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The contribution of mining to clean water and sanitation (SDG 6): Case studies from South Africa

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Abstract

Water is essential to all life, and, in their Global Risks Report 2017, the World Economic Forum rates the current water crisis as one of the top five global risks. Access to a secure and stable water supply is also critical to all mining operations, many of which occur in water-stressed areas. In South Africa, water security risks are compounded by the fact that mines frequently occur in close proximity to human settlements, and it is thus critical to consider other users such as communities and the environment when using and managing water. This paper outlines case studies that show how mining companies in South Africa are realizing the benefits of public-private partnerships in terms of securing their own water supply, whilst contributing to the sustainable development of the communities in which they operate by promoting access to clean water and participating in water conservation and infrastructure development. Whilst these case studies show that mining companies can play a crucial role in regional water supply, the challenges are significant and complex. In South Africa, the Mine Water Coordinating Body, established in 2016 and active since early 2017, brings together mining organizations and government departments to collectively address these challenges and find solutions to the complex regulatory, institutional and financial barriers to improve mine water management and reuse.

Keywords: Mine water management, South Africa, Mpumalanga coal fields, Mogalakwena Platinum Mine.

Introduction

Meeting the United Nation's Sustainable Development Goals (SDGs) by 2030 will require commitment of, and collaboration between, all sectors and stakeholders, including governments, non-governmental organizations, the private sector and communities. One of the sectors of key relevance to many developing countries, is that of mining. Although mining

has the potential to make a significant contribution to sustainable development in mineral resource-rich countries, it can also lead to degradation of the surrounding environment and impact negatively on the health and well-being of local communities.

It was in this context that the World Economic Forum (WEF) published an atlas in 2016, which maps the relationship between mining and the SDGs, and highlights opportunities for mining companies to make positive contributions towards achieving these goals (World Economic Forum 2016). In accordance with this atlas, an SDG of particular relevance to the mining sector is that of Clean Water and Sanitation (SDG 6). This is because mining operations can impose long-term, and sometimes permanent, impacts on the availability and quality of local water resources, and consequently on the quality of life and traditional livelihoods of surrounding communities who depend on local water resources for domestic use, agriculture and livestock farming. These risks can, furthermore, translate to very real tensions and conflicts between mines and external stakeholders (communities, governments and other industries), particularly where mineral resources occur in water-stressed, environmentally sensitive or culturally sensitive areas (Zarsky 2015). Conversely socio-political pressures and regulatory reforms threaten the industry's access to a secure and stable water supply, thereby posing a very real and critical risk to the financial and practical viability of mining operations (Lewis 2017, Maennling et al. 2016).

The mining atlas (World Economic Forum 2016) also outlines many opportunities for the mining industry to contribute to adequate access to clean water and sanitation, by reducing its own water footprint and by increasing the local supply of water and sanitation through the sharing of water infrastructure and expertise with local governments and communities. This paper presents two case studies which highlight how mining operations in South Africa are engaging in activities that are not only reducing their own footprints, but also promoting access to clean water and water conservation on a local and regional level.

Background

Access to water for the extraction, transport and processing of minerals is crucial to all mining operations. Although typically only accounting for between 3% and 6% of national water consumption, mining operations can have a significant impact on a local and regional scale, where they compete with other water users for access to water. In many cases, mine

pits or underground workings occur below the groundwater table, and mines are required to continuously dewater these workings to gain access to the ore body, thus potentially disrupting surrounding groundwater tables and hydrogeological pathways. Mining operations can also impact on the quality of local water resources, with the continuous generation of contaminated discharge from mine workings and mine waste piles potentially resulting in prolonged pollution of ground and surface waters. Mine discharge waters and effluents contaminated with salts and metals impose harmful, usually irreversible, impacts on aquatic eco-systems, soil fertility and mammalian health. A decline in the availability and quality of water can also have an adverse impact on the livelihoods of local communities. In their study to assess the cost of coal mining on agriculture and human health in Odisha, Hota and Behera (2015) found the cost of environmental pollution incurred by the local communities, in terms of loss of agricultural production and increase in medical expenses, to be substantial. Pollution of land and water by acid mine drainage (AMD) arising from coal mining resulted in a loss in livelihood from both fishing and farming. Locally, a report by the Centre for Environmental Rights (2016) has claimed that the impact of mining activities are in most cases so severe that farming activities cannot be sustained on the land.

These impacts have often led to mine company-community conflicts, and have received a great level of attention by advocacy organizations and traditional and social media. A study by the International Council on Mining and Metals (2015) revealed that mining-related conflict between communities and companies had increased over the period 2012-2013, with environmental and economic grievances dominating. A further study by Davis and Franks (2014) confirmed environmental pollution to be the most common cause of mine-community conflict globally, followed by access to resources and distribution of benefits. Costs resulting from losses induced by conflicts between the mining company and the community can be significant. For instance, Davis and Franks (2014) reported that the lost productivity as a result of temporary delays or shutdowns was estimated at approximately US$20 million per week, mostly due to lost sales. To add to the industry's woes, regulatory bodies in many countries have responded to the concerns of local communities and community support organizations by imposing stricter regulations governing the use and management of water resources by mining companies.

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Water-related impacts and risks are of particular significance to the mining sector in South Africa, which features prominently in the world's supply of many minerals and metals. South Africa is also the 30th driest country in the world and, whilst mining typically accounts for less than 3% of national water consumption, mining activities are mostly concentrated in water-scarce and populated areas, placing additional strain on the limited water resources. This situation has been aggravated by poor water management practices and governance by the mining industry in the past, leaving a legacy of degraded and polluted environments which impact negatively on the health and traditional livelihoods of surrounding human settlements. Reports by civil society organizations (Bench Marks Foundation 2014 and 2015, Center for Environmental Rights 2017, International Human Rights Clinic 2016) provide documented evidence of the adverse effects of mining on the surrounding environment and communities in South Africa, and the consequential incidents of mine-community conflict around the country, many of which center around water security and pollution. Over the past two decades, there have been several legislative reforms, and regulations have become more stringent, placing social and environmental well-being as much a priority as that of the economic benefit of mining.

With growing external pressures from government and society and internal concerns over water security, mining houses have become increasingly committed to more responsible use and sound custodianship of water. Today, most mining recognize water as a critical business issue, with site management plans typically emphasizing water re-use and recycling, as well as the use of non-potable or secondary water sources as far as possible. In this way mining companies are able to improve water efficiency, minimize pollution of water resources, and avoid competing with other water users for access. Many companies around the world are also starting to realize the benefits of going beyond merely managing impacts and using site water more efficiently. These companies are adopting a more collaborative and participative approach to regional water management, by actively engaging with external stakeholders, including communities, local business, farmers, and government. The establishment of collaborative partnerships calls on mining companies to develop a better understanding of the water priorities of all stakeholders in a region, and to co-develop mutually beneficial solutions, based on the principle of "shared value". As highlighted by the International Finance Corporation (2014), this can lead to establishing trust and enhancing company reputation, ultimately reducing the risk of conflict and

improving water security. Case studies, cited in documents by the International Council on Mining and Metals (2012), the International Finance Corporation and International Council of Mining and Metals (2017) and Toledano and Roorda (2014), bear testimony to this paradigm shift in the approach of mining companies to mine water management over the past 5-10 years.

In South Africa, the Mine Water Coordinating Body (MWCB), established as an outcome of the broader Strategic Water Partnership Network (SWPN) in early 2017 and hosted by the Nepad Business Foundation (NBF), is setting the bar for collaboration on mine water collaborations. This body, comprising members from industry, government, academia and the NGO sector, aims to promote effective mine water management and re-use through cross-sectoral and multi-stakeholder engagement and innovation. South African mining companies are also taking the lead in terms of integrated mine water management, by adopting innovative solutions and entering into partnership agreements with government and community to both secure water for their own operations, and contribute to local and regional supply of clean water and sanitation to communities. This paper presents and assesses two case study examples; one in the Mpumalanga coal fields and one in the Northern Limpopo platinum belt. These case studies are based on a review of published papers and articles, supplemented by stakeholder interviews and participation in relevant workshops and seminars. Special attention is paid to specific challenges encountered, particularly in terms of sustainability of the solutions over the long-term, and the impacts on stakeholder relationships.

Case study 1: Mine water reclamation in the Mpumalanga coal fields

Context

Coal mining is a major economic activity in the north-east Mpumalanga Province (Figure 1), with a total of 239 operating mines and 788 derelict and ownerless mines being recorded in 2015 (Centre for Environmental Rights 2016), mostly lying in and around the towns of eMalahleni and Middelburg. Apart from 84% of South Africa's coal production, the province also accounts for 46.4% of the country's major arable soils, and is the heart of South Africa's maize production. Historically, coal mining has had a significant impact on the environment, with saline neutral and acidic metal-rich discharge from coal workings and discard piles resulting in extensive pollution of water resources and land in the province, and concomitant

adverse effects on surrounding eco-systems, community health and crop productivity. The area is also one of the fastest growing regions in South Africa, and the municipalities are battling to provide potable water to the rapidly expanding population.

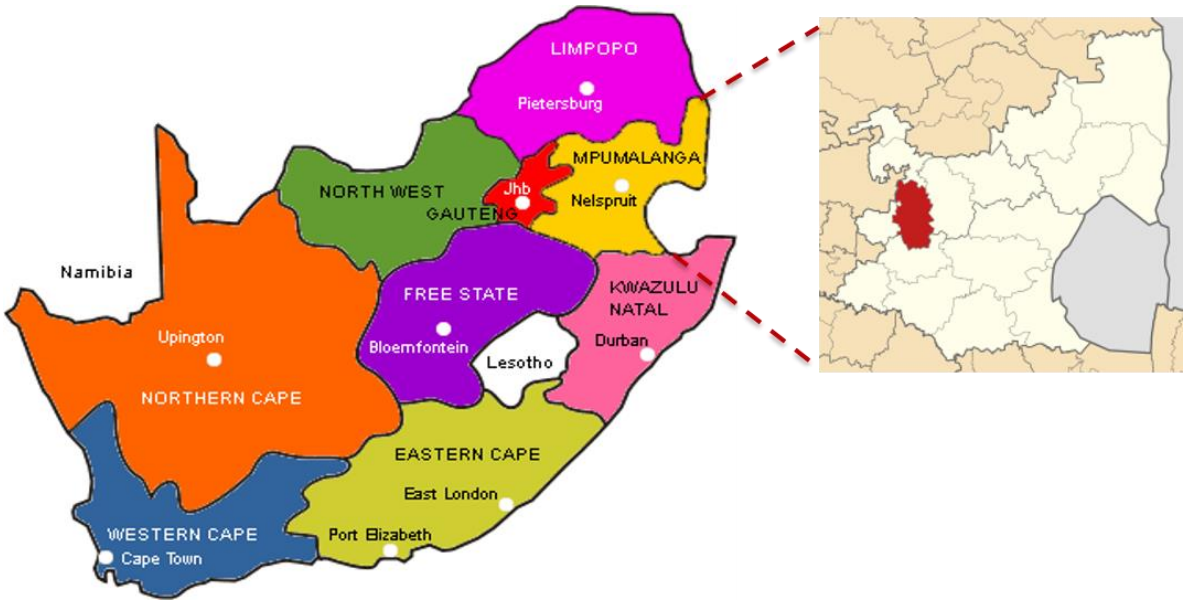

Figure 1: Mpumalanga coal field in South Africa (marked in red)

Paradoxically, whilst civil society struggles with water-scarcity above ground, the mines in the Province, some of which have reached the end of their working life and others which are still operating, are constantly having to deal with an excess of ingress groundwater. This mine ingress water poses a challenge to both operating and closed mines as it is contaminated by elevated levels of salts and metals, and is often highly acidic. It is thus unfit for human consumption or use and, without adequate management and resources, can lead to pro-longed pollution of groundwater and, ultimately, surface waters.

Description of interventions

It was against this background, that Anglo American's coal division (Anglo Coal), BHP Billiton Energy Coal South Africa (now owned by South32), and the eMalahleni Municipality embarked on a joint initiative to install the first commercial plant in the world for recovering potable water from acid mine drainage (AMD) in 2007 (Gunther et al. 2006). The operational eMalahleni Water Reclamation Plant (EWRP) uses a combination of lime neutralization (HDS process), reverse osmosis (HiPRO process) and ultrafiltration to treat contaminated mine water from three operating Anglo mines and one defunct coal mine belonging to

South32, removing 99% of the metals and salts. This plant is currently producing 30 ML/day potable water of which 25 ML/day is sold to the eMalahleni municipality, supplying 12% of the cities daily water needs and effectively providing drinking water for 60 000 people. Currently the plant is undergoing expansion and modification to treat mine water from additional collieries and extend capacity to 50 ML/day. The EWRP has been operating successfully for a decade with constant monitoring, routine maintenance and safety at the center of its function. Its success and impact has been recognized through several national awards. These include a gold medal by the South African Institute for Engineers, a Mail & Guardian's Greening Future Award and the sustainability category of Nedbank Capital's Green Mining Awards. The project was also recognized by the United Nations Framework Convention on Climate Change (UNFCCC) in 2011 as one the Lighthouse Projects in their Momentum for Change awards at COP17. On the back of the success of the EWRP, a mine water reclamation demonstration plant was commissioned at Optimum opencast coal mine (Cogha and van Niekerk 2009), followed by a second full-scale plant at Glencore's Tweefontein Colliery in 2016. The Tweefontein plant also uses the HiPRO desalination process to treat excess mine to drinking water standard, producing 15 -20 ML/day potable water, a portion of which is to be supplied to the local municipality at municipal tariffs.

Apart from augmenting the supply of drinking water in the Province, opportunities are also been explored for mining and agricultural sectors to work together to achieve food security, whilst simultaneously contributing to the protection of water sources. Under the auspices of the MWCB, the South African Water Research Commission (WRC), Anglo Coal, Exxaro and South32 are currently undertaking a demonstration project on 60 Ha of allocated land on the Mafube Colliery, using poor quality mining water to cultivate salt tolerant crops such as soybean and wheat (Mining Review 2017).

Challenges and impacts

The mine water treatment plants, whilst contributing significantly to the yield of the Middelburg and Witbank dam catchment areas, are not without their challenges. The costs of the treatment processes are relatively high, and the provision of potable water by the eMalahleni Mine Water Plant remains heavily subsidized by the mining industry. This brings into question the sustainability of current arrangements in the long-term as the mines have a finite life.

The treatment processes, furthermore, produce significant quantities of gypsum sludge (from the HDS neutralization and clarification processes) and salt brines (from the HiPRO process), the disposal of which typically amounts to between 25% and 30% of the total costs of the process. In an attempt to reduce the costs of waste disposal and potentially generate additional income to cover the costs of water treatment, 66 houses were constructed using the gypsum sludge from the EWTP as building material in a proof-of-concept pilot project in 2010. Following the success of this project, the EWRP currently sells the bulk of its gypsum waste to a local construction company for use as building material. The HiPRO brines from both plants are currently still disposed of in evaporation ponds. These require a huge amount of land and each one costs upwards of R100 million to construct. Furthermore, the life span for such ponds is only about five years and the risk of leaks into the surrounding soil is a danger. To address these issues, the world's first full-scale working unit for the eutectic freeze crystallization (EFC) of brines will soon be operational at the Tweefontein Colliery in Mpumalanga. The unit has been purchased by Glencore and built and designed by Prentec, based on the technology developed at the University of Cape Town's Department of Chemical Engineering. This plant will recover 5 ML/day desalinated water, as well as potentially useable salts from the hypersaline brines (Nicolson 2017).

Interviews with community representatives conducted by Shongwe (2016) indicated that interventions by the coal mining industry in Mpumalanga remain largely unrecognised, and have thus done little to relieve tensions and conflicts in the area. Community activists in particular felt that there had been no response or any plans to mitigate or address the impacts and risks presented by coal mining, and that community concerns in Mpumalanga are not being taken sufficiently seriously or receiving adequate response from government, mining companies or the general media. Whilst consultants felt that there had been some response to concerns, these had been insufficient and did not match the severity of the impacts. In fact, it was the impact of coal mining on water quality of local water resources, particularly as a result of AMD emissions, in Mpumalanga that raised the biggest concern amongst interviewees. The perceived lack of adequate interventions was, furthermore, attributed largely to the political influence and the unethical arrangements between government representatives and mining companies. Participants also called for more meaningful engagement between the different stakeholders to mutual benefit. In particular, the majority of participants suggested a joint initiative between civil society, mining

corporations and government in order to address, and effectively mitigate, the environmental and social impacts of coal mining in the Province. Companies were also expected to involve mining communities in decision-making and to develop more effective community grievance mechanisms.

Case study 2: Unique water partnerships for Mogalakwena platinum mine

Context

With 90% of their operations occurring in water stressed regions in the Northwest and Limpopo provinces, Anglo American's Platinum (Amplats) division has also adopted a collaborative, shared value approach to water management. In particular, the Mogalakwena mine, which is the largest open pit platinum mine in the world, is situated in the very arid and water-stressed Bushveld complex in the Northern Limpopo province, 35 km from town of Mokopane and 65 km from the city of Pholokwane (Figure 2). It is surrounded by 64 villages with a total population of 350 000, which make up the local Mogalakwena municipality.

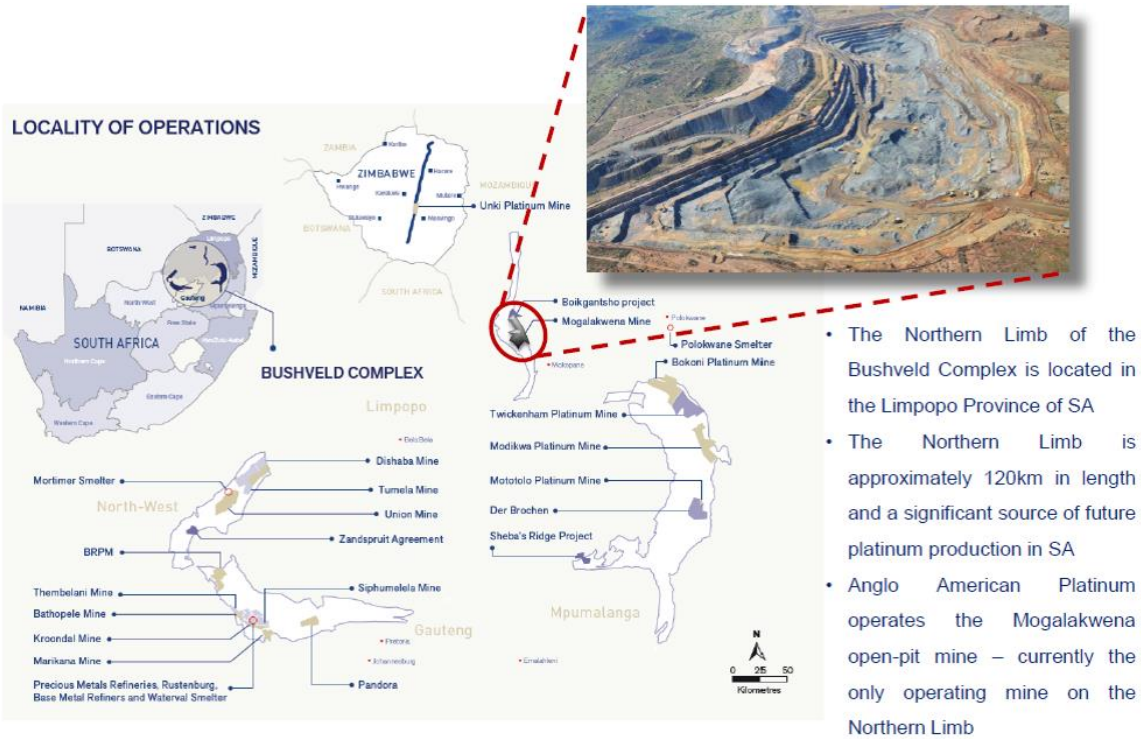

Figure 2: Mogalakwena platinum mine (modified from Anglo American site visit presentation, October 2014)

In a strategy report issued by the South African Department of Water and Sanitation (2016), the Mogalakwena catchment, which is the largest and most densely populated and industrialised catchment in Northern Limpopo, was identified as having insufficient water supply to meet current needs. Challenges also relate to lack of water infrastructure, with a number of settlements having no access to basic water and sanitation services. In a separate report (Fourie 2016), it was stated that stated that 179 Mogalakwena villages were experiencing a water crisis and that *"residents are forced to purchase 25 litres of water for R20 and those who cannot afford it, share water from the river beds with animals"*. Challenges of water scarcity and supply in the region are further aggravated by pollution issues. According to the Department of Water and Sanitation (2016), the large number of densely populated informal settlements posed a significant risk to groundwater quality, due to the high concentration of pit latrines which result in *e.coli* and nitrate contamination. These settlements are mainly dependant on borehole water to meet their needs, with pollution posing a serious health risk. Groundwater quality was also threatened by mining activities, with antimony, pH, total dissolved salts (TDS) and total suspended solids (TSS) being of potential concern. Large-scale irrigation of crops in the vicinity of the dams in this catchment area were also a source of potential surface water pollution.

Description of interventions

In line with Amplats water management strategy to reduce the use of potable water in its operations, and following an extensive test campaign, the Mogalakwena mine entered into an agreement with the municipalities of Mokopane and Pholokwane whereby secondary water from the sewage treatment plants would be use in the ore processing plant. In return, Amplats committed to assisting with the development and upgrading of various water supply, treatment and storage facilities, and the construction of a new pipeline from the town of Polokwane. The mine's parent company Anglo American has taken this partnership a step further by collaborating with the Development Bank of Southern Africa (DBSA) and the Investment Climate Facility for Africa (ICF) to implement a capacity building support programme at Mogalakwena, and 10 other municipalities across South Africa.

More recently, the mine has started to provide a number of communities, and two primary schools in the area with water from its deeper boreholes as a temporary measure, due to water shortages and the poor quality of locally available borehole water. This arrangement

was put in place following violent community protests in August 2015, during which a lack of potable water provision was highlighted as a key community concern. In March 2018 this effort was intensified, with 3.5-million litres a day of water being trucked to 42 villages in the region, in response to the drought conditions (Arnoldi 2018). In terms of relieving the water situation over the long-term, Amplats is currently collaborating with the South African Government and other stakeholders on the Olifants River Water Resource Development Project (ORWRDP), which includes construction of the De Hoop Dam and associated distribution components by 2019. This cross-sectorial partnership will meet the mining sectors requirements on the Eastern Limb and Northern limb of the Limpopo Province, and provide water to local communities, agriculture and other industries. Approximately 1.9 million people are eventually expected to be provided with clean water through this collaborative endeavor.

Challenges and impacts

Projected water requirements (Figure 3) have shown that the majority of the future water requirements will be met by the ORWRDP, with water predicted to be transferred from the Flag Boshielo Dam by the year 2022 (South African Department of Water and Sanitation 2016). In accordance with these predictions the effluent transfer from the Pholokwane Wastewater Treatment Works (WwTW) to the Mogalakwena Platinum Mine will, furthermore, free up water from this dam for other water users. At the time of these predictions, transfer of the treated sewerage effluent to the mine had, however, been discontinued due to inadequate quality of the effluent, attributed to the Pholokwane WwTW operating above capacity. The ORWRDP has, furthermore, been beset by a number of delays, adding to the water-related tensions and conflicts in the area.

Despite initiatives by Amplats to supply water to distressed communities surrounding the Mogalakwena Platinum Mine, community activists and community support organizations continue to consider the mine at least partially responsible for water shortages and pollution in the region. Furthermore, such initiatives raise questions as to where the responsibilities of private companies should lie such that that they do not supplant the role of local government. This question has been the subject of much debate at mining forums and workshops, and is complicated by the fact that many of the municipalities in South Africa are

in debt and have been accused of capacity deficits and financial mismanagement (Omarjee 2018).

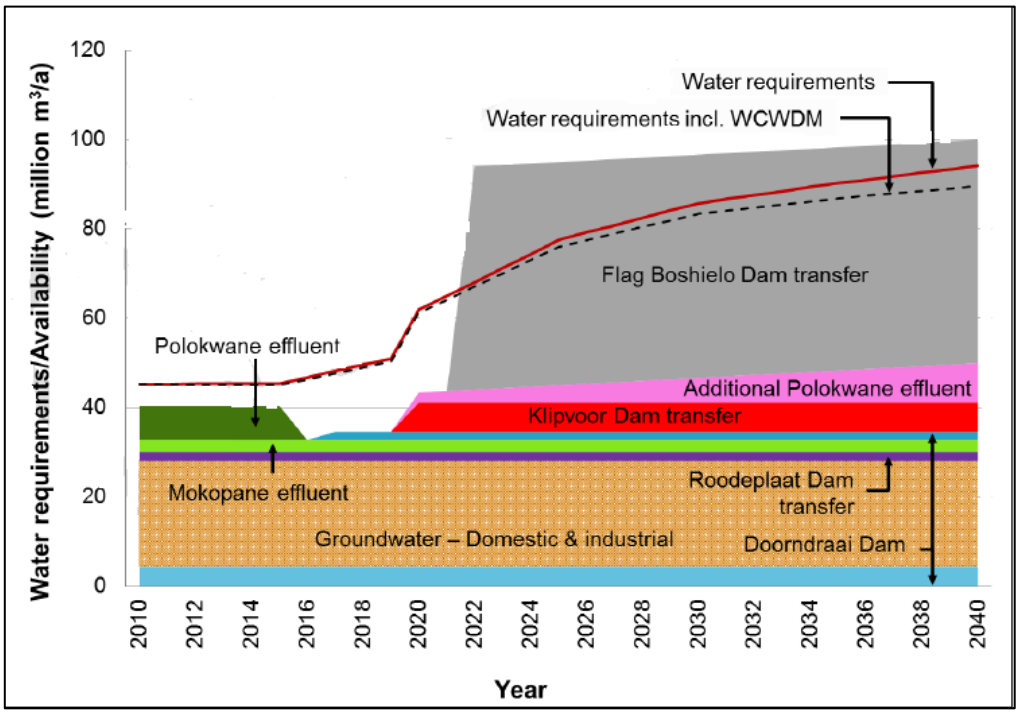

Figure 3: Water balance for Mogalakwena catchment (South African Department of Water and Sanitation 2016)

Conclusions

The mining sector is facing increasing regulatory and social pressures to both demonstrate efficient use of water resources on an operational and site level, and contribute positively to water planning on a local and regional scale. Case studies in South Africa have demonstrated that, by adopting innovative solutions and entering into partner agreements with local government and communities, mining companies can secure access to water for their operations whilst simultaneously contributing to regional supply of clean water and sanitation.

However, application within the South African mining industry remains relatively constrained and largely limited to major multi-national organizations. Whilst the benefits of adopting a “shared value” approach to mine water management can be significant, so are the

challenges. Firstly, the construction and operation of plants to reclaim mine water for drinking water purposes is expensive. Furthermore, despite efforts by many mining companies to reduce their water footprint, these efforts are not always appreciated, and there is still much work to be done to overcome cultural barriers and trust deficits within, and between, the various stakeholders. Another major barrier to the development and effective implementation of water management plans and activities in South Africa is the lack of institutional capacity and funding required within local government organizations to effectively manage water supply infrastructure.

Meeting these challenges is likely to require more than a few isolated public-private partnership initiatives. What is needed is the establishment of multi-partner networks to create and support inclusive approaches for the management of mine water on both an operational and regional scale, and to align practical activities with the discourse about mining's contribution to the UN's Sustainable Development Goals. In South Africa, the establishment of the Mine Water Coordinating Body and its sister organization, the Strategic Water Partner Network, is certainly a step in the right direction. However, it is essential that these organizations are extended to include a wider range of partners in order to facilitate decision-making that integrates the (often conflicting) perspectives and priorities of the multiple parties affected by mining operations. Such decisions should, furthermore, be underpinned by a sustained programme of research and development which drives technology innovation, and develops the necessary understanding and tools to overcome the business strategy and governance challenges involved.

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