FACT SHEET 1 - WHAT IS AMD

AMD MANAGEMENT TRAINING SERIES

Acid and metalliferous drainage (AMD) is a general term used to describe waters impacted chemically by mining activities and can contain significant quantities of toxic metals, salts, and acidity.

AMD is typically generated by the excavation of rocks that contain sulfide minerals, such as pyrite. When these minerals are exposed to oxygen and water, they undergo weathering processes and oxidise, generating acidity and releasing toxic metals.

The oxidation of pyrite is explained by Equations 1-3 where the ferric (Fe^{3+}) iron precipitates in a goethite or ferrihydrite type form (iron-oxyhydroxide) such as the orange precipitate seen in the image.

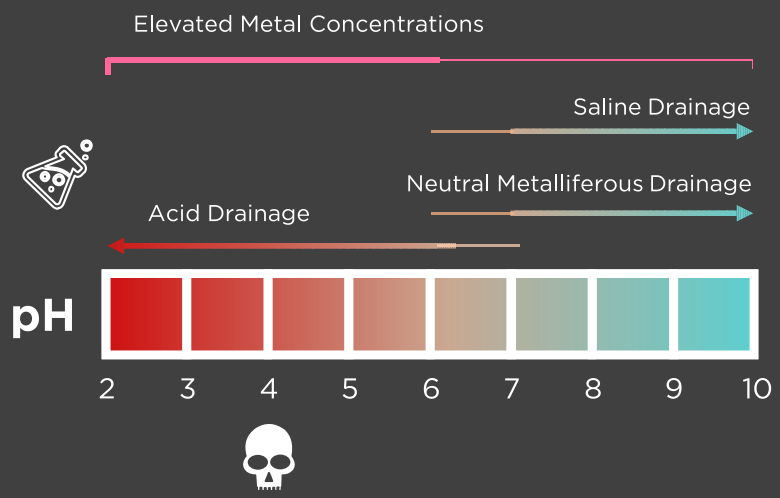
- **Equation 1:** $FeS_2 + {}^{7}/_{2}\ O_2 + H_2O \longrightarrow Fe^{2+} + 2SO_4^{2-} + 2H^+$
- **Equation 2:** $Fe^{2+} + {}^{1}/_{4}\ O_2 + H^+ \longrightarrow Fe^{3+} + {}^{1}/_{2}\ H_2O$
- **Equation 3:** $Fe^{3+} + 3H_2O \longrightarrow Fe(OH)_3 + 3H^+$

Microorganisims play an important part in the oxidation of sulfide minerals and the formation of AMD. Such bacteria can increase sulfide oxidation rates by many orders of magnitude.

Once acidity and metals are generated they can then be mobilised by any water sources, including rainfall, run-on water, water from dust suppression, or water added via processing. It is important to note that this can occur in both high rainfall and low rainfall environments.

TYPES OF AMD

AMD waters can be sub-divided into three general water types depending on their pH and concentration of sulfate and metals.



Acid Rock Drainage (ARD):
Has high acidity, low pH drainage, and has occurred due to the oxidation of acid producing sulfide minerals. ARD generally contains significant dissolved toxic metals.

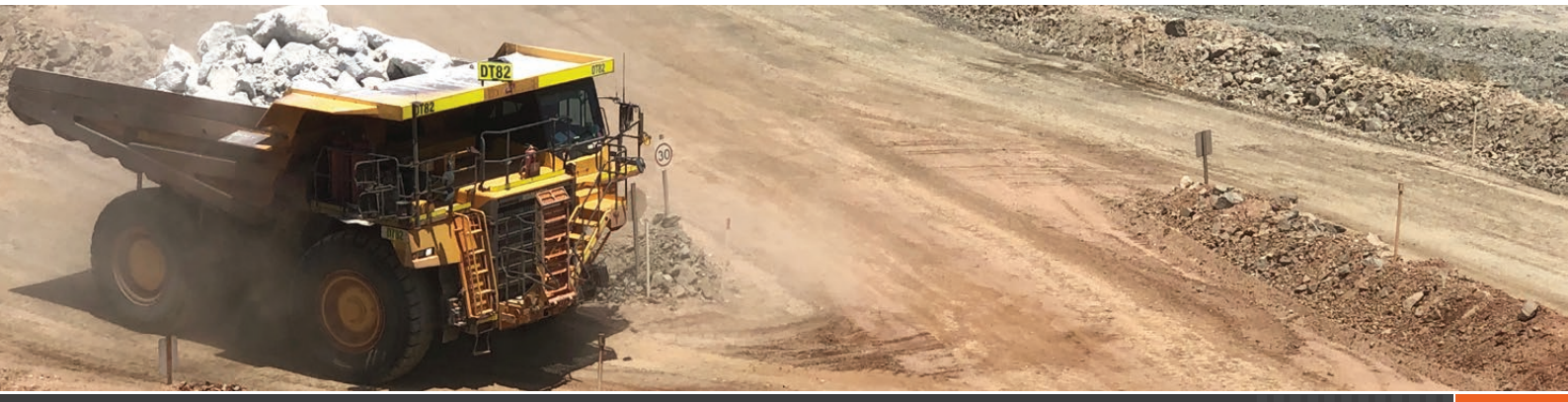
Neutral Metalliferous Drainage (NMD):
Often referred to as metalliferous drainage where the acid produced by the oxidation of sulfide minerals has been neutralised by other minerals such as carbonates, with the resultant waters having high toxic metal concentrations but circum-neutral pH.

Saline Drainage (SD):
Which refers to waters that are close to neutral-to-alkaline in pH with elevated sulfate.

AMD EFFECTS

AMD can create a number of other health, safety, environmental, and community issues:

- Acute short term and chronic long term effects of interactions with acid waters and waters containing elevated metals where pathways include skin contact, ingestion, and inhalation.
- Metals derived from AMD entering the food chain (bio accumulation) causing health issues for animals, livestock, and humans.
- Sedimentation and smothering of drainage channels with metal-rich precipitates.
- Increased erosion rates for sulfidic materials.
- Interaction of AMD with concrete (acid- and sulfate- attack) leading to degradation of site infrastructure.
- Spontaneous combustion.
- Generation of gases such as carbon dioxide and hydrogen sulfide, which may be at fatal concentrations.
- Generation of low oxygen air, which can be fatal.
- Visual impacts and negative stakeholder perceptions.
- Impacts on business reputation and business sustainability including social licence / social value.
- Ability to close sites affected by AMD and long term treatment costs and risks.



AMD LEGACY EFFECTS

AMD MANAGEMENT TRAINING SERIES: FACT SHEET 1

Internationally, there are many examples of historical legacy sites where AMD has not been managed correctly resulting in significant impacts to the environment.

For instance:

- In Spain, the **Rio Tinto River** is coloured red due to iron, from sulfide mineral oxidation and is highly acidic. (see image)

  This is the result of AMD from thousands of years of base metal mining for gold, silver, and copper within the Iberian Pyrite Belt.

- **Iron Mountain**, a historical minesite in California, is another example. Untreated AMD from the site was causing fish kills in the river and the build-up of contaminated sediments in the downstream receiving environment.

- **Mount Lyell**, Tasmania is one of Australia's worst AMD sites where 100 million tonnes of sulfidic tailings were dumped into the Queen River resulting in low pH and elevated metals.

Modern mining companies must address the risks of AMD through sustainable best practicable management options to prevent the creation of future legacy sites

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