

# Go with the flow

Ewan Wilson and James Blyth look at the importance of understanding the local hydrology for good mine water management

*Many environmental factors need to be taken into consideration when planning water treatment for a mine project*

**“Whether it is required for a construction camp or for final remediation, water management is an essential component to overall project success”**

The flow of water through a mine is central to every stage of the project life, from exploration to post-closure. Whether it is required for a construction camp or for ensuring final remediation, water management is an essential component to overall project success.

The hydrological regime is generally well understood with respect to operations. However, its importance is not always recognised in the context of remediation, closure planning and relinquishment of mine leases.

Understanding the options available for treatment and remediation in preparation for closure requires a sound knowledge of the local hydrology.

The hydrological and hydrogeological conditions of a mine site’s geographical location need to be managed and controlled to suit the operational requirements of the project. Controlling this environment is subject to a range of social, environmental, corporate, financial and regulatory constraints that are intended to serve and protect the interests of all stakeholders.

Environmental regulations, in particular, are intended to limit or prevent adverse mining impacts. Where practical, closure regulations and guidelines should aim to achieve conditions that are as near as possible to the pre-existing environment.

## VARIATIONS IN CONDITIONS

Across a country the size of Australia, hydrological conditions vary not only in the relative nature of wet or dry climates, but also across a range of factors that are important to ecosystems. The tropical north has distinct dry seasons, accompanied by wet seasons characterised by intense cyclones. The arid interior is typified by dry conditions, low flows and high evaporation, and in areas of the temperate south, seasons may display less distinct differences in wet and dry season climate than in the north.

While this all might be obvious, it is important to note that the wide variability displayed by the hydrological regimes at these locations affects not only the total volumes of water, but also the timelines associated with water movement – whether daily, monthly or seasonal in nature – that have to be considered over the life of a project. Long-term trends in climate, whatever their cause, also have to be considered. There is no evidence of

a one-size-fits-all solution where such variability exists.

Site hydrology and water management interact closely to affect water quality. Controlled discharge of water that has come into contact with mining operations or processing activity is an area of increasing importance to all stakeholders affected by a mining project. Mining activity has the potential to alter physical properties such as turbidity and pH, and to elevate concentrations of a range of pollutants in water that include heavy metals, salts and sediment. As a result, it is an established part of best practice in mine water management to separate clean and contaminated streams.

Effective control of discharge relies on a combination of water-treatment processes and also on the volume and timing of water movement through an operation. Selection of best practice approaches for water treatment and on-site remediation is essential for operators to protect the interests of all stakeholders and secure cost-effective statutory environmental compliance.

## HYDROLOGY

An understanding of hydrology has an important role to play in controlling water quality. During low flow conditions in streams, concentrations of contaminants increase naturally. Following the onset of rains, the salts and contaminants that have built up on the land surface during prolonged dry periods can be flushed into the system to give an initial spike to the concentration levels. As wet seasons develop and river flows increase, there is the potential for concentration levels to decline. Intense rains and high runoff volumes lead to dilution of metal concentrations, but can risk an increase in suspended sediment loads due to higher erosion off disturbed land.

During the dry season, ephemeral streams may not flow at certain locations along the water course. Native flora and fauna have adapted to these environments, so that any discharge out of step with normal seasonal conditions will have the potential to disrupt the ecosystem and lead to succession of other species.

The volume and variability of rainfall, runoff and baseflow each have the potential to create highly complex conditions. Hydrological regimes can also be used to advantage in site water



management and for controlled discharge.

Controlled offsite discharge to the environment usually requires more management than mere treatment and release. It can be demanding in terms of storage infrastructure, levels of water treatment required and management in terms of blending and scheduling any releases to take best advantage of flow conditions in the receiving environment.

Numerous treatment processes are available and they depend on a range of factors to treat water cost-effectively to the required standard. These include the type of contamination (i.e. metals, sediment or pH issues), the environmental flow conditions, the prevailing regulations governing discharge, the throughput volumes and, importantly, the management of waste streams generated as part of the treatment process.

All of this is labour-intensive, and any large volumes of contaminated water will become a significant liability if they are not dealt with well before mine closure.

Sediment basins are important components of the water-management system for final treatment at discharge sites. They are specific to each location, where it is necessary to design for local conditions to ensure appropriate residence times and storage volumes for the expected sediment loading.

Land forming, involving contouring earthworks and revegetation, aims to return disturbed land to natural

conditions and is an important part of remediation and closure. It can go a long way towards supporting re-establishment of ecosystems present prior to mining.

In cases where it is impossible to return to the pre-existing conditions, an understanding of the local hydrology and the application of appropriate land forming can support the development of new ecosystems. For example, in situations where fundamental changes are made to catchment drainage through construction of large-scale diversion works or through the development of open-pit operations, flows may be redirected from one catchment to another, with the result that it is not practical to return affected ecosystems to the original baseline condition.

Such situations also offer opportunities where increased flows and appropriate topography can be used to establish wetlands, which offer advantages both during mine operations and after closure. Globally, natural wetlands have been severely impacted; it is estimated that around 90% of the Earth's wetlands have been drained. They are often termed 'nature's kidneys' due to their ability to filter out nutrients, sediments and, to a certain degree, metals.

Wetlands form in depressions where a combination of surface runoff and groundwater discharge occurs, leading to the establishment of unique plants. Anaerobic conditions associated with wetlands promote bacterial breakdown of nutrients. The vegetation retards flow, allowing settlement of suspended particles and potential attenuation of flood peaks.

Wetlands can be developed at mine sites for use in operations and closure to help increase water quality. If the water is high in heavy-metal concentrations, pilot studies may be needed to identify more tolerant species. Metals will be adsorbed into the soil, but once the soil is saturated and limited plant uptake occurs, metals will be lost through the system.

### CLOSURE PLANS

Questions for closure plans (involving solutions that might include land forming, capping of waste dumps and the construction of diversions) that should be considered with respect to hydrology include:

- Mine plans evolve continually, so how well aligned is the closure plan to the current mine plan?
- How effective are closure plans in limiting or preventing the risk of mobilisation of contaminants?
- Do the proposals put forward for remediation take full advantage of the

hydrological regime of the area?

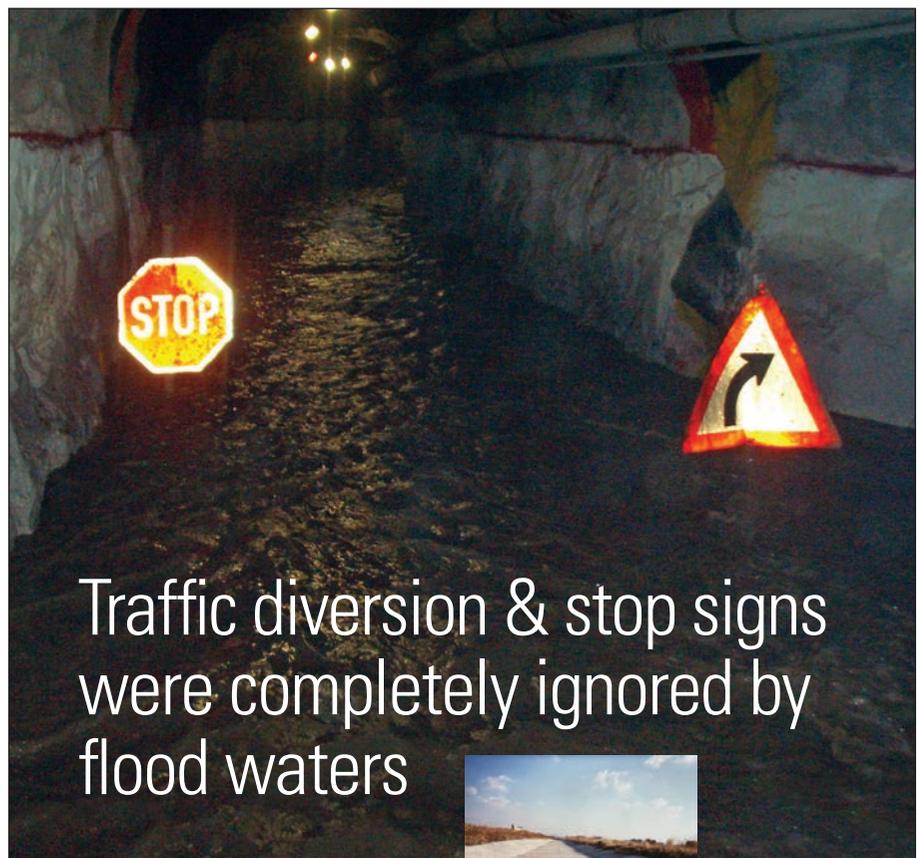
- Where will the surface drainage flow to following closure?
- Will any areas become more prone to erosion or flooding following closure?
- Are groundwater levels likely to be permanently affected after closure?
- Will seepage conditions and permanent springs develop?
- Where are the point sources for

potential contamination, and how will they behave following closure?

- Is it possible to maintain flow levels and flow variability following closure to suit the dependent aquatic habitat?

A sound understanding of the site's hydrological regime and careful selection of appropriate options is central to cost-effective remediation and closure. ▽

Authors: Ewan Wilson is principal consultant (water management) and James Blyth is consultant (water management) at SRK. See: [www.srk.com](http://www.srk.com)



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