

Sustainable Mine Water Management Strategies

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Abstract

Mine water management is critical to most mines across the globe. Effective and sustainable water management is imperative to facilitate the successful permitting of new mines, to achieve community acceptance, to maintain regulatory compliance during operation, and to avoid long term legacy issues following mine closure. Mine water supply, mine dewatering and site water discharge are critical aspects for successful mining operations. Building in water resilience to mining operations with regards to climate risk, ESG, geopolitics and sustainability is imperative in the mining industry today. Holistic water management approaches and integrated mine design are critical to building the mines that we all want to see. Climate change, ESG and sustainability are all key drivers in society today and water is central factor in all these globally important topics.

Keywords: Water, resilience, ESG, climate change, sustainability

Introduction

There are numerous different water management challenges facing mines today, these challenges vary throughout the mine life cycle and vary with differing climate, environment and geopolitical circumstances. Climate change will play a key role in shaping effective mine water management practices and designs. Mine water management can include many different aspects including groundwater aspects (mine water supply, mine inflows, mine dewatering), surface water aspects (mine water supply, managing catchment runoff, managing existing surface water features, flood risk/protection, spring snow melt release and site water discharges), the interaction between both groundwater and surface water and the associated impacts. It is important to not only consider the mine site itself but also to consider the wider catchment and all other water users or water features which the locality. Understanding the site wide water balance is critical to effective and sustainable water management and provides critical insight to broader mine design decision making.

The Role of Water in Mining

Water plays an important part in most mines around the world, with most mines having to consider the following aspects:

- Water supply
- Mine dewatering/depressurisation
- Surface water management
- Site discharges
- Seepage from tailings dams and waste rock dumps
- Interaction with the environment and local communities

The importance of these aspects varies depending on where the project is in the mine life cycle and varies as it progresses through the mine life cycle. Projects at early exploration stage, while primarily focussed on expanding the mineral resource, must also consider aspects such as securing a water supply for the drill rigs and in many jurisdictions require permits associated with discharge to groundwater/surface water and often lead to disputes that the exploration drilling activities are impacting other domestic or commercial wells within the immediate area. Exploration stage is also an ideal time to initiate baseline water data collection, where valuable insight on the water environment can be gathered with little additional cost and there is the opportunity to start the baseline water data collection clock.

As mining projects progress into scoping and feasibility phases the focus on water increases, with a requirement to identify

a sustainable water supply to meet *all* the mines various life of mine water demands, to develop practical and effective mine dewatering strategies, to provide preliminary mine water management designs and estimate water related capital/operational costs. Appropriately addressing these aspects requires a more in depth understanding of the water environment, such that an appropriate level of confidence can be derived with respect to the proposed water related designs, strategies and costs.

Prior to mine construction and operation Environmental Impact Assessments (EIA) and various water related permits (which may include abstraction, discharge and/or impoundment) are likely to be required. This further raises the level of water environment understanding required (usually including the requirement for an appropriate duration baseline dataset) to accurately assess the potential water related impacts and the expected interaction of the proposed mine on the environment and the community. A key focus being to ensure that appropriate measures are in place to monitor, manage and mitigate any potential impacts.

Once a mine moves into the operational phase the water focus often shifts to confirming and validating the predictions from the earlier mine planning stages. There is a focus on gathering operational data, ensuring compliance with permit conditions, regulatory reporting and often looking to ensure optimal and sustainable mine water management. Throughout the operational phase integrated water management across the mine operation is a key aspect, with water playing a key role in many of the different mining departments including mining, mineral processing, waste management, tailings management, infrastructure, environment and community liaison.

Finally, as the mine moves towards closure phase the water related focus generally moves to ensuring no long-term negative water related impacts and minimising active mine water management strategies. The water related aspects of mine closure, in most cases, will have been considered during the earlier planning stages, prior to the mine even being constructed but these early mine closure

plans will have been reviewed and updated throughout the operational life of the mine, and it is at this stage that many of the closure strategies and designs will be finalised.

So water plays an integral role in mining throughout its progression through the mine life cycle, although the key elements themselves and the level of detail/certainty required vary throughout the journey. The exact nature of the role will also vary depending on the climate, location, geology, regulatory environment and many other factors but water plays a critical role in most mines across the globe.

Water Related Risks to Mining Operations

The important role that water plays through the mine life cycle is detailed in the section above. Consequently, appropriate management of water related risks is critical to ensure successful mining operations.

Water can be a constraint on mining projects as a result:

- Insufficient water of suitable quality, where there is an imbalance between available water and mine water demand.
- Discharge limitations, where the operation is not able to discharge water from site at rates or from locations required and this negatively impacts operation.
- Water related licence/permit conditions impacting optimal water management practices.

Water can also cause disruptions and/or unplanned downtime to mining operations. Commonly the cause can be related to mine dewatering (underground or open pit) or to the ineffective management of extreme rainfall events, leading to in some cases flooding of mine access roads causing restricted access (Figure 1) or pit inundation (Figure 2).

Mine water risks have the potential to impede mining or curtail processing which can have substantial financial impacts on the mine. In addition, they have the potential to lead to legal ramifications, company reputation damage, breakdown of trust and good stakeholder relationships, environmental damage and in extreme instances loss of life.



Figure 1 Surface Flooding in Pilbara Region of Western Australia



Figure 2 Flooded Gold Mine Cote d'Ivoire

Mining in a Changing World

Mining is undertaken in highly variable environments across the globe ranging from arid deserts to tropical rainforests, high mountains to coastal plains, arctic circle to searing heat. These environments all pose their own specific challenges but on top of these we are living in a changing world.

We live in a world with changing weather patterns, which include more frequent and longer droughts, increased number of extreme weather events and higher temperatures (more hot days and more heatwaves). The impact of climate change is very closely related to water, as clearly portrayed in the below two quotes:

- “If climate is the Shark, water is its teeth” – Alexis Morgan, Global Water Stewardship Lead for Global Conservation Group, WWF (Morgan 2022).
- “Climate change is primarily a water crisis.” – United Nations, Water & Climate Change Website (UN 2023).

The consequence of increased extreme weather events is predicted to lead to increased flood risk across the globe as illustrated across the American continent in Figure 3 taken from the WWF Water Risk Filter website (WWF 2023).

Environmental Social Governance (ESG) is a key focus of both mining



Flood Risk 2020



Flood Risk 2050

Figure 3 Flood Risk Predictions 2020 vs 2050 (WWF Water Risk Filter-Maps)

companies and society, with strong ESG being a critical element for any successful mine. Some of the main ESG focusses being sustainability, transparency, accountability, stricter regulation, low carbon emission (net zero), nature positive, social responsibility and multi-stakeholder consideration. All these aspects have strong links with water and again focus operations on effective and acceptable mine water management practices.

Geopolitical influences also play a key role when considering mine water management aspects. Some of the geopolitical factors being conflict, transboundary agreements/water rights, rising energy/materials prices and changing demographics (including urbanisation and population growth).

This changing world of climate, ESG and geopolitics not only presents new water related risks to the mining industry but also provides opportunities. Effective mine water management practices, particularly where it includes a strong focus on the environment and community engagement across the wider catchment, provides opportunities related to economic growth, social improvement, the protection and enhancement of the natural

environment, reduced operational costs and improved operational performance.

Navigating the challenges, managing the risks and realising the opportunities leads to successful mining operations. Getting the water balance right needs to be the focus and few mines across the globe have mastered the perfect water balance. Mines with the ability to balance the water deficits and the water surpluses, effectively manage the impacts, be adaptive and flexible throughout the mine life cycle, manage seasonality and effectively control the influences of our changing world are building resilience into their operations and will be the mines of the future.

Water Resilience

Resilience is a measure of the ability to recover quickly after a stress has occurred, to return to a previous state after being impacted, to transform and adapt to new circumstances, and to adapt in line with future stresses. A key consideration is water stewardship and the fact that water is a shared resource within the catchment. Incorporating water resilience into mining projects can be achieved by following an approach which has the following characteristics:



Figure 4 Water Resilience - Integrated Approach

1. Starts early
2. Holistic
3. Integrated
4. Clearly defines goals and targets
5. Practical roadmaps
6. Water stewardship
7. Dynamic

Imbedding water resilience into mining projects necessitates consideration of all the various relevant aspects. The relevant aspects are likely to vary for different mines, in different locations at different stages of their development, an example is illustrated in Figure 4.

A fundamental pre-requisite to building water resilience into a mining project is developing a comprehensive understanding of the following aspects:

- the entire water system and all water users within the catchment,
- the baseline water environment,
- the water resources within the catchment,
- the mine water demand throughout the life of mine,
- the mine water discharge requirements throughout the life of mine,
- the impact that the mine is predicted to have on the water environment,
- the impact that the water environment is predicted to have on the mine,
- the regulatory environment,
- stakeholder expectations/requirements and
- ultimately what the water related aspects of mine closure will look like.

Understanding the water system and the role that the mine plays within the catchment is vital and is achieved by instigating a phased approach (often lopping back through earlier phases) of appropriately detailed data collection, data management, data analysis and interpretation, modelling and subsequent planning/permitting. This provides the framework for developing appropriate and effective water management designs, and the implementation of sustainable water management strategies.

The water management strategy developed needs to incorporate appropriate mine water management designs and procedures, which are based on an appropriate understanding of the integrated water system and due consideration of the influences of changing climate, ESG, sustainability and geopolitical factors. The mine water management strategy needs to be a live document (regularly updated), integrated, practical, efficient, effective, and sustainable. Achieving a sustainable water management strategy is not only an obligation in the world we live in today, but also ensures maintenance of asset value for the company, helps maintain a

Conclusion – The Mine We All Want To See

Developing robust strong sustainable mine water management strategies facilitates:

- Water resilience
- Optimal mine operation (not constrained)
- Reduced carbon footprint
- Regulatory compliance
- Good company reputation
- Community collaboration

Sustainable mine water management strategies are a key element of “The Mine We All Want to See”. This is a mine that the mining company are proud of, that the staff who work in the mine are proud of, that customers are happy to buy from, that regulators consider fulfils all their requirements, that communities are proud of, that minimises environmental impact and that generates value for all stakeholders even following mine closure.

References

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