



DE BEERS
GROUP OF COMPANIES

DE BEERS GAHCHO KUÉ WATER LICENCE AMENDMENT TECHNICAL SESSIONS PRESENTATION

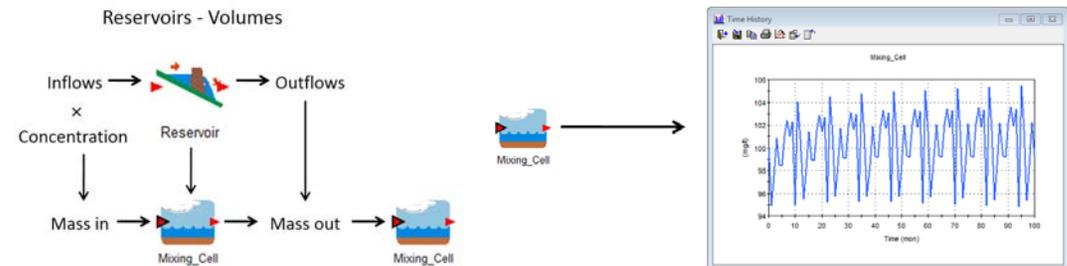
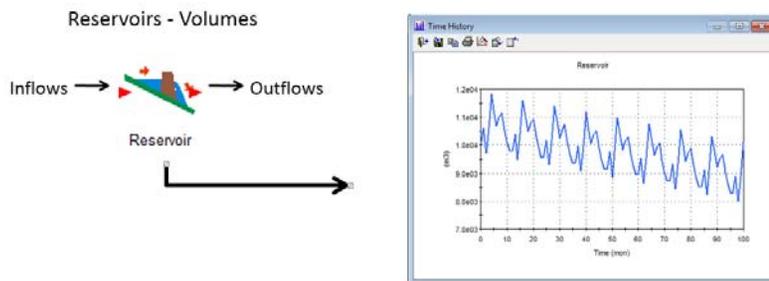
Yellowknife (Location TBD)
May 24, 2018

TOPIC 4 – WATER QUALITY MODEL



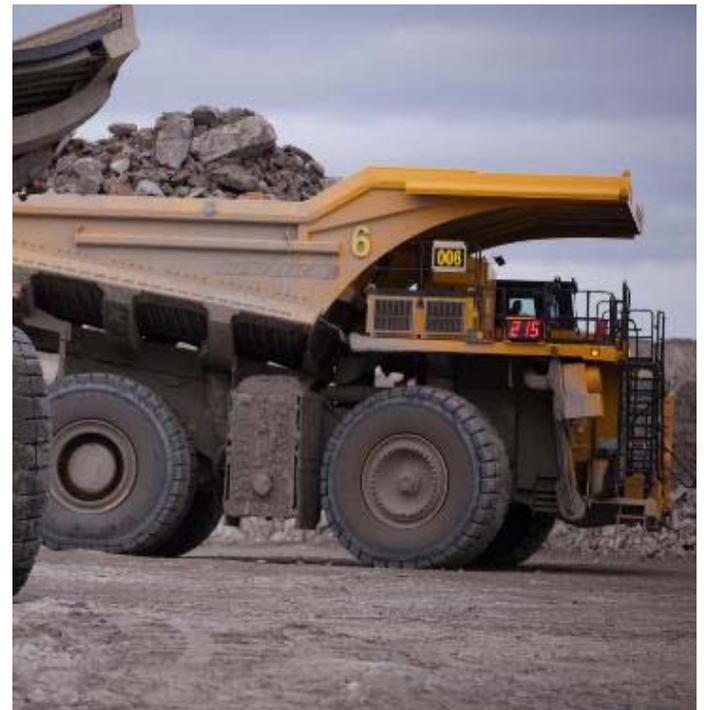
INTRODUCTION

- A site-wide water quality model was developed as part of the EIS and subsequently updated as part of the Water Licence application
- The model was designed to estimate inflow volumes and loads from contact water sources (e.g., groundwater inflows) and natural inflows to simulate constituent concentrations in Kennedy Lake during operations, closure and post-closure on a monthly timestep
- Site-water quality model is reliant on the following supporting models
 - Hydrogeological model
 - Tuzo Pit Lake hydrodynamic model



MODEL UPDATES

- The site water quality model was updated for the Water Licence Amendment application
- The update included the following changes to the mine plan:
 - Extending the mine life from 11 to 11.6 years
 - A deepening of Tuzo Pit
 - Alignment with changes to the water management strategy
 - Expansion of the West Mine Rock Pile



MODEL INPUTS (GNWT-ENR-29, ECCC-13, MVLWB-27, MVLWB-28, MVLWB-29)

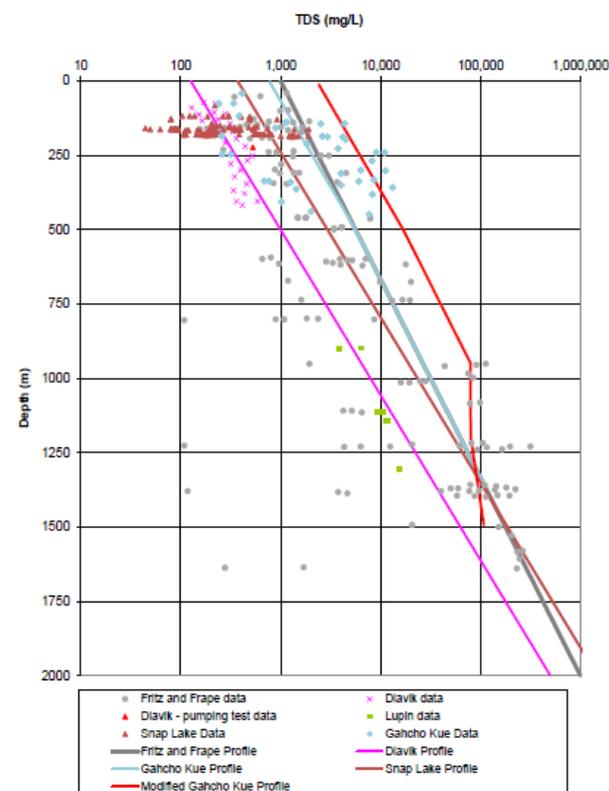
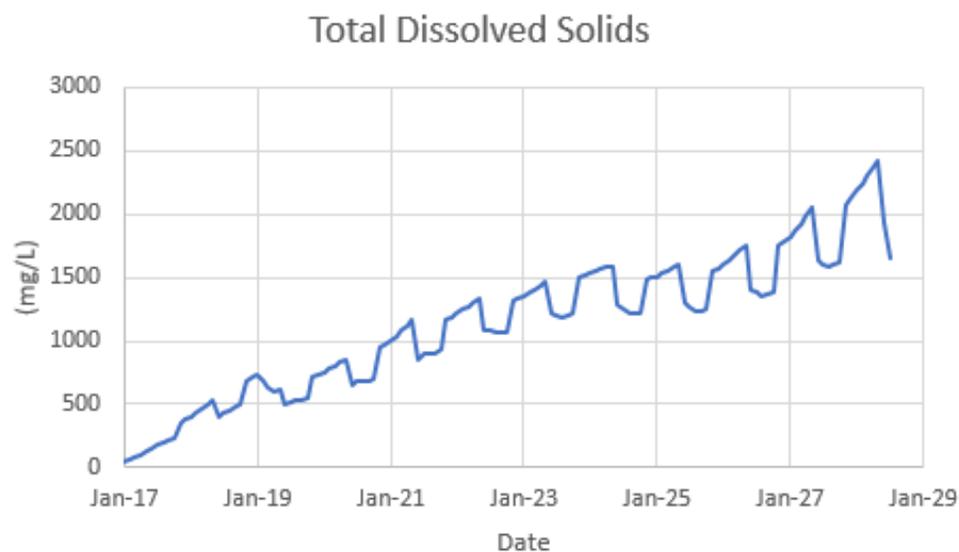
- In GoldSim, each source that could influence water quality was assigned an input water quality
- Mine Rock and Kimberlite
 - First-flush and steady state inputs based on humidity cell test results during the EIS
 - Compared to seepage monitoring results and in general input source terms were higher than what is occurring at site
- Processed Kimberlite
 - Similarly based on humidity cell testing for non-saturated materials (e.g., coarse PK)
 - Saturated column tests used to derive inputs for saturated PK
- Groundwater
 - Correlated and non-correlated to TDS
 - Correlated parameters estimated based on regression equations derived from WestBay monitoring
 - Non-correlated inputs assigned baseline concentrations from WestBay monitoring
- Natural runoff
 - Baseline water quality in the Kennady Lake watershed

EXPLOSIVES INPUTS (MVLWB-30)

- Predominantly emulsion is used with some ANFO
 - Results in leaching of ammonia, nitrate, and sodium (emulsion)
- Load estimated based on average annual load calculated based on total life of mine usage
 - Consistent with approach used in the EIS and Water Licence application
- The majority of mine water is managed through the WMP and therefore, all explosives load was conservatively added to the water management pond
 - Conservative because:
 - All load is released
 - Explosives load may “bleed” out more slowly from Mine Rock Piles
 - Permafrost development may limit load from Mine Rock Piles
 - Channelization in Mine Rock Piles may limit loading

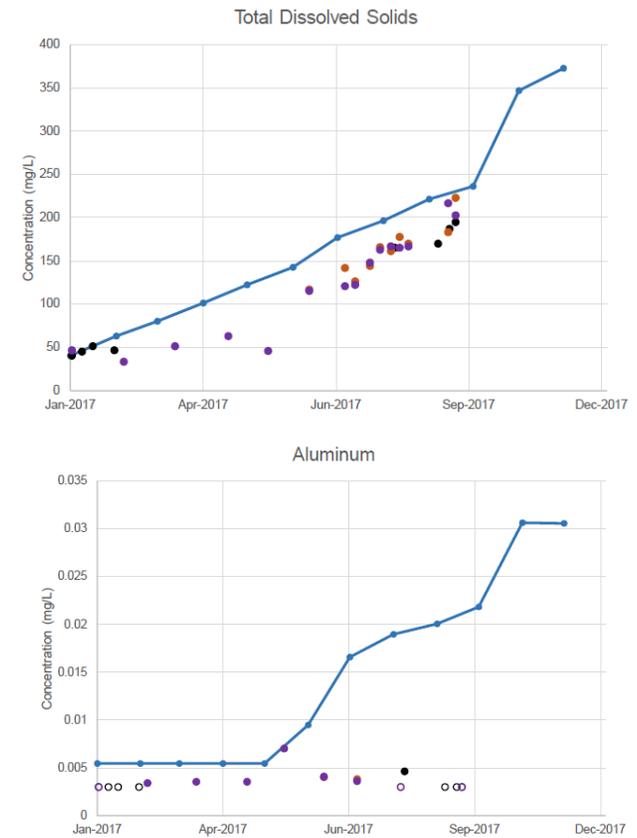
MODEL UPDATES (MVLWB-8, MVLWB-9)

- The model was also updated to account for:
 - Salt exclusion due to ice formation
 - Empirical monitoring data



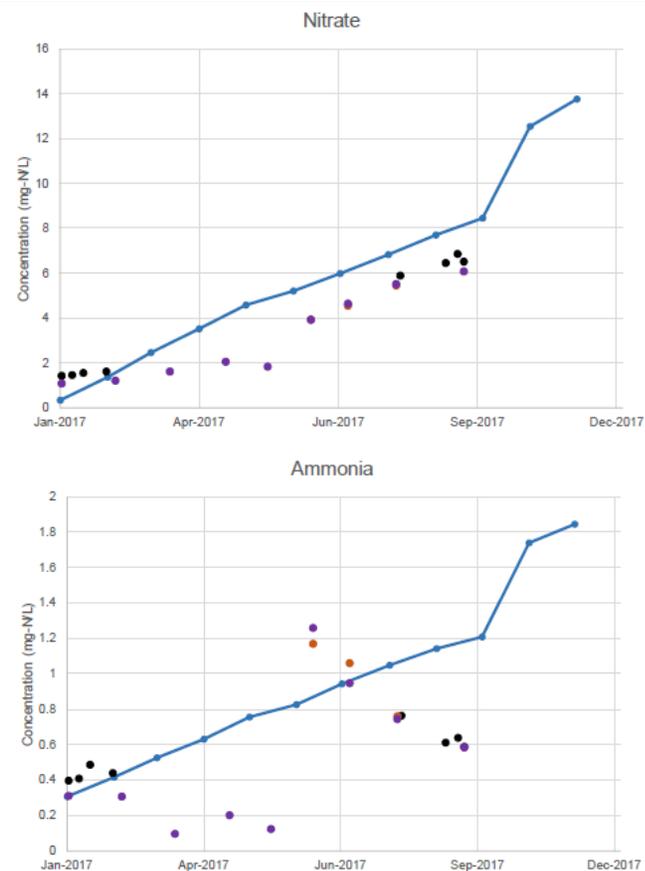
MODEL CALIBRATION (MVLWB-10, MVLWB-11, MVLWB-12, MVLWB-31)

- After the model was updated for the most up-to-date mine plan, it was calibrated in the following locations
 - 5034 Pit
 - Fine PKC Facility (Area 2)
 - WMP
- Calibrated from January to September 2017
- The focus of the calibration was to optimize agreement of the majority of constituent concentrations, while minimizing adjustment to input parameters
- Calibration focused towards constituents that were under-predicted in the model to add a level of conservatism in the predictions
- Constituents that can affect the EQC evaluation (e.g., TDS, ammonium, total phosphorus) were adjusted if they were over-predicted



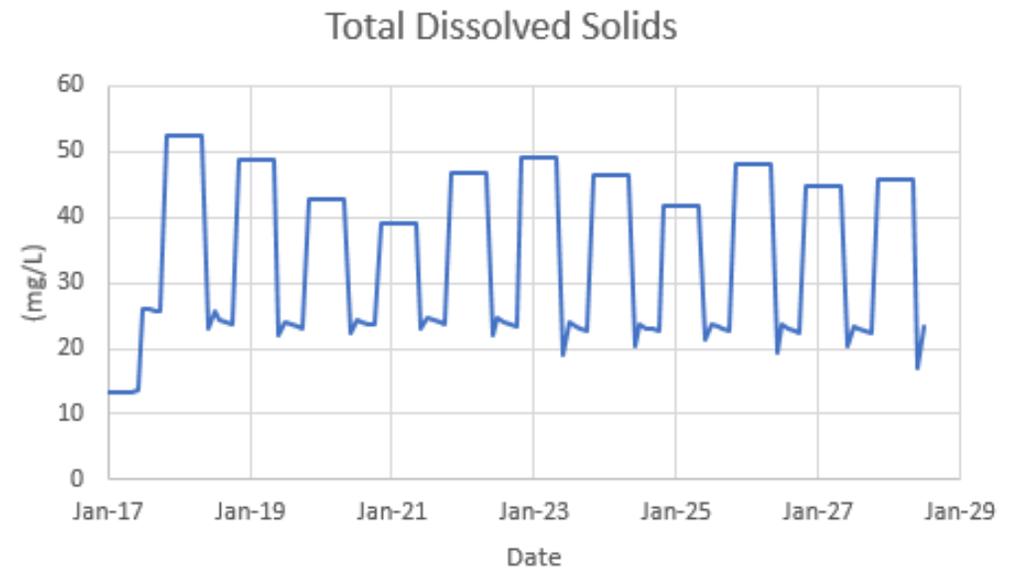
MODEL CALIBRATION (MVLWB-10, MVLWB-11, MVLWB-12, MVLWB-31)

- Model calibrated as follows:
 - The open pit wall rock runoff water quality and groundwater inflow proportion adjusted
 - Explosives waste rate was adjusted;
 - Proportion of nitrate and ammonia produced from wasted explosives; and
 - Calibration factors used when the above adjustments still resulted in an under-prediction of constituent concentrations, or an over-prediction of EQC parameters
- Calibration Points
 - 5034 Pit
 - Fine PKC Facility
 - WMP



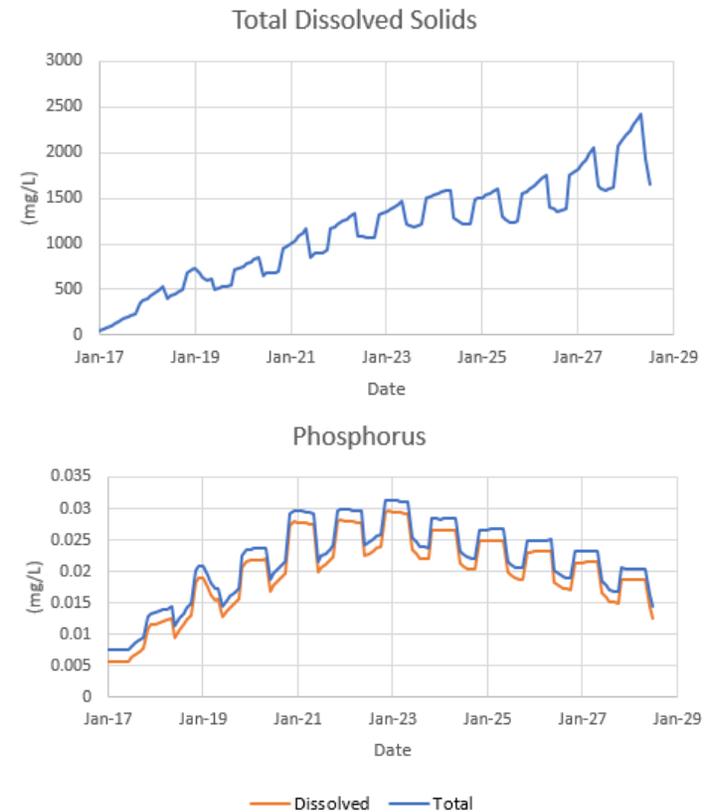
AREA 7 PREDICTIONS (GNWT-ENR-30)

- De Beers is proposing to discharge from Area 7 to Area 8
 - Requires approval of proposed EQC for this Area
- Water quality projected in Area 7 is a function of:
 - Natural runoff
 - Runoff from a small area of the SMRP
 - Runoff from the Kimberlite Ore Stockpile
 - Other disturbed areas (e.g., roads, pads etc.)
- Projected water quality indicates constituent concentrations are driven by:
 - Natural runoff
 - Salt exclusion during ice-formation



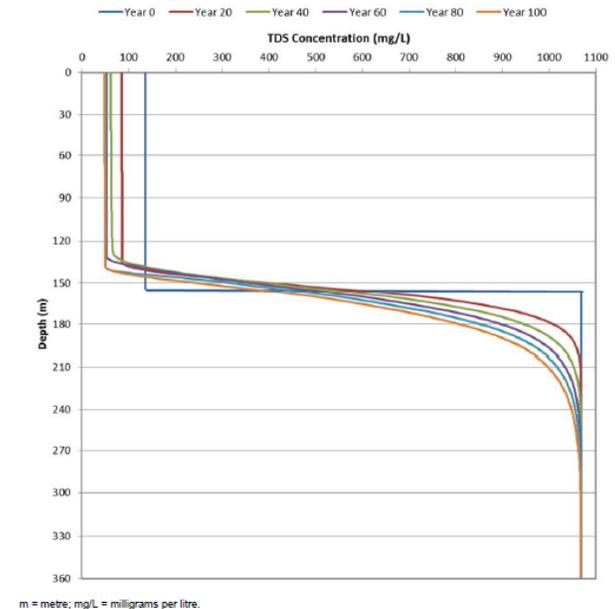
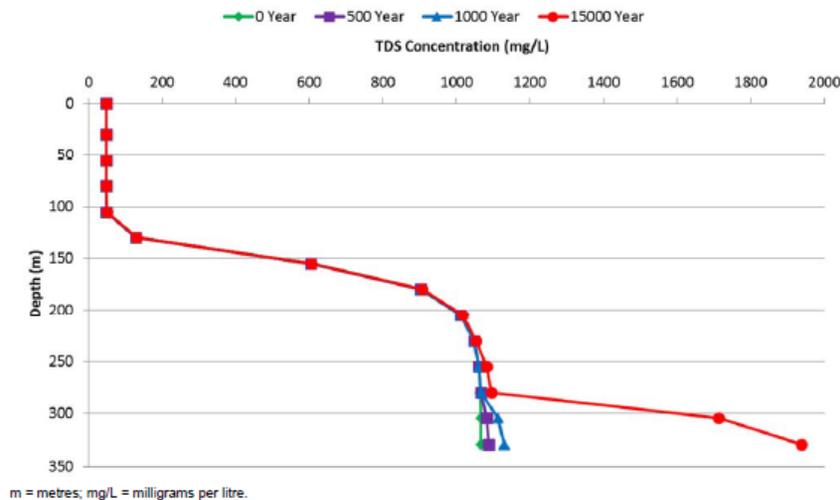
MODEL RESULTS - OPERATIONS

- Projected WMP constituent concentrations are seasonal with peak concentrations occurring during under-ice conditions, followed by lower concentrations during open water
- Two trends observed in the predictions
 - Increasing through operations
 - Increase followed by a decrease
- Maximum projected discharge concentrations used to determine if EQC are achievable



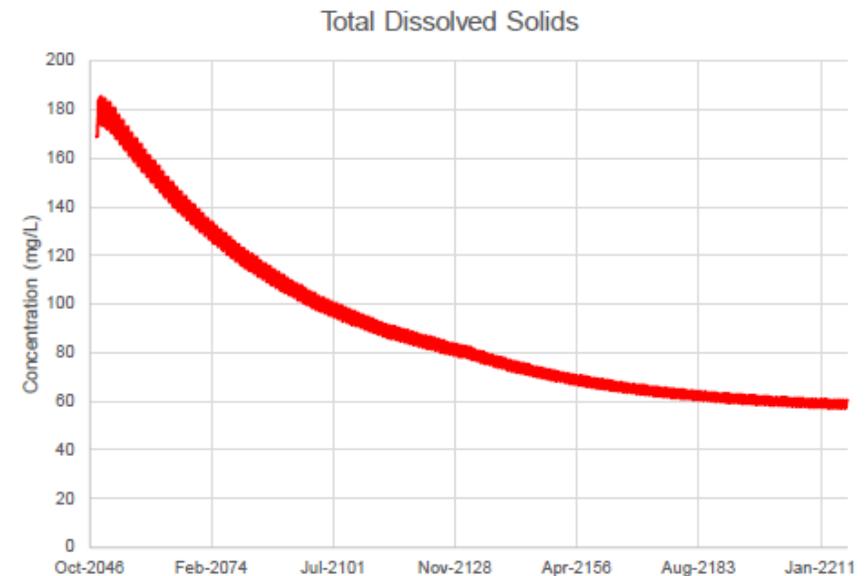
STABILITY OF MEROMIXIS

- Key component of the water management plan is to lower the lake elevation to 417m at closure, directing water above this location to Tuzo, and back-flooding Kennady Lake with water pumped from Lake N11
- Stability of meromixis evaluated in two ways
 - CE-QUAL-W2 hydrodynamic model for the first 100 years of post-closure
 - Vertical slice spreadsheet model for 15,000 years of post-closure



SUMMARY

- Model developed as part of the 2014 Water Licence application was updated as part of this amendment
 - Consistency in modelling approach and source terms
- Model designed to project operational discharge water quality in the WMP and A7 for the purpose of evaluating achievability of proposed EQC
- Model also used to simulate Post-closure water quality in Kennady Lake
 - Similar to the 2014 Water Licence Application, projected concentrations evolve to steady state concentrations
 - Some steady-state concentrations are greater in comparison to the 2014 Water Licence application as a result of additional fine PK and mine rock being stored at surface in comparison to the 2014 application
 - Consistent with the EIS, post-closure water quality predictions indicate the mine will not result in significant adverse effect to surface water quality in Kennady Lake



THANK YOU

Questions