H3D Assumptions & Facts

- Releases and fate of dissolved metal contaminants from the tailings discharge were simulated using the proprietary three-dimensional hydrodynamic model H3D.
    - H3D is a three-dimensional time-stepping model that computes the three components of velocity (u,v,w) on a rectangular grid in three dimensions (x,y,z), as well as scalar fields such as temperature and contaminant concentrations.

- The model encompasses the interconnected system of the tailings pond, the polishing pond, Drizzle Lake, Murky Lake and Thor Lake.
    - 40 m horizontal resolution
    - 0.5 to 2 m vertical resolution, thinner layers near surface
    - Bathymetry data of all water bodies from Stantec Inc. (E-mail communication 2011).

- The model was run for a 20-year period starting at the commencement of mine operations. The transport and fate of the dissolved contaminants modelled in the study were represented as a conservative tracer. At model initiation, a tracer concentration of zero in all water bodies in the model was assumed. This assumption is a reflection of the starting point when mine operation commence.

    - Since tailings solids settle out to the bottom of the tailings pond, significant amounts of contaminant associated with the solids will be carried out of the water column to the bottom. Consequently, the 5-day decant concentrations were used to characterize the inflow into the tailings pond. It is further recognized that this is a worst case condition relative to recent water quality analysis from pilot plant toxicity studies. Water that is trapped in sediment voids in the TMF is assumed to have the same dilution as in the overall water body

- The water balance and hydrology of the lake system were obtained from Knight Piésold Consulting (2011), covering a 20-year period of mine operations.
    - Flow rate from the plant was uniform over the year, and modelled flow between water bodies did not shut off in the winter. This assumption is acceptable with respect to the long-term 20 year description of the effects of the discharge, since it reflects the annual loading, but overestimates contaminant concentrations throughout the year because it does not incorporate the plan to match effluent flow with the general hydrology of the area.
    - Groundwater inflow and outflow were assumed to be small relative to surface flows, and were not considered in this model study.

- Flow between water bodies driven by the hydraulics of the system (surface slope).

- Water will be withdrawn from Thor Lake and recycled to the concentrator plant, which will in turn discharge the tailings water to the tailings pond at 1,040 cubic meters/day. It was

conservatively assumed that the day 5 decant concentrations were additive to the Thor Lake concentration when determining the characteristics of the effluent discharging to the TMF.

- Wind, air temperature, humidity and cloud cover data have been collected at Yellowknife Airport since 1953 and the data collected between 1987 and 2007 were utilized in the model.

- A reduction of the wind speed was required to take account of the shielding effects of the trees that surround the water bodies of such small size. A reduction of wind speed by 50% was deemed appropriate after model calibration by comparing the simulated temperature profiles with measured profiles (Stantec Inc. 2010). Despite the reduction in wind velocity, all of the water bodies were characterized by fairly high rates of mixing, driven by the winds and associated circulation, so that contaminant concentration was nearly uniform in each of the lakes.

- Other model calibrations included conducting a 1-year run in which tailing solids were simulated. It was found that over 99% of the solids settled out in the TMF, thereby justifying the use of the 5-day decant values, which primarily reflect the loss of metals due to setting of the tailings. As well, oxygen profiles were simulated. The vertical oxygen concentration is dominated by high oxygen demand in the bottom sediments, and a seasonal flux in oxygen supply at the surface, which shuts down when ice forms. This simulation was found to reproduce data in the Stantec 2010 report, providing confirmation of the vertical mixing rates.

- The winter formation of an ice cover and it's disappearance in the spring was simulated, based solely on meteorological forcing. Being able to simulate the formation and disappearance of the ice cover is an indicator that the model hydrodynamics are capturing the effects of mixing and stratification.

- Background levels for some metals are relatively high, sometimes exceeding CCME values. Because background values differ for each contaminant, they are added in after the simulation is completed. Otherwise, separate simulations of each contaminant would be required.

REFERENCES

Avalon Rare Metals Inc. 2011. Characteristic of Ore, Concentrate and Tailings from the Nechelacho Rare Earth Project.

Knight Piésold Consulting. 2011. Memorandum: Time Series Data from Thor Lake Watershed Water/Solid Balance.

Stantec Inc. 2010. Thor Lake Earth Metals Baseline Project. Environmental Baseline Report: Volume 3 – Aquatics and Fisheries