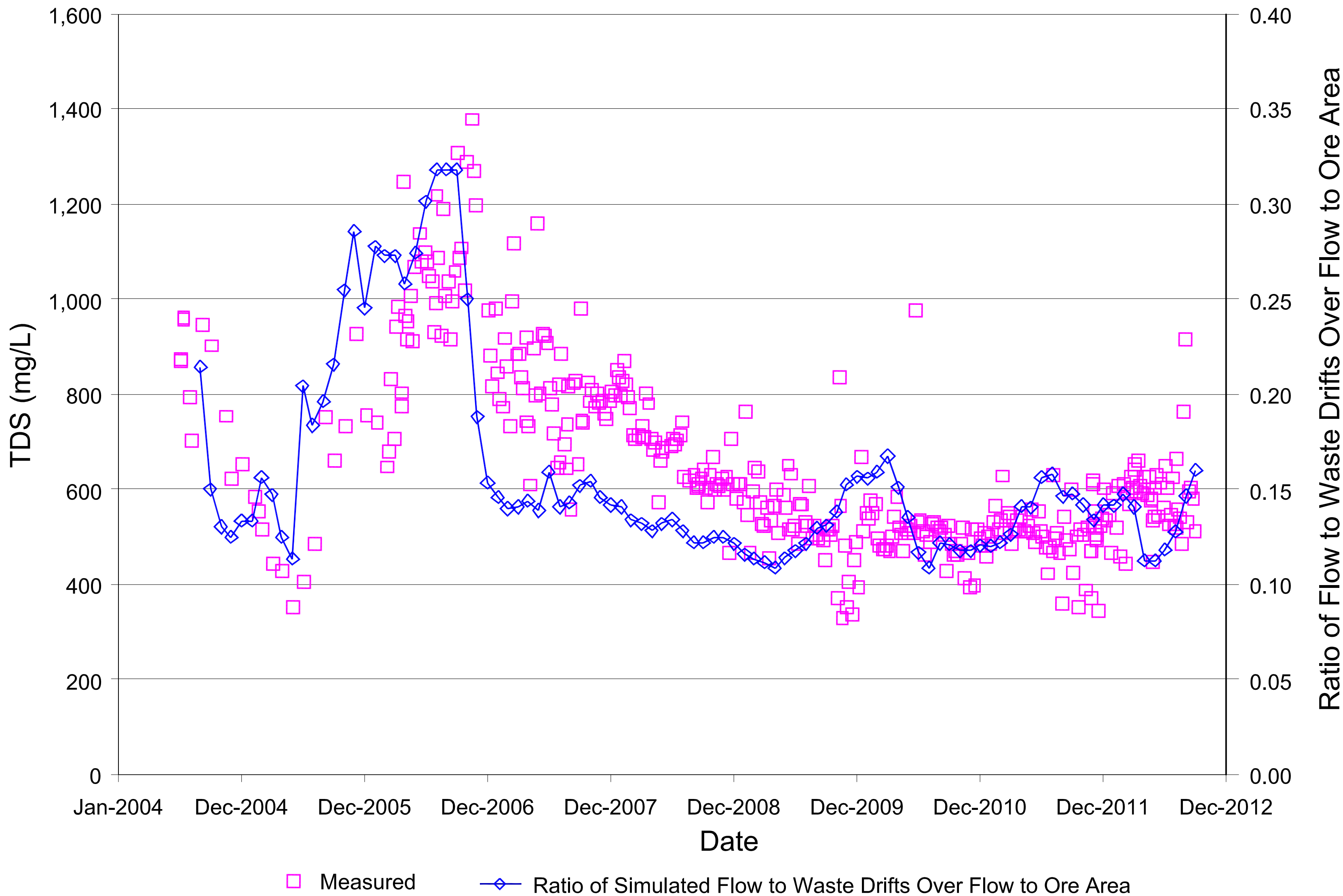
ITASCA™
Denver, Inc.

Measured Total Inflow and Simulated Inflow to Entire Mine and to Waste Drift

CLIENT:
De Beers Canada - Snap Lake Mine

FIGURE NO.
17

DRAFT



PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	TDS-VS-RATIO
DRAWING DATE	10 DEC 2012
REVISION DATE	--

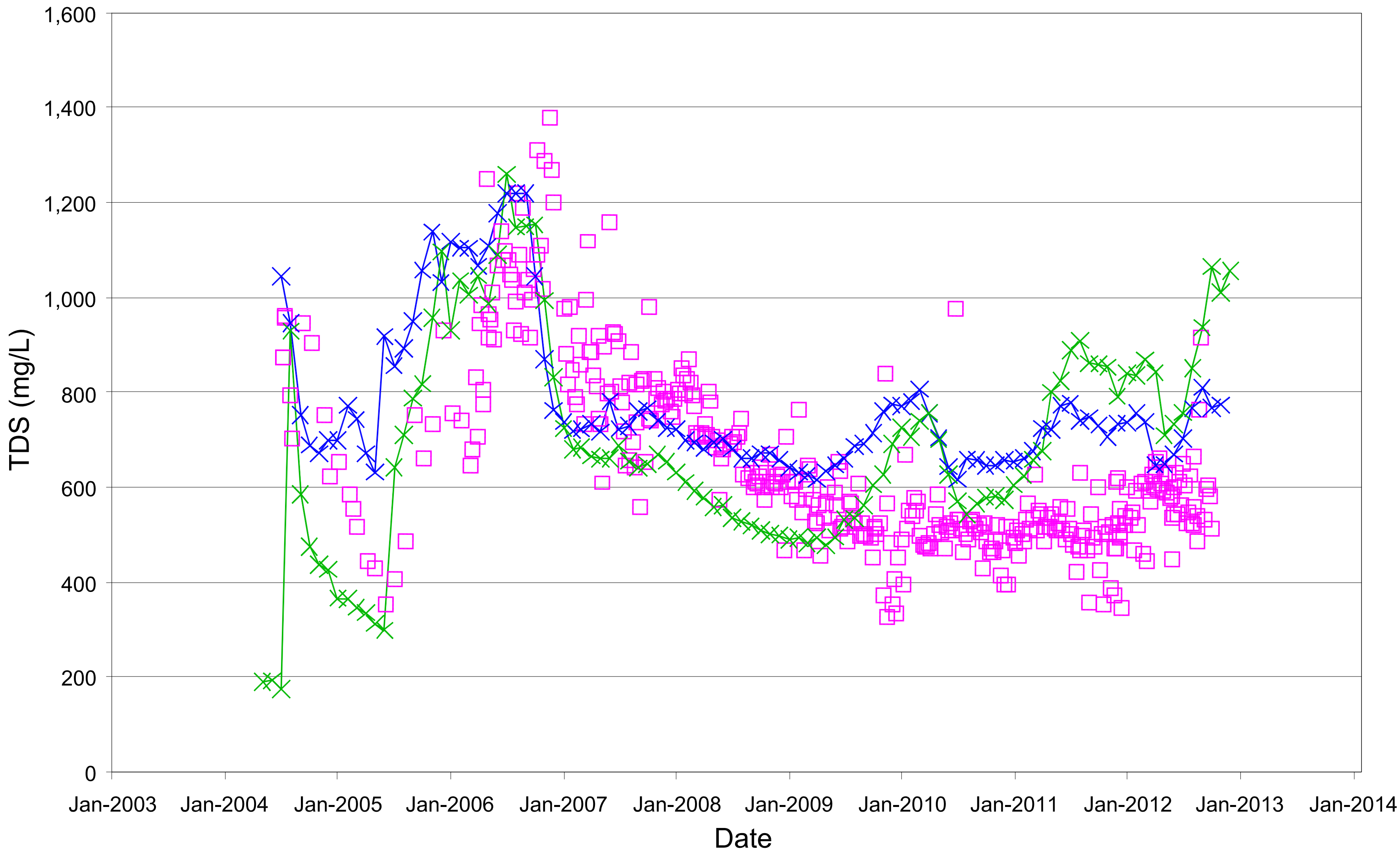
ITASCA™ Denver, Inc.

Measured TDS vs. Ratio of Simulated Flow to Waste Drifts Over Flow to Ore Area

CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 18

DRAFT



PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	SIM–MEAS–TDS
DRAWING DATE	10 DEC 2012
REVISION DATE	--

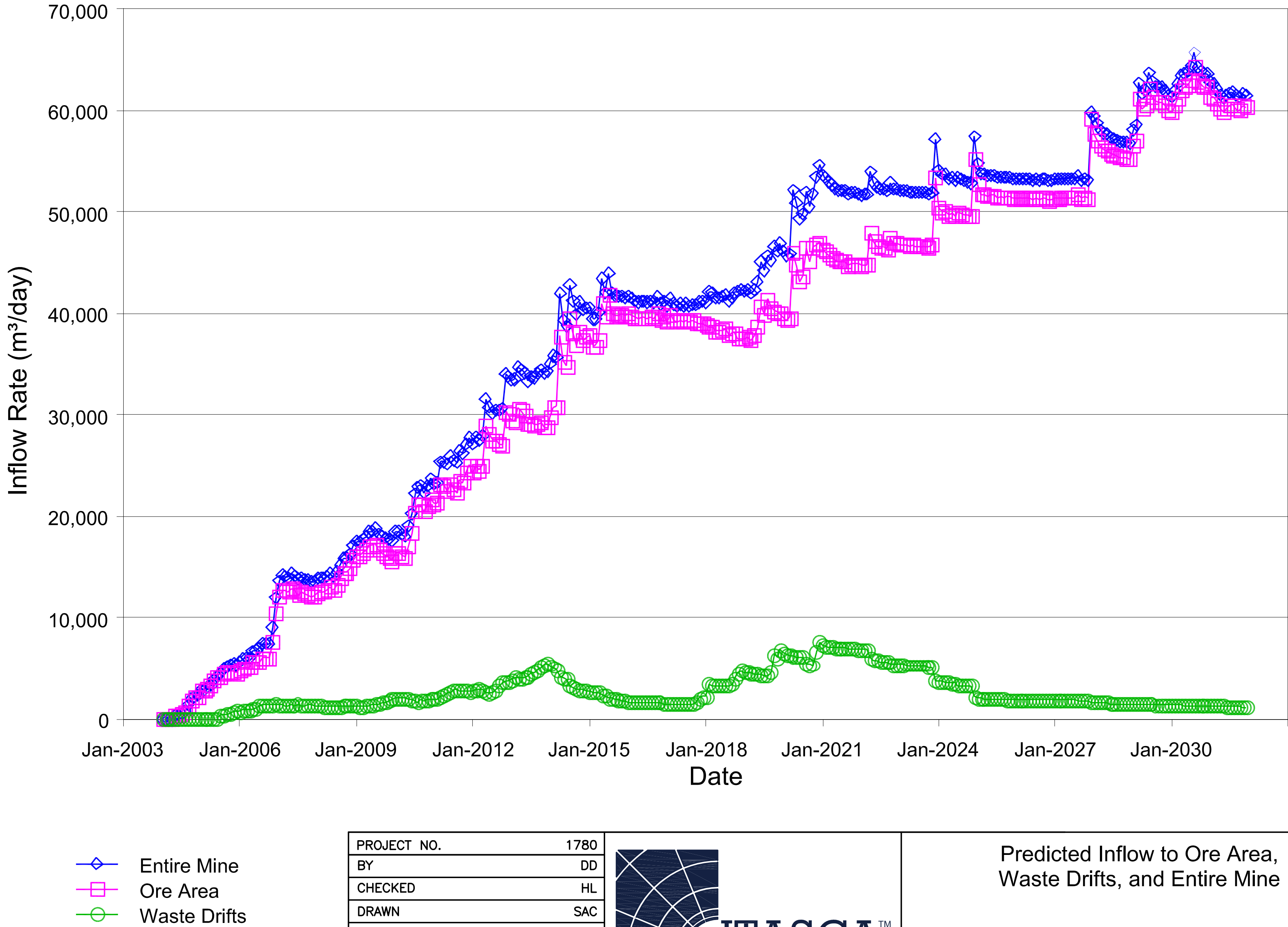
ITASCA™
Denver, Inc.

Calculated and Measured TDS Concentrations in Mine Discharge

CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 19

DRAFT



PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	PRED–INFLOW
DRAWING DATE	10 DEC 2012
REVISION DATE	––

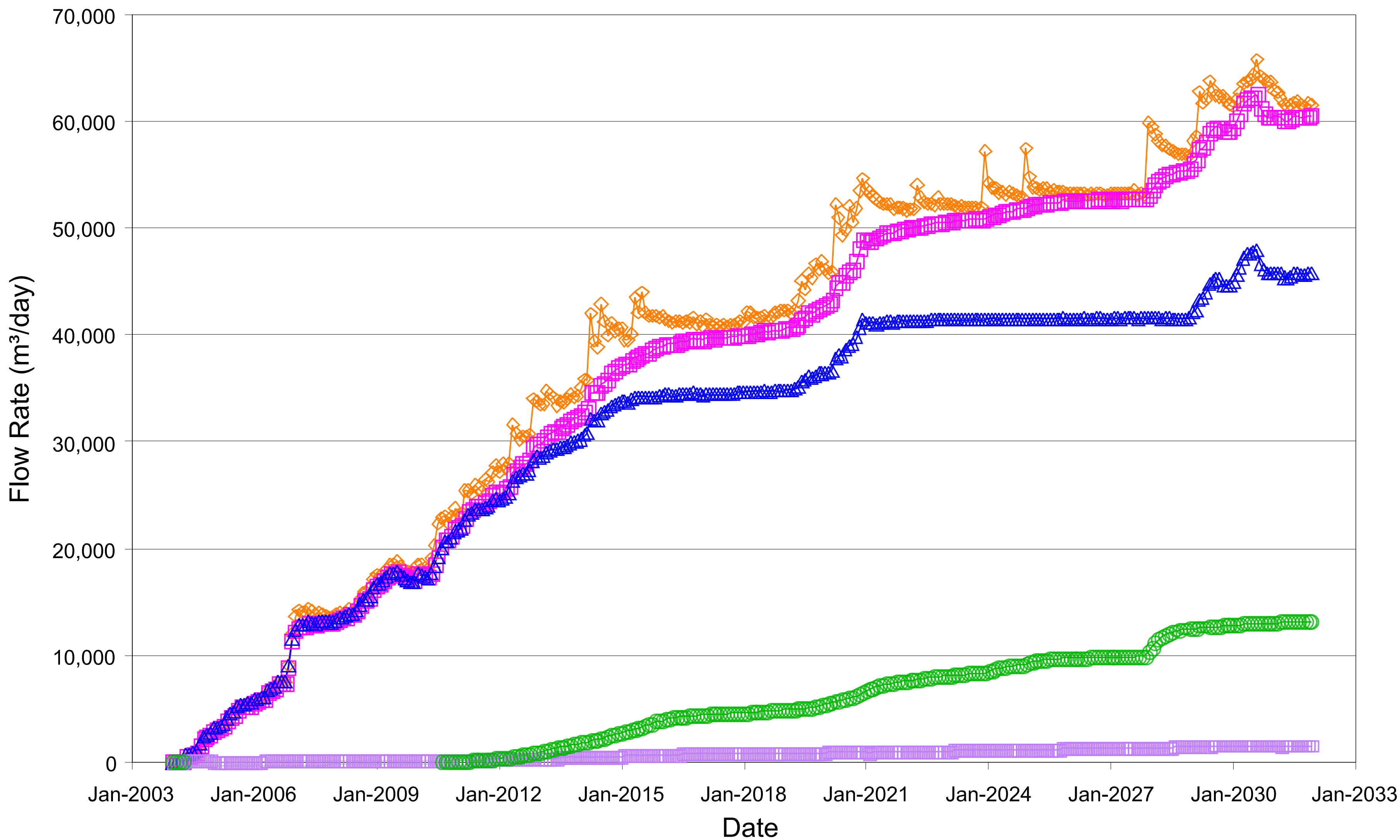
ITASCA™ Denver, Inc.

Predicted Inflow to Ore Area, Waste Drifts, and Entire Mine

CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 20

DRAFT



Total mine inflow

Discharge from Lakes

All lakes

Snap Lake

North Lake

Northeast Lake

PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	PRED–TOT–INFLOW
DRAWING DATE	10 DEC 2012
REVISION DATE	––

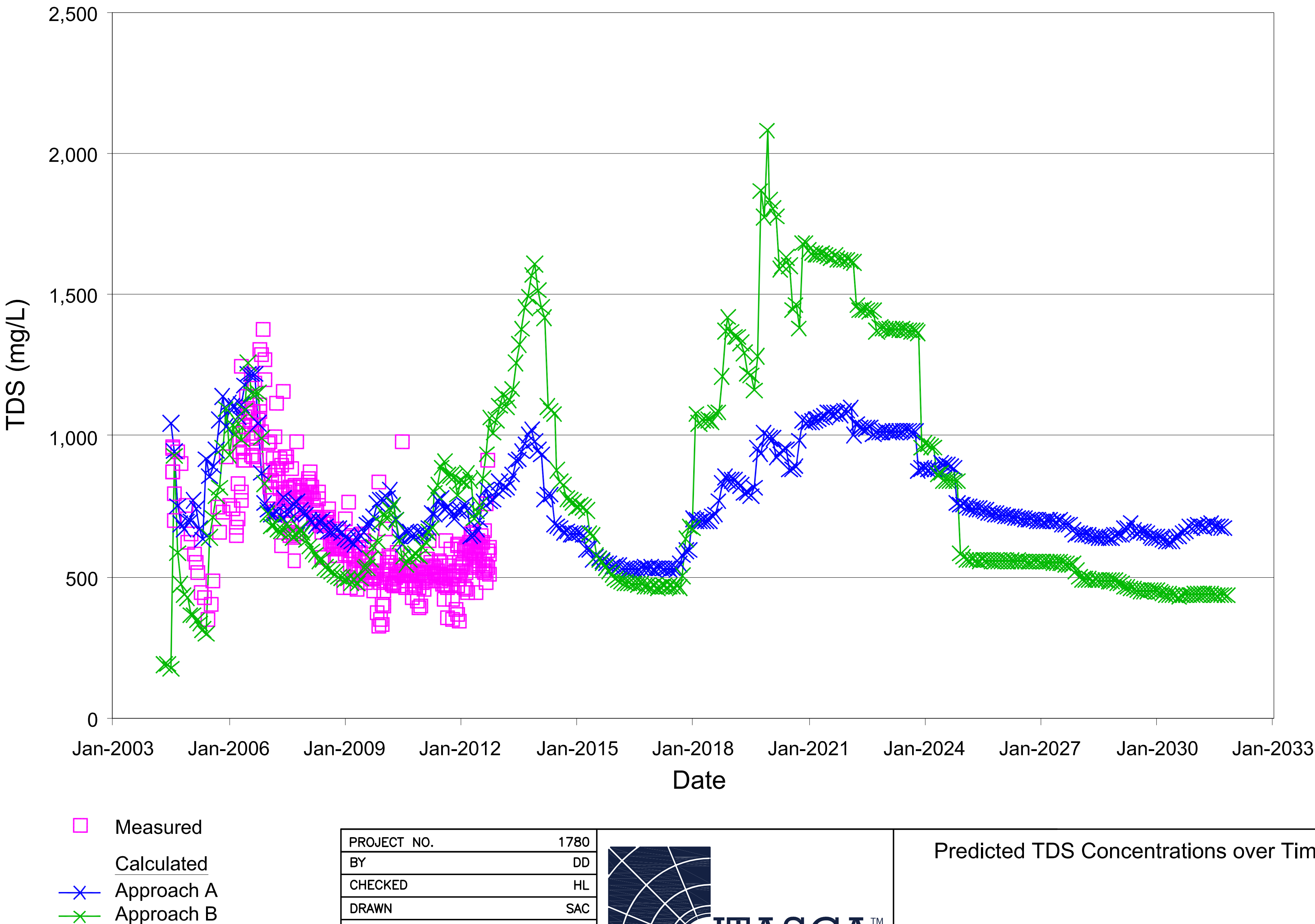
ITASCA™ Denver, Inc.

Predicted Total Mine Inflow and Contributions from Lakes

CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 21

DRAFT



PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	PRED–TDS
DRAWING DATE	10 DEC 2012
REVISION DATE	––

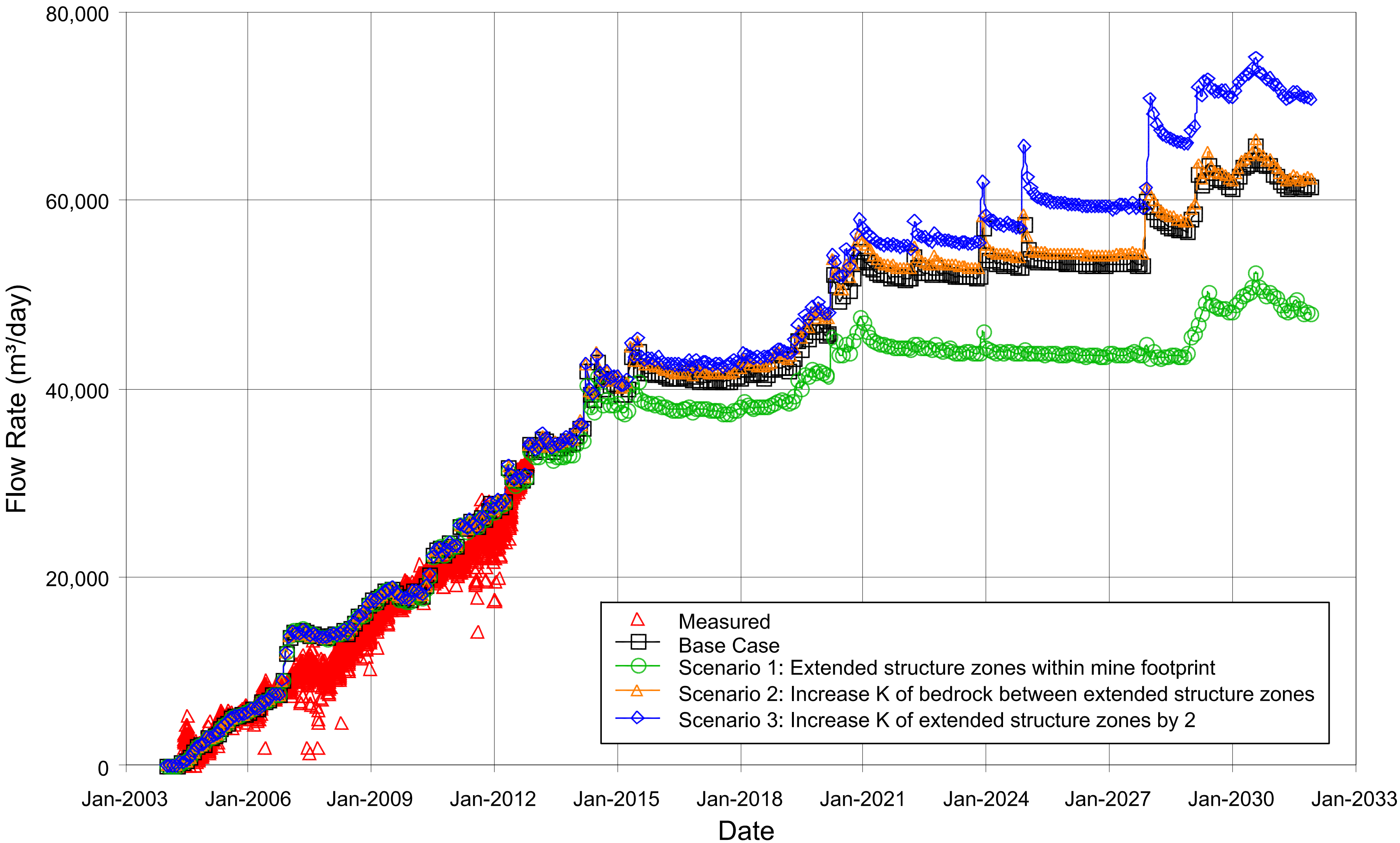
ITASCA™ Denver, Inc.

Predicted TDS Concentrations over Time

CLIENT: De Beers Canada - Snap Lake Mine

FIGURE NO. 22

DRAFT



PROJECT NO.	1780
BY	DD
CHECKED	HL
DRAWN	SAC
DRAWING NAME	SENSITIVITY
DRAWING DATE	10 DEC 2012
REVISION DATE	--

ITASCA™
Denver, Inc.

Predicted Inflow to Entire Mine
from Sensitivity Simulations

CLIENT:
De Beers Canada - Snap Lake Mine

FIGURE NO.
23

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TABLE 1

List of Selected Data and Files Provided by Snap Lake Mine

File Number	Sub-file Number	File Name	Date	Content
1-Hydrogeologic, General Reports, and Modeling	A - Reports	AMEC Optimisation Study Report	Dec-2002	
		090115 Tech Memo FFC-NL-488-GIM-002_Total	Jan-2009	Geochemical and isotope monitoring, analysis, and interpretations
		BGC Report 2008	Jun-2008	Standard and best practices for inflow preparedness
		DM Rose May 2007	May-2007	Snap Lake Diamond Project: structural geology, emplacement, geostatistics, and hydrogeology
		FINAL Snap Lake North Lakes Oct 2002	Oct-2002	Snap Lake Diamond Project: 2002 Environmental Information North Lakes Program
		Phase I Program Interim Results Report Rev06	Feb-2005	Snap Lake pre-production development. Phase 1, Results
		UG water management plan	Dec-2006	UG water management plan at Snap Lake
		Additional General Notes on Water Management Plan	Aug-2012	The Water management plan will be updated by Snap Lake
	B - Modeling	FracFlow Model 2011	Jun-2011	Model, reports, technical memos, presentations, data
		2007 Annual Hydrogeological Modelling	Mar-2007	Part B, Item 5S
		2008 Annual Hydrogeological Modelling	Feb-2009	Draft hydrogeologic modeling section of the 2008 Annual Report
		2009 Annual Hydrogeological Modelling	Mar-2009	Part B, Item 5S
		2011 Annual Hydrogeological Modelling	2011	Part B, Condition 5S
		HCI1780 Snap Lake 9-05 Update Report	Sep-2005	Hydrogeologic framework and predicted inflow to proposed mine
2-Geology		Report Winspear Resources Ltd	Feb-2000	Bedrock geology of the Snap Lake Area
		8th International Kimberlite Conference		Structural controls on the morphology of the Snap Lake Kimberlite Dike
		Gernon_Report	2008	The dynamics of Dike emplacement at Snap Lake
		Jan 2007 Structural Geology of the Snap Lake Diamond Project	Jan-2007	
		June 2007 Structural Geology of the Snap Lake Diamond Project	Jun-2007	
		triplepoint snap05 final updated may 05	Feb-2005	Snap Lake Kimberlite Dike, comments on water-bearing structures
3-Mine Discharge and Mine Inflow	A - Flow meters	Data from 2005 to 2012		Flow measurements
	B - Field Tests	Z12-50DR Water Flow Feb 15, 2012	Feb-2012	Flow measurement from a hole, AutoCAD drawing for location
	C - Mine water discharge data	Historical Minewater Discharge Data 2004 to 2010		Daily discharge
4-TDS Measurements and Predictions	A - Report	Snap Lake - TDS Predictions and Mitigation Options 2 July 2008	Jul-2008	Snap Lake TDS loading predictions and mitigation options
	B - TDS Measurements	Minewater TDS Profile 2004-2012		
		MW & WTP & SL TDS Profile 2004-2006		Minewater, water treatment plant and water
5 - Surface Water and Monitoring Data	A - Flumes	Stream Selection Sites		Flumes location
		Flumes Measurements 2010 2011		
		Flumes Measurements 2012		
	B - Piezometers	Data	2006 - 2012	Piezometers data
		Draft Log		Log for SSP03 and SSP06
		Maps	1999, 2010	Piezometer locations
6 - Past and Future Mine plans		Mine plans for 2009, 2011 and 2013 mining zones	2009, 2011, 2012	Future mine plans
		Memo - Basis for Life-of-Mine Production Plan	Jan-2010	Basis for Snap Lake life-of-mine development and production plan
		R169510572 Life-of-Mine Production Plan (Rev 1)	Apr-2011	Snap Lake Mine re-optimization, life-of-mine production plan (rev 1)
7 - Regional Topography		Regional topography map		
8 - AutoCAD Drawings			2012	Walls,planned walls, sill elevations, water inflows, major and minor faults, intercept, dewatering system, flowmeters, surface layers
3-D DXF Surfaces		The Mine May 15, 2009.dxf		
		The Mine July 19, 2010.dxf		
		The Mine July 15, 2011.dxf		
		The Mine July 17, 2012.dxf		
Geology		Kymberlit Dyke Surface August 23, 2012.dxf		
		Fault Model August 24, 2012.dxf		
2011 Hydro Modeling for WL	WL	Meeting, commitments, and questionnaires		
	Presentations	Three (3) presentation files		
	Pastefill	Related reports, draft memos, and final memos		
	North Pile Meeting Minutes	2010 and 2011		
	Mine Plan	Three (3) pdf files for Apr 2011		
	Golder	Water quality model, model, model reports, meetings, and emails		
	FracFlow	3D hydro model for WL, and cost estimates		
	Blasting Audit	Two (2) pdf files		
Additional Data	TDS related data	Conceptual TDS Correlations.docx	Nov-2012	For TDS calculation
		Data FW.xls	Nov-2012	Footwall TDS measurements
		Minewater TDS Profile 2012.xls	Sep-2012	
		Snap Lake Overall Water Tracking.xlsm	Oct-2012	
		Water Sampling.mdb	Nov-2012	
	Appendix files with fault drawings	Major Structure Dips.xlsx	Sep-2012	
		SL Drawing Summary.docx	Sep-2012	
	Corrected mine plan and mine site drawings	LTP_OD_Blocks.dwg	Nov-2012	Future orebody mining plan and development
		LTP_Waste for import.dwg	Nov-2012	Future waste plan
		Effective Grouting November 2012.dwg	Nov-2012	
		SL LTP Drawing Sept 2012.dwg	Sep-2012	
		SL Mine Layout Sept 2012.dwg	Sep-2012	
		SL Structural Zone Sept 2012.dwg	Sep-2012	
		The Mine November 8, 2012.dwg	Nov-2012	

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TABLE 2

Dips of Major Faults

Fault	Dip Angle	Dip Direction
45 Degree	45	SW
505-490	83	N
Baby Snap	50	SW
C10	75	N
Central 1	88	E
Central 2	89	E
Crackle	65	NW
Gravel	69	E
Gridline	85	E
Snap	84	S
Snap Rib	70	S
Twin 1	84	NE
Twin 2	58	NE
Twin 3	85	SW

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TABLE 3
Summary of Horizontal Hydraulic Conductivity

ITASCA Denver, Inc.

Hole ID	Depth (m)	From (m)	To (m)	*K* (m/day)	Collar			Dip Angle	Azimuth	Hole Length (m)
					Easting (m)	Northing (m)	Elevation (melev)[1]			
SL-11-0008	164.0	346.0	510.0	1.8E-05	NA			-70.0	240.0	650.0
	59.0	286.0	345.0	3.8E-05						
	164.0	346.0	510.0	4.3E-05						
	29.0	577.0	606.0	5.8E-05						
	29.0	547.0	576.0	8.5E-05						
	20.0	631.0	651.0	9.5E-05						
	20.0	631.0	651.0	2.6E-04						
	29.0	547.0	576.0	2.9E-04						
	29.0	577.0	606.0	3.2E-04						
	20.0	82.0	102.0	3.2E-04						
	29.0	577.0	606.0	4.0E-04						
	29.0	547.0	576.0	4.2E-04						
	20.0	631.0	651.0	6.0E-04						
	32.0	253.0	285.0	2.2E-03						
	32.0	253.0	285.0	2.4E-03						
	38.0	181.0	219.0	2.9E-03						
	32.0	253.0	285.0	3.0E-03						
	38.0	181.0	219.0	3.4E-03						
	38.0	181.0	219.0	4.2E-03						
	35.0	511.0	546.0	7.1E-03						
	35.0	511.0	546.0	7.6E-03						
	35.0	511.0	546.0	9.3E-03						
	35.0	220.0	255.0	9.5E-03						
	35.0	220.0	255.0	1.0E-02						
	35.0	220.0	255.0	1.5E-02						
	44.0	607.0	651.0	2.0E-02						
	44.0	607.0	651.0	2.2E-02						
	44.0	607.0	651.0	2.6E-02						
SL-11-0010	35.0	640.0	675.0	1.6E-05	NA			-75.0	140.0	675.0
	41.0	481.0	522.0	8.7E-05						
	29.0	421.0	450.0	9.2E-05						
	44.0	199.0	243.0	1.3E-04						
	29.0	421.0	450.0	1.6E-04						
	44.0	199.0	243.0	1.8E-04						
	29.0	421.0	450.0	3.5E-04						
	62.0	358.0	420.0	6.2E-04						
	62.0	358.0	420.0	7.3E-04						
	80.0	340.0	420.0	8.8E-04						
	62.0	358.0	420.0	9.6E-04						
	80.0	340.0	420.0	9.9E-04						
	80.0	340.0	420.0	1.3E-03						
	32.0	565.0	597.0	1.5E-03						
	32.0	565.0	597.0	1.5E-03						
	32.0	565.0	597.0	1.6E-03						
	29.0	451.0	480.0	4.6E-03						
	29.0	451.0	480.0	4.7E-03						
	29.0	451.0	480.0	4.7E-03						
	38.0	601.0	639.0	5.0E-03						
	29.0	451.0	480.0	5.2E-03						
	38.0	601.0	639.0	5.5E-03						
	38.0	601.0	639.0	6.0E-03						
	38.0	601.0	639.0	6.5E-03						
	65.0	325.0	390.0	2.2E-02						
	65.0	325.0	390.0	2.4E-02						
	65.0	325.0	390.0	3.2E-02						
SL-11-0013/14/15	32.0	457.0	489.0	1.1E-05	NA			-77.0	200.0	597.0
	44.0	349.0	393.0	1.7E-05						
	32.0	457.0	489.0	4.8E-05						
	32.0	457.0	489.0	4.9E-05						
	35.0	313.0	348.0	6.8E-05						
	32.0	187.0	219.0	1.1E-04						
	32.0	280.0	312.0	3.9E-03						
	32.0	280.0	312.0	4.1E-03						
	32.0	280.0	312.0	4.3E-03						
	62.0	217.0	279.0	3.3E-02						
	62.0	217.0	279.0	3.5E-02						
	62.0	217.0	279.0	4.0E-02						
	26.0	253.0	279.0	9.1E-02						
	26.0	253.0	279.0	1.0E-01						
	26.0	253.0	279.0	1.3E-01						
UG04-237	24.0	1.5	25.5	3.4E-02	507837.0	7053092.0	5264.0	NA	NA	31.0
	24.0	1.5	25.5	7.6E-02						
	3.0	25.5	28.5	6.2E+00						
UG04-244	4.0	1.5	5.5	9.3E-01	507834.0	7053107.0	5264.0	NA	NA	31.0
	4.0	1.5	5.5	3.3E+00						

Note: [1] mine elevation = meters above mean sea level + 5000 m.

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TABLE 3
Summary of Horizontal Hydraulic Conductivity

ITASCA Denver, Inc.

Hole ID	Depth (m)	From (m)	To (m)	*K* (m/day)	Collar			Dip Angle	Azimuth	Hole Length (m)
					Easting (m)	Northing (m)	Elevation (melev)[1]			
UG04-250	20.5	1.5	22.0	5.6E-02	507853.0	7053074.0	5265.0	NA	NA	25.0
	20.5	1.5	22.0	8.9E-02						
UG04-252	15.7	1.5	17.2	4.7E-01	507828.0	7053078.0	5265.0	NA	NA	25.5
UG04-271	79.0	1.5	80.5	1.7E-02	507751.0	7053166.0	5283.0	45.0	80.0	80.5
	132.0	1.5	80.5	1.7E-02						
	79.0	1.5	80.5	2.3E-01						
UG05-177	45.0	1.5	45.0	2.0E-03	NA			NA	NA	NA
UG05-178	249.0	1.5	249.0	6.0E-03						
UG05-179	90.0	1.5	90.0	1.2E-02						
UG05-180	90.0	1.5	90.0	1.6E-02						
UG05-197	69.0	1.5	69.0	1.8E-02						
UG05-205	163.5	1.5	163.5	1.4E-02						
	182.5	166.5	182.5	2.6E-01						
	166.5	163.5	166.5	2.6E-01						
UG05-206	25.5	24.0	25.5	3.6E+00						
UG05-207	41.5	1.5	41.5	2.1E-02						
UG05-208	328.0	205.5	328.0	2.0E-02						
	205.5	170.0	205.5	4.2E-02						
	138.0	107.0	138.0	8.5E-02						
	170.0	138.0	170.0	1.2E-01						
UG05-236	39.5	1.5	39.5	1.9E-01						
UG05-237	25.5	1.5	25.5	7.1E-02						
	28.5	25.5	28.5	1.1E+00						
UG05-244	5.5	1.5	5.5	4.4E-01						
UG05-250	22.0	1.5	22.0	8.4E-02						
UG05-252	17.2	1.5	17.2	1.4E-01						
UG05-267	20.5	1.5	20.5	4.3E-02						
UG05-269	72.5	37.5	72.5	1.0E-03						
	37.5	1.5	37.5	1.2E-01						
UG05-270	62.3	1.5	62.3	3.1E-02						
UG05-271	80.5	1.5	80.5	5.9E-02						
UG05-290	37.0	44.0	81.0	4.1E-03	507837.7	7053090.8	5264.0	NA	NA	81.0
	81.0	44.0	81.0	2.0E-02						
	28.5	1.5	30.0	7.1E-02						
	30.0	1.5	30.0	7.4E-02						
	36.0	30.0	36.0	7.1E-01						
	44.0	36.0	44.0	8.0E-01						
	6.0	30.0	36.0	8.0E-01						
	8.0	36.0	44.0	8.4E-01						
	8.0	36.0	44.0	1.3E+00						
	6.0	30.0	36.0	1.4E+00						
	28.5	1.5	30.0	1.7E+00						
UG05-295	28.5	1.5	30.0	4.6E-02	507827.0	7053083.8	5264.0	NA	NA	30.0
	30.0	1.5	30.0	7.7E-02						
	28.5	1.5	30.0	1.4E-01						
UG05-297	34.5	1.5	36.0	1.3E-01	507825.4	7053084.4	5264.0	NA	NA	52.0
	34.5	1.5	36.0	2.7E-01						
	38.0	36.0	38.0	1.7E+00						
UG05-298	48.5	1.5	50.0	1.8E-02	507848.8	7053100.4	5265.7	NA	NA	52.0
	50.0	1.5	50.0	3.3E-02						
UG05-302	50.5	1.5	52.0	3.6E-02	507710.6	7053111.4	5285.3	NA	NA	52.0
UG05-316	168.0	141.0	168.0	3.0E-03	507734.0	7053265.0	5283.0	-70.0	65.0	231.0
	104.0	84.0	104.0	4.0E-03						
	84.0	63.0	84.0	6.0E-03						
	160.0	141.0	168.0	9.0E-03						
	27.0	141.0	168.0	9.1E-03						
	20.0	84.0	104.0	1.3E-02						
	160.0	104.0	126.0	1.4E-02						
	22.0	104.0	126.0	2.5E-02						
	160.0	84.0	104.0	2.6E-02						
	42.0	21.0	42.0	2.7E-02						
	126.0	104.0	126.0	3.3E-02						
	21.0	21.0	42.0	1.2E-01						
	160.2	21.0	42.0	2.0E-01						
	160.2	63.0	84.0	2.1E-01						
	21.0	63.0	84.0	2.4E-01						
	21.0	21.0	42.0	2.9E-01						
UG05-323	21.0	42.0	63.0	3.7E-04	507901.1	7053049.5	5263.5	-80.0	NA	222.0
	63.0	42.0	63.0	1.0E-03						
	105.0	84.0	105.0	1.1E-02						
	21.0	84.0	105.0	8.7E-02						

Sources: Brown 2006.
HCI 2005c.
Fracflow 2012.

Note: [1] mine elevation = meters above mean sea level + 5000 m.

TABLE 4

Summary of Vertical Hydraulic Conductivity

Hole	Depth (m)	From (m)	To (m)	*K* (m/day)	Collar			DIP	Azimuth	Hole Length (m)
					Easting (m)	Northing (m)	Elevation (melev)[1]			
UG04-177	126.0	1.5	45.0	6.8E-03	507287.0	7052928.0	5323.0	-5.0	78.0	141.0
	43.5	1.5	45.0	6.8E-03						
	43.5	1.5	45.0	8.4E-03						
UG04-178	247.5	1.5	249.0	1.3E-02	507457.0	7053145.0	5326.0	-1.0	100.0	249.0
	120.2	1.5	249.0	1.3E-02						
UG04-179	88.5	1.5	90.0	2.1E-02	507778.8	7053114.9	5281.8	-2.3	89.9	90.0
	163.9	1.5	90.0	1.7E-01						
	88.5	1.5	90.0	1.7E-01						
UG04-180	88.5	1.5	90.0	4.1E-02	507778.9	7053114.1	5281.7	-2.0	104.3	90.0
	163.4	1.5	90.0	9.4E-02						
	88.5	1.5	90.0	9.4E-02						
UG04-181		1.5	126.0	5.4E-02	507778.5	7053113.1	5281.8	-1.5	125.2	90.0
	88.5	1.5	90.0	7.4E-02						
	163.0	1.5	90.0	7.4E-02						
UG04-182	124.5	1.5	126.0	5.4E-02	507778.5	7053113.1	5281.9	-1.1	114.8	126.0
UG04-197	141.3	60.0	141.0	1.2E-01	507672.1	7053070.8	5288.7	8.0	248.8	282.0
	81.0	60.0	141.0	1.2E-01						
UG04-205	162.0	1.5	163.5	1.3E-02	507688.0	7053257.0	5281.0	2.0	21.0	190.0
	165.0	1.5	166.5	1.8E-02						
	165.0	1.5	166.5	6.9E-02						
	160.1	1.5	166.5	6.9E-02						
	162.0	1.5	163.5	1.5E-01						
	160.1	1.5	163.5	1.5E-01						
	16.0	166.5	182.5	8.8E-01						
	156.9	166.0	182.5	5.6E+00						
	16.0	166.5	182.5	5.6E+00						
	7.5	182.5	190.0	1.1E+01						
UG04-206	24.0	1.5	25.5	3.1E-01	507849.9	7053052.5	5266.0	37.7	84.2	25.5
	24.0	1.5	25.5	3.1E-01						
	169.7	1.5	25.5	6.6E-01						
	169.7	1.5	25.5	6.6E-01						
	24.0	1.5	25.5	6.6E-01						
	24.0	1.5	25.5	6.6E-01						
UG04-207	40.0	1.5	41.5	5.7E-02	507849.8	7053052.4	5264.9	19.2	79.7	41.5
	40.0	1.5	41.5	2.0E-01						
	172.0	1.5	41.5	2.0E-01						
UG04-208	31.0	107.0	138.0	6.2E-02	507470.0	7053283.0	5328.0	-5.2	88.8	291.0
	123.0	205.0	328.0	1.6E-01						
	140.2	205.0	328.0	1.6E-01						
	133.0	170.0	205.0	9.0E-01						
	35.0	170.0	205.0	9.0E-01						
	32.0	138.0	170.0	1.1E+00						
	130.0	138.0	170.0	1.1E+00						
	127.1	107.0	138.0	1.6E+00						
	31.0	107.0	138.0	1.6E+00						
UG04-236	37.5	1.5	39.0	1.1E-01	507844.5	7053038.6	5265.0	27.8	78.8	39.5
	37.5	1.5	39.0	4.4E+00						
	169.6	1.5	39.0	4.4E+00						
UG04-267	18.5	1.5	20.0	9.5E-03	507750.0	7053166.3	5282.3	29.0	44.3	67.0
	156.5	1.5	20.0	9.5E-03						
UG04-269	162.6	1.5	72.0	2.2E-02	507751.3	7053166.0	5281.4	0.0	80.0	85.3
	70.5	1.5	72.0	2.2E-02						
	162.6	1.5	37.0	5.0E-02						
	35.5	1.5	37.0	5.0E-02						
	70.5	1.5	72.0	1.2E-01						
	35.5	1.5	37.0	1.8E+00						
UG04-270	60.8	1.5	62.3	3.3E-02	507750.8	7053166.0	5282.0	23.0	60.0	62.3
	149.5	1.5	62.3	3.3E-02						
	60.8	1.5	62.3	3.8E-02						
UG05-275	21.0	1.5	21.0	5.0E-03	507734.0	7053265.0	5284.0	-3.4	84.0	38.5

Note: [1] mine elevation = meters above mean sea level + 5000 m.

TABLE 4

ITASCA Denver, Inc.

Summary of Vertical Hydraulic Conductivity

Hole	Depth (m)	From (m)	To (m)	*K* (m/day)	Collar Easting (m)	Collar Northing (m)	Collar Elevation (melev)[1]	DIP	Azimuth	Hole Length (m)
UG05-276	63.0	402.0	465.0	2.3E-04	507734.0	7053265.0	5284.3	-1.0	85.0	564.0
	40.5	1.5	42.0	1.7E-03						
	62.0	42.0	62.0	2.0E-03						
	60.5	1.5	62.0	2.5E-03						
	162.4	126.0	180.0	2.8E-03						
	60.5	1.5	62.0	2.8E-03						
	42.0	21.0	42.0	3.0E-03						
	162.1	126.0	147.0	3.2E-03						
	40.5	1.5	42.0	3.2E-03						
	465.0	402.0	465.0	4.0E-03						
	21.0	126.0	147.0	5.7E-03						
	163.6	209.0	233.0	5.7E-03						
	354.0	292.5	354.0	6.0E-03						
	24.0	209.0	233.0	6.7E-03						
	161.7	99.0	126.0	6.7E-03						
	165.3	292.0	354.0	6.7E-03						
	19.5	1.5	21.0	6.7E-03						
	147.0	126.0	147.0	7.0E-03						
	230.0	209.0	230.0	7.0E-03						
	376.0	354.0	376.0	7.0E-03						
	21.0	126.0	147.0	7.1E-03						
	63.0	402.0	465.0	7.3E-03						
	21.0	1.5	21.0	8.0E-03						
	522.0	465.0	522.0	9.0E-03						
	42.0	126.0	168.0	1.0E-02						
	21.0	209.0	230.0	1.0E-02						
	120.0	402.0	522.0	1.1E-02						
	168.0	147.0	168.0	1.2E-02						
	164.5	260.0	292.5	1.2E-02						
	21.0	209.0	230.0	1.2E-02						
	252.0	233.0	252.0	1.5E-02						
	120.0	402.0	522.0	1.5E-02						
	167.4	402.0	486.0	1.6E-02						
	83.5	292.5	376.0	1.6E-02						
	99.0	62.0	99.0	1.7E-02						
	120.0	99.0	120.0	1.7E-02						
	396.0	393.0	396.0	1.8E-02						
	564.0	522.0	564.0	1.8E-02						
	260.0	252.0	260.0	2.1E-02						
	393.0	376.0	393.0	2.1E-02						
	42.0	522.0	564.0	2.4E-02						
	201.0	180.0	201.0	2.5E-02						
	180.0	168.0	180.0	2.6E-02						
	83.5	292.5	376.0	2.7E-02						
	167.3	402.0	465.0	2.8E-02						
	61.5	292.5	354.0	2.8E-02						
	43.0	209.0	252.0	2.8E-02						
	233.0	230.0	233.0	2.9E-02						
	29.0	180.0	209.0	3.0E-02						
	100.5	292.5	393.0	3.0E-02						
	209.0	201.0	209.0	3.3E-02						
	280.5	260.0	280.5	3.3E-02						
	61.5	292.5	354.0	3.7E-02						
	42.0	522.0	564.0	4.2E-02						
	97.5	1.5	99.0	4.7E-02						
	292.5	280.5	292.5	4.7E-02						
	43.0	209.0	252.0	4.7E-02						
	165.5	292.0	376.0	4.7E-02						
	42.0	126.0	168.0	5.3E-02						
	21.0	99.0	120.0	5.3E-02						
	163.1	180.0	209.0	5.3E-02						
	162.3	126.0	168.0	5.3E-02						
	126.0	120.0	126.0	5.7E-02						
	19.5	1.5	21.0	5.9E-02						
	20.5	260.0	280.5	5.9E-02						
	163.0	180.0	201.0	6.6E-02						
	97.5	1.5	99.0	6.6E-02						
	161.6	99.0	120.0	6.9E-02						
	51.0	209.0	260.0	7.2E-02						
	21.0	99.0	120.0	7.4E-02						
	21.0	180.0	201.0	8.4E-02						

Note: [1] mine elevation = meters above mean sea level + 5000 m.

TABLE 4

Summary of Vertical Hydraulic Conductivity

Hole	Depth (m)	From (m)	To (m)	*K* (m/day)	Collar Easting (m)	Collar Northing (m)	Collar Elevation (melev)[1]	DIP	Azimuth	Hole Length (m)
UG05-276	165.7	292.0	393.0	8.4E-02	507734.0	7053265.0	5284.3	-1.0	85.0	564.0
	51.0	209.0	260.0	8.4E-02						
	21.0	180.0	201.0	9.2E-02						
	163.8	209.0	260.0	9.2E-02						
	159.9	1.5	21.0	1.4E-01						
	21.0	522.0	543.0	1.6E-01						
	169.0	522.0	543.0	1.6E-01						
	54.0	126.0	180.0	1.6E-01						
	163.7	209.0	252.0	1.9E-01						
	54.0	126.0	180.0	1.9E-01						
	402.0	396.0	402.0	2.2E-01						
	160.1	1.5	42.0	2.4E-01						
	167.8	402.0	522.0	2.4E-01						
	100.5	292.5	393.0	2.4E-01						
	163.5	209.0	230.0	2.9E-01						
	27.0	99.0	126.0	2.9E-01						
	160.6	1.5	99.0	2.9E-01						
	9.0	393.0	402.0	3.6E-01						
	166.6	393.0	396.0	3.7E-01						
	20.5	260.0	280.5	3.7E-01						
	9.0	393.0	402.0	3.9E-01						
	32.5	260.0	292.5	4.3E-01						
	160.3	1.5	62.0	4.8E-01						
	164.4	260.0	280.5	6.8E-01						
	29.0	180.0	209.0	6.8E-01						
	32.5	260.0	292.5	1.0E+00						
	166.6	393.0	402.0	1.0E+00						
	3.0	393.0	396.0	1.2E+00						
	3.0	393.0	396.0	1.2E+00						
	169.2	522.0	564.0	1.2E+00						
	27.0	99.0	126.0	2.3E+00						
UG05-280	161.9	1.5	99.0	2.0E-04	507798.0	7053145.0	5276.0	7.0	70.0	99.2
	36.2	1.5	36.2	2.5E-02						
	99.0	36.2	99.0	4.4E-02						
	34.7	1.5	36.2	1.4E-01						
	34.7	1.5	36.2	1.5E-01						
	97.5	1.5	99.0	2.4E-01						
	165.7	1.5	36.2	3.6E-01						
	97.5	1.5	99.0	3.8E-01						
UG05-287	165.3	1.5	27.0	1.1E-02	507786.0	7053138.0	5277.0	7.0	95.0	120.0
	90.0	27.0	90.0	4.0E-02						
	161.4	1.5	90.0	4.2E-02						
	88.5	1.5	90.0	6.8E-02						
	19.0	1.5	19.0	1.0E-01						
	88.5	1.5	90.0	1.3E-01						
	27.0	19.0	27.0	1.4E-01						
	25.5	1.5	27.0	2.9E-01						
	17.5	1.5	19.0	3.7E-01						
	25.5	1.5	27.0	4.5E-01						
	17.5	1.5	19.0	4.8E-01						

Note: [1] mine elevation = meters above mean sea level + 5000 m.

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TABLE 4

Summary of Vertical Hydraulic Conductivity

Hole	Depth (m)	From (m)	To (m)	*K* (m/day)	Collar Easting (m)	Collar Northing (m)	Collar Elevation (melev)[1]	DIP	Azimuth	Hole Length (m)
UG05-307	397.5	1.5	399.0	5.1E-04	507901.1	7053049.5	5264.7	-1.0	91.6	450.0
	292.5	1.5	294.0	7.7E-04						
	250.5	1.5	252.0	8.6E-04						
	181.7	1.5	273.0	9.0E-04						
	271.5	1.5	273.0	9.3E-04						
	182.1	1.5	315.0	1.0E-03						
	181.6	1.5	252.0	1.0E-03						
	181.9	1.5	294.0	1.0E-03						
	180.8	1.5	168.0	1.1E-03						
	166.5	1.5	168.0	1.1E-03						
	313.5	1.5	315.0	1.1E-03						
	182.3	1.5	336.0	1.2E-03						
	334.5	1.5	336.0	1.2E-03						
	376.5	1.5	378.0	1.3E-03						
	183.0	1.5	412.0	1.3E-03						
	182.7	1.5	378.0	1.3E-03						
	410.5	1.5	412.0	1.3E-03						
	355.5	1.5	357.0	1.4E-03						
	183.1	1.5	432.0	1.4E-03						
	182.5	1.5	357.0	1.4E-03						
	430.5	1.5	432.0	1.4E-03						
	397.5	1.5	399.0	1.6E-03						
	182.8	1.5	399.0	1.6E-03						
	145.5	1.5	147.0	1.9E-03						
	180.6	1.5	147.0	1.9E-03						
	273.0	252.0	273.0	2.0E-03						
	399.0	378.0	399.0	2.0E-03						
	432.0	412.0	432.0	2.0E-03						
	180.5	1.5	126.0	2.2E-03						
	124.5	1.5	126.0	2.2E-03						
	430.5	1.5	432.0	2.2E-03						
	82.5	1.5	84.0	2.3E-03						
	180.3	1.5	105.0	2.3E-03						
	180.1	1.5	84.0	2.3E-03						
	103.5	1.5	105.0	2.3E-03						
	271.5	1.5	273.0	2.7E-03						
	58.5	1.5	60.0	3.0E-03						
	252.0	168.0	252.0	3.0E-03						
	315.0	273.0	315.0	3.0E-03						
	336.0	315.0	336.0	3.0E-03						
	357.0	336.0	357.0	3.0E-03						
	378.0	357.0	378.0	3.0E-03						
	412.0	399.0	412.0	3.0E-03						
	179.9	1.5	60.0	3.0E-03						
	334.5	1.5	336.0	3.6E-03						
	124.5	1.5	126.0	3.7E-03						
	355.5	1.5	357.0	4.0E-03						
	105.0	84.0	105.0	4.0E-03						
	147.0	126.0	147.0	4.0E-03						
	292.5	1.5	294.0	4.2E-03						
	250.5	1.5	252.0	4.9E-03						
	410.5	1.5	412.0	5.0E-03						
	168.0	147.0	168.0	5.0E-03						
	84.0	60.0	84.0	5.0E-03						
	82.5	1.5	84.0	5.2E-03						
	145.5	1.5	147.0	5.7E-03						
	313.5	1.5	315.0	5.8E-03						
	126.0	105.0	126.0	6.0E-03						
	179.7	1.5	42.0	6.1E-03						
	40.5	1.5	42.0	6.1E-03						
	42.0	1.5	42.0	8.0E-03						
	376.5	1.5	378.0	8.1E-03						
	103.5	1.5	105.0	8.4E-03						
	60.0	42.0	60.0	9.0E-03						
	40.5	1.5	42.0	1.5E-02						
	166.5	1.5	168.0	2.0E-02						
	58.5	1.5	60.0	3.1E-02						

Note: [1] mine elevation = meters above mean sea level + 5000 m.

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TABLE 4

Summary of Vertical Hydraulic Conductivity

Hole	Depth (m)	From (m)	To (m)	*K* (m/day)	Collar			DIP	Azimuth	Hole Length (m)
					Easting (m)	Northing (m)	Elevation (melev)[1]			
	126.0	105.0	126.0	1.0E-03						
	21.0	105.0	126.0	3.0E-03						
	21.0	105.0	126.0	7.0E-03						
	162.1	105.0	126.0	7.0E-03						
	396.0	336.0	396.0	9.0E-03						
	528.0	507.0	528.0	1.8E-02						
	36.0	360.0	396.0	2.5E-02						
	21.0	1.5	21.0	3.0E-02						
	507.0	486.0	507.0	3.6E-02						
	67.0	486.0	553.0	3.6E-02						
	225.0	205.0	225.0	3.7E-02						
	553.0	528.0	553.0	4.3E-02						
	42.0	486.0	528.0	4.4E-02						
	258.0	237.5	258.0	4.4E-02						
	20.2	237.8	258.0	4.5E-02						
	282.0	261.0	282.0	5.4E-02						
	90.0	74.0	90.0	7.9E-02						
	21.0	486.0	507.0	8.7E-02						
	21.0	261.0	282.0	8.7E-02						
	105.0	90.0	105.0	9.5E-02						
	300.0	288.0	300.0	9.5E-02						
	205.0	192.0	205.0	9.6E-02						
	74.0	54.0	74.0	9.7E-02						
	16.0	74.0	90.0	1.1E-01						
	20.0	54.0	74.0	1.1E-01						
	26.0	310.0	336.0	1.2E-01						
	197.3	486.0	553.0	1.4E-01						
	67.0	486.0	553.0	1.4E-01						
	15.0	90.0	105.0	1.5E-01						
	19.5	1.5	21.0	1.6E-01						
	40.5	1.5	42.0	1.6E-01						
	153.9	1.5	42.0	1.6E-01						
	52.5	1.5	54.0	1.6E-01						
	12.0	288.0	300.0	2.0E-01						
	153.0	1.5	21.0	2.8E-01						
	19.5	1.5	21.0	2.8E-01						
	180.0	174.0	180.0	3.0E-01						
	237.5	231.5	237.5	4.0E-01						
	42.0	486.0	528.0	4.3E-01						
	196.2	486.0	528.0	4.3E-01						
UG05-360	20.0	205.0	225.0	4.6E-01	507699.0	7053392.0	5292.0	-5.0	56.0	553.0
	13.0	192.0	205.0	4.7E-01						
	195.3	486.0	507.0	6.6E-01						
	21.0	486.0	507.0	6.6E-01						
	21.0	465.0	486.0	7.3E-01						
	193.4	465.0	486.0	7.3E-01						
	6.0	174.0	180.0	1.1E+00						
	6.0	231.5	237.5	1.5E+00						
	184.9	360.0	396.0	2.0E+00						
	36.0	360.0	396.0	2.0E+00						
	163.0	105.0	147.0	2.5E+00						
	42.0	105.0	147.0	2.5E+00						
	20.0	54.0	74.0	2.5E+00						
	173.6	237.0	258.0	3.6E+00						
	20.2	237.8	258.0	3.6E+00						
	169.3	192.0	205.0	3.8E+00						
	13.0	192.0	205.0	3.8E+00						
	21.0	261.0	282.0	4.0E+00						
	175.7	261.0	282.0	4.0E+00						
	159.1	74.0	90.0	5.2E+00						
	16.0	74.0	90.0	5.2E+00						
	178.1	288.0	310.0	5.3E+00						
	22.0	288.0	310.0	5.3E+00						
	6.5	225.0	231.5	7.0E+00						
	171.9	225.0	231.5	7.0E+00						
	180.2	310.0	336.0	7.2E+00						
	26.0	310.0	336.0	7.2E+00						
	160.5	90.0	105.0	7.9E+00						
	15.0	90.0	105.0	7.9E+00						
	20.0	205.0	225.0	8.8E+00						
	170.7	205.0	225.0	8.8E+00						
	12.0	288.0	300.0	9.4E+00						
	177.6	288.0	300.0	9.4E+00						
	168.2	180.0	192.0	1.3E+01						
	12.0	180.0	192.0	1.3E+01						
	172.4	231.0	237.5	1.6E+01						
	6.0	231.5	237.5	1.6E+01						
	6.0	147.0	153.0	1.8E+01						
	165.1	147.0	153.0	1.8E+01						
	6.0	174.0	180.0	2.7E+01						
	167.4	174.0	180.0	2.7E+01						

Note: [1] mine elevation = meters above mean sea level + 5000 m.

TABLE 4

ITASCA Denver, Inc.

Summary of Vertical Hydraulic Conductivity

Hole	Depth (m)	From (m)	To (m)	K (m/day)	Collar Easting (m)	Collar Northing (m)	Collar Elevation (melev)[1]	DIP	Azimuth	Hole Length (m)
UG05-453	61.5	1.5	63.0	9.7E-04	507639.1	7053470.8	5294.4	-3.0	32.0	450.0
	151.8	1.5	63.0	1.0E-03						
	63.0	42.0	63.0	2.0E-03						
	420.0	399.0	420.0	2.0E-03						
	441.0	420.0	441.0	2.0E-03						
	40.5	1.5	42.0	2.1E-03						
	150.7	1.5	42.0	2.1E-03						
	42.0	1.5	42.0	3.0E-03						
	399.0	378.0	399.0	3.0E-03						
	152.4	1.5	105.0	3.0E-03						
	103.5	1.5	105.0	3.0E-03						
	40.5	1.5	42.0	3.4E-03						
	105.0	63.0	105.0	4.0E-03						
	315.0	294.0	315.0	4.0E-03						
	336.0	315.0	336.0	4.0E-03						
	357.0	336.0	357.0	4.0E-03						
	378.0	357.0	378.0	4.0E-03						
	168.0	168.0	336.0	5.0E-03						
	294.0	273.0	294.0	5.0E-03						
	103.5	1.5	105.0	5.1E-03						
	273.0	168.0	441.0	5.8E-03						
	273.0	252.0	273.0	6.0E-03						
	147.0	168.0	315.0	6.2E-03						
	189.0	168.0	357.0	6.5E-03						
	252.0	168.0	420.0	6.6E-03						
	252.0	168.0	252.0	7.0E-03						
	105.0	168.0	273.0	8.7E-03						
	231.0	168.0	399.0	9.0E-03						
	126.0	105.0	126.0	9.0E-03						
	164.4	168.0	399.0	9.0E-03						
	124.5	1.5	126.0	1.0E-02						
	152.9	1.5	126.0	1.0E-02						
	252.0	168.0	420.0	1.1E-02						
	165.0	168.0	420.0	1.1E-02						
	210.0	168.0	378.0	1.3E-02						
	273.0	168.0	441.0	1.3E-02						
	165.5	168.0	441.0	1.3E-02						
	163.9	168.0	378.0	1.3E-02						
	163.3	168.0	357.0	1.4E-02						
	189.0	168.0	357.0	1.4E-02						
	126.0	168.0	294.0	1.5E-02						
	162.8	168.0	336.0	1.5E-02						
	168.0	168.0	336.0	1.5E-02						
	231.0	168.0	399.0	1.6E-02						
	210.0	168.0	378.0	1.7E-02						
	161.7	168.0	294.0	1.9E-02						
	126.0	168.0	294.0	1.9E-02						
	162.2	168.0	315.0	1.9E-02						
	147.0	168.0	315.0	1.9E-02						
	159.5	168.0	210.0	2.2E-02						
	42.0	168.0	210.0	2.2E-02						
	84.0	168.0	252.0	2.7E-02						
	161.1	168.0	273.0	2.8E-02						
	105.0	168.0	273.0	2.8E-02						
	124.5	1.5	126.0	2.9E-02						
	158.9	168.0	189.0	3.5E-02						
	21.0	168.0	189.0	3.5E-02						
	160.6	168.0	252.0	3.5E-02						
	84.0	168.0	252.0	3.5E-02						
	168.0	147.0	168.0	3.5E-02						
	147.0	126.0	147.0	4.0E-02						
	63.0	168.0	231.0	4.1E-02						
	160.0	168.0	231.0	4.1E-02						
	42.0	126.0	168.0	1.1E-01						
	21.0	126.0	147.0	1.7E-01						
	42.0	126.0	168.0	5.0E-01						
	157.3	126.0	168.0	5.0E-01						
	156.7	126.0	147.0	1.2E+00						
	21.0	126.0	147.0	1.2E+00						

Note: [1] mine elevation = meters above mean sea level + 5000 m.

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TABLE 4

Summary of Vertical Hydraulic Conductivity

Hole	Depth (m)	From (m)	To (m)	*K* (m/day)	Collar Easting (m)	Collar Northing (m)	Collar Elevation (melev)[1]	DIP	Azimuth	Hole Length (m)
UG05-456	190.0	131.0	190.0	1.6E-02	507787.0	7053323.0	5274.0	-30.0	4.0	190.0
	190.0	1.5	190.0	1.9E-02						
	265.0	1.5	190.0	2.0E-02						
	131.0	1.5	131.0	2.8E-02						
	235.5	1.5	131.0	4.0E-02						
	190.0	1.5	131.0	4.1E-02						
UG05-457	93.0	1.5	93.0	1.9E-02	507787.0	7053323.0	5274.0	-20.0	10.0	262.0
	260.0	93.0	260.0	2.4E-02						
	262.0	1.5	93.0	5.9E-02						
	202.0	1.5	93.0	6.0E-02						
	258.9	1.5	260.0	1.1E-01						
	262.0	1.5	260.0	1.1E-01						
UG05-458	132.0	1.5	132.0	2.5E-02	507787.0	7053323.0	5274.0	-20.0	350.0	258.0
	258.0	198.0	258.0	3.7E-02						
	198.0	144.0	198.0	5.6E-02						
	215.1	1.5	132.0	7.5E-02						
	258.0	1.5	132.0	7.5E-02						
	258.0	144.0	258.0	3.7E-01						
	258.2	198.0	258.0	3.7E-01						
	258.0	144.0	198.0	7.3E-01						
	237.7	144.0	198.0	7.3E-01						
UG05-460	153.0	1.5	153.0	3.5E-02	507694.6	7053389.1	5290.3	-25.0	40.0	220.0
	180.0	153.0	180.0	1.0E-01						
	220.0	1.5	153.0	1.7E-01						
	218.4	1.5	153.0	1.7E-01						
	236.1	153.0	195.0	5.5E-01						
	220.0	153.0	195.0	5.5E-01						
	220.0	153.0	180.0	2.3E+00						
	229.8	153.0	180.0	2.3E+00						
UG05-462	187.0			6.0E-02	507694.0	7053389.0	5290.0	-30.0	40.0	225.0
UG05-463	163.0	1.5	117.0	1.9E-02	507748.5	7053152.2	5281.0	0.0	90.0	144.0
UG05-465	201.4	1.5	177.0	2.5E-01	507680.0	7053400.5	5241.0	5.0	322.0	309.0
	198.8	177.0	309.0	2.8E-01						
	199.8	177.0	186.0	5.0E+00						
UG05-479	204.0			1.6E+00	507757.5	7053419.5	5229.5	20.0	334.0	45.0
UG-106	154.4			4.4E-02	507348.0	7053148.0	5304.4	-4.3	87.6	300.2
	152.2			4.9E-02						
	161.2			1.5E-01						
UG-173	164.2	3.0	37.0	1.0E-03	507775.0	7053119.0	5281.3	3.6	337.8	100.0
	100.0	3.1	36.9	1.0E-03						
	167.8	55.0	80.0	3.1E-03						
	100.0	55.0	80.0	3.1E-03						
	100.0	80.0	100.0	3.6E-02						
	169.4	80.0	100.0	3.6E-02						
	100.0	36.9	55.2	1.1E-01						
	166.1	37.0	55.0	1.1E-01						
UG-174	155.1	73.0	98.0	5.0E-04	507763.0	7053093.0	5280.9	5.4	201.0	97.5
	97.5	73.0	98.0	5.1E-04						
	162.0	0.0	24.0	1.0E-03						
	97.5	0.0	24.0	1.0E-03						
	159.7	24.0	49.0	2.4E-03						
	97.5	24.0	49.0	2.4E-03						
	157.4	49.0	73.0	3.4E-03						
	97.5	49.0	73.0	3.4E-03						
UG-175	289.9	24.4	48.8	6.8E-04	507779.0	7053115.0	5281.3	0.3	93.6	289.9
	162.5	24.0	49.0	7.0E-04						
	161.5	208.0	232.0	2.2E-02						
	289.9	207.6	232.0	2.2E-02						
	161.7	183.0	208.0	2.5E-02						
	289.9	183.2	207.6	2.5E-02						
	161.8	147.0	171.0	7.7E-02						
	289.9	146.6	171.0	7.7E-02						
	289.9	122.2	146.6	8.9E-02						
	162.0	122.0	147.0	8.9E-02						
	162.2	77.0	99.0	1.0E-01						
	289.9	76.5	99.4	1.0E-01						
	162.3	52.0	76.0	1.3E-01						
	289.9	52.1	75.9	1.3E-01						
	162.1	99.0	122.0	2.5E-01						
	289.9	99.4	122.2	2.5E-01						
	289.9	171.0	183.2	4.3E-01						
	161.8	171.0	183.0	4.3E-01						
	161.4	232.0	241.0	4.4E-01						
	289.9	232.0	241.1	4.4E-01						

Note: [1] mine elevation = meters above mean sea level + 5000 m.

TABLE 4

Summary of Vertical Hydraulic Conductivity

(Page 8 of 9)

Hole	Depth (m)	From (m)	To (m)	*K* (m/day)	Collar Easting (m)	Collar Northing (m)	Collar Elevation (melev)[1]	DIP	Azimuth	Hole Length (m)
UG-45	116.0	5.8	39.0	6.0E-04	507457.0	7053363.0	5329.0	-2.6	91.9	301.0
	301.0	5.8	39.0	6.2E-04						
	120.5	109.0	132.0	1.2E-02						
	301.0	109.0	132.0	1.2E-02						
	301.0	58.0	83.0	1.4E-01						
	118.2	58.0	83.0	1.4E-01						
	301.0	167.0	191.0	2.2E-01						
	123.1	167.0	191.0	2.2E-01						
	126.2	234.0	258.0	2.2E-01						
	301.0	234.0	258.0	2.2E-01						
	125.1	213.0	234.0	2.3E-01						
	301.0	213.0	234.0	2.3E-01						
	127.3	277.0	301.0	3.0E-01						
	301.0	277.0	301.0	3.0E-01						
	121.6	132.0	158.0	3.2E-01						
	301.0	132.0	158.0	3.2E-01						
	119.4	83.0	109.0	3.7E-01						
	301.0	83.0	109.0	3.7E-01						
	301.0	39.0	58.0	5.6E-01						
	117.2	39.0	58.0	5.6E-01						
	301.0	173.0	198.0	7.3E-01						
	123.4	173.0	198.0	7.3E-01						
	301.0	152.0	167.0	9.6E-01						
	122.2	152.0	167.0	9.6E-01						
	124.2	198.0	208.0	4.3E+00						
	301.0	198.0	208.0	4.3E+00						
	124.6	208.0	213.0	6.2E+00						
	301.0	208.0	213.0	6.2E+00						
UG-83	350.5	23.0	47.0	3.5E-04	507453.0	7053372.0	5329.3	1.6	6.4	350.5
	113.7	23.0	47.0	4.0E-04						
	350.5	47.0	72.0	2.6E-03						
	113.0	47.0	72.0	2.6E-03						
	107.5	244.0	268.0	1.1E-02						
	350.5	244.0	268.0	1.1E-02						
	105.3	320.0	350.0	1.7E-02						
	350.5	320.0	350.0	1.7E-02						
	106.8	268.0	294.0	1.9E-02						
	350.5	268.0	294.0	1.9E-02						
	106.1	294.0	320.0	5.5E-02						
	350.5	294.0	320.0	5.5E-02						
	110.2	150.0	175.0	8.6E-02						
	350.5	150.0	175.0	8.6E-02						
	128.1	120.0	136.0	6.2E-01						
	350.5	120.0	136.0	6.2E-01						
	350.5	219.0	244.0	8.1E-01						
	108.2	219.0	244.0	8.1E-01						
	111.6	104.0	120.0	9.1E-01						
	350.5	104.0	120.0	9.1E-01						
	350.5	200.0	219.0	1.1E+00						
	108.8	200.0	219.0	1.1E+00						
	350.5	71.0	96.0	1.2E+00						
	112.4	71.0	96.0	1.2E+00						
	109.5	175.0	200.0	1.2E+00						
	350.5	175.0	200.0	1.2E+00						
	350.5	91.0	104.0	4.6E+00						
	112.0	91.0	104.0	4.6E+00						
	350.5	106.0	109.0	7.9E+00						
	111.7	106.0	109.0	7.9E+00						
	110.7	136.0	149.0	9.6E+00						
	350.5	136.0	149.0	9.6E+00						

Note: [1] mine elevation = meters above mean sea level + 5000 m.

TABLE 4

Summary of Vertical Hydraulic Conductivity

(Page 9 of 9)

Hole	Depth (m)	From (m)	To (m)	*K* (m/day)	Collar Easting (m)	Collar Northing (m)	Collar Elevation (melev)[1]	DIP	Azimuth	Hole Length (m)
UG-84	395.4	254.0	280.0	7.6E-02	507454.0	7053372.0	5329.3	4.6	27.5	395.4
	93.3	254.0	280.0	7.6E-02						
	91.3	280.0	304.0	1.2E-01						
	395.4	280.0	304.0	1.2E-01						
	89.3	304.0	329.0	1.9E-01						
	395.4	304.0	329.0	1.9E-01						
	395.4	236.0	254.0	3.7E-01						
	95.0	236.0	254.0	3.7E-01						
	395.4	327.0	352.0	3.8E-01						
	87.5	327.0	352.0	3.8E-01						
	111.4	29.0	53.0	3.8E-01						
	395.4	29.0	53.0	3.8E-01						
	101.8	148.0	173.0	4.3E-01						
	395.4	148.0	173.0	4.3E-01						
	98.7	186.0	212.0	4.4E-01						
	395.4	186.0	212.0	4.4E-01						
	395.4	212.0	236.0	4.5E-01						
	96.7	212.0	236.0	4.5E-01						
	103.8	123.0	148.0	6.9E-01						
	395.4	123.0	148.0	6.9E-01						
	395.4	53.0	72.0	1.1E+00						
	109.7	53.0	72.0	1.1E+00						
	105.7	102.0	123.0	1.2E+00						
	395.4	102.0	123.0	1.2E+00						
	395.4	77.0	102.0	1.3E+00						
	107.5	77.0	102.0	1.3E+00						
	395.4	173.0	186.0	1.4E+00						
	100.3	173.0	186.0	1.4E+00						
	395.4	352.0	376.0	2.5E+00						
	85.5	352.0	376.0	2.5E+00						
	395.4	376.0	396.0	2.6E+00						
	83.7	376.0	396.0	2.6E+00						

Sources: Brown 2006, HCI 2005c, Fracflow 2012

Note: [1] mine elevation = meters above mean sea level + 5000 m.

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TABLE 5

Summary of Measured TDS Concentrations
(Page 1 of 2)

<table>
<tr><th>Sample</th><th>Date</th><th>Collar Elevation (melev)[1]</th><th>End of Hole Elevation (melev)[1]</th><th>Collar Depth (m)</th><th>End of Hole Depth (m)</th><th>Average Depth Below Lake (m)</th><th>TDS (mg/L)</th><th>Related to Dyke</th></tr>
<tr><td rowspan="3">DW5</td><td>13-Jun-08</td><td rowspan="3">5280</td><td rowspan="3">5280</td><td rowspan="3">164</td><td rowspan="3">164</td><td rowspan="3">164</td><td>216</td><td rowspan="44">Above</td></tr>
<tr><td>6-Nov-08</td><td>162</td></tr>
<tr><td>28-Aug-10</td><td>243</td></tr>
<tr><td rowspan="2">GP08-1</td><td>14-Jun-08</td><td rowspan="2">5314</td><td rowspan="2">5314</td><td rowspan="2">130</td><td rowspan="2">130</td><td rowspan="2">130</td><td>181</td></tr>
<tr><td>7-Nov-08</td><td>160</td></tr>
<tr><td>UG04-305</td><td>23-Aug-08</td><td>5285</td><td>5292</td><td>159</td><td>152</td><td>152</td><td>187</td></tr>
<tr><td>UG04-306</td><td>24-Aug-08</td><td>5284</td><td>5289</td><td>160</td><td>155</td><td>155</td><td>182</td></tr>
<tr><td rowspan="2">UG04-310</td><td>23-Aug-08</td><td rowspan="2">5284</td><td rowspan="2">5336</td><td rowspan="2">160</td><td rowspan="2">108</td><td rowspan="2">129</td><td>206</td></tr>
<tr><td>9-Nov-08</td><td>159</td></tr>
<tr><td>UG04-311</td><td>24-Aug-08</td><td>5284</td><td>5316</td><td>160</td><td>128</td><td>128</td><td>184</td></tr>
<tr><td>UG04-312</td><td>24-Aug-08</td><td>5284</td><td>5298</td><td>160</td><td>146</td><td>146</td><td>190</td></tr>
<tr><td rowspan="2">UG05-413</td><td>16-Jun-08</td><td rowspan="2">5294</td><td rowspan="2">5213</td><td rowspan="2">150</td><td rowspan="2">231</td><td rowspan="2">125</td><td>218</td></tr>
<tr><td>6-Nov-08</td><td>157</td></tr>
<tr><td rowspan="3">UG05-464</td><td>13-Jun-08</td><td rowspan="3">5282</td><td rowspan="3">5282</td><td rowspan="3">162</td><td rowspan="3">162</td><td rowspan="3">162</td><td>203</td></tr>
<tr><td>9-Nov-08</td><td>162</td></tr>
<tr><td>28-Aug-10</td><td>257</td></tr>
<tr><td rowspan="3">UG06-496</td><td>13-Jun-08</td><td rowspan="3">5321</td><td rowspan="3">5378</td><td rowspan="3">123</td><td rowspan="3">66</td><td rowspan="3">97</td><td>210</td></tr>
<tr><td>27-Aug-10</td><td>245</td></tr>
<tr><td>7-Nov-08</td><td>338</td></tr>
<tr><td>UG06-531</td><td>16-Jun-08</td><td>5229</td><td>5229</td><td>215</td><td>215</td><td>215</td><td>208</td></tr>
<tr><td>UG06-532 (surrogate for 502)</td><td>16-Jun-08</td><td>5257</td><td>5288</td><td>187</td><td>156</td><td>156</td><td>175</td></tr>
<tr><td>UG06-532</td><td>7-Nov-08</td><td>5257</td><td>5288</td><td>187</td><td>156</td><td>156</td><td>176</td></tr>
<tr><td rowspan="3">UG06-535</td><td>14-Jun-08</td><td rowspan="3">5234</td><td rowspan="3">5286</td><td rowspan="3">210</td><td rowspan="3">158</td><td rowspan="3">182</td><td>204</td></tr>
<tr><td>6-Nov-08</td><td>153</td></tr>
<tr><td>29-Aug-10</td><td>212</td></tr>
<tr><td rowspan="3">UG06-536</td><td>15-Jun-08</td><td rowspan="3">5212</td><td rowspan="3">5219</td><td rowspan="3">232</td><td rowspan="3">225</td><td rowspan="3">229</td><td>200</td></tr>
<tr><td>8-Nov-08</td><td>181</td></tr>
<tr><td>31-Aug-10</td><td>254</td></tr>
<tr><td>UG06-536 (duplicate)</td><td>31-Aug-10</td><td>5212</td><td>5219</td><td>232</td><td>225</td><td>229</td><td>257</td></tr>
<tr><td rowspan="2">UG07-670</td><td>16-Jun-08</td><td rowspan="2">5230</td><td rowspan="2">5230</td><td rowspan="2">214</td><td rowspan="2">214</td><td rowspan="2">214</td><td>210</td></tr>
<tr><td>6-Nov-08</td><td>169</td></tr>
<tr><td rowspan="2">UG08-736</td><td>23-Aug-08</td><td rowspan="2">5289</td><td rowspan="2">5334</td><td rowspan="2">155</td><td rowspan="2">110</td><td rowspan="2">125</td><td>186</td></tr>
<tr><td>7-Nov-08</td><td>176</td></tr>
<tr><td rowspan="3">UG08-737</td><td>23-Aug-08</td><td rowspan="3">5289</td><td rowspan="3">5342</td><td rowspan="3">155</td><td rowspan="3">102</td><td rowspan="3">306</td><td>274</td></tr>
<tr><td>7-Nov-08</td><td>224</td></tr>
<tr><td>27-Aug-10</td><td>246</td></tr>
</table>

Note: [1] melev = meters above mean sea level + 5000 m

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Denver, Inc.

TABLE 5

Summary of Measured TDS Concentrations

(Page 2 of 2)

Sample	Date	Collar Elevation (melev)[1]	End of Hole Elevation (melev)[1]	Collar Depth (m)	End of Hole Depth (m)	Average Depth Below Lake (m)	TDS (mg/L)	Related to Dyke
DW11A-N	15-Jun-08	5183	5183	261	261	261	3320	Below
	5-Nov-08						3260	
DW11A-S	15-Jun-08	5183	5183	261	261	261	2130	
	5-Nov-08						2370	
FLT65/020	14-Jun-08	5234	5234	210	210	210	192	
UG07-650	13-Jun-08	5280	5223	164	221	200	199	
	9-Nov-08						151	
	28-Aug-10						256	
UG07-711	15-Jun-08	5196	4924	248	520	520	1280	
UG07-711-W (duplicate)	15-Jun-08	5196	4924	248	520	520	1270	
UG07-711-Z1	2-Aug-10	5196	4924	248	520	520	11000	
UG07-711-Z3	2-Aug-10	5196	4924	248	520	520	8330	
UG07-711-Z5	2-Aug-10	5196	4924	248	520	520	7300	
UG08-720 (696-716 ft~Zone 3)	16-Jun-08	5196	4995	248	449	356	3030	
UG08-720-Z1	25-Aug-08	5196	4995	248	449	409	3140	
	8-Nov-08						3220	
	2-Aug-10						4910	
UG08-720-Z3	25-Aug-08	5196	4995	248	449	356	2970	
	8-Nov-08						3140	
	2-Aug-10						5100	
UG08-720-Z3 (duplicate)	2-Aug-10	5196	4995	248	449	356	4910	
UG08-720-Z5	25-Aug-08	5196	4995	248	449	294	1190	
	8-Nov-08						1310	
	2-Aug-10						3810	
UG08-720-Z6	25-Aug-08	5196	4995	248	449	269	1040	
UG08-724	15-Jun-08	5196	5174	248	270	268.5	877	
UG08-730	5-Nov-08	5196	5209	248	235	238	537	
UG08-730 (Dis) - filtered	15-Jun-08	5196	5209	248	235	238	492	
UG08-730 (Tot) - unfiltered	15-Jun-08	5196	5209	248	235	238	481	
UG08-734	14-Jun-08	5230	5192	214	252	234	202	
UG08-740	14-Jun-08	5230	5109	214	335	275	1520	
UG08-756	22-Jun-08	5171	5171	273	273	273	14400	
UG08-762 (pre-grout)	12-Jul-08	5172	5180	272	264	264	15300	
UG08-762G (post-grout)	13-Jul-08	5172	5180	272	264	264	16100	
UG08-763G	14-Jul-08	5172	5180	272	264	268.5	14400	
UGO8-762GD (duplicate)	13-Jul-08	5172	5180	272	264	264	15600	

Source: Based on stand-alone table provided by Snap Lake

Note: [1] melev = meters above mean sea level + 5000 m

TABLE 6

Hydraulic Parameters Used in the Groundwater Flow Model

Hydrogeologic Unit	Hydrogeologic Zone	Hydraulic Conductivity (m/day)			Specific Yield S_y ()	Storativity S_s (m^{-1})	Depth or Elevation Interval (m)[1, 2]
		K_x	K_y	K_z			
Lakebed Sediments		5.0E-03	5.0E-03	5.0E-03	5.0E-03	1.0E-06	Depth = 2 m
Permafrost		1.0E-07	1.0E-07	1.0E-07	1.0E-03	1.0E-07	Depth = 210 m
Exfoliated Bedrock	EX1	1.0E-01	1.0E-01	4.0E-02	1.0E-02	1.0E-05	2 m < Depth < 32 m
	EX2	3.0E-02	3.0E-02	3.0E-02	5.0E-03	1.0E-05	32 m < Depth < 62 m
Bedrock Above Dike (BAD)	BAD1	1.0E-03	1.0E-03	1.0E-03	5.0E-03	1.0E-06	Z< 5000
	BAD2	3.5E-02	3.5E-02	3.5E-02	5.0E-03	1.0E-05	Z>5230
	BAD3	9.0E-03	9.0E-03	9.0E-03	5.0E-03	5.0E-06	Z>5100
	BAD4	3.0E-03	3.0E-03	3.0E-03	4.0E-03	1.0E-06	Z>5000
	BAD5	5.0E-04	5.0E-04	5.0E-04	2.0E-03	1.0E-06	Z<4890
	BAD6	3.0E-04	3.0E-04	3.0E-04	1.0E-03	1.0E-06	Z<4700
Kimberlite Dike		5.0E-04	5.0E-04	5.0E-04	5.0E-03	1.0E-06	
Bedrock Below Dike (BBD)	BBD1	3.0E-03	3.0E-03	3.0E-03	2.0E-03	1.0E-06	Z>5230
	BBD2	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-06	Z>5000
	BBD3	4.0E-04	4.0E-04	4.0E-04	1.0E-03	1.0E-06	Z<5000
	BBD4	2.0E-04	2.0E-04	2.0E-04	1.0E-03	1.0E-06	Z<4700
Deep Bedrock		2.0E-04	2.0E-04	2.0E-04	1.0E-03	1.0E-06	
Country Bedrock		1.0E-04	1.0E-04	1.0E-04	1.0E-03	1.0E-06	
Structural Zones Above Dike	Zone 2	3.0E-01	3.0E-01	3.0E-01	1.0E-02	5.0E-06	Z>5382
		1.0E-01	1.0E-01	1.0E-01	1.0E-02	2.0E-06	Z>5300
		5.0E-02	5.0E-02	5.0E-02	5.0E-03	1.0E-06	Z<5300
	Zones 3, 5, 6	2.0E-01	2.0E-01	2.0E-01	1.0E-02	5.0E-06	Z>5382
		6.0E-02	6.0E-02	6.0E-02	1.0E-02	2.0E-06	Z>5300
		4.0E-02	4.0E-02	4.0E-02	5.0E-03	1.0E-06	Z<5300
	Zone 4	6.0E-01	6.0E-01	6.0E-01	1.0E-02	5.0E-06	Z>5382
		3.0E-01	3.0E-01	3.0E-01	1.0E-02	2.0E-06	Z>5300
		1.8E-01	1.8E-01	1.8E-01	5.0E-03	1.0E-06	Z<5300
	Zone 7	4.0E-01	4.0E-01	4.0E-01	1.0E-02	5.0E-06	Z>5382
		2.0E-01	2.0E-01	2.0E-01	5.0E-03	2.0E-06	Z>5300
		1.0E-01	1.0E-01	1.0E-01	5.0E-03	1.0E-06	Z<5300
Structural Zones Below Dike	Zone 2	2.0E-03	2.0E-03	2.0E-03	5.0E-03	1.0E-06	Z>5000
	Zones 3, 5, 6	2.0E-03	2.0E-03	2.0E-03	5.0E-03	1.0E-06	Z>5000
		1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-06	Z<5000
	Zone 4	2.0E-03	2.0E-03	2.0E-03	1.0E-03	1.0E-06	Z>5000
		1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-06	Z<5000
	Zone 7	2.0E-03	2.0E-03	2.0E-03	1.0E-03	1.0E-06	Z>5000
		1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-06	Z<5000

Notes: [1] Depth refers to meters below ground surface.
[2] Z: Mine elevation of the assigned hydrogeologic zone.