Department of Mineral Resources

The National Strategy for the Management of Derelict and Ownerless Mines in South Africa

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LIST OF ACRONYMS

DMR	Department of Mineral Resources
CGS	Council for Geoscience
DWA	Department of Water Affairs
DEA	Department of Environmental Affairs
D&O	Derelict and Ownerless Mines
MPRDA	Minerals and Petroleum Resources Development Act

1. INTRODUCTION

South Africa, like many other mining jurisdictions is faced with a legacy of the negative environmental and human impacts of mining. The Department of mineral resources has undertaken extensive research on the subject matter and has discovered about 6000 derelict and ownerless mining sites including mine dumps. From the research conducted to date, it is clear that there is a need for a systematic approach to address this mammoth challenge. This strategy seeks to provide such approach.

2. Problem Statement

South Africa has a long history of mining, however it has only recently developed and implemented comprehensive legislation to regulate environmental management and mine closure processes. Consequently, a large number of historical mining operations have been abandoned by their operators with little or no regard to the management of the impacts on public health and safety and the environment. This strategy therefore aims to provide guidance for the management of the residual mining legacies and propose a prudent course of action by which the State can discharge its responsibility to maintain the constitutional rights as contemplated in section 24 of the Constitution of the Republic of South Africa, which guarantees everyone the following environmental rights:

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

Formal mine closure only became legislative requirement in 1956 with the promulgation of the Mines and Works Act, and the regulation of environmental management of the mining sites only came to being with the promulgation of the

Minerals Act of 1991 and the Minerals and Petroleum Resources Development of 2002.

In many cases, mines have adverse negative impacts on the health and safety of local and remote communities and the environment. Public health and safety

impacts include physical features of the mines such as open shafts, unstable slopes on dumps and pits, collapse features and abandoned mine infrastructure. Other hazards such as contaminated water and soil, mining chemicals, explosives, radioactivity, windblown dust and, in the case of coal mines, spontaneous combustion of coal and coal wastes. In addition to the hazards relating to people accessing abandoned sites, mining can have a devastating impact on surface and groundwater resources, air quality and on sensitive and protected ecosystems. There are cases where mining forms part of the historical heritage and a balance therefore needs to be found between rehabilitation and the preservation of historical sites.

3. PURPOSE OF THE STRATEGY

The overall purpose of the strategy is to provide a framework within which the State can implement management measures, including undertaking the rehabilitation of derelict and ownerless mines. It also aims to propose an action plan for a programme to address challenges related to these mines.

4. OBJECTIVES OF THE STRATEGY

4.1 Compilation and maintenance of an inventory of derelict and ownerless mines in order to effectively address associated challenges. The data base should include information on accurate positions of the mines, commodities mined, scale of operations and possible impacts from those mines.

3.2 Provide a framework for the identification of priority sites in terms of public health and safety, environmental and social risks. Due to the large number of sites identified in the national database to date, it will not be possible to immediately rehabilitate all derelict and ownerless mines. For this reason, it is necessary to rank the sites in terms of risks associated with each one of them. This is a two stage process comprising of a desktop level assessment, which allows for the identification of high priority sites for screening-level field risk assessment and a ground truthing exercise.

3.3 Development of an Action plan for the management of the risks related to derelict and ownerless mines

3.4 Ensure that all D&O sites are rehabilitated to acceptable levels where they can either be habitable by humans where possible or can be used for other development activities and in cases where it is not possible, be at acceptable environmental state where there is a stable bionetwork balance.

4. A BROAD PERSPECTIVE ON DERELICT AND OWNERLESS MINES

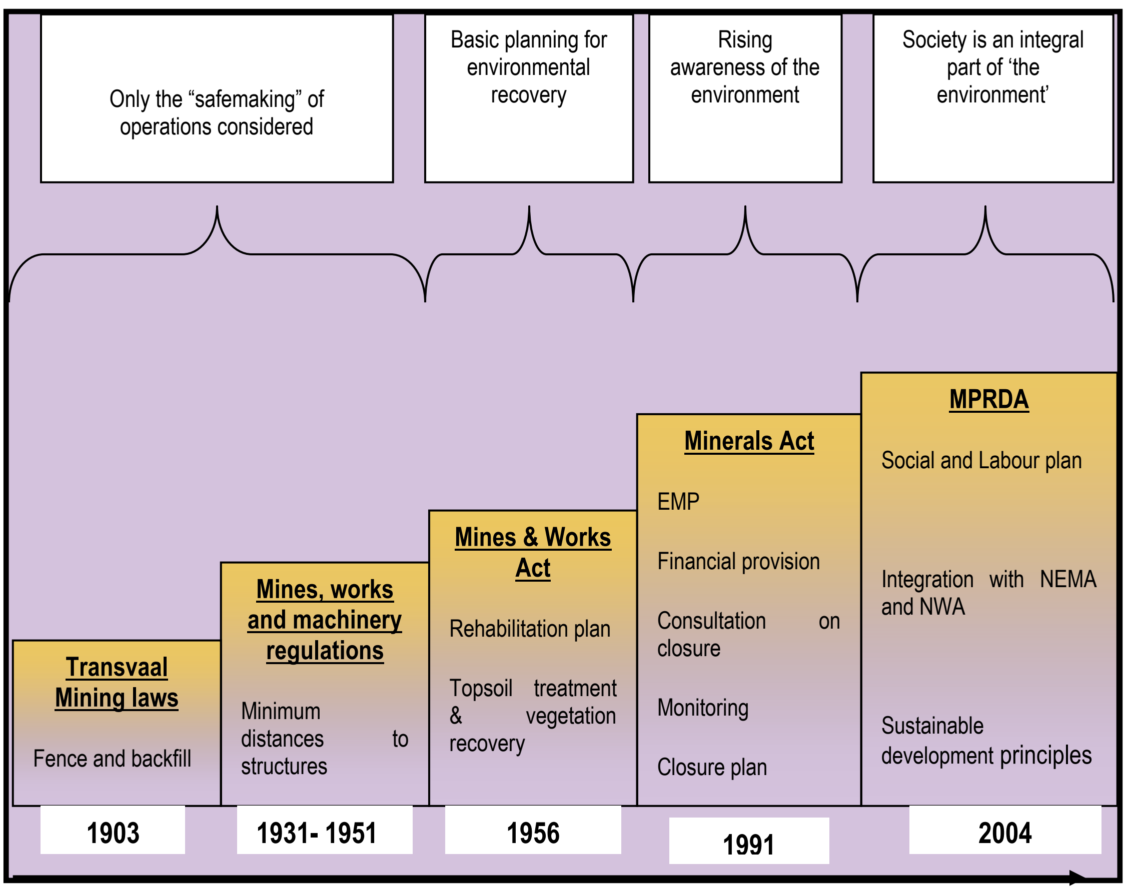
4.1 What are Derelict and Ownerless Mines

It should be noted that the term “derelict and ownerless mines” is not defined in the Minerals and Petroleum Resources Development Act (MPRDA). However, the Mine Closure provisions in this legislation provide some guidance on mine closure process, which depicts that mines are only regarded as closed when the closure certificate is issued in terms of section 43 of the MPRDA.

Derelict and ownerless mines can be defined as mines whose owners or mining rights or lease holders have abandoned and are not operating nor maintaining to mitigate and manage their associated safety, health and environmental impacts and can no longer be traced. These would comprise of mines that were operational during the period when environmental management at the mining sites was not well regulated.

4.2 Overview of the Legislative Framework

About 6000 mines were abandoned before legislation which requires detailed prescriptions for environmental management was developed. For example, the Mines and Works Act, 27 of 1956 merely required fencing of sites and the making safe of dangerous openings, although in terms of the Water Act some remediation with regards to contaminated water was required. Some mining rights were issued in terms of the Mining Rights Act, 20 of 1967 which also did not have requirements for environmental management on the mining sites. The Minerals Act 50 of 1991 was the first piece of legislation to prescribe more comprehensive environmental management and rehabilitation which included providing financially for rehabilitation at the commissioning stage of mining followed by the currently operational MPRDA.



5. THE KEY COMPONENTS OF THE STRATEGY

- The development of a national database of derelict and ownerless mines.
- The ranking of the mines in terms of their potential impact on public health and safety and the environment.
- The programme to address the impacts of derelict and ownerless mines through rehabilitation and other measures aimed at minimising risks to the public and the environment.

6. PROCESS FOLLOWED IN DEVELOPING THE STRATEGY

An initial ranking of the sites listed in the National Database of Derelict and Ownerless Mines was undertaken, looking simply at the expected hazards due to the mining of various commodities

MINE NAME	COM1	COM 2	COM3	COM4	COM5	Rank Com1	Rank Com2	Rank Com3	Rank Com4	RankCom5	RankCom12345	Max Rank
ABBOTT'S	Au	Ag				2	2	0	0	0	22000	2
ADOLFSKOP	Mn	Co	Li			1	2	1	0	0	12100	2
AFRICAN RAINBOW MINERALS (VAAL REEFS)	Au	U	Ag	S	Os	2	3	2	3	2	23232	3
AFRIKANDER LEASE (RIETKUIL	Au	U				2	3	0	0	0	23000	3

SECTION)												
ALBERT SILVER	Cu	Ag	Pb	Zn	Sb	2	2	2	2	2	22222	2
ALFREDA	Au	Co	As	Cu	Mo	2	2	2	2	1	22221	2
AREACHAP	Zn	Cu	Spy	Ag		2	2	3	2	0	22320	3
AURORA WEST UNITED	Au	Ag	PGM	U		2	2	2	3	0	22230	3
BALMORAL GOLD	Au	Ag	PGM	U		2	2	2	3	0	22230	3
BEISA MINE	U	Au	Ag			3	2	2	0	0	32200	3
BRAKPAN	Au	Ag	PGM	U		2	2	2	3	0	22230	3
DAGGAFONTEIN	Au	Ag	U	S		2	2	3	3	0	22330	3
ORKNEY OPERATIONS (5 SHAFT)	Au	U	Ag	S	Os	2	3	2	3	2	23232	3

Key	
3	High
2	Medium
1	Low

Tabular analysis

The table above illustrates the above-mentioned methodology with the following steps:

- Assigning the number rankings of 1, 2 and 3 to the risk rankings of “High”, “Medium” and “Low” associated to the relationship between the commodity type and the air pathway.

- Concatenate the number ranks for commodities 1, 2, 3, 4 and 5 in the field RankCom12345 to show the contribution of each commodity to the final risk ranking in the Maximum Rank field.

- Apply the Maximum function to the number rankings of all 5 commodities, which returns the maximum number to the Maximum Rank field.

The *Maximum Rank* field in the attribute table will be used to identify the “High” risk mines on the map.

For purposes of having an effective management and rehabilitation programme, it is crucial that the mines in question are ranked on the basis of their potential or already existing negative impacts on the environment and human beings. These will take priority in the State rehabilitation programme.

Cluster of High Risk Mines

A number of clusters of mines which have a high risk in relation to the commodities mined have been identified as follows:

Region	**Commodities**	**Pathway(s)**[1]	**Comments**
Asbestos mines in NC, LP and MP Provinces	Asbestos	A, SW	High risks due adverse health impacts and sw pollution

[1] A=Air, SW=Surface Water, GW=Groundwater, Direct access has not been listed, as this is derived from the distance to settlements and infrastructure and is present in all mining areas.

Region	Commodities	Pathway(s)[1]	Comments
Witwatersrand gold mines from the Free State to Evander)	Gold, uranium	A, SW, GW	High environmental risks due to uranium content.
Gold mines occurring in the greenstone belt of Mpumalanga	Gold, silver, arsenic	A, SW, GW	High risks due to arsenic and uranium content.
Gold occurring in the greenstone belt in Limpopo	Gold, antimony	A, SW, GW	High risks due to the presence of antimony and, in some cases, mercury
Coal mines in Mpumalanga	Coal	A,SW, GW	High risk due to AMD
Copper mines	Copper, tungsten, molybdenum, bismuth	SW, GW	Water related risks due to the presence of bismuth
Pegmatites in Northern Namaqualand	Many commodities	A, SW, GW	Risks are primarily due to radioactive components or bismuth

In addition to these high-risk mines, the gold mines of the Giyani Greenstone Belt in Limpopo Province and the coal mines in Kwazulu-Natal constitute significant clusters of high-risk mines as well. These contain minerals which lead to the formation of acid mine drainage, their impacts have not yet been visible or adverse in some cases due to the minimal nature of mining activities that have been undertaken in these areas.

Other areas and commodities suggested as potentially high-risk by economic geology and environmental specialists include:

- Phalaborwa
- Vanadium mines (Brits & Lydenburg)
- Mines containing Radioactive minerals
- Heavy mineral sands
- Iron and Manganese mines (dust and mine openings)
- Antimony mines (included in Greenstone Gold) Bismuth (Associated with Greenstone Gold)
- Messina Copper
- Lead (east of Pretoria)
- Argent mine (polymetallic)
- Western Cape tin (arsenic)
- Zinc (Pering & Bushy Park).

These have also been ranked **medium risk** mines and will require more investigation and planning for incorporation into the national rehabilitation programme.

Low risk mines would constitute small artisanal mining areas within communities, quarries etc. However some of these may pose high risks to their communities and would fall within the high risk category e.g. hard rock quarries and dams filled with water resulting in children drowning. Other sites that fall within this category could be sites where very minimal exploitation occurred and over time the sites have to a large degree rehabilitated naturally. These will be identified and mapped for incorporation into the national rehabilitation plan.

7. CLASSIFICATION OF IMPACTS RELATING TO DERELICT AND OWNERLESS MINES.

7.1 Human factors classification

7.1.1 Public Health and Safety

Some of the most significant impacts related to derelict and ownerless mines are those relating to public health and safety. These are particularly high when the public has direct access to sites, as is the case in most areas in South Africa where mining occurs within close proximity to communities and in the case of old mine dumps or residues in urban areas where people are resident within proximity to such.

The risks include, but are not limited to:

- Cavities and subsidence features
- Human and animals falling into shafts
- Illegal and unsafe mining on derelict and ownerless mine sites

- Contamination of surface water bodies and groundwater which the public depends on for their domestic use or for their irrigation needs.

- Risks related to the minerals or chemical substances in the host rock, ore and residue deposits

7.2 Environmental factors Classification

7.2.1 Surface Water

Open water bodies e.g. storm water storage systems, return water dams which are unlined, natural and anthropic mine depressions, open canals and any other place where surface water can accumulate and which are close to or in direct contact with the mine residue areas, pose high risk to the environment and humans due to the pollution of such water resources. The land capability weight of open waters could be high due to the safety risk associated with it; especially close to urban development areas. If these open water systems get their water from mine dumps, it contains soluble heavy metals and high acidity and salinity as a result of chemical reactions in the process.

Water flowing from the dumps or decanting from underground also has an impact on natural wetlands which are close or adjacent to the such mine dumps or underground water decant points, if this happens, the wetlands get polluted and cease to be functional. In some cases the extent could be transboundary thus impacting on water resources of other jurisdictions.

In addition to the risk of pollution, some mining activities could also result in the disturbance and diversion of river courses. This can result in silting up of streams or dams, as well as significant soil erosion.

7.2.2 Groundwater

The pollution in underground or deep open pit mining is often facilitated by the dewatering of mine workings. This can lead to the localised depression of the water table and a reduction in the availability of groundwater. In many cases, after mining, the groundwater levels recover to their pre-mining levels or levels close to these, but the groundwater is polluted due to chemical reaction in the mined out areas. In the gold and coal mining areas, this results in the formation of acid mine drainage which as it rises over time to fill the mine voids underground, sometimes decant onto to the surface thus polluting surface water bodies and in some cases land suitable for irrigation.

Pollution of groundwater resources is also evident in areas where there is seepage or ingress of polluted water to the underground aquifers from the surface. In most mining basins, mine voids are interconnected underground and therefore present some difficulty in the apportionment of the rehabilitation liability with regards to acid mine drainage. For this reason, a regional approach to addressing these is imperative. Regional mine closure strategies will be used as guidelines for the rehabilitation and management of impacts as well as the management of acid mine drainage at a regional scale.

7.2.3 Air Quality

Two major impacts on air quality have been identified namely windblown dust and, in the case of some coal mines, combustion gases arising from the spontaneous reaction of coal both in underground mine workings and in discard and spoil heaps. One other biggest commodity easily transported by air is asbestos, it can be transported over long distances resulting in people contracting non-occupational asbestosis.

7.2.4 Radiation

Radioactivity is a health risk and is associated with gold tailings, dumps and dams and the main question to be answered is whether the radiation will remain unacceptably high after removal of the dumps and dams. The experience is that radiation does penetrate only or in some cases into the unconsolidated soil profile. Research on this aspect has also been conducted and it has been established that in the case of removal or reclamation of dumps as a rehabilitation option, there are possibilities in some cases that some degree of radiation would still remain post the reclamation process.

7.3 Land Use land availability

Due to a long history of mining, a significant portion of South Africa's land is locked up in mine dumps. This is one of the biggest negative impacts particularly on economic development. It is estimated that 45 million cubic meters of underground mine excavations exists between Crown and Carletonville on the West Rand and that there are three billion cubic meters of gold tailings in South Africa. These mining activities and tailings occupy a large area without any proper development or land use. The challenge is to identify those mining sites which could be used for other purposes e.g. urban and rural development, land fill sites or recreational activities.

8. ACTION PLAN

8.1 REGIONAL PROGRAMMES

A number of regions have been identified where multiple mines, in some cases including operational mines have cumulative impacts on the environment and on human health and safety. In these cases it is vital that the impact of derelict and ownerless mines is known, quantified and addressed through the national rehabilitation and management programme in a regional approach. These impacts will require longer-term programmes to address and a degree of institutional control and monitoring extending into the future. The following areas have been identified as having regional impacts necessitating a regional approach to their rehabilitation and management:

- Gold Mining areas and dumps
- Coal Mining areas and dumps
- Copper Mining areas and dumps

Impacts of these commodities on water resources are huge and often extend to a regional scale and with time if left uncontrolled can be transboundary between countries.

The approach to addressing these impacts will be as follows:

✓ Catchment-scale assessment of impacts and first-order apportionment of loads to derelict and ownerless and operating mines in areas where there are still active mines.

✓ Assessment of additional impacts over and above the known impacts on surface water

✓ Implementation of monitoring programmes with sufficient detail to identify and quantify the impact of major pollution sources.

✓ Apportion pollutant loads to derelict and ownerless Mines

✓ Identify and implement appropriate mitigatory and remedial measures which address impacts on the River Catchment's surface and ground water.

To the extent that water pollution, more particularly acid mine drainage has been determined to be extending to a regional scale, active treatment will be implemented; this will be based on the feasibility of a specific treatment method.

<u>The following methods will be implemented on a case by case basis where applicable</u>:

1. Dewatering of mine voids

Throughout most of South Africa's coal and gold fields, underground mines are the principal source of AMD pollution and these include D&O sites. Removing water, one of the principal reactants in pyrite oxidation, should theoretically stop the production of AMD. Without water to move reaction products from the surfaces of pyrite, no contamination of waters should occur. While this can be done in a laboratory setting, complete removal of water in nature is nearly impossible. However, reducing the amount of water contacting pyritic material and containing water that is in contact with acid-producing materials may reduce the impacts of AMD to off-site water bodies and streams. Removing water before it contacts pyritic material by pumping may also be done. A series of peripheral deep wells may be installed to dewater abandoned deep mines to allow the water to be discharged without treatment.

Draining water away from pyritic materials as rapidly as possible may keep water from reacting and forming acid products. Water may move around mine tailings or compacted refuse of low permeability if placed within high-permeability overburden within a backfill. If the permeability contrast between the tailings and the surrounding material is large, groundwater will flow around the tailings mass rather than through it, and metal leaching will be minimized.

2. Dewatering and treatment of acid mine water (Active treatment)

In cases where the voids have been filled with already polluted water, dewatering and treatment methods will be implemented. This will be prioritised in the Wits and Emalahleni basins due to known rising water levels. This is a technique involving dosing acid water with hydrated lime thus bringing the pH to acceptable levels and where necessary remove other salts contained in the water through the use of relevant chemicals. Depending on the feasibility of the option, the pumping and treatment facilities could be either be centralised in the affected basins or it could be decentralised where multiple stations are set up within one basin.

8.2 LOCALISED PROGRAMMES

Many problem sites have been identified which have a smaller geographic scale with localised environmental risks and impacts and may not have long-term continuous impacts, but which pose an immediate threat to local communities and the local environment surrounding the mines. Examples of these are:

- Quarries and mine shafts and trenches in close proximity to residential areas
- Unrehabilitated mine dumps
- Other sites, as identified in the ranking process.

The main objective of rehabilitation of these sites would be to create areas where urban and rural development could take place or any alternative land use can be applied e.g. land fill sites. The classic concepts of sustainable land use with biodiversity and vegetation covers are not applicable at all places, although mine closure standards would still be required where tailings areas have to be rehabilitated without future development associated with it. The classical concept of sustainable rehabilitation will be necessary to in the case of mine residue or quarries which are a threat to community health and safety. These will be addressed at a localised scale in a relatively limited time period and will be addressed in parallel with the longer term projects described above. In the case of water management and treatment, the following methods will be implemented:

Water rehabilitation and management

Surface Water Diversion

Diverting surface water above a mined site to decrease the amount of water entering the mined area will be implemented in acid-producing areas. This technique can control water volume and direction and minimize the effects of acid mine drainage (AMD) on receiving streams. Surface diversion of runoff involves construction of drainage ditches to move surface water quickly off the site before infiltration or to limit its movement into the backfill. The diversion is accomplished either by ditching on the uphill side of surface mines or by providing new channels or impervious channels of existing surface streams to convey water across the disturbed area or through the construction of canals that divert clean water away from ingress points into the underground workings.

A strategy for alkaline loading can be accomplished by diverting surface water into beds of alkaline material (slag or other lime materials) to pick up alkalinity and allowing the alkaline water to flow into spoils or underground mine pools. Alkaline loading of water upgradient of mined areas or before it enters the backfill buffers the effects of subsequent contact with acid water.

Passive Water Treatment

Depending on the nature and extent of the pollution in different areas, the following passive treatment technologies will be implemented at different sites at a localized scale.

TECHNOLOGY NAME	TECHNOLOGY DESCRIPTION	FUNCTION
Aerobic wetlands	Shallow surface flow wetlands with emergent vegetation	Fe and Mn oxidation and precipitation of metals
Open limestone channels	Acidic water flows over limestone or other alkaline agent	Alkalinity addition, ppt of Al, Fe, Mn as metal oxides
Successive alkalinity	Vertical flows systems that drain	Alkalinity addition, sulphate

producing systems	through limestone layers and anaerobic matter	reduction and metal ppt.

Rehabilitation and covering of dumps

General rehabilitation principles and techniques will be applied through the following pathway procedures of rehabilitation in five main stages. These stages are:

- Stage 1. The problem – defining all impacts (erosion, pollution, dust, visual etc).
- Stage 2. Limitations and risks – identification of constraints e.g.
  - Natural (low average rainfall, dry seasons, floods, surface temperature, veld fires etc)
  - Physical (slope length, slope gradient, aspect, texture, structure, water holding capacity etc)
  - Chemical (pH, heavy metals, salts, nutrient balance, low buffer capacity etc)
  - Biological (lack of vegetation, low organic content, low micro-organism activity etc)
- Stage 3. Solution/method statement – using supportive information (data basis, theory, research, models, technology etc) to obtain innovative solutions.
- Stage 4. Validation – test the solution against legislation requirements, and the pillars of sustainable management.
- Stage 5. Implementation.

Stage 5 will be implemented based on the outcomes of the considerations in stages one to four. The nature and extent of the problems identified as well as the identified end land use would determine the rehabilitation method to be applied.

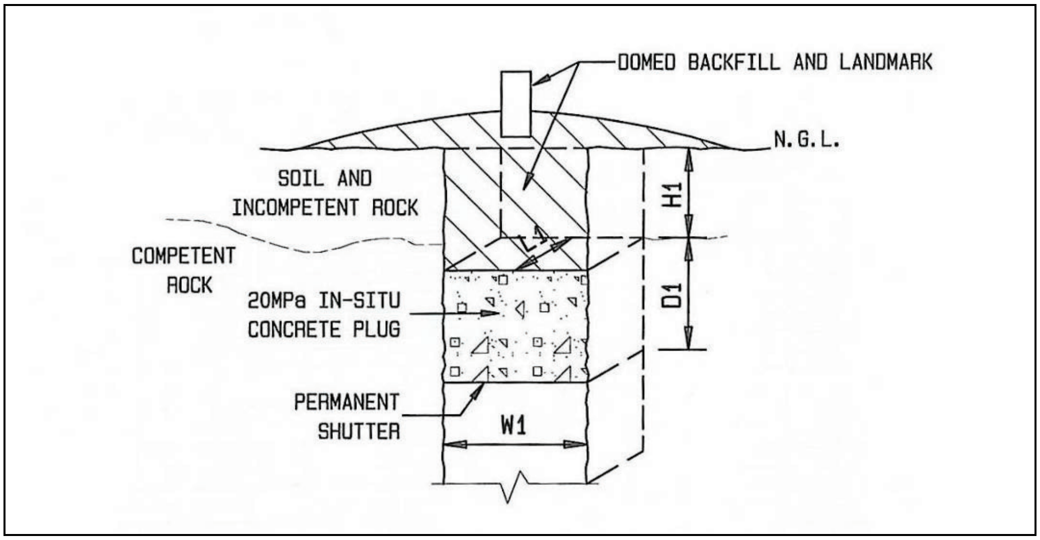
Reclamation of dumps

Many rehabilitation designs exist and one could make use of many methods to reach the goal and objectives of rehabilitation, but it is necessary to always consider the end land use, monitoring, maintenance programs etc. Although the main objective with this method would be to make more land available through reclamation and occupation of mine residue areas, it would still be necessary to do the rehabilitation within a mine closure framework. The mine closure procedures are well defined and they are in line with the objectives of turning the mine residue areas into sustainable productive land. The final rehabilitation and closure plans for each site will to take cognisance of the shortcomings and impacts of historical tailings disposal facilities and integrates appropriate construction techniques and operational practices into developing a landscape that can be rehabilitated to attain a sustainable eco-system that can integrate back into the surrounding environment.

Sealing of abandoned open shafts and trenches

A literature study of existing methods to close unsafe mine openings has been undertaken. These methods typically involved either erecting masonry walls or wire fences, placing concrete or steel slabs or grates across the tops of the openings or inserting plugs. Under the prevailing conditions where these are located, the concrete plugs method has been considered as suitable to provide a lasting solution.

A generic concrete plug design has been designed by engineers and developed i.e. one design fits all and used to seal the identified unsafe mine shafts and trenches in all the Provinces..



Massive, concrete plugs, as per the chosen design will be placed 3-10m below surface and then covered with topsoil as a deterrent to anyone considering removing the plugs. No valuable materials, such as steel rebar, will be used in the plugs thereby decreasing possibilities of the damage to the plugs to search for such materials.

A heavy 2,5 ton concrete landmark containing no reusable materials, will be placed on top of the newly sealed shafts as a permanent reminder to residents of the dangerous shaft buried below. Upon completion of the sealing process, 10m x 10m servitudes on all the sites will be created around each of these sealed shafts and registered with the Surveyor General. This is to ensure that even future land owners are aware that such land is not suitable for the erection of permanent structures as it has a possibility of subsidence or caving in.

REHABILITATION TO DIFFERENT END LAND USE

Rehabilitation of D&O sites will be oriented towards being end land use driven. It is therefore crucial that an investment be made into the land use determination so as to derive maximum benefits from the rehabilitation programme. This entails turning the pollution challenge onto an opportunity. End land uses will fall in the following categories:-

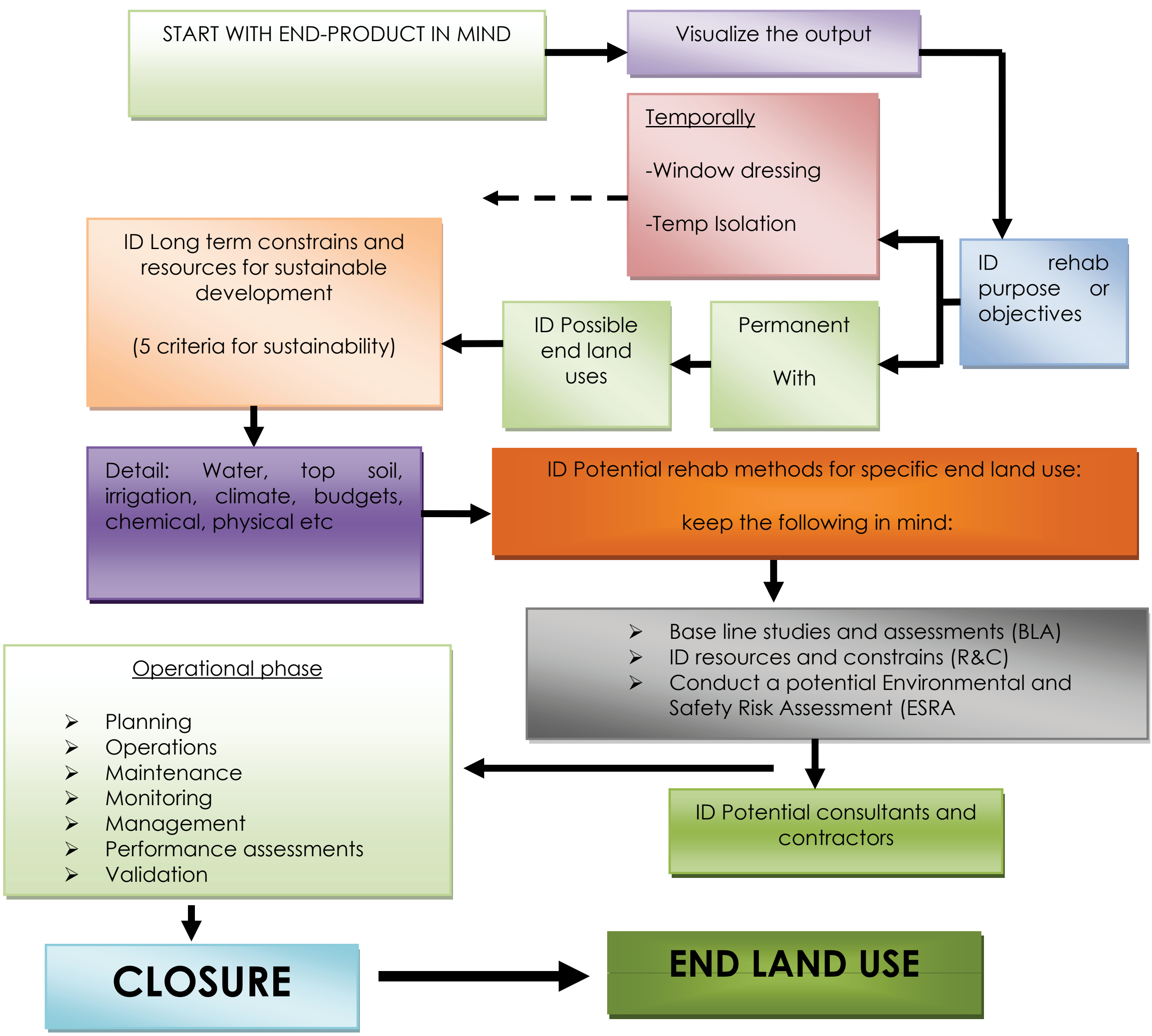
- ✓ Recreational land use
- ✓ Economic development
- ✓ Residential (e.g. Ebotse Golf Estate in Benoni)

In a number of areas, mining may form part of heritage Sites in South Africa which provide a good basis for market to tourists on the basis of their mining heritage. Hence, remediation and rehabilitation is not the only solution to management of derelict and ownerless mines, however some of these mines can be used as tourists attraction site or heritage site. Typical examples would be the Gold Reef City, Big hole in Kimberly and Pilgrims rest etc.

Sustainable projects based on mining heritage can help sustain communities, however this cannot be used as a reason for not addressing the negative legacies of mining, where these relate to health, safety and the environment. Furthermore, in some areas, rehabilitation may have a negative impact on the environment, for example where old mines have been colonised by animals. Rehabilitation should therefore be sensitive to these factors and should take them into account.

SUSTAINABILITY

Sustainable land management ensures the health and vitality of human life, culture and nature, for present and future generations, by ending activities that destroy human life, culture and nature, by conserving what exists, restoring what has been damaged, and prevents future harm. In the case of mine rehabilitation and closure the focus is more towards a safe environment with limited or very low pollution and therefore surface stability and the end state becomes the main criteria within the concept of overall sustainability.



8.4 Scheduling and Prioritisation

The determination of a schedule for rehabilitation will be based on a number of factors. The key factors are:

- Priority based on risk (determined in the ranking of derelict and ownerless Mines).
- Rehabilitation potential – Is efficient rehabilitation possible or is further research and investigation required.
- Impact of rehabilitation: While a mine such as the open shaft indicated may not have the highest risk rank in the database, effective rehabilitation is relatively simple, would have a high positive impact at local level and will allow the programme to address derelict and ownerless mines to show some early successes

Rehabilitation Planning

The database compilation exercise has revealed quite a huge number of sites for rehabilitation by the State. Considering the limited financial resources available to address the challenge, an implementation plan indicating short to medium term and medium to long term interventions will be developed. For the rehabilitation of both local and regional programmes, the implementation plan will reflect different phases for the implementation of the projects.

8.5 Public Awareness

In cases where sites are found to pose a risk to local communities, the provision of understandable information to the public is paramount.

Even before rehabilitation it is necessary to warn local communities and local authorities about potential hazards in these areas, consequently limiting the potential impacts of these mines to the local communities as well as to warn them about the rehabilitation programme when it is due to commence.

In some cases, derelict and ownerless mine sites have been found to be extremely remote, however many exist in areas regularly visited by hikers, overland 4x4 travellers etc. These communities need to be made aware of the dangers inherent to these sites and could also provide valuable assistance in the identification of sites in the wilderness areas which they visit.

MONITORING AND MAINTENANCE (M&M)

Monitoring of any rehabilitation is absolutely necessary to ensure that the integrity and performance of the rehabilitation methods are still in line with the original objectives and purposes of the method. A monitoring and evaluation team would conduct inspections over pre-determined periods e.g. in dry and wet seasons. This would be done using a monitoring and evaluation manual which designed specifically for rehabilitation projects.

Framework for surface stability monitoring

A logical pathway procedure should be used to evaluate surface stability (and sustainability) to ensure that all-important dimensions of stability are considered in the analysis. The pathway proceeds through five main stages:

- Stage 1. The objective – the purpose of the land management system being evaluated (at present, mostly there is no defined end use for the slimes dam, except for “wilderness area”).

- Stage 2. The means – the management or practices, inputs and circumstances by which the objectives of the land use system are to be achieved.
- Stage 3. Evaluation factors – identification of all physical, biological, social and economic factors, which potentially bear on the sustainability of the system.
- Stage 4. Diagnostic criteria – establishing cause- and effect relationships between factors, collecting evidence of trends in these relationships, on the site and projecting a pattern of future trends; very much like a environmental risk assessment
- Stage 5. Quality indicators and thresholds – identification of the conditions of sustainability, or the measures beyond which the system can be judged to be unsustainable.

9. FUNDING MECHANISMS FOR MANAGING DERELICT AND OWNERLESS MINES

This programme will be funded from the fiscus however where partnerships can be established with other stakeholders funding would also be sourced from such alternative sources.

10. ROLES AND RESPONSIBILITIES

It is important to note that the impacts of these mines cross-cut the jurisdictions of a number of Government Departments, most notably Department of Mineral Resources, Department of Water Affairs and the Department of Environmental Affairs, all of whom have an important role to play in the management of legacies.

11. CONCLUSION

A two pronged strategy is proposed for the management of derelict and ownerless mines. For purposes of this strategy, two clusters of sites have been identified.

- The first cluster is of those which should be rehabilitated completely in localised projects.

- The second cluster has larger or more regional impacts and will require larger scale, longer term programmes to mitigate their impacts.

In a number of cases, particularly the large-scale integrated impacts of groups of larger and more complex mines, additional research will be undertaken in order to quantify, characterise and apportion impacts and further research to identify or develop appropriate rehabilitation and mitigatory measures.

The involvement of local communities in the implementation of solutions is critical. In many cases, this will require a concerted programme of training and skills development to empower community groups and local small and medium contractors to undertake rehabilitation and mitigation activities. It is also likely that many of the skills transferred to communities may be applicable in or convertible to other fields, stimulating local economic development after the rehabilitation programme has been completed.