The future of water in the mining industry

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Abstract

The current dynamics of the mining industry are largely driven by the demand for mined commodities in China and other developing economies. These dynamics are resulting in new mines being developed in remote areas where water infrastructure is often non-existent and must be built as part of the overall mine project. In addition, stresses on local water resources and changes in the regulatory environment are increasing the significance of water issues for mining companies. These factors lead to requirements for improved mine water expertise, equipment and infrastructure as mining operations need to address water issues in an integrated manner to successfully develop the projects that are needed to meet the industry's projected growth.

Keywords: mine water management, mine water use, water footprint, sustainability

Introduction

Water and mining have always had a close connection. Most mining and mineral processing operations require water, often in large amounts. Mines are increasingly encountering conflicts with other water users, including ecosystems. There is increased pressure for mines to meet stricter environmental and sustainability goals from regulatory agencies, governments and other stakeholders. As a result, mining companies are trying to reduce their water footprint, which provides significant opportunities for advancing the approaches and technologies for managing mine water issues.

A Snapshot of the Mining Industry

Mining is essential to the growth and development of today's economies. It provides the mineral commodities for manufacturing as well as the energy minerals used to generate a significant proportion of the world's energy supply. Since the middle of this decade, mining has been in a 'super cycle', largely fueled by economic growth in developing countries such as China, which now accounts for about two thirds of the increase in demand for commodities.

A second key driver for mining is the move to green technologies. Copper, which is at the heart of the lithium battery, makes up about 80% of the battery by weight. Electric cars use 200 to 300 percent more copper than gas powered cars. In addition, other metals such as rare earths are needed for electronics, renewable energy devices and electric cars. Mining costs for commodities are increasing due to higher development, energy and labor costs. Often, new mining projects are being developed in areas where significant infrastructure is needed, including water infrastructure. Water and other infrastructure such as rail and ports may comprise a major portion of the CAPEX needed to develop a mining project.

Copper is a key indicator of economic activity and growth. Refined copper consumption worldwide has increased from about 10 million metric tonnes per year in 1980 to about 18 million metric tonnes per year in 2009 (ICSG, 2010). Most of this growth has come in Asia, where copper use has increased from about 2.0 million tonnes in 1980 to about 11.2 million tonnes in 2009. China now accounts for over 35% of copper imports and by 2025 the country's annual use is expected to exceed the current worldwide annual production rate. Projections indicate that the world will consume more copper in the next 20 years than it did during the period from 1900 to now.

Chile is currently the major copper producer today with a production of about 5.4 million tonnes in 2009 (ISCG, 2010). Peru and the United States are a distant second and third at about 1.3 and 1.2 million tonnes, respectively. Because much of the copper mined today comes from the very arid regions of northern Chile and southern Peru, water supply is a big issue for copper mines in these areas. As a result, large seawater desalination projects are being planned or are currently in construction to meet water demands since other water supply options are unavailable.

New mining projects in mineral rich Africa are likely come to emerge within the next 5 to 10 years. Some of these mines will be located in Sub-Saharan Africa where water is scarce and conflicts with other water users will arise.

Water in the Mining Industry

Water is integral to mining operations but water issues tend to vary with climatic, hydrologic and hydrogeological regimes. Some mines must manage significant precipitation and stormwater runoff while others must deal with large groundwater flows to dewater open pit or underground mines.

Most mines need water for the mineral processing activities and subsequently they must deal with effluents from those activities, including tailings. In arid areas, mines often develop major systems to supply the required water whereas in wet climates, they may have a water surplus that must be managed. Some of the key differentiators and drivers that are raising the profile of water in the mining industry include:

- Water is required for mining and mineral processing, often at a certain quality.
- There is growing competition for water resources, particularly in arid areas. This competition is often with agricultural and municipal water users.
- Mines are increasingly being developed in remote locations where little or no water infrastructure exists. Significant investment in wells, pipelines, water treatment and other infrastructure is often needed.
- Mining is often conducted at a massive scale, thus requiring a lot of water.
- Mines can be relatively short lived, thus they may need large quantities of water over a relatively limited period of time.

- Mines are exploiting lower grade resources, which generally need more water per tonne of finished product.
- Regulatory requirements related to water production, water use, water quality, mine closure and mitigation of impacts are increasing in most countries where mining occurs.
- Issues related to environmental sensitivity and sustainability of mining operations are becoming a key component of mine permitting, operations and closure.

Because of the role that water plays in mineral processing activities, water supply has a significant impact to individual mining operations and to the mining industry as a whole. As a result, mining companies are looking at new sources of water to meet their water supply needs, including the use of seawater or desalinated seawater in mining operations. Mining is now the second largest global user of desalination plants with a number of desalination projects being planned in arid regions such as northern Chile. Other arid regions like Sub-Saharan Africa and parts of Australia are also looking at desalination as a water supply source. However, desalination plants and the associated pumping and pipeline systems are a major mine development and operating cost and can easily have CAPEX costs exceeding $500 million.

On one hand mine water supply demands are increasing while, on the other hand, mining operations are trying to reduce their water footprint by using water more efficiently. To meet demands while reducing the footprint, mine operators need detailed data on water usage throughout the mine operation as well as a good operating water balance model that incorporates the entire mine water cycle. It is becoming more common to incorporate uncertainty in the natural and mine water cycles by using probabilistic water balance models to manage water for a wide range of conditions.

Mines are also looking for opportunities to recycle water in the operation and reduce water use through process improvements. The use of dry stack tailings is gaining popularity because it allows more water to be recycled. New treatment technologies such as membrane separation are being used to improve water recovery and water quality from mining effluents.

Mining is coming into conflict with water users over environmental and sustainability issues and, as a result, governments are increasing the regulatory requirements associated with water use and water quality. For example, the Government of South Australia (Office of Water Security, 2010) launched The Water for Good Plan which *"… outlines the actions we will take to ensure our water supplies are secure, safe, reliable – and able to sustain continued growth – for at least the next 40 years."* Action 48 of the plan relates to water used for mining and requires: *"mining ventures to provide their own water supplies within the sustainable framework of natural resources management planning, and regional water demand and supply plans."* It includes requirements that mines sustainably manage water resources, do not cause impact to ecosystems, maintain the quality and quantity of water supply to existing users during and post mining, and assure there is no net ongoing liability to the Government related to control of impacts resulting from mining operations. This is one of many examples of new requirements that governments around the world are setting for mining.

Forecast for Mine Water

Demand for mined commodities will grow as will the challenges for mine water. Thus, the integrated management of water resources associated with mining will take on a greater importance. Global Water Intelligence (GWI, 2010) estimates the total expenditure for mine water in 2010 to be about $7.7 billion. It predicts this expenditure will increase to about $12 to $13 billion by 2014 and that the largest markets for mine water include the countries of Australia, Brazil, Canada, Chile and Peru. These estimates mainly comprise equipment and infrastructure costs for mine water and they are probably low if one considers other water related activities such as water exploration, tailings management, environmental permitting and closure costs.

With growing awareness of the importance of good water management practices, mining companies and mine water service providers will need to look for improvements in water use efficiency and technology in areas such as:

- Water supply including surface dams, well fields and conveyance including treatment to acceptable quality (desalination, filtration, chemical treatment);
- Process water including chemicals required in the ore separation, water use, water reuse and process improvement;
- Process dewatering equipment for products and wastes to allow water recycling within the process (e.g. thickeners, filters);
- Conveyance and storage of tailings and reclaim of tailing water;
- Mine water control and management including surface water diversions, mine dewatering systems, and conveyance;
- Collection and treatment facilities for mine contact waters (e.g. mine waste dumps, tailings).

Mine Water from a Global Perspective

The United Nations World Water Development Report (UN Water, 2012) recognizes five major water use sectors that contribute to global water use including: food and agriculture, energy, industry, human settlements (domestic and municipal use) and ecosystems. Estimates of global water withdrawals from surface water and groundwater systems vary but generally range from about 3,800 to 4,200 km^3/yr for the first four sectors listed above (UN Water, 2012; Simonovic, 2002; Postel et al, 1996) with about 4,000 km^3/yr being a reasonable average estimate.

Agriculture accounts for about 70% of global water withdrawals (surface water and groundwater), or about 2,800 km^3/yr. About 65 to 70% of this amount used consumptively. The global population increase is estimated to result in an increase in demand for food of 50% by 2030 and 70% by 2050 with similar increases expected in the water demands for food and agriculture.

Municipal and domestic water withdrawals are about 10% of the total global use, or about 400 km^3/yr based on a total withdrawal of 4,000 km^3/yr. The consumptive use for this sector is in the range of 10 to 15%.

The energy and industrial sectors (including mining) are often combined and represent about 20% of the total global water use, or about 800 km^3/yr. Consumptive use for energy (excluding reservoir evaporation) and industry is estimated to be about 10 to 15% of the total withdrawals.

Global water use for the mining industry (excluding aggregate mining) is estimated to be 7-9 km^3/yr by Global Water Intelligence (GWI, 2011). Based on this estimate, mining comprises about 1% of the combined energy and industrial water use and about 0.2% percent of the total global water use in all sectors. As another point of reference, the USGS (Kenny, et al, 2009) estimates that in 2005, total water withdrawals in the US for all mining activities (including aggregate) were about 1% of the total US water withdrawal for all sectors. Applying this percentage to the global withdrawal estimate of 4,000 km^3/yr results in a total mine water withdrawal estimate of about 40 km^3/yr. The actual number is difficult to quantify but probably falls within this range.

UN Water (2012) suggests that the paradigm for water resource management is changing from one that regards the ecosystem (environment) as an unfortunate but necessary cost of development to one that sees the ecosystem as an integral part of development solutions (Figure 1).

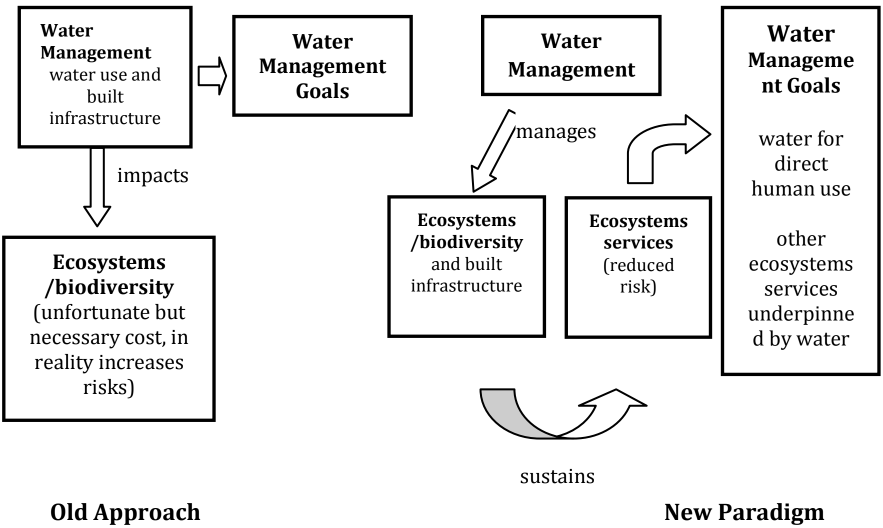

Figure 1 *Changing Paradigms for Water Management (From UN Water, 2012)*

For mines, this means viewing water as part of an integrated water management plan that includes protecting the environment, minimizing the water footprint through efficient water use, recycling water, and improving process technology.

The new paradigm would consider all water users and stakeholders during the development of an overall water management plan.

Conclusions

Water for the mining industry probably comprises less than 1% of total water withdrawals on a global scale but is often a significant user at a local scale. Mines can result in large disturbances to land and water resources that either do or are perceived to cause environmental impacts and conflicts with other water users, including the ecosystem. The challenge for mining companies and mine water professionals is to manage mine water using an integrated approach to improve the efficiency of water use (reduced water footprint), develop new water supply options, and provide sustainable water resource plans that accommodate and protect other water users, including the ecosystem.

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