GUIDANCE FOR ATTAINING REGULATORY APPROVAL OF IRRIGATION AS A LARGE-SCALE, SUSTAINABLE USE OF MINE WATER

Gina Pocock and Leanne Coetzee

WATER RESEARCH COMMISSION

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Report

to the Water Research Commission

by

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EXECUTIVE SUMMARY

The beneficial re-use of treated mine-impacted water is not currently a priority in South Africa. Although the discharge of effluent to water resources should be the option of last resort, it is often the first choice of many in the mining industry and industry as a whole, due to its simplicity and low cost. Unfortunately, the discharge option in many instances requires the use of high-quality water to dilute the treated effluent to within allowable discharge limits. In addition, many activities use high-quality or potable water unnecessarily.

While pollution from mine-impacted water is a significant problem with high costs often associated with treatment, the potential increase in water availability if this water can be used untreated or partially treated for irrigation offers opportunities for making additional water available to supplement traditional water resources.

Mine land post-mine closure is currently rehabilitated, but usually not to the advantage of the local communities. Mines in South Africa tend to be located in water-scarce areas, and use of the land for agricultural purposes would require fresh water to be provided from further afield, which is not economically viable. However, the treatment of mine water provides a water source on site or nearby, which then allows agriculture on mine land to become a realistic opportunity for the surrounding community on a year-round basis.

Agriculture currently and unnecessarily makes use of the majority of South Africa's high-quality water resources for the irrigation of crops (food, forage or energy crops). The beneficial use of mine water for crop irrigation confers a number of notable advantages. Gypsiferous mine water may require no treatment or a low level of treatment prior to re-use in irrigation, resulting in substantial treatment cost savings: a potential 87% and 78% reduction in capital and running costs, respectively. Large portions of irrigated land are located near sources of mine water, which would limit collection and distribution costs if mine water were utilised. The treatment and re-use of mine water could operate as a single financial initiative, with income from the mine water-irrigated crops funding the mine water treatment and/or creating jobs and food security for the local community. The availability of water for irrigation may serve to drive the impetus that mine rehabilitation should serve to return mined land to a state where viable economic enterprises can be incentivised to stimulate job creation and economic reactivation, not merely to return the land to a state of stability to ensure no net environmental impact, or to achieve a state that will meet the satisfaction of the Department of Mineral Resources and Energy. The creation of bioenergy crop farms on rehabilitated mine land, for example, will result in opportunities to employ and upskill people, thereby justifying the use of such land as a viable investment and further opening the door for emerging commercial farmers. Irrigation with mine water on conventional agricultural land is expected to be more difficult than with low salinity water, and rehabilitated land even more so due to the challenges associated with disturbed geology and poor top soil quality and depth. Emerging commercial farmers should be supported with training and mentorship to increase the potential success of such projects.

The treatment and re-use of mine water in crop irrigation would relieve the environmental and health liabilities of the mines producing the mine water, while simultaneously stimulating agriculture in the vicinity, and would make more high-quality or potable water available for more pressing needs. This option fits well within the Water-Energy-Food (WEF) nexus, which is becoming increasingly prominent on the international agenda that continues to focus on collaborative initiatives to solve the numerous limitations surrounding water, energy and food provision to a growing global population.

The current regulations surrounding mine closure certification and water use licence (WUL) applications do not prevent irrigation with mining-impacted water, but there is an absence of guidance to sufficiently inform both mining companies and regulators too make informed decisions regarding irrigation in the post-mining landscape.

In this light, this project aimed to review the policy and regulatory framework to provide guidance for the establishment of the irrigation of agricultural land as a large-scale, sustainable use of mine water during mine operation and post-closure. The goal is to ensure that this water is viewed as a national agricultural asset for beneficial use, not as problematic wastewater that requires disposal, in an enabling regulatory environment with clear guidelines as to the process to follow in order to get regulatory approvals.

The outcome of this project is therefore a comprehensive guideline for the relevant stakeholders engaged in a decision-making process regarding whether a specific mine water source can be applied for irrigation, as well as what ongoing monitoring would be required to maintain the applicable licences and approvals once implemented, considering community and environmental safety. The guide informs which legislation is applicable to the decision-making process, what applications need to be made to the Department of Human Settlements, Water and Sanitation (DHSWS), the Department of Agriculture, Land Reform and Rural Development (DALLRD), the Department of Environment, Forestry and Fisheries (DEFF) and the Department of Mineral Resources and Energy (DMRE), and how to manage these procedures within the framework of the necessary legislation and guidelines that govern mine water management activities.

The legislation and supporting guidelines relating to water re-use in South Africa exist and are readily accessible. However, they tend to be contradictory and confusing in many cases, which may have had the unintended consequence of negatively affecting the consideration of mine water as an agricultural resource in the past. The recent development of a Draft Mine Water Management Policy, which seeks to align and clarify the responsibilities of the various government departments in terms of mine water management, is encouraging. It illustrates the political will to strengthen a proactive mine water management approach, with an integrated departmental approach to mine water management. The Presidential proclamation that the timeframe for WUL authorisation should be reduced from 300 days to 90 days indicates a strong political will to stimulate the economy and remove unnecessary red tape.

While the existing legislative framework has some challenges, this guideline has illustrated that the framework allows for the beneficial use of mine water for irrigation under the right conditions. Where a surplus of water is identified after all possible internal re-use possibilities have been exhausted, irrigation can be considered as a beneficial use. Tools such as the decision support system (DSS) of the amended Irrigation Water Quality Guidelines allow a thorough assessment of the fitness for use and water quality indicator, which, when combined with soil suitability testing and the rigorous specialist studies that accompany the required environmental impact assessment (EIA) process, support the licencing of mine water irrigation as a water use under the relevant section 21 uses of the National Water Act (NWA), thus enabling WUL authorisation.

The importance of thorough monitoring after the implementation of the licence must be emphasised, with all requirements of the WUL, the Conservation of Agricultural Resources Act (CARA) regulations and the regulations of the National Environmental Management: Biodiversity Act (NEMBA) being observed.

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ABBREVIATIONS

BPG	Best Practice Guideline
CARA	Conservation of Agricultural Resources Act
CCAW	Coordinating Committee on Agriculture Water
CMA	Catchment Management Agency
DAFF	Department of Agriculture, Forestry and Fisheries
DALRRD	Department of Agriculture, Land Reform and Rural Development
DDG	Deputy Director-General
DEA	Department of Environmental Affairs
DEFF	Department of Environment, Forestry and Fisheries
DG	Director-General
DHSWS	Department of Human Settlements, Water and Sanitation
DMRE	Department of Mineral Resources and Energy
DRDLR	Department of Rural Development and Land Reform
DSS	Decision Support System
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
e-WULAAS	Electronic Water Use Licence Application and Authorisation System
GDP	Gross Domestic Product
GN	Government Notice
HDI	Historically disadvantaged individual
IMC	Interministerial Committee
IWUL	Integrated Water Use Licence
IWWM	Integrated Water and Wastewater Management

MPRDA	Mineral and Petroleum Resources Development Act
MWMP	Mine Water Management Policy
NDA	National Department of Agriculture
NDP	National Development Plan
NEMA	National Environmental Management Act
NEMBA	National Environmental Management: Biodiversity Act
NGO	Non-government Organisation
NWA	National Water Act
NWC/WDMS	National Water Conservation and Water Demand Management Strategy
NWRS 2	National Water Resources Strategy 2
PDA	Provincial Department of Agriculture
SACNASP	South African Council for Natural Scientific Professionals
SMME	Small, medium and micro enterprise
SWAF	Standardised Water Accounting Framework
SWB	Soil-water Balance
WAF	Water Accounting Framework (Australia)
WEF	Water-Energy-Food
WMA	Water Management Area
WRC	Water Research Commission
WRRP	Water Reuse and Reclamation Plan
WSI	Water Services Institutions
WUA	Water User Association
WUE	Water Use Efficiency
WUIWG	Water Use and Irrigation Working Group
WUL	Water Use Licence

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CHAPTER 1: INTRODUCTION

The Water Research Commission (WRC) has completed several research projects investigating the productive use of mining-impacted water for agriculture from both the coalfields of Mpumalanga and the goldfields of the Witwatersrand (Jovanovic et al., 2002; Annandale et al., 2007; Vermeulen et al., 2008; Van der Laan et al., 2014). A number of opportunities are provided when using gypsiferous mine wastewater in irrigation, including the potential to enable dry season production, as well as stabilising dryland crop production. Field research at scales ranging from experimental to semi-commercial over a period of more than ten years has successfully demonstrated that, by irrigating with gypsiferous mine wastewater, a large percentage of the salts present can be removed from the mine effluent through gypsum precipitation into the soil profile (Annandale et al., 2007), thereby avoiding soil salinity or crop production problems. Technical aspects such the water chemistry, soil water balances, impacts on soil structure, ground water and suitable crops for the sustainable application of mining-impacted water to agricultural land have therefore been well addressed, and are not interrogated further in this study. A separate technical guideline “Technical Guideline for Irrigation with Mine-Affected Waters”, TT 855/2/21 by Heuer et al. (2021) has been published by the Water Research Commission to provide a technical platform for guidance for water users looking to irrigate with mine-affected waters.

While pollution from mine-impacted water is a significant problem with high costs often associated with treatment, the potential increase in water availability if this water can be used untreated or partially treated for irrigation offers opportunities for making additional water available to supplement traditional water resources. It was observed that 360 Mℓ/d may be generated after closure of the entire Mpumalanga coalfields (Grobbelaar et al., 2004). In the study by Annandale et al. (2007), which aimed to predict the environmental impact and sustainability of irrigation with coalmine water in the central Witbank coalfields in Mpumalanga, 170 Mℓ/d of this was suggested for irrigation in the Olifants River catchment. The expected discharges at each decant position ranged between 12 and 40 Mℓ/d. These volumes of decant water have the potential to support in excess of 6,000 ha of irrigation in the Olifants River catchment alone. On a more site-specific scale, the Kleinkopjé Colliery in Witbank, which has an estimated daily water intake of around 14 Mℓ with a further 120,000 Mℓ of water stored underground could, depending on the crop system chosen, sustain irrigation of 500 to 700 ha.

Van Zyl et al. (2001) reported that simply treating mine water decant to irrigation standards, rather than for urban or industrial applications, would reduce capital and running costs by 87 and 78%, respectively. Similarly, Annandale et al. (2007) compared the capital costs of several treatment options, and showed treatment for irrigation to be lower in cost by an order of magnitude when compared to other water uses. In addition, and of particular importance in the post-closure period of a mine, the income generated from the sale of the water could be offset against the running costs. Further benefits include job creation and the protection of water resources, which are aligned to the government's National Development Plan (NDP).

Currently, mine land post-mine closure is rehabilitated, but usually not to the advantage of the local communities. Mines in South Africa tend to be located in water-scarce areas, and use of the land for agricultural purposes would require fresh water to be provided from further afield, which is not economically viable. However, the treatment of mine water provides a water source on site or nearby, which then allows agriculture on the mine land to become a realistic opportunity for the surrounding community on a year-round basis (Jovanovich et al., 2002).

The current regulations surrounding mine closure certification and WUL applications do not prevent irrigation with mining-impacted water, but there is an absence of guidance to inform both mining companies and regulators sufficiently for informed decisions to be made regarding irrigation in the post-mining landscape. In this light, this project aims to review the policy and regulatory framework to provide

guidance for the establishment of the irrigation of agricultural land as a large-scale, sustainable use of mine water during mine operation and post-closure.

The goal is to ensure that this water is viewed as a national agricultural asset for beneficial use, not a problematic wastewater that requires disposal, in an enabling regulatory environment with clear guidelines as to the process to follow to get regulatory approvals. Mines facing closure would be able to provide economic advantages for retrenched workers and also create opportunities for emerging commercial farmers.

By providing a clear framework through which regulatory approval can be obtained for this practice, such activities can be fast-tracked. This will allow for expanded farming activities in areas where water resources may be limited, and free up higher-quality water for other economic activities and domestic supply, thus driving the economy by attracting investment through surety of supply.

The philosophy of the WEF nexus needs to integrate with the need for sustainable development solutions and the need to inform policy and decision making. As an example, a current concern in the water-scarce Olifants River catchment is that if all excess mine water is used for irrigation in future, the basic ecological and domestic needs of downstream water users may not be met (Annandale et al., 2007). It is likely that a compromise will need to be agreed on between all stakeholders that provides for these basic needs, but also allows for irrigation with mine water as a cost-effective way of providing food security and employment in the future as the mining regions diversify their economies away from mining.

The project methodology involved first conducting a thorough review of the applicable laws, regulations and guidelines that may play a role in governing the application of mine water for irrigation, so as to define the relevant legislative framework. Based on the defined legislative framework, a preliminary guideline of the process to be followed to attain regulatory approval of irrigation as a beneficial use for mine water was drafted. One-on-one interviews were held with key stakeholders to establish the requirements for the application of a licence to irrigate, to critically evaluate the proposed process, and to ascertain whether all the necessary legislation had been included in the legislative framework. The input from the stakeholder interviews was used to refine the framework and define the application process in the guideline. Finally, a joint stakeholder workshop was held to interrogate the amended guideline, to identify any additional gaps and to offer recommendations for improvement. These were incorporated into the final guideline document.

The outcome of this project is the development of a comprehensive guideline for the relevant stakeholders engaged in a decision-making process regarding whether a specific mine water source can be applied for irrigation, as well as what ongoing test work would be required to maintain the applicable licences and approvals once implemented, considering community and environmental safety. The guide informs which legislation is applicable to the decision-making process, what applications need to be made to the DHSWS, the DALLRD, the DEFF and the DMRE, and how to manage these procedures within the framework of the necessary legislation and guidelines that govern mine water management activities.

CHAPTER 2: LEGISLATIVE FRAMEWORKS FOR MINE WATER MANAGEMENT, MINE CLOSURE AND IRRIGATION

A review of the legislative frameworks for mine water management, mine closure and irrigation, and how these regulations and guidelines may apply to the irrigation of mine water is presented in the following sections.

2.1 CONSTITUTION OF SOUTH AFRICA, 1996 AND COMMON LAW

Mines have to comply with the South African constitutional and common law by conducting their operational and closure activities with due diligence and care for the rights of others. Section 24(a) of the Constitution states that everyone has the right to an environment that is not harmful to their health and wellbeing. This supersedes all other legislation.

Section 24(b) of the Constitution continues that everyone has the right to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation, and promote conservation and secure ecologically sustainable development and use of natural resources, while promoting justifiable economic and social development.

Therefore, a person suffering harm as a result of mining activities may still claim damages from a mine and/or its directors and even the shareholders in terms of Company Law once the mine has closed.

Any common law claims based on pollution emanating from a closed mine will have to be instituted by the plaintiff within three years of the incident that caused the pollution, unless it is an ongoing source of pollution. A claim could be based on any of the following causes of action:

- Nuisance (infringement of the right of a neighbouring owner's use and enjoyment of property)
- Property rights (subsidence)
- Aquilian action (damage to person or property)
- Administrative law (review of an administration decision or act by an official or organ of state)

A court may grant a number of different kinds of relief, including an interdict, damages or judicial review of any decision or act of an official or organ of state.

The Constitution also provides for the right of access to sufficient water under section 27(1)(b). The Constitution places the duty on the state to ensure that the rights of citizens are promoted and fulfilled by way of putting measures in place, which include the development and implementation of regulatory frameworks and other management measures. The Constitution precisely sets out the designated functions of each tier of government. It is the state's responsibility to monitor, regulate and enforce compliance of those activities that are likely to cause serious damage or significant degradation of the environment and the water resources.

The Constitution compels everyone to conduct their activities with due diligence and care for the rights of others and to ensure the prevention of pollution and ecological degradation. Therefore, anyone or any entity using mine water for irrigation must conduct their operations with due diligence and care for the rights of others. The use and management of mine water should be done within the ambit of the Constitution, taking into account the rights of people as enshrined in the Constitution.

2.2 NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998

The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) provides the framework and principles for sustainable development and sets national norms and standards for integrated environmental management (section 24), where all spheres of government and all organs of state must cooperate, consult and support one another. Section 28 of the Act also imposes a duty of care and remediation of environmental damage on any person who causes, has caused or may cause significant pollution or degradation of the environment. Furthermore, sections 32 and 33 of the Act provide for legal standing to enforce environmental laws and private prosecution, respectively.

The EIA Regulations in terms of NEMA are published under Government Notice No. 982. This includes the requirements for environmental impact assessment, environmental management programmes (EMPrs) and closure plans. Listing Notice 1, 2 and 3 of 2014 in terms of the EIA Regulations, published under Government Notice No. 983, 984 and 985, respectively, serve to list activities and identify competent authorities under sections 24(2), 24(5) and 24D of the Act, where environmental authorisation is required prior to the commencement of that activity in specific identified geographical areas only, read with section 47A(1)(b) of NEMA. These regulations were amended in 2017 as published in Government Notice No. 327, 328 and 329, respectively.

Mines are required to have a closure plan that is updated annually. The Financial Provisioning Regulations of NEMA (Government Notice R1147 of 2015, as amended by Government Notice 1314 in 2016) specify the requirements, which include the following:

- Annual rehabilitation, as reflected in an annual rehabilitation plan
- Final rehabilitation, decommissioning and closure of the prospecting, exploration, mining or production operations at the end of the life of operations, as reflected in a final rehabilitation, decommissioning and mine closure plan
- Remediation of latent or residual environmental impacts that may become known in the future, including the pumping and treatment of polluted or extraneous water, as reflected in an environmental risk assessment report

If irrigation is to be part of the management of water after closure, this needs to be included in the closure plan. Any new activity will require an amendment of the closure plan and the mine's EMPr as specified in section 37 of the EIA Regulations, Government Notice 982 of 2014.

When considering irrigation, the National Environmental Management: Biodiversity Act, Act No. 10 of 2004, as amended by the National Environmental Management Laws Amendment Act, Act No. 14 of 2013, Government Notice No. 530 may apply. Any deviations will require an amendment to the EMPr. This includes an assessment in terms of the following:

- Alien and invasive species regulations and lists
    - National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) Alien and Invasive Species Lists, 2016, Government Notice No. 864
    - Alien and Invasive Species Regulations No. R598 in terms of section 97(1) of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)
- Threatened or protected species regulations and lists
    - National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004): Publication of lists of critically endangered, endangered, vulnerable and protected species, Government Notice R151 of 2007
    - National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004): Threatened or Protected Species Regulations, 2007, Government Notice R152 and its amendments

2.3 THE MINERALS AND PETROLEUM RESOURCES DEVELOPMENT ACT, 2002

The mining industry in South Africa is administered by the DMRE. South African Mining Law is regulated by the Mineral and Petroleum Resources Development Act, Act No. 28 of 2002 (MPRDA), which is the predominant piece of legislation dealing with acquisitions or rights to conduct reconnaissance, prospecting and mining, as amended by the Mineral and Petroleum Resources Development Amendment Act, Act No. 49 of 2008, Notice No. 437, and the Mineral and Petroleum Resources Development Regulations of 2004, published under Government Notice R527, as amended in Government Notice R420 in 2020.

The objectives of this Act are to do the following:

- Constitute the official policy concerning the exploitation of the country's minerals
- Address the environmental sustainability of the mining industry
- Apply penalties for non-compliance and require that an EIA be undertaken for mining operations

The MPRDA regulates the following:

- The prospecting for and optimal exploration mineral and petroleum resources
- The processing and utilisation of minerals
- The provision for safety and health in the mining industry
- Control of the rehabilitation of land disturbed by exploration and mining

The MPRDA stipulates that the principles of NEMA apply to all mining, and serve as guidelines for the interpretation, administration and implementation of the environmental requirements of the MPRDA. The MPRDA also includes some key legal and regulatory mechanisms such as the Environmental Management Programme and the Pollution Control and Waste Management Regulations, which ensure that water management, soil erosion and pollution control comply with applicable legislative requirements. The MPRDA provides a holistic cradle-to-grave approach to protect the environment for the benefit of present and future generations and ensure the ecologically sustainable development of mineral and petroleum resources, while promoting economic and social development.

Section 37 of the MPRDA deals with environmental management principles and confirms that the principles for sustainable development, as set out in section 2 of NEMA, apply to all prospecting and mining operations, as the case may be, and any matter or activity relating to such operation, and serve as guidelines for the interpretation, administration and implementation of the environmental requirements of this Act. Any prospecting or mining operation must be conducted in accordance with generally accepted principles of sustainable development by integrating social, economic and environmental factors into the planning and implementation of prospecting and mining projects in order to ensure that the exploitation of mineral resources serves present and future generations.

Sections 38 to 42 were deleted in the amended regulations, and section 38A was added. Section 38A states that the Minister is the responsible authority for implementing environmental provisions in terms of NEMA as it relates to prospecting, mining, exploration, production or activities incidental thereto on a prospecting, mining, exploration or production area. An environmental authorisation issued by the Minister shall be a condition prior to the issuing of a permit or the granting of a right in terms of this Act.

Section 43 provides for the issuing of a closure certificate by the Minister of Minerals and Energy and the transfer of environmental liabilities and responsibilities as identified in the environmental authorisation to a competent person contemplated in section 59. The holder of a mining right remains responsible for any environmental liability, pollution, ecological degradation, the pumping and treatment of extraneous water, compliance to the conditions of the environmental authorisation and the management and sustainable closure thereof until the Minister has issued a closure certificate in terms of this Act to the holder or owner concerned.

No closure certificate may be issued unless the Chief Inspector of Mines and each government department charged with the administration of any law that relates to any matter affecting the environment have confirmed in writing that the provisions pertaining to health and safety, and pollution management of water resources, the pumping and treatment of extraneous water and compliance to the conditions of the environmental authorisation have been addressed. When the Minister issues a certificate, he or she must return such portion of the financial provision contemplated in the Financial Provisioning Regulations of NEMA, as the Minister may deem appropriate, to the holder of the mining right, but may retain any portion of such financial provision for latent and residual safety, health or environmental impact that may become known in the future.

Section 45 provides for the Minister to take urgent remedial action pertaining to environmental degradation and pollution, and to recover costs in this regard. Section 46 provides for the Minister to rehabilitate abandoned and ownerless mines or dumps, to register such sites in the title deeds of land and to transfer the liability for maintaining the rehabilitation work being undertaken to the responsible landowner.

The MPRDA also provides for the implementation of a Social and Labour Plan. The purpose and objectives of such plan is to do the following:

- Integrate and manage the social, economic and environmental impacts of mining within all the phases of a mine, until closure
- Avoid job losses and mitigate social and economic impacts on individuals should a mine close prematurely or at the closure of mines
- Avoid the establishment of settlements that cannot be sustained after the closure of mines

When considering irrigation with mine water, in terms of the MPRDA, the requirements will likely be different depending on the stage of the mine, i.e. whether it is a new mine application, in which case the intention of irrigation will likely need to be included in the EMPr for approval, or whether it is an operational mine or a mine facing closure. Amendments to existing EIAs and EMPrs may be required in the latter cases. The use of mine water for irrigation after closure provides an opportunity, in terms of the required Social and Labour Plan, to mitigate social and economic impacts on individuals upon mine closure. The provision for joint decision making between the various departments may aid the approval process, which will require input from multiple stakeholders.

2.4 MINE HEALTH AND SAFETY ACT, 1996

The Mine Health and Safety Act, 1996 (Act No. 29 of 1996), is administered by the Mine Health and Safety Inspectorate of the DMRE. The following sections apply to mine operations and closure:

- Sections 2 and 5 where the employer must ensure and maintain a safe and healthy environment at the mine, during commissioning, operation, decommissioning and closure
- Sections 6, 10 and 11 make provision that the employer must provide and supply adequate health and safety equipment, training, and assess and respond to any risk or hazard to which employees may be exposed
- Sections 12 and 13 pertain to the medical surveillance system
- Sections 19, 22 and 23 pertain to employees' rights with regard to access to information, duties for health and safety, and permission to leave a dangerous working place if circumstances arise.

When irrigating with mine water, regardless of the stage of mining, consideration should be given to the safety of workers and the communities. With regard to the irrigation of land that is not within a mining right area, it should be noted that the Occupational Health and Safety Act, Act No. 85 of 1993, as amended by the Occupational Health and Safety Amendment Act, Act No. 181 of 1993, will be applicable, as opposed to the Mine Health and Safety Act.

2.5 NATIONAL WATER ACT, 1998

The purpose of the National Water Act, 1998 (Act No. 36 of 1998), is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in ways that take into account, among other factors, the following:

- Meeting the basic human needs of present and future generations
- Promoting equitable access to water
- Facilitating social and economic development
- Protecting aquatic and associated ecosystems and their biological diversity
- Reducing and preventing the pollution and degradation of water resources
- Meeting international obligations
- Promoting dam safety and managing floods and droughts

The National Water Act of 1998 also contains wide provisions, particularly related to responsibility for the integrity of water resources. The basis of water management at mines is therefore the mine water management hierarchy. This hierarchy is based on a precautionary approach and sets the following order of priority for mine water management actions:

- Pollution prevention
- Water re-use or reclamation
- Water treatment
- Discharge

In order to comply with the above hierarchy, an integrated mine water management system is required, which must adhere to the following principles:

- Compliance to all legislation
- A life-cycle approach being followed with regard to water management throughout the life of the mine
- A cradle-to-grave approach with regard to the responsibility for mining waste streams and consequential impacts
- A risk-based approach being followed to quantify the current and long-term risks pertaining to water management

According to the NWA, the authorisation of water use is based on the risk of impact on the water resources. Three types of water use authorisations determine those water use activities that require a licence and those activities that do not require a licence, as indicated in Table 2.1.

Table 2.1: Three types of water use authorisations that determine licence requirements

Schedule 1	General authorisation	Water use licences
These are activities that do not require registration for water use. Small quantities of water are used and have minimal or no risk to the water resources (e.g. taking water directly from any source for domestic use).	Some of these activities require registration and some do not, and have limited waster use with low water risk to water resources.	These are activities that have greater water use with high risk to water resources if not controlled. Activities such as taking water from a resource to use it, storage such as keeping water in a dam, and diverting the flow of water for activities such as operational mining.

The Directorate of Resource Protection and Waste is directly responsible for any application (water use authorisation) that is made in connection with mining and where the application for an integrated water use licence (IWUL) is required. An IWUL is one where multiple water uses are involved.

The DHSWS defines water use as the use of water at the point where the water is *taken* from the resource and not at the point where it is *applied,* such as for irrigation or mining.

The Water Use Licence Application and Appeals Regulations (Government Notice R267 of 2017), in terms of the National Water Act, inform the water use licencing process. This process is discussed in more detail in Chapter 4.

A summary of the section 21 water uses is presented in Table 2.2, including comments in terms of mine water licencing as contemplated by Walkersdorfer et al. (2018).

Table 2.2: Section 21 water uses

Section 21	Description of use	Comment in terms of mine water licencing
(a)	Taking water from a water resource	Any reuse of water authorised under section 21(j) will also trigger a section 21(a) water use.
(b)	Storing water	Applies to clean or raw water storage.
(c)	Impeding or diverting the flow of water in a watercourse	Mining activities within 100 m or the 100-year floodline of a watercourse or within 500 m of a wetland will also trigger this use.
(d)	Engaging in a stream flow reduction activity	Only use of land for afforestation currently applies.
(e)	Engaging in a controlled activity (e.g. irrigation with water containing waste and recharging an aquifer)	In the context of mining irrigation with water containing waste and recharging, an aquifer will trigger this use.
(f)	Discharging waste or water containing waste into a water resource through a pipe, canal, sewer or other conduit	Re-use optimisation has to be demonstrated before this use will be approved for mining.
(g)	Disposing of waste in a manner that may detrimentally impact on a water resource	Applies to the storage of dirty water, disposal of mine residues and run-of-mine or other stockpiles that may have the potential to pollute water.
(h)	Disposing in any manner of water that contains waste from or which has been heated in any industrial or power generation process	This does not typically apply to mining.

Section 21	Description of use	Comment in terms of mine water licencing
(i)	Altering the bed, banks, course or characteristics of a watercourse	Section 21(c) water uses also trigger section 21(i) water use, as does undermining a watercourse (mining within 100 m vertical depth of a water course).
(j)	Removing, discharging or disposing of water found underground for the continuation of an activity or for the safety of persons	Dewatering of open pit and underground workings.
(k)	Using water for recreational purposes	Not applicable to mining operations.

The following sections of the Act are important with regard to the licencing of mine water. Where they also apply to irrigation, this is highlighted.

2.5.1 Section 21(a) Taking water from a water resource

Section 21(a) is applicable when water is being abstracted from a dam, river or borehole. It is also applicable to water removed from below the ground in terms of section 21(j) that is not discharged into a water resource, i.e. water used by mines in their processes, for the irrigation of golf courses, or for other uses.

It should be noted that the DHSWS has a raw water pricing strategy in place that has been prepared in terms of sections 56 to 60 of the NWA, which requires a charge to be levied upon any water resource abstraction. This raw water pricing strategy is applicable to the domestic and industrial sectors and only excludes the following water:

- Permissible water use as described under schedule 1 of the NWA and generally authorised
- Basic human needs
- Ecological sustainability
- International obligations

Since this water is being used for agriculture, the Act states that this sector will attract all abstraction-related activity costs pro rata to productive use. These charges are calculated based on the distinctions made at the point of discharge with potential non-point source impact, such as irrigated effluent tailings dams and evaporation dams, and point source discharges directly to surface water resources. The annual waste load is calculated per water management area (WMA) and is based on the load of salt (electrical conductivity) and phosphorus (limiting nutrient for freshwater eutrophication). For section 21(f), the discharged salt and phosphorus waste loads are the average (mean) concentration multiplied by the volume of water, as reflected on a lawful permit or licence and/or verified as existing lawful use. However, the costs allocated to waste discharge-related water use will be allocated according to the management effort applied in the WMA. In the case of a point source discharge, as this mine water irrigation would be, the management effort for irrigated effluent includes all waste discharge-related activity costs.

The SAPWAT program, developed by the WRC, or another method, as approved by the Department of Water and Sanitation (DWS), is used for assurance of sustainable supply and includes existing lawful use related to irrigation agriculture for the allocation of new licences and amendments. Multi-year weather data is used to statistically analyse estimated irrigation requirements for different levels of risk. The facility to do enterprise budget analyses is included, as is the facility to do small-scale water harvesting analysis and design. Crop irrigation requirement estimates are used for irrigation system design, as peak requirements and cycle length – two crucial elements in design – can be deduced from the results.

2.5.2 Section 21(e): Engaging in a controlled activity

In order to ensure that sufficient information is available for the application process, some basic information is required for this section of the WUL application. This includes the area to be irrigated with mine water, as well as the crop type.

The basic water quality variables, along with any additional variables that have been identified, need to be included as part of the monitoring required in the mine's Integrated Water and Wastewater Management (IWWM) Plan. This monitoring programme should also ensure compliance with the groundwater quality reserve on the property or properties, and therefore be designed in consultation with the affected parties.

There is limited legislation or documentation that provides any guidance in terms of irrigation with waste water, including the "Guide: Permissible Utilisation and Disposal of Treated Sewage Effluent", issued by the former Department of Health (Department of Health, 1978). Additional guidelines are available as part of the "South African Water Quality Guidelines, Volume 4: Agricultural use: Irrigation" (DWAF, 1996). The final set of documentation is the "Guidelines for the Utilisation and Disposal of Wastewater Sludge", volumes 1 to 5. However, it is noted that most of these documents are heavily invested in and focused on the irrigation and use of sewage sludge and water quality, and not of mine water. These guidelines state that irrigation with waste shall be practised in a systematic manner and precautions shall be taken so as to prevent the following:

- Water logging and the pooling of waste in any location
- The pollution of underground water or surface water due to seepage or otherwise
- Fly breeding, public health hazard, odour or secondary pollution
- Runoff from the irrigation area because of wet weather or any other conditions whatsoever

The site of the irrigation area shall be adequately fenced to prevent the entry of animals and unauthorised persons.

2.5.3 Section 21(f): Discharging waste or water containing waste into a water resource through a pipe, canal, sewer or other conduit

This section relates to the discharge of waste or wastewater directly into a water resource. Common examples of this water use are waste released into a river or dam at a discharge point, such as wastewater from factories, or partially treated wastewater from treatment plants. Waste discharged into a municipal sewer is not included in this water use.

This use is not likely to be applicable with respect to a licence application for irrigation as the water is not discharged directly into the resource.

2.5.4 Section 21(g): Disposing of waste in a manner that may detrimentally impact on a water resource

Typically, this disposal, which is a water use, takes place in on-site facilities, such as slurry dams, tailings facilities, return water dams, slimes dams or slag dumps, which may cause the pollution of water resources. It may, however, also occur off-site. Other examples of this water use are disposal into wastewater treatment systems, such as oxidation ponds that do not have outlets into water resources and disposal into evaporation dams.

This water use includes the disposal of contaminated stormwater in dams.

2.5.5 Section 21(j): Removing, discharging or disposing of water found underground for the continuation of an activity or for the safety of persons

This section is usually used to ensure continued production and safety in underground or in open-cast mines. Many construction sites also require groundwater to be removed. Where water is abstracted from below the ground for purposes of dewatering, this will also trigger a section 21(a) water use.

2.5.6 Regulations on Use of Water for Mining and Related Activities

The regulations relevant to the mining industry published in terms of the NWA are the Regulations on Use of Water for Mining and Related Activities, Government Notice 704 of 4 June 1999, which states that mines must collect, confine and take reasonable measures to prevent water resource contamination, as well as ensure that water used in any process at a mine or activity is recycled as far as is practicable. These regulations are supported by Operational Guideline No. M6.1, "Guideline document for the implementation of regulations on use of water for mining and related activities aimed at the protection of water resources" (Second Edition), issued by the Department of Water Affairs and Forestry (DWAF) (2000).

Regulation 7 of Government Notice 704 specifically deals with the protection of water resources. Applicable regulations listed under Regulation 7, when considering irrigation with mine water, include the following:

Every person in control of a mine or activity must take reasonable measures to do the following:

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

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

c. Cause effective measures to be taken to minimise the flow of any surface water or floodwater into mine workings, open-cast workings, other workings or subterranean caverns, through cracked or fissured formations, subsided ground, sinkholes, outcrop excavations, edits, entrances or any other openings

f. Ensure that water used in any process at a mine or activity is recycled as far as is 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

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

Regulation 9 deals with the temporary or permanent cessation of a mine or activity. 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. These are usually addressed within the EMPr (or closure plan) for mining activities. This would apply to the irrigation of mine water after closure. In terms of section 19 of the NWA, the person in control of a mine or activity remains responsible for any damage to a water resource.

Regulation 12 deals with the requirements for technical investigation and monitoring, which also applied to irrigation as an activity. The Minister may 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 the 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. In addition, the Minister may require 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, and may require a compliance monitoring network to be implemented to monitor this programme.

The regulations specified in Government Notice 704 stipulate what is required from a mine, but provide little guidance as to how it should be achieved. A series of best practice guidelines (BPGs), developed by Munnik and Pulles (2009), has been implemented, and is aimed at assisting mines to meet the requirements of pollution prevention and impact minimisation.

Best practice guidelines

Best practice guidelines have been produced in three series:

1. A hierarchy series based on dealing with aspects of the water management hierarchy of the DWAF:
    - H1: Integrated Mine Water Management
    - H2: Pollution Prevention and Minimisation of Impacts
    - H3: Water Reuse and Reclamation
    - H4: Water Treatment

2. A series of best practice guidelines dealing with general water management strategies, techniques and tools, which could be applied cross-sectorally:
    - G1 Stormwater Management
    - G2: Water and Salt Balances
    - G3: Water Monitoring Systems
    - G4: Impact Prediction

3. Best practice guidelines dealing with specific mining activities to address the prevention and management of impacts:
    - 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

In South Africa, mines are classified according to the potential impacts that the mining activity may have on water resources. These classifications are described in “Best Practice Guideline A5: Water Management for Surface Mines (DWAF, 2008b):

- *Category A:* Any mine with a potentially significant and/or permanent impact on water quality; all gold and coal mines, irrespective of size; any kind of extractive metallurgical process, including heap leaching (this includes most other precious and base metal mines); any mine where sulphide-producing or other acid-generating material occurs in the mineral deposit.
- *Category B:* Mines with potentially significant and/or permanent impact only on non-water quality aspects of the water environment, such as yield or availability of water, dynamics of the river, riparian uses, etc.

- *Category C:* All other mines not covered by categories A and B. This includes big mines with no significant impact on the water environment and small- or low-impact mines and prospecting operations.

The basis of IWWM at mines is the resource protection and waste management hierarchy of decision-taking at DWAF (now the DHSWS). This hierarchy is based on the precautionary principle, as set out in the NWA, and sets the following order of priority for mine water and waste management decisions and/or actions (see Figure 2.1):

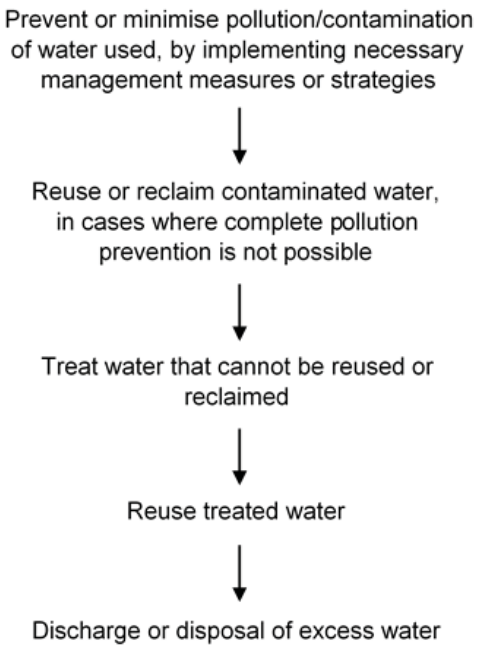

Figure 2.1: Order of priority for mine water and waste management decisions

All new and existing mines are, therefore, required to optimise water reuse and reclamation. According to Best Practice Guideline H3: Water Reuse and Reclamation (DWAF, 2006d), the process or approach to be followed to establish a Water Reuse and Reclamation Plan (WRRP) for a new or existing mine would be the same, although the implementation or execution may be different. The WRRP should ideally form part of the larger IWWM Plan, but in some instances, may be developed as a standalone document. As a standalone document (in the absence of an IWWM Plan), the WRRP may be used as motivation to DWAF (now the DHSWS) for a WUL or authorisation to discharge and/or dispose of waste or water containing waste. A flow chart for the process to develop a WRRP, as presented in Best Practice Guideline H3, is presented in Figure 2.2. As water reclamation refers to the operational use of water, Best Practice Guideline H3 will not have application to closed mines. Where desired, the reuse and reclamation of water decanting from closed mines could be considered on a case-by-case or site-specific basis. During the decommissioning and closure phase of the mine, reuse and reclamation activities include the following:

- Verify latent or residual excess water quantity and quality (decant) through monitoring systems, performance assessments and predictive modelling.
- Define post-closure water reuse and reclamation options and determine best practicable environmental option, e.g. treatment and discharge, irrigation with decant water, sustainable development projects, etc.
- Finalise financial and contractual arrangements or agreements for post-closure water management and the maintenance of infrastructure with future landowners and/or responsible parties and/or water users.

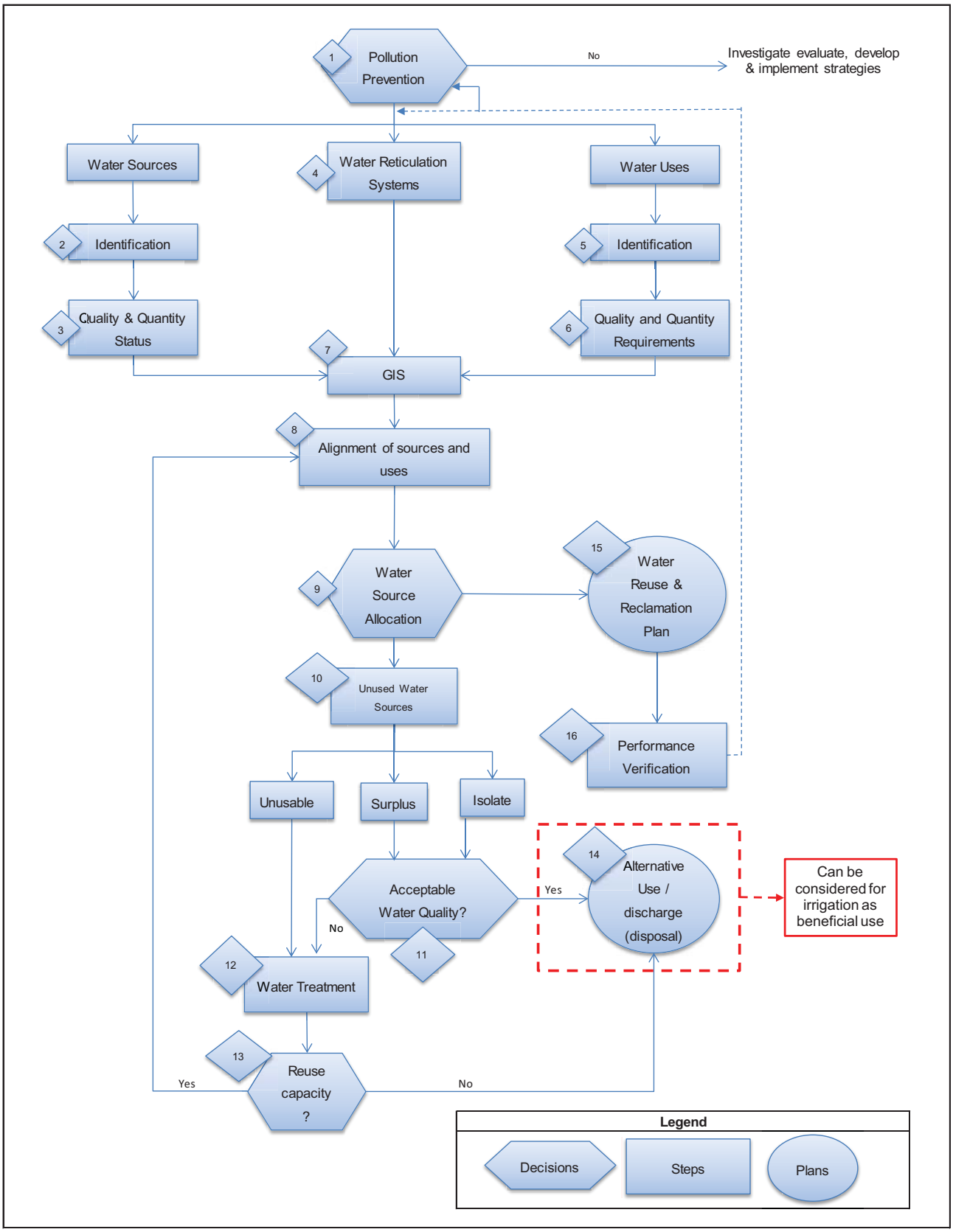

Figure 2.2: Flow chart for the process to develop a Water Reuse and Reclamation Plan

The steps in the process to develop a WRRP, as illustrated in Figure 2.2 are described below:

Step 1: Pollution prevention

Purpose:

To ensure that all pollution prevention strategies have been applied.

Method:

- Investigate, evaluate, develop and implement appropriate pollution prevention strategies wherever possible, e.g. early recognition of the potential for acid mine drainage and the adoption of appropriate management strategies (encapsulation, selective handling, clean and dirty water separation, etc.).

Step 2: Identify water sources

*Purpos*e:

To ensure that all possible water sources available on the mine have been identified.

Method:

- Locate where processes are fed with raw water and establish from where these processes are fed (dams, boreholes, natural water bodies, service providers, etc.).
- Locate all water-using processes, including utility services and establish from where their water originates.
- Locate all points where (waste) water or effluent is generated.
- Locate all water or contaminated water storage and collection areas.
- Consider water quality, supply and volume (use data for the past five years if possible).

Step 3: Water source quality and flow status

Purpose:

To define the water quality and flow status, as well as the variability of the possible water sources identified in Step 2.

Method:

- Characterise the water streams or sources with respect to flow rate, quality and variability data through a monitoring system. Base the characterisation on information over the past five years if possible.

Step 4: Water reticulation system

Purpose:

To assess (identify and define) current or existing water reticulation systems.

Method:

- Assess the current or existing water reticulation system.
- Identify opportunities for reusing effluent water from one process as influent water to another process.
- Establish where water reticulation networks may need to be installed, extended or modified once reuse pathways are validated.

- Check pipe sizes (diameter), pump rates, etc. with requirements.
- Assess the adequacy of water storage facilities within the reticulation system and establish the necessity of additional requirements.

Step 5: Identify mine water uses

Purpose:

To identify all mine water uses, i.e. areas or processes on the mine that require water for their operation.

Method:

- Conduct a water use inventory. A list of existing and potential mine-related uses needs to be compiled because water quality requirements are intrinsically linked and based on use requirements (Step 6).
- Identify both direct and indirect water uses. Water use on a mine can range from potable use to use for mineral processing, cleaning, dust suppression, transport, irrigation, etc.

Step 6: Water use quantity and quality requirements

Purpose:

To define water quality and quantity requirements of all mine water uses.

Method:

- Consider water quality parameters that affect or impact on product quality or yield and/or process performance or optimisation.
- Establish fit-for-purpose quality and quantity criteria.
- Consider the water quality needs of the mine-related use and not only the water quality currently supplied (e.g. supply of potable water for a use that actually requires water of a lesser quality).
- Distinguish between direct and indirect water use and the different requirements for these.
- Determine the potential acceptance of water quality and quantity at proposed standards (without treatment). If unacceptable, determine additional treatment required to render water quality and quantity of an acceptable standard.
- Group uses with similar water quality requirements together to provide a number of different water quality groups or categories that will meet all use requirements. These will be linked to key contaminants, specific applications or water uses.
- Aim to use water with the minimum amount of treatment.

Step 7: Geographically referenced plans

Purpose:

To develop geographically referenced plans showing water sources, water uses and existing reticulation system(s) in order to assist with linking these. This will support effective water and waste management and the compilation of accurate water and salt balances for the mine.

Method:

- Create a flow sheet model (schematic flow diagram) of the water reticulation system(s).
- Select an appropriate tool to use for data and information management.
- Validate the reliability of data before entering it into the information management system.

Step 8: Aligning water sources to water uses

Purpose:

To align and allocate water sources to water uses, taking all previous steps into account

Method:

- Align and allocate recycled water quality and quantity to various applications or water uses.
- Achieve the minimum use of raw water or optimal flow configuration in the particular system of operations.
- Optimise the water reticulation system as far as possible. Conceptual designs derived from water allocation analysis steps must be comparatively evaluated to choose the best option.
- The alternative analysis includes an evaluation of technical, monetary, environmental and social factors.
- Ensure true and accurate cost analysis since decisions are based on financial considerations.

Step 9: Water source allocation

Purpose:

To determine whether all water sources have been allocated for reuse.

Decision:

- If, at this point in time, all water sources have been allocated to a specific water use, i.e. all recycled water has been reused, the mine can complete its WRRP (Step 15).
- If, however, this is not the case, and there is still surplus water that has not been allocated for reuse, proceed to Step 10.

Step 10: Define unused water sources

Purpose:

To define the unused water sources, i.e. the reason for not being allocated to a specific water use during Step 8.

Method:

- Categorise the unused water in terms of the reason for it not being allocated to a specific water use for reuse.
- Generally, the main reasons for not being allocated are the following:
  - The water source is of too poor a quality for reuse by any of the identified mine water uses.
  - There is a surplus of water, i.e. more water is generated in the process than can be reused.
  - The water source is too small or isolated to be incorporated into the water reticulation system.
- In the case of unusable water due to water quality constraints, proceed directly to Step 12. In the case of the other reasons, proceed to Step 11.

Step 11: Acceptable water quality

Purpose:

To determine whether the unused water is of an acceptable quality to allow alternative use, discharge or disposal.

Method:

- Establish discharge limits and points in consultation with DWAF based on resource water quality objectives and downstream water user requirements.
- Evaluate the surplus and/or isolated water sources with respect to water quality.

Decision:

- If the water quality is acceptable, proceed to Step 14.
- If the water quality is not acceptable, proceed to Step 12.

Step 12: Water treatment

Purpose:

To identify and investigate the relevant water treatment alternatives that are available based on target criteria (flow and quality requirements).

Method:

- Consider water quality and quantity requirements for water use (Step 6). Consider contaminants that cause adverse effects such as corrosion or scaling, which affect or impact on product quality or yield and affect or impact on process performance.
- Identify and investigate water treatment options.
- Determine process reliability. Consider whether the planned treatment process has been used for a similar situation or application. Reliability is particularly important if treatment facilities will be part of the production process. Also, consider cleaner technologies (such as baghouse systems rather than wet scrubber systems) as these become available.
- Evaluate all side streams from the treatment process to ensure that all costs and impacts are known (handling and disposing of sludge, etc.).
- Establish whether it would be more appropriate to treat effluent streams simultaneously or separately based on characteristics or contaminants of concern.
- Evaluate the type and optimal placement of the treatment process to achieve the desired trade-off between performance, reliability, capital expenditure, operating costs, environmental impact and waste generated. This may include laboratory or pilot plant testing to gather additional information.

Step 13: Determine reuse capacity after treatment

Purpose:

To determine whether the treated water could be reused within the mine water system.

Decision:

- If after treatment, the water has a reuse capacity based on the previous work, proceed back to Step 8 for the alignment and allocation of the treated water.
- If the treated water cannot be reused within the mine water system, proceed to Step 14.

Step 14: Alternative use or discharge

Purpose:

To investigate alternative use or discharge options.

Method:

- Two options can be considered if not all water can be reused in the system:
  - Identify alternative users (off-site or downstream) for this water.
  - Discharge or dispose to the environment with an appropriate water use licence or authorisation.
- Evaluate the alternative options with respect to technical feasibility, cost, environmental impact and long-term sustainability.
- Determine the best practicable option based on specialist investigations (if necessary) and an environmental risk assessment.
- Discuss options with DWAF and obtain the necessary approval, whatever the final decision may be.

Step 15: Water Reuse and Reclamation Plan

Purpose:

To develop and implement the WRRP.

Method:

- After completion of the process described in steps 1 to 14, the mine can complete its WRRP. The WRRP could be included in the overall IWWM Plan for the mine, or could be completed as a stand-alone document, depending on its purpose.
- The methodology and process followed during the development of the plan must be described in detail and all other relevant plans and/or procedures (such as the water and salt balance) must be revised in accordance with the WRRP.
- The reuse and reclamation plan should address the whole life of the mine, including decommissioning and post-closure.
- The WRRP for a new mining operation will still be conceptual with long-term commitments and actions for closure.
- An existing operation, approaching closure, will have detailed plans for reuse and the reclamation of excess water post-closure.
- Develop an action plan for the implementation of the WRRP.
- Develop measurable, quantifiable performance indicators for the WRRP.
- Develop a performance verification plan to monitor the implementation process and verify its success (Step 16).

Step 16: Performance verification

Purpose:

To verify and review the success of the implementation process through its performance.

Method:

- Implement a monitoring and auditing programme.
- Evaluate the performance of the WRRP (comparison of actual and planned performance based on performance indicators).
- Verify and review the plan regularly, especially if any changes in activities or processes have been made.
- Implement corrective actions, if necessary.
- Modify, revise or correct the plan where necessary (corrective action requires going back into the loop).

As can be seen in Figure 2.2, the process is an iterative process to ensure continuous improvement.

The Water Conservation and Water Demand Management Guideline for the Mining Sector in South Africa (DWAF, 2011), and the Guideline for the Development and Implementation of Water Conservation and Water Demand Management Plans for the Mining Sector (DWS, 2016b) that followed, are discussed in Section 2.7.1 regarding the implementation of water conservation and demand management in operational mines.

Best Practice Guideline H4: Water Treatment (DWAF, 2007a) deals with the treatment of water, which is the fourth step in the water management hierarchy. Discharge or disposal should not be considered by the mine and will not be allowed by DWAF (now the DHSWS) unless all prior steps in the water quality management hierarchy have been considered and applied. Water treatment is a consideration for exploration, operational and defunct or closed mines, although the water treatment technology of choice may be different. Close inspection and evaluation of a mine's water and salt balance according to Best Practice Guideline G2: Water and Salt Balances, DWAF 2006b) will indicate when water treatment is required:

- Where the implementation of pollution prevention, minimisation of impacts and water reuse or reclamation strategies do not result in zero discharge. Thus, water containing waste is discharged or disposed and there is a need to further reduce the pollution load from the mine and minimise the mine's impact.
- Wherever significant water quality-related problems (e.g. corrosion, scaling, biofouling, etc.) are experienced by mine water users due to the reuse of process water.
- Wherever significant water quality-related problems are experienced by downstream water users and the source(s) of the water quality deterioration can be ascribed to the mine.

Any water treatment option must take account of the changing water and salt balance (Best Practice Guideline G2) over the life cycle of the mine and that it must be sustainable, flexible and capable of accommodating the relevant changes.

The objectives of Best Practice Guideline H4 can be incorporated into the IWWM Plan and documents in which an IWWM Plan is required (EIA, EMPr or closure plan), but can also be used in a WUL application. In a WUL application, it can be used by the mine to motivate why a treatment plant is required and/or why a particular treatment method was selected. This will be in the following WUL applications pertaining to section 21 of the NWA:

- Section 21(e): Engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1)
- Section 21(f): Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit
- Section 21(g): Disposing of waste in a matter that may detrimentally impact on a water resource
- Section 21(h): Disposing, in any manner, of water that contains waste from, or which has been heated in, any industrial or power generation process.

Where a long-term water discharge is predicted, it will be important to show that adequate financial provision has been made by appropriate means for water management or treatment when motivating for the closure of a mine. Collection and treatment can be considered to be the last remaining option if neither the source nor the pathway can be sufficiently controlled to protect the receptor.

When the intention is to dispose excess water from a mine during operations or after closure, the requirements for treatment should be guided by Best Practice Guideline H4, supported by Best Practice Guideline G2, to ensure that it has no impact on the environment or downstream users, as well as the requirements for water quality for irrigation, as discussed in Section 2.6.2 below. The selected treatment, if any, should then be motivated in the existing or new WUL in light of the requirements of both of these guidelines.

2.6 LEGISLATIVE FRAMEWORK AND GUIDELINES FOR IRRIGATION

The Republic of South Africa covers an area of 122,081,150 ha in total, of which approximately 14 million ha (13%) is cultivated land (BFAP, 2011). It is estimated that about 35% of the people in South Africa are directly or indirectly dependent on agriculture for employment and income. The sector contributes about 2.6% to the gross domestic product (GDP) and 7% to formal employment. The agricultural sector is made up of commercial, smallholder and subsistence farmers (DWA, 2013).

According to the National Water Resources Strategy 2 (NWRS 2), the agriculture sector uses about 60% of the water withdrawals. It is estimated that 1.6 million ha is under irrigation, where about 50,000 ha is located in the previous homelands and is allocated to smallholder farmers. The NWRS 2 has indicated that additional water for an increase in irrigation would be very limited. There is therefore motivation to investigate alternative water sources such a mine water, which may have been previously unavailable due to quality concerns or prohibitively expensive treatment costs, provided the crop and soil requirements are met.

2.6.1 The Irrigation Strategy for South Africa (Department of Agriculture, Forestry and Fisheries, 2015)

The Irrigation Strategy for South Africa (DAFF, 2015) is informed by the NDP (National Planning Commission, 2012) and the NWRS 2) (DWA, 2013). The strategy aims to provide direction on realising the outcomes and activities required to contribute towards food security, while protecting and enhancing our environmental assets and natural resources.

The NWRS 2 (DWA, 2013) outlines the key challenges, constraints and opportunities in water resource management and proposes new approaches that ensure a collective and adequate response for the benefit of all people in South Africa.

The purpose and objectives of the Irrigation Strategy are as follows:

- Increase the contribution of irrigated agriculture to the GDP (at least in absolute terms), poverty alleviation, employment creation and skills development
- Increase equity of access by historically disadvantaged individuals (HDIs) to irrigated agriculture, especially commercial irrigated agriculture, without compromising irrigation water use efficiency in the process
- Contribute to food security and improved socio-economic conditions at household and community level by means of small-scale irrigation projects
- Optimise irrigation water use efficiency with a view to the long-term sustainability of irrigated agriculture
- Improve planning and investment coordination in the following:
  - Revise and refine the revitalisation of irrigation schemes programmes
  - Scale-up scheme-based interventions to expand irrigation areas
  - Phase in and expand systemic interventions of water use efficiency and management
- Increase investment in skills and the training of farmers, extension officers and irrigation specialists
- Increase investment in relevant research

The Irrigation Strategy acts as a link between policy and the practical implementation of the policy in a structured way and outlines the approaches and steps required to achieve the policy objectives. The strategy aims to prevent uncoordinated, fragmented development that would lead to inefficient and conflicting resource use.

The Irrigation Strategy operates within policies and strategies in reference to agricultural water that are well developed in South Africa at national level.

These include the following documents developed by the Department of Agriculture, Forestry and Fisheries (DAFF):

- The Draft National Agriculture Development Strategy
- The Integrated Growth and Development Plan for Agriculture, Forestry and Fisheries
- The Revitalisation of Irrigation Schemes – Irrigation Infrastructure progress 2012/13
- The draft strategy document, "National Guidelines for Integrated Management of Agricultural Water Use – an integrated approach to upliftment and local economic development through the transformation of state support for agricultural water use"

Those documents developed by the DWS (now the DHSWS) include the following:

- The National Water Act, Act No. 36 of 1998
- The National Water Resources Strategy, Second Edition (DWA, 2013b)
- The Water for Growth and Development Framework (DWAF, 2009)
- The Draft Position Paper for Water Allocation Reform in South Africa: Towards a Framework for Water Allocation Planning (DWAF, 2005)

The Irrigation Strategy acknowledges that meeting the ambitious targets of the expansion of irrigated areas and the revitalisation of smallholder irrigation schemes will require learning to do new things, as well as scaling up existing practices, while making them more effective.

The NWRS 2 also makes provision for infrastructure development to support the implementation of this strategy, sets targets for water use efficiency by the agriculture sector, and sets targets for water reallocation to historically disadvantaged water users.

A major challenge to addressing rural poverty is how to create economic opportunities in communal land tenure areas in the face of the overwhelming trend of urbanisation. Here irrigation can play a significant role because, by its very nature, it is concentrated in the rural areas. This is particularly applicable in the case of some of the new irrigation developments, as well as the revitalisation of existing irrigation schemes that have been identified in national strategic initiatives. The availability of mine water as a result of mine closure to support mining communities is aligned with these initiatives.

Strategies related to resource surveys, land suitability and land use planning

In terms of the Irrigation Strategy, successful, efficient farming, especially intensive high-input or high-value irrigated farming, is not possible without high-quality land use planning based on correct land suitability evaluation and high-quality detailed resource maps and information.

Land suitability evaluation and land use planning are not only required when new areas are to be put under irrigation, but each time changes to existing land use are considered. This would include each envisaged change in enterprise (e.g. type of crop or even cultivar), irrigation system or general management practices. Unfortunately, irrigated agriculture often fails because of inadequate resource information and/or poor land suitability evaluation and, consequently, poor land use planning. It is extremely important that all the necessary feasibility studies and resource information collection, especially detailed soil surveys, must be completed before the final planning of the siting of dams, canals, etc. is done, and definitely before construction is begun.

Land suitability evaluation for irrigated agriculture must include the following:

- Crop requirements and tolerances
- Soil and climatic requirements and tolerances of different irrigation systems
- Environmental requirements, including climate change considerations
- Management requirements

Institutional arrangements: Role players and their functions

In terms of the importance of irrigation agriculture in South Africa, it is evident that effective communication, coordination and cooperation between various stakeholders, including government, research institutions, the private sector and farmers, will be required. Some of the role players and their functions are described below, as contained in the Irrigation Strategy.

Department of Agriculture, Forestry and Fisheries (now the Department of Agriculture, Land Reform and Rural Development)

The DAFF will take the responsibility of guiding irrigated agriculture in the country. The DAFF has recognised the importance of irrigation and the desirability of supporting irrigation farmers.

The DAFF, as the coordinator of the Irrigation Strategy, will undertake to perform the following functions:

- Coordinate and conduct effective communication on irrigation-related matters through the establishment of institutional arrangements, including the following:
  - Chairing the Water Use and Irrigation Working Group
  - Establishing a senior-level committee at national level between DAFF, DHSWS, the provincial departments of agriculture (PDAs) and the Department of Rural Development and Land Reform (DRDLR), chaired by the Director-General (DG) and Deputy Director-Generals (DDGs) to review or revise policy, make decisions and create policy around land, water and irrigation. The committee is to meet once a year or once in two years.
- Develop general documentation for the sourcing of funding for irrigation schemes in South Africa.
- Develop basic implementation guidelines for the revitalisation of government irrigation schemes, the expansion of new irrigated areas and water use efficiency and management.
- Consult with research institutions such as the WRC on research needs and the funding of research projects relevant to irrigation in South Africa.
- Create a favourable or enabling environment through which the private sector and other organisations can get involved.
- Support and monitor the implementation of irrigation projects that have been provided funding by DAFF.
- Review the Irrigation Strategy every 10 years.

Provincial departments of agriculture

The PDAs will undertake the following:

- Develop feasibility reports and subsequent business plans for irrigation and drainage projects.
- Compile business plans for the sourcing of funding for the implementation of irrigation projects through DAFF.
- Develop irrigation, surface and subsurface drainage designs for irrigation projects.
- Implement irrigation projects.
- Establish a Coordinating Committee on Agriculture Water (CCAW) and chair the meetings, at least four meetings a year.
- Appoint permanent members of the Water Use and Irrigation Working Group (WUIWG).
- Provide extension support to irrigation farmers on the maintenance, management and scheduling of irrigation and drainage systems.
- Allocate budget for irrigation initiatives.

Department of Human Settlement, Water and Sanitation

The National Water Act specifies that government is the trustee of the nation's water resources and requires the DHSWS to act as custodian of these resources. The NWRS 2 provides the implementation framework for the Act.

The DHSWS's role will include the following:

- Consult with DAFF on dealing with unlawful water users, legal actions where needed, water pricing, increase of water tariffs, etc.
- The authorisation and licencing of water use.
- The construction, repair and maintenance of bulk infrastructure according to existing agreements with water user associations (WUA) and irrigation boards.
- Implement the Water-based Rural Livelihoods and Food Security Implementation Framework.
- Accelerate the validation and verification process.
- Consult with DAFF on policy developments in order to ensure proper alignment between departments (DAFF, DHSWS and DRDLR).

Department of Rural Development and Land Reform (which is now incorporated in the Department of Agriculture, Land Reform and Rural Development)

The DRDLR is responsible for land allocation, rural development and land reform. This department currently supports the revitalisation of irrigation schemes in various provinces.

Department of Environmental Affairs (now the Department of Environmental Affairs, Forestry and Fisheries)

The Department of Environmental Affairs (DEA) is currently responsible for the implementation of environmental laws, NEMA and adherence to these laws, including EIAs.

Private sector

The private sector will include institutions such as commodity organisations, financial organisations, academic institutions, research institutions, farmer organisations and other non-government organisations (NGOs).

The private sector should participate in the development and support of small irrigation farmers and subsistence irrigation farmers on food plots through the provision of linkages and technical support.

2.6.2 Irrigation water quality guidelines

In 1996, DWAF developed a series of eight volumes comprising the South African Water Quality Guidelines as its primary source of information and decision support to judge the fitness for use of water and for other water quality management purposes. "Water Quality Guidelines for Irrigation" was the fourth volume, specifying the quality of water required for different irrigation uses. It was intended to provide information to make judgements on the fitness of water to be used for irrigation purposes, primarily for crop production. The guidelines applied to any water that was to be used for irrigation purposes, irrespective of its source (municipal supply, borehole, river, etc.) or whether it had been treated or not.

In 2008, a panel of experts performed a needs assessment on the 1996 Water Quality Guidelines on behalf of DWAF (now the DHSWS). The approach to water resource management within DHSWS had changed fundamentally since 1996 as a result of the promulgation of the MWA, and the 1996 guidelines provided generic guideline values without considering local site-specific conditions, which was identified as a significant shortcoming.

It was determined that the existing water quality guidelines required revision to include recent advances in guideline determination, both internationally and locally, to ensure that South African guidelines were based on the latest and most appropriate science and practice, and to review existing water uses and the water constituents they cover to rationalise or extend them. The report developed a general philosophy and described the general specifications of a decision support system for a revised suite of risk-based, site-specific water quality guidelines. The DSS for the Irrigation Water Quality Guidelines was developed by Du Plessis et al. (2017) on behalf of DAFF and the WRC.

The primary tool for evaluating fitness-for-use or establishing water quality requirements is a software-based DSS (available for download from https://www.nbsystems.co.za/downloads.html), which operates at three tiers:

1. Tier 1 resembles the 1996 generic guidelines (but modified where applicable), which are generated by the DSS. Tier 1 relies on the minimum user defined input, and provides a conservative water quality assessment, highlighting potential problems if the conservative assumptions are not met. Should a Tier 1 evaluation indicate potential problems, a more rigorous and site-specific Tier 2 evaluation is indicated.
2. Tier 2 allows for site specificity, the extent of which is predetermined by the site-specific variables that are provided for as part of the DSS. The DSS allows a user to conduct a more in-depth water quality assessment and guideline generation, by making use of a relatively sophisticated crop growth model, the soil-water balance (SWB) and chemistry model, which uses selectable site-specific input parameters to simulate the response of soils, crops and irrigation equipment to irrigation water composition under different climatic and water management conditions.
3. Tier 3 allows for site specificity in other ad hoc contexts, where required, possibly using modules of the DSS and other specialised resources as required for a specific purpose. Tier 3 guidelines are of a specialised nature. They require significant expertise and do not explicitly form part of the DSS, although some guidance is provided for conducting Tier 3 investigations.

A clear distinction is maintained between the resource management decision domain (as used by water resource managers and users) and the supporting science. For example, application of the precautionary principle (“safety factors”) is transparent.

The diagram in Figure 2.3 depicts the overall structure of the DSS. At the highest level, a user has to decide whether they want to use the DSS to assist with the following:

- Assessing the fitness of water for irrigation use
- Setting water quality requirements for irrigation users
- Obtaining additional information, as indicated in the diagram

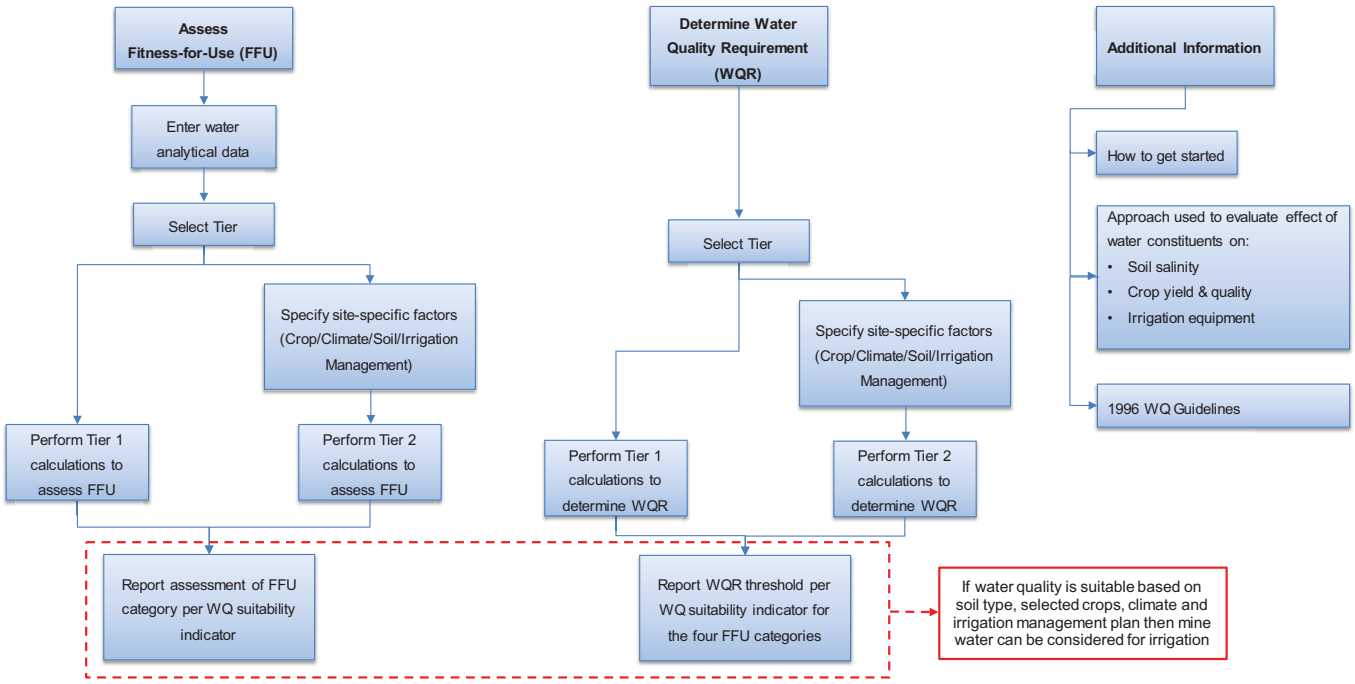

Figure 2.3: Decision support system structure

After selecting the appropriate DSS functionality to access, the user is guided through a decision tree to choose between different options and select the appropriate route in order to process the user's need and provide output. It is assumed in the DSS that the fitness for use of a specific water body can be categorised into different levels of acceptability and implied risk. The classification system is based on a DHSWS system, which describes four suitability categories to which water quality can be assigned. The four categories are defined in generic terms, which are applicable to any water use, and colour coding is employed throughout the DSS to express the evaluated fitness for use of the different indicators of water suitability (Table 2.3).

Table 2.3: Fitness for use categories

Fitness for use category	Description
Ideal	A water quality that would not normally impair the fitness of the water for its intended use
Acceptable	A water quality that would exhibit some impairment to the fitness of the water for its intended use
Tolerable	A water quality that would exhibit increasingly unacceptable impairment to the fitness of the water for its intended use
Unacceptable	A water quality that would exhibit unacceptable impairment to the fitness of the water for its intended use

Both the fitness-for-use of irrigation water and establishment of water quality requirements in the DSS are assessed with regard to the effect its constituents have on soil quality, crop yield and quality, as well as irrigation equipment. The approach adopted was to use simplified conservative assumptions that require no input to determine water quality requirements, and only the irrigation water composition to establish fitness-for-use for Tier 1 assessments. In this way, a rapid "conservative" irrigation water quality assessment is obtained. Should the Tier 1 assessment indicate no potential problems with the water composition, the water is deemed fit for use on all crops under all but the most exceptional circumstances.

On the other hand, should the Tier 1 assessment identify problems with the water quality, a more detailed, site-specific assessment, as provided by a Tier 2 assessment, is indicated. Tier 1 calculations of soil-crop-water interactions assume an idealised four-layer soil in which crops withdraw 40% of their water requirement from the top layer, 30% from the second, 20% from the third and 10% from the bottom layer. The steady state (or equilibrium) concentration of soluble constituents in each layer is calculated from the concentration of constituents in the irrigation water and the leaching fraction for the profile as a whole.

Tier 2 calculations make use of a simplified version of the dynamic SWB model that is run for a minimum of 10 years, using data from an appropriate weather station to calculate the water requirements and uptake of a user-selected crop. It also simulates transient salt transport and simplified soil chemical interactions. This output is used to derive crop yield and other outputs, from which the likelihood with which specific yield intervals occur over time can be calculated. Tier 2 assessments allow the user to select between site-specific conditions in order to provide a significantly enhanced assessment of how the specific water composition can be expected to affect a specific crop under specific climatic conditions, with defined, selectable irrigation management when irrigating a soil with a specific, selectable texture. Tier 2 assessments, therefore, allow the user to assess how the implementation of alternative site-specific management options (for example, a different crop, soil or irrigation management strategy) can be expected to modify a fitness-for-use or water quality requirement determination. The adoption of different management practices may reduce or overcome the problems associated with a specific water composition. Whenever the selectable management options or the modelling procedure provided for in Tier 2 are deemed insufficient or inappropriate for a specific application, a Tier 3 evaluation is called for.

Tier 3 assessments are viewed as specialised in nature. It is anticipated that Tier 3 investigations would focus on specific targeted aspects of water quality assessments. Tier 3 investigations would thus require situation-specific on-site investigations and significant expertise. The current DSS does not provide for Tier 3 investigations, although some guidance for conducting Tier 3 investigations, using modules of the DSS, is provided.

When applied to the irrigation of mine water, this DSS will be valuable for determining the fitness for use under different conditions. The inclusion of site-specific conditions greatly enhances the decision-making process when determining whether a specific mine water quality can be applied to a specific piece of land and what crops may be suitable, together with the highlighting of associated risks. Assessing the fitness for use of a particular mine water is recommended as the first step in the process to be followed to attain regulatory approval of irrigation with mine water. In the context of mine water irrigation, The Water Quality Guidelines for Irrigation should be read in conjunction with the WRC Technical Guideline for Irrigation with Mine Affected Waters (Heuer et al., 2021).

2.7 WATER CONSERVATION AND WATER DEMAND MANAGEMENT IN MINING AND AGRICULTURE

In 2004, the DWAF developed the National Water Conservation and Water Demand Management Strategy (NWC/WDMS), together with the Water Conservation and Water Demand Strategy for the industry, mining and power generation sectors, water services and the agriculture sector. The eight objectives of the NWC/WDMS are as follows:

1. To facilitate and ensure the role of water conservation or water demand management to achieve the sustainable, efficient and affordable management of water resources and water services
2. To contribute to the protection of the environment, ecology and water resources
3. To create a culture of water conservation or water demand management within all water management and water services institutions

4. To create a culture of water conservation or water demand management for all consumers and users
5. To support water management and water services institutions to implement water conservation or water demand management
6. To promote the allocation of adequate capacity and resources by water institutions for water conservation or water demand management
7. To enable water management and water services institutions to adopt integrated planning
8. To promote international cooperation and participate with other southern African countries, particularly basin-sharing countries, in developing joint water conservation or water demand management strategies.

2.7.1 Water conservation and water demand management for operational mines

The latest integrated WUL conditions also require mines to develop water conservation or water demand management strategies, in line with the National Water Conservation and Water Demand Management Strategy To align with the requirements of this strategy, as well as to comply with the requirements for water conservation or water demand management in Government Notice 704 of 4 June 1999, the Department of Water Affairs (DWA) developed the Water Conservation and Water Demand Management Guideline for the Mining Sector in South Africa (DWA, 2011), as well as Best Practice Guideline H3: Water Reuse and Reclamation (DWAF, 2006d) as part of the series of guideline documents. Whereas both these earlier documents remain directly relevant for water conservation or water demand management planning in the mining sector, the Guideline for the Development and Implementation of Water Conservation and Water Demand Management Plans for the Mining Sector, developed by the DWS in 2016, further supports and enhances water conservation or water demand management planning and implementation within the mining sector and references the two abovementioned documents as and when required.

The use of water from operating mines for irrigation will need to be undertaken within the framework of the water conservation or water demand management requirements, and this use will need to be included in the mine's water balance and water accounting framework. The requirements for water conservation or water demand management, as described in the implementation guideline, are discussed in more detail below.

Water Conservation and Water Demand Management Implementation Guideline, Department of Water and Sanitation, 2016

The DWS (now the DHSWS), in collaboration with the Chamber of Mines (now the Minerals Council South Africa), commissioned a project to undertake the setting of water conservation or water demand management targets for the mining sector, with the active participation and management involvement of both the DHSWS and a wide range of stakeholders from the mining sector. The primary deliverables that emanated from this project are the following:

- Benchmarks for Water Conservation and Water Demand Management in the Mining Sector (DWS, 2016a), also referred to as the Benchmarks Report, which describes the key indicators and commodity-based water use benchmarks
- Guideline for the Development and Implementation of Water Conservation and Water Demand Management Plans for the Mining Sector (DWS, 2016b)
- Development of a Standardised Water Accounting Framework (SWAF) to support the online water conservation and water demand management reporting system to be integrated with an Electronic Water Use Licence Application and Authorisation System (e-WULAAS) developed by the DHSWS

- Updated Best Practice Guideline G2: Water and Salt Balances to include a chapter to assist mines in summarising their operational water balances into a format that can be reported into an online SWAF system
- Draft regulations that require the implementation of water conservation or water demand management within the mining sector. These water conservation or water demand management regulations will be incorporated into Government Notice 704, which is currently being revised.

The different approaches and methodologies that are followed internationally in setting water use targets, and developing and implementing water conservation or water demand management plans were reviewed. No country in the world had set definitive and enforceable water use efficiency (WUE) targets for the mining sector, despite substantial work being done in developing methodologies for setting realistic and defensible WUE targets for specific mining operations. Too many site- and mining-specific water variables needed to be taken into account, which rendered the setting of national WUE targets impractical.

It was also recognised that the level of accuracy, reliability and detail of water balances at mines was so varied that this problem would first need to be rectified before accurate baseline conditions could be developed to use as the basis for WUE target setting. This prompted Australia, the country most advanced with water conservation or water demand management in the mining sector, to develop the Water Accounting Framework (WAF) as a standardised water balance information reporting system for mines, which would serve as a precursor to the development of national or sector-based WUE targets. South Africa's SWAF is largely based on the WAF developed by the Minerals Council of Australia (Minerals Council of Australia, 2014).

A variables matrix was developed that identifies characteristics of a generic mine water system that could have a major impact on the achievement of water conservation or water demand management targets. The development of the variables matrix for the South African mining industry also confirmed that there are many climatic, surface and groundwater mining methods and operational variables that could influence water conservation or water demand management opportunities on a mine. Furthermore, it was found that each of these variables could have a different effect on different mines, and that it was not possible to identify or develop a generic mine water system with associated water conservation or water demand management features or measures that would, in any way, be scientifically or legally defensible to consider the effects of all variables on water conservation or water demand management status for such a generic mine.

An extensive survey of 39 representative South African mining operations was undertaken to collect detailed data on current water management activities on mines and to obtain current water balance data to determine current WUE indicators and evaluate current water conservation or water demand management measures being implemented. The mine survey confirmed that a primary problem was the widespread lack of accurate and credible water balances that could be used as a baseline for the development of WUE targets. Only 29% of the water balances were aligned with the minimum requirements as set out in the DHSWS's Best Practice Guideline G2: Water and Salt Balances (DWAF, 2006b), while 48% of mines were found to have balances with significant deficiencies, but still broadly suitable for use in this project. The survey also found that, on those few mines that had started addressing water conservation or water demand management within their operations, current efforts were largely focused on the replacement of imported water sources with alternative on-site water sources, with no significant effort being made to improve WUE through the development and application of a holistic water conservation or water demand management plan, aimed at identifying WUE measures that would ultimately lead to water use reductions or savings throughout the mine's operations.

Based on the above findings from the first phase of the project, it was concluded that it would not be scientifically or legally defensible to attempt to set national WUE targets that would be applied to all mines within the different commodity groups. The alternative process that was developed to initiate water conservation or water demand management within the mining sector comprised the following components:

1. Definition of appropriate WUE indicators for the mining sector.
2. Calculation of the WUE indicators for the different commodity groups (coal, gold, platinum and other), based on the data collected during the site visits.
3. Determination of national WUE benchmarks (not targets as originally intended) based on the current WUE indicators for the three top-performing mines within each commodity group (with the top three mines being selected based on an objective assessment of the survey results for the mines with regard to a wide range of water management indices). The outcomes of this exercise are contained in a separate report entitled "Benchmarks for Water Conservation and Water Demand Management in the Mining Sector" (DWS, 2016a).
4. Development of an implementation methodology that provides technical guidance to mines as to how they should develop a mine-specific water conservation or water demand management plan that includes mine-specific WUE targets that are designed to optimise the mine's WUE status in the shortest possible time. These water conservation or water demand management plans should be integrated into the mine's IWWM Plan.
5. Provision for a mine to report on its performance against its water conservation or water demand management plan in a standardised online system designed to integrate with the mine's WUL reporting requirements. This SWAF will not replace the mine's detailed water and salt balance information, but will simply provide a standardised format in which all mines are required to report on their achievement towards their WUE targets. The DHSWS will take responsibility to integrate this into the online Electronic Water Use Licence Application and Authorisation System. A guideline document to assist mines to complete the SWAF will be developed and incorporated into an updated Best Practice Guideline G2: Water and Salt Balances.
6. Development of regulatory procedures that recognise progress with the development and rapid implementation of a mine's water conservation or water demand management plans towards an improved WUE status.

Step 6 will be implemented through the current water use authorisation and regulatory processes, where a mine's WUE status and/or rate of implementing water conservation or water demand management measures will be considered in the allocation or authorisation of water use or the restriction of water use during drought conditions. Furthermore, regulations that are applicable to the mining sector are in the process of being revised and will include regulations that address water conservation or water demand management within the mining sector.

The methodology that has been developed to allow for the implementation of water conservation or water demand management within the mining sector is shown in Figure 2.4 below.

There are clearly defined separate responsibilities and roles for the mining industry and for the regulator (DHSWS and/or other institutions).

Mining sector's responsibility

The responsibility of the mining sector is to compile accurate and computerised water balances in accordance with Best Practice Guideline G2 (DWAF, 2006b) and revised regulations, and to use these balances to develop a water conservation or water demand management plan using the procedures set out in this Water Conservation or Water Demand Management Implementation Guideline and the Best Practice Guideline H3 (DWAF 2006d). In order for water balances to meet this requirement, they need to be capable of being used as reliable simulation tools to simulate the effects of identified water

conservation or water demand management management options on the WUE indicators (other than for the most basic of water balances). This would generally exclude spreadsheet-based water balances. The balances also need to be dynamic, must consider seasonal effects, must be regularly updated with new data and must be used by mine personnel responsible for the day-to-day management of the mine's water systems.

The mine will endeavour to develop a water conservation or water demand management plan that enables it to set and achieve WUE targets that are well below the mine's current water conservation or water demand management situation or WUE benchmarks within a defined timeframe. For existing mines, the water conservation or water demand management plan will initially be submitted as an addendum to an existing IWWM Plan and will be integrated and incorporated into the mine's IWWM Plan when this Plan is updated. New mines will submit their first water conservation or water demand management plan as part of their first IWWM Plan. The mine will then implement its water conservation or water demand management plan and complete an initial submission of its water conservation or water demand management plan into an online SWAF and will then also submit an annual SWAF update in order to monitor performance against and report adherence with its water conservation or water demand management plan. It is also envisaged that the mine will substantially review and update its water conservation or water demand management plan every five years.

Where mines are unable to develop a water conservation or water demand management plan that brings their WUE status to a level below the national benchmarks, the mine will need to meet with the DHSWS to consult and reach agreement on the reasons for this inability. In future, DHSWS will give consideration to those mines that have progressed rapidly with the development and implementation of their water conservation or water demand management plans when WULs need to be reviewed, when allocating water to new applicants or when water restrictions need to be implemented.

DHSWS's responsibility

The responsibility of the DHSWS is firstly to develop a standardised water accounting framework and computerised online reporting system (the SWAF) that will ensure that all mines submit their water balance data to the DHSWS in a standardised format, allowing for online and standardised calculation and recording of the various WUE indicators and standardised ranking and assessment of a mine's water conservation or water demand management plan and its compliance with this plan.

Additionally, the DHSWS is in the process of amending the current Government Notice 704 regulations. These new regulations, once published, will also contain regulations on the development and nature of water balances and the need for the mines to develop water conservation or water demand management plans and submit relevant performance data into the SWAF.

The DHSWS, in consultation with the mining sector, will develop a standardised set of evaluation criterion to be used when reviewing water conservation or water demand management plans. These criteria will be incorporated into the online SWAF in order to ensure that the rating and ranking of mines with respect to the adequacy of their water conservation or water demand management plans and their WUE status will take place in a transparent and consistent manner. DHSWS officials will use the results of the rating and ranking system in a predetermined manner, in accordance with defined administrative procedures to facilitate decision making with regard to water use allocations and the imposition of differentiated water restrictions. The DHSWS (or catchment management agencies (CMAs), where these exist) will be able to access the SWAF rating and ranking results through the SWAF's pre-determined reporting outputs.

Where mines are unable to develop and implement a water conservation or water demand management plan that brings their WUE indicators to below the national benchmarks, the DHSWS will consult with such

mines to consider the motivations for such a suboptimal water conservation or water demand management plan and will then reach agreement with such mines on a case-by-case basis as to what would constitute an acceptable water conservation or water demand management plan. The DHSWS will also review the annual SWAF updates from the mines to determine that mines are on track with regard to their stated WUE targets that were included in the water conservation or water demand management plan and to follow up with the mine when targets are not met.

The DHSWS will also follow up with mines that do not submit water conservation or water demand management plans or that do not submit annual SWAF updates to establish the reasons for this and to agree on appropriate corrective actions.

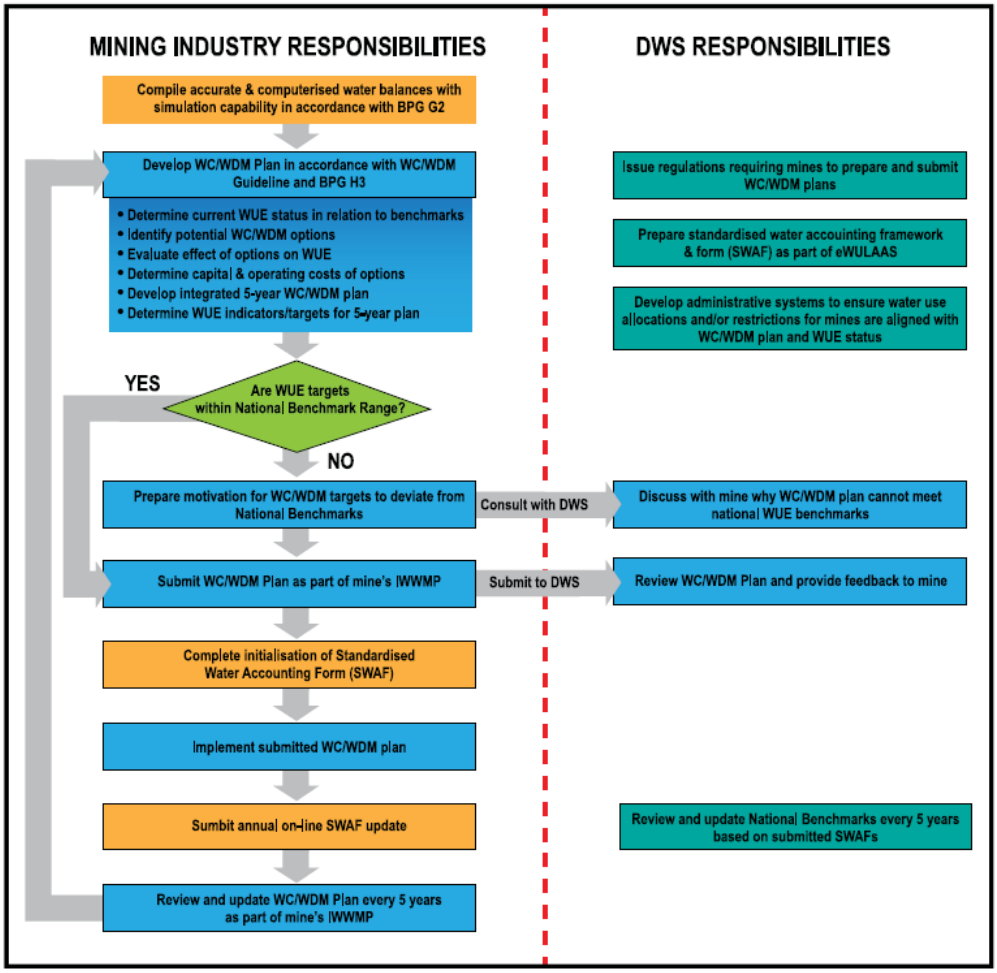

Figure 2.4: Implementation methodology for water conservation and water demand management in the mining sector (DWS, 2016b)

In future, it is envisaged that the DHSWS will utilise the SWAF rating and ranking results whenever the following decisions are made:

- Applications for water use licences, reviews or amendments
- Applications for additional water use: water use licence applications
- Water restrictions in times of drought
- Water reallocations to cater for demand changes in catchments: compulsory water use licencing processes

The intention is for mines that have progressed the furthest with regard to developing and implementing a comprehensive water conservation or water demand management plan, that are clearly adhering to their WUE targets, and who are performing well below the national WUE benchmarks to receive recognition in accordance with transparent decision-making criteria, compared to mines that are less water use efficient or are performing poorly with regard to the above criteria. The DHSWS will see such progressive mines as effectively managing their water security and reducing their risk during times of high water stress.

According to the water conservation or water demand management requirements, all possible measures should be taken to reduce use, reuse and recycle mine water. However, there is the provision to discharge excess water that cannot be accommodated within the mine's water balance, in compliance with regulatory discharge standards, to streams and rivers for downstream water users, provided that all external supply sources to the mine have been replaced.

Irrigation with mine water from operating mines may therefore be restricted to those sites that have exhausted reuse and recycling opportunities and continue to be water-positive according to their water balance, as an alternative to discharging to a river. The cost to treat the water to meet the often stringent in-stream water quality objectives could potentially be avoided through irrigation as an alternative.

2.7.2 Water conservation and water demand management in agriculture

The Water Conservation and Water Demand Management Strategy for the Agricultural Sector (DWAF 2004b) addresses water conservation and water demand management in agriculture. This document constitutes part of the section on agriculture in the National Water Conservation and Water Demand Management Strategy that is the basis of Chapter 3, Section 3 of the NWRS.

Being the largest water user in South Africa, a successful water conservation or water demand management drive in the agriculture sector is likely to make available significant quantities of water that could be used both within and outside the sector. Irrigation methods, irrigation scheduling, soil type, soil preparation and crop selection all have a significant impact on the efficient use of water in agriculture. The aim of the strategy is to promote the equitable and efficient use of water by providing a regulatory support and incentive framework. The strategy also seeks to promote the optimal use of water in order to release water for use by previously marginalised farmers and by other water use sectors. This is achieved through water allocation and compulsory licencing processes. The reuse of partially treated effluent water is fully encouraged in this strategy as a contribution to water conservation, and thus irrigation with untreated or partly treated mine water may be considered appropriate, provided it meets the other conditions of quality and licencing.

The strategy for the agricultural sector is aligned with the eight objectives of the NWC/WDMS framework of objectives, with eight strategic outputs for the agricultural sector linking to specific objectives as presented in Table 2.4 below.

Table 2.4: Strategic outputs from the agricultural sector and links to the NWC/WDMS framework of objectives

Output	Description of output	Link to objective
1.	To ensure that appropriate measures to influence the reduction in water wastage are implemented	2, 3 and 4
2.	To ensure that the WUAs and end users understand and appreciate the need to modernise their water conveyance systems and irrigation equipment progressively	2 and 3
3.	To ensure that water allocations promote the equitable and optimal utilisation of water	1
4.	To ensure that preventative maintenance programmes are in place	3 and 4

5.	To ensure that sufficient irrigation information is generated and is accessible to all stakeholders	3 and 4
6.	To ensure that the concepts of environmental awareness and protection are promoted and accepted by all stakeholders	3 and 4
7.	To ensure that accurate water management and service providers implement audits from the water source to end users and beyond	3 and 5
8.	To encourage water management and services institutions to use the latest technologies in water release and distribution systems	3 and 6

It is important to note the different operational boundaries for water resources management and water services (Figure 2.5). Water resources management is undertaken on a catchment basis, whereas water services are provided according to municipal demarcation.

This introduces complexity into the management of relationships between the CMA and the water services institutions (WSI). The CMAs are responsible for water resources management planning and implementation at a WMA level. This includes the entire scope of water conservation or water demand management. However, it is envisaged that a WSI will have a greater focus on demand management for domestic and industrial use within its area of jurisdiction. Each CMA will coordinate the activities of those WSIs falling within the WMA, possibly one or more bulk water suppliers and a number of WUAs.

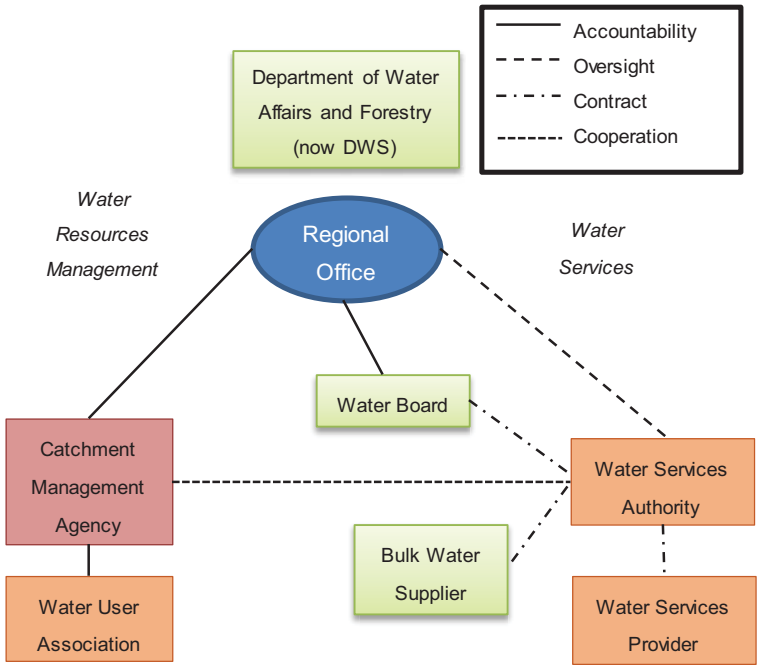

Figure 2.5: Roles of water sector institutions for water conservation or water demand management (adapted from DWAF, 2004b)

Specific activities associated with the outputs listed in Table 2.5 that may be involved in the use of alternative irrigation sources such as mine water, and the institutions responsible for these activities are presented in Table 2.5.

Table 2.5: Activities associated with the strategic outputs for the agricultural sector

Output	Activity	Responsible institutions
2. To ensure that the WUA and end users understand and appreciate the need to modernise their water conveyance systems and irrigation equipment progressively	Support ongoing research and development of new crop varieties that are water-efficient, high yielding and high valued to enable farmers to be competitive in the global marketplace.	DWAF, National Department of Agriculture (NDA), PDAs, WRC, CMA, WUA
	Use the latest water conveyance and irrigation technology that prevents unnecessary water wastage and minimises water losses.	CMA, WUA and farmer
	Develop models to assist in water management, crop water requirements, equipment selection and design.	DWAF, NDA, PDAs, WRC, CMA, WUA
	Practice irrigation scheduling based on crop water requirements to avoid under- and over-irrigation and the associated problems of salinisation and the destruction of irrigable land.	Farmer
	Select the irrigation system to suit the crops that are grown, as well as the scheme, water supply regime and farming practices.	WUA, farmer
	Ensure that pesticides, herbicides and fertilizers are applied optimally and only when needed to produce high-quality food and avoid the contamination of surface and groundwater resources. Ensure that the quality of the return flows from the irrigation area do not adversely affect the irrigators and other consumers downstream.	WUA, farmer
3. To ensure that water allocations promote the equitable and optimal utilisation of water	Use the water allocation process to promote water conservation or water demand management principles	DWAF, CMA
	The WUA must submit a water management plan in accordance with the Implementation Guidelines for Water Conservation or Water Demand Management in Agriculture: Development of Water Management Plans as part of its application for water licences.	CMA, WUA
4. To ensure that preventative maintenance programmes are put in place	Provide appropriate support services, where these are needed, in the planning and development of new irrigation schemes and the rehabilitation of existing schemes.	DWAF, CMA, NDA
5. To ensure that sufficient irrigation information is generated and is accessible to all stakeholders	Develop irrigation databases and make this information widely available.	DWAF, CMA, WUA, NDA
6. To ensure that the concepts of environmental awareness and protection are promoted and accepted by all stakeholders	Minimise return flows from irrigated fields. Minimise the pollution and degradation of surface and groundwater by the optimal application of pesticides, herbicides and fertilizers.	Farmers, NDA, PDAs
	Monitor and measure water quality upstream and downstream of the irrigation areas to protect the aquatic ecosystem and downstream users. Apply the “polluter pays principle” to encourage compliance with the regulations/rules.	CMA, WUA
7. To ensure that accurate water management and service providers implement audits	Install accurate and reliable measuring devices to determine water balances.	CMA, WUA, NDA

Output	Activity	Responsible institutions
from the water source to end users and beyond		

Those water users who do not belong to a WUA and who apply for a licence to use water will be required to develop and submit a Water Management Plan to the responsible authority that complies with the Implementation Guidelines for Water Conservation and Demand Management in Agriculture: Development of Water Management Plans, and water users who are members of a WUA and who apply for a licence to use water will be required to adopt and implement the Water Management Plan developed by their WUA.

CHAPTER 3: CONSIDERATIONS FOR APPLICANT PRIOR TO ENGAGING IN THE WATER USE LICENCING PROCESS

3.1 OPTIMISE PLAN FOR WATER RE-USE AND RECLAMATION

The basis of IWWM at mines is the Best Practice Guidelines, which define and document best practice for water and waste management, developed by DHSWS (previously DWAF).

These documents are based on a precautionary principle, as described in Section 2.5.6.1 above, and set the following order of priority for mine water and waste management decisions and/or actions (Best Practice Guideline H3):

- Prevent or minimise the pollution or contamination of water used by implementing the necessary management measures or strategies
- Reuse or reclaim contaminated water in cases where complete pollution prevention was not possible (water use inventory)
- Treat water that cannot be reused or reclaimed
- Reuse treated water
- Discharge or dispose of excess water

Therefore, all mines are required to optimise a WRRP, which should form part of a larger IWWM Plan. This WRRP or IWWM Plan can form the basis for the WUL application and should be compiled with the following four key considerations in mind:

- Prevention/minimisation of pollution (Step 1 in Best Practice Guideline H3)
- Conservation of water
- Adequate water quality (fit for use)
- Sustainability over the life cycle of the mine.

An IWWM Plan should contain the following:

- A detailed water and salt balance for the mine (Best Practice Guideline G2) and projections for mine closure and post-mine closure. Both direct and indirect water uses.
- Plans to limit evaporative losses from evaporative cooling systems
- How seepage or overflow losses will be minimised
- Optimised water use with water that is “fit for purpose” and the implementation of monitoring to verify performance

This is an interative process, and the IWWM Plan is expected to be reviewed and changed regularly, depending on new information from the monitoring plan and/or technology that may become available.

Note that there is no legal or regulatory obligation for a mine to produce a WRRP unless this is stipulated in the licence conditions of the mine (section 41(2)(a) of the NWA). This appears to be a shortcoming in the legislation and it is therefore recommended that the licence conditions always include the development of a WRRP by the mine. Currently, the only legally required documents associated with water reuse and reclamation and IWWM are the EMPr) and water use licences/authorisations.

Determining accurate and credible water balances at mines has been found to be problematic and many mines do not have such data. It is therefore very difficult for most mines to address water conservation and water demand management within their operations.

When a mine a facing closure, the excess water quantity (decant) and quality should be determined through the various monitoring programmes already in place, and the best option to handle the excess water should be investigated. The Water Reuse and Reclamation Guidelines (Best Practice Guideline H3) do not apply to mines that have already closed. There are three basic options:

- Treatment and discharge
- Irrigation with decant water
- Sustainable development projects

Of importance during mine closure is the financial and contractual agreements with the future owners and/or responsible parties to ensure maintenance and monitoring of the required infrastructure and water.

In the case of indirect uses, reuse needs to be consistent with the water resource management plan for the river basin or catchment (e.g. resource water quality objectives) and must consider downstream water rights, water use and user requirements.

It is in the best interest of the mine, as well as future users of the water, to aim to use water with the minimum amount of treatment required. Reuse of water must be considered carefully in order to meet health and environmental requirements, and fitness for purpose to ensure sustainability.

3.2 DETERMINING FITNESS FOR USE OR ESTABLISHING WATER QUALITY REQUIREMENTS

The suitability of the soil for irrigation hinges on whether the soil will be sustainably sufficiently drained to prevent waterlogging and salinisation. Salinisation is the build-up of salt in the soil. Excessive amounts of salt in the soil increases the energy that is needed to be exerted by a plant to extract water from the soil (osmotic pressure). Under irrigation, large amounts of salt are deposited in the soil. Through the processes of evaporation and transpiration, the water is extracted from the soil, while the salt remains behind. If these processes carry on for several seasons, the salt build-up can be so severe that no plants can grow in the soil. The salt build-up can be negated by washing the salts from the soil, either in excessive rainfall seasons or through over-irrigation. However, a prerequisite for this to occur is, of course, that the soil must be well drained.

The primary tool used to determine fitness for use or establishing water quality requirements for the irrigation of mine water is the software-based DSS to provide generic and site-specific risk-based irrigation water quality guidelines for South Africa (Du Plessis et al., 2017), which is discussed in detail in Section 2.6.2 above. This software provides a three-tiered model to estimate the impact of mine water irrigation on the crop, soil and groundwater, based on some basic information.

Tier 1 relies on minimal user-defined input and provides a baseline conservative water quality assessment, which highlights potential problems. This tier is designed to provide a rapid conservative

irrigation water quality assessment based on four different levels (ideal, acceptable, tolerable and unacceptable). Should any problems be highlighted in Tier 1, a second-tier assessment is required.

The second tier includes site-specific variables, which allow the user to conduct a more in-depth water quality assessment using a simplified version of the dynamic SWB model to determine crop growth, soil-water balance and chemistry interactions. This allows the user to try different management options (such as different crops or soil, or irrigation management strategies) to reduce or overcome the problems that were associated with this mine water irrigation. If the modelling procedures or management options provided in Tier 2 are insufficient, a Tier 3 evaluation is required.

Tier 3 is for higher-level investigations, which may use modules of the DSS and other resources on an ad-hoc basis and is more specialised in nature. It does not form part of the standard DSS, although some guidance is provided, where required.

The DSS assesses the fitness of water for irrigation, may be used to set water quality requirements for irrigation users or can be used to assist with obtaining any additional information, as may be required to determine suitability for irrigation. It should be the mandatory procedure to determine suitability for mine water irrigation.

3.3 ENGAGEMENT WITH THE DEPARTMENT OF AGRICULTURE, LAND REFORM AND RURAL DEVELOPMENT, AND THE DEPARTMENT OF ENVIRONMENTAL AFFAIRS, FORESTRY AND FISHERIES

If the mine plans to irrigate the excess water as the means for beneficial use, there must first be approval from both the DALRRD and the DEFF. The DSS will indicate the suitability of the soil and water quality for crop irrigation.

3.3.1 DALRRD requirements

The CARA and its regulations impose certain duties on the so-called “land users”. A “land user”, as defined by the CARA, means the following:

“…the owner of land, and includes –

(a) any person who has a personal or real right in respect of any land in his capacity as fiduciary, fideicommissary, servitude holder, possessor, lessee or occupier, irrespective of whether he resides thereon;

(b) any person who has the right to cut trees or wood on land or to remove trees, wood or other organic material from land; and

(c) in relation to land under the control of a local authority, that local authority, ***but not a person who carries on prospecting or mining activities****.”*

The CARA is therefore not applicable to mining operations. However, it will be applicable in the case of non-mining land (i.e. agricultural land).

Before land can be cultivated, a ploughing certificate is required from DALRRD. If the land intended to be irrigated with mine water is privately owned, already being cultivated, and has been ploughed in the past 10 years, the existing ploughing certificate will remain in place, with only a requirement for a change in the WUL in terms of the water use. If, however, the land is virgin land, i.e. it has never been cultivated, or has not been ploughed within the past 10 years, then written permission is required from DALRRD. The relevant regulations of the CARA, Regulation 2: Cultivation of Virgin Soil, and Regulation 3: Cultivation of Land with Slope, will apply.

Regulation 2: Cultivation of Virgin Soil

> No land user shall cultivate any virgin soil except on authority of a written permission by the executive officer. An application for a permission to do so shall be made on a form obtainable from an extension office for this purpose. Such application form shall be completed by the land user of the farm unit on which such virgin soil is situated and shall be lodged at the extension office for the area within which the farm unit concerned is situated at least three months prior to the intended date of cultivation.
>
> An officer may, for the purposes of an investigation deemed necessary to consider such application, direct a land user to dig such soil profile pits as such officer may determine and to take such other steps as that officer may determine.

Regulation 3: Cultivation of Land with Slope

> Except on authority of a written permission by the executive officer, no land user shall cultivate any land if it has a slope of more than 20%, or has a slope of more than 12%, is situated in a restricted area, restricted soil form or series or has any restricted physical properties as specified in the Regulations.

If the South African Council for Natural Scientific Professionals (SACNASP) soil scientist deems the area suitable for irrigation, and the area complies with the requirements for slope, then DALRRD issues a ploughing certificate. The ploughing certificate is issued for a specific area, and cannot be transferred from one site to another.

A Soil Suitability Report for irrigation from DALRRD is a prerequisite for a WUL application in terms of section 21(a): Taking water from a water resource. Irrigation field and crop details (submitted in Form DW 787), are required for both section 21(a) and section 21(e): Engaging in a controlled activity applications.

3.3.2 Department of Environment, Forestry and Fisheries requirements

When clearing the natural vegetation of an area larger than 1 ha, DEFF's approval is required. Approval can only be granted following an EIA, according to the Environmental Impact Assessment Regulations (Government Notice 982 of 2014, as amended in 2017) in terms of NEMA. If the area is smaller than 20 ha, a basic EIA is required, while areas larger than 20 ha require a full EIA. These assessments require a public participation process, done by an environmental assessment practitioner (EAP), as well as specialist studies, conducted by SACNASP-registered scientists in the respective fields. Normally, the specialist studies include a soil assessment (already included in the ploughing certificate), an ecological assessment and a heritage assessment. When the source of irrigation water is a borehole (or in the case of mines, pumping from a groundwater resource), a geohydrological study is also required. Additionally, the EAP must acquire additional specialist studies if the situation demands it.

In contrast to the ploughing certificate, an EIA is either approved or declined. Therefore, it is wise to follow the EAP's recommendation to exclude certain areas if so required. Even though the EIA takes much longer than the ploughing certificate, it is recommended that the soil investigation is done first. The reason is that soil is often the definitive factor, which determines whether the licence will be approved or not. The EIA process can be initiated at the same time as the WUL application, and the processes can run in parallel, as discussed in Chapter 4 below.

Until recently, CARA specified the assessment and monitoring requirements in terms of alien and invasive species. In its original form, CARA listed 46 weeds (invaders of cultivated or waste lands) and 35 invasive exotic species (invaders of natural or semi-natural habitats). It was specifically enacted to manage the impact of alien and invasive species on the agricultural sector. In 2001, the Act was amended to facilitate the regulation of the impacts of alien and invasive species on biodiversity conservation, and a new single list of 198 invasive alien plant species was developed.

In 2004, NEMBA was enacted. Chapter 5 of NEMBA deals directly with invasive alien species. The Invasive Alien Species Regulations were promulgated in 2014. The regulations list 379 alien and invasive species, which must be controlled and may not be imported, propagated, moved or sold. The NEMBA regulations list four categories that require control: Category 1a includes emerging invasive alien plants that require immediate compulsory control or eradication. Category 1b includes the most widespread and problematic species, which require control, and landowners must adhere to any associated management plans. Category 2 includes species that require permits for cultivation. Category 3 includes species that require control within riparian areas.

CHAPTER 4: THE WATER USE LICENCE APPLICATION PROCESS

The content of the WUL application has been informed by various guidelines, but was standardised in March 2017 with the promulgation of the Water Use Licence Application and Appeals Regulations, Government Notice R267. The purpose of these regulations is to prescribe the procedure and requirements for WUL applications as contemplated in section 41 of the Act, as well as an appeal in terms of section 41(6) of the Act, which aims to facilitate the WUL application review process. Appendix A of the regulations, presented in Table 4.1 below, presents the steps involved in a WUL process, and a summary of the time frames for receiving and processing a WUL application.

Table 4.1: Time frames for receiving a water use licence application and steps in processing it

Regulation	Steps in processing of WUL applications	Maximum days allocated	Cumulative days	Responsible person
0	Pre-application enquiry	0	0	Applicant/ responsible authority
1	Application submitted	1	1	Applicant
2	Responsible authority acknowledges receipt of the application	10	11	Responsible authority
3	Applicant confirms arrangements for site inspection with an allocated case officer	5	16	Applicant
4	Site inspection to confirm water uses, determine information requirements and the need for public participation	20	36	Applicant/ responsible authority
5	Confirm requirements for WUL application technical report based on site visit and meeting	5	41	Responsible authority
6	Compilation, consultation and submission of WUL application technical report by applicant	105	146	Applicant
7	Reject/accept WUL application technical report	10	156	Responsible authority
8	Assessment	139	295	Responsible authority/ applicant

9	Decision and communication to applicant	5	300	Responsible authority

The inclusion of a 300-day WUL application time frame in Regulation R267 aligns WUL applications with the EIA and EMPr processes that are required for the environmental authorisation of mines. The alignment of the WUL application and EIA/EMPr processes is schematically presented in Figure 4.1.

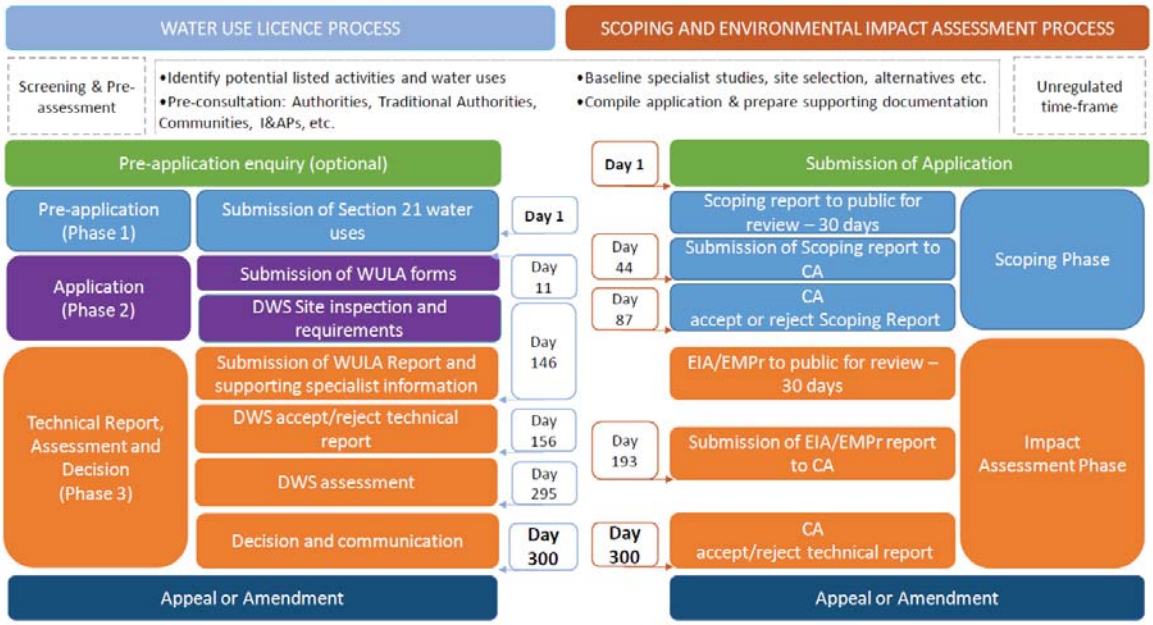

Figure 4.1: Alignment of the 300-day water use licence application and EIA/EMPr processes

Each WUL issued contains the following:

- A general set of conditions applied to all WULs issued
- Site-specific conditions based on the information provided in the WUL application, the outcome of any engagement between the applicant and DHSWS during the WUL application review process and the DHSWS management objectives for the catchment in which the mine falls
- Quality and quantity limits for the authorised section 21 water uses. Water quality limits may also apply for the surface and groundwater resources in the mine area.

An online WUL application submission system, known as the Electronic Water Use Licence Application and Authorisation System, was launched in several catchments in 2017 to support the 300-day process, and follows the three phases indicated in Figure 4.1.

Objectives of the e-WULAAS are twofold (DWS, 2017): firstly, to provide an online portal to DHSWS clients to register and subsequently submit their water uses alongside the current paper-based system, and secondly the system will provide an internal web-based interface for the authorisation staff to manage, coordinate, track and finalise the authorisation processes of registered water uses, culminating in the issuing of a WUL.

In his State of the Nation Address on 23 February 2020, President Cyril Ramaphosa made a declaration that water use licences should be finalised within 90 days, with effect from 1 April 2020. While this change has not yet been gazetted, since the President's declaration, the DHSWS has revised the process to ensure that the WUL application is finalised within 90 days, including pre-application engagement with the applicant, compilation of the required technical reports and public participation. The Department will assess the application, which can be rejected if it is incomplete, or accepted if the

required information is complete. When all the information required is made available, the accepted applications are assessed and a decision should made within 82 days. The final step, which lasts for four days, comprises post-administration of the decision (a letter of rejection of the application or the issuing of a licence) and communication to the applicant. It remains vital that the licences issued in this 90-day process will still serve the purpose of protecting our water resources. This means that the licence cannot be too generic, but should be specific to the activity or operation being authorised, and should take the specific catchment requirements into account.

4.1 PRE-APPLICATION PHASE

Once the mine has established that excess water is available, which cannot be reused internally, and it has exhausted all other water management options, the mine may approach DHSWS for a licence to discharge or dispose of the excess water. Any other alternative uses should already have been identified and evaluated prior to the application for a WUL. This may include use by neighbouring industries or small, medium and micro enterprises (SMMEs) or beneficial use for irrigation, as is the focus here.The application process is initiated by the person or entity that is planning to use the water as defined in section 21 of the NWA. A process flow diagram guiding the pre-application activities is presented in Figure 4.2.

During the pre-application enquiry meeting, the responsible authority must advise the applicant on the procedural requirements and required documents for a WUL, the type of WUL required, the information required and the technical report for the proposed WUL.The water uses proposed by the applicant will dictate the type or types of authorisation required, as well as the approach that should be followed when applying for a WUL. For mine water irrigation specifically, this will – in most cases – involve appications in terms of section 21(a): taking water from a resource, section 21(e): engaging in a controlled activity, section 21(g): disposing of waste in a manner that may detrimentally impact on a water resource and section 21(j): if the water is abstracted from underground. This pre-application consultation with DHSWS is a key step in aligning the environmental authorisation processes (EIA/EMPr) to ensure cooperative governance. The WUL application is dependent on the proposed water use activity.

The applicant can submit their application at any time after the pre-application enquiry meeting.

The Directorate of Resource Protection and Waste is mandated to facilitate this process where mining and the use of mine water is indicated.

Some of the key questions that will be asked in the pre-application consultation include the following:

- **Is there enough water?**
  The DHSWS requests a reserve determination for the licence assessment (where required) and the Chief Directorate: Resource Directed Measures advises the applicant on the water availability (volume). The water quantity requirement is assessed based on the outcomes of the SAPWAT assessment.
- **What will the water be used for?**
  - Depending on the proposed uses of the water provided by the applicant, the DHSWS official will determine which sections of the NWA are applicable for this application.
  - The DHSWS official should advise the applicant on any additional investigations, consultations or other information required.
  - The DHSWS official should advise the applicant on any other legal requirements (environmental or agricultural authorisations) to be met, e.g. environmental and agricultural authorisations;
- **What are the risks?** Waste discharge-related water uses in terms of sections 21(e), 21(f), 21(g) and 21(h) will be subject to a risk-based approach. If the planned water use includes more than

one single use (e.g. irrigation and discharge to resource and removal of underground water), then an integrated WUL application, which includes non-waste discharge (which will apply to mine waters (sections 21(a), 21(b), 21(c), 21(i) and 21 (k)), and waste discharge-related water uses in a single application, then a risk assessment must be undertaken for all the uses.

- **Determine and confirm the risk classification of the activity**
- **Determine investigations required to provide sufficient information on the water use application**

The risk of the activity is determined by defining the hazard class of the activity in combination with the sensitivity of the water resource where the water use activity will take place.

The internal guideline for WUL applications requires the DHSWS representative to follow the protocol in Figure 4.2 to categorise risk during the pre-application process.

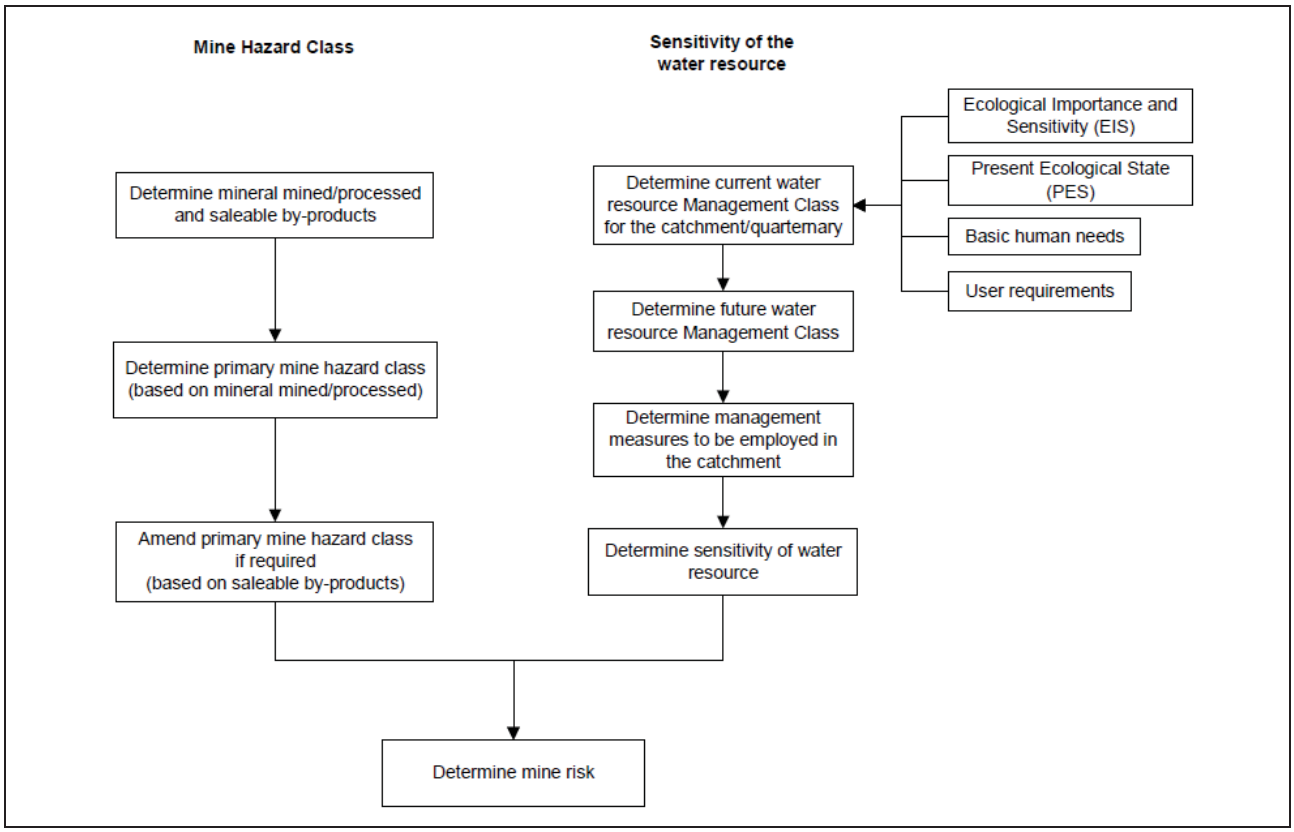

Figure 4.2: Process flow diagram for risk categorisation in mining

From this flow diagram, the following information should be obtained from the mine:

- Identify the primary mine hazard class based on either the type of mineral mined or processed or the mineral related to quarrying
- Identify what saleable by-products (if any) are produced
- Adapt primary risk class if required
- It should be noted that the list of water use guidelines provided to the DHSWS includes guidelines for the utilisation and disposal of treated sewage effluent (Table 5.8 of the internal guideline) and that there are no guidelines for the disposal of mine water or mine water waste products.

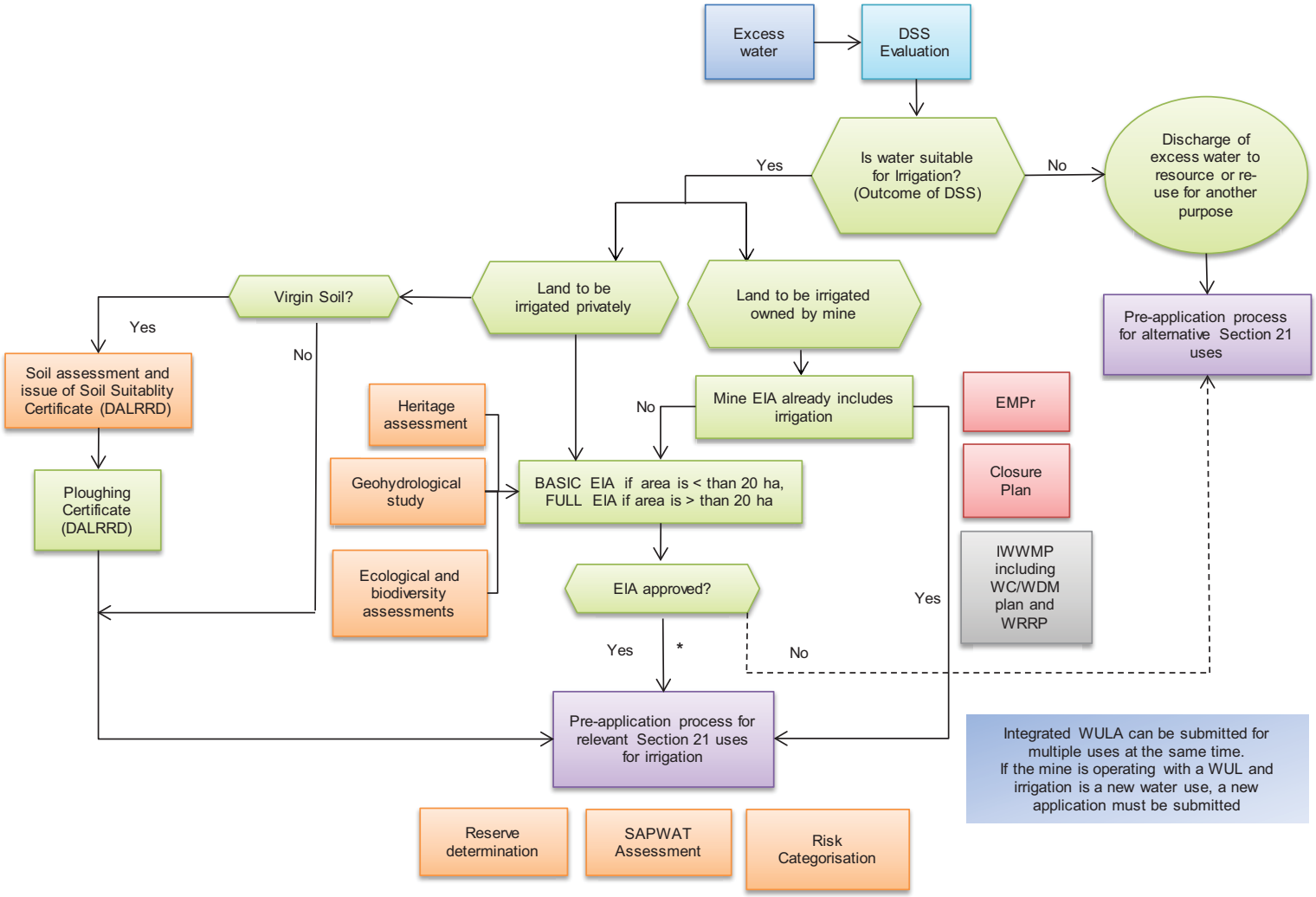

Figure 4.3: Process to inform the pre-application phase when the intention is irrigation with mine water as a beneficial use

4.2 APPLICATION SUBMISSION AND INFORMATION GATHERING

4.2.1 Submission of WUL application forms

This step in the process requires the user to complete all the documentation, including the DHSWS water use application form, and to conduct the necessary specialist studies, as identified in the pre-consultation phase. In accordance with the WUL regulations, the following forms are required for applications under sections 21(a), 21(e), 21(g) and 21(j):

Forms and supporting documents required for applications in terms of section 21(a): Taking water from a water resource:

- Taking Water from a Water Resource Form (DW 773)
- Pump Technical Data Form (DW 784)
- Canal Technical Data Form (DW 786)
- Irrigation Field and Crop Details (DW 787)
- Supplementary Information: Power Generation, Industrial or Mining (DW 788)
- Supplementary Information: Domestic, Urban, Commercial or Industrial (DW 789)
- Soil Suitability Report (for irrigation from the Department of Agriculture)
- Supporting documents:
  - Agriculture Business Plan (if the purpose of taking water from a water resource is for irrigation or animal production)
  - Integrated Mine Water Management Plan

Forms required for applications in terms of section 21(e): Engaging in a controlled activity

- Engaging in a Controlled Activity Form (DW 765)
- Monitored Waste Discharge Details Form (DW 904)
- Irrigation Field and Crop Details (DW 787)
- Supporting documents:
  - Integrated Mine Water Management Plan
  - Geohydrological Report

Forms required for application in terms of section 21(g): Disposing of waste in a manner that may detrimentally impact on a water resource:

- Submit the following technical reports with supporting appendices if the purpose of disposing of waste in a manner that may detrimentally impact on a water resource is for the following:
  - Integrated Water and Wastewater Management Plan if the purpose is for disposing waste or water after treatment in a water works from industry or mining use
  - Geohydrological Report if the purpose is for discharging waste or water after treatment in a water works that affects groundwater.

Forms required for application in terms of Section 21(j): Removing, discharging or disposing of water found underground:

- 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 (Form DW 780)
- Supporting documents:
  - Integrated Water and Wastewater Management Plan

All supporting documentation that has already been collected during the pre-application consultation phase and reports prepared during the information-gathering phase (see Appendix C) (soil suitability report, EIA reports or applications, geo-hydrological studies, etc.) or any other such documents as may be required by the responsible authority during or after the pre-consultation meeting should be submitted with the application forms above. The applicant will also be expected to submit all designs and plans, together with the mine's Integrated Water and Wastewater Management Plan, mine closure and rehabilitation plan, and water quality results for the water to be used. If an applicant intends applying for a multiple WUL within the same catchment area, the responsible authority may consolidate the water use applications into one integrated application.

All costs associated with any of the required studies (geohydrology, EIA, water quality analysis) are to be paid by the applicant.

Upon receipt of an application, the responsible authority must issue the applicant with a receipt as proof of application, and must evaluate whether the application has been properly completed and is accompanied by the relevant documents, and has taken any minimum information required for the application into account, as well as instructions or guidance provided to the applicant by the responsible authority.

The responsible authority must, in writing, and within 10 days of receipt of an application, either accept or reject the application. A rejection letter of an application must provide adequate reasons for the rejection.

4.2.2 Site inspection

Where an application necessitates a site inspection, the applicant must, within five days of receipt of an acceptance letter, confirm arrangements for the site inspection with a case officer. The site inspection can take the form of a meeting between the applicant and the responsible authority, or a meeting between the applicant, the responsible authority and other relevant stakeholders. Following the site inspection, the responsible authority shall inform the applicant, in writing, of the information required to compile a technical report for a WUL application within five days of the site inspection. The site inspection process must be concluded within a period of 30 days of acceptance of an application. Failure by the applicant to confirm a date for the site inspection and to make himself or herself available on the agreed date will result in the responsible authority rejecting the application.

4.3 TECHNICAL REPORT, ASSESSMENT AND DECISION

4.3.1 Submission of technical report on the WUL application

The applicant must, within a period of 105 days of the date of being informed of the required information for the compilation of a technical report on the WUL application, submit such a report to the responsible authority, including any relevant specialist reports as set out in Annexure D of the regulations.

Failure to submit the required WUL application technical report within the stipulated time frame will result in the rejection of the application. Where the application is rejected, the responsible authority must notify the applicant and any other interested and relevant institutions.

4.3.2 Assessment of technical report on the WUL application

The technical report on the WUL application shall be subjected to an evaluation to check whether it meets the formal requirements of these regulations. The responsible authority must, within 10 days of receipt of the technical report on the WUL application, either accept the technical report on the WUL application if the report meets the formal requirements of these regulations, or reject the application in writing if the report does not meet the formal requirements of these regulations. The written rejection must state the reasons for its rejection.

If the technical report on the WUL application meets the requirements of these regulations, the responsible authority shall proceed with the technical assessment, which shall be finalised within 139 days.

The responsible authority may request written comments from relevant competent authorities or state departments before making a decision on WUL applications. The responsible authority may invite the applicant to present their specialist reports.

4.3.3 Consideration of and decision on a WUL application

A WUL application shall be considered and finalised within 144 days from the date of acceptance of the technical report on the WUL application, and in accordance with the processes stipulated in Annexure A of the regulations.

4.3.4 Appeals arising from the integrated WUL applications

An applicant or a person who objected to an application and who is aggrieved by a decision of the responsible authority on a WUL application arising from the integrated process contemplated in section 41(5) of the Act may lodge an appeal to the Minister. Any other appeal must be lodged and dealt with in accordance with section 148 of the Act.

4.4 IMPLEMENTATION OF WATER USE LICENCING AND MONITORING REQUIREMENTS FOR ONGOING IRRIGATION

4.4.1 Water use licence-mandated monitoring

The implementation process will include ongoing monitoring of the process and quality of the effluent, as well as implementation of the water management plan and water conservation practices. These monitoring requirements will likely be site-specific and depend on the potential perceived risks associated with the site-specific conditions and water quality.

Over time, there has been a greater emphasis of WUL conditions on resource quality, which encompasses the following:

- Quantity: assurance of instream flow
- Quality: physical, chemical and biological
- Instream and riparian habitat
- Aquatic biota

In order to fully comply with the resource quality-related conditions in a WUL, mines are required to extend managing water and water containing waste generated and consumed on site to managing the riparian zone and underlying aquifers, and all influences on these as stipulated in the WUL.

4.4.2 Monitoring requirements according to the CARA Regulations

Where the land under irrigation is privately owned farmland, the CARA Regulations will be applicable to the monitoring and maintenance of the ploughing certificate, and the landowner is responsible for this monitoring, although DALRRD will conduct audits to determine compliance with the regulations.

The following regulations will apply:

Regulations 4 and 5: Protection of cultivated land against erosion through the action of water and wind

Every land user shall, by means of as many measures described in the regulations as are necessary in his situation, protect the cultivated land on his farm unit effectively against excessive soil loss as a result of erosion through the action of water and wind.

If the executive officer is satisfied that the measures applied by a land user in a particular case are not sufficient to protect cultivated land effectively against excessive soil loss as a result of erosion through the action of water and wind, he may direct such land user, in writing, to apply such additional measures as the executive officer may determine.

Regulation 6: Prevention of waterlogging and salination of irrigated land

Every land user shall, by means of as many of the measures described in the regulations as are necessary in his situation, protect the irrigated land on his farm unit effectively against waterlogging and salination.

If the executive officer is satisfied that the measures applied by a land user in a particular case are not sufficient to protect irrigated land effectively against waterlogging or salination, he may direct such land user, in writing, to apply such addition measures as the executive officer may determine.

Regulation 7: Protection of wetlands and water courses

Subject to the provisions of the NWA, no land user shall utilise the vegetation in a vlei, marsh or water sponge or within the flood area of a water course or within 10 m horizontally outside such a flood area in a manner that causes or may cause the deterioration of or damage to the natural agricultural resources. Every land user shall remove the vegetation in a water course on his farm unit to such an extent that it will not constitute an obstruction during a flood that could cause excessive soil loss as a result of erosion through the action of water. Except on authority of written permission by the executive officer, no land user shall drain or cultivate any vlei, marsh or water sponge, or a portion thereof on his farm unit, or cultivate any land on his farm unit within the flood area of a water course or within 10 m horizontally outside the flood area of a water course.

While CARA does not apply to mine-owned land, it is strongly recommended that the monitoring requirements for rehabilitated mine land being cultivated under mine water irrigation should also be guided by these regulations, as the WUL monitoring requirements typically only deal with water quality impacts and do not address potential soil impacts.

4.4.3 Biodiversity monitoring

Ongoing assessment of biodiversity will be required in accordance with NEMBA according to the alien and invasive species regulations and lists, and threatened or protected species regulations and lists.

CHAPTER 5: CHALLENGES EXPERIENCED BY APPLICANTS AND AUTHORITIES

While the current legislative framework as defined in this document allows for the authorisation of mine water irrigation as a water use, the following challenges were highlighted in the study relating to the legislative framework and the application process itself:

- There is no legal or regulatory obligation for a mine to produce a Water Reuse and Reclamation Plan unless this is stipulated in the licence conditions of the mine (section 41(2)(a) of the NWA). This appears to be a shortcoming in the legislation and it is therefore recommended that the licence conditions always include the development of a WRRP by the mine. Currently, the only legally required documents associated with water reuse and reclamation and IWWM are the EMPr and water use licences or authorisations.
- In the current legislations (NEMA, MPRDA and NWA), it is worth noting that mine water management is not formally defined. This may continue to hinder the process of dealing with mine water management decisively. These policy principles may require legislative review or policy alignment.
- The development of accurate and credible water balances at mines has been found to be problematic and many mines do not have such data. It is therefore very difficult for most mines to address water conservation or water demand management within their operations, and – as such – it is difficult to define when there is an actual surplus of water that could be beneficially used as irrigation water.
- The list of water use guidelines provided to the DHSWS includes guidelines for the utilisation and disposal of treated sewage effluent. There are no specific guidelines for the utilisation of mine water or mine water waste products.
- There is a perception that mine water for irrigation is not a use that would be authorised in a WUL authorisation. Consultation with DHSWS has indicated that this is not the case, and, in fact, beneficial use of mine water is encouraged under the right circumstances. Irrigation with mine water should therefore be identified as a potential water use when planning new mines, as well as when developing the mine's EMPr and closure plans.
- Capacity within departments is limited, which makes it difficult to adhere to the timelines as legislated for the adjudication and authorisation of applications.

CHAPTER 6: DEVELOPMENT OF THE MINE WATER MANAGEMENT POLICY

There is a need to rationalise and align national legislation, to remove ambiguity and address mine water directly. Given the challenges noted above, it is prudent that the DHSWS formulates a policy principle to support its response to mine water challenges. An Interministerial Committee (IMC), originally comprising the ministers of Mineral Resources and Energy, Water and Environmental Affairs, Science and Technology, and the Minister in the Presidency: National Planning Commission, was established to develop a Mine Water Management Policy (MWMP). The draft proposal was approved by Cabinet in 2017 and later gazetted by the DWS (now the DHSWS) in July 2017 as Government Notice No. 658, allowing a 60-day period for public comment. This MWMP has not yet been promulgated.

The MWMP is aimed at ensuring improved water quality management and a reduction of water pollution, strengthening the protection of water resources from mine water contamination from the short to the long term, and providing a basis for holding parties potentially liable for negative effects and damages through pollution with mine-impacted water. The principles of the MWMP aim to strengthen the protection of water resources from mine water contamination from the short to the long term, with a focus on improving mine closure management. The policy principles are informed by the current legislative framework on water resource management, and further propose an integrated departmental approach to mine water management. Where legislative gaps exist, this policy provides relevant and appropriate legislative remedy to strengthen a proactive mine water management approach.

Section 5.9 of the draft MWMP deals with the reuse of treated mine water, including acid mine drainage. In this section, the focus is on the treatment of mine water to alleviate water shortage by treating water for drinking purposes through desalination for supply into municipal networks. Consideration should also be given to the use of water that is fit for purpose, or treated as little as possible to be so, such as irrigation with gypsiferous mine water, which may require very little or no treatment.

The draft MWMP calls for the formalisation of a Mine Water Management Unit in the Department of Human Settlements, Water and Sanitation, which will accomplish an integrated and composite approach, ensuring the efficient coordination of all mine water management-related initiatives and activities within the Department and among all other departments and institutions.

Government's responsibility with respect to the handling and management of mine water is ambiguous and, as a result, roles and responsibilities require clarification, which will have potential policy and law review implications. The draft MWMP recommends a new Trilateral Memorandum of Understanding that will include the three departments – DHSWS, DMRE and DEFF – through which the regional mine closure plan must be developed.

The legislative amendments should be considered for incorporation into a National Mine Water Strategy, with the aim of enabling government to have enhanced control and legal administration of the mine water challenges and issues and to further give more clarity on responsibilities and obligations. This should not only apply after mine closure, but should also enable government to apply regulatory provisions and mines to implement proactive steps long before mine closure. Roles and responsibilities must indicate clear and specific agreements on the process of mine closure, even prior to actual mining.

CHAPTER 7: CONCLUSION

The beneficial reuse of treated mine-impacted water is not currently a priority in South Africa. Although the discharge of effluent to water resources should be the option of last resort, it is often the first choice of many in the mining industry and industry as a whole, due to its simplicity and low cost. Unfortunately, the discharge option in many instances requires the use of high-quality water to dilute the treated effluent to within allowable discharge limits. In addition, many activities are using high-quality or potable water unnecessarily.

Agriculture currently and unnecessarily makes use of the majority of South Africa's high-quality water resources for the irrigation of crops (food, forage or energy crops). The beneficial use of mine water for crop irrigation confers a number of notable advantages. Gypsiferous mine water may require no treatment or a low level of treatment prior to reuse in irrigation, resulting in substantial treatment cost savings: a potential 87 and 78% reduction in capital and running costs, respectively. Large portions of irrigated land are located near sources of mine water, which would limit the collection and distribution costs if mine water were utilised. The treatment and reuse of mine water could operate as a single financial initiative, with income from the mine water-irrigated crops funding the mine water treatment and/or creating jobs and food security for the local community. The availability of water for irrigation may serve to drive the impetus that mine rehabilitation should serve to return mined land to a state where viable economic enterprises can be incentivised to stimulate job creation and economic reactivation, not merely to return the land to a state of stability to ensure no net environmental impact, or to achieve a state that will meet the satisfaction of the DMRE. The creation of bioenergy crop farms on rehabilitated mine land, for example, will result in opportunities to employ and upskill people, thereby justifying the use of such land as a viable investment. This would further open the door for emerging commercial farmers. Irrigation with mine water on conventional agricultural land is expected to be more difficult than with low-salinity water, and rehabilitated land even more so due to the challenges associated with disturbed geology and poor top soil quality and depth. Emerging commercial farmers should be supported with training and mentorship to increase the potential success of such projects.

The treatment and reuse of mine water in crop irrigation would relieve the environmental and health liabilities of the mines that produce mine water, while simultaneously stimulating agriculture in the vicinity, and would make more high-quality or potable water available for more pressing needs. This option fits well within the WEF nexus, which is becoming increasingly prominent on the international agenda, and continues to focus on collaborative initiatives to solve the numerous limitations surrounding water, energy and food provision to a growing global population.

The legislation and supporting guidelines relating to water reuse in South Africa exist and are readily accessible. However, they tend to be contradictory and confusing in many cases, which may have had the unintended consequence of negatively affecting the consideration of mine water as an agricultural resource in the past. While the existing legislative framework has some challenges, this guideline has illustrated that the framework allows for the beneficial use of mine water for irrigation under the right conditions. Tools such as the DSS allow a thorough assessment of the fitness for use and water quality indicator, which, when combined with soil suitability testing and the rigorous specialist studies that accompany the required EIA process, support the licencing of mine water irrigation as a water use under the relevant section 21 uses of the NWA, thus enabling the authorisation of the WUL. The development of a draft MWMP, which seeks to align and clarify the responsibilities of the various government departments in terms of mine water management, is encouraging. The presidential proclamation that the timeframe for WUL authorisation should be reduced from 300 days to 90 days also indicates a strong political will to stimulate the economy and remove unnecessary red tape.

The importance of thorough monitoring after the implementation of the licence must be emphasised, with all requirements of the WUL, as well as the CARA and NEMBA Regulations, observed.

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