Valuing Mine Water — A South African Perspective

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ABSTRACT

Water is an integral and essential part of mining business. Two issues crucial in the management of this resource, scarcity and excess, are increasing awareness of the importance of water and changing the value perceptions of the industry because they affect both the existence and continuation of the business. Therefore its value should be reflected in the water management that is practised on site. Historically water in mining has been perceived to be of low value so management practices have not been good or well implemented.

Political and social transformation in South Africa has been accompanied by the promulgation of new legislation. South African water law is now underpinned by Integrated Water Resource Management (IWRM) principles. It impacts water pricing, provides for water pollution charges, prioritises water users, has specific mining and water related components and requires water licensing as part of the licence to mine. Mining no longer has a priority on water resources and has to compete with other water users to gain access to resources. New institutional arrangements are being put in place to implement the regulations. All this requires a paradigm shift in mining's view of water. Generally the sector is still catching up with the new requirements, principles and philosophies.

However, the way in which South African mining values water is changing. This is demonstrated in partnerships between the industry and other water users. These partnerships are Integrated Water Resource Management (IWRM) in practice and they achieve sustainable development goals. These partnerships are essential for mining to stay in business, expand operational capacity, reduce impacts, prevent legal action and reduce reputational risks.

INTRODUCTION

Understanding how mining interacts with water systems enables the value of water to mining business to be appreciated. Changes in South African legislation, such as the introduction of integrated water management principles and application of sustainable development principles, have required new approaches to water management by mining. These are changing the perception of the value of water in the industry. However, for historical reasons mining is slow in appreciating and understanding the value good water management brings to the business.

How South African water law applies to mining is fundamental in understanding the value of water to this sector. The concept of Integrated Water Resource Management (IWRM) is embodied in South African water and environmental law. The law impacts water pricing, provides for water pollution charges, prioritises water users and requires water use licensing, which is needed as part of the licence to mine. The issuing of a licence is now dependent on stakeholders in catchments, satisfying the regulatory requirements and demonstrating an understanding of the water regimes with adequate technical data and information. In this paper, the components of the legal framework for mining and for water that drive the value of water in mining is documented. These components include acts, regulations, policies, strategies and guidelines. Comment is made on the status and the implementation of these components and how they have affected water management in the South African mining industry.

Mining business in South Africa is committing to sustainable development principles and mechanisms. These principles have changed the perceptions of the value of water through increasing awareness that water resources and their management are essential for economic productivity, economic growth, poverty alleviation, enhancing living standards and maintaining biodiversity and ecosystems. Value is also being recognised with the growth in understanding of the complex interconnections between water and factors such as energy, climate change, environmental health, economic development and security and by the recognition that depletion of water flows and degradation of water quality weakens water as one of the resources on which society is built. Sustainable Development (SD) principles lead to the need to understand and apply IWRM. In South Africa there are examples of proactive IWRM that commenced before the implementation of the new water legislation in the country (Salmon and Van Zyl, 1999 and Salmon, 2003). It is incumbent on mining to implement good water management practice to satisfy both legislative and SD needs. The approaches and activities needed to manage these risks include situation analysis, risk assessment, water management systems, integrated water resource management and mine water action plans.

The most relevant applications of the principles of the new legislation and SD are shown in partnerships between mining and other water users. This demonstrates how mining in South Africa applies IWRM. These partnerships are essential for mining to stay in business, expand operational capacity, reduce impacts, prevent legal action and reduce reputational risks. This paper records ways in which South African mining is partnering with water users in catchments and achieving significant benefits and adding value.

The mining and minerals industry in South Africa

South Africa is a leading producer of a range of minerals of which gold, diamonds, coal and platinum dominate production. Mining is South Africa's largest industrial sector and it has contributed significantly to the national economy for well over 150 years. The South African Department of Minerals and Energy (2005) recorded the production of 59 different minerals from 993 mines and quarries during 2004 to 2005. Of the total number of mines 49 are gold mines, 28 are platinum group metal mines, 64 are coal mines and 145 are diamond mines. These commodities are exported to 85 countries.

The total primary mineral sales revenue in South African Rands for this period was R125.2 billion. Sales of primary mineral products made up 28.7 per cent of South Africa's total export revenue. The industry employs 2.95 per cent of the economically active population.

Water in South Africa

South Africa is a semi-arid country with a relatively low rainfall. Rainfall patterns are erratic but there is a gradient of increasing rainfall from the desert areas on the west side that may have less than 150 millimetres (mm) per annum (pa) to 1200 mm pa towards the east side of the country. Most accessible water sources are becoming fully utilised with increasing demand from a high population growth rate and an expanding economy. Groundwater supplies are limited and often of poor quality.

The country is divided into 19 major catchment areas (see Figure 1). The main mining areas are located in the following river catchments. Gold in the Upper and Middle Vaal River catchments, Platinum in the Limpopo, Crocodile West, Marico and Olifants River catchments, Coal in the upper and Middle

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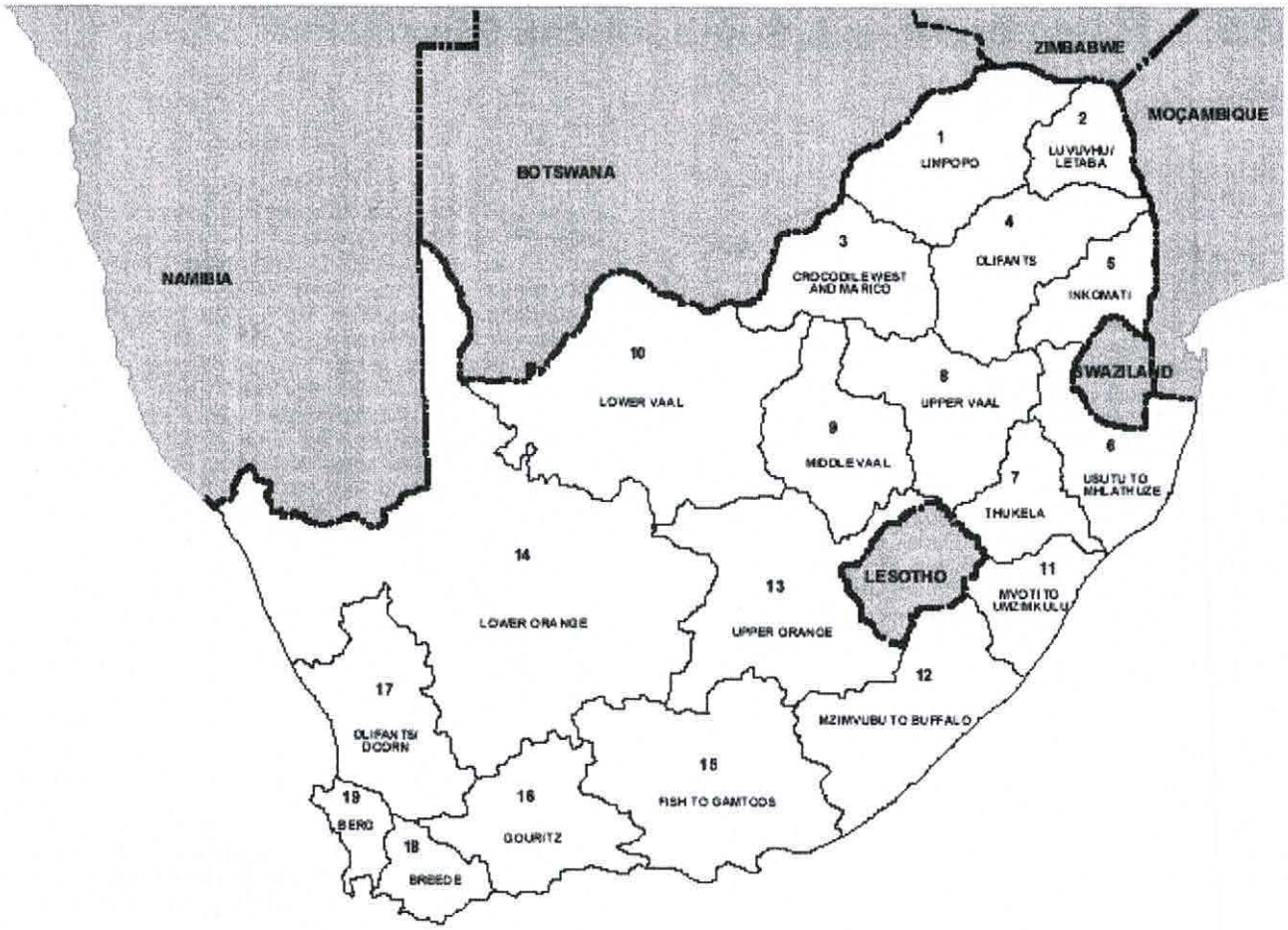

FIG 1 - The water catchment areas of South Africa.

Vaal, Olifants, Usutu/Mhlathuze River catchments and Diamonds in the Vaal, Lower Orange, Olifants-Doorn and Olifants River catchments.

Some of the catchments are shared river systems that act as international boundaries or cross international boundaries between South Africa and adjacent countries. These include:

- the Limpopo River, which forms the border between South Africa and Botswana, Zimbabwe and Mozambique;
- the Orange River, which forms the border with Namibia; and
- the Olifants and Crocodile River systems, which cross the border and flow into Mozambique.

Water usage in South Africa

Mining is a very low user of water compared to other users in the country, as shown in Table 1. However, at a local catchment level the percentage of water use by mining can be considerably higher.

Table 1 shows water withdrawals by water-use sector in South Africa (for 2000) as a percentage of the total withdrawal of 22 438 GL (Cogho and Hugo, 1996).

TABLE 1

Water withdrawals by water use sector in South Africa (2000) as a percentage of the total withdrawal.

Activity	Percentage withdrawal
Irrigation	48.9
Municipal	14.4
Ecological use	13.1
Industrial	9.1
Forestry	7.0
Electricity	3.5
Mining	2.6
Stock watering	1.4

FACTORS AFFECTING MINE WATER VALUE

Water is a fundamental component of mining and mineral processing operations. It can rarely be substituted, although technology allows water quality to be improved for certain uses, and it is recognised as the major environmental issue in South African mining. Regulators and stakeholders consider mining to be a water intensive industry in South Africa although it is comparatively a low user at a national level (see Table 1). Water is essential in all phases of the mining life cycle from exploration to post closure.

Historic factors affecting existing value perceptions

Mining, as a major contributor to the South African economy and its socio-economic development, has historically had easy and preferential access to water and at a low cost or at preferential rates. Awareness of the true value of water to mining has therefore not been realised as the perception of value is based upon a history of abundant and cheap water.

Change in value perceptions

Over time mining in the country has gained a reputation as an excessive user and polluter of water. This is reflected in increasing regulatory constraints on the mining sector as the government tries to protect the resources.

Local factors that have or are changing how South African mining views water are:

- the change in the political regime and political dispensation in 1994,
- the promulgation of new legislation specifically the *National Water Act of 1998* (Act Number 36 of 1998) (NWA), and
- the growing recognition by mining businesses that water scarcity and excess water have potentially large impacts on the development of ore reserves in the country.

Value drivers

In South Africa drivers giving perspective in the valuation of water for mining include environmental, legislative, social, economic, technological, production and product use, cultural and public health values. More specific mining-related drivers include the following.

Geographic location

Mining occurs in diverse geographic regions within South Africa. The location of a mine may affect water availability, use, disposal and pollution. It follows that the value of water to a particular mine operation will be dependent on the location and geological setting.

Operational methods

Different mining methods and mineral beneficiation techniques have different water demands and affect water in different ways. A description of these affects in South African coal mining is given in Salmon (2000). Valuation of water will depend on the commodity being mined and the mining and processing methods used. These methods will also define an operation's ability or inability to use water efficiently and change the valuation accordingly.

Integrated water resource and catchment management

The principles of integrated water resource and catchment management are fundamental in South African legislation. The impact of external water users will drive up the value of water in a catchment and this should be reflected in the way the mine views water on site.

Scarcity

The need to overcome existing water shortfalls and increasing demands for water from expanding populations and for economic development will result in an increase in water scarcity. Scarcity will increase the cost of water and boost competition for water resources. Mining will have to demonstrate ongoing improvements in water management to be able to compete for water allocations in future scarce water scenarios.

Global sustainable development drivers

The global importance of water to economic production, economic growth, poverty alleviation, enhancing living standards maintaining biodiversity and ecosystem health, is included in global sustainable development policies, strategies and imperatives. Mines are or have developed corporate responses and are putting in place sustainable development approaches to water management. Water management principles have been put in place within the sustainable development framework based on the Dublin Principles, Agenda 21, the Millennium Development Goals, the unity of the water (hydrological) cycle and the understanding that water is a source, a pathway and a receptor of pollution.

Economic drivers

The driver with the potentially greatest impact on mining business is economic value. Sustainable water resource management approaches recognise the importance of economic value. Economic value of water is identified in principle 4 of the Dublin Statement (1992) on water and sustainable development, which states:

> *Water has an economic value in all its competing uses and should be recognised as an economic good.*

Similarly, Agenda 21, chapter 18 (UNCED 1992) mentions economic value:

> *Water should be regarded as a finite resource having an economic value with significant social and economic implications regarding the importance of meeting basic needs.*

Agenda 21 requires integrated water management approaches.

Price provides a quantified figure for the economic value of water. Unfortunately the price of water is often only the charge levied by the water supplier and therefore is only a portion of the cost. Full cost pricing and hence fully quantified economic value is only seen when users pay the full cost of obtaining, collecting, treating and distributing water as well as the cost for collecting, treating and disposing wastewater. In mining the full costs can be determined by considering all costs involved, such as transport, pipelines, pumping, manpower, analyses, monitoring treatment and water studies. Such costing is rarely found on mining operations.

Mine water valuation indicators

The way in which water management is implemented on an operation is indicative of the value placed on water by a mine. In the past the low charges for water reduced the incentive to conserve water resulting in water overuse, poor management control, wasteful attitudes and poor maintenance of water systems that are seen in leaks and lack of monitoring.

Fundamental water management factors that should be in place are:

- water reticulation plans,
- water balances,
- water management systems including maintenance plans,
- monitoring systems both on and off site,
- integrated mine water management plans that are linked into the catchment management plan for the catchment in which the mine is situated, and
- full cost accounting of the water use on the mine site.

LEGISLATION

The legal framework

The components of the legal framework relevant for mining and for water in South Africa are acts, regulations, government notices and guidelines, policies and strategies informing the legislation and best practice guidelines for mine water management. The legislation in South Africa suffers from a lack of implementation; therefore, as a driver of value this aspect has not had the impact that would be expected.

The Constitution (*Constitution of the Republic of South Africa* Act 108 of 1996) underpins all legislation in South Africa. There are a number of acts that relate to mining and water but four have the greatest bearing. The *National Water Act* (Act 36 of 1998), and the *Water Services Act* (Act 108 of 1997) are very specific. The *National Environmental Management Act* (Act 107 of 1998) and the *Mineral and Petroleum Resources Development Act* (Act 28 of 2002) are of a more general nature.

The Constitution

The South African legal situation changed markedly with the advent of a democratic South Africa in 1994, which led to the promulgation of the constitution. This statute lays the foundation for a more just and equitable society. Section 24 ensures a basic anthropocentric right to an environment that is not harmful to human health or well-being and states that pollution must be prevented, the environment protected and sustainable use of resources must be promoted through reasonable legislative and other measures. It upholds the integrated protection of resources using the legislation to prevent pollution and ecological degradation, and it promotes conservation and secures ecologically sustainable development.

Mineral and Petroleum Resources Development Act 2002 (MPRD)

This Act ensures that the mining sector is subject to the same norms, standards and requirements applicable to the other industries in South Africa. The objective of the Act is focused on pollution prevention and control and synchronisation with other Acts such as the *National Water Act 1998* and *National Environmental Management Act 1998*. The MPRD notes the importance of managing water resources in an integrated way.

National Environmental Management Act 1998 (NEMA)

NEMA endorses integrated environmental management and ensures equitable access to environmental resources, benefits and services to meet human needs. The Act was promulgated within the framework of the constitution and makes provision for cooperative governance. Cooperative governance is important because the Department of Water Affairs and Forestry (DWAF), the Department of Minerals and Energy (DME) and the Department of Environmental Affairs and Tourism (DEAT) are three major governmental departments who each have Acts that relate to mining and water.

The National Water Act 1998 (NWA)

The NWA recognises the need for integrated management of all aspects of water resources, and the protection of water quality to ensure equitable allocation and beneficial and sustainable use. The Act promotes sustainability principles such as integration and holism, the Cradle to Grave principle, the Polluter Pays Principle (internalisation of external costs), accountability and liability, the Precautionary Principle, due consideration to alternative options – the best practical and most sustainable environmental options, continual improvement, transparency and democracy.

It aims to maximise value through reducing costs, recovering costs and addressing socio-economic needs. South African water resources management policy does not aim to prevent the disposal or discharge of waste into the environment at all costs, because in a developing country such prevention is not justifiable because social and economic growth may not be achieved.

National Water Act principles

The water law principles were accepted by the South African Cabinet in November 1996 after extensive consultation. The NWA is based on 27 principles that fall into seven main categories, from which water value can be derived. The seven categories are as follows.

1. The water cycle

In this category the unity of the water cycle and the interdependence of its elements are recognised and water in the water cycle is considered variable and has an unpredictable nature. Mine staff needs to understand the climatological, meteorological and catchment characteristics of the area in which it operates. These characteristics should be built into their planning. An operation has an effect on water supply and demand and needs to manage the effects of floods and droughts, and hence flood protection measures, levee designs, stream diversions, etc. This implies the need to understand integrated catchment management approaches.

2. Legal aspects principles

Water is a resource common to all, the use of which is subject to national control. Water is not owned, no riparian rights exist and there is only a right to use water. Water use requires registration and licencing under section 21 of the Act. Mining must compete with other users to be able to use the water, even if it is sourced from its own property.

3. Water resources management principles

The quantity and quality of water will be managed to achieve optimum long-term social and economic benefit. Water will be reserved to meet people's domestic needs and to maintain ecological function of watercourses and bodies. The water demands of a mine are placed at a lower priority than potable water supplies to people and water to satisfy the ecosystem requirements.

The principles recognise international water resources. Many South African mines lie in catchments where the water resources are shared internationally as noted above. The knowledge and understanding of cooperative agreements between countries is needed.

4. Water resource management approaches

There are ten principles in this section and the relevant ones include:

- water resources are considered an indivisible national asset, which national government has ultimate responsibility for, and authority over, including the equitable allocation and usage of water, the transfer of water between catchments and international water matters;
- the DWAF will use criteria of public interest, sustainability, equity and efficiency of use that reflect the value of water to society;
- user sectors will be able to gain equitable access to water through the regulator who will manage the demand using various measures;
- integrated approaches to water quality and quantity management including consideration of broader environmental approaches will be applied;
- the polluter pays principle will apply;
- land uses that impact the water cycle must be managed; and
- contributions to or investments in water infrastructure by the water user will be considered when setting conditions to water rights.

There are a number of implications to mining arising from this set of principles:

- Mines will have to apply to DWAF to abstract water for their use or to transfer water from other catchments for their use.
- Mines need to approach water management with a knowledge and understanding of Integrated Water Resources Management approaches and principles including the need for public consultation.
- Mines will have to compete with other user sectors to obtain the water they require. Operations have to put in place conservation measures such as optimising water use on site, reuse and recycling, and minimising water losses to ensure that they will qualify for available water or for additional water they may require. Their performance in these areas will be judged against other competitors for the same water resource.
- Mining, especially opencast operations and mining waste disposal facilities, have a significant impact on land use and the water cycle so integrated land use plans are needed.

5. Water institutions

The institutional framework for water management is defined and responsibility for the development, apportionment and management of available water resources will be delegated to a catchment or regional management level. Water management systems will be established by the catchment authority and maintained by water users who will contribute to costs. In future mines will respond to catchment management agencies and water charges, which are already being charged, will fund the management systems.

6. Principle of existing water rights

Water rights existing under the 'old water act' maintain validity but all mines have to register all water uses as defined by the new act (section 21) and then apply for licences under the new act. This implies that some previous rights may not continue. However, there is compensation allowed in these cases. The new water use registration and licensing system has been implemented slowly so that previous permit conditions still apply.

7. Water services principles

The right of all citizens to have access to basic water necessary to afford them a healthy environment on an equitable, economically and environmentally sustainable basis should be supported, but this provision of service will be in a manner consistent with the goals of water resource management.

Mines that supply water to other users may fall under the water services act and should take note of the requirement to follow IWRM goals and will have to register as water suppliers.

Water use licensing

This is extremely important in the mining context. Without a licence to use water, a mining licence cannot be issued. If a mine has existing water use permits under the old water act of 1954, the operators can continue to use water under the conditions of these permits providing they have registered the water use and applied for a new licence under the requirements of the NWA.

Licences are required under section 21 of the NWA for the following uses of water:

a. taking water from a water resource;

b. storing water;

c. impeding or diverting the flow in a watercourse;

d. engaging in a streamflow reduction activity (for example land-based activities that significantly reduce streamflow);

e. engaging in a controlled activity (ie activities having a detrimental impact on water resources);

f. discharging waste or water containing waste into a water resource;

g. disposing of waste in a manner that may detrimentally impact on a water resource;

h. disposing of water that contains waste from any industrial or power generation process;

i. altering the bed, banks, course or characteristics of a watercourse;

j. removing, discharging or disposing of water found underground; and

k. using water for recreational purposes.

Most identified uses have an impact on the quality of the water resources. The Act requires source and resource directed measures to be taken into consideration when applying for a licence.

The regulations relating to use of water in mining

Regulation R704 provides regulations on the use of water for mining and related activities aimed at the protection of resources. This regulation details:

- Information and notifications required by the regulator including the manner in which emergency incidents or potential incidents have to be handled.
- Restrictions on the locality of mine infrastructure in relation to water resources, for example no surface activity is allowed within 1:100 flood lines.
- Restrictions on the use of materials that could pollute water resources. This requires planning in the placement of mining materials and waste and will require geochemical characterisation of materials.
- The requirements for clean and dirty water separation systems to ensure that these are separate, are sized according to the flows that they will take, and that they are maintained.
- Methods to protect water resources.
- Security measures that might be needed for water systems.
- Temporary or permanent cessation of the mine.
- Regulations in respect of sand winnowing.
- Regulations in respect of coal residue deposit rehabilitation, which requires compaction of coal discards.
- Technical investigations and monitoring specified by the regulator.
- The need for the mine owner to provide every facility to enable managers on the mine to meet the regulation requirements. Budgets and staffing levels are important in this respect.
- The penalties for offences, which include fines and imprisonment terms.

Exemptions from the regulations may be allowed on application to the DWAF.

Policies

There are seven policies that relate to mining and water and published by DWAF and DME.

Department of Water Affairs and Forestry policies

- Development of resource directed water quality management policies, and
- MS5.3 initial report: in support of an ISO 14001 based management system for water quality management 2003.

Department of Minerals and Energy

- Policy requirements of government, employers, small-scale miners and others regarding environmental management;
- policy concerning financial provision for the rehabilitation of land disturbed by mining activities;
- policy concerning the granting of a (closure) certificate in terms of section 12 of the *Minerals Act 1991*, to mines releasing such mines from further regulatory responsibilities concerning environmental management and conservation;
- broad-based socio-economic empowerment charter for the South African mining industry; and
- policy regarding governance, regulation and promotion of a competitive and sustainable mining industry in South Africa.

Water pricing strategy

This strategy covers the pricing of water but not the pricing of water services, which in South Africa is dealt with under the *Water Services Act 1997*. It introduces a water resource management charge. It deals with the use of raw water (also referred to as first tier water) from a water resource. This was first published in 1999 and allows for charges to be applied to any water use that has been licensed. Three categories of use are noted in this strategy. The individual water uses according to Section 21 (noted above) can be placed in these categories as follows:

- abstraction-related use (Section 21 a, b and d);
- waste discharge related use (Section 21 e, f, g, h and j); and
- non-consumptive use (Section 21 c, e, i, j and k).

The water pricing strategy was revised in 2005 to include the polluter pays principle in the form of the waste discharge charge system.

Waste discharge charge system (WDCS)

The WDCS is an economic instrument providing financial incentives for waste dischargers to reduce waste and use water resources in a more efficient manner. It is still being finalised and is expected to be in place by 2007. The system is based on the polluter pays principle and aims to:

- promote the sustainable development and efficient use of water resources,
- promote the internalisation of environmental costs by waste discharges, and
- recover costs associated with mitigating water quality impacts of waste discharges.

Charges will apply to:

- point source discharges,
- marine outfalls,
- waste disposal to facilities and land, and
- irrigated effluent.

The specified elements that will be charged in the WDCS include, but will not necessarily be restricted to:

- nutrients: phosphates, nitrate, ammonium;
- salinity: total dissolved solids, chlorine, sodium and sulfate;
- pH;
- heavy metals: arsenic, cadmium, chromium, copper, mercury, lead, nickel and zinc; and
- organic material: biological oxygen demand (BOD).

The WDCS drives the need for mining operations to achieve zero effluent discharge and correct handling of waste containing one or more of the substances that could be leached or discharged into the groundwater and surface water systems.

The WDCS will be applied at a catchment scale. The catchment area will be defined as those areas that have a significant impact on or are impacted by the specific water quality problems. This could be an entire catchment in which a widespread water quality problem exists or a subcatchment within a larger basin.

The charges to a waste discharger will be based on a linear relationship against load, using a constant charge rate for a specific element from the list of elements above. The charge rate will not vary against concentration. The load or concentration associated with the intake of water supplied to the discharger may be deducted from the waste discharge load in calculating the charge.

The WDCS consists of two distinct water use charges, either or both of which may be applied in a specific catchment:

1. The incentive charge is an economic charge to promote the reduction of discharge in order to meet specified resource quality objectives. The incentive charge rate in a catchment where the resource quality objectives are not being achieved (or are threatened), is based on the average costs of reducing load from the different dischargers contributing to the water quality problem within the catchment. This may be based on the costs of an intervention at any stage in the production process, including treating effluent, improving management practices and systems or adopting cleaner technology.
2. The mitigation charge is a user charge to recover the costs of mitigating the impacts of waste discharge on the resource.

Comprehensive framework – integrated water resource management: mining sector

This strategy is still being developed by the DWAF. Its purpose is to enable and ensure integrated management of water resources in the South African mining sector through participation by relevant stakeholders. The framework will ensure the application of source directed controls and resource directed measures for all sources of water pollution emanating from land.

The provision of water pollution control works at abandoned, derelict or ownerless mines

It provides a summary of the process to be followed for these mines and covers investigations, legal action, design and construction of pollution control works, and how to deal with the issues of owners that cannot afford to contribute significantly to the rehabilitation.

Closure methodology for mines

The basis of the methodology lies in various levels of risk assessment, and whether closure is acceptable without further mitigation measures. The issue of long-term pollution problems arising after the State assumes responsibility for the mine is also covered. This is still being drafted.

Guidelines

Seven operational guidelines, produced by the DWAF, and based on the previous water act provide insight into various aspects of mine water. They are:

1. The M1.0 Operational Guideline for the control over the alteration in the course of a public watercourse.

2. The M2.0 Guideline concerning financial provision for the rehabilitation of land disturbed by mining activities.
3. The M3.0 Policy and Strategy for management of water quality regarding the mining industry in the RSA.
4. The M4.0 Operational Guideline for the application by a mine for a permit in terms of sections 12B and 21 of the *Water Act No 54 of 1956*. This is out of date but contains the four-step hierarchy for mine water management that is the foundation of the DWAF integrated mine water management policy.
5. M5.0 Operational Guideline for DWAF to assist DME with EMPs in terms of the *Minerals Act 1991*.
6. M6.0 Guideline document for the implementation of regulations on use of water for mining and related activities aimed at the protection of water resources (2000).
7. The Guideline for Small Mining Operations. This is a comprehensive set of 11 guidelines covering sand mining, prospecting, crushing, salt mining, mining of gold deposits, material for road building and precious stone mining.

Best practice guidelines for water quality management in the South African mining industry

Three tiers of best practice guidelines (BPGs) dealing with technical guidance, policy and strategy and operational guidelines are being produced for the DWAF. These will specifically supply guidance on how to comply with what the DWAF have called a four-step hierarchy of decision making in water management for mining. This hierarchy is really a process flow for decision making based on the precautionary principle and prioritises mine water management actions (see Figure 2).

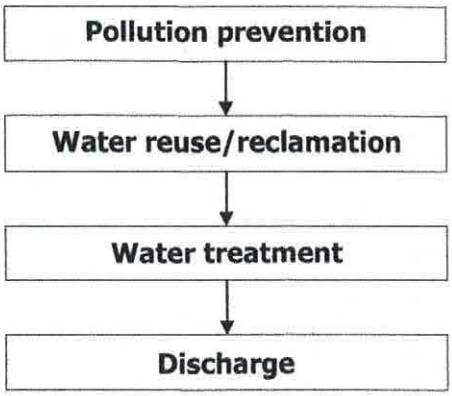

FIG 2 - The DWAF hierarchy of decision making.

All guidelines are still being drafted. There are seven guidelines in the first series covering:

- integrated mine water management,
- storm water management,
- water reuse and reclamation,
- overview of water treatment options,
- pollution prediction from mining sites,
- water and salt balances, and
- water monitoring systems.

A second series of BPGs will cover specific mining activities and a third series is planned to address the topic of mine water treatment.

Values realised

Multiple values for water resources are contained within this legislative framework. In broad terms these values include environmental, financial, business, economic and social values. These aspects form the foundation of sustainable development and therefore the sustainability of water resources.

PARTNERSHIPS

Integrated catchment management requires new mining projects and existing operations in South Africa to consider the needs of other water users in the catchments in which they operate. To achieve this mines and new mining projects in South Africa are forming partnerships with other water users in the catchment in which they operate so that they can stay in business, expand operating capacity, reduce impacts on the water resources, prevent legal action and reduce reputational risks. Examples from the crucial issues of excess or scarcity of water and the value they bring are discussed hereunder.

A partnership to deal with excess mine water

This example documents the joint venture between various coal operations of different mining houses and the Emalahleni Local Municipality to treat excess mine water in the Witbank coalfield of the Mpumalanga Province. More details on this can be found in Günther (2005). Value is seen in the ability to maintain mining where it could be stopped due to flooding, the onward sale of the water treated, planning for long-term post-closure and the potential to create a Black Economic Empowerment Mine Water Company.

The mining issues

Extensive mining of the coal reserves located in the Olifants River catchment has occurred for over a century. Infiltration, enhanced by the presence of extensive mining, leads to flooding of abandoned underground workings. Hydraulic gradients develop causing flow between adjacent mines, called intermine flow (Usher *et al*, 2003), as well as discharge to surface by seepage and decant. Opencast mining methods are commonly employed and these operations frequently mine into areas previously mined by underground mining methods. As opencast mining extends into deeper areas it has become necessary to dewater the old underground workings to allow access to ore reserves.

Studies indicate that when mining is complete some 360 ML/d with a sulfate load of 600 t/d could discharge into surface water streams (Usher *et al*, 2003). An estimated 126 Mm^3 has accumulated in the mines already. Three mines, Greenside, Kleinkopje and Landau, collectively referred to as South African Coal Estates (SACE), operated by Anglo Coal, lie at the lowest elevations in the coalfield. These mines receive the inter-mine flow from workings up gradient and water levels have risen to the extent that safety and productivity could be impacted and future reserves lost. In addition closed mines, such as BHP Billiton's Ingwe Coal Division, South Witbank mine, discharge acid drainage and this requires control.

Current water management practices that are in keeping with legislative requirements cannot manage the increasing water. Emergency permits to release untreated water in the short term have been applied for, but ongoing discharge of untreated water is not a final solution. Therefore water treatment is the option required according to the DWAF hierarchy of decision making for water management in mines.

Treatment flow rates from the collieries that will initially be treated are as follows:

- Kleinkopje Colliery an average of 11 ML/day with a maximum of 20 ML/d,

- Greenside Colliery an average of 7.5 ML/day with a maximum of 20 ML/d, and
- South Witbank Colliery an average of 1.5 ML/d and a maximum of 5 Ml/d.

This gives a total average of 20 ML/d and a maximum flow of 45 ML/d.

A multistage water treatment plant will treat influent mine water quality of pH 2.7, sulfates 3000 mg/L, calcium 660 mg/L and iron 210 mg/L. The treatment will involve:

- neutralisation using limestone and lime,
- clarification in settling ponds to remove suspended solids,
- ultra-filtration which will precede each of the three reverse osmosis (RO) units,
- a three-stage reverse osmosis train each producing potable water and brine,
- the potable water pH will be stabilised and then the water will be chlorinated,
- the sludge produced will be dewatered in belt filters, and
- the brine from the RO process will be combined with the dewatered sludge and disposed of in a double lined landfill site.

The capital cost is close to R300 M to treat 20 ML/d and the expected operating costs are in total R6.22/m^3.

The municipal issues

Local shortages of potable water in the Olifants River catchment have resulted in Emalahleni over-abstracting their permitted allowance of 96.85 ML/d. The municipality predicted a shortfall of water against available licence abstraction of 13 ML/d in 2007 rising to 20 ML/d by 2010 and to 24.7 ML/d by 2015. The alternative supply of additional water was from an inter-basin transfer. The operating cost to transfer and treat the raw water for potable purposes was estimated at between R5.50 and R7.00/m^3 with a total capital cost of R141M.

It was realised that part of this demand could be supplied from the treatment of the mine water and this could reduce reliance on an inter-basin transfer, which is not the preferred water management option.

It has been agreed that the mine treatment scheme will sell the treated mine water to the municipality at R3.5/m^3.

Values realised

The water management business case produces value from:

- Preventing the loss of production.
- Preventing the loss of reserves.
- Reduction in risk after mine closure, because mine water decant, as a result of water table rebound, will be reduced or prevented by the abstraction of the mine water for treatment. The mine water treatment plant will continue to process mine water for many years after the closure of the mines.
- Value to other mining projects in the area that may require water.
- Value of the treated water as a commodity saleable to the municipality, which is estimated at R25M pa.
- Savings made by the municipality in costs between interbasin transfer water and mine treated water.
- Environmental value in keeping water within the catchment and not taking from users in another catchment.
- The innovation of making mine water a business.
- Reduction in pollution.
- Enhancement of company reputation.
- New and appropriate technology is to be used to prevent present and future uncontrolled discharges of polluted mine water to the natural environment, which will allow the better use of the water resources and will restore water resources depleted by mining activity for use by all.
- The principle of selling water can continue after closure of the mines and could develop into a sustainable industry for the future.
- The long-term plan is to establish a water treatment company to take over the operation of the water treatment plant and the distribution of the water. This could be a Black Economic Empowerment operation. This would satisfy the political requirement for South Africa to become a more inclusive society where companies can benefit people, disadvantaged and prejudiced under the apartheid regime, by assisting them in establishing and running a business in the economic main stream and with considerable longevity potential.

Water scarcity and mine expansion plans

The example describes a partnership between an existing mine, the local municipality and a rural community in the Limpopo Province of South Africa.

The mine plans to expand its production by increasing its concentrator capacity. This expansion is limited by the lack of available water resources in the region. The only feasible water supply currently available is treated sewage effluent discharged from the local municipality. The existing sewage works requires upgrading and the municipality does not have the resources to do this. Presently sewage plant discharges are not being effectively treated and the municipality does not have the resources to improve the plant. The water supply scheme designed involves the upgrading of the existing infrastructure supplying water to the town of Polokwane in agreement with the Municipality. It would secure 14 ML/day of treated sewage effluent water for a period of 30 years that would be transported by a new pipeline to the mine. This volume would supply the necessary minimum 8 ML/day requirement allow for additional future production expansion and part of this supply would go to a local tribal community living along the route of the pipeline.

Values realised

- This will maintain and expand the mine's production capacity,
- improve a local municipality sewage treatment facility,
- supply water to a rural community,
- have value in maintaining and extending local employment,
- encourage partnership with the local municipality, and
- upgrade sewage works.

Water scarcity and mine project development

The final example is an open pit mine project where water rights are being purchased from a failing irrigation scheme managed by the local water board and the national water affairs department.

Water supply and availability for the washing plant are essential to this project. The project is located in a water deficient area that has low rainfall of 550 mm pa and high evaporation of 1590 mm pa. Investigations indicate that a number of options exist to provide bulk water supply. The most suitable supply identified is from an existing Government Irrigation Scheme. This scheme was developed to provide water for farmers but it proved to be ineffective in many cases due to

poor agricultural yields even with irrigation. Utilisation of the spare water capacity in the scheme would provide enough water to supply the project demand of 2640 ML per annum (220 ML per month). The project has to secure options on 1000 hectares (ha) of water rights available from farmers that no longer irrigate. Alternative water supplies have been considered but these cannot individually generate the volumes nor the assurance of supply offered by using the existing irrigation dam water.

Values realised

- Allowing the project to go ahead,
- providing work in an area of unemployment, and
- recovering monies that farmers in the irrigation scheme can no longer afford because irrigation is not financially viable.

CONCLUSION

The manner in which mining companies value water in South Africa is changing to a new paradigm to be consistent with legislation, with sustainable development and environmental management principles and because of the business risks associated with water scarcity and excess. Water scarcity and degradation and excess are changing policy, legislation and shareholder expectations, and competition strategies for water.

License to use water is an essential part of the license to operate the mine and it is increasingly dependant on stakeholders in a catchment.

Partnerships with other water users add value. It is in mining's best interest to partner and assist communities with water supply as this improves human well-being, reduces poverty, protects the environment thereby increasing safety, security, stability of communities and achieves sustainable development.

The business and economic value from partnerships is seen in the preservation of the market, acceleration of corporate learning, leveraging resources, building trust and increasing awareness to all.

Water is a business risk. Mining businesses should understand the values that good water management can bring and use full costing of water to quantify the economic benefits. Mining business decisions should be based on current and future conditions including increasing difficulties in accessing water. The change to less accessible and more expensive water, thereby placing a greater monetary value on water, emphasises its value in mining.

Mines must address risks proactively to preserve future freedom and seek relative advantage over other water users through their ability to effect early change.

Water management actions mine personnel can put in place to demonstrate that a new value has been placed on water could include:

- The use of IWRM approaches to water resources, which requires consideration of and consultation with all catchment water users and the production of integrated mine water management strategies and plans.
- Through the application of IWRM mine personnel should gain understanding on the rights of potable users and ecosystems who have first priority to water and plan mining operations accordingly.
- The investigation and study of water resources within the catchment that the mine is located to enable the mine to demonstrate the advantages it has and why it should receive water over other users who are competing for the same resource. Competition with other users, specifically agriculture, which is likely to have preference on water resources as this sector meets people's needs of food, security and poverty alleviation, will require an excellent understanding of water management.
- On-site pollution control to prevent contamination of water and the separation of clean or storm water from dirty water, should be undertaken by mines as part of the stewardship required of a resource that a mine does not own.
- Budgeting for increased cost to perform the additional water management requirements and to pay for water that previously was free or inexpensive will be essential. New charges will be applied to abstraction of surface water and groundwater including underground mine water, storage of water and discharge of polluted water.
- Demonstrating proactive on-site water management, that water is part of the core activities on site and not just another hurdle to production, best international practice and that the mine has kept to legal requirements will assist the water use license applications that enable existing mining operations to expand and new projects to commence.
- South African mines have been involved in mine water research, in particular new water treatment technologies and the reuse and recycling of polluted mine water. The results of this research could be applied to and in partnership with other business sectors.

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