Series A: Activity Guidelines



A5

BEST PRACTICE GUIDELINE

Water Management for Surface Mines

Best Practice Guidelines for Water Resource Protection in the South African Mining Industry

DIRECTORATE: RESOURCE PROTECTION & WASTE

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DOCUMENT INDEX

This is the fifth in a series of the following Activity Best Practice Guidelines documents:

BPG A1: Small-Scale Mining (Standard & User Format)

BPG A2: Water Management for Mine Residue Deposits

BPG A3: Water Management in Hydrometallurgical Plants

BPG A4: Pollution Control Dams

BPG A5: Water Management for Surface Mines

BPG A6: Water Management for Underground Mines

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Since 1999 a number of steering committee meetings and stakeholder workshops were held at various stages of the development and drafting of this series of Best Practice Guidelines for Water Resource Protection in the South African Mining Industry.

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APPROVALS

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PREFACE

Water is typically the prime environmental medium (besides air) that is affected by mining activities. Mining adversely affects water quality and poses a significant risk to South Africa's water resources. Mining operations can further substantially alter the hydrological and topographical characteristics of the mining areas and subsequently affect the surface runoff, soil moisture, evapo-transpiration and groundwater behaviour. Failure to manage impacts on water resources (surface and groundwater) in an acceptable manner throughout the life-of-mine and post-closure, on both a local and regional scale, will result in the mining industry finding it increasingly difficult to obtain community and government support for existing and future projects. Consequently, sound management practices to prevent or minimise water pollution are fundamental for mining operations to be sustainable.

Pro-active management of environmental impacts is required from the outset of mining activities. Internationally, principles of sustainable environmental management have developed rapidly in the past few years. Locally the Department of Water Affairs and Forestry (DWAF) and the mining industry have made major strides together in developing principles and approaches for the effective management of water within the industry. This has largely been achieved through the establishment of joint structures where problems have been discussed and addressed through co-operation.

The Bill of Rights in the Constitution of the Republic of South Africa, 1996 (Act 108 of 1996) enshrines the concept of sustainability; specifying rights regarding the environment, water, access to information and just administrative action. These rights and other requirements are further legislated through the National Water Act (NWA), 1998 (Act 36 of 1998). The latter is the primary statute providing the legal basis for water management in South Africa and has to ensure ecological integrity, economic growth and social equity when managing and using water. Use of water for mining and related activities is also regulated through regulations that were updated after the promulgation of the NWA (Government Notice No. GN704 dated 4 June 1999).

The NWA introduced the concept of Integrated Water Resource Management (IWRM), comprising all aspects of the water resource, including water quality, water quantity and the aquatic ecosystem quality (quality of the aquatic biota and in-stream and riparian habitat). The IWRM approach provides for both resource directed and source directed measures. Resource directed measures aim to protect and manage the receiving environment. Examples of resource directed actions are the formulation of resource quality objectives and the development of associated strategies to ensure ongoing attainment of these objectives; catchment management strategies and the establishment of catchment management agencies (CMAs) to implement these strategies.

On the other hand, source directed measures aim to control the impacts at source through the identification and implementation of pollution prevention, water reuse and water treatment mechanisms.

The integration of resource and source directed measures forms the basis of the ***hierarchy of decision-taking*** aimed at protecting the resource from waste impacts. This hierarchy is based on a *precautionary approach* and the following order of priority for mine water and waste management decisions and/or actions is applicable:

RESOURCE PROTECTION AND WASTE MANAGEMENT HIERARCHY

Step 1: Pollution Prevention

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Step 2: Minimisation of Impacts
Water reuse & reclamation
Water treatment

↓

Step 3: Discharge or disposal of waste and/or waste water
Site specific risk based approach
Polluter pays principle

The documentation describing Water Resource Protection and Waste Management in South Africa is being developed at a number of different levels, as described and illustrated in the schematic diagram on this page.

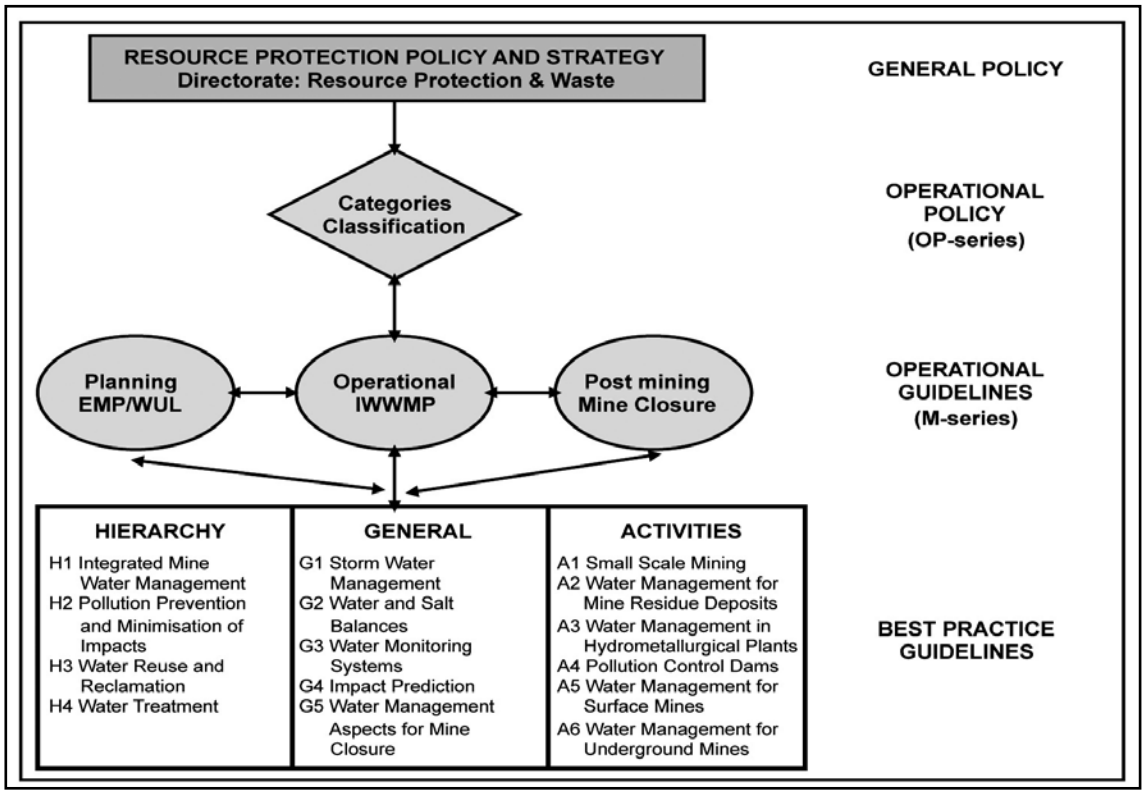
The overall Resource Protection and Waste Management Policy sets out the interpretation of policy and legal principles as well as functional and organisational arrangements for resource protection and waste management in South Africa.

Operational policies describe the rules applicable to different categories and aspects relating to waste discharge and disposal activities. Such activities from the mining sector is categorised and classified based on their potential risks to the water environment.

Operational Guidelines contain the requirements for specific documents e.g. licence application reports.

Best Practice Guidelines (BPG's) define and document best practices for water and waste management.

Schematic Diagram of the Mining Sector Resource Protection and Waste Management Strategy



The DWAF has developed a series of **Best Practice Guidelines** (BPGs) for mines in line with International Principles and Approaches towards sustainability. The series of BPGs have been grouped as outlined below:

BEST PRACTICE GUIDELINES dealing with aspects of DWAF's water management **HIERARCHY** are prefaced with the letter **H**. The topics that are covered in these guidelines include:

- H1. Integrated Mine Water Management
- H2. Pollution Prevention and Minimisation on Impacts
- H3. Water Reuse and Reclamation
- H4. Water Treatment

BEST PRACTICE GUIDELINES dealing with **GENERAL** water management strategies, techniques and tools, which could be applied cross-sectoral and always prefaced by the letter **G**. The topics that are covered in these guidelines include:

- G1. Storm Water Management
- G2. Water and Salt Balances
- G3. Water Monitoring Systems
- G4. Impact Prediction
- G5: Water Management Aspects for Mine Closure

BEST PRACTICE GUIDELINES dealing with specific mining **ACTIVITIES** or **ASPECTS** and always prefaced by the letter **A**. These guidelines address the prevention and management of impacts from:

- A1. Small-Scale Mining
- A2. Water Management for Mine Residue Deposits
- A3. Water Management in Hydrometallurgical Plants
- A4. Pollution Control Dams
- A5. Water Management for Surface Mines
- A6. Water Management for Underground Mines

The development of the guidelines is an inclusive consultative process that incorporates the input from a wide range of experts, including specialists within and outside the mining industry and government. The process of identifying which BPGs to prepare, who should participate in the preparation and consultative processes, and the approval of the BPGs was managed by a Project Steering Committee (PSC) with representation by key role-players.

The BPGs will perform the following functions within the hierarchy of decision making:

- Utilisation by the mining sector as input for compiling water use licence applications (and other legally required documents such as EMPs, EIAs, closure plans, etc.) and for drafting licence conditions.
- Serve as a uniform basis for negotiations through the licensing process prescribed by the NWA.
- Used specifically by DWAF personnel as a basis for negotiation with the mining industry, and likewise by the mining industry as a guideline as to what the DWAF considers as best practice in resource protection and waste management.
- Inform Interested and Affected Parties on good practice at mines.

The information contained in the BPGs will be transferred through a structured knowledge transfer process, which includes the following steps:

- Workshops in key mining regions open to all interested parties, including representatives from the mining industry, government and the public.
- Provision of material to mining industry training groups for inclusion into standard employee training programmes.
- Provision of material to tertiary education institutions for inclusion into existing training programmes.
- Provision of electronic BPGs on the DWAF Internet web page.

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1 INTRODUCTION

1.1 Background

South Africa has extensive mineral resources, such as coal, iron ore, diamonds, mineral sands, copper, gold, platinum and oil and gas, which have given rise to significant mining activities in many regions of the country. Many of these mineral resources are mined through surface mining operations. Ongoing prospecting programmes are also underway in many areas of South Africa. Such prospecting programmes will give rise to further mining activities in the country.

In 2003, the mining sector contributed R78.5 billion (7.1 %) to gross value added in South Africa, and 11.9 percent to Total Fixed Capital Formation (DWAF, 2006). This amount of some R23 billion is equal to about 29 percent of the sector gross value added contribution. In the same year, sales of primary mineral products accounted for 29.8 percent of South Africa's total exports revenue. The mining industry employed about 2.7 percent of South Africa's economically active population.

The mining and industrial sector utilises some 6 % of the water resources of the country (DWAF, 2006). This water is used in a wide variety of processes, including in the use of hydraulic drills, cooling and dust suppression, in the metallurgical and refining operations, ore processing, the transportation of wastes to mine residue dams and stockpiles and potable water. It is well known that South Africa is a water-stressed country, with a predominantly semi-arid climate, varying from desert and semi-desert in the west to sub-humid along the eastern coastal area. The average rainfall for the country is about 450 mm per year, well below the world average of about 860 mm per year, while evaporation is comparatively high. South Africa's water resources are thus scarce and extremely limited in extent. Against this backdrop, it is important that the South African mining industry adopt best practise in the management of water in all operations.

This Best Practice Guideline deals with water management on surface mines. The management of the transfer of water between distinct mining units, and between mines and other water users, is covered in ***BPG H1: Integrated Mine Water Management***.

1.2 Types of surface mining

The various types of surface mining techniques in South Africa include the following *(http://xmlwords.infomine.com):*

- **Open pit mining:** This includes workings in which excavation is performed from the surface to access the ore. Benches of ore are drilled, blasted, loaded on haul trucks and transported to the surface. Backfill of the pit is generally not required or feasible. Figure 1-1 illustrates a typical open pit mine
- **Strip mining** (also called open cast mining): This mining technique is generally practiced where the ore is sufficiently near the surface to "strip" the overburden to expose and mine the ore. Figure 1-2 shows an example of a coal strip mine. Figure 1-3 illustrates the overall strip mining process, and shows how successive cuts are used to advance the excavation and progressively rehabilitate the worked-out areas. The typical strip mining process for a coal mine is illustrated in Figure 1-4 as follows:
  - Mining: An area ahead of the working face is pre-stripped, drilled and blasted (1). Thereafter, the overburden above the coal seams are removed (2). Mining is undertaken using large excavators or draglines (3)
  - Rehabilitation: The excavated overburden is placed in the mined out areas behind the mining face (4). The area is levelled and top-soiled (5) and then vegetated (6) for final rehabilitation, concurrent with mining.

- **Alluvial diggings** (also called sand winning): The exploitation of alluvial deposits by dredging, hydraulicing or drift mining *(http://xmlwords.infomine.com)*. Figure 1-5 illustrates a typical sand winning operation
- **Quarrying:** The surface exploitation of stone or mineral deposits *(http://xmlwords.infomine.com).* Figure 1-6 illustrates a typical quarrying operation, and
- **Borrow pit:** The surface exploitation of borrow material (rock, weathered material, laterite, sand) for construction purposes (roads, railway line, buildings, etc.)

Figure 1-1: Typical open pit mine

Figure 1-2: Typical coal strip mine (dragline operation)

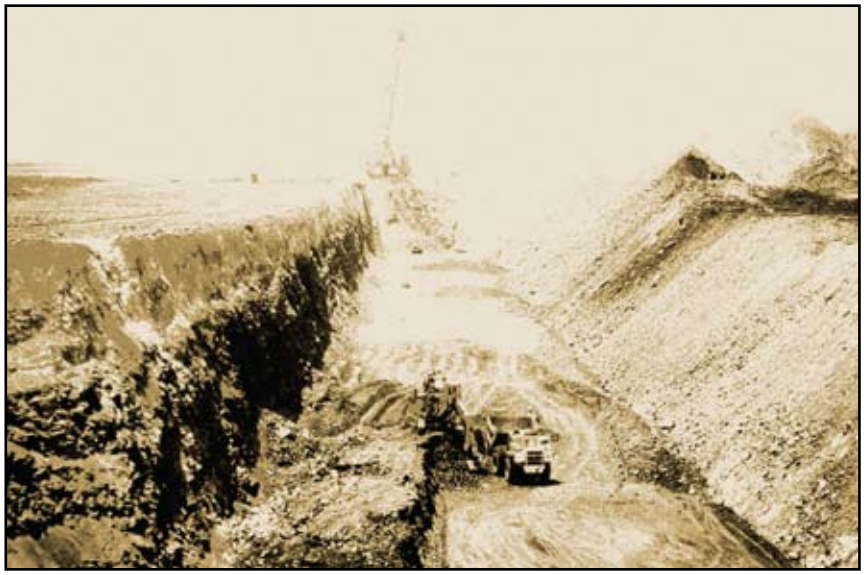


Figure 1-3: Overall strip mining process

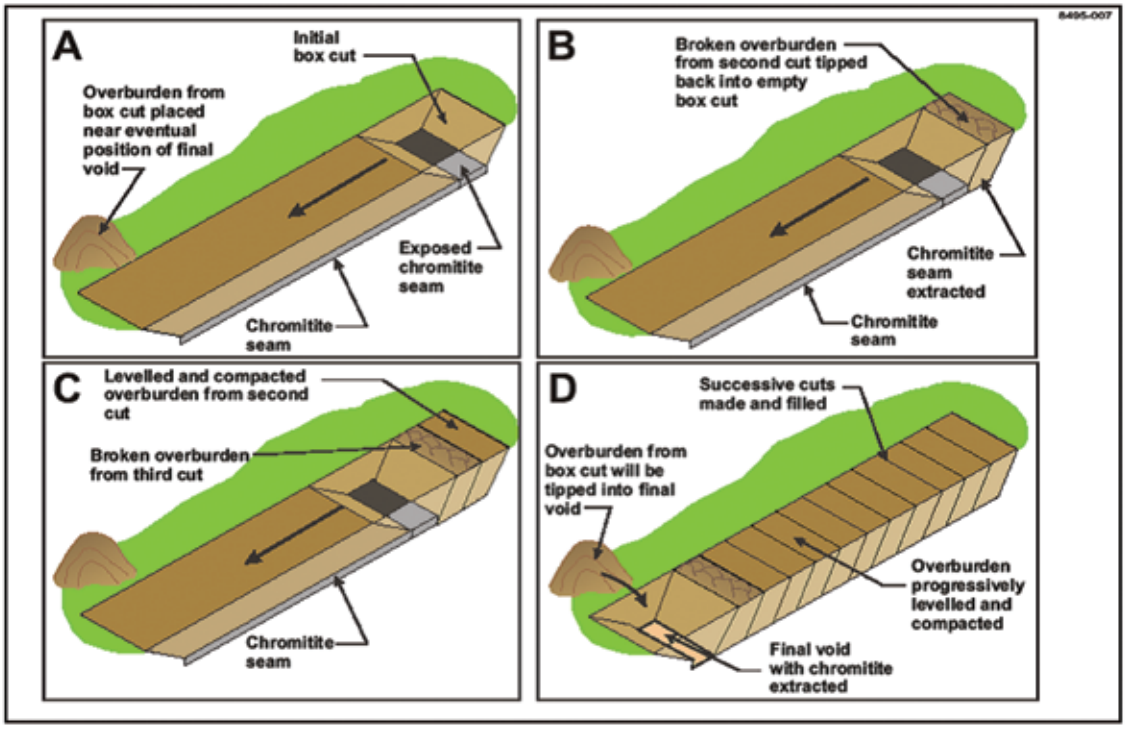


Figure 1-4: Typical section through a coal strip mine

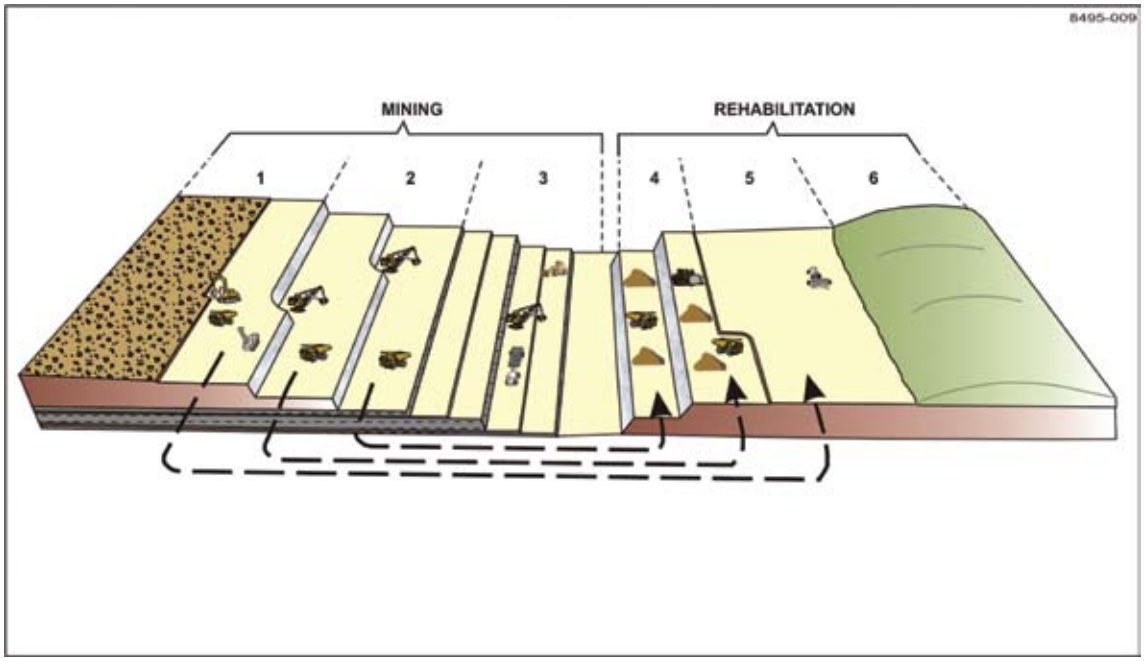


Figure 1-5: Typical sand winning operation

Figure 1-6: Typical quarrying operation

1.3 Risk classification for surface mine

The Department of Water Affairs and Forestry (DWAF) has implemented a risk classification system for mines based on their potential impact on the water resource. This risk classification will indicate the appropriate levels of regulatory effort needed to minimise waste at facility level.

The following categories have been defined:

Category A: Mines with a potentially significant and/or permanent impact on water quality. The following mines must always be classified as Category A mines:

All gold and coal mines, irrespective of size

Any mine with any kind of extractive metallurgical process, including heap leaching. (This will include most other precious and base metal mines), and

Any mine where pyrites occur in the mineral deposit.

Category B: Mines with potentially significant and/or permanent impact only on other aspects of the water environment, for example yield / availability of water, dynamics of the river, riparian rights, etc, and

Category C: All other mines. These can be divided further into the following sub-sections:

Big mines with no significant impact on the water environment, thus where ideal water quality and quantity objectives may be set. (Zero impact has been committed to), and

Small/Low impact mines/prospecting operations using the Abridged Aide-Mémoire (AAM) or a Standard Environmental Management Programme (SEMP). Note that as more SEMP's are developed, the use of the AAM is being phased out.

Quantitative impact assessments will only be necessary where the impact of a mine threatens the security of the water resource. In these cases, the magnitude and temporal nature of the impact must be determined and assessed in relation to the resource specific requirements in the catchment and/or groundwater sources that may be impacted.

All mines should be classified by the regional office of DWAF according to their potential impact on water resources. The classification system will be used to guide the DWAFs involvement in the EMP system. The DWAF will aim to optimise the effort, energy and resources in the management of the impact of mines depending on the potential impact on water resources.

The risk classification process involves the DWAF official classifying and confirming the risk of the proposed activity on behalf of the applicant in accordance with a set protocol. The activity sector for which the water use is required must be correctly identified at a preliminary stage in the risk classification. The next stage entails activity risk categorisation. In order to determine the potential impact, the proposed activities and processes are categorised based on a qualitative assessment of the level of threat to the water resource.

1.4 Context of BPG A5: Water Management for Surface Mining

Figure 1-7 provides guidance on the areas of applicability and interaction between the various BPGs in the DWAF series. As indicated, this BPG (***BPG A5: Water Management for Surface Mining)*** deals specifically with the water management aspects related to surface mining or remining operations on surface. The related Activity BPGs are as follows:

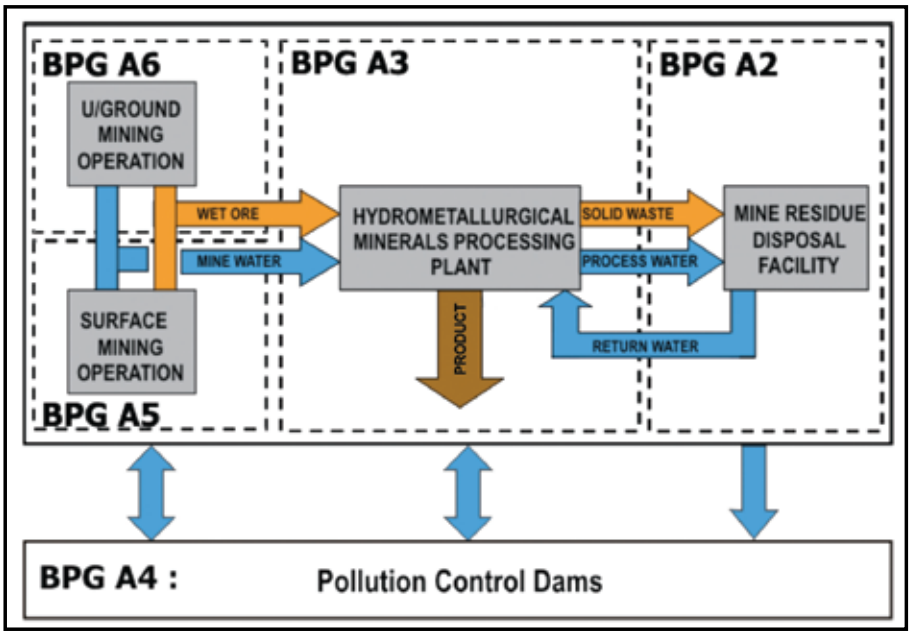
BPG A2: Water Management for Mine Residue Deposits. This BPG provides details on the recommended processes to follow for best practice water management for various types of mine residue deposits (MRDs), including water return to the hydrometallurgical plant

BPG A3: Water Management in Hydrometallurgical Plants. This BPG covers water management issues within the boundary fence of the hydrometallurgical processing plant. The BPG thus starts when ore (including water/ moisture) and water from the mining operation arrives at the hydrometallurgical processing plant for processing and finishes when residue (tailings) leaves the processing site (generally via a pipeline) for disposal,

BPG A4: Pollution Control Dams, and

BPG A6: Water Management for Underground Mines.

Figure 1-7: Relationship between selected Best Practice Guidelines



1.5 Focus and structure of the BPG

The primary focus for BPG A5 is to provide guidance on Water Management for Surface Mining activities. The water management measures that are applicable to this focus area are covered in detail in section 6. Water Management for Surface Mining is however also, by necessity, linked into the overall mine site-wide water balance, as well as into the regional or catchment water management objectives and requirements. BPG A5 thus covers the regional water management context within which the mine operates and the links to the mine water balance, with reference to the other BPGs, as applicable.

BPG A5: Water Management for Surface Mines is structured as follows:

- Chapter 2 covers the general principles for Water Management for Surface Mining
- Chapter 3 details the objectives and key considerations of the BPG
- Chapter 4, together with Appendix A, summarises the current legal framework in South Africa within which Water Management for Surface Mining must be undertaken
- Chapter 5 details the regional water management context, and the water management considerations that should be considered by the mine within this context, as well as the water management context and linkages on the overall mine site, and
- Chapter 6 covers the water management measures that are specifically applicable to surface mining operations, through the life cycle of the mine operation. These management measures include:
  - Water systems modelling through the mine life cycle
  - Separation of water of differing qualities on the mine site and the corollary of avoiding the combining water of differing qualities to optimise water reuse and recycling
  - Collection of water
  - Conveyance systems
  - Storage facilities
  - Treatment facilities for re-use
  - Siting of water storage facilities
  - Maintenance of water management facilities
  - Closure considerations for water management,
  - Exemptions, and
  - Water management.
- Appendix A covers the legal framework while Appendix B includes specific details on the water management modelling for surface mining.

2

GENERAL PRINCIPLES FOR WATER MANAGEMENT FOR SURFACE MINING

Best Practice Water Management for Surface Mining is based on the following general principles:

- The management of water for surface mining must comply with the legal and regulatory conditions within South Africa
- The design, operation and closure of water management facilities for surface mines should be based on a holistic approach, including:
  - Sustainability
  - Integrated water management approaches, including treatment for re-use
  - Optimisation of water use for a surface mine and the minimisation of the potential impact from the surface mine on water quantity and quality
  - Full life cycle of the mine
  - Process water during the operational phase
  - Water quantity and quality, and
  - Surface water and groundwater
- The "precautionary approach" is applicable and water management should therefore follow an anticipatory and conservative approach
- Technical studies and the design of water management facilities should be undertaken by suitably qualified and experienced personnel
- Water management on surface mines should take into account the "polluter pays principle"
- Water management measures should be designed and operated within the context of an overall closure plan. The design of water management measures should consider the impact on closure and whether this will compromise the closure objectives
- Adequate financial provisions need to be made during the mine life for water management measures to meet the closure objectives and beyond
- Concurrent rehabilitation should take place during the operational phase, where applicable, to:
  - Meet the post-mining topography requirements.
  - Minimise the post-closure water management requirements, by maximising free-draining areas and minimising contamination of clean water.
  - The above water management principles should play a key and decisive role when evaluating and deciding on rehabilitation and closure strategies.

3

OBJECTIVES AND KEY CONSIDERATIONS

3.1 Objectives of water management for surface mines

The primary objective of water management on surface mines is to protect the water resource (including the water quality, water quantity and the aquatic ecosystem). This is achieved through adherence to the hierarchy of decision-taking, which is based on a precautionary approach and includes the following order of priority for mine water and waste management decisions and/or actions:

- Step 1: Pollution prevention (see ***BPG H2: Pollution Prevention and Minimisation of Impacts***)
- Step 2: Minimisation of impacts (see ***BPG H3: Water Reuse and Reclamation*** and ***BPG H4: Water Treatment***), and
- Step 3: Discharge or disposal of waste and/or waste water

To achieve this primary objective, the water management infrastructure on a surface mine must be designed and operated with the following specific objectives in mind:

- To ensure that water management measures on the surface mine take account of and fit into the broader regional water management context (integrated approaches)
- To ensure that water of different quality (i.e. clean and dirty water) is kept separate, and managed separately, as far as possible. This will ensure that the contact between water of different quality, and the potential for unnecessary water quality deterioration, is minimised
- To minimise contact between water and potentially polluting substances, such as minerals, waste products, etc (***see BPG H2: Pollution Prevention and Minimisation of Impacts***)
- To address water pollution issues at source
- To maximise water reuse, avoid polluted water discharges from the mine site and maximise clean water runoff
- To ensure that the water management measures are sustainable (durable) over the long-term, and
- To ensure that the water management measures minimise the post-closure impairment of the water resource.

3.2 Objectives of this guideline

This guideline seeks to provide the necessary guidance on Water Management for Surface Mining. To achieve this, the guideline should meet the following objectives:

- To provide an overall context for water management which will illustrate the integration between water management in the broader catchment and the mine-specific water management
- To explain the hierarchy of water management and its applicability to surface mining
- To provide practical guidance on the water management measures to be included in the mines Environmental Management Plan (EMP), Integrated Water Management Plan (IWMP) and Integrated Water Use Licence Application (IWULA) documents. These documents are submitted by the mine in order to comply with the requirements stipulated in the Minerals and Petroleum Resources Development Act (Act 28 of 2002) and the National Water Act (Act 36 of 1998) and the applicable regulations
- To provide practical guidance and steps on water management best practice over the full life cycle of a surface mine

- To cover water management aspects for various types of surface mines and mining methods
- To assist in ensuring efficient water use on a mine, and
- To provide guidance on appropriate tools to be used for water management on surface mines, to complement those that are covered in other BPGs

3.3 Key considerations

The BPG has been developed, and should be used, taking into account the following considerations:

- The BPG is aimed at DWAF and mining personnel with a basic understanding of water management for surface mines
- The BPG draws on established international best practice, which is adapted to South African conditions, as applicable
- The BPG augments and expands (where necessary) existing literature on water management for surface mines
- The BPG references other BPGs prepared and issued by DWAF, and
- The BPG is developed for all surface mines and takes into account the differences between types of surface mining.

4

LEGAL FRAMEWORK

The current South African legal framework with regards to Water Management for Surface Mining is covered in Appendix A. The following details are included in Appendix A:

- The legal requirements for Water Management for Surface Mining, within the prevailing mining, water and environmental legislation in South Africa. This review focuses on the requirements of the National Water Act, 1998 (Act 36 of 1998) and the Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002). The provisions included in other legislation are also considered
- Summary of the applicable water management policies and strategies developed by the DWAF. These documents are available on the department's website (http:///www.dwaf.gov.za).

The sections below provide a summary of the current principal legal framework for Water Management for Surface Mining, as well as a list of the applicable water management policies and strategies.

4.1 Constitution of the Republic of South Africa, 1996 (Act 108 of 1996)

The environmental rights of the people of South Africa are specified in Section 24 of the Constitution. This guarantees everyone the right to an environment that is not harmful to her/ his health or well-being, and for the environment to be protected for the benefit of present and future generations. This is to be achieved through reasonable legislation and other measures.

4.2 National Environmental Management Act, 1998 (Act No.107 of 1998)

The National Environmental Management Act (NEMA) (Act No. 107 of 1998) provides the guiding legislation and framework for environmental management in South Africa. Chapter 2 of the NEMA describes a set of fundamental guiding principles governing the actions of those organs of state that may significantly affect the environment. These principles need to be considered in all dimensions of water management. The Department of Water Affairs and Forestry is thus guided by these principles in the development and implementation of various policies and strategies.

4.3 The Minerals and Petroleum Resources Development Act (MPRDA) (Act No. 28 of 2002)

The Minerals and Petroleum Resources Development Act (MPRDA) regulates the prospecting for, and optimal exploration, processing and utilisation of minerals; provides for safety and health in the mining industry; and controls the rehabilitation of land disturbed by exploration and mining. The Act supports the principle of IWRM by promoting the goal of sustainable development in the development of mineral and petroleum resources. The Act specifically states that *"any prospecting or mining operation must be conducted in accordance with generally acceptable principles of sustainable development by integrating social, economic and environmental factors in the planning and implementation of prospecting and mining projects, in order to ensure that exploration of mineral resources serves present and future generations.*"

The MPRDA and its regulations require that an environmental impact assessment be undertaken for a surface mine. The EIA will include a scoping report and an environmental impact assessment report.

4.4 National Water Act, 1998 (Act No.36 of 1998)

The National Water Act (NWA) emphasises the effective management of South Africa's water resources through the basic principles of Integrated Water Resources Management (IWRM). Both the NWA and IWRM seek to achieve social *equity*, economic *efficiency* and ecosystem *sustainability*, which are undertaken within a framework that includes institutional roles, an enabling environment (legislative, regulation and policy) and management instruments. Efficiency in water distribution and use is a fundamental premise of water conservation and water demand management.

The NWA stipulates that water use authorisations must be obtained for all water uses contemplated as part of surface mining. Section 21 of the NWA stipulates the eleven types of water use. A surface mine will require a license for each of the mine's water uses. Thus, for example, a mine could feasibly be required to prepare water use licence applications for the following section 21 water uses:

(a) taking water from a water resource
(b) storing water
(c) impeding or diverting the flow of water in a watercourse
(d) engaging in a stream flow reduction activity contemplated in section 36
(e) engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1)
(f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit
(g) disposing of waste in a manner which may detrimentally impact on a water resource
(h) disposing in any manner of water which contains waste from, or which has been heated in, 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 if it is necessary for the efficient continuation of an activity or for the safety of people; and
(k) using water for recreational purposes.

The Department of Water Affairs and Forestry does allow for an Integrated Water Use License Application (IWULA) in instances where more than one water use is being applied for.

4.5 Water use regulations

Government Notice No. 704 (GN704) provides regulations on the use of water for mining and related activities aimed at the protection of water resources, and was promulgated in terms of section 26 of the NWA on 4 June 1999. The detailed description and implications of these regulations are covered in section 6 of this BPG.

4.6 Dam safety regulations

The Dam Safety Regulations (published in Government Notice R. 1560 of 25 July 1986) requires that every dam with a safety risk shall be classified in accordance with section 2.4 of the regulation on the basis of its size and hazard potential. An authorisation is required from the dam safety office before construction of a dam, classified as having a safety risk, commences.

4.7 DWAF water management policies and strategies

The DWAF water management policies and strategies that are summarised in Appendix A include the following:

- National Water Resource Strategy (NWRS)
- Catchment Management Strategies (CMS)
- Internal Strategic Perspectives (ISP)
- Water Resource Availability and Utilisation in South Africa
- The Philosophy and Practice of Integrated Catchment Management: Implications for Water Resource Management in South Africa
- A Strategic Plan for the Department of Water Affairs and Forestry to facilitate the implementation of Catchment Management in South Africa
- Towards a Strategy for Waste Discharge Charge System (WDCS)
- Water Conservation and Water Demand Management (WC/WDM)
- Water Allocation Reform
- Water classification system, and
- The National groundwater strategy.

5 WATER MANAGEMENT CONTEXT

Surface mining is not undertaken in isolation of the regional, national and even global water management context. Any water management on a surface mine, and the development of a mine water management plan, must therefore conform and be guided by the overall water management context. Specific aspects of this context include the following:

- The global, national, regional and site-specific water management context
- Integrated Mine Water Management in the regional context
- Specific mine water management requirements for the various life cycle phases of a mine, and
- Integrated regulatory and procedural guidance.

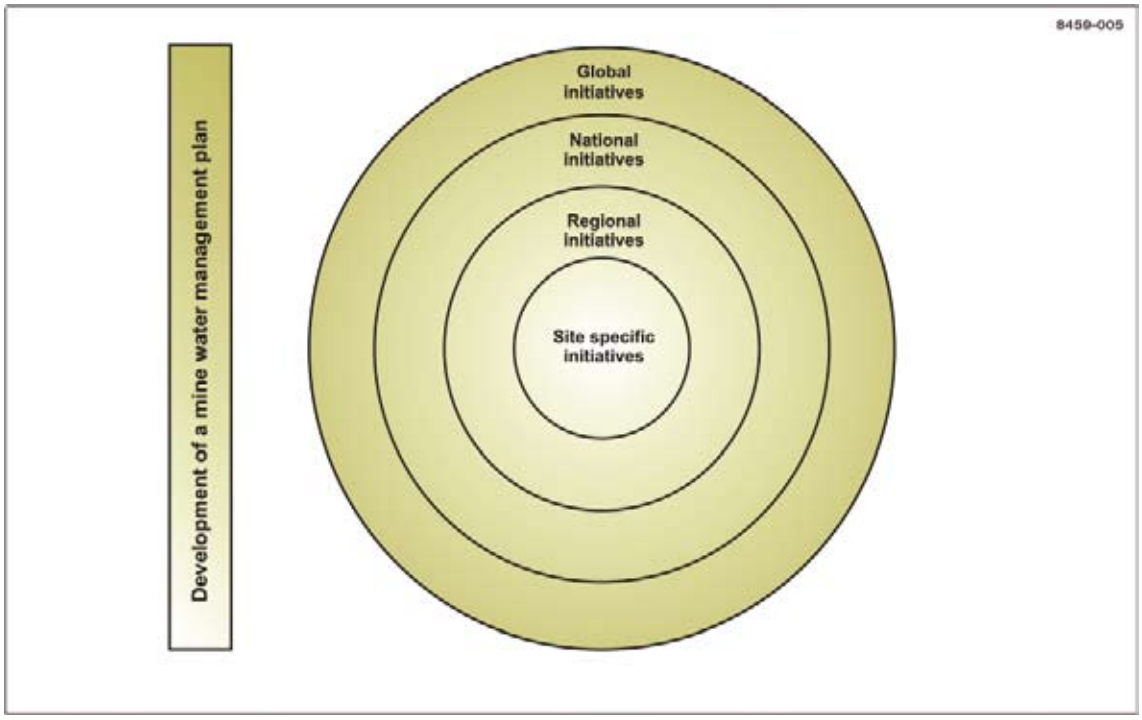
These various aspects are covered in the sections below.

5.1 Overall water management context

Figure 5-1 illustrates the development of a mine water management plan within the global, national, regional and site-specific context. This context can be summarised as follows:

- Global context: Various organisations have provided guidance on water management, monitoring and reporting on a global basis. One such development is the Global Reporting Initiative (GRI), who have published the following documentation of relevance to surface mines:
  - Sustainability Reporting Guidelines (2002) which provide a global standard and guidance for reporting
  - The Water Protocol (2003) which provides definitions and clarifications of the terms, concepts and expectations embedded in the reporting indicators, and
  - The Mining and Metals Sector Supplement (2005) which capture the relevant issues essential to sustainability reporting in the mining and metals sector
- National context: Chapter 4 and Appendix A, section A.2 provide details on the national water management legislation that must be complied with in developing the mine water management plan
- Regional context: Chapter 4 and Appendix A, section A.3 provide details on the water management policies and strategies that have been developed by DWAF, and are to be implemented on the regional/catchment basis. The requirements of these policies and strategies should be taken into account when developing the mine water management plan. Specific considerations include integrated water resource management plans, cumulative water quantity and quality impacts and regional mine closure strategies in terms of the MPRDA, and
- Site-specific context: This includes an understanding of the mine site and the impact that this can have on the mine water management model. Specific site-specific considerations include, amongst others, geology, topography, meteorology, geochemistry, and waste management.

Figure 5-1: Overall water management context



5.2 Integrated Mine Water Management

Best Practice Guideline H1 covers Integrated Mine Water Management and provides the following details:

- Discussion on the complete DWAF series of BPGs and how these should be used in the application of Integrated Mine Water Management on mine sites
- Discussion of Integrated Mine Water Management principles and how these should be applied at a mine site, taking into account both source-directed and resource-directed measures
- Presentation of typical mine site layouts and typical mine water management issues in order to demonstrate practically how Integrated Mine Water Management principles and the BPGs should be applied on mine sites
- Specific guidance on the contents and scope of an Integrated Water Management Plan (IWMP) that should be submitted to DWAF by mining proponents, the level of detail required and specific areas where suitably qualified specialists should be used, both in preparation and review of an IWMP

5.3 Mine life cycle phase specific requirements

Table 5-1 on page 17 summarises the information and water modelling and management requirements through the various phases of the mine development, including:

- Prospecting, conceptualisation and planning
- Pre-feasibility study
- Feasibility study, leading to a Bankable Feasibility Study (BFS)
- Mine design
- Construction and commissioning
- Mine operation
- Closure and after-care, with closure certificate.

The information and water management requirements for each of the mine phases are discussed in more detail in the sections below. Further details on water modelling are provided in Appendix B. Note that the information provided in this section and in Appendix B should be used as a guideline only and is not prescriptive. Items and/or actions mentioned in a particular phase or stage of mine development may overlap into a preceding or subsequent phase. For example, a WULA does not

always need to be submitted at the feasibility stage, but may be submitted at any appropriate phase in the mine development.

5.3.1 Prospecting, conceptualisation and planning

The prospecting, exploration, conceptualisation and planning stage will constitute the first high-level assessment of the water management requirements for the mine. It will be necessary at this stage to collect any background information that is available, such as meteorological data, water quantity and quality monitoring data for both the catchment and the site-specific area of the mine, topographical mapping, geological data, environmental information (such as a Strategic Environmental Assessment for the area) and any reports on water monitoring and modelling (both quantity and quality).

Potential sources of information include the conceptual mine plan, the database of the Department of Water Affairs and Forestry (Regional and National office), the South African Weather Bureau and other information in the public domain.

The legal entity that will be submitting the Integrated Water Use Licence Application (for water management) should also be identified during this phase.

Initial discussions with the regulatory authorities should be held at this stage to map the integrated regulatory process, discuss time-frame and the financial provisions related to water management.

A high level water management plan will be prepared as the output of this phase. This plan should include details on sealing of boreholes and closing of trenches, bulk sample pits and adits, to minimise the impact of these on the surface and groundwater regime. Guidance on closing of boreholes is provided in ***BPG A6: Water Management for Underground Mines***.

5.3.2 Pre-feasibility study

Baseline meteorological and water quantity/quality data for the mine site should be collected during this phase, with a view to preparing a first-order water management model (monthly time steps). The model should be integrated into the pre-feasibility mine plan and should be aligned with the mine closure objectives, the preliminary groundwater plan and the waste management plan.

The first-order water management model will have the following uses during the pre-feasibility study:

- To provide the preliminary sizing and costing of the water management infrastructure
- To provide a first order assessment of water supply and water demand for the mine
- Input to baseline studies on water management for the mine,
- Input to the high-level risk assessments that will be undertaken for the mine at this stage, and
- Input to the high-level impact assessments.

Further discussions with the regulatory authorities during this phase will focus on the mine water requirements and identifying potential water supply sources and other water user requirements.

The first order mine water plan will be the output of this phase.

This phase should include initial mine closure planning and closure costing.

5.3.3 Feasibility study

A detailed water management model (continuous daily time step modelling) should be developed at the mine feasibility stage. This will be integrated with the feasibility level mine plan, the detailed groundwater model, geochemical modelling and the detailed waste management plan.

This model will provide details on the water supply to the mine, the water management of the mine and the discharge quantity and quality (if applicable). The model should also be used to identify a water monitoring plan for the mine and to size the water infrastructure to meet the regulatory requirements.

The Integrated Water Use Licence Application (IWULA) should be prepared and may be submitted during this phase. This will also provide a check on the sizing of the water management infrastructure. The details from the water management model should also be used as input for the Environmental Impact Assessment (EIA) process, the Environmental Management Plan (EMP) and the Socio Economic Impact Assessment (SIA).

All water management infrastructure should be sized during this phase, and a cost estimate identified. The mine closure planning and closure costing details should be updated.

5.3.4 Mine design

The detailed design of the water management infrastructure (dams, pumps, pipelines, etc) should be undertaken during this phase. This should be integrated with the detailed mine plan, including details on ramps, haul roads, etc. This civil design should also be integrated with the mechanical, electrical and instrumentation design work. The water management model will be updated during this phase, as required.

The IWULA document, together with any mine water use licence condition, if the water use licence has been issued, should be converted to an Integrated Water Management Plan (IWMP) for the mine during this stage. This will provide details on the water management and monitoring plan for the mine.

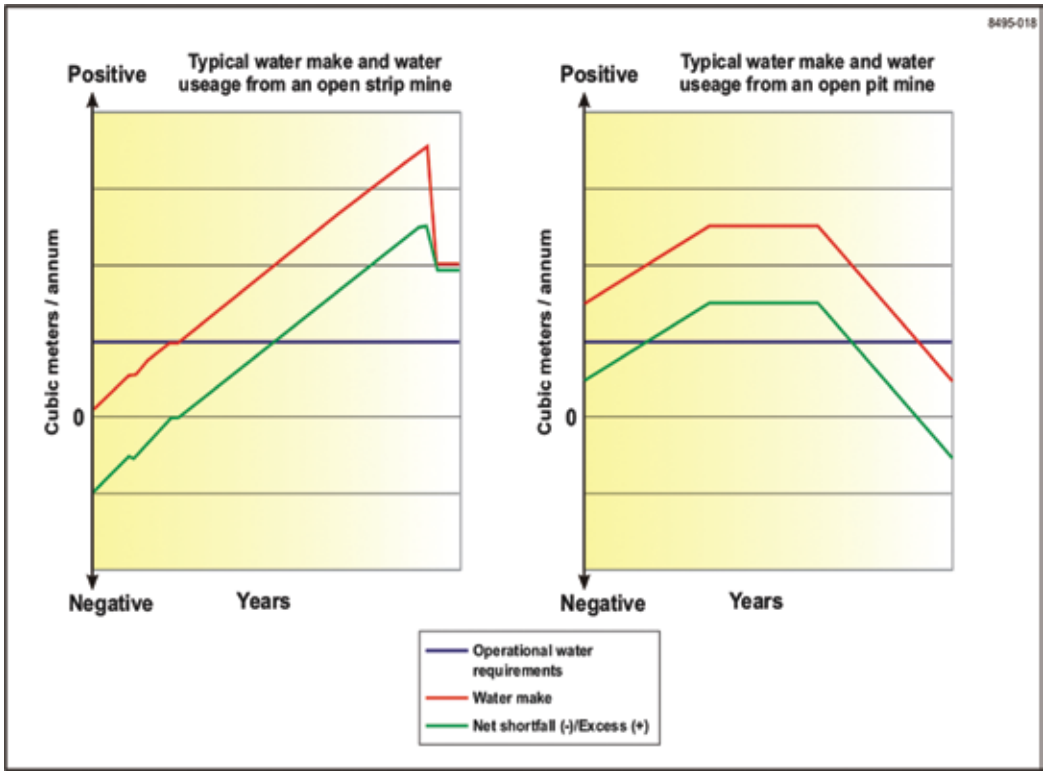
This phase should also include obtaining approval for the construction of the water management infrastructure (in particular any dams with a safety risk). The mine closure planning and closure costing details should be updated, based on the mine design.

The mine water management plans should take account of the water make and water use for surface mines over the life of mine. Figure 5-2 illustrates this concept for an open strip mine (graph on the left) and an open pit mine (graph on the right) as follows:

- The water make curve represents the mine water make from startup of operations through to closure. This generally increases over time for an open strip mine. An open pit often however has to be dewatered in advance of mining so that there is an excess of water from the start of operations. Once water table levels have been dropped to the final pit floor elevation pump rates tend to even out or even reduce somewhat. Water make is generally derived from rainfall infiltration, groundwater seepage and water moving through inter-mine pillars. Rainfall ingress can be greatly reduced by applying best practice for rehabilitating of the disturbed areas
- The Operational water requirements represents the total annualised operational water requirements for the mine and includes water for dust suppression, water used in the beneficiation plant, workshops and domestic requirements (offices and change houses)
- Net shortfall (-) / Excess (+): This curve represents the net shortfall or excess between mine water make and mine water requirements. A typical open strip mine will experience a net shortfall of water during the initial years of operation, when water will have to be imported for the mines operational needs. At some point in the mine operations, the open strip mine will experience a net surplus of water which will require water storage and water management facilities to be planned and built. Conversely, a typical open pit mine will need to manage a surplus of water in the earlier years, followed by a water shortfall in later years.

The potential exists for a mine to meet the water shortfall though the treatment of mine water. Such mine water treatment need only produce industrial type of water for the beneficiation process and potable water for the offices and change houses. This approach will result in the mine having to store less water during the operation phase and will have a treatment plant that can treat part of the water generated after closure.

Figure 5-2: Typical water make and water use for opencast mines



5.3.5 Construction and commissioning

The phase will include the construction of the water management infrastructure. Data will be collected on water quantity and quality. This data will be used to report to the regulatory authorities against the requirements of the IWMP and other authorisations.

Regular monitoring and audit reports will be provided to the mine management and construction team during this phase. The water management model should also be updated, as required.

5.3.6 Mine operation

Water quantity and quality data should be collected on a regular, ongoing basis during mine operations. These data will be used to **recalibrate and update the mine water management model**, to prepare monitoring and audit reports, to report to the regulatory authorities against the requirements of the IWMP and other authorisations and as feedback to stakeholders in the catchment, perhaps via the CMA.

The water management model should be used to consider and design the water management measures required for mine closure including making financial provision for closure costs. The mine closure planning and closure costing details should be regularly updated during mine operations, taking into account the mine operations planning at that time.

5.3.7 Closure, post-closure and after-care

The water management measures will form an integral part of the mine's Closure Plan. The design of these water management measures for mine closure will be confirmed and costed during this phase. These measures will then be implemented. Details of the water management measures for mine closure are covered in more detail in ***BPG A2: Water Management for Mine Residue Deposits, BPG A4: Pollution Control Dams and BPG G5: Water Management Aspects for Mine Closure***.

Regular monitoring and reporting against the IWMP, authorisations, and closure plan will be required during this phase.

Table 5-1: Information and water management requirements through the mine phases

(Note: there is generally significant overlap between sections and activities often cross stage boundaries)

Mine Phase	Baseline Information and evaluation requirements	Links to other information not forming part of the IWMP	Outputs	
			Regulatory	Mine management
Prospecting, conceptualisation and planning	• Background information categorising the receiving water environment (water monitoring data and programmes, meteorological data, etc) • Catchment description, catchment management plan and water availability • Information on existing mining in the region	• Geology reports • Preliminary mine plan • Environmental overview (Strategic Environmental Assessment) • Socio economic impact assessment • Confirmation of the legal entity for water use authorization	• Mine risk classification • Mapping of the integrated regulatory process • Project specific requirements and constraints for water supply, source management and water resource quality objectives	• High level mine water management plan that can practically be implemented • Confirmation of adequate water for the mine over the full mine life
Pre-feasibility	• Baseline data (surface water, groundwater and process water) required to assess the impact on the receiving water environment • Monthly time-step water management model • Preliminary sizing of water management infrastructure	• Mine closure objectives • Preliminary groundwater model • Catchment model • Pre-feasibility level mine plan • Initial waste management concepts • Stakeholders / water users database for the catchment	• Initial discussions on project specific water requirements and water allocations • Fatal flaw analysis • Request for details on the Reserve from the Regulatory Authority • Discussion on water supply and mine water requirements, including potential supply sources and other water user requirements • Input to EIA • Identified mine water uses • Agreed terms of reference for required information	• Monthly time-step mine water plan • Affordability of water management measures
Feasibility	• Baseline data for impact assessments and feasibility study • Data Water management model (daily time-step modelling) • Mine water demand and source of reliable water supply • Waste Discharge Charges • Water quantity and quality monitoring • Hierarchy of water management • Discharge quantity and quality	• Groundwater modelling and assessment • Geochemical modelling • Waste management plan • Feasibility level mine plan	• Submission of Integrated Water Use License Application (IWULA) • Input to documents on Environmental Impact Assessment (EIA), Environmental Management Plan (EMP) and Integrated Water Management Plan (IWMP) • Input to socio-economic impact assessment	• Detailed water management plan (infrastructure sizing and operating rules) • BFS cost estimate for water management • Input to mine water management plan covering mitigation of water impacts

Mine Phase	Baseline Information and evaluation requirements	Links to other information not forming part of the IWMP	Outputs	
			Regulatory	Mine management
Design	• Water Use License • Model updates • Design of water management infrastructure • Closure planning and costing	• Mechanical and electrical design • Instrumentation design • Process and Instrumentation Diagrammes (P&IDs)	• Submit IWMP in support of Integrated Water Use License Application (IWULA) • Approval for the design of water supply and pollution control dams	• IWMP for the mine • Water management and monitoring plan
Construction and commissioning	• Water infrastructure construction details • Water quantity and quality monitoring • Audits and model revisions, using collected data	• Other construction activities	• Reporting to verify that the construction is completed in accordance with the approvals	• Monitoring and audit requirements for construction phase • Water management system enabling requirements • Model updates to confirm that water quantity and quality objectives can be met with required level of reliability • Requirements for reporting against IWMP and Integrated Water Use License (IWUL)
Mine operation	• Regular water management data collection and assessment • Recalibration and revisions to water management model, according to water monitoring results • Ongoing operational management • Update to closure plan and costing	• Operations mine plan • Rehabilitation schedules • Best Practice Guidelines • Mine closure plan	• Reporting and monitoring in terms of compliance against water use authorization conditions • Annual update of IWMP (continual improvement)	• Monitoring and audits • Non conformance follow up and mitigation • Model updates to confirm validity of IWMP • Reporting against IWMP and IWUL
Closure, post-closure and after-care	• Design of sustainable water management measures for closure • Maintenance of water quantity and quality monitoring • Implement closure	• Catchment level water management plan • Mine closure plan	• Approved Closure and Rehabilitation Plan • Monitoring and reporting against Closure Plan	• Reporting against IWMP and IWUL • Closure plan for water aspects • Closure certificate

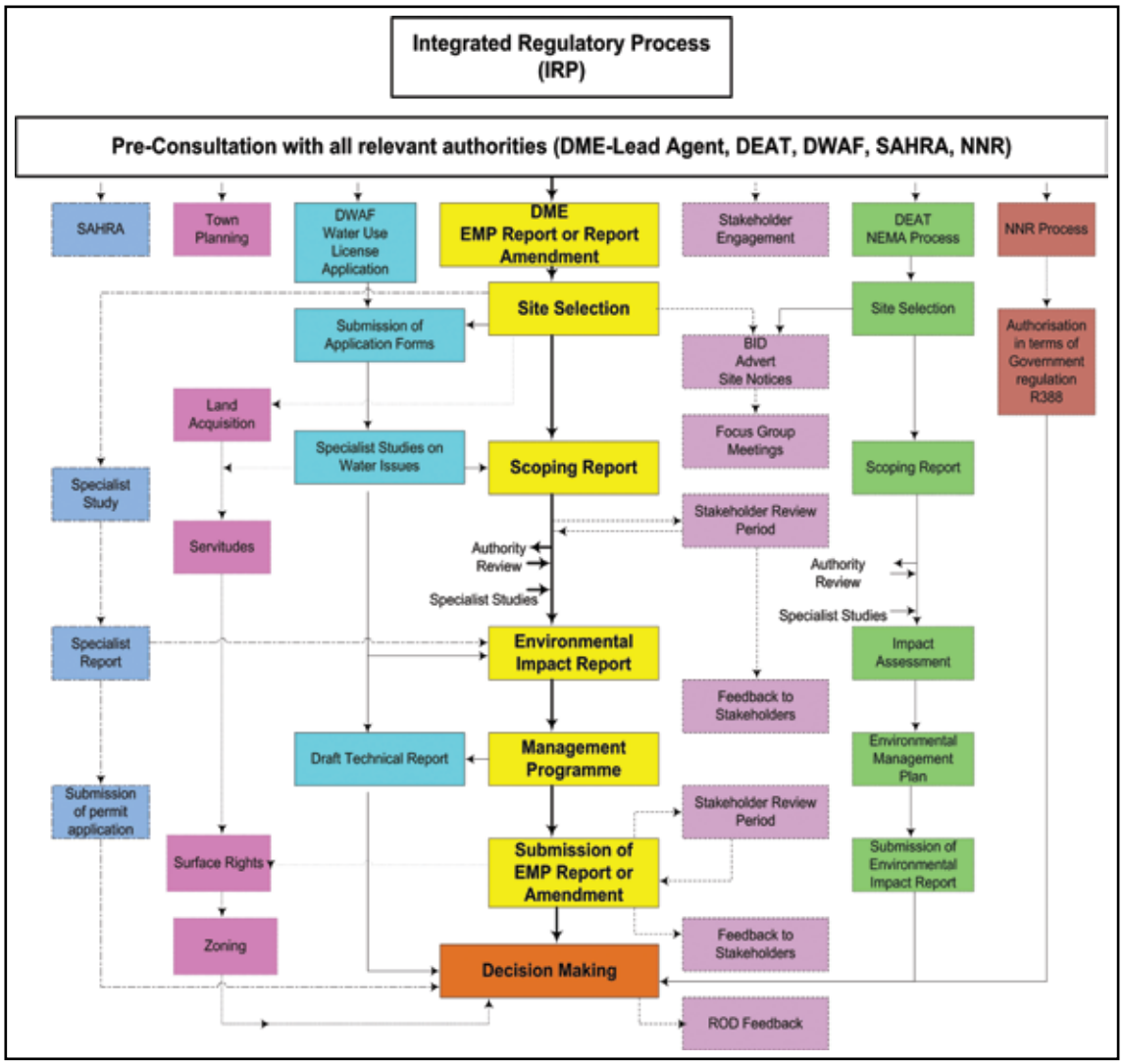
5.4 Integrated Regulatory and Procedural guidance

Figure 5-3 provides a proposed guide on Integrated Regulatory Process (IRP) for use by water managers on a surface mine. Note that this diagramme is included as a guide only to illustrate a process that may be followed. It is not prescriptive and is subject to change in line with any changes in the legal environment in South Africa. There is a need to liaise with the relevant Provincial departments to confirm the regulatory requirement. Figure 5-3 indicates the following:

- The procedural requirements and process for each regulatory authority (DME, DWAF, DEAT, SAHRA, Town Planning and NNR). This is generally at a provincial/catchment level, but may also be at national or local level
- The procedural requirement for stakeholder engagements, and
- The inter-linkages between the various regulatory processes,

Under the current legislation, it is a requirement that the mine management follow all of the regulatory processes identified in Figure 5-3 in the development, expansion or amendment of a mine. Co-operative governance may however, in some instances, streamline the process.

Figure 5-3: Guide for Integrated Regulatory Process (IRP)



6 WATER MANAGEMENT MODELLING AND MEASURES FOR SURFACE MINES

6.1 Introduction

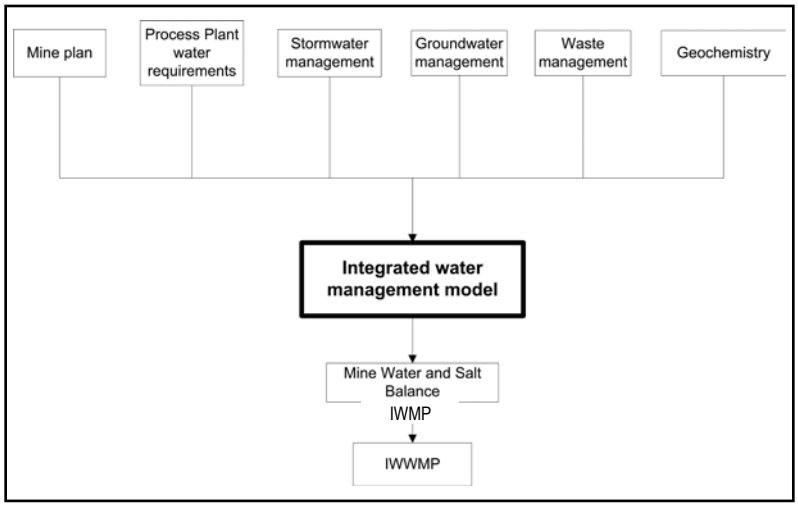
This section addresses the two primary areas of water management on a surface mine, namely:

- Integrated water management modelling, and
- Water management measures that are required on a surface mine to conform to the details included in Government Notice No. 704 (GN704) of 4 June 1999.

6.2 Integrated water management modelling

Water modelling is undertaken on a surface mine as input to the IWMP and to provide regular information to the mine management and operational personnel on the mine water systems. The water modelling is integrated as this needs to include information from mining, the process plant, stormwater management, groundwater management, waste management and geochemistry. The integrated modelling in turn provides information to the Mine Water and Salt Balance (see ***BPG G2: Water and Salt Balance***) and the IWMP. This is illustrated in Figure 6-1 below.

Figure 6-1: Integrated water management modelling for a surface mine



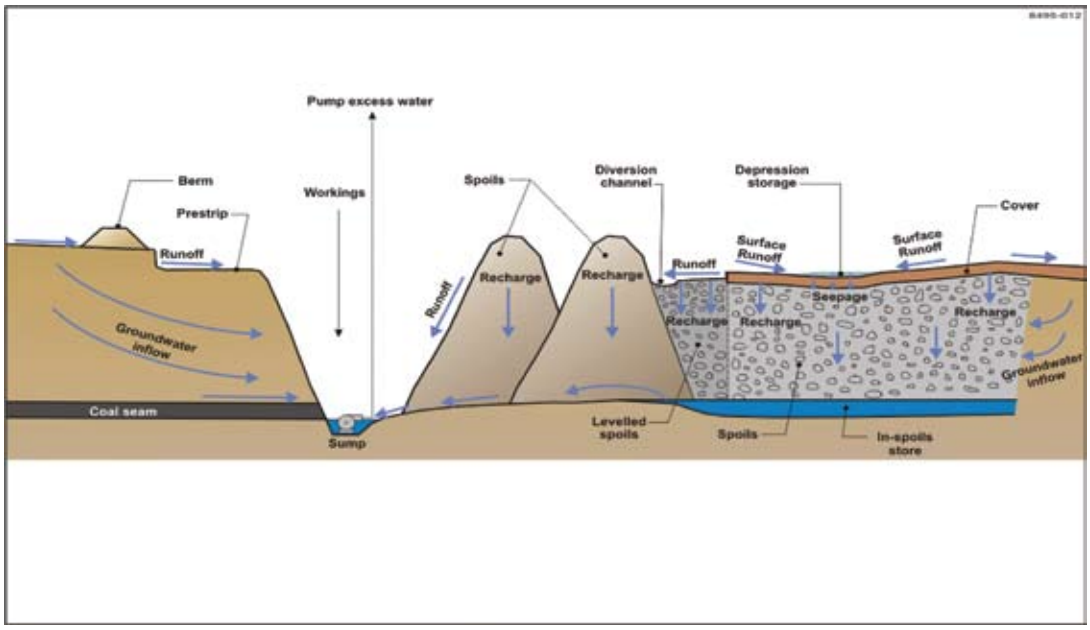
Details on the integrated water management modelling process are included in **Appendix B**, in terms of:

- Details of the baseline information requirements, and
- The water modelling requirements through the mine life cycle. This describes the level of detail required in the water modelling for each of the mine phases and the recommended water modelling outputs per mine phase.

6.3 Water management measures

Figure 6-2 illustrates the typical water management requirements for a surface mine, including surface water management (water retaining dams, etc) and groundwater management (seepage cutoff, etc). Note that there are often water flow path links between surface and underground mining (reference ***BPG A6: Water Management for Underground Mines***).

Figure 6-2: Typical water flow paths in an open pit mine



Details on the following best practice water management measures are provided in the sections below:

- Separation of water
- Collection of water
- Conveyance systems
- Storage facilities
- Siting of water storage facilities
- Maintenance of water management facilities
- Closure considerations for water management,
- Exemptions, and
- Water management.

Each section covers the water management measure in the following manner:

- Details included in Government Notice No. 704 (GN 704) of 4 June 1999 that are relevant to the particular water management measure
- The practical implications of the water management regulations, and

The final section of this chapter provides practical examples of the use of these water management measures for the activities on a surface mine.

6.3.1 Separation of waters

Objective

The objective is to keep, as far as possible, water of differing qualities separate on a mine, so as to minimise the water management requirements.

Requirements of Government Notice No. 704

The requirements of water management regulations 6 (a) and 7 (c) are applicable to the separation of waters. These are included in Technical Box 6.1 below.

Technical Box 6.1

Regulation 6 (a): Capacity requirements of clean and dirty water systems

Every person in control of a mine or activity must-

(a) confine any unpolluted water to a clean water system, away from any dirty area;

Regulation 7 (c): Protection of water resources

Every person in control of a mine or activity must take reasonable measures to-

(c) cause effective measures to be taken to minimise the flow of any surface water or floodwater into mine workings, opencast workings, other workings or subterranean caverns, through cracked or fissured formations, subsided ground, sinkholes, outcrop excavations, adits, entrances or any other openings.

Practical implications

The practical implications of these water management regulations on a mine are as follows:

- The clean and dirty water flow areas on a mine site should be identified. Guidance on the process to follow to identify these areas is provided in ***BPG A4: Pollution Control Dams*** and ***BPG G1: Storm Water Management***
- Every effort should be made to maximise the clean area and minimise the dirty area when locating the diversion berms, channels and dams. In the case of a new mine, the maximisation of the clean areas should have an influence in overall mine planning and the location of the mine infrastructure
- The mine planning should consider concurrent rehabilitation of mine workings and waste management facilities, to maximise the areas of clean runoff that can be discharged to the natural watercourses
- The runoff from the dirty areas must be captured, retained and managed within the mine water systems. The use of structures such as diversion berms, channels and pollution control dams are the typical methods used to manage the runoff. The berms and channels are used to isolate the dirty areas so as to prevent the runoff from the clean areas from entering the dirty areas, and to ensure that the dirty runoff enters the pollution control dam(s). Settling dams, silt traps and oil traps are also used to manage discharge from dirty water areas
- The design of the channel gradient must be such that the water is free-flowing without eroding the channel
- The recycling or reuse of the runoff and seepage water collected in the pollution control dams should be considered. The uses are typically dust suppression, irrigation of rehabilitation, reuse in the plant and/or the mine. The size and frequency of the abstraction for reuse will depend on the water use within the site wide water balance. Guidance is provided in ***BPG H3: Water Reuse and Reclamation***
- Areas that may have subsided or areas of depressions and/or sinkholes should be filled to create free-draining surfaces.

Examples of water separation

Figure 6-3 provides an illustration of a clean water cutoff canal. Note in this example, however, that the sides of the cutoff canal are relatively steep and vegetation may not be able to establish. This could lead to erosion and damage of the side-slopes.

Figure 6-3: Illustration of a clean water cutoff canal

Figure 6-4 show various examples of unlined earth trenches and canals for water separation. Again note that the side-walls of these canals are susceptible to erosion. This can be mitigated by locating a small berm at the crest of the canal (see bottom right photograph) which prevents stormwater from the surrounding areas flowing over the canal side-slopes. This may however not be practical if the canal is specifically designed to capture stormwater from the surrounding areas.

Figure 6-4: Examples of water separation trenches and canals

Figure 6-5 show examples of poor water separation practices. In the example on the left, the dirty water (containing tailings) has mixed with the clean natural runoff. In the example on the right, the clean water diversion canal has filled with tailings, resulting in a mix of clean and dirty water.

Figure 6-5: Examples of poor water separation practices

Figure 6-6 shows a further example of poor water separation. In this example, the system to capture dirty water has breached which allows dirty water to discharge into clean runoff areas.

Figure 6-6: Example of poor water separation practices

6.3.2 Collection

Objective

The objective is to design and manage effective water collection infrastructure for the various water streams/ sources on the mine.

Requirements of Government Notice No. 704

The requirements of water management regulations 6 (c) and 7 (a) are applicable to the collection of waters. These are included in Technical Box 6.2 below.

Technical Box 6.2

Regulation 6 (c): Capacity requirements of clean and dirty water systems

Every person in control of a mine or activity must-

(c) collect the water arising within any dirty area, including water seeping from mining operations, outcrops or any other activity, into a dirty water system;

Regulation 7 (a): Protection of water resources

Every person in control of a mine or activity must take reasonable measures to-

(a) prevent water containing waste or any substance which causes or is likely to cause pollution of a water resource from entering any water resource, either by natural flow or by seepage, and must retain or collect such substance or water containing waste for use, re-use, evaporation or for purification and disposal in terms of the Act;

Practical implications

The practical implications of these water management regulations on a mine are as follows:

- In-pit water management will be required to assess and manage the seepage water and rainfall. A groundwater investigation and development of a groundwater model and management plan will be required to assess the level of recharge to the pit. ***BPG A4: Pollution Control Dams*** provides details on groundwater investigations and developing a groundwater model. The groundwater recharge and rainfall in the pit should be managed as follows:
  - Maximise the abstraction and discharge of clean groundwater ahead of the pit development, and
  - Manage in-pit seepage and rainfall through a collection and storage system. Water stored in pit should be utilised locally for dust suppression, as far as possible. Excess pit water should be pumped to surface to be incorporated into the mine water balance,
- Water management measures will be required to ensure separation of clean from dirty water and to reduce the infiltration of clean rain water into the rehabilitated part of the pit
- Dewatering of old mine workings will be required prior to the pit development. This water should be captured and managed in pit or in the mine water balance.
- Seepage from waste management facilities must be collected and managed in the dirty water system. Guidance on this seepage collection is provided in ***BPG A2: Water Management for Mine Residue Deposits, Appendix D***.

Examples

Figure 6-7 illustrates the collection of water and the dewatering requirements when mining into old underground mine workings. The practise of openstrip mining into previously underground workings is undertaken so as to maximise the coal/ore recovery, avoid greenfields sites when previously worked areas are available and stabilize the old workings, especially where bord and pillar workings can collapse. These old mine workings may however contain significant amounts of (generally) poor quality water. This water will need to be collected and managed in the mine water management system. The challenge in these instances is to plan and design a water collection system that will adequately collect and manage the water make from the underground workings. It is generally best practice to dewater from the lowest point in the mine workings, ahead of the mining operation, to ensure that the dewatering is effective over the workings.

Figure 6-7: Dewatering in old mine workings

Figure 6-8 shows an example of a groundwater seepage collection trench. In this example, groundwater seepage is being pumped from boreholes into the collection canal. This water will be stored and managed within the mine water system. The photograph shows the jib crane for lifting and maintenance of the borehole pump.

Figure 6-8: Groundwater seepage cutoff trench

Figure 6-9 shows a seepage collection system in operation at a waste management facility. The seepage flow discharges into an unlined dirty water collection and conveyance trench. The photograph shows the positive aspects of free flow of water and the trench is free of vegetation growth. On the negative side, there is some channel erosion at the entry point of the seepage discharge. This can be minimised by discharging closer to the channel flow level and parallel to the flow direction. Should this not be possible, then it is recommended that suitable erosion protection measures be placed on the stream banks.

Figure 6-9: Seepage collection at a waste management facility

Figure 6-10 provides examples of poor and good water collection practices. The left hand photograph illustrates uncontrolled discharge of excess dirty water from the plant area. This uncontrolled discharge will also have an unwanted silt load. The right hand photograph shows a well bunded area to contain dirty water runoff.

A method to obviate this poor practice is to extend paving well beyond the plant footprint, with the paving sloped to effectively remove the water to a collection facility.

Figure 6-10: Examples of poor and good water collection practices

6.3.3 Conveyance

Objective

The objective is to design and manage infrastructure on the mine for the effective conveyance of the various water streams.

Requirements of Government Notice No. 704

The requirements of water management regulations 6 (b), (d) and (f) are applicable to the conveyance of waters. These are included in Technical Box 6.3 below.

Technical Box 6.3

Regulation 6 (b), (d) and (f): Capacity requirements of clean and dirty water systems

Every person in control of a mine or activity must-

(b) design, construct, maintain and operate any clean water system at the mine or activity so that it is not likely to spill into any dirty water system more than once in 50 years;

(d) design, construct, maintain and operate any dirty water system at the mine or activity so that it is not likely to spill into any clean water system more than once in 50 years;

(f) design, construct and maintain all water systems in such a manner as to guarantee the serviceability of such conveyances for flows up to and including those arising as a result of the maximum flood with an average period of recurrence of once in 50 years.

Practical implications

The practical implications of these water management regulations on a mine are as follows:

- The clean and dirty water systems should be designed separately. The size of the berms must be able to convey the 50 year flood peak without overtopping while the pollution control dams must only spill on average once in 50 years,
- The determination of the 50 year flood peak for the sizing of the berms requires the application of standard flood peak calculation procedures such as the Rational method, the application of kinematic rainfall-runoff models and/or the Regional Maximum Flood (RMF). Further details on the methodology to calculate flood peaks are covered in ***BPG G1: Storm Water Management***.
- Consideration should be given to whether the conveyance is a temporary or permanent structure. A risk management plan should be developed should the design criteria given above not be adhered to for temporary conveyance structures. The risk management plan should include contingency planning,
- The requirements of lining of the conveyance structures should be considered on the design. The design velocity in the conveyance structure, together with the geotechnical conditions, can be used to determine the need for a lining.

Examples

Figure 6-11 shows examples of lined conveyance structures. Several methods of lining are available, including concrete, plastic (HDPE or other), rock lining, etc. The left hand photographs show good practice of well maintained free-channels. The right hand photographs illustrate that continuous maintenance is required in channels to maintain free flow.

Figure 6-11: Examples of lined conveyance structures

Figure 6-12 gives examples of poor water conveyance practices. In the example on the left, the bund wall has failed and the free flow of water in the canal is obstructed by the influx of coal discard. On the right, there is no formalised water conveyance system in place, resulting in uncontrolled flow of dirty wash down water. There is also no gradient to promote free flow of the water.

Figure 6-12: Examples of poor water conveyance practices

6.3.4 Storage

Objective

The objective is to design and manage water storage facilities that meet the legislative requirements.

Requirements of Government Notice No. 704

The requirements of water management regulations 5, 6 (e), and 7 (d) and (e) are applicable to the storage of waters. These are included in Technical Box 6.4 below.

Technical Box 6.4

Regulation 5: Restrictions on use of material

No person in control of a mine or activity may use any residue or substance which causes or is likely to cause pollution of a water resource for the construction of any dam or other impoundment or any embankment, road or railway, or for any other purpose which is likely to cause pollution of a water resource.

Regulation 6 (e): Capacity requirements of clean and dirty water systems

Every person in control of a mine or activity must-

(e) design, construct, maintain and operate any dam or tailings dam that forms part of a dirty water system to have a minimum freeboard of 0.8 metres above full supply level, unless otherwise specified in terms of Chapter 12 of the Act.

Regulation 7 (d) and (e): Protection of water resources

Every person in control of a mine or activity must take reasonable measures to-

(d) design, modify, construct, maintain and use any dam or any residue deposit or stockpile used for the disposal or storage of mineral tailings, slimes, ash or other hydraulic transported substances, so that the water or waste therein, or falling therein, will not result in the failure thereof or impair the stability thereof;

(e) prevent the erosion or leaching of materials from any residue deposit or stockpile from any area and contain material or substances so eroded or leached in such area by providing suitable barrier dams, evaporation dams or any other effective measures to prevent this material or substance from entering and polluting any water resources;

Practical implications

The practical implications of these water management regulations on a mine are as follows:

- The determination of the size of the pollution control dams so as to only spill once in 50 years requires the application of a continuous model (not single event) at an appropriate (preferably daily) time step. A typical model for a pollution control dam consists of a component that models the sources of the water entering the dam and the water balance for the dam itself. Further guidance is provided in ***BPG A4: Pollution Control Dams*** and in ***BPG G2: Water and Salt Balances***,
- Guidance on the lining of pollution control dams is provided in ***BPG A4: Pollution Control Dams***,
- Suitable fill material for use in dam embankments will need to be identified. The various considerations in the identification of suitable fill are as follows:
  - Geotechnical considerations: An assessment of the soil characteristics and stability. A geotechnical site investigation with laboratory testwork will be required to confirm the geotechnical properties of the soil and its suitability as fill. Guidance on geotechnical investigations is provided in ***BPG A4: Pollution Control Dams***,
  - Geochemical considerations: The pollution potential of the various soil horizons should be assessed,
  - Environmental considerations, such as stripping and stockpiling of topsoil for later rehabilitation and vegetation, and
  - Mining and plant considerations: The mine and plant will produce waste streams that can be used as fill.

Each of the above should be considered independently, and concurrently, to identify the most suitable fill for the pollution control dam embankments,

- A potential exclusion from the above process is the use of potentially polluting material in isolated areas, for example, the use of waste rock for creating temporary ramps or impoundments in-pit,
- The design and operation of pollution control dams and mine residue deposits should be such as to maintain a minimum of 0.8m of freeboard above the full supply level of the dam. The full supply level is defined as follows:
  - The spillway level for a pollution control dam,
  - The normal operating level plus the water depth for a 50 year 24 hour storm for a mine residue deposit. Refer to ***BPG A2: Water Management for Mine Residue Deposits, Section 6.7*** for further details
- All dams with a safety risk must adhere to section 12 of the National Water Act and the dam safety criteria. Refer to ***BPG A4: Pollution Control Dams*** for further details
- Monitoring of water storage facilities, particularly pollution control dams, is imperative to manage the risk of spillage from the dams. Stage-storage (elevation-capacity) curves are useful tools to monitor the remaining capacity within a water storage facility.
- Water management measures around mine residue deposits, to control erosion and leaching, are covered in ***BPG A2: Water Management for Mine Residue Deposits***.

Examples

Figure 6-13 shows examples of typical water storage facilities on a mine, using different fill for the wall construction. On the top left is a water storage dam linked to the mines recreational facilities. The photograph on the top right shows an example of using coarse discard on the inner face of the dam. This could result in water quality impacts in the dam from leaching of the discard.

The bottom two photographs show typical water storage dam down slope of tailings facilities, to capture and retain dirty water from the tailings facilities and to return this water to the mine water system. The photograph on the bottom right shows a typical return water pump system on a barge.

Figure 6-13: Examples of water storage facilities

Figure 6-14 shows a HDPE lined pollution control dam (water storage facility).

Figure 6-14: Example of a lined water storage facility

Figure 6-15 shows examples of poor water storage practices. In the example on the left, the entrance to the water storage facility has been filled with silt washed down from the plant, rock dump and surrounding areas. The example on the right shows a discharge from a dirty water storage facility to the water environment.

Figure 6-15: Examples of poor water storage practices

6.3.5 Siting

Objective

The objective is to ensure that all mine infrastructure, in particular the waste management infrastructure, is located in such as way as to minimise the potential impact on the water resource.

Requirements of Government Notice No. 704

The requirements of water management regulations 4, 7 (h) and 10 (1) (b) are applicable to the siting of water management facilities. These are included in Technical Box 6.5 below.

Technical Box 6.5

Regulation 4: Restrictions on locality

No person in control of a mine or activity may-

locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year flood-line or within a horizontal distance of
100 metres from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked;

(a) except in relation to a matter contemplated in regulation 10**,** carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood-line or within a horizontal distance of 100 metres from any watercourse or estuary, whichever is the greatest;

(b) place or dispose of any residue or substance which causes or is likely to cause pollution of a water resource, in the workings of any underground or opencast mine excavation, prospecting diggings, pit or any other excavation; or

(c) use any area or locate any sanitary convenience, fuel depots, reservoir or depots for any substance which causes or is likely to cause pollution of a water resource within the 1:50 year flood-line of any watercourse or estuary.

Regulation 7 (h): Protection of water resources

Every person in control of a mine or activity must take reasonable measures to-

(h) cause all domestic waste, including wash-water, which cannot be disposed of in a municipal sewage system, to be disposed of in terms of an authorisation under the Act.

Regulation 10 (1) (b): Additional regulations relating to winning sand and alluvial minerals from watercourse or estuary

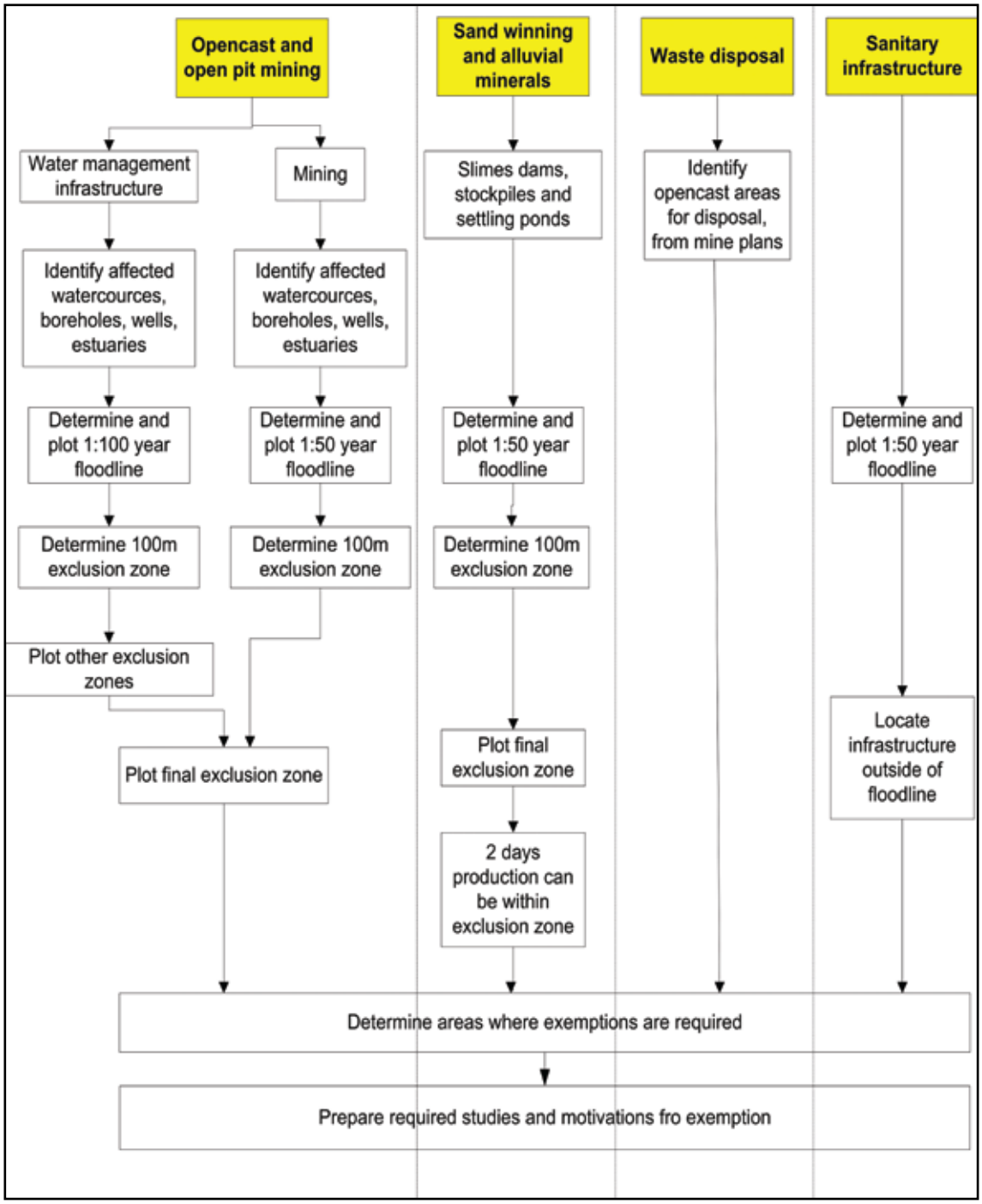
(1) No person may-

(b) establish any slimes dam or settling pond within the 1:50 year flood-line or within a horizontal distance of 100 metres of any watercourse or estuary.

Practical implications

Figure 6-16 provides details on the process to follow in the siting of various water management facilities, based on the above regulations. Cognisance must also be taken of the mining plan and the geology. The practical implications of these water management regulations on a mine are covered in the sections below.

Figure 6-16: Process for siting water management facilities



Siting of residue deposits, dams, reservoirs, together with any associated structure or any other facility

The process for siting of the water management facilities is as follows:

- Identify all affected watercourses, boreholes, pans, wetlands, wells and estuaries. The definition of a watercourse (as provided in the National Water Act) is given in Technical Box 6.6 below,
- Determine the 1:100 year floodline for all watercourses on site that will be affected by mining or mining infrastructure. Plot the 1:100 year floodline on a plan,
- Plot the horizontal distance for the exclusion zone, as follows:
  - 100m from the centre-line of the watercourse, on each bank, and
  - 100m radius from boreholes, wells and/or estuaries on site.
- Plot any other restriction zones on a plan of the site, including:
  - Any ground that is currently water-logged (for example pans, etc)
  - Any ground likely to be water-logged (for example depressions, low-lying ground, etc)
  - Undermined, unstable or cracked areas, and
  - Mine blast zones.
- Plot the final exclusion zone as a combination of the above three criteria. All water management infrastructure must be outside of this exclusion zone,
- Identify areas where exemptions are required. This is covered in more detail in section 6.5.

Technical Box 6.6

A "watercourse" means -

(a) a river or spring;

(b) a natural channel in which water flows regularly or intermittently;

(c) a wetland, lake or dam into which, or from which, water flows; and

(d) any collection of water which the Minister may, by notice in the *Gazette,* declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks;

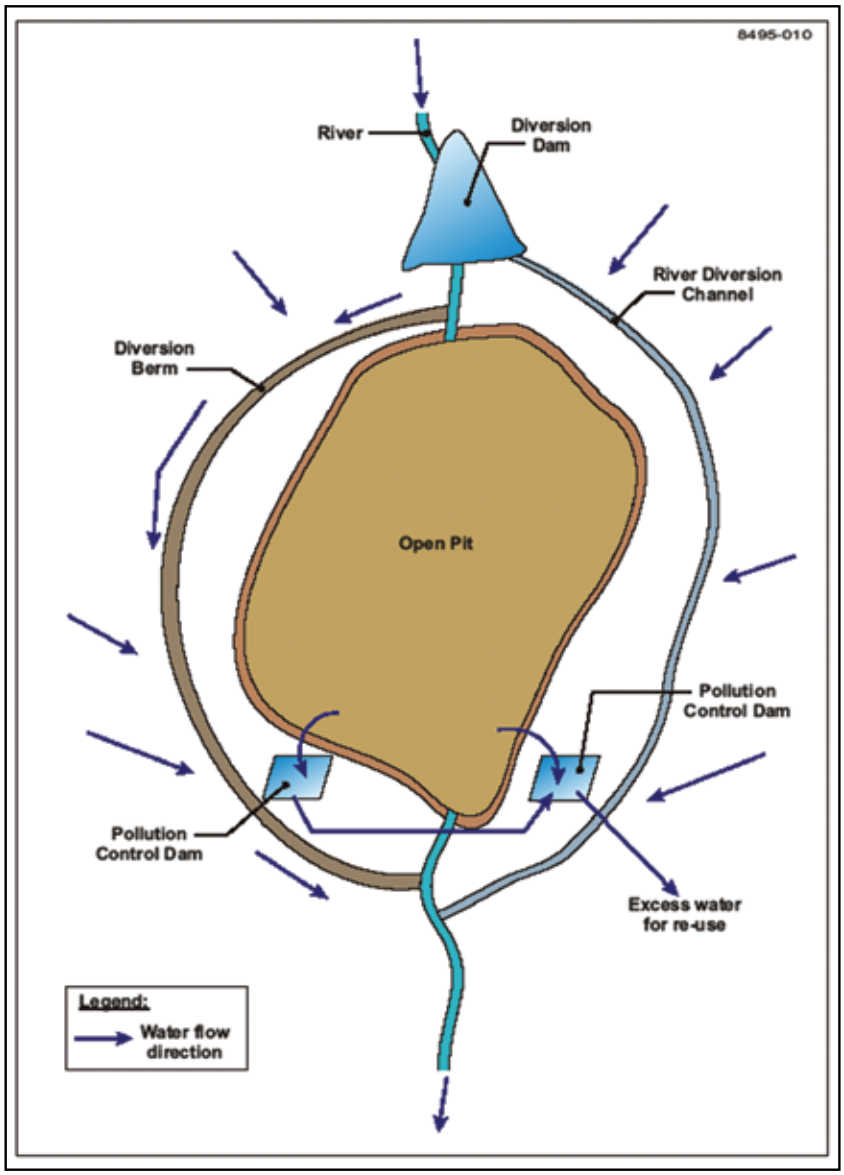
Opencast mining

The process for the restriction of opencast mining is as follows:

- Identify all affected watercourses, boreholes, wells, estuaries and wetlands. Note that wetlands could include those found either instream and/or on hill slopes, with the latter being more difficult to identify
- Determine the 1:50 year floodline for all watercourses on site that will be affected by mining or mining infrastructure. Plot the 1:50 year floodline on a plan,
- Plot the horizontal distance for the exclusion zone, as follows:
  - 100m from the centre-line of the watercourse, on each bank, and
  - 100m radius from boreholes, wells and/or estuaries on site.
- Plot the final exclusion zone as a combination of the above two criteria. All opencast mining must be outside of this exclusion zone,
- Identify areas where exemptions are required.

The above restrictions on opencast mining should be adhered to at all times. However, a motivation for an exemption can be submitted should mining through or in a watercourse be envisaged. The motivation will need to provide details of the water management measures during operations as well as the plans for closure of the area. Figure 6-17 indicates schematically the typical water management measures that are likely to be required if mining though or in watercourse is undertaken.

Figure 6-17: Typical water management measures for mining in a watercourse



Sand winning and alluvial minerals

The process for locating slimes dams, stockpiles and settling ponds is as follows:

- Identify all affected watercourses, boreholes, wells and estuaries,
- Determine the 1:50 year floodline for all watercourses on site that will be affected by mining or mining infrastructure. Plot the 1:50 year floodline on a plan,
- Plot the horizontal distance for the exclusion zone, as follows:
  - 100m from the centre-line of the watercourse, on each bank, and
  - 100m radius from boreholes, wells and/or estuaries on site.
- Plot the final exclusion zone as a combination of the above two criteria. All infrastructure must be outside of this exclusion zone,
- Identify areas where exemptions are required.

Note that the tonnage from two days of production may be stored within the exclusion zone.

Borrow pits

Mining operations in the construction, operation and closure phases will require borrow material for infrastructure such as terraces, foundations, access roads, haul roads, railway lines, etc. It is generally best practice to carry out extensive geotechnical surveys for borrow material to establish sources. Sources for borrow material should, as far as possible, be located within the life of the mine operation foot print, i.e. in the planned mining areas or the waste dump areas. The rehabilitation of the borrow pits will then form part of the mining or dump rehabilitation plan.

The borrow pits will need to be rehabilitated in accordance with the mines Environmental Management Plan should these borrow areas be located outside of the operational footprint then.

Additional requirements for potentially polluting infrastructure

This includes all sanitary conveniences (sewage treatment works, soakaways, etc), fuel depots and storage facilities for potentially polluting substances. These facilities must be located outside of the 1:50 year floodline.

Examples

Figure 6-18 illustrates the above process for locating a mine residue deposit. Figure 6-19 provides an example of a wetland.

Figure 6-18: Siting of a mine residue deposit

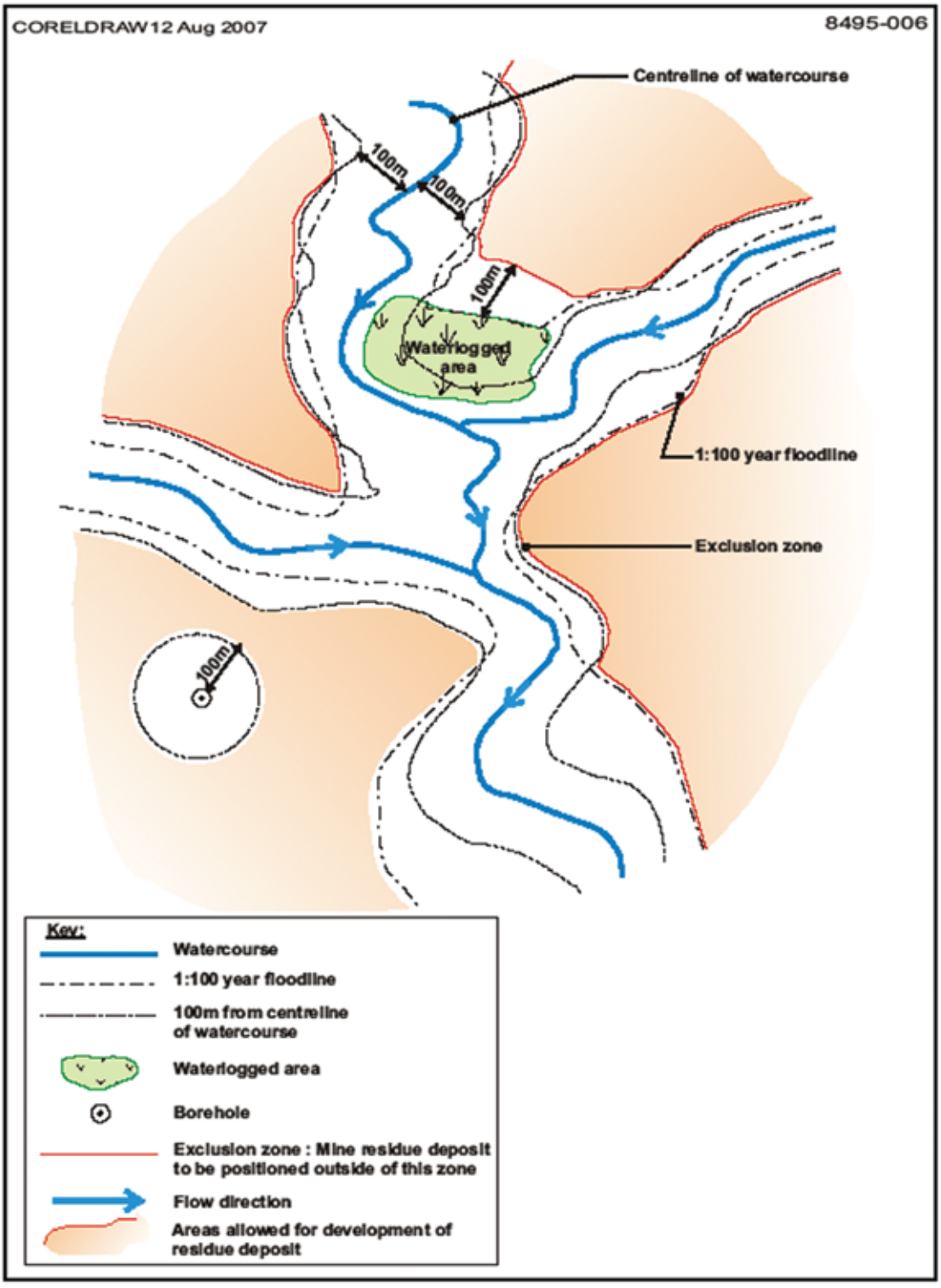
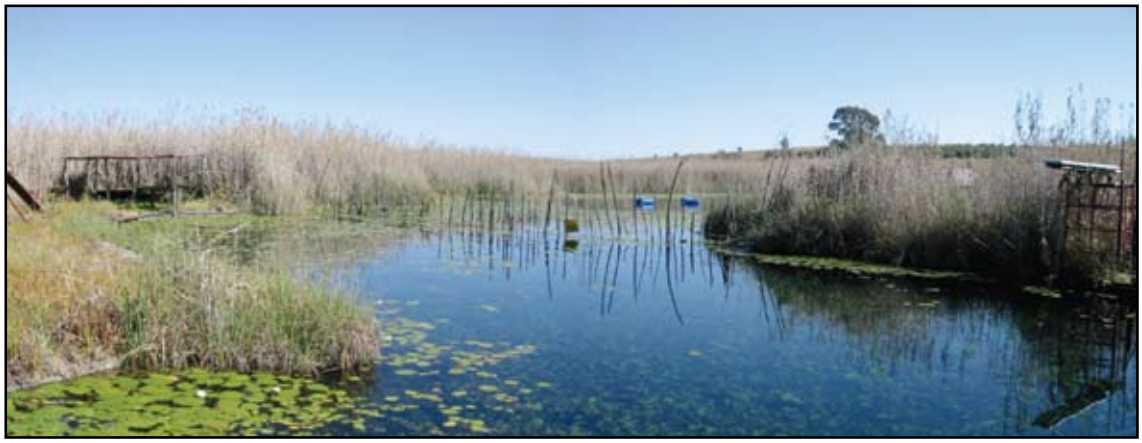


Figure 6-19: Example of a wetland



6.3.6 Design and operational considerations

Objective

The objective is to ensure that all design and operational activities are undertaken within the water management hierarchy and to minimise impacts on the water resource.

Requirements of Government Notice No. 704

The requirements of water management regulations 7 (b), (f) and (h), 10 (1) (a) and 11 are applicable to the design and operations of water management facilities. These are included in Technical Box 6.7 below.

Technical Box 6.7

Regulation 7 (b), (f) and (h): Protection of water resources

Every person in control of a mine or activity must take reasonable measures to-

(b) design, modify, locate, construct and maintain all water systems, including residue deposits, in any area so as to prevent the pollution of any water resource through the operation or use thereof and to restrict the possibility of damage to the riparian or in-stream habitat through erosion or sedimentation, or the disturbance of vegetation, or the alteration of flow characteristics;

(f) ensure that water used in any process at a mine or activity is recycled as far as practicable, and any facility, sump, pumping installation, catchment dam or other impoundment used for recycling water, is of adequate design and capacity to prevent the spillage, seepage or release of water containing waste at any time;

(h) cause all domestic waste, including wash-water, which cannot be disposed of in a municipal sewage system, to be disposed of in terms of an authorisation under the Act.

Regulation 10 (1) (a): Additional regulations relating to winning sand and alluvial minerals from watercourse or estuary

No person may-

(a) extract sand, alluvial minerals or other materials from the channel of a watercourse or estuary, unless reasonable precautions are taken to-

(i) ensure that the stability of the watercourse or estuary is not affected by such operations;

(ii) prevent scouring and erosion of the watercourse or estuary which may result from such operations or work incidental thereto;

(iii) prevent damage to in-stream or riparian habitat through erosion, sedimentation, alteration of vegetation or structure of the watercourse or estuary, or alteration of the flow characteristics of the watercourse or estuary.

Regulation 11: Additional regulations for rehabilitation of coal residue deposits

Any person mining or establishing coal residue deposits must rehabilitate such residue deposits so that-

(a) all residue deposits are compacted to prevent spontaneous combustion and minimise the infiltration of water; and

(b) the rehabilitation of the residue deposits is implemented concurrently with the mining operation.

Practical implications

The practical implications of these water management regulations on a mine are as follows:

- All water systems should be sited, designed and operated to restrict the possibility of damage to the riparian or in-stream habitat. The practicalities of this are:
  - Silt traps and sedimentation ponds should be designed and operated around plant areas and upstream of the return water dam for the mine residue deposit,
  - The design of watercourses must be such as to achieve permissible velocities in the channel to limit erosion for unlined or lined channels, and
  - Mine designs should avoid, as far as possible, the discharge of large flows into small streams, which will cause changes in the flow characteristics of the stream, result in erosion potential and change the stream habitat.
- The design and operation of water management facilities should optimise water reuse and reclamation. Further guidance on this is provide in ***BPG H3: Water Reuse and Reclamation***,
- Water use authorisations under section 21 (f) or 21 (g) of the National Water Act, and Environmental Conservation Act (ECA) section 20, will be required if the mine is contemplating the discharge of water containing waste or the storage of waste,
- The design of water management facilities should include suitable erosion protection measures to ensure that downstream erosion or sedimentation is minimised,
- Suitable areas should be designated for maintenance and the storage of waste and other equipment. Suitable management measures must be implemented in these designated areas,

The practical implications for the rehabilitation of coal residue deposits are as follows:

- A suitably qualified rehabilitation team must undertake the work. The rehabilitation team must have a suitable management plan and construction to ensure that adequate moisture content and compaction is achieved on an ongoing basis,
- The rehabilitation team must be on site during operations to ensure that concurrent rehabilitation of the coal residue deposits is undertaken,
- The rehabilitation work must be included in the Operations Manual for the mine, and
- Reporting proformas and protocols must be established and adhered to, to ensure that the rehabilitation is undertaken to the required standard.

Examples

Figure 6-20 shows examples of various configurations for silt traps. The example on the left also includes a slurry pump which is useful for the removal of accumulated silt. Good design practice is to ensure that the silt removed from the trap is in an enclosed system to the disposal point, e.g. a pipeline. The photograph also shows a ramp for access for a front-end loader to remove silt. In these instances, the silt must be transported to the final disposal point, without spillage.

In the example on the right, maintenance is required to the overflow system from the silt trap. This illustrates that it is important that the design takes into consideration the high rainfall events.

Figure 6-20: Examples of silt traps

Figure 6-21 illustrates good practice for the storage of waste drums in a maintenance area. The storage area is bunded to prevent uncontrolled runoff in the event of a spill and the drums are neatly stored.

Figure 6-21: An example of good practice for a maintenance area

Figure 6-22 show poor practice for silt traps and maintenance areas. In the top left example, the silt is not adequately removed from the silt trap and will wash back into the trap during subsequent stormwater events. This could be improved by installing a slurry pump to keep the channel clean and convey the silt to the final destination.

In the bottom left photograph, a system for the removal of water from a storage area should be included in the design. In the example on the right, the storage area is not bunded, and any spills from the area (as is currently happening) will result in uncontrolled discharge and associated pollution.

Figure 6-22: Examples of poor practice for silt traps and maintenance areas

6.3.7 Maintenance

Objective

The objective is to ensure that all water management infrastructure on a mine is well maintained and managed at all times.

Requirements of Government Notice No. 704

The requirements of water management regulations 7 (g), 8 and 12 are applicable to the maintenance of water management facilities. These are included in Technical Box 6.8 below.

Technical Box 6.8

Regulation 7 (g): Protection of water resources

Every person in control of a mine or activity must take reasonable measures to-

(g) at all times keep any water system free from any matter or obstruction which may affect the efficiency thereof.

Regulation 8: Security and additional measures

Every person in control of a mine or activity must-

(a) cause any impoundment or dam containing any poisonous, toxic or injurious substance to be effectively fenced-off so as to restrict access thereto, and must erect warning notice boards at prominent locations so as to warn persons of the hazardous contents thereof;

(b) ensure access control in any area used for the stockpiling or disposal of any residue or substance which causes, has caused or is likely to cause pollution of a water resource so as to protect any measures taken in terms of these regulations;

(c) not allow the area contemplated in paragraph (a) and (b) to be used for any other purpose, if such use causes or is likely to cause pollution of a water resource; and

(d) protect any existing pollution control measures or replace any existing pollution control measures deleteriously affected, damaged or destroyed by the removing or reclaiming of materials from any residue deposit or stockpile, and establish additional measures for the prevention of pollution of a water resource which might occur, is occurring or has occurred as a result of such operations.

Regulation 12: Technical investigation and monitoring

(1) The Minister may, after consultation with the Department of Minerals and Energy and the Department of Environmental Affairs and Tourism, in writing require any person in control of a mine or activity to arrange for a technical investigation or inspection, which may include an independent review, to be conducted on any aspect aimed at preventing pollution of a water resource or damage to the in-stream or riparian habitat connected with or incidental to the operation or any part of the operation of a mine or activity.

(2) Such investigation must be conducted and a report thereon compiled in the manner and within the time period that the Minister may specify.

(3) The person in control of the mine or activity must inform the Minister as to the expertise and qualifications of the persons who are to conduct an investigation or inspection contemplated in subregulation (1) before the commencement thereof.

(4) The Minister may in writing require any person in control of a mine or activity to submit a programme of implementation to prevent or rectify any pollution of a water resource or damage to the in-stream or riparian habitat as recommended by the investigation contemplated in subregulation (1) within the time period that the Minister may specify.

(5) The Minister may in writing direct any person in control of a mine or activity to implement a compliance monitoring network to monitor the programme of implementation contemplated in subregulation (4), through establishing, operating and maintaining monitoring installations of a type, at the locations and in the manner specified by the Minister and to submit the monitoring information and results to the Minister for evaluation.

(6) Subject to Chapter 4 of the Act, any person in control of a mine or activity must submit plans, specifications and design reports approved by a professional engineer to the Minister, not later than 60 days prior to commencement of activities relating to-

  (a) the construction of any surface dam for the purpose of impounding waste, water containing waste or slurry, so as to prevent the pollution of a water resource;

  (b) the implementation of any pollution control measures at any residue deposit or stockpile, so as to prevent the pollution of a water resource; and

  (c) the implementation of any water control measures at any residue deposit or stockpile, so as to prevent the pollution of a water resource.

Practical implications

The practical implications of these water management regulations on a mine are as follows:

- All water management facilities must be regularly inspected and monitored to ensure that the facilities are capable of meeting the design requirements,
- The water management facilities must be cleaned and maintained, to ensure that:
  - All conveyances are capable of accommodating the 1:50 year flood without overtopping,
  - Pollution control dams are maintained at the design capacity, and
  - Mine residue deposits and pollution control dams are maintained to ensure that the required freeboard is available.
- A reporting system must be in operation on the mine and adhered to
- A maintenance schedule for the water management facilities must be developed
- Access to all waste management facilities must be suitably controlled
- In the case of remining activities:
  - The future use of the remined area will be subject to an Environmental Impact Assessment (EIA),
  - Any damage that is caused during the remining activities must be rectified, and
  - The current water management measures must be upgraded if the remining activities results in these measures being inadequate

The implications of regulation 12 are as follows:

- The Department of Water Affairs and Forestry can direct any person in control of a mine or activity to undertake a technical investigation or review, if such an investigation or review is deemed necessary
- The Department of Water Affairs and Forestry can direct any person in control of a mine or activity to rectify any incidents and to implement a monitoring system to ensure that the remedial work is successful, and
- The requirements of section 6 of regulation 12 should be included in the Water Use Licence Application (WULA) for the mine.

Examples

Figure 6-23 give examples of water management systems that are well maintained and are functioning according to the design requirements. This includes conveyance canals (top left and bottom right), a flow measuring weir (top right) and a dirty water management system (bottom left). In the bottom right photograph, the sump should however be empty at all times.

Figure 6-23: Examples of well maintained water management systems

Figure 6-24 shows examples of poorly maintained water management systems. This includes:

A canal that has completely silted and has lost all conveyance capacity (top left)

Uncontrolled vegetation growth around water flow measuring devices (top and bottom right). These devices will thus be unable to function according to their design an operational requirements, and

Uncontrolled vegetation growth in a canal (bottom left). This will restrict the effectiveness of the canal to convey the stormwater flow for which it has been designed for.

Figure 6-24: Examples of poorly maintained water management systems

6.3.8 Closure

Objective

The objective is to ensure that any long-term residual water quality impacts are identified and adequately managed in the closure scenario.

Requirements of Government Notice No. 704

The requirements of water management regulation 9 are applicable to the closure of water management facilities These are included in Technical Box 6.9 below.

Technical Box 6.9

Regulation 9: Temporary or permanent cessation of mine or activity

(1) Any person in control of a mine or activity must at either temporary or permanent cessation of operations ensure that all pollution control measures have been designed, modified, constructed and maintained so as to comply with these regulations

(2) Any person in control of a mine or activity must ensure that the in-stream and riparian habitat of any water resource, which may have been affected or altered by a mine or activity, is remedied so as to comply with these regulations.

(3) On either temporary or permanent cessation of a mine or activity the Minister may request a copy of any surface or underground plans as required in terms of the Minerals Act, 1991.

Practical implications

The practical implications of these water management regulations on a mine are as follows:

- In the case of temporary cessation of mining, the mine management team must:
  - Review and update the mine closure plan, where required,
  - Identify all water management measures that need to be put in place to ensure effective operations and maintenance of the pollution control measures during the temporary cessation period, and
  - Identify and implement the required monitoring programmes.
- In the case of permanent cessation of mining, i.e. closure, the mine management team must:
  - Ensure that the required rehabilitation of pollution control measures is undertaken in accordance with the closure objectives and the mine closure plan (developed in terms of the Minerals and Petroleum Resources Development Act and the Mining Environmental Series (MEM) and guidelines on closure prepared by the Department of Water Affairs and Forestry. Additional information on closure of pollution control measures is provided in ***BPG A4: Pollution Control Dams***,
  - Identify temporary conveyances that will not be required for closure,
  - Update the temporary conveyances that are required for closure to permanent structures and,
  - Add any additional conveyances that are required for the closure conditions.
- In terms of regulation 9, section 2, the mine management must ensure that:
  - All existing impacts from the water management infrastructure are remediated,
  - Stream diversions systems are managed according to closure plan and closure objectives,
  - The potential future impacts, for example, decant from the mine, have been identified and are covered in the closure plan and the closure financial provisions, and
  - A procedure is in place in the closure plan for the closure of the final voids, if applicable.

In addition, in order to seek alignment and coordination between the DME and DWAF, the respective requirements from each Department on mine closure has been consolidated into a single document in the Mine Environmental Management (MEM) series on Mine Closure, which is to be used by the mining industry.

The MEM Guideline on Mine Closure provides a legal framework stipulating the specific requirements from the regulatory authorities. It further provides an overview of all environmental legislation that needs to be considered with regard to cooperative governance.

The guideline provides a planning framework for mine closure. The methodology to be followed is centered on the environmental risk-based approach for mine closure. In addition, guidance is also provided in the MPRDA and its regulations in terms of the administrative procedures to be followed as part of the formal mine closure application.

This guideline also promotes the concept of regional closure plans in terms of the integration and alignment to be followed. This follows the concept of regional closure plans that has been captured in the Regulations as contemplated in terms of the MPRDA. The essential need for post closure monitoring is fully addressed in the guideline to ensure that progressive achievement of closure objectives is properly recorded.

Other practical implications in terms of water management measures for mine closure are as follows:

- All water management infrastructure should be designed and managed to facilitate mine closure. This includes the following considerations:
  - The durability and longevity of water management designs, e.g. provision of erosion protection for long-term control of erosion,
  - The critical role that water modelling must play in the design process for long-term water quality impact prediction and the design of adequate impact mitigation measures
  - The consideration of active versus passive care of the water management infrastructure post-closure, and
  - The consideration of the final land use and final land forms should be incorporated into the design of the water management measures for closure
- The post-closure water use should be considered in the design process
- The final mine topography should be planned, as far as possible, to be free-draining
- The post-closure water management plan should take cognisance of the likelihood that the water table will rebound in the rehabilitated pits. Modelling of the post-closure groundwater situation will be required to determine:
  - The long-term water level in the pit
  - The long-term management of the pit lake
  - The likelihood and position of future decant and/ or seepage points, and the impact of these on the receiving water
  - The mine management will need to consider the use of the water post-closure. This water can be used for irrigation purposes if of suitable quality. If the water is not of suitable quality, it will need to be treated prior to re-use or discharge (see ***BPG H4: Water Treatment***)
  - The institutional arrangement for water re-use in the closure phase will need to be considered and planned.

Examples

Figure 6-25 provides examples of rehabilitation on opencast pits. In the example on the left, the area has been rehabilitated and is being used for cattle grazing. On the right, the area has been rehabilitated and the grass cover is establishing.

Figure 6-25: Examples of rehabilitated opencast pits

Figure 6-26 illustrates the undesirable instance of acid seepage from a pit area. This could negatively impact on the receiving water environment in the post-closure phase.

Figure 6-26: Acid seepage from pit

6.3.9 Exemptions

Objective

The objective is to streamline mine water management through exemptions, where applicable.

Requirements of Government Notice No. 704

The requirements of water management regulation 3 are applicable to exemptions from the requirements of the water regulations. These are included in Technical Box 6.10 below.

Technical Box 6.10

Regulation 3: Exemption from requirements of regulations

The Minister may in writing authorise an exemption from the requirements of regulations 4, 5, 6, 7, 8, 10 or 11 on his or her own initiative or on application, subject to such conditions as the Minister may determine.

Practical implications

The practical implications of these water management regulations on a mine are as follows:

- The mine management must provide a motivation for the need for an exemption from the requirements of the water management regulations,
- The motivation will be in the form of a report which will cover the following:
  - Identification of the various options, including those options that meet the requirements of the regulations and options applicable to the exemption,
  - A detailed assessment of the options, including impact assessment for each option, for example, the impacts of dirty water spill to a clean system or the impacts of mining within the exclusion zone,
  - A justification for not being able to meet the requirements of the water management regulations, and
  - A motivation for an exemption from the requirements of the regulations.

6.4 Management Cycle

6.4.1 Introduction

The management cycle for the water infrastructure on a mine will include aspects such as monitoring, assessment, reporting, auditing and a feedback loop. These aspects are generally covered in other literature, including the following:

- Details on water monitoring systems are provided in ***BPG G3: Water Monitoring Systems***,
- Guidance on assessment is provided in ***BPG G4: Impact Prediction***, and
- Reporting and auditing for water management facilities is covered in the Global Reporting Initiative (GRI). This is a long-term, multi-stakeholder, international process whose mission is to develop and disseminate globally applicable *Sustainability Reporting Guidelines*. These *Guidelines* are for voluntary use by organisations (corporate, governmental and non-governmental) for reporting on the economic, environmental and social dimensions of their activities, products and services. The aim of the *Guidelines* is to assist reporting organisations and their stakeholders in articulating and understanding contributions of the reporting organisations to sustainable development.

This section will thus focus only on the requirements of the water regulations in relation to management. Examples of monitoring are also provided.

6.4.2 Requirements of Government Notice No. 704

The requirements of water management regulation 2 are applicable to water management. These are included in Technical Box 6.11 below.

Technical Box 6.11

Regulation 2: Information and notification

(1) Any person intending to operate a new mine or conduct any new activity must notify the Department of such intention not less than 14 days before the start of such operation or activity.

(2) Any person in control of an existing mine or activity must-

(a) submit a copy of all amendments of their environmental management programme to the Department;

(b) notify the Department in writing 14 days before the temporary or permanent cessation of the operation of a mine or the conducting of an activity, or the resumption of such operation or activity;

(c) notify the Department by the fastest possible means of any emergency incident or potential emergency incident involving a water resource at or incidental to the operation of a mine or the conducting of any activity, furnishing information regarding-

(i) the date and time of the incident;
(ii) a description of the incident;
(iii) the source of the pollution or potential pollution;
(iv) the impact or potential impact on the water resource and the relevant water users;
(v) remedial action taken or to be taken by the person in control of the mine or activity to remedy the effects of the incident; and

(d) within 14 days after the date of an incident contemplated in paragraph (c) inform the Department in writing of measures taken to correct and prevent a recurrence of such incident.

6.4.3 Practical implications

The practical implications of these water management regulations on a mine are as follows:

- Any amendments to the mine's environmental management plan (EMP) must be submitted to the Department of Water Affairs and Forestry,
- The mine must undertake regular monitoring of the water management facilities. The monitoring data in support of the EMP must also be submitted to the Department,
- The mine must have an incident and emergency plan and reporting procedure in place, as part of the Integrated Water Management Plan. The reporting criteria required for this plan and reporting procedure must be included in the monitoring programme of the water management facilities, and
- The mine must have clear roles and responsibilities in the incident and emergency plan for reporting such incidents or emergencies to the authorities.

6.4.4 Examples

Figure 6-27 illustrates various techniques for monitoring in water storage facilities. The example on the top left shows continuous water level monitoring in the water storage facility. The lower photograph illustrates taking of water quality measurements in the water storage facility. The top right illustrates a method for taking a grab water sample from a storage facility. This is not considered good sampling practice. It is preferable in these instances to take water samples off a boat or vessel launched onto the water storage facility.

Figure 6-27: Monitoring in water storage facilities

Figure 6-28 illustrates the monitoring of water flow in surface water channels, including:

Measurement of flow depth in the canal (top left). This is not the preferred method of flow measurement

Flow and water quality measurements at a weir (top right), and/or

Flow depth measurement using a V-notch (bottom picture).

Figure 6-28: Monitoring flow in surface water channels

Figure 6-29 illustrates groundwater monitoring boreholes. The depth to the groundwater is measured in the borehole. The photograph on the left shows an uncapped borehole which is poor practice. The boreholes should have a concrete collar and a cap, as shown in the photograph on the right. Consideration should also be given to remote data capturing systems, e.g. radios and cells phones, in instances of remote borehole monitoring installations (see ***BPG G3: Water Monitoring Systems***).

Figure 6-29: Groundwater monitoring boreholes

Figure 6-30 shows various examples of in-line measurement of flow in pipes.

Figure 6-30: Pipe flow monitoring

6.5 Practical examples on applying the water management measures

The following sections cover practical examples of the use of the water management measures from GN 704 for typical activities on a surface mine.

6.5.1 Haul roads and ramps

Separation, collection and conveyance of water of different quality is important in the design of haul roads and ramps for surface mines. Lower roads and ramps will act as channels for surface water that will need to be collected and managed in the pit. Higher roads and ramps act as berms which may impede the runoff of clean stormwater. Collection and diversion systems for the stormwater will need to be designed in these instances. The figures below illustrate pit ramp designs typically used in opencast coal mining to reduce rainfall ingress. Figure 6-31 and Figure 6-32 illustrate opencast mines with low wall ramps, while Figure 6-33 and Figure 6-34 illustrate opencast mines with high wall ramps. The best practice procedures to follow are as follows:

- Clean and dirty water cutoff berms should be constructed of weathered low permeability material containing no carbonaceous formation
- Water drainage paths should be designed to maximise flow without erosion
- Cognisance should be taken of materials erodeability when designing flow path gradients
- The berm material could be re-used as the mining window advances
- The unleveled spoil piles should be kept to a minimum. A maximum of three cut widths of unleveled spoil is recommended to reduce rainfall ingress
- Low wall ramps should periodically be backfilled to reduce rainfall ingress, and
- Rehabilitation growth must be maximised to facilitated erosion control and maximise evapotranspiration.

Figure 6-31: Plan view of best practices utilising low wall ramps

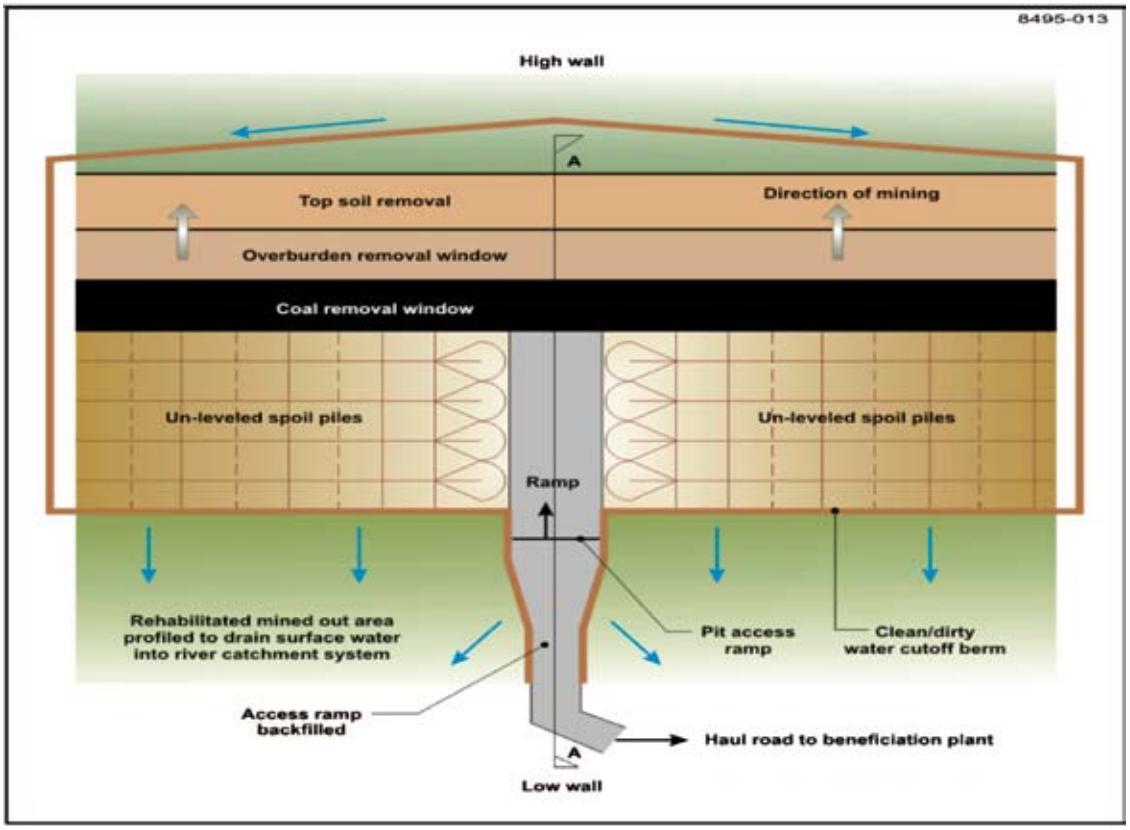


Figure 6-32: Section through mine pit with low wall ramps

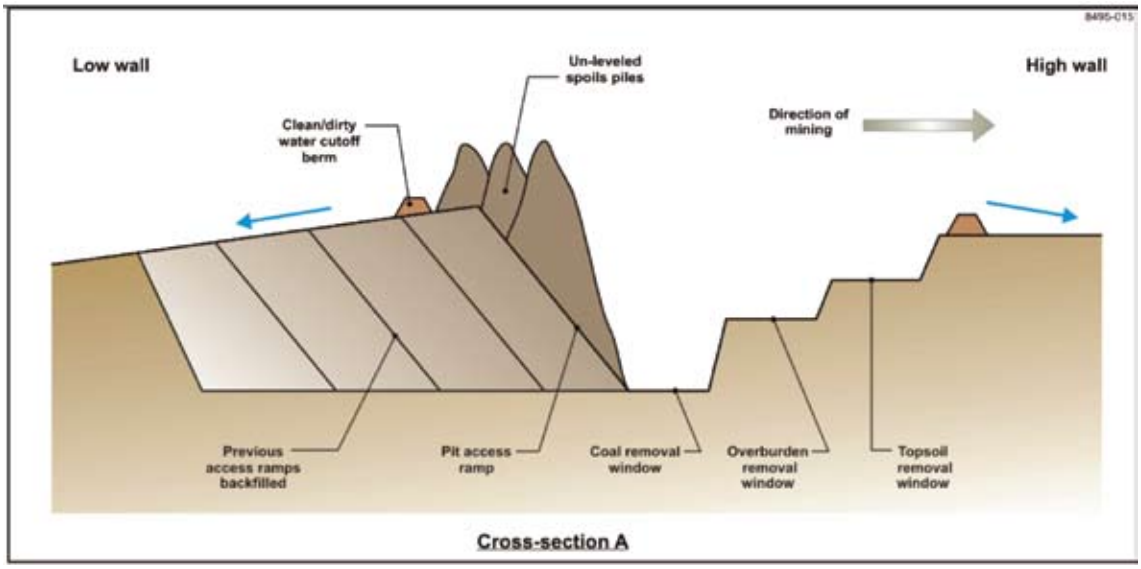


Figure 6-33: Plan view of best practices utilising high wall ramps

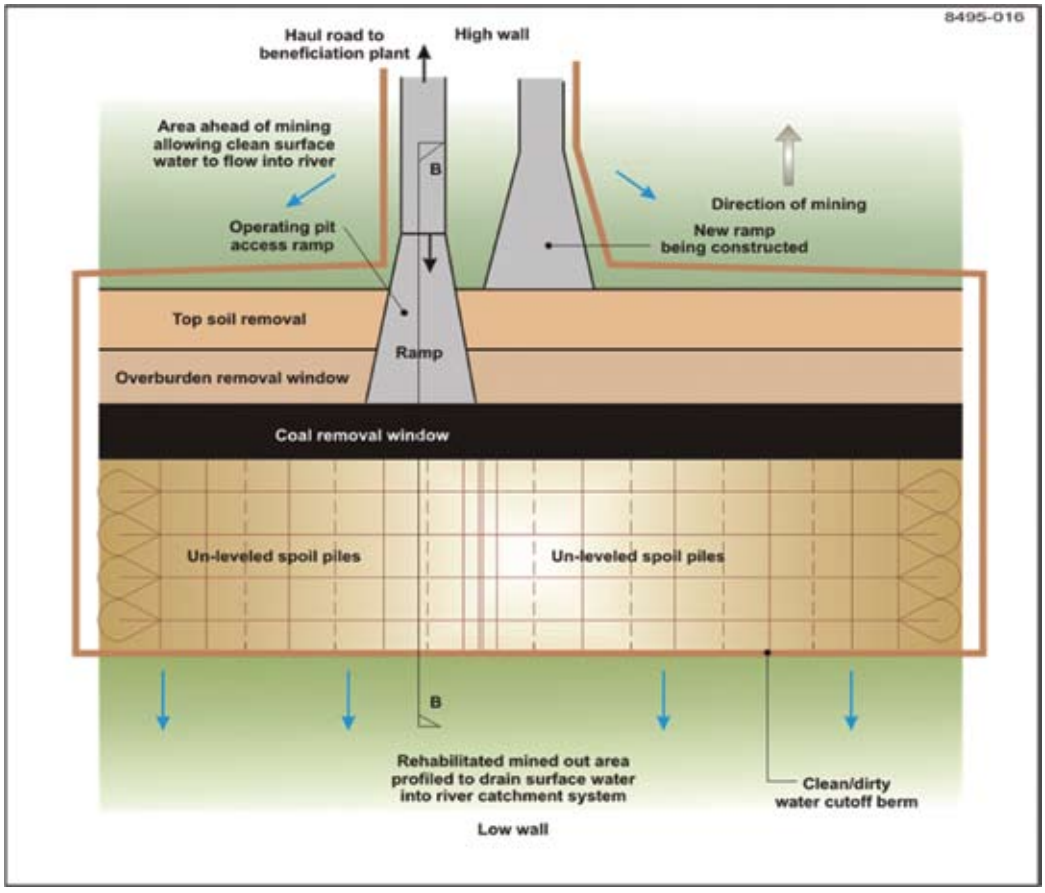
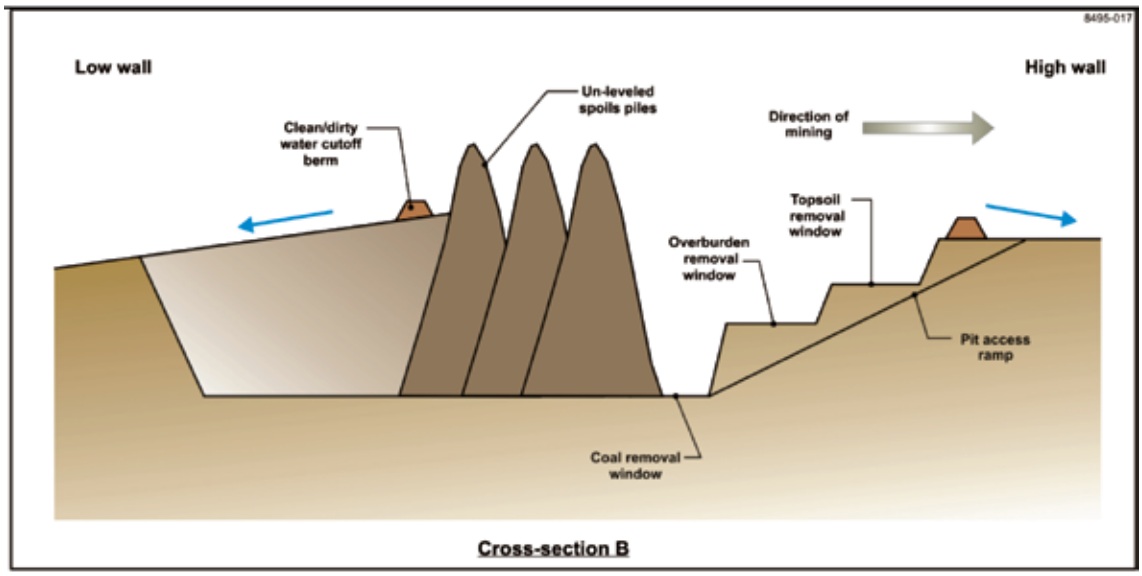


Figure 6-34: Section through mine pit with high wall ramps



6.5.2 Dragline walkways

Dragline walkways and haul roads should be kept within the operating windows of the pits. The topsoil, subsoil and soft weathered overburden should be removed prior to construction to provide a good foundation for the road/ walkway. These materials should be stockpiled for reuse after closure. During the design of the road/walkway, cognisance should be taken of clean and dirty water separation along either side of the routes with clean water being channelled into streams and dirty water channelled into the mine water collection system.

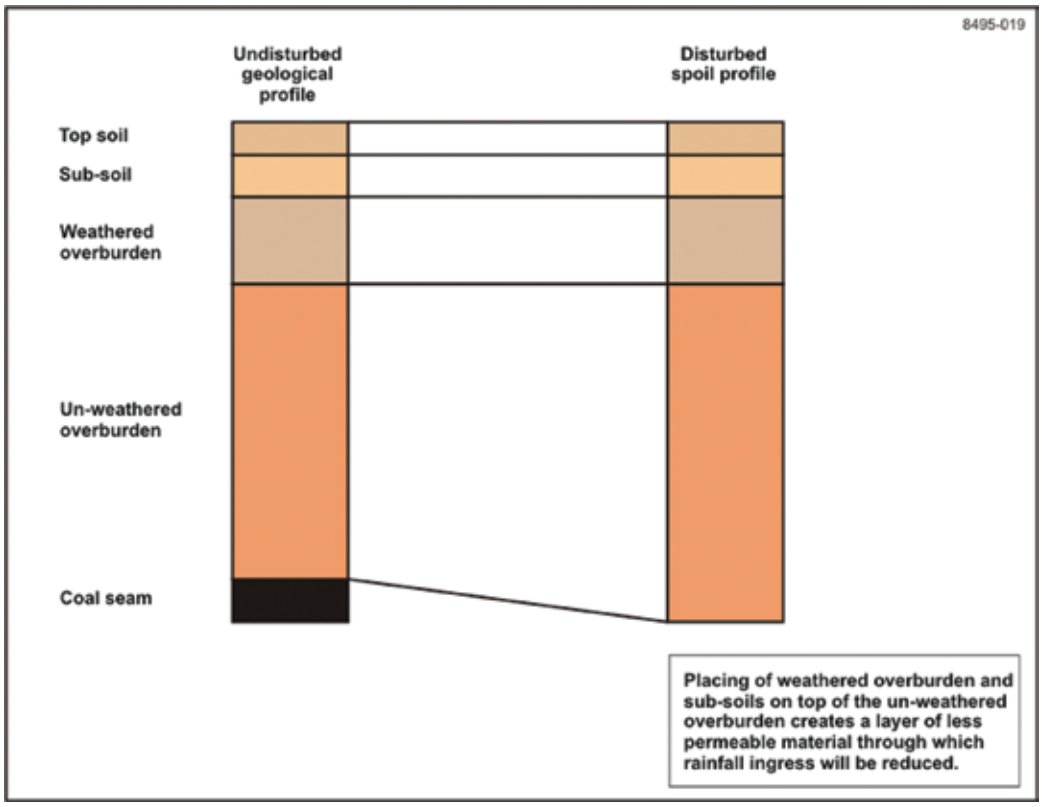
6.5.3 Diversion berms

Diversion berms will be required around the pit that forms part of the active mining window, to divert clean stormwater away from the pit. These berms may need to be constructed and managed on an ongoing basis in the case of strip mining.

6.5.4 Rehabilitation

Figure 6-35 demonstrates best practice for spoils placement to reduce rainfall ingress. All top soil and subsoil not immediately used for rehabilitation should be stockpiled for future use when required. These stockpiles need to be managed to minimise erosion and subsequent loss of material.

Figure 6-35: Best practice for spoils placement to reduce rainfall ingress



6.5.5 Workshops, hard parks, vehicle and machinery ways bays and fuel bays

Topsoil, subsoil and soft weathered overburden should be removed prior to construction to provide a good foundation for the facilities. These materials should be stockpiled for reuse after closure.

During the design of the facilities cognisance must be taken of clean and dirty water separation along either side of the routes with clean water being channelled into streams and dirty water channelled into the mine water collection system designed for handling water contaminated with oils and greases. Silt and oil traps should also be used to manage dirty water runoff.

Dirty water from these areas will contain oils and greases and need to be channelled into the mine's system for collecting oils and greases.

7

REFERENCES AND FURTHER READING

a) Department of Water Affairs and Forestry, 2004. National Water Resource Strategy, First Edition. September 2004

b) Department of Water Affairs and Forestry, 2006. Generic Water Conservation and Water Demand Management Framework Guideline for the Mining Sector in South Africa

c) Global Reporting Initiative, 2002. Sustainability Reporting Guidelines.

d) Global Reporting Initiative, 2003. The Water Protocol, 2003. For use with the GRI 2002 *Sustainability Reporting Guidelines*. February 2003.

e) Global Reporting Initiative, 2005. GRI Mining and Metals Sector Supplement, Pilot version 1.0, incorporating an abridged version of the GRI 2002 *Sustainability Reporting Guidelines*. February 2005.

f) Government Gazette, 1998. National Water Act (Act No. 36 of 1998).

g) Government Gazette, 1998. National Environmental Management Act (Act No. 107 of 1998).

h) Government Gazette, 1999. Regulation on use of water for mining and related activities aimed at the protection of water resources. Regulation No. 704, 4 June 1999.

i) http://xmlwords.infomine.com.

j) http://www.dwaf.gov.za

k) http://www.dme@gov.za

8 GLOSSARY

Activity	Any mining related process on the mine including the operation of washing plants, mineral processing facilities, mineral refineries and extraction plants, and the operation and the use of mineral loading and off-loading zones, transport facilities and mineral storage yards, whether situated at the mine or not, in which any substance is stockpiled, stored, accumulated or transported for use in such process or out of which process any residue is derived, stored, stockpiled, accumulated, dumped, disposed of or transported.
Approved professional person (APP)	A professional engineer approved by the Minister of Water Affairs and Forestry after consultation with the Engineering Council of South Africa (ECSA), for the purposes of executing certain "tasks" relating to dams.
Clean water system	Any dam, other form of impoundment, canal, works, pipeline and any other structure or facility constructed for the retention or conveyance of unpolluted water.
Dam	Any settling dam, slurry dam, evaporation dam, catchment or barrier dam and any other form of impoundment used for the storage of unpolluted water or water containing waste.
Dam with a safety risk	A dam with a storage capacity in excess of 50 000 cubic metres and a vertical height in excess of 5 metres. The design of new dams, alterations to existing dams, quality control during construction, dam safety inspections and dam safety studies are described as "tasks" relating to dams. MRDs are currently exempt but can be classified under certain circumstances.
Dirty area	Any area at a mine or activity which causes, has caused or is likely to cause pollution of a water resource.
Dirty water system	Any dam, other form of impoundment, canal, works, pipeline, residue deposit and any other structure or facility constructed for the retention or conveyance of water containing waste.
Environmental management programme	An environmental management programme submitted in terms of section 39 of the Mineral and Petroleum Resources Development Act, 2002 (MPRDA).
Facility	In relation to an activity, includes any installation and appurtenant works for the storage, stockpiling, disposal, handling or processing of any substance.
Height of dam	In the case of a dam situated across a water course, the maximum wall height is measured from the natural level of the bed of the water course on the downstream face of the dam to the top of the dam, which is the level of the roadway or walkway. In the case of any other dam the height is measured from the lowest elevation of the outside limit of the dam to the top of the dam which is the level of the roadway or walkway. In the case of a dam consisting of a spillway across the full dam width, the height is measured to the crest level of the spillway.
Inter-alia	Among other things.
Loca standi	A person who has locus standi, or legal standing, and has the right to appear before a court on a particular matter.
Mine Manager	The meanings assigned to them in the Mine Health and Safety Act, 1996 (Act No. 29 of 1996)

Person in control of a mine, activity or holder	In relation to a particular mine or activity, includes the owner of such mine or activity, the lessee and any other lawful occupier of the mine, activity or any part thereof; a attributer for the working of the mine, activity or any part thereof; the holder of a mining authorisation or prospecting permit and if such authorisation or permit does not exist, the last person who worked the mine or his or her successors-in-title or the owner of such mine or activity; and if such person is not resident in or not a citizen of the Republic of South Africa, an agent or representative other than the manager of such a mine or activity must be appointed to be responsible on behalf of the person in control of such a mine or activity.
Residue	Includes any debris, discard, tailings, slimes, screenings, slurry, waste rock, foundry sand, beneficiation plant waste, ash and any other waste product derived from or incidental to the operation of a mine or activity and which is stockpiled, stored or accumulated for potential re-use or recycling or which is disposed of.
Residue deposit	Includes any dump, tailings dam, slimes dam, ash dump, waste rock dump, in-pit deposit and any other heap, pile or accumulation of residue.
Solids content	The volumetric concentration (Cv) is defined as the ratio of the volume of solids to the total volume of the mixture or slurry. The mass concentration (Cw or Cm) is defined as the ratio of the mass of dry solids to the total mass of the mixture or slurry
Stockpile	Includes any heap, pile, slurry pond and accumulation of any substance where such substance is stored as a product or stored for use at any mine or activity
Suitably qualified person	A person with suitable professional expertise for the task who can be accountable for the output of the task.
Water system	Any dam, any other form of impoundment, canal, works, pipeline and any other structure or facility constructed for the retention or conveyance of water.

9

LIST OF ACRONYMS AND ABBREVIATIONS

ABA	Acid Base Accounting
APP	Approved Professional Person
BFS	Bankable Feasibility Study
BPEO	Best Practice Environmental Option
BPG	Best Practice Guideline
CMA	Catchment Management Agency
CM	Catchment Management
CMS	Catchment Management Strategy
DEAT	Department: Environmental Affairs and Tourism
DME	Department: Minerals and Energy
DWAF	Department of Water Affairs and Forestry
ECA	Environment Conservation Act, 1989 (Act 73 of 1989)
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FRD	Fine Residue Deposit
GCL	Geosynthetic Clay Liner
GN704	Government Notice No. 704, National Water Act, 1998 (Act No. 36 of 1998)
GRI	Global Reporting Initiative
HDPE	High Density Polyethylene
ICP	Inductively Coupled Plasma
IRP	Integrated Regulatory Process
ISP	Internal Strategic Perspective
IWULA	Integrated Water Use License Application
IWMP	Integrated Water Management Plan
LLDPE	Liner Low Density Polyethylene
MC	Management Class
MEM	Mine Environmental Management
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)
MRD	Mine Residue Deposit
NEMA	National Environmental Management Act, 1998 (Act No.107 of 1998)
NNR	Natural Nuclear Regulator
NWA	National Water Act, 1998 (Act No. 36 of 1998)
NWRS	National Water Resources Strategy
NWRCS	National Water Resource Classification System
P&IDs	Process and Instrumentation Diagrammes
RMF	Regional Maximum Flood
RO	Regional Office (DWAF)
RQOs	Resource Quality Objectives
SABS	South African Bureau of Standards
SAHRA	South African Heritage Resource Agency
SEA	Strategic Environmental Assessment
TSF	Tailings storage facility
XRD	X-Ray Diffraction
XRF	X-Ray Fluorescence Spectrometry
WC/WDM	Water Conservation and Water Demand Management
WDCS	Waste Discharge Charge System

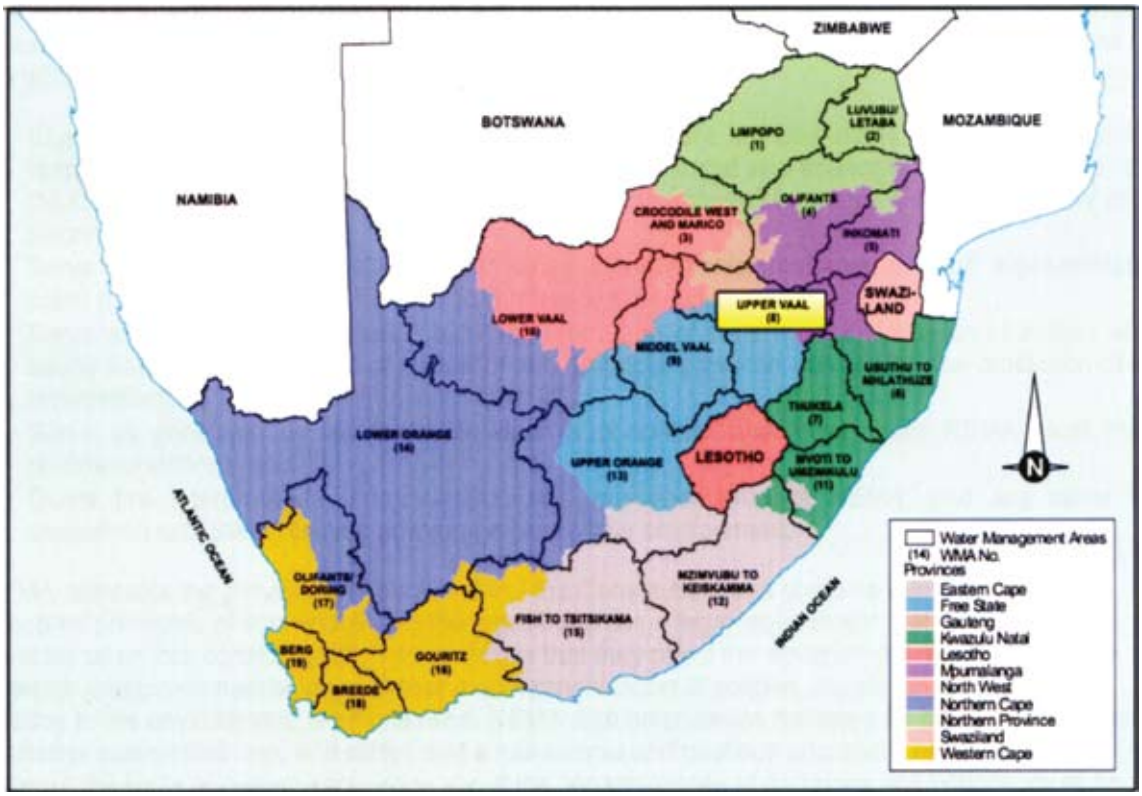
APPENDIX A LEGAL FRAMEWORK

A.1 INTRODUCTION

The legal review provides an outline of the requirements for water management within the prevailing mining, water and environmental legislation in South Africa. The legal review focuses in two main areas, namely:

1) Section A.2 covers the water management requirements in the national legislation, including the National Environmental Management Act, 1998 (Act 107 of 1998), the Mineral and Petroleum Resources Development Act, 2002 (MPRDA) (Act 28 of 2002) and the National Water Act, 1998 (NWA), (Act 36 of 1998). The provisions included in other legislation are also considered
2) Section A.3 covers the policies, strategies and guideline documents that have been developed by DWAF at a national level to assist in effective water management throughout South Africa. These policies and strategies are required to be implemented regionally, or on a catchment basis in the case of DWAF. The guideline documents have been developed to assist the catchment-based implementation process. This implementation is currently being undertaken through DWAFs regional offices, but will in future be delegated to Catchment Management Agencies (CMAs) who will be responsible for all water management within a defined catchment areas. Figure A-1 indicates the division of the country into the 19 Water Management Areas (WMAs).

Figure A-1: Water Management Areas in South Africa



Note that the regulatory environment is continuously being amended within South Africa. The legal framework and review included in this BPG thus covers the current legislative status.

A.2 SOUTH AFRICAN NATIONAL LEGISLATION

A.2.1 Constitution of the Republic of South Africa Act, 1996 (Act 108 of 1996)

Section 24 of the Constitution provides that *everyone has the right … to an environment that is not harmful to their health or well-being; and … to have the environment protected for the benefit of present and future generations through reasonable legislative and other measures that - (i) prevent pollution and ecological degradation; (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development*.

Section 33 of the Constitution entitles everyone to administrative action that is lawful, reasonable and procedurally fair and, if one's rights have been adversely affected by administrative action, to be given written reasons for the decision.

Section 38 provides locus standi or the right to get involved to any member of public. This means that a member of public has the right to take appropriate action to prevent environmental damage. This may include taking action against the responsible authority for failing to perform its duties in preventing environmental damage or against an individual or authority who are in the process of undertaking a water use identified in the NWA without the necessary authorisation to undertake such water use.

A.2.2 National Environmental Management Act, 1998 (Act 107 of 1998)

The National Environmental Management Act, 1998 (NEMA) contains certain principles in section 2. These principles apply throughout the country to the actions of all organs of state (as defined in the Constitution) that may significantly affect the environment and:

- Shall apply alongside all other appropriate and relevant considerations, including the State's responsibility to respect, protect, promote and fulfil the social and economic rights in Chapter 2 of the Constitution and in particular the basic needs of categories of persons disadvantaged by unfair discrimination
- Serve as the general framework within which environmental management and implementation plans (referred to in section 11 of NEMA) must be formulated
- Serve as guidelines by reference to which any organ of state must exercise any function when taking any decision in terms of NEMA or any statutory provision concerning the protection of the environment
- Serve as principles by reference to which a conciliator appointed under NEMA must make recommendations, and
- Guide the interpretation, administration and implementation of NEMA, and any other law concerned with the protection or management of the environment.

NEMA reiterates the provisions of section 24 of the Constitution, and contains the internationally accepted principles of sustainability. It therefore becomes a legal requirement that these principles must be taken into consideration in all decisions that may affect the environment. Furthermore, the need for intergovernmental co-ordination and harmonisation of policies, legislation, and actions relating to the environment, is emphasised. NEMA also emphasises the need for a mechanism that promotes sustainable use, and states that a risk-averse and cautious approach, which takes into account the limits of current knowledge about the consequences of decisions and actions, must be used in decision-making. It is also important to note that the Best Practical Environmental Option (BPEO) is defined in NEMA as *the option that provides the most benefit or causes the least damage to the environment as a whole, at a cost acceptable to society, in the long term as well as the short term*.

In the context of mining, these principles are given further effect through section 37 of the MPRDA, which stipulates that the principles set out in section 2 of NEMA:

- Apply to all prospecting and mining operations, as the case may be, and any matter relating to such operation, and
- Serve as guidelines for the interpretation, administration and implementation of the environmental requirements of the MPRDA.

Section 28 of NEMA further establishes a general duty of care on every person who causes, has caused or may cause significant pollution or degradation of the environment to take reasonable measures to prevent such pollution or degradation from occurring, continuing

or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.

New EIA Regulations, promulgated under NEMA, came into effect on 03 July 2006 (as covered in Government Notices R385, R386 and R387 of 21 April 2006 - the "NEMA EIA Regulations").

A.2.3 Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002)

A.2.3.1 Mining Authorisation

Section 5(4)(a) of the MPRDA stipulates that no person may prospect for or remove, mine, conduct technical or reconnaissance operations, explore for and produce any mineral or petroleum or commence with any work incidental thereto (including the construction of any residue deposits) on any area without *inter alia* an approved environmental management programme or approved environmental management plan, as the case may be.

A.2.3.2 Prospecting rights

If the application for a prospecting right is accepted by the Regional Manager, the Regional Manager must within 14 days from the date of acceptance notify the applicant in writing to *inter alia* submit an environmental management plan (section 16(4)(a)). The granting of a prospecting right only becomes effective on the date on which the environmental management plan is approved in terms of section 39 of the MPRDA (section 17(5)). The application for renewal of a prospecting right must *inter alia* be accompanied by a report reflecting the extent of compliance with the requirements of the environmental management plan, the rehabilitation completed and the estimated cost thereof (section 18(2)(c)) and the Minister must grant the renewal of a prospecting right if the application complies with sections 18(1) and 18(2) and the holder of the prospecting right has *inter alia* complied with the requirements of the approved environmental management plan (section 18(3)(c)). The holder of a prospecting right must comply with the requirements of the approved environmental management plan in terms of section 19(2)(c). In the case of a retention permit, the environmental management plan approved in respect of the prospecting right remains in force as if the prospecting right had not lapsed in terms of section 32(2) (section 32(3)) and the holder of the retention permit must give effect to the approved environmental management plan (section 35(2)(a)).

A.2.3.3 Mining rights

If the application for a mining right is accepted, the Regional Manager must within 14 days from the date of acceptance notify the applicant in writing to *inter alia* conduct an environmental impact assessment and submit an environmental management programme for approval in terms of section 39 (section 22(4)). A mining right granted in terms of section 23(1) comes into effect on the date on which the environmental management programme is approved in terms of section 39(4) (section 23(5)). An application for renewal of a mining right must *inter alia* be accompanied by a report reflecting the extent of compliance with the requirements of the approved environmental management programme, the rehabilitation to be completed and the estimated cost thereof (section 24(2)(b)) and the Minister must grant the renewal of a mining right if the application complies with sections 24(1) and 24(2) and the holder of the mining right has *inter alia* complied with the requirements of the approved environmental management programme (section 24(3)(c)). The holder of a mining right must comply with the requirements of the approved environmental management programme in terms of section 25(2)(e).

A.2.3.4 Mining Permits

If the Regional Manager accepts the application for a mining permit, the Regional Manager must, within 14 days from the date of acceptance, notify the applicant in writing to *inter alia* submit an environmental management plan (section 27(5)(a)). The Minister must issue a mining permit if *inter alia* the applicant has submitted the environmental management plan (section 27(6)(b)).

A.2.3.5 Environmental management

Section 37 requires that the principles set out in section 2 of NEMA must apply to all prospecting and mining operations, and that the generally accepted principles of sustainable development must be applied by integrating social, economic and environmental factors during the planning and implementation phases of mining projects.

Section 38(1) requires that the holder of a reconnaissance permission, prospecting right, mining right, mining permit or retention permit:

- Must at all times give effect to the general objectives of integrated environmental management laid down in Chapter 5 of NEMA

- Must consider, investigate, assess and communicate the impact of his or her prospecting or mining on the environment as contemplated in section 24(7) of NEMA
- Must manage all environmental impacts in accordance with his or her environmental management plan or approved environmental management programme, as the case may be; and as an integral part of the reconnaissance, prospecting or mining operation, unless the Minister directs otherwise;
- Must as far as it is reasonably practicable, rehabilitate the environment affected by the prospecting or mining operations to its natural or predetermined state or to a land use which conforms to the generally accepted principle of sustainable development, and
- Is responsible for any environmental damage, pollution or ecological degradation as a result of his or her reconnaissance prospecting or mining operations and which may occur inside and outside the boundaries of the area to which such right, permit or permission relates.

Section 39 of the MPRDA deals with the requirements of an environmental management programme or plan, whichever is applicable. Section 40 allows for the consultation with other State departments that administers any law relating to matters affecting the environment.

Section 41 deals with the financial provision for remediation of environmental damage, and the requirement to maintain and retain the financial provision in force until the Minister issues a certificate in terms of section 43, which states that the holder of a prospecting right, mining right, retention permit or mining permit remains responsible for any environmental liability, pollution or ecological degradation, and the management thereof, until the Minister has issued a closure certificate to the holder concerned. In terms of section 43(5) no closure certificate may be issued unless the Chief Inspector (MHSA) and the DWAF (NWA) have confirmed in writing that the provisions pertaining to health, safety and management of potential pollution to water resources have been addressed.

Section 42 deals specifically with the management of residue stockpiles and residue deposits, and stipulates that these must be managed in the prescribed manner on any site demarcated for that purpose in the environmental management programme or plan in question only. Regulation 73 provides comprehensive supporting information for this section of the act.

In line with section 20 of the NWA and section 30 of NEMA, section 45 of the MPRDA allows the Minister to direct the implementation of urgent remedial measures in the case of ecological degradation, pollution or environmental damage which may be harmful to the health or well-being of anyone. If the holder of the relevant right, permit or permission fails to comply with this directive, the Minister may take the necessary steps to implement the required remedial measures and recover the cost for implementation from the holder concerned.

A.2.3.6 Mineral and Petroleum Resources Development Regulations

Government Notice No. R.527 (R527), dealing with the mineral and petroleum resources development regulations was published in the Government Gazette of 23 April 2004 (GG No. 26275, Volume 466). In particular, Part III of R527 deals with environmental regulations for mineral development, petroleum exploration and production.

In terms of regulation 48, an environmental impact assessment contemplated in section 39(1) of the MPRDA is a process which results in the compilation of a:

- Scoping report, the contents of which is described in regulation 49, and
- An environmental impact assessment report, the contents of which are described in regulation 50.

The contents (framework) of an environmental management programme or plan, whichever is applicable, is described in regulations 51 and 52, respectively, while the requirements for monitoring and performance assessments of these programmes/plans are described in detail in regulation 55. The methods and quantum of financial provision for the rehabilitation, management and remediation of negative environmental impacts (including those associated with mine residue deposits) are given in regulations 53 and 54.

Regulations 56 deals with the requirements for mine closure, including the principles for mine closure, closure objectives and the contents (framework) of the environmental risk assessment report and closure plan.

Part IV of R527 deals with pollution control and waste management regulation and stipulates a number of requirements specific to the management of mine residue stockpiles and deposits (regulation 73). Regulation 73(1) stipulates that the assessment of impacts relating to the management of residue stockpiles/deposits must

form part of the environmental impact assessment report (regulation 50) and environmental management programme or plan, as the case may be. Other requirements with respect to the design, operation and maintenance, and decommissioning and closure of a mine residue deposit include:

- Characterisation of mine residue, by a competent person, to identify any significant health or safety hazard and environmental impact that may be associated with the residue when stockpiled or deposited at the site(s) under consideration (regulation 73(2))
- Classification of residue stockpiles/deposits, by a competent person, in terms of the safety and environmental hazard/impact thereof. The classification will determine the level of investigation and assessment required, the requirements for design, construction, operation, decommissioning, closure and post-closure maintenance, and the qualifications and expertise required of person undertaking the necessary investigations and/or assessment (regulation 73(3))
- Selection and investigation of a site, following the prescribed process, with specific requirements for geotechnical and groundwater investigations (regulation 73(4))
- Incorporations of prescribed considerations during the design of residue stockpile/deposits (regulation 73(5))
- Implementation of a monitoring system for residue stockpiles/deposits with respect to potentially significant impacts (regulation 73(7)), and
- Management requirements for residue deposits during the decommissioning, closure and post-closure phases (regulation 73(8)).

A holder of any right or permit must further ensure that (regulation 73(6)):

- The residue deposits, including surrounding catchment paddocks, are constructed and operated in terms of the approved environmental management programme/plan
- The residue deposit is constructed strictly in accordance with the design, and if not, that the necessary approvals are obtained and the environmental management programme/plan amended accordingly
- All residue transported to and the surplus water removed from the site are recorded as part of the monitoring system
- Appropriate security measures are in place to limit unauthorised access to the site
- Specific action is taken in respect of any sign of pollution
- Adequate measure are implemented to control dust pollution and erosion of the slopes, and
- Details of the rehabilitation of the residue deposit are provided in the environmental management programme/plan.

Other requirements which could apply to surface mining are stipulated, namely:

- Regulation 64: Air quality management and control
- Regulation 65: Fire prevention
- Regulation 66: Noise management and control
- Regulation 68: Water management and pollution control
- Regulation 69: Disposal of waste material, including mining waste, and
- Regulation 70: Soil pollution and erosion control.

A.2.4 National Water Act, 1988 (Act 36 of 1998)

A.2.4.1 Water use

Section 21 of the NWA stipulates the following water uses:

(a) taking water from a water resource
(b) storing water
(c) impeding or diverting the flow of water in a water-course
(d) engaging in a stream flow reduction activity contemplated in section 36
(e) engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1)
(f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit
(g) disposing of waste in a manner which may detrimentally impact on a water resource
(h) disposing in any manner of water which contains waste from, or which has been heated in, 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 if it is necessary for the efficient continuation of an activity or for the safety of people, and

(k) using water for recreational purposes.

Note that in the above, waste includes *any solid material or material that is suspended, dissolved or transported in water (including sediment) and which is spilled or deposited on land or into a water resource in such volume, composition or manner as to cause, or to be reasonably likely to cause, the water resource to be polluted*.

In terms of section 4 of the NWA, water may only be used if it is a Schedule 1 use, a continuance of an existing lawful use (ELU), or authorised in terms of a general authorisation (GA) or licence. A water use may therefore not be implemented unless it is properly authorised through one of these types of authorisations. The circumstances that will determine the type of authorisation to be issued for a specific water use that is not a Schedule 1 use, and the different possibilities for regulating particular water uses are briefly discussed below.

A.2.4.1.1 Existing Lawful Water Uses (Sections 32 to 35)

Section 32 identifies water uses that were authorised under legislation, which was in force immediately before the date of commencement of the NWA (such as the 1956 Water Act), as ELUs. This is subject to the requirement that such water use took place at any time during the two years prior to the date of commencement of the NWA. Should a person have had such authorisation to use water but have not exercised this authorisation in the two years prior to this date, that person may apply to have the water use declared as an ELU in terms of section 33 of the Act. The section on ELU is designed to enable existing economic activities based on the use of water to continue until such time as compulsory licensing is called for in a particular catchment management area.

A.2.4.1.2 General Authorisations (GAs) (Section 39)

The aim of GAs is to set a cut-off point below which strict regulatory control is not necessary. If a water use is not described under Schedule 1, but authorised under a GA as published in the Government Gazette, such water use does not require a licence, unless the GA is repealed or lapses, in which case licensing will be necessary. For example, Government Notice No. 399 (GN399) of 26 March 2004 provides for GAs with respect to various water uses in terms of section 21 of the NWA.

A.2.4.1.3 Licences (Sections 40 to 52)

A person who wishes to use, or who uses water in a manner that is not a Schedule 1 use, not covered under a GA, or in a manner that is not regarded or declared as an ELU, may only use that water under the authority of a license (section 4). The NWA makes provision for two types of applications for water use licences, namely individual applications and compulsory applications. The provisions applicable to an individual application for a water use license are described in sections 40 to 42 of the NWA. These sections also provide that a responsible authority may require an assessment by the applicant of the likely effect of the proposed water use on the resource quality, and that such assessment be subject to the Environmental Impact Assessment (EIA) regulations promulgated under section 26 of the Environment Conservation Act, 1989 (Act 73 of 1989) (ECA). In terms of sections 43 to 48 of the NWA, compulsory applications for licences will be required under certain circumstances (e.g. in catchment management areas which are under water stress) from all water users using a particular water resource or in a specific geographical area, irrespective of whether or not their water use has been authorised by a GA or an ELU. Compulsory applications for the authorisation of these water uses are subject to the development of a Water Allocation Plan, which needs to be prepared by the responsible authority.

In the event that the purpose of the NWA will be met by the granting of a license, permit or other authorisation under any other law, the licensing authority may either dispense with the requirement for a license in terms of section 22(3), or may combine the various license requirements of other organs of state into a single license (section 22(4)). These provisions are of particular importance with regard to certain multiple water uses (section 22(4)), such as may occur for surface mining, e.g. a mine may require water use licenses under sections 21(a), (b), (c), (f) and (g).

Section 27 of the NWA specifies some factors that must be taken into consideration when considering a water use authorisation, including:

(a) existing lawful water uses
(b) the need to redress the results of past racial and gender discrimination
(c) the efficient and beneficial use of water in the public interest
(d) the socio-economic impact of the water use or uses if authorised of the failure to authorise the water use or uses
(e) any catchment management strategy applicable to

the relevant water resource

(f) the likely effect of the water use to be authorised on the water resource and on other water users

(g) the class and the resource quality objectives of the water resource

(h) investments already made and to be made by the water user in respect of the water use in question

(i) the strategic importance of the water use to be authorised

(j) the quality of water in the water resource which may be required for the Reserve and for meeting alignment with the catchment management strategy

(k) international obligations, and

(l) the probable duration of any undertaking for which a water use is to be authorized.

These decision-making considerations are important when contemplating the prioritisation of a particular application, and when establishing preferences when evaluating competing applications for specific water uses.

Section 148(1)(f) of the NWA makes provision for an appeal to the Water Tribunal against a decision on a license application under section 41 by the applicant or any other person who has lodged a written objection against the application. If applicable, appeals against decisions on license applications may also be taken to the High Court.

A.2.4.2 Water use regulations

Government Notice No. 704 (GN704), regulations on use of water for mining and related activities aimed at the protection of water resources, was promulgated in terms of section 26 of the NWA on 4 June 1999. These regulations are covered in detail in this BPG and are not repeated here.

A.2.4.3 Dam safety requirements

Chapter 12 of the NWA contains measures aimed at improving the safety of new and existing dams with a safety risk so as to reduce the potential for harm to the public, damage to property or to resource quality. A dam with a safety risk means any dam which can contain more than 50 000 m^3 of water (irrespective whether such water contains substances or not) and which has a wall of a vertical height of more than 5 metres, or which has been declared as a dam with a safety risk under section 118(3)(a). Dam Safety Regulations published in Government Notice R.1560 of 25 July 1986, which are still in force under the NWA, require that dams with a safety risk must be classified into categories, and that licenses must be issued before any task relating to a specific category of dam may commence. These regulations also prescribe the conditions, requirements and procedures to classify, register, obtain a license to construct a new dam, impound a dam, or alter an existing dam. It further stipulates the requirements and responsibilities in respect of dam safety inspections, emergency procedures, recording and reporting.

A.2.4.4 Other important requirements in the NWA

Section 19 of the NWA further stipulates the general duty of care on persons who own, control, use or occupy land on which any activity or process is or was performed or undertaken, or any other situation exists which causes, has caused or is likely to cause pollution of a water resource, to take all reasonable measures to prevent any such pollution from occurring, continuing or recurring.

Section 20 deals with the reporting, containment and remedying of any incident or accident in which a substance pollutes or has potential to pollute a water resource or have a detrimental effect on a water resource. It further states that the CMA may take the necessary measures, if the remedial measures fail or inadequately comply, at the expense of the responsible person(s). Section 30 of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA) stipulates similar requirements.

Sections 56 to 60 deals with water use charges and allows the Minister to establish a pricing strategy with charges for any water use to fund the direct and related costs of water resource management, development and use, and for achieving equitable and efficient allocation of water. These charges may be used to ensure compliance with prescribed standards and water management practices according to the *user pays* and *polluter pays* principles. Provision is made for incentives for effective and efficient water use and could therefore be used as a means of encouraging reduction in waste and water wastage.

The Department of Mineral and Energy Affairs (DME) administrates the Mineral and Petroleum Resources Development Act, 2002 (MPRDA), but due to the major impact that mining can have on the environment, especially the water environment, DME is obliged to consult with DWAF with regard to certain decisions made in terms of this Act.

A.2.5 Mine Health and Safety Act (MHSA), 1996 (Act 29 of 1996)

Section 2(1) stipulates that the owner of a mine that is being worked must ensure, as far as reasonably practicable, that the mine is designed, constructed and equipped to provide conditions safe for operations and a healthy working environment and that the mine is commissioned, operated, maintained and decommissioned in such a way that employees can perform their work without endangering the health and safety of themselves or of any other person. Section 2(2) further stipulates that the owner of a mine that is not being worked, but in respect of which a closure certificate has not been issued, must take reasonable steps to prevent injuries, ill-health, loss of life or damage of any kind from occurring at or because of the mine. The Chief Inspector of Mines has the power to monitor and control those environmental aspects at mines that affect, or may affect, the health or safety of employees or other persons and is required to consult with the Director: Mineral Development concerning the exercise of those powers.

The above is reiterated in Section 5 which states that every manager must, to the extent that it is reasonable practicable:

- Provide and maintain a working environment that is safe and without risk to the health of employees
- Identify the relevant hazards and assess the related risks to which persons who are not employees may be exposed, and
- Ensure that persons who are not employees, but who may be directly affected by the activities of the mine, are not exposed to any hazards to their health and safety.

Regulation 2.10.15, promulgated in terms of the MHSA, stipulates that the appointed manager must ensure that in the construction of any dump or any slimes dam in the neighbourhood of any building, thoroughfare or other public road, railway or public place, no danger to life or limb or damage to property can result there from.

In terms of Section 9, a manager must prepare and implement a code of practice on any matter affecting the health or safety of employees and other persons who may be directly affected by activities at the mine if the Chief Inspector requires it. These codes of practices must comply with guidelines issued by the Chief Inspector.

According to section 11(1) every manager must:

- Identify the health and safety hazards to which employees may be exposed while at work
- Assess the health and safety risks to which employees may be exposed while at work, and
- Record the significant hazards identified and risks assessed and make these records available for inspection by employees.

Sections 11(2) and 11(3) states that the manager must determine and implement all measures necessary to:

- Eliminate the risk
- Control the risk at source
- Minimise the risk
- Provide protective equipment, and
- Institute a programme to monitor the risk.

A.2.6 Atmospheric Pollution Prevention Act, 1965 (Act 45 of 1965)

Part II of the Atmospheric Pollution Prevention Act, 1965 (APPA) describes the control of noxious and offensive gases, as described in sections 9 to13 and summarised below:

- Schedule 2 of APPA contains a list of scheduled processes
- Any operator of a scheduled process shall apply for a registration certificate from the Chief Air Pollution Control Officer (CAPCO) before operation to register the premises on which the scheduled process will be carried on
- Maximum allowable ambient level control measures and apparatus will be included as the conditions of the registration certificate
- The CAPCO will firstly issue a provisional certificate, valid for a certain period
- If the measures, apparatus and controls implemented are effective, the CAPCO will issue a final registration certificate which will be valid until changes to the process, plant or building takes place or until it is withdrawn by the CAPCO, and

The holder of the certificates shall at all times comply with provisions of all certificates (provisional and final certificates).

Part IV of APPA deals with dust control and states that the owner or occupier shall take steps (prescribed) or if not prescribed, adopt the best practicable means to prevent the dust dispersion from causing a nuisance (Section 28). Further, if the CAPCO is of the opinion that any other dust generation, apart from that described in Section 28 (1) is causing a nuisance, an abatement

notice may be served on the owner/occupier to take prescribed steps or to adopt best practicable means to abate such nuisance (Section 29).

Finally, according to Section 32, if a mine has received a notification of the Chief Inspector of Mines that the mine is likely to cease operations within 5 years, the owner of the mine may not dispose of any assets without a certificate issued by the CAPCO to the effect that that all necessary dust control measures has been taken, or without the consent of the Minister of Health in consultation with the DME. Any such disposal in contravention with above constitutes an offence.

A.2.7 Environment Conservation Act, 1989 (Act 73 of 1989)

Waste is defined in section 1 of the Environment Conservation Act, 1989 (ECA) as *any matter, (whether gaseous, liquid or solid, or any combination there-of) which from time to time may be proclaimed by the Minister (of Environmental Affairs and Tourism) by notice in the Government Gazette as an undesirable or superfluous by-product, emission, discharge, excretion, or residue of any process or treatment.*

Government Notice No. 1986 in Government Gazette 12703 of 24 August 1990 describes what is meant by waste in this context. This definition specifically excludes (and is therefore not applicable to mine residue deposits):

- Water used for industrial purposes as governed under the 1956 Water Act
- Any matter discharged into a septic tank or french drain sewerage system
- Building rubble used for filling or levelling purposes
- Any radio-active substances
- Any minerals, residue, waste rock or slimes produced at a mine, or
- Ash produced by or resulting from the generation of electricity.

Section 19 and 20 of the ECA deal specifically with waste management and pollution prevention.

A.2.8 National Heritage Resources Act, 1999 (Act 25 of 1999)

Section 34 stipulates that a permit is required from the relevant provincial heritage resources authority to alter or demolish any structure or part of a structure which is older than 60 years. Various other forms of protection may also apply.

A.2.9 National Nuclear Regulator Act, 1999

The National Nuclear Regulator Act, 1999 (NNR) is applicable to "facilities specifically designed to handle, treat, condition, temporarily store or permanently dispose of any radioactive material which is intended to be disposed of as a waste material". The following sections of the NNR are relevant to surface mines:

- Chapter 3 provides details on authorisations of facilities and the responsibilities of holders of nuclear authorisations. A licensing guide (LG-1032) has been published by the Council for Nuclear Safety (CNS). This guide provides details on the methodology for the assessment of nuclear hazards and guidance on submissions to the CNS
- Chapter 4 details the financial securities and liabilities that are applicable to holders of nuclear authorisations, and
- Chapter 5 provides information on safety and emergency measures.

A.2.10 Other Acts

The Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983) and the Biodiversity Act, 2004 (Act 10 of 2004) are also relevant for surface mining.

A.3 SUMMARY OF APPLICABLE WATER MANAGEMENT POLICIES AND STRATEGIES

A.3.1 National Water Resource Strategy (NWRS)

The National Water Resources Strategy, 2004 (NWRS) is the implementation strategy for the NWA and provides the framework within which the water resources of South Africa will be managed in an integrated manner in the future. This strategy sets out policies, strategies, objectives, plans, guidelines, procedures and institutional arrangements for the protection, use, development, conservation, management and control of the country's water resources. The NWRS sets out the current government objectives for managing water resources in South Africa as follows:

- To achieve equitable access to water, that is, 1) equity of access to water services, 2) equity to the use of water resources, and 3) equity to the benefits from the use of water resources
- To achieve sustainable use of water, by making progressive adjustments to water use to achieve a balance between water availability and legitimate water requirements, and by implementing measures to protect water resources and the natural environment
- To achieve efficient and effective water use for optimum social and economic benefit.

The NWRS also lists important principles to facilitate achievement of these policy objectives, such as:

- Water will be regarded as an indivisible national asset. The Government will act as the custodian of the nation's water resources, and its powers in this regard will be exercised as a public trust
- Water required to meet basic human needs and to maintain environmental sustainability will be guaranteed as a right, whilst water use for all other purposes will be subject to a system of water use authorisation.
- The responsibility and authority for water resource management will be progressively decentralised by the establishment of suitable regional and local institutions, with appropriate community, racial and gender representation, to enable all interested persons to participate.

Water use for surface mining activities will be subject to the requirements of a water use authorisation. The benefits and need for this water use will be assessed in the context of the water availability and spread of water use in the catchment.

A.3.2 Catchment Management Strategies (CMS)

The country has been divided into 19 WMAs (see Figure A.1). The delegation of water resource management from central government to catchment level (as proposed above) will be achieved by establishing Catchment Management Agencies (CMAs) at WMA level. The NWRS requires that CMAs progressively develop a Catchment Management Strategy (CMS) for the protection, use, development, conservation, management, and control of water resources within its WMA(s). The Department's eventual aim is to hand over certain water resource management functions to CMAs. Until such time as the CMAs are established and are fully operational, the Regional Offices (ROs) of the Department will continue managing the water resources in their areas of jurisdiction.

The water management and water licensing issues for a surface mine will thus be dealt with by the Regional Office of the Department of Water Affairs and Forestry, until the CMAs are established and operational.

A.3.3 Internal Strategic Perspectives (ISP)

The objective of the Internal Strategic Perspective (ISPs) is to provide a framework for the management of the water resources in each WMA, until such time as the ROs can hand over the management functions to the established CMA. The ISP provides details on the Department's view on how Integrated Water Resource Management (IWRM) should be practiced in each WMA. This will ensure consistency when answering requests for new water licences, and informing existing water users (including authorities) on how the Department will manage the water resource within the area of concern. Stakeholders must be made aware of the bigger picture as well as the management detail associated with each specific water resource management unit.

The ISPs for each WMA provide details on the available water resources and the current and future use of the water resource. The ISPs thus provide useful catchment-based information to the planning and water management team on a surface mine.

A.3.4 Water Resource Availability and Utilisation in South Africa

This report provides an overview of South Africa's available water resources for 1996 and the current patterns of utilisation. This availability and utilisation has then been projected to 2030, based on the present trends in water use and population growth, indicating that South Africa will reach the limits of its economically usable, land-based fresh water resources during the first half of the century.

The report indicates that these trends can be changed to ensure the secure and adequate supply of water and to sustain the prosperity and natural environment of South Africa. Key recommendations made in the report in this regard include a) coordination of water allocation priorities with national development objectives and strategies for the country as a whole, b) greater emphasis be placed on water conservation and c) comprehensive programme

to install a new appreciation of the value of water and the importance of the changed approach to the utilisation of water.

The details in the report include:

- A summary of the water requirements and resource potential for the various regions within the country
- Future options on availability and utilisation of water, and
- Recommendations on the way forward.

A.3.5 The Philosophy and Practice of Integrated Catchment Management: Implications for Water Resource Management in South Africa

The Department of Water Affairs and Forestry, through the NWA and the National Water Policy, have identified that naturally occurring water usually can be effectively and efficiently managed only within a river basin or catchment area, because of the need to manage, or at least account for, all aspects of the hydrological cycle. Thus, the Department recognises and accepts that an integrated catchment management (ICM) approach will be adopted in South Africa (DWAF, 1986). This approach is seen to facilitate the achievement of a balance between the interdependent roles of resource protection and resource utilization.

The document identifies the role of central government in Integrated Catchment Management (ICM) as being one of leadership, aimed at facilitating and co-ordinating the development and transfer of skills, and assisting with the provision of technical advice and financial support, to local groups and individuals. Where specific areas of responsibility fall outside the mandate of a single government department, appropriate institutional arrangements are required to ensure effective inter-departmental collaboration. At a lower level in this process, individual landholders and communities must be recognized as competent partners. Where these individuals may lack the necessary skills for full participation, the lead agencies must take responsibility for assisting with their development and application.

The document identifies five basic principles for effective ICM as follows:

- A systems approach which recognizes the individual components as well as the linkages between them, and addresses the needs of both the human and natural systems
- An integrated approach, rather than a comprehensive approach, in which attention is directed towards key issues of concern identified by all stakeholders in the process
- A stakeholder approach which recognizes the importance of involving individual citizens and landowners, as well as government agencies, in a participatory process to define all decisions around the conservation and use of natural resources which affect their lives
- A partnership approach which promotes the search for common objectives, and defines the roles, responsibilities and accountabilities of each agency and individual who participates in the process of decision making, and
- A balanced approach where close attention is given to decisions designed to achieve a sustainable blend of economic development, protection of resource integrity, whilst meeting social norms and expectations.

A.3.6 A Strategic Plan for the Department of Water Affairs and Forestry to facilitate the implementation of Catchment Management in South Africa

The Strategic Plan provides the Department of Water Affairs and Forestry with a strategic plan to facilitate the implementation of the concept of ICM. The philosophy of managing water resources on an ICM approach is taken as a guiding principle in the strategic plan.

The strategic plan document is divided into two parts, namely part I which is designed to meet urgent management interests in the form of an Implementation Strategy, a Programme of Activities and a Schedule of Human Resources, and Part II which provides the motivation and context for individual proposals in Part I.

The strategic plan provides details on the concepts, functionalities and institutional structures surrounding "Integrated Water Resource Management on a Catchment Basis", as follows:

- Framework for IWRM in RSA which will evolve in a three-tiered framework comprising a National Water Resources Strategy (NWRS), a Statutory Framework for CM and CM Processes/ Strategies/ Plans in particular catchments
- CM Functions: Three classes of CM Functions are distinguished, namely Core, Physical Development and Administrative functions, and

- Institutional Context and Evolution of CM: the Department is foreseen to play a leading role regarding CM, both through a National CM Facility (Directorate), and through the Regional Offices.

A.3.7 Towards a Strategy for Waste Discharge Charge System (WDCS)

The Waste Discharge Charge System (WDCS) forms part of the Pricing Schedule for Water Use Charges established in terms of section 56 of the NWA and will be introduced to address the particular issue of excessive water pollution.

The resource quality objectives (RQOs) form the integral basis and fundamental principle of the WDCS. Water resource management in South Africa links the acceptable level of impact to the concept of RQOs, which balance the need to protect water resources with the need to develop and use these resources. The setting of RQOs is catchment specific, based on the social, economic and political drivers for development and utilisation of a specific water resource. RQOs are to be set as part of the classification system for water resources, through a process of consensus seeking among water users and other stakeholders, in which the government is responsible for ensuring that environmental interests are represented. The WDCS will therefore focus on reducing discharge loads in order to achieve or maintain RQOs in a catchment. Where RQOs are being met, the WDCS is not applied. Where RQOs are exceeded or in threat of being exceeded, the WDCS may be applied as part of water quality management in the catchment. The WDCS applies to surface water and groundwater resources where RQOs have been defined and an adequate understanding of the resource supports the implementation of the system.

The WDCS will be applied to a particular catchment area in which a water quality problem exists. This could be a whole catchment in which a widespread water quality problem occurs or a sub-catchment within a larger water basin.

Where downstream RQOs are more stringent than upstream RQOs, and downstream RQOs are exceeded or threatened, the WDCS may be applied in the upstream catchment even if the upstream RQOs are achieved.

The implementation of the WDCS will achieve the following supportive and additional objectives:

- To encourage efficient resource utilisation (incentive objective)
- To recover costs of activities aimed at pollution abatement and damage caused by pollution (financial objective)
- To discourage excessive pollution (deterrent objective), and
- To promote sustainable water use (social objective).

Four levels of discharge charges are envisaged in the strategy, as follows:

- Tier 1: Basic/Administrative charge: this charge will cover the administrative and management functions in the catchment,
- Tier 2: Load-based charge, for pollution loads higher than the Recommended Resource-Directed Value (RRDV) for the catchment, and
- Tier 3 and 4: Deterrent charges for pollution loads higher than the Maximum Allowable Resource-Directed Value (MARDV).

The Department will use the WDCS as a tool for source control and management, which will provide the following benefits:

- A strong financial incentive to reduce pollution loads to the water resource, particularly if the pollution loads discharged are in excess of the RRDV and the MARDV, and
- The revenue from the WDCS will be ring-fenced to cover water quality management work within the Department. This work will include rehabilitation and remediation projects, waste abatement work (such as regional treatment facilities or on-site pollution prevention or treatment) and investigative studies.

A.3.8 Water Conservation and Water Demand Management (WC/WDM)

The management of water resources and the provision of water services culminated in a new approach which Water Conservation and Water Demand Management (WC/WDM) plays a crucial role in ensuring environmental sustainability, socio-economic equity and efficiency. The NWA and Water Services Act, Act 108 of 1997, (WSA) has provided an enabling environment in which all relevant institutions could be required to integrate WC/WDM into their strategic roles and responsibilities. It is thus a requirement that mines (and other water use sectors) consider WC/WDM during all life cycle phases and strategies. In this instance the DWAF has compiled three sectoral strategy documents, complementary to the present National Water Conservation and Water

Demand Management Strategy, namely:

- Agriculture
- Water Services, and
- Industry, Mines and Power Generation.

These documents provide detailed information in terms of strategic outputs, prioritised activities and key role-players. The NWC/WDMS objectives to be achieved by each sectoral strategy include:

- To facilitate and ensure the role of WC/WDM in achieving sustainable, efficient and affordable management of water resources and water services
- To contribute to the protection of the environment, ecology and water resources
- To create a culture of WC/WDM for all consumers and users
- To create a culture of WC/WDM within all water management and water service institutions
- To support water management and water services institutions to implement WC/WDM
- To promote the allocation of adequate capacity and resources by water institutions to WC/WDM
- To enable water management and water services institutions to adopt integrated planning, and
- To promote international co-operation and participate with other Southern African countries, particularly basin-sharing countries in developing joint WC/WDM strategies.

The Industry, Mining and Power Generation sector, because of its diversity, is considered to offer numerous opportunities for contributing towards WC/WDM. Such opportunities include the efficient use of water during industrial production, re-use of water, recycling of water from other sectors and improved quality of effluent discharge.

A.3.9 Water Allocation Reform

As custodians of the national water resource, the DWAF is obliged to promote the beneficial use of water in the best interests of all South Africans.

In order to do this, water allocations must be carried out in a manner that promotes equity, addresses poverty, supports economic growth and provides opportunities for job creation. The allocation process recognises that redressing the effects of previous discriminatory legislation is necessary for social stability and to promote economic growth. Moreover, the water allocation process must allow for the sustainable use of water resources and must promote the efficient and non-wasteful use of water.

However, allocating water without ensuring that all users have the capacity to use this water productively will limit these benefits. Water allocations should, therefore, not only aim at realising the above goals, but must work closely with all spheres of government and other institutions to promote the productive and responsible use of water. Likewise, where possible, water reallocations should try to minimise possible negative impacts on existing productive lawful water users who are contributing to social and economic stability, growth and development. Water allocations must promote shifts in water use patterns that are equitable but also phased and carefully considered.

These objectives go well beyond the Department's primary mandate and require the active pursuit of cooperative governance arrangements to support the productive use of water. Accordingly, approaches to reallocating water between users will initially be rolled out in areas experiencing shortages of water. However, in order to address the urgent short-term need for equity across the country, rollout will also be fast-tracked in areas where there are less serious water availability concerns. These implementation approaches take into account the prevailing resource and capacity constraints within the Department and our country.

A.3.10 Water classification system

The water classification system using A to F ecological categories has been used for preliminary Reserve determinations. A need had been expressed for a classification system that integrates ecological and user requirements into management classes and which allows for the examination of the socio-economic and ecological implications of water management decisions. The National Water Resource Classification System (NWRCS) is a set of guidelines and procedures for determining the desired characteristics of a water resource, as represented by a Management Class (MC). The MC outlines the attributes that the responsible authority and society require of different water resources. The NWRCS will be used in a consultative approach with all relevant stakeholders to classify water resources in order to facilitate a balance between protection and the utilisation of the water resource.

The outcome of the water classification process incorporating economic, social, ecological and stakeholder consent will be promulgated by the Minister or her delegated authority setting the MC for every significant water resource, which will be binding on all authorities or institutions when exercising any power, or performing any duty under the NWA. The MC of a resource sets the boundaries for the volume, distribution and quality of the Reserve as well as Resource Quality Objectives. The MC ranges from Natural to Heavily Used/Impacted and essentially describes the desired ecological condition of the resource, and conversely, the degree to which the resource could be utilised.

A.3.11 The National Groundwater Strategy

The groundwater quality management strategy forms part of the DWAFs National Water Resource Strategy. South Africa's water resources are very unevenly distributed across the country, and in arid or water-scarce areas. The value and vulnerability of groundwater represent a strategic component of the water resources of South Africa. Security of groundwater supplies is thus essential and protection of groundwater has become a national priority.

It is common for groundwater to be poorly managed. It takes a long time to detect that it has become polluted and groundwater has only limited ability to purify itself. It is difficult, often impossible, and also very expensive to restore polluted groundwater to its original quality. The major reason for poor management of groundwater resources, however, has been a lack of a structured approach to management as well as a lack of knowledge and information about groundwater.

In order to manage groundwater quality in an integrated and sustainable manner within the context of the National Water Resource Strategy and thereby provide an adequate level of protection to groundwater resources and secure the supply of water of acceptable quality, the DWAF has identified the following policy goals:

- To implement source-directed controls to prevent and minimise, at source, the impact of development on groundwater quality by imposing regulatory controls and by providing incentives
- To implement resource-directed measures in order to manage such impacts as do inevitably occur in such a manner to protect the reserve and ensure suitability for beneficial purposes recognized, and
- To remedy groundwater quality where practicable to protect the reserve and ensure at least fitness for the purpose served by the remediation.

Principles that will guide the implementation of this strategy include subsidiary and self-regulation, pollution prevention, integrated environmental management, equity, sustainability, the polluter pays, and public participation.

APPENDIX B WATER MANAGEMENT MODELLING FOR SURFACE MINES

B.1 BASELINE INFORMATION

Table B.1 identifies the likely information requirements for water management modelling and design of the water management measures.

Table B.1: Baseline information requirements

Design area	Information Requirements
Mine planning	• Layout of the mine and supporting infrastructure • Location of open pits, processing plants and water and waste management facilities
Hydrology and stormwater	• Climate data: Patterns of temperature, rainfall, evaporation and atmospheric moisture for the area • Reports, documents and maps on the hydrology of the area • All available river flow data • Surface water quality information • Downstream water users and their quality criteria • Resource quality objectives for the affected catchment(s).
Water balance	• Reports and documents on the mine water balance • Water flow and water quality measurements or predictions • Ambient water qualities
Geotechnical	• Reports and documents on the geology and geotechnical conditions for the area
Hydrogeology	• Published and unpublished geological and hydrogeological reports, maps and documents • Borehole positions, logs and well construction details • Details of groundwater abstractions and groundwater users in the area • Conceptual and/or detailed groundwater models • Recharge estimations • Groundwater quality information • Any available monitoring data
Mine residue	• Annual anticipated tonnage and overall total tonnage • Life of mine • Results of any testwork on the mine residue • Residue characteristics, such as particle size distribution, dry density, etc. • Mine residue deposit details, e.g. footprint area, rate-of-rise
Geochemical	• Reports and document on the geochemical properties of the residue, e.g. particle size distribution, porosity, moisture content including soil moisture retention tests, mineralogy, acid base accounting, kinetic data, etc. • Geotechnical conditions for the area • Ambient water quality
General	• Archaeological sites within the mine area • Wetlands and ecologically sensitive areas

The baseline information that is collected should meet the following objectives:

- Provide an understanding of the regional water resource context in which the mine is to operate
- Identify the potential sources of water for the project
- Delineate the study area for the water management
- Determine the hydrological and groundwater data availability
- Identify gaps in the database and implement monitoring to fill these gaps

- Prepare base maps for use in the study, and
- Identify the water courses that could be impacted by mining.

The baseline information that should be collected is likely to include the following:

- The location of mine working, mine lease and surface rights areas as well as towns, roads, rivers and water supply infrastructure
- Determination of the water volume and water quality mine water requirements
- Topographical map of the area (1:50 000 and 1:250 000 scale)
- Land use, geological and soil maps of the area
- The mine plan
- A definition of study area, which is the area of potential impact of the mine. During the conceptualisation and planning phase, the available information should be used to provide an estimate of the study area. A conservative estimate should be made at this stage. The extent of the area can be revised as baseline data becomes available
- Discussions with the regional offices of DWAF should also be held so that the water situation, in particular the regional context and the possible sources of water for the project can be obtained. Information on the catchment management strategy, future water resource developments, ecological Reserve data and reports should be collected and reviewed
- Identification of flow and water quality sampling points in the study area and collection of data from the DWAF databases
- Collection of data from the groundwater databases of DWAF
- Establish the location of rainfall gauges and weather stations that could be used in the development of water management measures. Any data from these monitoring stations should be collected and assessed
- A hydrocensus of boreholes in the study area should be undertaken. The information collected includes location of boreholes, borehole yield, borehole owner, type of pump, water level, water quality data and use of water abstracted from the borehole
- A surface water user survey in the study area
- Collection of surface water samples for water quality analysis and flow measurements of streams in the area
- Establishment of closure objectives for the mining operation
- The available data should be reviewed and a gap analysis undertaken. The following could be the result of this analysis:
  - Ongoing groundwater data collection for water levels and water quality
  - Drilling of further boreholes. These boreholes can be linked to the geotechnical and mineral resource studies.
  - Required pump tests on boreholes to determine yields and determine the aquifer properties for use in the groundwater modelling
  - Surface water flow monitoring program. This may require the installation of weirs to characterise the rainfall - runoff characteristics of the catchments and the flow regimes. This data can be used to calibrate a rainfall – runoff model for use in the water management modelling for the mine
  - Surface water quality monitoring program. This program should be designed to capture the seasonal variation in water quality of the water courses and water supply to users that could be impacted on by the planned mining operations. If the local water resource is to be developed as a source of supply for the mine then the program should be sufficiently detailed to supply the mine's needs. An iterative process should be used to determine the water quality variables that need to be included in the analysis. This process starts with analysing for a comprehensive set of variables. The initial set tested for will be revised depending on the results of the analysis
  - A weather station and a rain gauge system should be installed if needed. The rain gauges should be located to provide information for use in conjunction with the flow measurements for rainfall-runoff model calibration
  - Soil surveys of area to quantify the types and quantities of soil in the area, and
  - Biomonitoring of the river ecology.
- The available hydrological and climate data should be analysed. The following information is needed from the database
  - The Mean Annual Precipitation of the site should be determined as well as the average monthly rainfall depths, and
  - The average monthly pan evaporation depths.

- A representative daily rainfall record at least 50 years long should be synthesised from the available rainfall data records.

B.2 INTEGRATED WATER MANAGEMENT MODELLING

B.2.1 Conceptualisation and planning phase

B.2.1.1 Objective

The objectives of the water management modelling at this phase are to establish the following:

- Preparation of an initial water management layout and sizing of the water management system
- The mine water requirements for processing
- Potable water requirements
- Initial layout of mine infrastructure
- Initial layout of waste facilities
- Clean and dirty water catchment areas
- Identify sources of water supply
- Establish the hydrological database for use in the water management modelling. The main elements are rainfall and evaporation.

B.2.1.2 Preparation of hydrological database

The water management modelling for this phase will involve an assessment of the rainfall data to produce the following:

- Monthly average rainfall depths and mean annual precipitation. The dry, median and wet years should be identified from the record and the average rainfall depths identified for each of these years
- A statistical analysis of the daily rainfall depth time series to produce the 2 year, 5 year, 10 year, 20 year, 50 year, 100 year and probable maximum precipitation (PMP) information. This information is required for the tailings dam and pollution control dam safety assessments
- Intensity-duration-frequency curves developed for the site
- A daily and monthly time series of rainfall depths for the site. These are required to drive the water management models. A rainfall time series in excess of 50 years is ideally required
- Monthly average evaporation depths are needed for the water management modelling to determine evaporation from pollution control dams and in soil moisture budgets for catchment runoff modelling and covers for rehabilitated surfaces.

B.2.1.3 Determination of flood lines

The 1:50 and 1:100 year flood lines for the water courses passing over the mine site should be determined. The 50m and 100m exclusion zones should also be determined and located on the mapping.

B.2.1.4 Water management modelling

The contour mapping of the area showing the layout of the mine infrastructure will be used to identify the clean and dirty catchment areas. The catchment areas should be measured and the locations of pollution control facilities and diversion channels and berms should be provisionally located on the maps. The process plant design team should provide an estimate of the water volume and water quality requirements of the process plant and the mass and characteristics of the waste streams.

At this stage there could be a number of teams involved in the project. The battery limits of the different teams as far as water management is concerned should be clearly established. The type of information and level of analysis that is required from each team should also be established. A design criteria and assumption register should be established for the project.

The water management modelling at this stage of the project is best done at a monthly time step using the average monthly rainfall depths for the dry, median and wet years. A spreadsheet model can be set up for the mine system. The model should include the major elements making up the system. A number of the elements change in size over the life of the mine. Sizes of these elements at specific points in time over the life of the mine can be used in the model. Simple algorithms such as the use of runoff factors should be considered for application to catchment areas. The preliminary waste stream characteristics will be used to determine the entrainment volumes in the waste management facilities and water volumes returned. At this stage, with the absence of any geochemical data, water quality is likely not to be considered in the analysis.

The water management model will be applied for the different years at a monthly time step to determine the preliminary sizes of pollution control dams, return volumes available from the dams and the make-up

water requirements for the project over the life of the project. The need for a discharge from the mine must also be identified. The results of the analysis will be used to revise the layout where necessary and locate the pollution control facilities. A source of water supply to meet the water needs of the mine should be identified.

The possibility of developing a groundwater or surface water source, abstracting from existing infrastructure and/or receiving water from adjacent mines should be investigated. The most likely source should be identified and a preliminary analysis undertaken on the feasibility of supply from the source and the type of infrastructure needed to supply the required water.

The information gaps should be identified and studies or monitoring programs put in place to fill the gaps. At this stage the progress with the water management study should be communicated to the regulator.

B.2.2 Pre-feasibility phase

B.2.2.1 Objective

The objective of this phase of the study is to further refine the output from the water management model developed during the conceptualisation and planning phase, based on the information generated during this phase.

B.2.2.2 Water management modelling

The information that should be available at this stage of the project, which will be used in the water management modelling, will include the following:

- A pre-feasibility mine plan, including details on the mining methods and other mines in the vicinity to cover aspects such as intermine flow considerations and demands / pollution of the same water sources
- Updated process plant water requirements
- Revised layouts of the plant infrastructure
- Results of the groundwater investigations and modelling, including the results of the pit dewatering assessments
- Initial geochemical results
- Water quantity and quality information from the baseline monitoring, and
- Updated characteristics of waste streams.

The water management model should be progressed to a higher level of accuracy during this phase, using the above information. A daily time-scale for the model would be appropriate at this stage in the mine development. The model should include the details from the pre-feasibility mine plan and the revised infrastructure plot plan. The variations in the different types of mining areas in the opencast pits, i.e. pre-strip areas, mine workings, spoil heaps and mine rehabilitation areas, should be included in the model. For opencast mines, the changes in soil types with depth, which leads to changes in runoff characteristics, should be included in the model. Other water requirements, such as potable water use, should also be included in the model.

The water requirements for the process plant should be reviewed at this stage, including water quantity, any water quality constraints and the interaction with the mine pit water. The results of the groundwater studies will provide input to the assessment of water make in the pit(s). The water quality model should be developed at this stage, using the first round of geochemical results, the water quality information from the baseline monitoring and the updated characteristics of the waste sources and management requirements. Any results from rainfall-runoff modelling should also be used to calibrate the model.

With the input data updated, the model should be run so as to size the water management infrastructure to meet the design criteria of Government Notice No. 704 (GN704), regulations on use of water for mining and related activities (See also ***BPG A4: Pollution Control Dams*** for guidance on spill criteria). Details of the sizing should be sent to the design team to confirm the location and layout of this infrastructure. Some iteration may be required to optimise the size, location and layout of the infrastructure to suit local conditions.

The output of the water management model should be used to identify the need and quantity of water supply to the mine and the need to discharge to a watercourse. Pre-feasibility level design of the water supply, and an impact assessment of any discharge, should be undertaken at this stage.

The design team should also liaise with the regulator to start preparing the water use licence application for the various water uses, e.g., water abstraction, water storage, discharge, etc.

B.2.3 Feasibility phase

B.2.3.1 Objective

The objective of this phase will be to revise the water management model with the latest information from the feasibility study work.

B.2.3.2 Water management modelling

The water management modelling will follow the same approach as covered above with the new information. The water use licence application should be prepared and submitted during this phase.

B.2.4 Design phase

B.2.4.1 Objective

The objective of this phase will be to prepare water monitoring programmes for the construction and operations phase

B.2.4.2 Water management modelling

The infrastructure plot plan will be updated during the mine design phase. Using this information and the water management model, the design team should:

- Develop operating rules for the water infrastructure,
- Identify and design the water supply system for the construction phase,
- Undertake detailed design of the water management infrastructure
- Develop a water quantity and quality monitoring programme for the construction and operations phases of the mine. Further information on developing such a programme is provided in ***BPG G3: Water Monitoring Systems***, and
- Identify and design (at a preliminary level) the water management measures required for mine closure.

B.2.5 Construction and commissioning phase

B.2.5.1 Objective

The objective of this phase will be to develop water management programmes for the construction phase.

B.2.5.2 Water management modelling

The water management model will be used during this phase to prepare and implement water management measures during construction. These will be implemented to manage the quantity and quality of the water supply for construction, as well as the management of any waste stream from construction.

B.2.6 Operations phase

B.2.6.1 Objective

The objective of this phase is to update and/or amend the water management model developed at the design stage to an operational model.

B.2.6.2 Water management modelling

The water management model should be updated to reflect the "as-built" conditions on site, following the construction phase. The model will thereafter be regularly updated during the mine operational phase, as changes are made in the mine plan and the infrastructure layout and additional water-related information in available.

The generic steps that will be followed during the operations phase are as follows:

- Collection of data from the monitoring programme (water quantity, water quality, volumes in the raw water dams and process water dams and meteorological data)
- Input of the collected data into the water management model. This data will be used to check the assumptions made in the model and to calibrate the model
- Apply the water management model, using monthly predictions, to assess the short-term operations of the water management system
- Use the water management model to manage the water on the mine site to meet the regulatory requirements, and
- Update the water management measures required for mine closure.

Consideration should be given during operations to managing the water systems on the mine using real-time data collection and use of information in the model.

B.2.7 Closure phase

B.2.7.1 Objective

The objective of this phase will be to confirm the design of the water management measures for mine closure.

B.2.7.2 Water management modelling

The calibrated water management model should be used to:

- Confirm the predictions of water management used in preparing the mine closure plan

- Undertake an assessment of the water management requirements for mine closure
- Design the water management measures required for mine closure, and
- Develop cost estimates of the water management measures, to include in the overall quantum of financial provisions for closure to be made by the mine.