Probabilistic water balance modelling for informed mine management and planning

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Overview

Part 1. Integrated water balance model – A generic approach
Part 2. Application – Waihi Gold Mine, Project Martha case study

Water Balance Modelling?

Aim
Represent the water budget across a site and its receiving environment
  ➢ sources, sinks, stores and movements

Purpose
Inform management and planning

Tools
Monte Carlo simulation
**Model schematic**

- **Key**:
  - Source Water
  - Evaporation
  - Runoff Water
  - WTP Discharge
  - Decant Water
  - Seepage
  - Slurry
  - Allocator

- **Flow Diagram**:
  - Rainfall
  - Evaporation
  - Ore
  - Ground Water
  - Ore
  - Mine Pit
  - Outflows / Overflows
  - Waste Rock
  - Dewatering
  - Storage Pond
  - Processing Plant
  - Rock Stack
  - Collection Pond
  - Seepage
  - Settling / Consolidation
  - Water Treatment
  - Receiving Environment / Compliance Monitoring
  - Processing / Makeup
  - Evaporation
  - Runoff (Calibrated AWBM)
  - Natural Catchment
  - Rainfall (long term stochastic record)
  - Evaporation
Probabilistic analysis – Monte Carlo simulation

Inputs
- Probabilistic
  - Evaporation
  - Water quality
  - Groundwater inflow rates
- Stochastic
  - Rainfall
  - Production rates
- Site operation logic
  - WTP operating regimes
- Consent conditions
  - Pumping rates and behaviour

Outputs
- Probabilistic water balance predictions and quantifiable risk based assessments
Project Martha – Waihi Gold Mine, Oceana Gold NZ

Martha mine
Water treatment plant
Tailings storage facilities
Dewatering
Decant
Runoff
Tailing Storage Facilities
Ruddock Gauge
Frendrup Gauge
Martha mine
Met station
Chinenmu River
Ruahorehoare Stream

Legend
- Road
- Key River/Streams
**Waihi** mine water balance model

Current model applications

- TSF storage forecasting
- Ongoing water management evaluation
- Post closure water treatment requirements
- Water quality analysis
- **Future development planning**
**Key water management considerations**

- **Water sources**
  \[ \text{Flow} = f (\text{runoff, seepage, decant, dewatering}) \]

- **Water treatment plant**
  \[ \text{Treatment regime} = f (\text{mine water, cyanide water}) \]

- **Discharge to Ohinemuri River**
  \[ \text{Discharge rate} = f (\text{river flow, dilution requirement}) \]
Waihi mine water balance model

Priorities for water treatment and discharge

1. Seepage and collection pond water
2. Decant water
3. Mine dewatering
**Key stochastic input**

Rainfall  100 years of measured data (stochastic model input)
- Runoff models
- Calibration of receiving environment
Water budget

Statistics for Gains to Discharge Ratio (30 Day Rolling Mean)

- Min..1% / 99%..Max
- 1%..5% / 95%..99%
- 5%..25% / 75%..95%
- 25%..75%
- 50%
**Dewatering analysis**

![Graph showing target water table elevation](image-url)
**Dewatering analysis**

Statistics for dewatering capacity of 18,000 m³/d

- 95th percentile deficit ≈ 5 mRL
TSF water balance
Rewatering of the Pit Lake

Estimated rewatering time of 9.4 years (± 0.7 due to hydrology considerations)
Summary

- Multiple applications throughout a project's life cycle
- Opportunity to assess multiple scenarios
- Risk-based assessments to represent uncertainties
- Informs decision making and planning

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Questions?

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Annual water balance

Mine Water Treated, Mean
Cyanide Water Treated, Mean
WTP Maximum Discharge, Mean
WTP Maximum Discharge, 5th%
WTP Maximum Discharge, 95th%

Annual Mean Daily Flow Rate (m³/d)

Year
1 2 3 4 5 6 7 8 9 10 11 12

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