

A systems modelling approach to manage mine discharge risk to rivers

Claire Cote, Chris Moran
Centre for Water in the Minerals Industry
Sustainable Minerals Institute
UQ



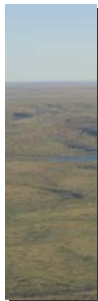
Mine River Discharge

- **Strategic Risk**
 - › Environmental Impact
 - › Social license to operate
- **Operational Risk**
 - › Breach of license, fines
 - › Loss of community support
 - › Errors in holding required volumes
- **Critical to manage discharge risk**



Outline

- **Current Practice**
 - › Issues
- **Systems Modelling Approach**
 - › Mine Water Systems
 - › Model Development
 - › Scenarios
- **Results and Discussion**



Current Practice

- **Stores and Ponds considered in isolation from remainder of mine water systems**

- › Dam safety

- **Hydrological Analysis**

- › Catchment model, IFD data for design events, analyse scenarios for specific ARIs



Issues

- **Water stores are connected to the water systems**
- **Any change to the water system has the potential to impact on the discharge risk**
- **With many practices being implemented, it is critical to try and assess their impact on discharge risk**

Features of Mine Water Systems (1)

- **Multiple Inputs**

- › Climate (rainfall and runoff, lakes and rivers)
- › External regulating bodies (water suppliers, third parties)
- › Physical characteristics (aquifers)
- › Site conditions (water entrained in the materials brought on site)

- **Causal relationships between water tasks, water treatment and stores**

- › Depend on the water management strategies implemented

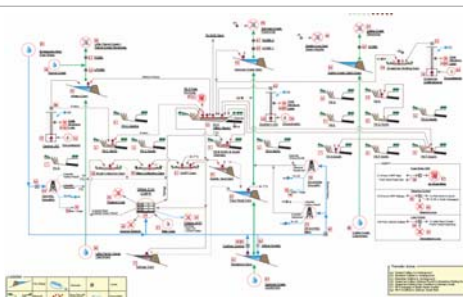
Features of Mine Water Systems (2)

- **Various sources of water**
 - › Surface water, groundwater, sea water, third-party water
 - › Varying quality
- **Various “states” of water**
 - › Raw Water: Water that is supplied or captured and has not been used for any purpose
 - › Worked Water: Water that has been used for a purpose and is returned for future use
 - › Treated Water: Raw and/or worked water that is treated on-site to provide water of a more appropriate quality.
- **Water flows represented as combination of sub-sets**

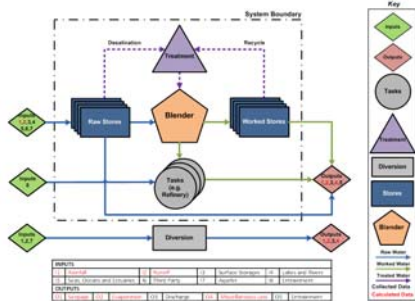
Features of Mine Water Systems (3)

- **Feedback mechanisms**
 - › Quantity – eg. Rules on water level in stores.
 - › Quality – eg. Rules on water quality tolerance at the input of certain tasks.
- **Non-linearity of input/output relationships**
 - › Climate control
 - › Feedback mechanisms
- **Non-linear system of connected elements not controlled by a central entity, that includes causal relationships between objects embedded in other objects \Rightarrow Complex System**

Traditional Engineering Models



Systems Model



Scenarios

Two mines

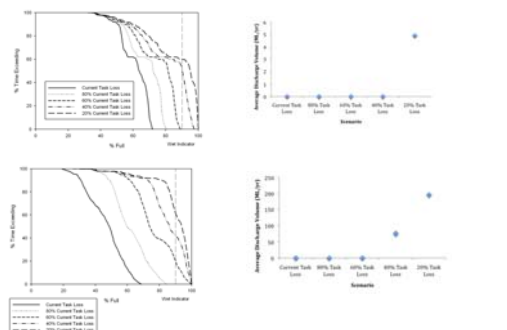
- One small gold/silver operation, high level of treatment
- One large coal operation
- Applicability of model to range of commodities and operation types.



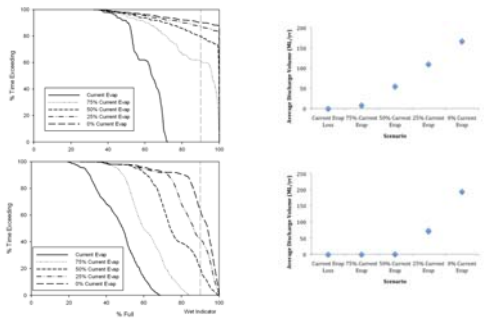
Analysis of impact of management strategies

- Loss reduction
- Change in proportion of raw water at task's input (task = processing)
- Adoption of production ratio

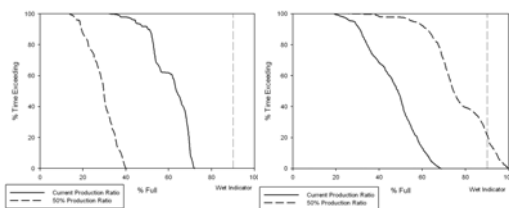
Reduction in Task Loss



Reduction in Evaporation Loss



Changes in Production Ratio



Concluding Remarks

- Mine water stores are part of complex systems
- Changes to the system can impact on discharge risk
- Impact of water management strategies cannot be deducted, modelling is required
- System modelling approach is appropriate to assess the impact of water management strategies on discharge risk
- Use of the model can provide a risk profile for management options