



**SA urged to say  
'NO'  
to instant wealth and  
'YES'  
to environment**

*Investors and regulators need to look beyond the economical gains of mining and consider the long-term costs borne by society and the environment. This is one of the main messages emanating from the International Mine-Water (IMWA) Conference, held in Pretoria earlier this year. Lani van Vuuren attended the conference.*

South Africa's economy has benefited greatly from the country's vast mineral and metal resources. More than hundred years of mining have lined government coffers and made many mining houses and their shareholders rich beyond their dreams. However, the environmental costs are only now beginning to emerge.

Large mining operations are present in several of South Africa's nationally important water management areas, including the Vaal, Olifants, Crocodile and Mhlatuze. Some mining operations are even located at the vulnerable headwaters of these catchments with far-reaching consequences.

Many earlier mines now lie defunct and abandoned on the South African landscape. The lack of historical consciousness over the environmental impact of mining has resulted in few of these sites having been rehabilitated, leaving cavernous voids festering with poisonous water. This water, known as acid mine drainage (AMD), is teeming with heavy metals, salts and other toxins, bringing death, rather than life, everywhere it flows.

**LEGACY OF THE PAST**

When mining started over a century ago, water was approached as something to be avoided in mining operations. Authorities often turned a blind eye to pollution by mines, and there was little legislation compelling mines to clean up.

In later decades, water was considered in mine planning, but the full impact of water on mining – and the long-lasting effect of mines on water and the environment – was neither fully recognised nor appreciated. Today, legislation and policies have changed, but many areas are now suffering due to South Africa's mining legacy.

One such area is the Highveld Coalfields, in Mpumalanga, which contain about 50% of South Africa's recoverable coal reserves. Coal mining started in the

Witbank area in 1895, spreading out gradually as demand for coal was fuelled by the export market and the need in South Africa to produce more electricity. Three different methods have been used to extract the coal, namely bord and pillar mining, longwall mining and, more recently, opencast mining.

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Through the decades some deposits have been worked out and many mines have closed, leaving behind numerous environmental problems, the most significant being that of AMD. In their paper presented at the IMWA conference Prof Terence McCarthy of the School of Geosciences at the Witwatersrand University and Dr Koos Pretorius of the Federation for a Sustainable Environment explained that AMD is the result of the generation of sulphuric acid due to a chemical reaction between an iron sulphide mineral (pyrite) present in the coal and its host rocks and oxygen-bearing water.

“Mining breaks up the rock mass allowing free access of water and the acid-producing chemical reactions proceed faster than the acid can be neutralised. Consequently, the water becomes acidic and toxic to animal and most plant life. The acid water dissolves aluminium and heavy metals, such as iron and manganese, increasing its toxicity.”

Today, about 522 million m<sup>3</sup> of water is stored in the Highveld Coalfields (compared to the combined storage capacity of the Witbank, Middelburg and Loskop dams of 514 million m<sup>3</sup>). Post-closure decant from the defunct coal mines has been estimated at 62 Mℓ/day, with about 50 Mℓ/day of AMD draining into

the Upper Olifants River Catchment. This water eventually flows through the Kruger National Park and ends up in Mozambique.

Coal mining has also disturbed the aquifer structure of the Highveld, explained Prof McCarthy and Dr Pretorius. “Open-cast mining completely destroys the groundwater aquifer and creates a single, massive aquifer in the mine void. After mine closure, water fills this aquifer to the lowest elevation of the bedrock rim, and additional water entering the void decants over the rim. This water is of extremely low quality.”

As a result of long-term mining operations, water quality in Witbank and Middelburg dams have, over the past 30 years, shown a steady increase in total dissolved solids (TDS) and sulphate. “Bearing in mind that prior to mining the rivers concerned probably contained about 50 parts per million TDS, mining



*There are about 400 km<sup>2</sup> uranium-bearing gold-mine tailings on the Witwatersrand.*

has resulted in a ten-fold increase,” noted Prof McCarthy and Dr Pretorius. “Of greater concern is the fact that the sulphate concentration in the Middelburg Dam now exceeds the maximum recommended concentration for water for human consumption, and is still rising.”

In the Loskop Dam, fish kills have become commonplace while large-scale crocodile deaths have also started to occur as a result of the cumulative pollution of the Olifants River. (For more on the crocodile deaths, see *the Water Wheel* January/February 2009).

Various measures are being implemented to try to mitigate the deteriorating water quality in the Olifants River. These include the construction of evaporation dams, using contaminated water for irrigation, acid neutralisation, water purification, controlled release and soil protection. Notwithstanding these efforts, water resources in the area continue to degrade.

### THREAT TO HUMAN HEALTH

Another area where pollution from mining has become acute is the

Wonderfonteinspruit catchment. The Wonderfonteinspruit starts near Randfontein on the West Rand of the Witwatersrand and moves all the way down to Potchefstroom on the Far West Rand. It flows through one of the richest gold-mining regions in the world. During more than hundred years of mining in the catchment deep-level gold mining brought more than 100 000 of the radioactive heavy metal uranium from depths of up to 3 000 m to the densely populated surface.

As Prof Frank Winde of the School of Environmental Sciences and Development at North West University reported, the uranium producing gold in this area had exported some 240 000 t of uranium since 1952. More than double that amount (about 600 000 t) is estimated to still be contained in gold-mining tailings covering some 400 km<sup>2</sup> in the Witwatersrand basin.

“These slimes dams and associated infrastructure such as return water dams, pipelines and metallurgical plants, together with unmined uraniferous ore in mine voids constitutes a multitude of sources from which

**“Applications are dealt with on a single application basis without a larger development framework context being in place.”**

uranium migrates, mostly uncontrolled, into the environment,” noted Prof Winde. Like most non-essential heavy metals, uranium is toxic to humans. Consumed above certain concentrations it can lead to damage of the brain and kidneys. It has also been linked to certain cases of cancer and is an endocrine disruptor. The fact that thousands of informal residents are using the uranium-infected water in the Wonderfonteinspruit catchment for drinking and other purposes (such as watering homestead gardens) the situation is particularly serious.

### A NEW FUTURE

Increased regulatory pressure, coupled with the rising cost of water, has resulted in many South African mines introducing improved water management measures since the 1990s. According to Wendy Mey of BHP Billiton, some of these measures include: selective handling of different mining waste and spoils materials to reduce pollution generation; separating clean and dirty water; implementing better surface rehabilitation practices to minimise water ingress; free drainage of rehabilitated and disturbed areas; and irrigation use of mine-water to enhance rehabilitation vegetation cover.

“There has been a paradigm shift from considering excess impacted mine-water as a nuisance to considering it as a valuable resource,” said Mey. “Mine-water is now considered critical to the management of a mining operation.” Implementation of the full spectrum of what is considered best practice water management actions may, however, still result in excess



Lani van Vuuren

*Mine-water is increasingly being seen as a resource rather than a pollutant. At the Emalaheni Water Reclamation Plant outside Witbank mine-water is treated to potable standard for use by the local municipality.*

water decanting from mining operations, especially in the later years of the life of the mine and in the post-closure situation.

**RECYCLING AND RE-USE**

With 98% of South Africa’s existing water resources allocated at a high assurance of supply all eyes are turning to ‘alternative’ sources of water – treated mine-water being one such a potential source. In Emalahleni (Witbank) mine-water is already being reclaimed for potable use by the local municipality. In the Witswatersrand basin, plans are afoot to pump underground mine-water to a central treatment plant in Germiston where the water will be purified and sold to Rand Water. This somewhat controversial project is being led by the Western Utilities Corporation.

Dr André van Niekerk of Golder Associates believes that mine-water can be retained for a number of uses, including municipal and industrial operations, new mining ventures, and agriculture. “There is considerable volumes of water being stored in South Africa’s old and active mine workings. In the Witwatersrand basin alone, the volume is reaching 656 million m<sup>3</sup>.”

Much research effort has been mobilised to find appropriate and reliable mine-water technologies, said Dr Van Niekerk. This includes membrane treatment, precipitated processes such as CSIR’s barium carbonate process; ion exchange, passive treatment using renewable carbon sources and biological treatment involving sulphate removal and sulphur recovery.

However, as Mey pointed out, the capital and operational costs associated with mine-water treatment have been an impediment to the implementation of such advanced water treatment processes. Challenges also remain with respect to the handling and disposal of sludges and brines generated by these treatment processes.

Mine-water reclamation and re-use projects not only require substantial capital investment, but also long-term operation and maintenance. This is so even for passive mine-water treatment systems. Mining companies might just not get the ‘set up and walk-away’ solutions they are seeking following closure.

**NEW MINING APPLICATIONS**

South African mining development is not at an end. Numerous areas have been earmarked for new mines. Voices of concern have especially been raised over the numerous new coal-mines being proposed for Mpumalanga’s Great Lakes District. At least 114 mining-related applications for coal have been received to date.

This hydrologically-sensitive area, which includes South Africa’s largest freshwater lake, Chrissiesmeer, lies at the headwaters of three major river catchments, the Vaal, the Olifants and the Komati. The pans that make up the Lakes District are considered geomorphically unique, and are home to hundreds of bird and animals species.

Prof McCarthy and Dr Pretorius have called for a moratorium on new mining

applications in this area until such time as the cumulative impact of mining is fully understood and adequate sustainable mitigation measures can be guaranteed. “Experience in the Highveld area provides some insight into what the future consequences might hold. The mitigation measures currently being employed are not adequate to prevent the area from turning into a wasteland. The scale of the problem is going to increase enormously in the future as the mines close and water management becomes more difficult.”

“There is currently no large-scaled master plan either in place or planned to prevent this based on knowledge of the impact and within a decision-making framework taking all of the impacts into account. Applications are dealt with on a single application basis without a larger development framework context being in place.”

South Africa has made strides in the improved management of mine-water. It is important that we look beyond the bottom-line at the legacy we are leaving our children. Concerted efforts are required by all parties to prevent the country’s scarce water resources from being compromised. 



*Fish kills are a regular occurrence in Loskop Dam on the Olifants River.*

Courtesy/Jan Myburgh