Evolution of East Pit Water Chemistry Predictions at Huckleberry Mine: Effect of a Wall Failure and Mine Plan Changes

Stephen Day, SRK and Ron Roubichard, Huckleberry Mines Limited

18th ANNUAL BRITISH COLUMBIA-MEND ML/ARD WORKSHOP

Dec 1 and 2, 2011

srk consulting

Acknowledgement

Huckleberry Mines Limited

Outline

- History of Huckleberry Mine.
- Geological and geochemical background.
- Pit water chemistry prediction methods.
- Results of modelling.

srk consulting

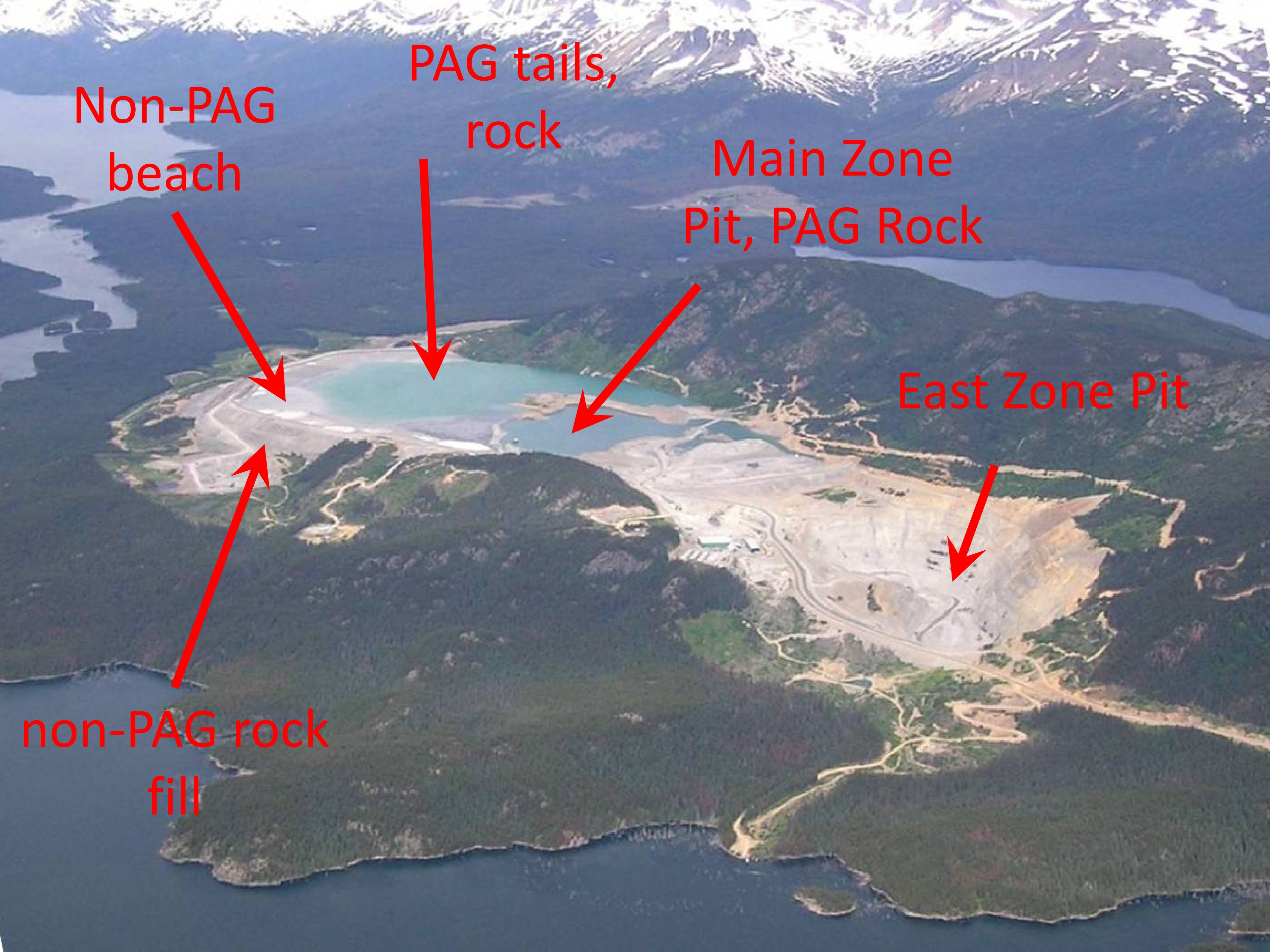
Location

srk consulting

History

- 1962 – Copper discovered by Kennco Explorations
- 1960s to 1970s – Drilling and resource estimation (Main Zone)
- Early 1990s – Continued exploration (East Zone).
- 1995 – Project Approval Certificate
- March 1996 – Construction started.
- October 1997 – Officially opened.
- December 1999 – BC ARD Workshop Presentation
- 2014 Current projected end of mining

srk consulting


Non-PAG beach
PAG tails, rock
Main Zone Pit, PAG Rock
East Zone Pit
non-PAG rock fill

General Description

- Porphyry deposit
- Two open pits
- 21,000 tonnes/day
- 0.5 % Cu, 150 ppm Mo
- Concentrates
  - Copper to port at Stewart, BC
  - Molybdenum to Vancouver, BC
- 12.4 M tonnes of remaining reserves at 0.327% Cu

Environment

- Average elevation – 1,036 m.
- Average annual precipitation (1997 to 2008) – 1043 mm (57% as snow).
- Average annual temperature 3.0°C.

Geology

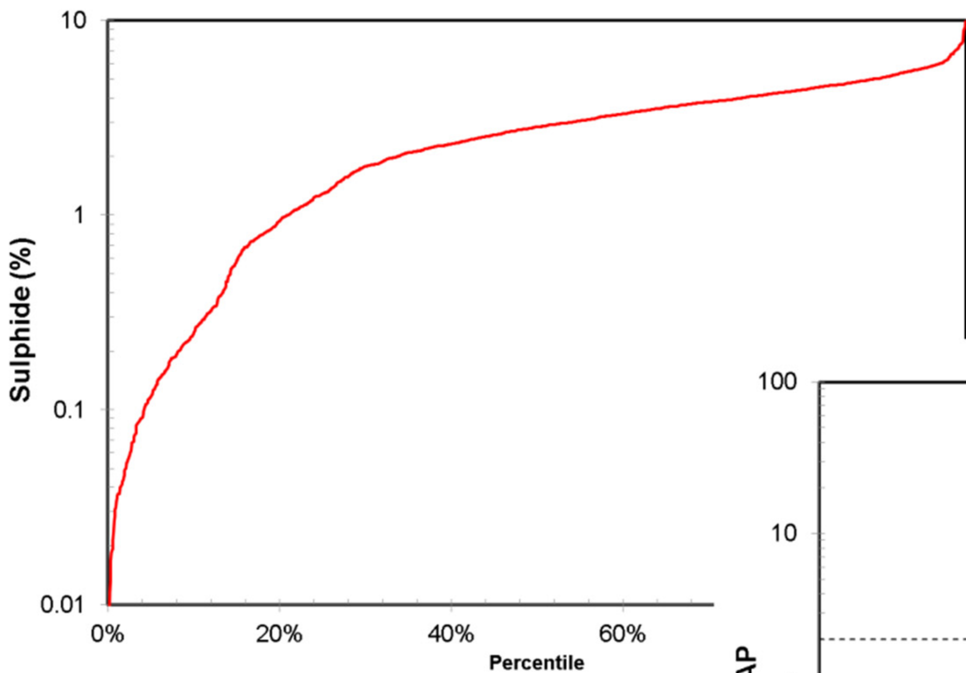
- Deposit type
  - Calc-alkalic porphyry.
- Main geological hosts
  - Biotite granodiorite stock intruding and hornfelsing andesite.
- Hydrothermal alteration
  - Potassic (biotite) dominates

- Important minerals
  - Sulphides – pyrite, chalcopyrite, molybdenite.
  - Carbonates – calcite.
  - Other – gypsum.

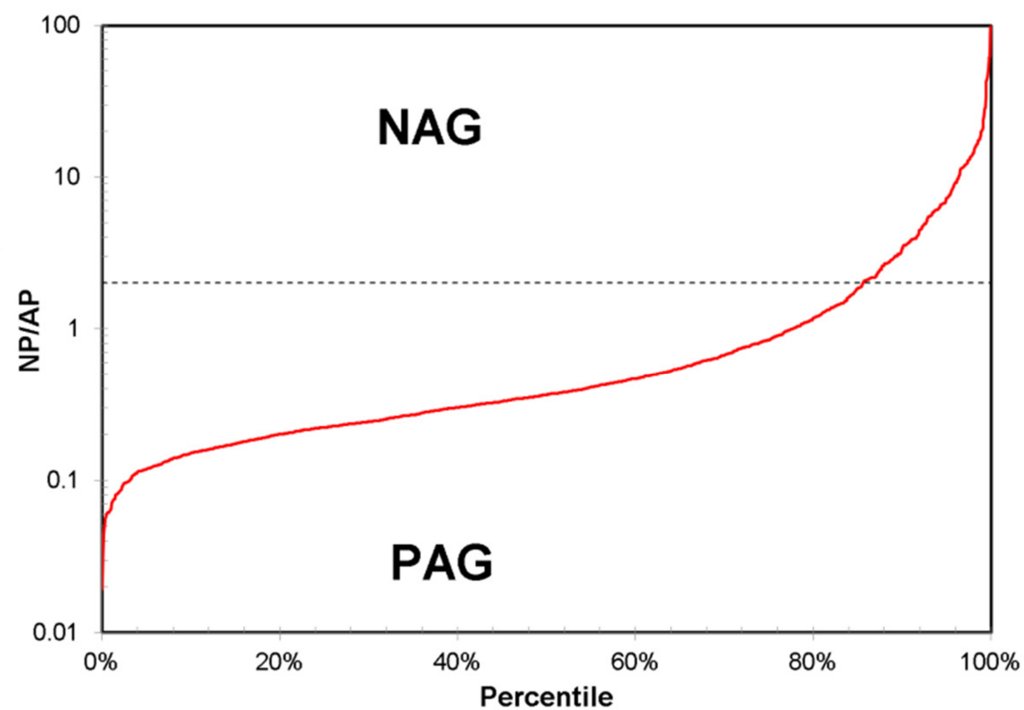
- Surficial geology
  - glacial till, colluvium


East Zone Pit

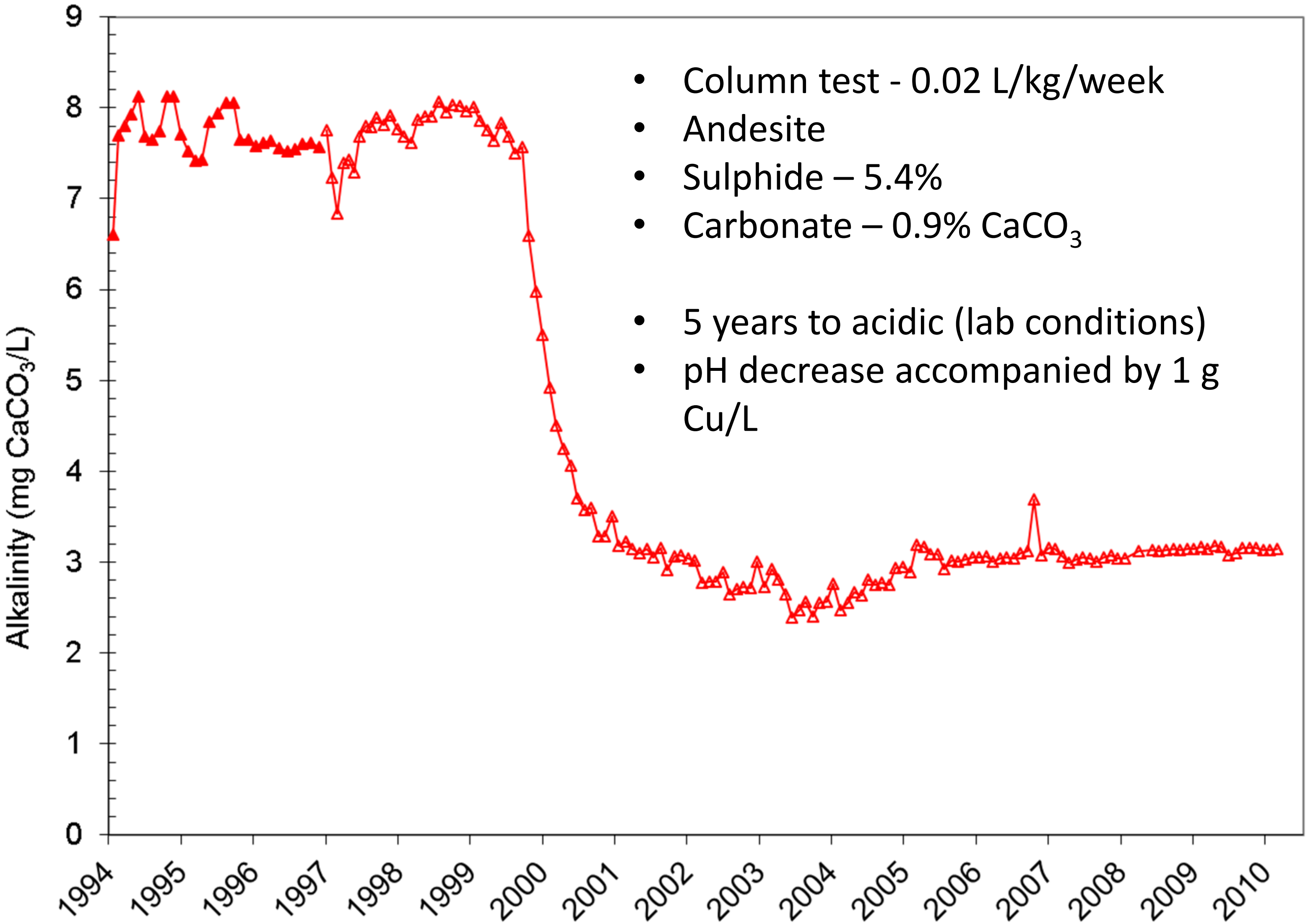
East Zone Pit Walls ML/ARD Potential



Pit walls are andesite



East Zone ML/ARD Potential



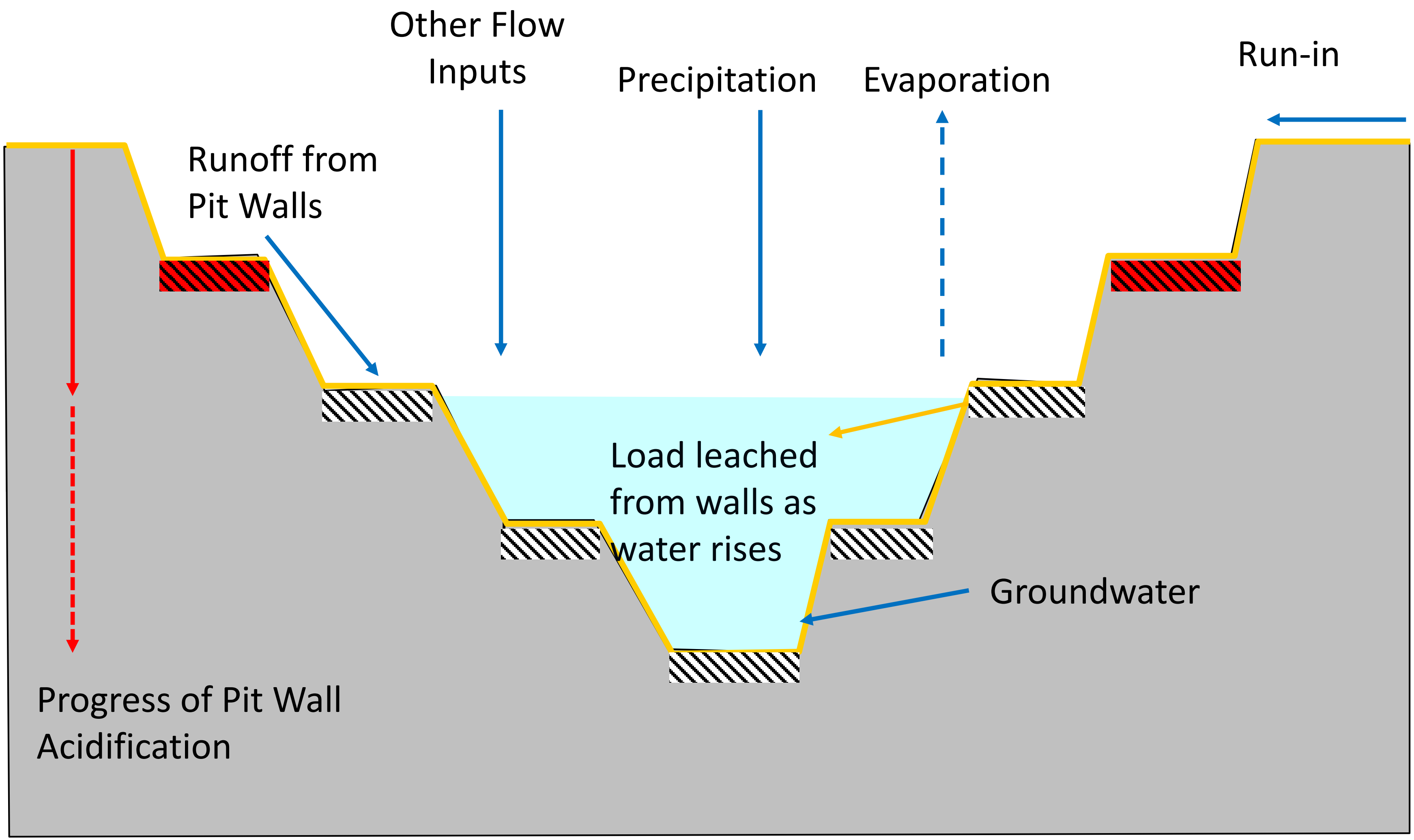
- Column test - 0.02 L/kg/week
- Andesite
- Sulphide – 5.4%
- Carbonate – 0.9% $CaCO_3$

- 5 years to acidic (lab conditions)
- pH decrease accompanied by 1 g Cu/L

Pit Water Quality Model

- Objective
  - Compare water management and closure alternatives.
  - Evaluate sensitivity to input assumptions.
  - Decision-making tool.
- Factors Considered at Various Times:
  - Changes in pit geometry due to mine design changes.
  - Uncertainty in groundwater inflows.
  - Use of a plug dam to raise pit water level.
  - Use of external flows for fast flooding (eg tailings supernatant).
  - Removal of excess rubble from pit walls.
  - Effect of ARD onset lag time.
  - Effect of changes in inflow chemistry.

Open Pit Modeling



srk consulting

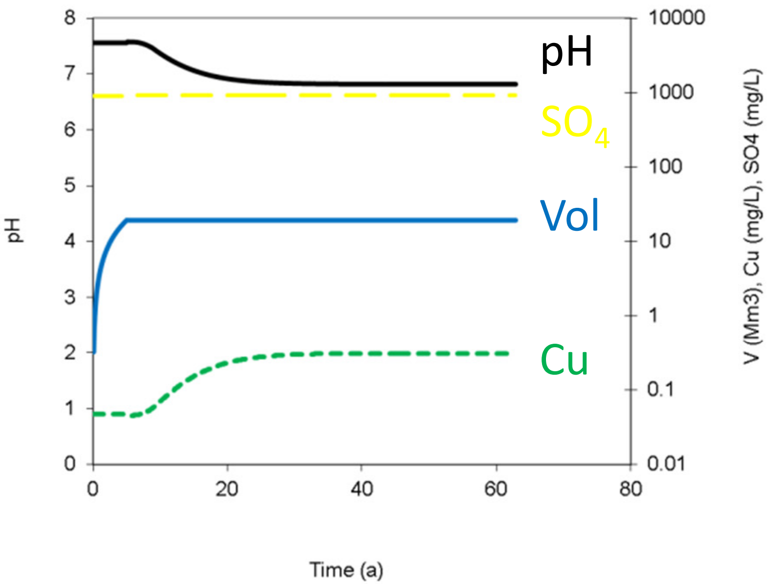
Model Construction

- Simple conservation of mass.
- Spreadsheet.
- Zero order reaction rates.
- Complete mixing, stratification not considered.
- Approximation of wall geometry, inflow rates by equations.

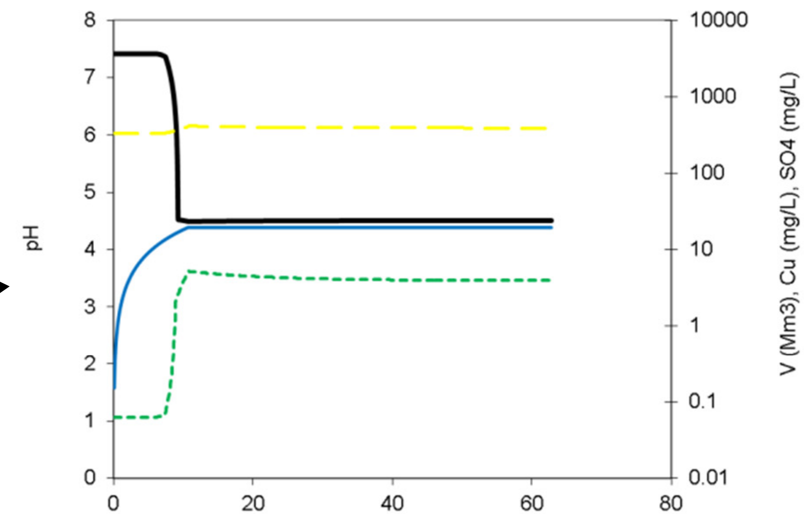
Water Balance

- Typical values
  - Groundwater – 1×10^6 m^3/year.
  - Run-in – 0.6×10^5 m^3/year.
  - Total Precipitation – 0.8×10^5 m^3/year.
  - Evaporation – 1×10^5 m^3/year.

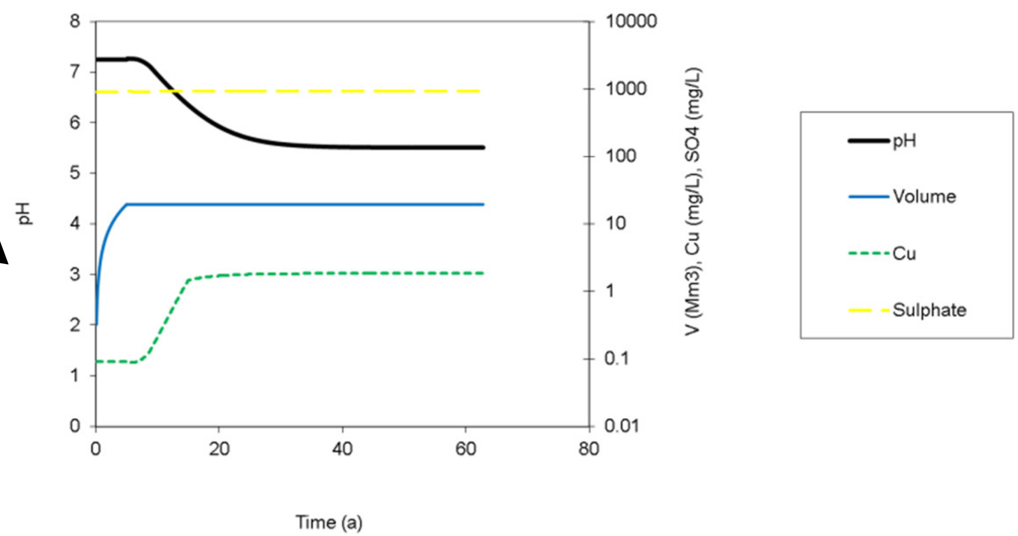
2002 Comparative Results



Tailings
water
not used
to flood

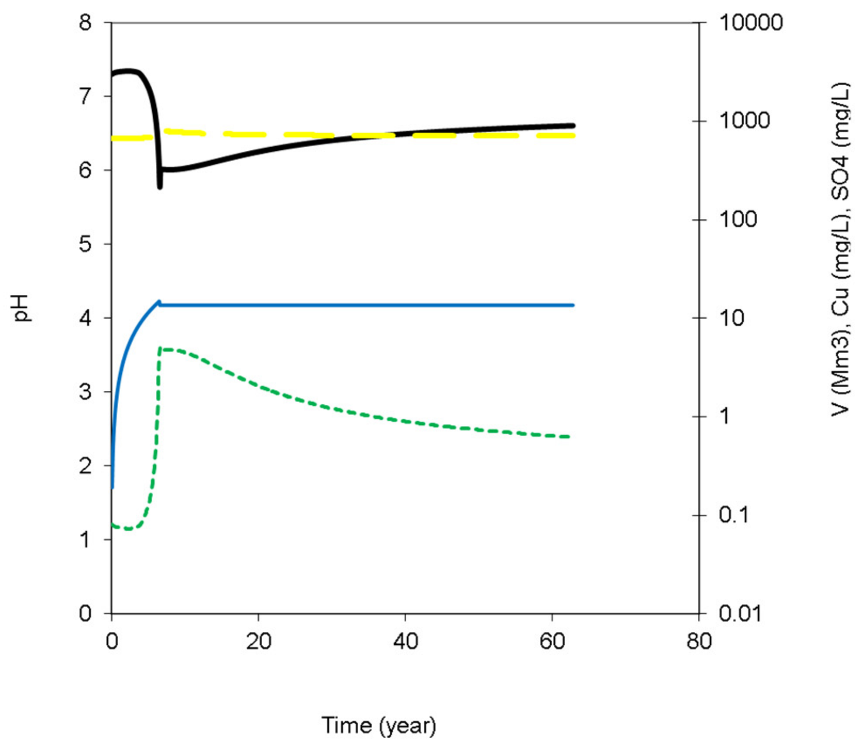


Tailings water
with lower
alkalinity

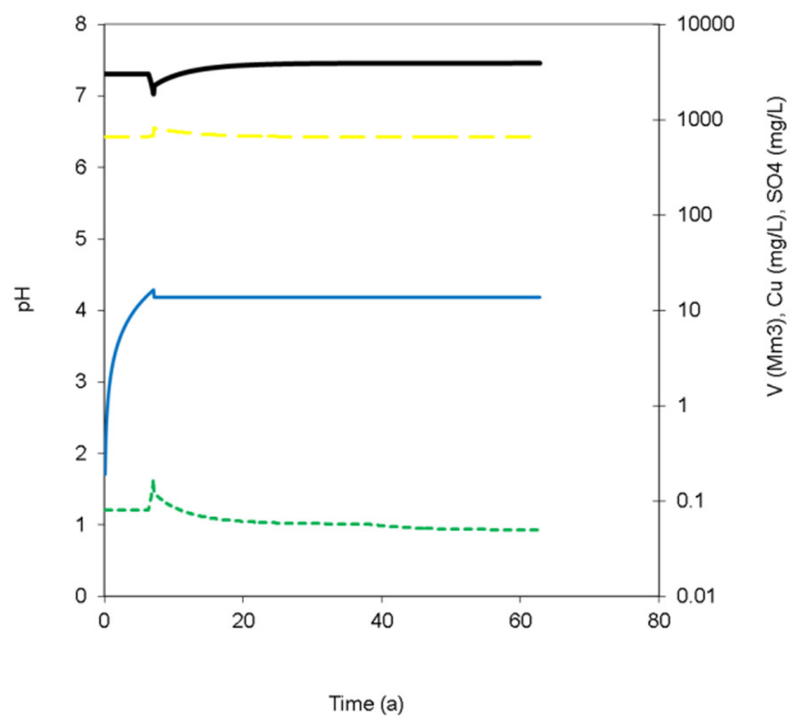


2005 Evaluations

Non-zero Order Oxidation



Wall Covers (60%)



srk consulting

June 22, 2007 Wall Failure

srk consulting

Model Updates - 2007

- 8.6 million m^3 of wall failure rubble (5.3 million m^3 above flood level).
- Construction of plug dam with a crest at elevation 1040 m.
- Placement of PAG pit waste in the Pit.
- Placement of PAG tailings in the Pit.
- Final water cover of 2 m.

2007 Model Updates - Results

- Rapid filling of pit.
- Acidic water with copper concentrations decreasing from about 30 mg/L stabilizing to 2 mg/L in long term (century scale) due to decay.

Conclusions

- Pit wall model provided a simple method to evaluate relative effects of remedial measures including fast flooding and pit wall management.
- Prior to pit wall failure, predicted pit water chemistry was sensitive to alkalinity load from inflows and acid generation rate assumptions.
- Leaching of wall failure rubble led to prediction that pit water chemistry is likely to be acidic.

srk consulting