Predictive Water Balance and Mass Load Modelling for Mine Water Through a Passive Treatment System

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Abstract

Predictive modelling has been carried out to assess potential environmental benefits from constructing a passive treatment system (PTS) for mine water treatment for the Reefton Restoration Project (RRP). The RRP is managing the closure and rehabilitation phase of works at the Globe Progress Mine where active mining ended in 2016. The predictive modelling investigates contaminant removal through a proposed PTS utilising Vertical Flow Reactor (VFR) technology. The VFR is designed to co-precipitate Arsenic and Iron from influent mine waters before discharging to the receiving environment. The associated reduction in mass load reporting to the receiving environment is evaluated along with the resultant concentrations in the receiving waters.

The proposed PTS is represented within a probabilistic site-wide water balance and mass load model. The model was developed using the GoldSim® platform to evaluate system performance where daily and sub-daily time steps are applied within a probabilistic Mote-Carlo simulation. Through the simulation stochastic representation of hydrological model inputs were incorporated with probabilistic water quality inputs based on recorded site data. Further, site data was evaluated to determine correlation coefficients between key probabilistic inputs and improve predictive capabilities. Dynamic contaminant mass removal through the system is represented based on modelled and experimental data. Representation of the system includes cumulative sludge build up effects on treatment efficiency and flow capacity.

Modelling demonstrated how effective operation of the PTS can have a positive influence on the receiving environment with a 42% reduction in total Arsenic loads from site and a 56% reduction in iron loads. Considering the operational cycles of the VFR, sludge accumulation is shown to reduce capacity of the system over a 12 month period. Where conservative scour estimates are applied, treatment capacity can be reduced to approximately 50% of influent flows near the end of a 12 month period. In these cases annual median and 90th percentile performance targets are still achieved. Modelling of maintenance period risks, where one of two reactor cells are taken off-line, indicate that temporarily raised concentrations would be observed within the receiving environment, while annual targets would be achieved.

Detailed representation of the proposed PTS within a site-wide water balance and mass load model enables ongoing evaluation of the PTS performance, quantified assessment of environmental effects, implementation of operational decisions through a risk-based assessment, and informing decisions within the adaptive management framework.