FACT SHEET 9 - ADAPTIVE MANAGEMENT

AMD MANAGEMENT TRAINING SERIES

This fact sheet describes the approach of adaptive management for acid and metalliferous drainage (AMD). Adaptive management is an industry recognised learning orientated approach to environmental management where uncertainty exists. It is also considered an observation approach.

The Global Industry Standard on Tailings Management (GISTM) developed by the International Council on Mining and Metals (ICMM, 2020) supports the use of adaptive management and trigger action response plans (TARPS).

AMD RISK ASSESSMENT

There are many risks associated with the management of AMD. One common risk is uncertainty.

Examples of uncertainty (risk) include:

- The amount of rock that will be ore or low-grade ore, and the amount of rock that will be potentially acid forming (PAF) and/or non-acid forming (NAF).
- The materials schedule for PAF and NAF and its availability for key construction activities such as NAF covers.
- The quality and quantity of water flow from mine domains that have the potential for AMD, e.g., toe seepage from a tailings storage facility.
- Contaminant load predictions such as the amount of acidity or other contaminants produced over time.
- Climate change and potentially higher flow rates / contaminant loads.
- Changing community expectations with time leading to more stringent water quality standards.

Generally, the risks associated with AMD can be assessed by an informed risk assessment process (see MWM **Fact Sheet 5**). The AMD risk assessment should be based on data obtained from prediction activities (e.g., source hazard characterisation testing) to understand potential effects. The determination of these potential effects (risks) provides the opportunity to consider additional management options that may, or may not, be required. This could include AMD management techniques (engineering controls) such as prevention and minimisation, and if necessary, the control and treatment of AMD.

ADAPTIVE MANAGEMENT

AMD MANAGEMENT TRAINING SERIES: FACT SHEET 9

AMD MANAGEMENT PLANS AND ADAPTIVE MANAGEMENT

AMD management plans are acknowledged as a suitable mechanism to explain the necessary engineering controls to mitigate the effects of AMD. They are used widely by industry. Often these plans incorporate adaptive management processes. AMD management plans are discussed further in **Fact Sheet 10**.

Effective adaptive management is supported by understanding the nature and duration of possible events that could occur, monitoring for these events, and then having management options in place should there be variance from the expected condition.

Adaptive Management Requires:

- Understanding the uncertainty.
- Monitoring (i.e. performance monitoring).
- Variance planning.
- Trigger Action Response Plans.

Understanding the Uncertainty

Identification of potential AMD risks that could affect the closure of the site, or operational performance are identified in the AMD risk assessment. Minor risks do not generally need adaptive management processes.

Each potential risk should have a range of potential controls and actions identified in case there is variance from the expected case. Monitoring is required together with assigned responsibilities. Responsibilities associated with any variance are often managed by a RACI matrix (Responsibility, Accountability, Consulted, Informed).

Monitoring of Key Risks

Monitoring of performance is critical to help identify early departure from the expected case. Performance monitoring is an early warning system to enable a timely response to develop and implement other management options to manage the change. Monitoring should be specific to the risk and the duration of the risk. Performance monitoring is divided into leading and lagging indicators.

For Instance:

- Leading performance monitoring could include monitoring of oxygen content in a waste rock dump to ensure paddock dumped lifts are excluding oxygen as per the design.
- Lagging performance indicators could include monitoring of waste rock dump toe seepage water quality to confirm water quality meets expectations. (i.e., the expected case)

Variance Planning

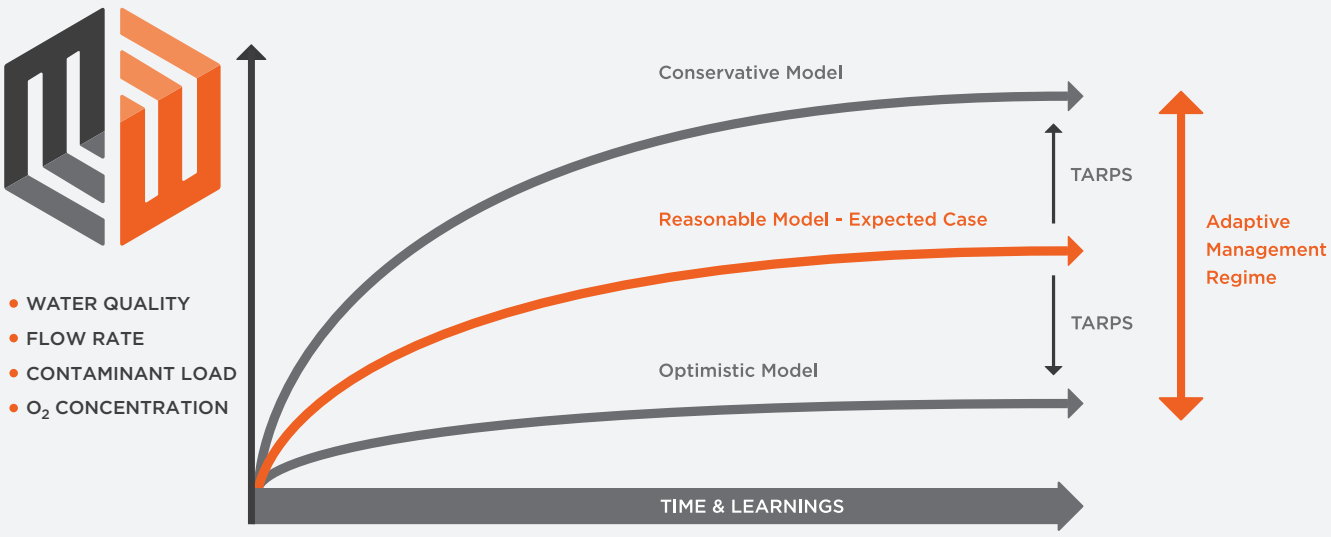
Variance from the expected case is common. There needs to be supporting management options to show how such variance will be managed. For key AMD risks, it is necessary that the following processes relating to AMD uncertainty are considered.

1. A range is determined such that there is confidence in the conservative and optimistic model bounds;
2. The expected case, the most reasonable estimate, sits within these model bounds; and
3. Management options are available for the proposed range to achieve agreed operational and closure criteria.

This range of management options can be referred to as the "adaptive management regime" and needs to be acceptable to both internal and external stakeholders.

Figure 1 provides an illustrative example of the adaptive management regime for AMD impacted waters at a mine site. It provides a clear graphic for explaining to stakeholders how variance will be managed as part of a learning-orientated approach (with time) to environmental management where uncertainty exists.

Figure 1: Adaptive Management Regime for AMD



ADAPTIVE MANAGEMENT

AMD MANAGEMENT TRAINING SERIES: FACT SHEET 9

TRIGGER ACTION RESPONSE PLANS

Almost any variance from the expected case can be managed by Trigger Action Response Plans (TARPs). The number of TARPs is based on the risk assessment process to ensure potential higher risk effects have management options in place. Generally, a TARP has set trigger limits for performance monitoring data to define what a significant change is, and then describes the actions to respond to the variance. TARPs need to be developed to cover the adaptive management regime.

EXAMPLES - WHERE TARPS COULD BE UTILISED

- Reconciliation of waste rock block model material volumes versus mined material quantities.
- Waste rock placement verification to ensure design methodologies are achieved.
- Performance monitoring of waste rock dumps for oxygen content and net percolation rates.
- Monitoring of AMD discharge (rates and quality).
- Performance monitoring of treatment system effluent quality against design expectations.

The use of TARPS provides the framework to manage uncertainty in a manner that makes stakeholders (internal and external) more comfortable that solutions are available and are ready to be implemented if there is variance from the expected case. Done effectively, consistently, and by adapting to new learnings the approach will fundamentally support successful AMD management.

Summary

The use of adaptive management processes can help with knowledge transfer, community engagement, and stakeholder acceptance of potential AMD risks such that a project can proceed with uncertainty.

AUS - Perth Office
Key Contact: Josh Pearce
M: +61 409 882 823
E: josh.pearce@minewaste.com.au

AUS - Brisbane Office
Key Contact: Dr Karan Jain
M: +61 469 348 420
E: karan.jain@minewaste.com.au

NZ - Christchurch Office
Key Contact: Dr Paul Weber
M: +64 272 945 181
E: paul.weber@minewaste.com.au