GUIDELINES FOR THE REHABILITATION OF MINED LAND

CHAMBER OF MINES OF SOUTH AFRICA/COALTECH
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These guidelines are the result of a joint initiative between Coaltech Research Association and the Chamber of Mines of South Africa.

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These guidelines are a compilation of existing knowledge and information provided by a range of South African companies. There may be gaps and omissions, and this document should be reviewed and revised on a regular basis. All comments, corrections and additional information will be gratefully received.

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INTRODUCTION

Mature rehabilitated land with native species (*Hyparrhenia*) beginning to dominate the vegetative cover

Mining is, and has been for many years, a vital component of the development of South Africa. At the same time, mining has resulted in major impacts, both environmental and social, that have not been fully recognised or dealt with. While South Africa now has a legal framework that instructs the mining industry on "what" to do to minimise environmental impacts from mining activities – the Department of Mineral and Energy's (DME) Mine Environmental Management (MEM) guidelines – information on "how" to achieve compliance is scattered through a range of publications and in-house mining corporation policies and procedures.

In South Africa, a guideline for the rehabilitation of land disturbed by surface coal mining was first published by the Chamber of Mines in 1981. This provided excellent guidance for coal strip mine rehabilitation, but both legal requirements and rehabilitation objectives and procedures have changed considerably over the last twenty-five years.

Internationally, a number of rehabilitation guidelines have been produced. In particular, the Australian mine rehabilitation and mine closure and completion guidelines are of relevance. These "new" South African guidelines are intended both to update the previous coal-based strip-mining guidelines and to expand them for use with other mining methods. They are a compilation of current "best practice", both South African and international, and are aimed at providing the basis for the "how" to go about achieving a satisfactory, sustainable, rehabilitation end-product following mining.

The guidelines should apply to all forms of mining, both surface and underground, and all mineral extraction industries. Excluded are exploration activities, ocean mineral extraction and the rehabilitation of rock dumps, tailings dams and sinkholes.

What is "rehabilitation"?

Rehabilitation, from the mining industry perspective, means putting the land impacted by the mining activity back to a sustainable usable condition. It recognises that the restoration of what was previously there is simply impossible with current best practice. This definition (and implied intention) includes the concepts of minimisation of loss of land use capability and of net benefit to society. Section 38 (1) of the MPRDA refers to having the mine area restored to its natural or predetermined state but this is tempered by the qualification that rehabilitation must be practicable and also provides for a Public Participation Process to define "end use".

What is "effective rehabilitation"?

Rehabilitation that will be sustainable, in the long term, under normal land management practices.

What are "decommissioning and restoration"?

Several international accounting standards do not refer to rehabilitation but to "decommissioning and restoration costs". Although, from a dictionary point of view, restoration may imply a full return to pre-mining condition, for these guidelines, the definition of restoration has been taken as being synonymous with the definition of rehabilitation given above. That is, the key driver is not to restore to previous condition but to a final, sustainable end land-use that has been defined by the interaction with and agreement of the government agencies, the communities affected and the mining company concerned.

Objectives of rehabilitation

Internationally, there seem to be three schools of thought:

- "What the affected community wants, the affected community gets" – that is, the key focus is on providing the end product requested by the affected communities, rather than focusing on the previous status quo.
- "Restoration of previous land use capability" – the original thought process in the South African context, because mining often occurs on land with high agricultural potential.
- "No net loss of biodiversity" – the focal point in the ICMM/IUCN dialogue sponsored guidelines for mining and biodiversity, and of many mining corporate policies.

In the South African context, rehabilitation objectives usually contain elements of all three approaches. Historically, restoration of land capability has been the key factor. Currently, rehabilitation objectives should align with the national and regional Integrated Development Plans (IDPs), which may or may not match local community wishes.

However, rehabilitation objectives must be aligned with EMP and Closure Plan objectives and commitments, and must provide for a sustainable post-mining land use. Consensus on these commitments has to be reached through a Public Participation Process before permission to mine is granted.

Layout of these guidelines

The physical actions of rehabilitation cannot be dealt with in isolation from the associated planning and permitting actions, so this guideline includes the whole process from the initial conceptualisation, through the actual mining and rehabilitation processes, the development and monitoring of criteria for completion, up to and including the actions needed to obtain final clearance from the authorities that the rehabilitation process has been completed.

The key sections in these guidelines are:

1. Rehabilitation planning, permitting and financing
2. Land preparation for mining
3. Soil stripping
4. Soil stockpiling
5. Infrastructure removal
6. Landform changes resulting from high extraction mining, the associated environmental impacts and their remediation
7. Landform re-creation (spoil shaping)
8. Soil replacement
9. Soil amelioration
10. Dealing with problem areas
11. Revegetation and biodiversity re-establishment
12. Rehabilitation monitoring
13. Management system during mining (i.e. how to ensure that processes remain on track between construction and closure)
14. Final closure planning
15. Definition of final closure
16. Legal compliance framework.

Additional technical detail on key aspects is contained in 15 Appendices. A separate, much more concise, field operator’s booklet, which provides bullet-point reminders of key actions to be done, will also be generated.

1. REHABILITATION PLANNING, LEGAL AUTHORISATION AND FINANCING

Rehabilitation planning and legal authorisation is a complex, iterative process that involves interaction with a wide range of people to ensure that it progresses smoothly. The recent developments in the mining and environmental legislative framework for the authorisation process for mining (which relates directly to land rehabilitation) have also increased the complexity of the situation. As these changes have only come into effect recently (mid 2006) experience in successful completion of the new processes is limited.

These guidelines focus principally on the "how to" of mine rehabilitation, rather than on the "what to". Accordingly, this section on the planning and authorisation activities has been restricted to broad outlines of the activities concerned. However, it is recognised that good planning is absolutely essential to the attainment of an effective end-product and, accordingly, Planning, Authorisation and Financing are covered in more detail in Appendix 1 of these guidelines.

More detailed explanations of the legislative processes involved in legal authorisation and financing are also included in the legal framework section (section 15) and in the flow-chart of actions required to obtain authorisation to mine (see page 10).

1.1. Planning

The current standard practice is for the mine planner to design the mine using various optimisation techniques, which are usually based on geological reserve parameters and optimising cost efficiency of mining methods. Environmental considerations should be taken into account during this process.

The ideal planning process includes rehabilitation effectiveness and long-term maintenance cost implications as full components. Closure objectives must be outlined so that the planning is done with the end use in mind. In this way final closure costs may be minimised and design disasters that will prevent full compliance with the legal commitments made in the mine EMPR may be avoided.

Planning has to be done as an iterative process, with the initial outlines based on the mine's concepts of the impacts likely to occur and how these should be mitigated. However, these initial outlines must be reviewed in the light of comments received from interested and affected parties, and this may involve two or more modification stages to the original plan. Interested and affected parties are identified in the Public Participation Process, which is central to the legal authorisation process.

The key planning phase activities are as follows:

- Clearly define the nature and scope of the baseline environmental studies that must be done. The studies required will be determined by the scoping phase of the permitting process.
- Baseline environmental studies (soil, flora, fauna, hydrology, etc) should be completed early in the planning process. This will permit the identification of "no go" or "special rehabilitation requirement" areas on a realistic basis before mine planning begins.
- Mine planner generates initial outline mine plan.

- Rehabilitation specialist evaluates the mine plan to assess the extent to which the current plan will debase land use capability, ecological status, or result in long-term (i.e. post-closure) maintenance liabilities.
- This evaluation should be based on a risk/opportunity analysis of all rehabilitation options and should balance short-term cost considerations against long-term (including post-closure) maintenance considerations.
- Rehabilitation specialist proposes mine plan modifications to mitigate environmental impacts.
- Mine planner re-assesses the mine plan to determine the extent to which the rehabilitation specialist's requirements can be accommodated.
- The residual impacts, and the likely end product, to be agreed between mine planner and rehabilitation specialist.
- This information to be included in the mine Environmental Management Programme for submission to the interested and affected parties, and to the authorities (see Permitting section).
- Concerns of interested and affected parties and of authorities, as identified in the Public Participation Process, are to be considered by the mine planner in association with a rehabilitation specialist. To what extent is the mine viability compromised by these additional requirements? If the changes requested by the authorities and others, through the Public Participation Process, cannot be fully met, then the revised Environmental Management Programme must be submitted again to authorities (and interested and affected parties, if required) for final approval.

1.2. Legal authorisation processes

The legal authorisation process for obtaining a mining right or mining permit is the official way in which the mine proponent gains the acceptance of the mining activity plan by both the interested and affected parties (I&APs) and by government. These two groupings have the major influence in the acceptance or rejection of the mining proposal.

The I&APs are usually more concerned with net benefit or loss to their sections of society. The authorities, ideally, should be more concerned with the longer-term issues and should see the proposal in relation to regional or national resource constraints.

De facto, in South Africa, authorities place great importance on the proposal having the approval of the directly affected parties and, hence, the authorisation process has to focus with equal intensity on meeting the requirements of the local communities and of the authorities.

For this guideline, we assume that the exploration and assessment of the mineral resource have been successfully completed using the correct interactive approaches and, accordingly, that the local communities and authorities are both fully aware that the area has been identified as a mining prospect.

The authorisation process should include the following activities:

- The mineral resource boundaries, and the probable boundaries of the impacts of the mining activity, should be identified.
- All parties likely to be affected by the mining activity in the area should be listed and contacted regarding the proposed mining activity. This will initially be done as part of the scoping process required in terms of existing legal obligations prescribed in the MPRDA.

- A Scoping Report as well as an Environmental Impact Assessment Report (EIA) should be generated, based on the initial mine plan, and this should be presented to the I&APs and to the authorities.
- Concerns of the I&APs and authorities in relation to the mining proposal should be identified by the Public Participation Process as part of the scoping process.
- These concerns should be collated and addressed by mine planning, in association with the rehabilitation specialist.
- The mine plan and environmental management plan (or programme, where applicable) should be revised, as far as practicable, to meet the reasonable requirements of I&APs and authorities. This revised mine planning information should be included in the mine Environmental Management Programme (EMP).
- The revised MEMP should be communicated to I&APs for comment.
- The finalised plan should be submitted to the authorities as the final EMP.
- If the issues raised during the scoping and EIA processes have been fully addressed, then approval and mining authorisations should follow. However, it is better to allow for a further round of mine plan revision and contact with I&APs and authorities prior to legal authorisations being finalised (this is not a legal requirement, but practical experience has shown that there are usually a number of queries that have to be answered, resulting in the further round of revisions).

The authorisation process covers all aspects of the mine's environmental and socio-economic impacts, both positive and negative. Accordingly, while these guidelines are concerned solely with the aspects of legal authorisation requirements related to rehabilitation of mined land, the process is an iterative one in which there may be some playoff required to attain approvals.

Primary concerns with the need for development may, in some instances, result in less than perfect rehabilitation solutions being accepted. However, these guidelines will continue to focus on the requirements for rehabilitation related to good practice.

1.3. Financing

Rehabilitation is an expensive business, which can account for as much as 10% of mining costs in certain circumstances. As the majority of these costs are usually incurred after mine closure, or at least after a significant portion of mining has been completed, some form of guarantee is usually required by authorities to ensure that these costs are met.

In addition, there is now a requirement to provide financial assurance that the costs of rehabilitation will be met in the case of early or unplanned closure. The question is, how will the costs of rehabilitation be funded if the mine closes prematurely, either due to mining issues or to decreased value of the product? There are a number of financial vehicles that can be used to meet the cost of rehabilitation. However, for all of them, there needs to be an accurate estimate of the cost of rehabilitation and of when that rehabilitation is going to be done.

Actions currently in use or proposed for the cost estimation and financing of land rehabilitation in the mining industry are:

- An estimate of the cost of rehabilitation should be developed based on the current mining plan.

- Ideally, cost estimates should be made by a qualified quantity surveyor, but this is not always practical, and estimates may be made by the mine survey department. DME guidelines are available to assist in generating estimates but, while these will be legally acceptable, these need to be tempered by local knowledge.
- The phasing of rehabilitation expenditure during the life of the mine should be planned, recognising that delays or accelerations may occur.
- The method of funding of the rehabilitation should be clearly stated.
- Financial instruments should be evaluated to determine the most cost-effective method of funding. This may be internal trust fund, external trust fund, payment into the government account, or independent financial guarantee.
- Additional costs incurred as a result of early or unplanned closure should be identified. The authorities' standard cost checklist (published by the DME) can be used for this purpose, unless better estimates that can be fully validated are available.
- The method of funding the additional cost of early closure (typically, the difference between amounts in a trust fund and actual early closure cost, which initially increases and then declines with time) need to be identified.
- Formal authority approval for the method of funding has to be obtained. This approval usually comes with conditions (annual audit and report on rehabilitation progress, for instance).

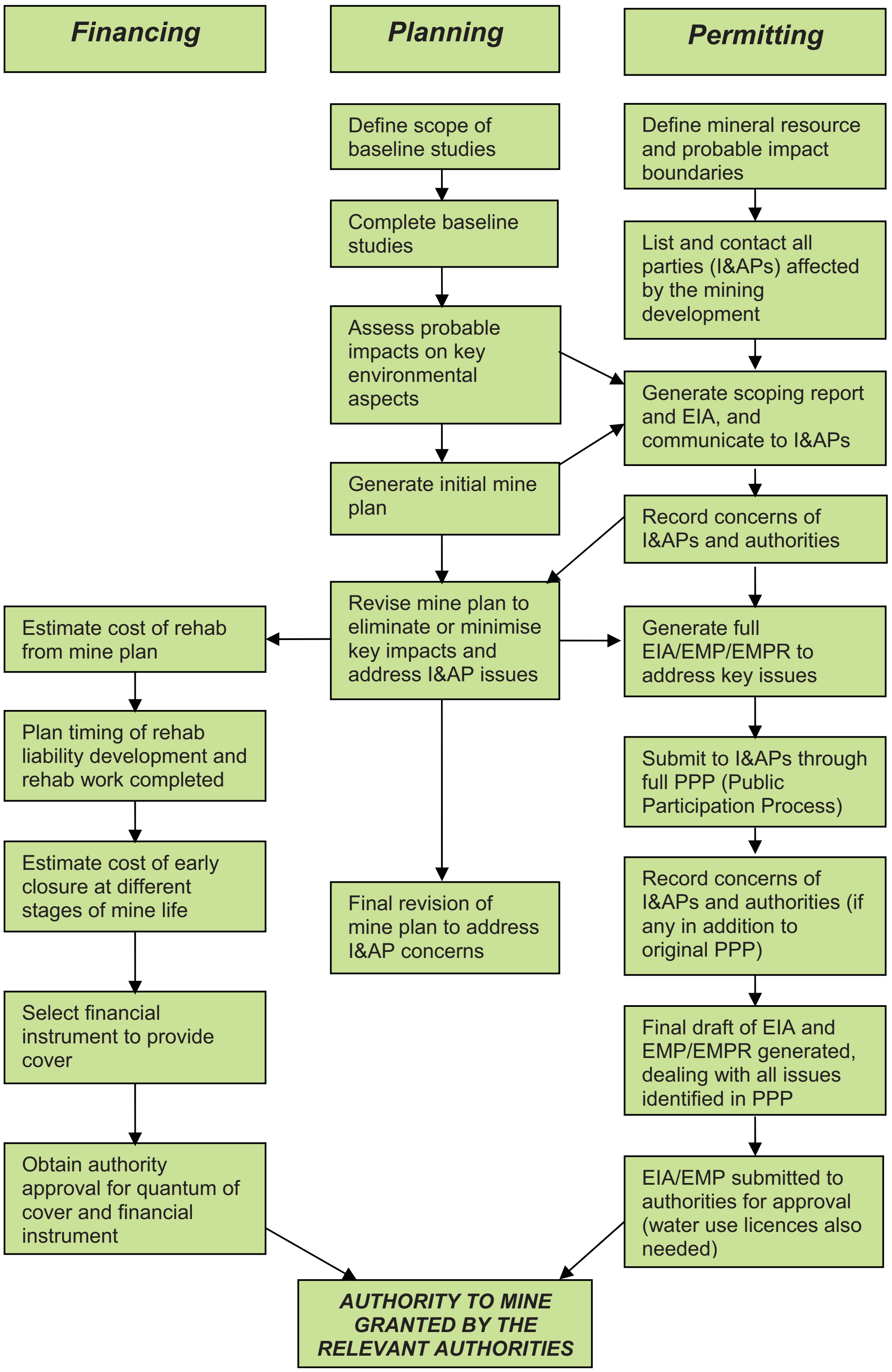
Annual reviews of funds available for rehabilitation, and of rehabilitation requirements, should be undertaken to ensure that ongoing activities are not incurring additional liabilities that emerge later in the mine life, for which finance has not been allocated.

1.4. The need for communication to ensure effectiveness of the planning, legal authorisation and financing processes

An effective planning process is all about communication: communication between planners and rehabilitation specialists, communication between mine staff and interested and affected parties, and communication between these parties and government officials. The complexity of the process comes about in large part because of the need to ensure that this communication takes place. It is effective in identifying key issues that will affect the long-term success of the rehabilitation activity and in addressing these.

Planning, Authorisation and Financing are discussed in more detail in Appendix 1. The following is a simple diagrammatic representation of these three processes.

PLANNING, AUTHORISATION AND FINANCING FLOW DIAGRAM



2. LAND PREPARATION FOR MINING (ACTIONS DURING THE CONSTRUCTION PHASE)

Mining takes many forms, but in its simplest division it either involves underground mining with minimal surface disturbance (e.g. bord and pillar mining to specified safety factors or deep vein mining); underground mining with significant surface disturbance (e.g. shallow longwall mining or block caving); surface open-pit mining (where the pit overburden material is relocated to permanent overburden dumps); and surface strip-mining (where the pit overburden material is replaced in an adjacent open mined-out section).

From the rehabilitation perspective, the key factors to consider during the preparation for mining (construction) phase are to minimise the area affected by the development, minimise potential future contact of toxic or polluting materials with the environment, and to maximise the recovery and effective storage of those mining profile materials that will be most useful during the rehabilitation process after mining is complete.

Construction should be done bearing closure in mind:

- Ensure that mine planning has minimised the area to be occupied by mine infrastructure.
- Ensure that construction crews restrict their activities to the planned areas.
- Locate all soil and overburden stockpiles in areas where they will not have to be re-moved prior to replacement for final rehabilitation.
- Ensure all stockpiles (especially topsoil) are clearly and permanently demarcated and located in defined no-go areas.
- All infrastructure should have been designed with closure in mind – either with clearly defined dual purpose or with ease of deconstruction. The key action during the construction phase is ensuring that designs of buildings are not changed without due consideration of the rehabilitation consequences of those changes.
- All soil stripping should be done in strict compliance with the soil stripping guidelines – soil management is the key process in determining rehabilitation effectiveness.
- Rock quarries and borrow-pits should be included in the construction environmental plans.

2.1. Ensure that mine planning has minimised the area to be occupied by mine infrastructure

The area to be used for the mine infrastructure (workshops, administration, processing plants etc) should be kept as small as practically possible. It should also be clearly defined and demarcated.

2.2. Ensure that construction crews restrict their activities to the planned areas

Without clear instructions and control systems in place, the activities of construction teams severely affect a much larger area than the construction site. The surrounding land may be subject to poaching, plants are damaged, areas may be used for recreational 4X4 driving, and so on. Clear instructions restricting construction work and construction personnel to the clearly defined limits of the construction site are essential. In addition, compliance to these instructions must be policed.

2.3. Locate all soil and overburden stockpiles in areas where they will not have to be relocated prior to replacement for final rehabilitation

In the interests of minimising the costs of opening a mine, overburden piles and soil stockpiles are usually located as close as possible to the extraction point. Frequently this is done without considering future expansion plans or mine closure requirements, thus necessitating future relocation. The ideal is to place all overburden materials removed at mine opening in their final closure location, or as close as practicable to it.

2.4. Ensure all stockpiles (especially topsoil) are clearly and permanently demarcated and located in defined no-go areas

During construction, soil cannot be stripped and replaced directly. Throughout the life of the mine there will be many other occasions where removed soil cannot be replaced directly onto rehabilitated land. This soil has to be stored in stockpiles for future use. In this situation, although the soil will have a lower rehabilitation value because of the seed reserve loss with time and impacts on the microbiota it will still be of significant value in the rehabilitation process. The value is provided by the structure, organic content and micronutrients available in topsoil. Soil loss is a significant problem encountered on older mines in South Africa. This is because, even though soils were stripped and stockpiled, they were not clearly identified either in the field or on plan and instructions for their preservation were not issued. Consequently, many stockpiles were used in error or lost. To ensure that they remain available for future use all soil stockpiles should be placed in clearly defined no-go areas, revegetated and monitored on an annual basis.

2.5. All infrastructure should be designed with closure in mind

Infrastructure should be designed with ease of deconstruction in mind, or with clearly defined dual purpose. The ideal is to employ modular construction methods so that reclamation of equipment and administration buildings at closure is simplified. Concrete foundation dimensions should be kept to the minimum required for safety and operational efficiency, as at closure all should be removed prior to rehabilitation.

2.6. All soil stripping should be done in strict compliance with the soil stripping guidelines

Soil management during construction is the key process in determining rehabilitation effectiveness. Soil stripping guidelines should be developed for the construction crews which clearly define the soil horizons to be removed and how and where to store them. Regular review of performance is required to ensure that stripping is done correctly. An example of a soil stripping guideline is given in Appendix 2.

3. SOIL STRIPPING

This is a key rehabilitation activity because soil, once lost, takes many years to regenerate. The assumption is made that detailed soil surveys have been made of all areas that will be subjected to major disturbance. Examples of the type of soil inventory and soil stripping guide that should be produced are included in Appendix 2.

Stripping of surface layer of soil using shovel (backhoe) and truck

Availability of soil materials is the key to successful rehabilitation. The surface layer that contains the fertility and seed bank should be stripped and stored separately.

Soil stripping should remove all materials that are suitable for supporting plant growth. In practice, the thickness of usable soil materials varies considerably. It is normally less than one metre but, on occasions, may be as much as 3-5 metres thick and, in others, less than 0.15 metres. The pre-mining soil survey will identify those horizons (normally down to a depth of 1.2 metres, limited by the equipment used to survey) that will support plant growth and those that will be less effective.

Experience has shown that significant losses of soil materials occur during the stripping and replacement processes, and it is advisable to strip and retain the deep materials when these have been identified. Planning the removal and stockpiling of soils will increase effectiveness of the rehabilitated end product.

Soils of significantly different characteristics should be stockpiled separately. This is to ensure that their characteristics are suitable for the drainage conditions they will encounter when they are replaced. They can then be used in different catenal (position on the slope) locations where their characteristics may be suitable for the drainage conditions they will encounter. In practice, it is rare for this to be done. At best, soils will be separated into three categories based on clay content, and into topsoil and subsoil horizons.

- Ensure that there is a detailed soil plan for the areas to be stripped
- Strip a suitable distance ahead of mining at all times, to avoid loss and contamination
- Demarcate boundaries of different soil types
- Define cut-off horizons in simple terms that the stripping operator can understand
- Supervise stripping to ensure soils are not mixed
- Strip soils only when moisture content will minimise compaction risk
- Strip and replace in one action wherever possible
- Use shovel and truck in preference to bowlscraper.

3.1. Ensure that there is a detailed soil plan for the areas to be stripped

A detailed soil plan must be generated before mining or construction begins. The soil survey and report will have been done as part of the mine EIA/EMP processes. This will contain the basic data concerning the soils and their nature, but it is essential that the data be converted into a soil use and stripping guide, which defines which soil horizons are of value for rehabilitation and what constraints to their use exist.

While the pedologist will produce a soil plan that defines the physical and chemical limitations of the soil, there is also a need to include a biologist in the process of defining the soil horizons to be stripped for rehabilitation. This is because the soil, in addition to providing the chemical and physical requirements to support plant growth, may also act as the principal or sole provider of seed of native plant species required for rehabilitation. It may also be the case that the area is heavily infested with alien vegetation; in which case retention of the seed bank in the surface soil will not be the best option for revegetation. These are rare exceptions; the general rule should be that all soil material suitable for supporting plant growth in the rehabilitation phase should be stripped and replaced on reprofiled land, or carefully stored for re-use.

Combining the soil physical, chemical and biological data, a detailed soil stripping guide should be generated. This should be geo-referenced, with indication of depths to be stripped and with clear definition of how different soil horizons are to be identified and handled in the stripping process.

3.2. Generate the soil stripping and use guide

Based on the soil report and on the biological aspects, the soil stripping and use guide should be developed. An example of a soil stripping and use guide is included in Appendix 2.

This guide should demarcate the boundaries of different soil types (forms and families) in the area to be disturbed. It should also define the suitability for rehabilitation purposes of the different soil horizons contained within each soil type profile. There are some soil horizons – for example, gleyed[1] or soft plinthic[2] horizons – which cause significant difficulty if used as surface soil materials in rehabilitation. For each soil type, the cut-off horizon boundary should be defined in simple terms so that the stripping operator can understand the instructions.

Gleyed soil mixed with “good” soil

[1] Gleyed soil materials are subsoils that are grey, blue or green in colour because of prolonged saturation with water
[2] Soft plinthic materials are subsoils with red, yellow or black mottles or concretions through more than 10% by volume of the horizon that have developed under fluctuating water conditions

Wherever possible, soils should be stripped and immediately replaced in a similar location in the catena (topographical slope) to their natural location. Thus red soils are best located on the crests, yellow-brown soils on side-slopes, sandy leached soils near the base of the slopes and melanic and vertic (dark and black cracking soils) in the wet areas at the base of the slopes. The guide should define the total volume of the different soil materials that will be available for rehabilitation and should also define the thicknesses in which the soil should be replaced in the various sections of the reshaped areas.

Soils should be stripped by horizon. The *ideal* situation would be to strip soils in at least three "lifts:

- Firstly, the surface soil horizons, which contain the seed bank, would be removed. Typically this would be 50-100 mm thick.
- Secondly, the rest of the "A" horizon – that portion of the surface soil that contains the organic matter – would be removed. Depending on the age, erosion exposure and rainfall regime, the "A" horizon thickness in total may reach 400-600 mm in thickness.
- Thirdly, the usable non-plinthic "B" horizon materials would be removed. These materials are physically suitable for rehabilitation but contain little or no organic matter and, accordingly, will not sustainably supply planted crops or grasses with nutrients if used as topsoil.

Three-layer stripping and replacement is not currently practised in South Africa.

Current "best practice", infrequently used, is to strip and replace soil in two layers. The organic enriched "A" horizon, which is usually 150-500 mm thick, is stripped and replaced separately from the usable "B" horizon material. In this case, the seed bank is spread throughout the replaced topsoil horizon and natural vegetation regeneration is slower than would be the case in the "ideal" situation.

In most cases, standard South African practice is to strip the "A" horizon and non-plinthic "B" horizon together, and to replace them together. This significantly dilutes the more fertile surface materials, and increases requirement for fertilisation and seeding. It is, however, the simplest to manage from an earthmoving point of view.

Soils should be replaced in catenal (i.e. position on the slope) locations similar to where they were stripped.

Unfortunately, it is rare for reshaped areas of the correct form to be available for topsoiling at the same time as soil stripping becomes necessary. This is when topsoil stockpiling becomes necessary. Guidance for soil stockpiling is given in the next section.

3.3. Strip a suitable distance ahead of mining at all times, to avoid loss and contamination

It is sometimes difficult to define what is meant by "a suitable distance" ahead of mining. There are two conflicting environmental imperatives at work here – firstly, the need not to strip too large an area ahead of mining, because this exposes the stripped surface to the risk of water and wind erosion, with the associated dust and water sediment pollution problems.

At the same time, if the stripping face is too close to the mining, it frequently results in the loss of valuable soil material. Contamination by overburden materials, particularly flyrock from opencast mining, also occurs. It is preferable to strip a little too much ahead of mining rather than too little, particularly where stripping is concentrated in the dry months so as to minimise the potential for compaction.

Soil lost because mining got too close to the stripping face

Soil contaminated by flyrock

As a norm, soil stripping should be kept within 3-9 months of mining, or between 50-100 metres ahead of the active mining face.

3.4. Supervise stripping to ensure soils are not mixed

Close supervision and monitoring of the stripping process is required to ensure that soils are stripped correctly. Common failings are stripping too little or too much. When too little, valuable rehabilitation materials are lost, when too much, good quality soil is contaminated with poorer quality and unsuitable materials which are frequently highly compactable and tend to cement when exposed at surface.

Risks of soil loss or contamination are particularly high when soil stripping contracts are purely issued on volume stripped, rather than on volume and quality. Monitoring requires assessment of the depth stripped, the degree of mixing of soil materials and the volumes of material replaced directly or placed on stockpiles.

3.5. Strip soils only when moisture content will minimise compaction risk

Most South African soils, other than the Vertisols, are highly susceptible to compaction. Compaction is usually greatest when soils are moist, so soils should be stripped when moisture content is as low as possible. Stripping and replacement of soil should be done during the dry winter months (summer months in Mediterranean climate areas of the southern and western Cape) when rainfall is at its lowest and soils are driest. Again, this is not always practical, and some soils have to be moved when wet. In this case, every effort must be made to minimise compaction by the methods used for soil stripping, stockpiling and replacement.

3.6. Strip and replace in one action wherever possible

Wherever possible, stripping and replacing of soils should be done in a single action. This is both to reduce compaction and also to increase the viability of the seed bank contained in the stripped surface soil horizons. Stockpiling both increases compaction and decreases the viability of the seed bank, and should only be done when no areas of reshaped mined land are available for direct placement.

3.7. Use shovel and truck in preference to bowlscraper

Bowlscrapers are ideal for creating roads or building dams – but far from ideal for stripping and replacing soils with a minimum of compaction. They are, however, still frequently used in the South African mining industry to move soils, particularly from stockpiles to rehabilitation backlog areas.

When used, their compactive effect can be reduced to some extent by only stripping and replacing soils when dry, maximising the thickness of soil layers placed per run, and running along the same wheeltracks.

Wherever possible, soils should be stripped and replaced using shovel (backhoe) and truck equipment.

Compaction is the single biggest limitation to the re-establishment of land use capability of rehabilitated soils and is currently the focus of a significant research effort.

Bowlscraper stripping soil

Stripping and replacement using shovel (backhoe) and truck

4. SOIL STOCKPILING

As far as possible, stockpiling of soils should be minimised and direct replacement of all stripped material encouraged. Where direct replacement is impossible, then soils have to be stockpiled in appropriate locations in an appropriate stockpile configuration.

While soils placed in compact stockpiles are degraded physically and chemically in cooler/wetter climates, the drier warmer climate of South Africa does not seem to pose the same quality reduction effects seen elsewhere.

Soils that have been in stockpiles for up to 20 years have provided a reasonable growth medium, as long as proper remediation techniques (tillage, fertilisation) have been applied to the rehabilitated soils. Nevertheless, the objective must be to minimise the quantity of soil stockpiled, the time it is stockpiled and the number of times it is rehandled.

- Locate soil stockpiles so that rehandle is minimised – they should not be moved after initial stripping unless being replaced in their final location in the rehabilitated profile.
- Ensure free draining location so as to minimise erosion loss and waterlogging
- Minimise compaction during stockpile creation. Keep stockpile soils loose, preferably by end-tipping, and limit stockpile height to prevent internal compaction. A logical maximum is the safe height that the material can be placed, without repeated traffic over already placed material. With equipment currently available on mines, this will restrict stockpile height to 4-5 metres maximum.
- Revegetate to avoid erosion losses.
- Ensure that stockpiled soil is only used for its intended purpose.

4.1. Locate soil stockpiles so that rehandle is minimised

Soil stockpiles should not be moved after initial stripping unless the soil is being replaced in its final location in the rehabilitated profile. This is because each rehandling damages soil structure and increases compactibility. Soil losses occur with each rehandling and additional cost is considerable. While it may cost more initially, it is better to place stockpiles in areas where they will not have to be moved. There will always be some soil that has to be stripped before any rehabilitated areas are available for direct placement – for example, soils stripped for roads infrastructure and boxcut development during construction – but these materials should be stockpiled as close as possible to where they are going to be ultimately used.

4.2. Ensure free draining location

Placing soil stockpiles in drainage lines has two major harmful effects: the soils become waterlogged and lose desirable physical and chemical characteristics; and the risk of loss of soil materials due to erosion is increased. Ideally, stockpiles should be placed on a topographical crest which provides free drainage in all directions. Alternatively, a side-slope location with suitable cut-off berm construction upslope is acceptable.

4.3. Minimise compaction during stockpile creation

Soils should be stockpiled loosely. The degree to which soils become compacted during stripping is largely dependent on the equipment used. If shovel and truck are used, the ideal is for soils to be dumped in a single lift. The use of heavy equipment over soil piles results in soil structure damage. If direct dumped soil piles are too low, then it is possible to increase stockpile height using a dozer blade or backacter bucket to raise the materials. Running trucks over the piles, or using bowlscraper or grader to level and shape stockpiles, is not recommended. When the only alternative to losing soil material is the use of unsatisfactory (i.e. bowlscraper) equipment, compaction damage can be reduced to some extent by stripping as thick a cut as possible and by dumping it as thickly as possible. In addition, deposition in a single track line may reduce to some extent the overall compaction of the dumped or replaced soil.

4.4. Stockpile management

Once established, stockpiles should be managed to ensure that losses from the piles are minimised and that additional damage to the physical, chemical or biotic content is minimised. There are several potential agencies which can harm stockpiles. They include erosion, “borrowing” for use for other purposes, contamination and water logging.

Stockpiles that will remain in location for more than one growing season and that have not revegetated naturally, should be revegetated to avoid erosion losses. To preserve the looseness of the stockpile (where this has been achieved by correct stripping and construction of the stockpile) fertilisation and seeding should be done by hand, by hydroseeding or aerially to prevent introduction of compaction. Where the stockpiles are already compact, the use of standard agricultural equipment to establish grass cover is acceptable.

Ensure that stockpiled soil is only used for its intended purpose. One of the greatest causes of loss of topsoil, when stockpiles are *in situ* for a long period, is their use for other purposes. Frequently they will be used for construction purposes (raising pad or foundation levels, creation of berms, etc) and this occurs most frequently when stockpiles are not clearly demarcated with warning signposts and monitored regularly.

Risks of contamination are also present. The dumping of waste materials next to or on the stockpiles, contamination by fly-rock from blasting and the pumping out of contaminated waters from the pit are all hazards faced by stockpiles. A detailed management and monitoring programme and an employee awareness programme will significantly reduce the risk of stockpile “robbery” or contamination.

5. INFRASTRUCTURE REMOVAL


Once mining has been completed, the processing facilities, accommodation and administration, mining, transport and storage facilities are usually surplus to the requirements of the ultimate land user. In some circumstances, certain portions of the existing infrastructure can be gainfully used after closure (for example, offices and workshops) and these structures need to be identified and protected.

Great care must be taken in determining which structures should be left for subsequent users as, frequently, the future land users are dazzled by the potential for uses which are not economically viable. Consequently, structures handed over in good faith become moribund, broken down and a hazard to health and safety. Although the handover of such structures may be legally sound, the failure of infrastructure that has been handed over will always be associated reputationally with the initial mining company.

After identifying the structures that can be gainfully and sustainably used after closure, the remainder of the structures should be removed so that the land can be converted to its final use. Infrastructure removal is a dangerous occupation and detailed attention must be paid to managing safety risks. A more detailed infrastructure removal guideline is contained in Appendix 4.

- Identify infrastructure items that may be of use to the future land users.
- In association with those users and the authorities, define what could be left, how it would be used and how sustainable that use would be.
- The remaining infrastructure should be assessed for its suitability for re-use/recycling.
- The re-usable items should be removed from the site.
- Hazardous material locations and deposits require specialised assessment and analysis to determine how these materials should be decontaminated and to ensure that all residual hazardous materials are deposited in officially-sanctioned hazardous waste deposit sites.
- Mining infrastructure must be rendered safe, all shafts sealed according to professionally engineered designs and DME requirements.
- Remaining structures should be demolished and demolition rubble removed or buried.
- The final landform agreed for the infrastructure areas should be created.
- All infrastructure rubble and residual foundations need to be covered with at least one metre of cover material. Best practice is to cover with 1 metre of inert cover material (which may be “B” or “C” horizon material that can be penetrated by plant roots), which in turn is covered with topsoil material.
- The infrastructure sites can then be formally included in the remainder of the minesite rehabilitation process.

5.1. Identify infrastructure items that may be of use to the future land users or is salvageable

In association with the persons who will be the ultimate land users and the authorities, assess all structures and determine which items can be left for their gainful use. This is a difficult activity, particularly when the mine site lies within a farming community, or is adjacent to an urban community, as many buildings can be seen as having value for storage after mine closure, or workshops that will be of value for maintaining farm machinery. In some cases, where significant amounts of accommodation and office space are available, it may be possible to establish an enterprise hub or accommodation centre.

However, South Africa is littered with examples of derelict mine infrastructure, where the controlling company handed the infrastructure over to the succeeding land users in good faith – but the ensuing enterprise was not a success. It is essential, then, that the viability of any project which will require the handover of mine infrastructure is carefully researched before the mining company agrees to the handover to the next land users. This should include adequate and appropriate legal input.

Frequently, retention of services such as roads, electricity supply, water supply, water treatment facilities (sewage plants) is requested. In each case, the probable future requirements of the ultimate land users and their ability to maintain the various infrastructures should be assessed. It is pointless, for instance, to leave a mine haul-road as access to a small farming location as its maintenance cost will far outweigh the benefit.

Likewise, sewage plants designed to cope with thousands will be overly expensive to maintain if only catering for a few hundred people. Whatever infrastructure that is handed over to subsequent land users must be correctly sized and financially viable to maintain.

The remaining infrastructure should be assessed for its suitability for re-use/recycling. Items such as cladding, roofing, electrical components, equipment, should be removed from the site prior to demolition occurring.

5.2. Make safe and decontaminate all hazardous material locations

All mine sites will have hazardous materials (pesticides, degreasers, hydraulic fluids, metallic sludges etc) in stores and stockpiles. The nature of these materials depends on the nature of the mining and processing that is being done.

Many mines currently undergoing closure started before the present focus on environmental management. Consequently, the older mine sites will have a range of hazardous material dump locations which may or may not have been identified and assessed.

For these older mines, a detailed survey of the possible location of hazardous materials, wastes and storage areas should be conducted. Hazardous material locations and deposits require specialised assessment and analysis, to determine how they should be decontaminated. All residual hazardous materials must be deposited in officially-sanctioned hazardous waste deposit sites. This may involve the removal of significant volumes of contaminated soil and overburden materials to officially registered hazardous waste sites.

5.3. Mining infrastructure must be rendered safe, all shafts sealed according to professionally engineered designs

Removal of all unwanted infrastructure and rendering this safe are basic legal requirements for mine closure. Where underground mining has been done, a key issue is the sealing and making safe of mine shafts, adits, ventilation tunnels and any other access routes to the underground workings. In all cases, the access routes must be sealed.

In the case of access or vertical shafts, the procedure involves the filling of the shaft, as far as possible, with inert rubble from demolition, or other waste materials. The shafts must be sealed with concrete seals, designed by a professional engineer and approved by the DME, and these should be positioned in unweathered rock to ensure their permanency.

There will be a requirement to install “breather” pipes for gas release, or for water release systems where the ultimate reestablishment of the water table will result in water decant from the shaft position. Finally, the seals should be covered with inert overburden material and topsoil, and then revegetated.

5.4. Remaining structures should be demolished and demolition rubble removed or buried

The infrastructure remaining after salvage should be demolished. Safety is a key issue in this activity, particularly where high structures are concerned, and care must be taken to push over all tall structures before final demolition occurs. In some cases, controlled explosion/implosion will be required. Concrete and brick structures are usually demolished using equipment fitted with hydraulic hammers.

Foundations should similarly be demolished, with the use of hydraulic hammers, and the rubble removed either to an adjacent rock dump, tailings deposit or shaft that has to be filled. Care must be taken to isolate any concrete structures with hazardous material contamination. This contamination may take the form of chemical toxicity, or radioactivity. Material thus contaminated will have to be deposited in appropriate hazardous waste disposal sites.

5.5. The final landform and soil cover agreed for the infrastructure areas should be created

Following removal of the infrastructure, the exposed underlying materials should be reshaped to create a gently-sloping, free-draining topography. Sealed shaft complexes should have a gentle whale-back shape to enhance runoff. Topsoil materials that were stripped prior to construction can be then be replaced, fertilised and ripped.

In some cases, where infrastructure was developed and constructed before the need to cater for removal at closure was apparent, foundations may be so massive that removal is impractical. In such situations, it is permissible to cover the structures with a minimum of 1 metre of cover material. This should be a combination of soft overburden or “B” horizon material covered with topsoil which, combined, will provide a potential plant rooting depth of at least 1 metre.

5.6. Include the infrastructure areas in the remainder of the minesite rehabilitation process

The infrastructure sites can then be formally included in the remainder of the mine site rehabilitation process. That is, these sites can now be revegetated and included in all post-closure monitoring and maintenance procedures.

6. LANDFORM CHANGES RESULTING FROM HIGH EXTRACTION MINING, THE ASSOCIATED ENVIRONMENTAL IMPACTS AND THEIR REMEDIATION

Subsidence in shallow areas of high extraction (HE) mining where the overburden is unweathered

Surface cracking from shallow HE mining

When underground mining is done using longwalling or pillar extraction, the back areas are left unsupported and are allowed to collapse. This results in subsidence at surface. The nature and impacts of this subsidence can be predicted and ameliorated.

6.1. Mechanism and extent of subsidence

As mining advances, the back areas collapse and the collapsed material fills the voids left by the mining. This collapse will continue until the resistance to compaction of the collapsed material equals the weight of the overlying material. The rate of collapse is relatively slow and it usually takes six weeks for 90% of total subsidence to occur, the remainder occurring over several years.

Because the collapsed material contains voids, the total depth of subsidence is significantly less than the total mining height. Typically, in South Africa, it is slightly less than half the mining height. However, when double seam mining is done, the additional subsidence that occurs as a result of extraction of the second seam is approximately 80% of the mining height of the second seam.

More accurate estimates of the extent and nature of subsidence can be made using the techniques of Van der Merwe and Madden (2002).

6.2. Surface impacts of high extraction mining

Surface impacts of subsidence due to longwalling or pillar extraction vary, depending on the depth of mining and the nature of the overlying materials. In cases where mining is deep and there is a significant thickness of soft material near surface, the impacts at surface may be almost imperceptible.

However, there will always be impacts on surface drainage and groundwater which will have to be managed. Where mining is shallower and surface materials are unweathered, surface impacts will be much more visible. Typically, the following impacts may occur:

- Ponding of water on the surface
- Increased make of groundwater
- Reduction of streambed water flows
- Surface cracking at zones of expansion and contraction
- Infrastructure damage, such as cracking of walls, damage to water pipes and electrical installations, damage to roadways, breaking or slackening of fences.

Subsidence and ponding from deep HE mining

6.3. Remediation

6.3.1. Ponding of water on surface

Trenching to dewater surface ponds is a common practice and is relatively simple in undulating topography.

Installation of cut-off drains to intercept upslope surface drainage will decrease the extent of surface ponding.

Drains need to be checked on a regular basis to ensure that they remain effective, particularly because of the residual subsidence, which may occur for two to three years after the initial subsidence phase.

Cut-off trenches decrease the extent of surface ponding

6.3.2. Increased make of groundwater

Groundwater make will increase, but this can be minimised by not undermining wet areas, by ensuring all surface ponding is drained and by ensuring that the areas overlying high extraction areas are well vegetated to increase evapotranspiration. Planting of trees to increase evapotranspiration is also an option.

6.3.3. Surface cracking

Where the cracks are large, inert material can be used to fill them. The fill material should be permeable to prevent the formation of sinkholes. More typically, surface cracks are small and can be effectively rehabilitated by agricultural deep ripping or, in more extreme cases, by dozer or backacter.

Surface cracks caused by pillar extraction

Rehabilitation of surface cracks using a backacter

6.3.4. Infrastructure damage

It is normal to relocate people away from all infrastructure areas while surface subsidence occurs, but frequently impacts are relatively small and easily repaired. In all cases, adequate budget must be provided for repairs to water and electrical supply systems, walls of buildings, fencing, and roadways.

7. LANDFORM RE-CREATION (SPOIL SHAPING)

Reshaping in progress

Reshaped profile

Landform re-creation (spoil shaping) is the process by which the mined overburden materials are placed and moved so as to create the “desired” final topography. *De facto*, cost considerations frequently prevent the full replacement of all mined-out materials back in to the original excavation and, in many open-pit operations, the resulting topography consists of an overburden dump and an excavation.

There remains considerable scope for the reshaping of both excavation and overburden pile to provide a final landform that will have improved post-closure usefulness. The key is early planning of the end land form to ensure that overburden materials are placed in the most appropriate location. While the current norm is to ensure that the final land-form is free-draining and has slopes such that erosion risk is minimised, the desired approach is to ensure that the final land form conforms as closely as possible to the agreed final configuration and blends in well with the surrounding landscape.

This is frequently difficult to achieve, as unpredicted variations in the mineral body frequently dictate changes to the mining plan, with often disastrous effects on the originally-selected landform. Changes to mining plans should be strictly controlled and their implications, in terms of change of final landform should be predicted and countered prior to the mining taking place.

One of the key uncertainties in final landform prediction is the bulking factor. Soft materials frequently compact by as much as 15%, while hard materials may expand by as much as 25%.

As a consequence of these factors, it is difficult to predict the final landform accurately and the standard commitment to landform re-creation should relate to agreed outcomes, such as the maximum slopes to be permitted over specific areas, and a commitment to maximise free surface water drainage.

- A post-mining land form concept should be developed at the planning stage. This should take account of expected bulking factors.
- This plan should allow the pre-mining proportions of land capability classes to be re-created, while also meeting water management requirements.

- Where the mining plan precludes the re-creation of the original topography, boxcut spoils, overburden dumps and final voids will be created. These final land forms must also be designed to maximise land capability and to meet water management objectives.
- Where slope length is excessive, use drainage channels and waterways to reduce erosion risk.
- Monitoring of the deposition of overburden materials and reconciliation of volumes moved in relation to plan should be done regularly – preferably on a monthly basis.
- The survey results should be used to correct bulking factors employed in the original planning exercise.
- All changes in mining plan should be analysed for their effects on final landform.
- Significant modifications to final landform will require modification to the mine EMP.
- Reshaping, following deposition, should be done taking into account surface water drainage and erosion risk considerations. In addition, water balance issues must be addressed. Adjusting the size of open water bodies can ensure that evaporation matches infiltration into the pit area, thus minimising seepage or decant of polluted water.
- An integrated approach is required to ensure that the optimal balance between conflicting final requirements (for instance, land capability and evaporative surface) is achieved.

7.1. Develop the post-mining conceptual land form at the planning stage

The greatest amount of surface disturbance and, hence, the greatest need for mining residue reshaping, usually occurs when mining is done by strip-mining, open-pit or block caving methods. Longwalling usually has a lesser impact, but in shallow situations it can have severe disturbance effects at surface and will invariably affect surface water flow.

The mining method used is normally dictated by the nature of mineral reserve and is usually not changeable. However, with mineral reserves that are relatively shallow, the possibility exists either to remove the overburden material and place it in an overburden dump on undisturbed surface; or to replace the material in previously excavated areas. The latter method results in a final topography that is closest to the original.

Whatever the options are, the conceptual framework for the final topography will have been set during the permitting phase and this will be the end-target to which the mine will have to work. The final topography will be a function of original topography, mining method and reshaping strategy.

In the planning phase, the land form design must take account of:

- Volumes of ore or product removed from the pit.
- Expected bulking factors for the remaining materials.
- The requirement to create a final surface with a satisfactory surface water drainage pattern.
- The need to keep water out of the mined area during the operational phase using constructions that can still be effective post-closure.

The diversion systems designed to keep surface water out of the pit for operational requirements may not be suitable for the post-mining phase. As far as possible, though, operational diversions should be designed to remain effective post-closure.

The post-mining land form commitments should relate to broad concepts (free drainage and provision of areas with certain slope characteristics and, hence, land capability) rather than to the provision of a geo-referenced detailed final design that may be economically impossible to achieve. Modelling has, however, proved to be of significant value when used to determine how to modify existing rehabilitated topography to attain final closure objectives in the most cost-effective way (see Appendix 5: Final landform, modelling, drainage and sustainability).

7.2. Land form design to achieve land capability and land use class commitments

The final design needs to meet the commitment to provide, at closure, areas with certain land capabilities. Land capability classification depends on a number of factors – the most important of which relate to topography and soils. For the higher capability classes (arable and grazing), slopes need to be sufficiently gentle to prevent erosion of the replaced soils at greater than sustainable rates.

The erodibility rate depends on several factors, such as regional rainfall intensity and soil type, so that a standard slope cannot be recommended for the whole country.

However, for rehabilitated areas in the Mpumalanga Highveld, standards have been set by various companies, who use a slope of not more than 1:5 or 1:7 for grazing land and not more than 1:10 or 1:14 for arable land. The erodibility of various slopes and, hence, the maximum slope for long-term sustainability are defined more completely in Appendix 8.

Land reshaped to meet arable capability

Excessively steep slopes reduce land capability class. However, there is also a minimum slope that is acceptable. This is because, with currently used overburden handling techniques, materials that are dumped undergo secondary, differential settlement. This can result in an undulating topography with frequent blind hollows in otherwise relatively level rehabilitated land.

While this may not be an issue where rainfall is relatively low and drainage through both soil and overburden is good, in the majority of cases, impeded drainage results in the creation of many “swampy hollows”, which significantly reduce the land’s usefulness for mechanised field crop production, and will result in the downgrading of capability classification from arable to grazing or wilderness. It is easier to create free drainage even where secondary subsidence occurs if the general slope of the land is in excess of 1%. The detailed definitions of the simplified land capability classes for mining are given in Appendix 3.

7.3. Designs for boxcut spoils, final voids and overburden dumps

Boxcut spoils, pre-rehabilitation

For some open-pit mines, it has not been and will not be possible to replace overburden materials into the mined-out space. The result, in the case of strip mining, is the creation of boxcut spoils (the piles of overburden created when the first mining cut is made) and a final void (the final cut hole, where there is no material available to fill the void.).

Boxcut spoils, post-rehabilitation

In open-pit mining, all overburden materials from the pit are dumped in an adjacent overburden dump. The end result of mining in this case is the creation of a large hole (the final void), with an adjacent overburden dump.

Reshaped final void

With boxcuts, voids and dumps, basic requirements and principles for topographical reshaping remain the same. They are to minimise slopes to maximise potential land capability and to minimise erosion risk. Slopes required to minimise erosion risk can be calculated from slope length, surface soil characteristics, profile drainage and rainfall intensity.

Resistance to erosion can be enhanced by modifying slope design. The slope inclination should be maximised at the top of the slope (where water accumulation is less) and minimised towards the foot of the slope (where water accumulation is more). This mimics slopes found in nature.

There is another factor of major significance in determining the final topographical requirement. This is the post-closure water balance and the need to provide sufficient evaporative surface in open water bodies to match the pit water "make" In this way, seepage of polluted water out of the pit can be minimised.

7.4. Designs for drainage channels on large overburden mounds or in rehabilitated areas with excessive slope length

The ideal is to avoid the construction of drainage channels on rehabilitated ground. This may be possible where:

- Profile reshaping and soil replacement are done during the dry months of the year
- Slopes are short, and
- Stabilising vegetation cover grows with the first rains.

However, this is frequently not the case and erosion control structures have to be inserted into the rehabilitated profile to control runoff water flow and minimise erosion.

There are a number of surface water drainage systems that are in common use and the design requirements to deal with particular climatic conditions and soil and slope characteristics are well known, tried and tested in the "normal" (i.e. unmined) condition (see Appendices 7 and 8, planning surface drainage and surface drainage structure design).

The difficulty lies in the practical application of these designs to rehabilitated land. Many well-designed (by normal standards) surface water drainage systems have actually made erosion worse on rehabilitated land.

The key problem is the differential settlement that occurs as mine spoils consolidate. Settlement can take many years to complete. It is usually greatest in the first few years after rehabilitation but another "spurt" of uneven settlement occurs after mining stops, whereupon the water table tends to re-establish and the wetting-up of the overburden materials results in further settlement.

To counter this, slopes used within the drainage "contour banks" must be significantly steeper than their equivalents on unmined land and the batters must be higher. Whereas slopes of 1:200 are frequently used for contour drains on unmined ground, on rehabilitated land slopes should not be less than 1:100. In many cases, slopes of 1:60 are strongly recommended. These steeper slopes may result in some scouring within the channel itself, but the risk of the contour banks or drains breaking is greatly reduced.

7.5. Monitoring of the spoil reshaping process should be continuous

Regular reconciliation of overburden volumes moved in relation to the mining work programme should be done. Where possible, survey results should be used to correct bulking factors employed in the original planning exercise, so that conceptual planning can be improved. It is most important to ensure that spoil deposition is done according to plan and that spoil reshaping is also done to specification. While the frequency of review or monitoring of post-deposition topography may justifiably vary from site to site, it must be frequent enough to ensure that any major deviations from the planned post-mining topography are identified soon enough to enable them to be corrected. Depending on the rate of pit development, formal review should be done on a monthly, quarterly or annual basis.

7.6. Assess the effects of changes to the mining work programme on final landform

All changes in mining plan should be analysed for their effects on final landform design. Significant modifications to final landform will require modification to the mine EMP, which will have to be resubmitted to government for approval.

8. SOIL REPLACEMENT

Replacement of topsoil

The benefit from topsoiling and fertilisation – good growth

Once the final land form has been created, soil replacement can begin. The timing of when best to replace soil is a matter for debate, as in many instances, the re-created landform is subject to ongoing settlement for some years after the reshaping has been completed. This resettlement, theoretically, accelerates after final pit closure due to the re-establishment of water-tables, with the resultant wetting of surfaces and consequent repacking and compaction of the deposited materials. This may result in significant surface irregularity in relation to the agreed final land form and may result in impeded drainage and surface soil waterlogging issues. However, on balance, early replacement of soil is the desired option as it should minimise the need to stockpile soil and increase the proportion of soil stripped and replaced directly.

Compaction is the greatest single problem which limits the effectiveness of rehabilitation in South Africa today. For instance, virtually all of the 40,000 hectares of coal strip-mined land that has been rehabilitated to date in the Mpumalanga Highveld suffers from unacceptably high bulk density and its associated problem of reduced rooting depth. Many of the South African soils are particularly susceptible to compaction, but there are things that can be done to minimise that compaction. Appendix 7: Soil compaction and its alleviation, summarises our current understanding of the causes, effects and mitigation of mining-induced compaction.

Soil horizons should be replaced in the same sequence in which they are dismantled. Thus, the usable subsoil material is replaced on the reshaped spoil, the underlying topsoil material (stripped from depths of 100 to 400 mm) is replaced next and, finally, the surface 100 mm of soil is replaced to return the seed bank and ensure natural revegetation with the species that were originally in the area. The problem with this concept, though, is that each horizon has to be replaced in sequence and, as a result, each layer will be subject to compaction during the replacement and smoothing processes prior to the placement of the next soil layer – all of which introduces compaction. *De facto*, in South Africa, the sequential removal and replacement of soil layers is not practised. Soils replaced by shovel and truck are replaced in a single "lift" and, while the potential exists for bowlscraper-assembled soil profiles to be done using soils in the correct sequence, this is not current practice in South Africa.

Accordingly, the following list of actions reflects current South African soil replacement best practice:

- Soils, which should have been stripped according to form, should be replaced according to a pre-existing plan.
- A soil reserve should be retained to repair localised surface subsidence areas.
- Compaction should be minimised by use of appropriate equipment and replacing soils to the greatest possible thickness in single lifts.
- Soils should be moved when dry to minimise compaction. If they have to be moved when wet, shovel and truck should be used as bowlscrapers create massive compaction when moving wet soils.
- Where multi-layer soil profiles are re-created, running over the lower layers with heavy equipment should be minimised.
- Minimise compaction during smoothing of replaced soils by using dozers rather than graders.
- Following placement, all soils should be ripped to full rooting depth.
- Where natural revegetation is not possible, the soils should be tilled to produce a seed-bed suitable for the plant species selected for seeding.

8.1. Soils, which should have been stripped according to form, should be replaced according to a pre-existing plan

As far as possible, soils should be replaced in similar locations on the re-created slope to those they occupied in the original slope. Thus, red and yellow soils belong on the crest and upslope areas, grey soils with hydromorphic characteristics belong on the lower slopes and hydromorphic clays belong in the bottom lands. This is required so that the replaced soils encounter moisture conditions that are related to their physical characteristics.

8.2. A soil reserve should be retained to repair localised surface subsidence areas

Where significant thicknesses of overburden materials have been removed and replaced and the replacement has taken place without overburden compaction, the resulting reshaped land will contain zones with differing void spaces. With time, the materials will settle as they wet up or become weathered. This “differential settlement” results in depressed patches that tend to become waterlogged. One method of remediation is to retain a stockpile of soil material to fill in the depressions, thus ensuring that satisfactory surface draining will be maintained.

Surface subsidence areas that have become waterlogged

The quantity of soil that should be retained for such “repair” work will differ, depending on the susceptibility of the rehabilitated profile to “slump” over time, and is best derived from practical experience. In the initial phases of rehabilitation, however, where such knowledge does not exist, 5-10% of total soil removed should be retained for repair work.

8.3. Compaction should be minimised by use of appropriate equipment and replacing soils to the greatest possible thickness in single lifts

Compaction is the greatest single factor limiting the effectiveness of replaced soils and this is usually caused by inappropriate replacement methods, applied at inappropriate times. Equipment used to replace soils has a major effect on compaction levels. The ideal is the use of soil spreading methods that do not involve heavy machinery traffic over rehabilitated areas. Conveyor systems with spreaders are an example of such a system.

Topsoil replacement by bowlscraper increases compaction. Ameliorate by minimising travel over soil, depositing soil as thickly as possible

At present the technology of soil replacement in South Africa is limited to the use of either shovel and truck or bowlscraper equipment. Shovel and truck is the preferred method as it introduces less compaction. The bowlscraper runs directly over the material being replaced and, in most cases, soil thicknesses being replaced require that multiple runs are taken to replace the full thickness of soil. Bowlscrapers are incapable of replacing more than 250 mm of soil in a single lift and, for arable purposes, more than 600 mm is required.

With truck deposition, the full thickness of soil required can be replaced in a single lift, with no need for the heavy vehicles to travel over the replaced soil material. However, replacement by truck requires careful management to ensure that the correct volumes of soil are replaced. The resulting surface consists of large numbers of discrete soil piles that normally will require the use of equipment to “smooth” the surface prior to re-establishment of vegetation.

Topsoil replacement by truck reduces compaction

8.4. Soils should be moved when dry to minimise compaction

The degree to which soils become compacted is highly dependent on the soil moisture content. Each soil has a moisture content at which compactibility is maximised – and the aim at all costs must be to avoid disturbing that moisture content when moving soils. As a general rule, the drier the soil, the lower the compactibility and, accordingly, all soil stripping and replacement work should be done in the dry season.

8.5. Where multi-layer soil profiles are re-created, running over the lower layers with heavy equipment should be minimised

Currently, there are no known cases in South Africa of large-scale rehabilitation where a deliberate effort has been made to replace soil materials in the same sequence as they occur in nature. However, the concept is well established internationally and would result in significant benefits in the re-establishment of the natural soil fertility recycling processes, as this would result in the organic-enriched, chemically fertile, soil zone being located in the zone of maximum plant root exploitation. However, while multi-layer replacement is the ideal from the chemical and biotic viewpoint, it is the worst option from the compaction point of view, as each layer has to be deposited and levelled prior to the next layer being replaced – all of which increases compaction. Compaction can be reduced by correct use of equipment, minimising travel over the re-created profile (to some extent), but also by only moving soils when they are dry

8.6. Smooth the replaced soils using dozers, rather than graders

Initial smoothing of the rough soil surface is either done by grader (the less-preferred option, as it causes compaction) or dozer, with dozer being the preferred option as tracks exert a lower bearing pressure and therefore compact less than wheeled systems.

Replaced soil being smoothed by dozer, the preferred method

Highly compact soil surface – smoothed by grader

Where the objective is natural revegetation and soils have been stripped and replaced directly with the seed-containing horizons on top, there should be no requirement for seed-bed preparation. However, the majority of soil stripping and replacement results in the mixing of top- and sub-soil, diluting the seed bank excessively, therefore necessitating the creation of a seed-bed for planting purposes.

9. SOIL AMELIORATION

Very compact soil: ripping has only loosened the surface 200 mm – roots cannot penetrate deeper

Compaction at soil/spoil interface: note the roots bending at interface and damaged roots in the spoil

Replaced soils require both physical and chemical amelioration. From the physical perspective, this is because the actions of soil removal, stockpiling and replacement result in high levels of soil compaction. There are 40,000 hectares of rehabilitated land in the Mpumalanga Highveld, where compaction has downgraded the land capability to support crop and pasture growth as a result of severely-reduced rooting depth.

While prevention of compaction is better than cure, current prevention methodologies and equipment choice and replacement methods are ineffective at prevention of compaction. Consequently, there is a need for virtually all reconstituted profiles to be loosened. This is usually achieved by deep ripping, with variable success, and this activity is a current focus for research by the coal mining industry.

From the chemical perspective, the stripping of the surface soil (topsoil) in a single, organic-rich, layer, results in the dilution of the fertility that is concentrated in the surface few millimetres throughout the underlying 300-400 mm of relatively impoverished material. The situation is worsened in those cases where topsoil and subsoil are mixed, or where subsoil alone is replaced. In this case, additional amounts of fertiliser application become necessary.

- Deposited soils must be ripped to ensure compaction is reduced.
  - Correct soil moisture content for maximum disturbance must be established.
  - Ripping must penetrate through soil into the underlying overburden materials.
  - Acceptable soil bulk density values must be determined and progress monitored against target.
- Surface tillage should produce an acceptable seedbed for the vegetation to be established.

- Soil fertility should be restored.
  - Soils should be analysed for plant nutrient content.
  - Fertiliser should be applied to raise soil nutrient content to the desired levels.
  - Rates of fertiliser to be applied frequently exceed normal agricultural dressings.
- Immobile fertilisers should be incorporated into the plant rooting zone.
- Maintenance dressings of fertiliser should be applied annually until the soil fertility cycle is restored.

9.1. Deposited soils must be ripped to ensure compaction is reduced

While a range of other methods for the amelioration of compaction have been suggested (use of plants with greater root penetration abilities, use of organic ameliorants, for instance) to date in the South African context deep ripping with appropriate equipment remains the sole method of effectively reducing compaction.

Ripping technology is well known in the agricultural industry. However, the degree of compaction and the depth to which compaction is achieved in the mining industry far exceed the levels of compaction normally found in agricultural soils. In addition, the surface of the underlying spoil or overburden material is usually also compacted and the soil/spoil interface also frequently acts as an impenetrable barrier to deep root penetration. The requirement, then, is to rip through the overlying soil material and into the underlying spoil material.

Agricultural rippers cannot penetrate the soil deeply enough

Correct soil moisture content for maximum disturbance (shattering effect) must be established, as must the desired spacing between rip lines. Due to the extreme levels of compaction encountered, ripping normally requires the use of a dozer with one or (at a maximum) two ripper tines, operating to a depth in excess of 1 metre. These tines are usually mounted directly behind the dozer tracks – which again raises an issue, as the spacing between dozer tracks is usually in excess of the desirable width between rip lines. The desirable rip pattern will be determined by the “breakout” pattern of the disturbance caused by each ripper tine.

Dozer rippers, mounted behind tracks, can penetrate the soil deeply

The breakout usually radiates outwards and upwards at an angle of some 45^0 from the ripper tine, but the zone of soil affected (the breakout zone) can be increased by fitting wings to the ripper tines.

Dozer rippers penetrate the soil deeply

Effects of dozer deep ripping in a drought year

Ripping must penetrate through soil into the underlying overburden materials in order to ensure free drainage and to ensure root penetration. This may result in contamination of the overlying soils by large rock fragments dragged up from the spoil layers and a number of these may end up on surface. For those rehabilitated areas that must be returned to row-crop production, the removal of large rocks, usually by hand, will be necessary. The benefit derived from decompaction and improved root penetrability far outweighs the inconvenience of stone-picking. For those areas due to revert to natural grazing, the presence of loose rock on surface should not pose a problem.

Acceptable soil bulk density values must be determined and progress monitored against target (see Appendix 14).

9.2. Surface tillage should produce an acceptable seedbed for the vegetation to be established

For those rehabilitated areas that are due to return to agricultural use, generating a tilth suitable for vegetation establishment relates principally to the need for the establishment of improved pastures or row-crops. In some cases, natural revegetation will be permitted to occur and, provided the natural surface horizons have been returned in the correct sequence and the surface layer was stripped and returned directly, there may be no need to undertake the procedures of generating a seedbed tilth. In this case, the rough surface left after ripping should not be subjected to further tillage. Items of equipment needed to establish the appropriate tilth include spring-time harrows and disc harrows. Standard agricultural equipment and techniques are appropriate for this activity.

9.3. Soil fertilisation

Where the surface soil is stripped separately from the subsoil and is replaced at surface, the previous fertility regime would have been preserved. This may or may not be a good thing because, in many soils, fertility and organic matter are concentrated in the surface soil horizons and, in highly weathered soils, the subsoil material is acid and very low in nutrients. If the objective is to re-establish the ecological *status quo*, the segregation of nutrients is a good thing and the chance of re-establishment of the original vegetation cover will be improved. In most cases, the surface soil is not stripped separately from the subsoil material. This results in significant dilution of both organic matter and chemical fertility in the surface layers of the rehabilitated soil. It does, however, have the advantage that the organic matter and fertility status of the replaced subsoil are improved slightly.

For the practical purpose of re-establishing good plant growth, a fertile surface soil material must be reinstated. The immobile chemical constituents (such as calcium, magnesium and phosphorus) are relatively easy to replace with a single application. The mobile constituents, in particular nitrogen and to some extent potassium, are not. In undisturbed soils, nitrogen fertility is a complex issue that revolves around the presence of organic matter. In the absence of sufficient organic matter, the nitrogen cycle is disturbed and, for several years following rehabilitation, additional nitrogen fertilisation will be required to ensure plant vigour. Organic matter build-up in soils is a slow process. It can, to some extent, be speeded up by the addition of large amounts of organic ameliorants such as sewage sludge, manure or compost, but the majority of these additions are broken down by microbial action and are lost.

In order for plant growth on the rehabilitated profile not to be restricted due to soil infertility, soils should be sampled (see Appendix 9: Sampling for soil analysis) and analysed for plant nutrient content. Fertiliser should be applied to raise soil nutrient content to the desired levels. In rehabilitated soils, rates of fertiliser to be applied frequently exceed normal agricultural dressings. This is because the rehabilitated soil is a mix of topsoil and subsoil materials and, in heavily-leached profiles found over much of South Africa, these heavily-leached subsoil materials have a greater ability to “bind” added nutrients, making them less available to plants (see Appendix 10: Guidelines for fertilisation and liming of rehabilitated soils).

9.4. Immobile fertilisers should be incorporated into the plant rooting zone

While some plant nutrients are relatively mobile (e.g. nitrogen and potassium) and will leach down into the plant rooting zone, others are less mobile. In particular, calcium, magnesium and phosphorus tend to be immobile and, for full effectiveness, these need to be incorporated into the plant rooting zone. This can be done during the final surface tillage.

9.5. Apply maintenance fertiliser dressings until the soil fertility status is restored

Frequently, a single pre-planting application of fertiliser is inadequate to restore soil fertility cycles. This applies to soils with low organic matter content and, in particular, to subsoil materials. In these cases, repeated applications of nitrogen and potassium fertilisers may be required for some years until fertility cycles are restored. Typically, this may take in excess of five years. More details are contained in Appendix 10.

10. DEALING WITH PROBLEM AREAS

Provided proper planning and management of the mining and rehabilitation actions occur, problem areas should not develop. However, there are situations which require revegetation but no topsoil is available, or where the soils that are available are heavily polluted.

These require specialised rehabilitation techniques to establish a growth medium that can sustainably support vegetation growth. Key issues include penetrability to plant roots, water holding capacity, toxicity and plant nutrient supply.

Rehabilitation without topsoil is particularly difficult to achieve under arid conditions and each situation has to be assessed on its merits. Listed below is a generalised method of approaching rehabilitation of problem areas. The key, though, is to identify such areas and seek expert help in devising a sustainable mitigation programme.

- Assess the problem area and analyse the materials available for rehabilitation.
- Evaluate specialised rehabilitation options. Will *in-situ* remediation be possible? Will encapsulation and isolation be the only solution? Will specialised plants be able to survive?
- Assess whether the proposed solutions fit in with the long-term land use plan.
- Ensure that all actions are fully documented and that this information is stored in a location where it will remain easily available, post-closure.

10.1. Assess the problem area and analyse the materials available for rehabilitation

The affected area should be assessed to determine the nature and extent of the problem. Types of issues encountered include lack of topsoil, contamination of topsoil with oils and grease, acidity, salinity and chemical toxicity. In all cases, an analysis of the affected area should be done.

10.2. Evaluate specialised rehabilitation options. Will *in-situ* remediation be possible? Will encapsulation and isolation be the only solution? Will specialised plants be able to survive?

Assess the options for rehabilitation of the affected area. Key questions to be answered include whether the problem area materials can be left *in situ*, or whether they need to be disposed of in a true HH waste disposal site.

In some cases, encapsulation of the offending material is possible and materials suitable for encapsulation are available on site. In others, the requirement will be to remove the offending materials and either treat them or dispose of them in an appropriate hazardous waste site.

The four most common issues encountered are lack of topsoil; acidity; metal toxicity; oil contamination; for all of which techniques are available to mitigate impacts and to assist with revegetation.

10.2.1. Lack of topsoil

Where no topsoil is available, it is frequently possible to establish plant growth in other overburden materials. It is essential that these materials have a satisfactory physical structure. They should be sufficiently porous to store and release water and they should not cap or crust excessively on surface exposure. If these types of material are available, re-establishment of sustainable vegetation will require the application of fertilisers and the establishment of a process whereby the re-development of the natural soil fertility cycle can begin. This requires the use of organic or inorganic fertilisers at establishment and also in regular maintenance applications for a number of years until natural nutrient recycling occurs. Plants used to establish vegetative cover in these conditions frequently are very different to the surrounding natural vegetation and, accordingly, while objectives regarding vegetative cover may be achieved, those regarding species composition may not.

10.2.2. Soil Acidity

Many soils in the higher rainfall areas are naturally acid. However, many of the minerals mined are associated with sulphide minerals, which, on exposure to atmosphere, oxidise producing sulphuric acid. Soils can be affected by acids either by leaching with highly acid waters, or by capillary action which raises the acidity from underlying sulphide containing materials upwards through the overlying soil profile. Acidity moving through a soil causes both chemical and physical composition changes. A key aspect for rehabilitation is to ensure that the source of the acidity is removed so that recontamination will not occur.

Spreading lime on acid-generating spoil

This is simple enough where the contamination is caused by surface flow of acid water, but for capillary rise there is little that can be done other than to reconstitute the rehabilitated horizons to prevent capillary action. This can be achieved by introducing a “capillary break” between the offending acid-generating horizon and the overlying soil material – i.e. encapsulating the acid-generating material (which should have been done in the first place) – or introducing a gravel or coarse sand layer which will prevent upward movement of the acid water. Where suitable materials for a “capillary break” are not available, heavy applications of lime have been spread on top of the acid-generating material to neutralise acidity raised by capillary action.

Severely acidified soils can be treated with limestone. However, for this limestone to be effective, it has to be incorporated throughout the acid soil horizon. There is no leaching of lime downwards. Accordingly, the entire thickness of acidified soil has to be mixed with the applied lime. This should be done by deep ploughing. After liming, the affected soils usually suffer from mineral imbalances. In particular, trace element deficiencies arise due to these elements having been leached from the soil by the acid water and due to the immobilising effect of the pH rise resulting from the heavy applications of lime on the small amounts of these trace elements that remain after acidification. Typically, this problem manifests itself as a zinc deficiency in South Africa.

10.2.3. Metal toxicities

Soils may be naturally high in particular metals (for example, there are nickel-rich soils associated with some ore bodies) or they may have become high as a result of deposition (for example, excessive levels of copper, where deposition has occurred from smelter emissions). While plant availability of these toxic nutrients can be manipulated to some extent by the application of other chemical ameliorants (for example, lime reduces copper and zinc availability), it is usually the case that simple chemical amelioration cannot correct the situation. However, it is usually possible to obtain a vegetative cover by use of plant species that are tolerant to an excess of the particular metal concerned.

Some attempts have been made to use plants to extract the metals concerned. For example, a nickel-accumulating plant species has been used to abstract nickel from high nickel soils and the resulting plants have been processed through the smelter to recover the metal content. However, this type of solution to the problem is rare.

10.3. Assess whether the proposed solutions fit in with the long-term land use plan

In-situ amelioration may well provide a solution in terms of vegetation cover and erosion prevention. The key question is whether the required intervention contravenes some other objective in the mine rehabilitation plan. While small areas of problem soil will not constitute a significant change in the overall scheme of things, if the problem areas are extensive, it is clear that there has been some major lack of understanding in the initial planning exercise and formal changing of the mine rehabilitation plan through an EMP revision process will be required.

10.4. Ensure that all actions are fully documented and that this information is stored in a location where it will remain easily available, post-closure

One of the biggest problems, when facing closure, is to determine exactly what has been done historically to correct a problem situation. It is essential that all corrective actions be documented and the records stored for future availability. Provided an effective EMS with good procedures is in place, and particularly if the EMS is certified to ISO14001, then a document control system will be in place to ensure that such records are kept.

11. REVEGETATION AND BIODIVERSITY RE-ESTABLISHMENT

Rehabilitated land restored to improved pasture

Establishing vegetation on steep slopes with kikuyu sod, seeding and mulching

There has been a tendency to view revegetation as part of the physical stabilisation activity and, accordingly, in certain sectors of the industry, revegetation standards employ “seed cocktails” – principally grasses – that establish rapidly and provide excellent protection against surface erosion. While this will be the desired end-product in lands designed for ultimate arable or grazing end-use, it may not be the best approach in areas where other biodiversity objectives have higher priority. The revegetation objectives should be set to meet the post-closure land uses that have been agreed for the site.

The end land use and, hence, the vegetation requirements, will have been set during the Public Participation Process in association with the end-user communities concerned. Defining the boundaries for mining company responsibility for biodiversity issues is becoming increasingly complex and the issue has been addressed in Appendix 12.

Alien invasive species have proved to be a major problem in many mining areas. One of the key objectives in the revegetation and maintenance programmes for mined land is the control or eradication of alien invasive species.

Wattle infestation of rehabilitated land

- Species selected for rehabilitation should meet the biodiversity objectives.
- Rehabilitation species selection must be based on practical considerations.
- Appropriate methods should be used for vegetation establishment.
- Planting should be done when climatic conditions are most likely to ensure success.
- Where specialised biodiversity objectives occur, each situation differs and general guidance is worthless – consult your expert!
- Good guidance is contained in the ICMM/IUCN good practice guidelines for mining and biodiversity.

11.1. Revegetation objectives

The revegetation objectives should be set to meet the post-closure land uses that have been agreed for the site. These could be the re-establishment of the native vegetation, erosion control for the protection of water resources, establishment of high quality grazing or the preparation of lands for arable use.

Species selected for rehabilitation establishment should provide protection from erosion and meet the biodiversity objectives. However, the primary objective of revegetation is the reduction of soil loss to a minimum. Rehabilitated soils in most cases are inferior to the natural profile (due to compaction, mixing of surface with subsoil horizons, etc).

As a result, they are less satisfactory as a plant growth medium, having lower organic matter content, reduced chemical fertility, degraded physical condition and depleted microbial populations.

Accordingly, even where crop production is the ultimate objective, it is essential to keep the land under permanent vegetative cover for a number of years to re-establish organic carbon status and the natural nutrient recycling processes.

11.2. Practical considerations for rehabilitation species selection

A series of criteria for the selection of appropriate species for rehabilitation was listed by John de Villiers in *"Guidelines for the rehabilitation of land disturbed by coal mining in South Africa"*, 1981. These remain as valid today as they were then:

(a) Only use species that are well adapted to local climatic conditions and post-establishment method of use
(b) Perennial species should form the basis of any revegetation programme
(c) At least one species used must provide rapid and dense ground cover during the establishment season
(d) Species selected must be tolerant of the adverse soil conditions (e.g. acidity, metal toxicity, levels of drought) present
(e) Good quality planting material or seed must be readily available
(f) Local experience regarding the establishment and maintenance of the species selected is important
(g) Preferred species should have a larger biomass and prolific root system
(h) As areas of rehabilitation expand, maintenance costs increase, so species selected should be those with minimal maintenance cost, or with production and financial returns that far exceed the cost. In general, management of farming enterprises within mining companies is poor, so the tendency should rather focus on the modification of species composition towards stable, low-maintenance ecosystems.

11.3. Methods of establishing vegetation

A range of methods are used, depending on vegetation goals. In common use are seeding, hydroseeding, seedling planting, transplanting, natural recolonisation and direct topsoil return.

11.3.1. Seeding with commercially-available seed

For the majority of South African situations, where the re-establishment of the full range of native species is not the prime objective, seeding is the commonly-used method. Appropriate commercially-available seed mixes have been established for various climatic and soil combinations and these have proved effective in generating a rapid erosion controlling cover that is sustainable under normal management conditions as, for example, the seed mixes used for perennial pasture establishment in the Anglo Coal strip mine operations in the Mpumalanga Highveld.

11.3.2. Seeding with locally collected seed

Locally collected seed will be fully adapted to the local climate and soil conditions, thus improving chances of success. Planning for collection should begin at least 2 years prior to establishment to ensure that enough seed can be sourced. Many of the indigenous species (for example, *Themeda triandra*) need treatment (heat, smoke and scarification) to initiate germination. More recently, gel planting has been tested as a technique for improving indigenous species re-establishment.

11.3.3. Direct soil replacement

Direct replacement of soil with windbreaks to prevent wind erosion

Natural re-establishment

Less frequently, the objective is the restoration of previous species composition. In this case, direct topsoil replacement is a valuable technique which has been practised, for example, at Namakwa Sands in the Western Cape. While a significant proportion of the originally occurring plant species can be established in this way, there remain some “recalcitrant” species that require specialised treatment. In windy areas, such as the Western Cape, windbreaks are required to retain replaced soil.

11.3.4. Methods of spreading seed

Spreading has been done by hand, by tractor mounted seed spreader, by hydroseeding, aerially and in mulch layers, particularly for *Themeda* and *Hyparrhenia*.

11.3.5. Planting of seedlings

Not frequently used in South Africa, the use of plug seedlings for establishment of islands of species has been done experimentally, again to stimulate the reintroduction of *Themeda* to the Mpumalanga coalfield rehabilitated areas.

11.3.6. Planting vegetative material

Planting of runners has been used for the establishment of kikuyu and star grass; planting of *Vetiveria*, using slips, has also been done. All require hand-planting in South Africa, as sprig planters are not commercially available. More detail on plant propagation methods is included in Appendix 11.

11.4. Planting should be done when climatic conditions are most likely to ensure success.

In general, planting is most successful when done at or immediately after the first rains and into freshly-prepared fine-tilled seedbeds (providing the soil material is not prone to crusting). To stimulate germination, water retention in the seed zone is essential and can be aided by the use of light vegetation mulches.

11.5. Vegetation maintenance

Once established, vegetation requires regular maintenance. When low-fertility soils and overburden material constitute the growth medium, vegetation maintenance requires regular application of plant food, either in the form of inorganic fertilisers or manure, until the natural fertility cycle has been restored.

Good establishment of *Hyparrhenia* is an indication of a move towards sustainability

This may take several years to achieve and has not been the subject of research locally. Empirically, the norm has been to continue fertilisation annually for at least three years and, more often, for five years. In some cases, however, successful and sustainable vegetation cover has been achieved through the application of a single pre-planting application of fertiliser.

Grasses require some form of use. If not regularly defoliated they become moribund and die off, thus exposing the soil to erosion. Defoliation is normally done by grazing or by mowing. In some instances, controlled burning has been used. However, with current concerns of greenhouse effect, this last option is falling into disfavour. Some ecosystems, however, require fire for their propagation and perpetuation, and burning at strictly defined intervals may be unavoidable. Mowing, and use of the removed vegetation as hay, requires less supervision than grazing, but large quantities of plant nutrients, in particular potassium, are removed in the hay. Mowing will require the application of larger dressings of fertiliser to maintain the soil fertility status quo.

Grazing, in contrast, ensures nutrient recycling and organic matter return to the soil, but is a great deal more difficult to manage. The land may be hired out for grazing, but close supervision is required to prevent overgrazing. The alternative, using mine-owned stock, requires significant managerial input.

11.6. Where specialised biodiversity objectives occur, each situation differs and general guidance is worthless – consult your local expert!

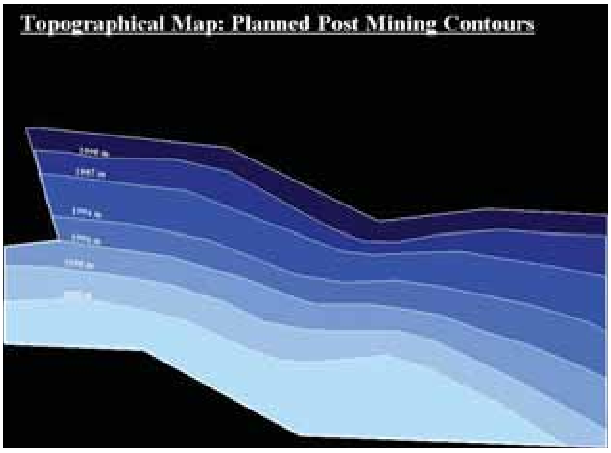
Good general guidance is contained in the ICMM/IUCN “Good practice guidance for mining and biodiversity” (2006) and in the Australian “Mine Rehabilitation” (2006) booklet. Species that may be used successfully on the Mpumalanga Highveld are described in the “Guidelines for the Rehabilitation of Land Disturbed by Surface Coal Mining in South Africa” (1981).

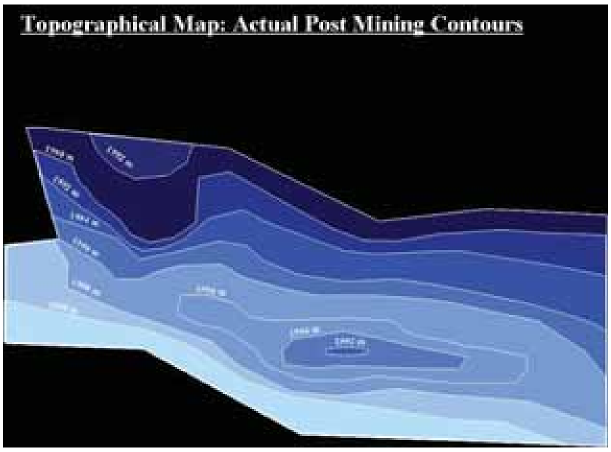
These references provide general information on techniques and species that have proved useful elsewhere. The need is to determine what will be successful for each mine site and this requires localised, specialised expertise.

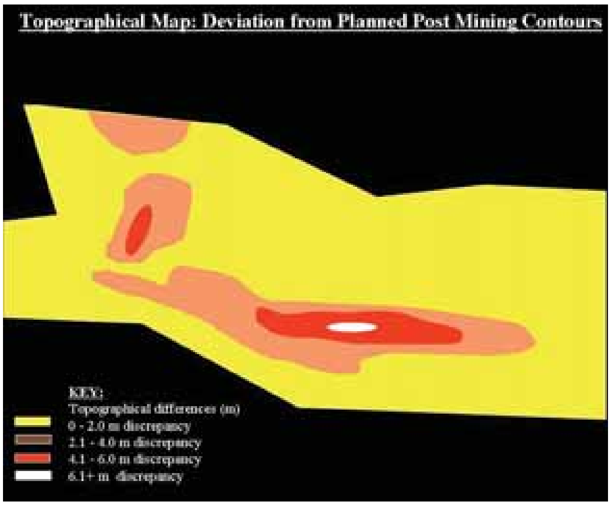
In some circumstances, when biodiversity objectives are very difficult or impossible to achieve on the mine site, the objective of zero net loss of biodiversity on a regional or local basis can still be attained by the use of offsets. For the offset to be valid, an off-mine site is selected for rehabilitation or exclusion from exploitation in order to compensate for the losses of the particular ecotype incurred at the mine-site. This is a complex subject, currently beset by practical pitfalls, but is a possible solution to some of the more difficult biodiversity challenges that are faced by mines. The subject is covered in some detail in Appendix 13: Biodiversity offsets.

12. REHABILITATION MONITORING AND MAINTENANCE

The objective of monitoring is to ensure that the agreed rehabilitation process remains on track. There is a need both to carefully monitor the progress of the physical aspects of rehabilitation (soil stripping, overburden handling, landform development and soil replacement) during the operational phase and the progress with the re-establishment of the desired final ecosystem. The list of items that should be monitored will vary from site to site and is usually based on the closure criteria that have been negotiated for the site.







Typically, they may include several or all of the following items:

- Alignment of actual final topography to agreed planned landform.
- Depth of topsoil stripped and replaced.
- Chemical, physical and biological status of replaced soil.
- Erosion.
- Surface water drainage systems and surface water quality.
- Groundwater quality at agreed locations.
- Vegetation basal cover.
- Vegetation species diversity.
- Faunal recolonisation.
- Crop growth and yield (on sites rehabilitated to agricultural end-uses).
- Proportion of mined land that has been fully rehabilitated.

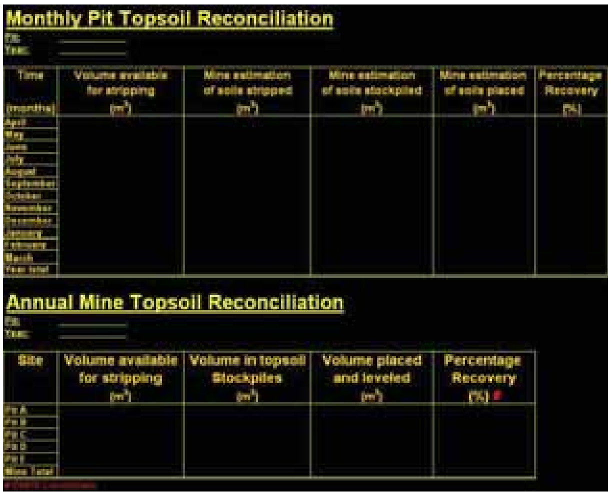
12.1. Alignment of actual final topography to agreed planned landform

Topography actually achieved, in relation to that actually planned, should be monitored regularly – the intervals between assessments will depend on the rate of pit development and reshaping. The key is to ensure that the final profile achieved is acceptable in terms of the surface water drainage requirements and of the end land-use objective. To this end, signoff of the reshaped area is required before topsoil is to be replaced. Normally, assessment would be done by the survey department, with signoff by the rehabilitation specialist.

12.2. Depth of topsoil stripped and replaced

Recovery and effective use of all available usable topsoil is essential. Regular reconciliation of volumes of topsoil stripped, stockpiled and returned to the reshaped landform is vital. Some companies have developed topsoil balances to keep track of soil resources (see example). Assessment, on a regular basis, of the stripping process is required to ensure that the correct depth of stripping has been employed; that there is no mixing of suitable and unsuitable soil horizons; that the stripped materials are being replaced in their correct locations; and to the correct depth.

The soil balance should compare the volumes of soil stripped with the volumes replaced and stockpiled. Exact balance is not expected, due to losses in transport and compaction; however, losses in excess of 10% should be investigated immediately.



Monthly Pit Topsoil Reconciliation

Pit: ________

Year: ________

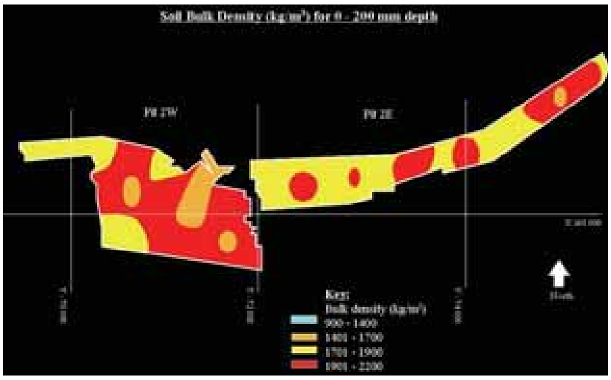
Time (months)	Volume available for stripping (m^3)	Mine estimation of soils stripped (m^3)	Mine estimation of soils stockpiled (m^3)	Mine estimation of soils placed (m^3)	Percentage Recovery (%)
April					
May					
June					
July					
August					
September					
October					
November					
December					
January					
February					
March					
Year total					

Annual Mine Topsoil Reconciliation

Pit: ________

Year: ________

Site	Volume available for stripping (m^3)	Volume in topsoil Stockpiles (m^3)	Volume placed and leveled (m^3)	Percentage Recovery (%)
Pit A				
Pit B				
Pit C				
Pit D				
Pit E				
Mine Total				



12.3. Chemical, physical and biological status of replaced soils

The depth of replaced soil should be assessed using soil auger in a regular grid pattern. Standard spacing of auger holes is 100m by 100m, giving coverage of one hole per hectare. In some cases sampling density should be increased. Augering should be done until spoil materials are intercepted. In most rehabilitated profiles, this interface is clearly distinguishable.

Confusing factors include rock introduced into the topsoil either naturally (the original soil material was stony) or as a result of deep ripping, which has brought rock into the overlying topsoil strata. Where auger results do not match expectation, a number of pits should be dug to find the explanation. Each auger hole should be georeferenced and the results plotted. A number of soil pits should be dug in the rehabilitated profile. These should penetrate at least

Heavily compacted soil and spoil

Rooting in compact profiles is restricted to the loosened surface and to cracks in the sub-surface horizons

100 mm into the underlying spoils and at least one should be dug for each rehabilitated soil unit. Normally, one soil pit should be dug in each uniform area of rehabilitation. A maximum area of 100 hectares could be covered by a single pit if the rehabilitated area is very homogeneous, but normally the variability is such that a much denser distribution of soil pits is required to properly assess the nature of the rehabilitated profiles. Inspection of these holes will permit the identification of compact soil layers and the degree of disturbance of the soil/spoil interface – and of the plant rooting pattern, provided the holes are dug at least one season after initial plant establishment.

Soil fertility sampling should be done independently of the auger soil survey. While a bucket auger can be used for soil fertility assessment, specialised "bicycle handlebar" (beater) augers make the task simpler. For each field to be assessed, the areas should be split into logical land use units and rarely should these units be larger than 100 hectares. For each homogenous unit, at least 20 sub-samples should be taken in a v-shaped or zig-zag distribution across the unit and mixed and sub-sampled.

This should be done pre-establishment, so that immobile nutrients such as lime and phosphorus can be applied and incorporated deep into the plant rooting zone during the initial tillage process. Analysis of the rehabilitated paddocks should continue for a number of years, until the desired fertility status has been achieved.

12.4. Erosion

Erosion status of the rehabilitated land should be monitored and zones with excessive erosion should be identified for remedial action. Erosion can be quantified by insertion of marked stakes into the rehabilitated profile and recording the rate at which the stakes are uncovered. However, the norm is simply the recording of the existence of erosion in a particular location.

12.5. Surface water drainage systems and surface water quality

The functionality of the surface water drainage systems should be checked annually, preferably after the first major rains of the season, and then after any major storm. This is both to ensure that the drainage of the re-created profile matches the plan; and to permit early repair of drainage structures that are not functioning efficiently, before they break and cause significant erosion damage. Water quality leaving the property (and at any other locations within the property specified by the Department of Water Affairs) should be monitored regularly. Samples taken should be analysed for particulate and soluble contaminants and for biological contamination.

12.6. Groundwater quality at agreed locations

Similarly, groundwater levels and quality should be measured at agreed locations in order to determine the impact of the mining operations on groundwater quality. The location of the monitoring positions should be set by a hydrogeologist in association with the regulatory authority. Monitoring locations should be down slope, hydrologically speaking, of the rehabilitated area. Monitoring frequency, likewise, is dependent upon the requirements of the regulator. Usually, there will be a requirement for monthly monitoring for the first year or two after installation of the monitoring boreholes; thereafter, provided the monitoring results indicate little or no change with time, monitoring frequency may be decreased to once per quarter, or, in rare cases, annually.

12.7 Vegetation basal cover

Basal cover is the measure of the proportion of ground, at root level, that is covered by vegetation and, more specifically, by the rooting portion of the cover plants. It can be measured by the line-transect method (where a rope or line some 50-100m long is drawn over an area and the length of rope vertically overlying living basal cover is measured). Alternatively, a quadrat bridge can be used to establish random sampling positions and in excess of 2,000 points should be recorded.

The norm that can be expected will vary depending on climatic and soil conditions; however, for the Mpumalanga Coalfields, for instance a target of 15% basal cover has been set for fully established (i.e. second season and beyond) vegetation.

12.8. Vegetation species composition and diversity

Where the re-establishment of natural plant communities is the objective, success is recorded on the basis of both the cover of vegetation achieved and its composition.

The metric used is the proportion of pre-existing species that have become established in the rehabilitated profile.

Vegetation: Species Diversity and Basal Cover

Rehabilitation Block Number (ha)	Year Block was Last Assessed	* Species Diversity Rating	Basal Cover # (%)	Schedule for Next Assessment

*Species Diversity Rating: Acceptable/Unacceptable, in last field evaluation
Basal cover commitment in EMPR usually 10%

Vegetation Biomass and Land Use Performance (last 12 months)

Rehabilitation Block Number x (ha)	Hay Cut (t/ha)	Large Stock Unit Grazing Days	Estimation of Dry Matter Yield (t/ha)	Crop Yield @ (t/ha)	Crop/Animal Revenue (R)

x Use mine code for rehabilitation block or cropping area
@ Crop Yield: Crop type to be specified, and mine yield to be compared with regional yield for same crop

Scientifically rigorous procedures are required. It is usual for the biodiversity surveys to be done by external experts. In order to establish the full range of plants that have become established, it is necessary to do both summer and winter samplings as plants are identified by their flowering parts and these develop at different seasons, depending on plant type.

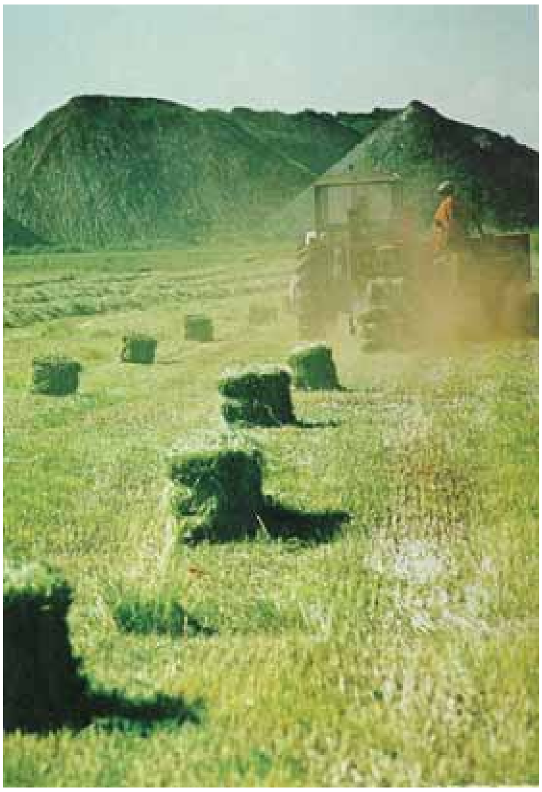
12.9 Faunal recolonisation

Again, evaluation of faunal recolonisation requires expertise that is usually external. However, valuable information can be obtained by regular recording, by mine personnel, of the presence of mammals, reptiles, birds, frogs and invertebrates on the rehabilitated lands.

12.10. Crop and pasture growth and yield (on sites rehabilitated to agricultural end-uses)

Cattle grazing on rehabilitated pastures

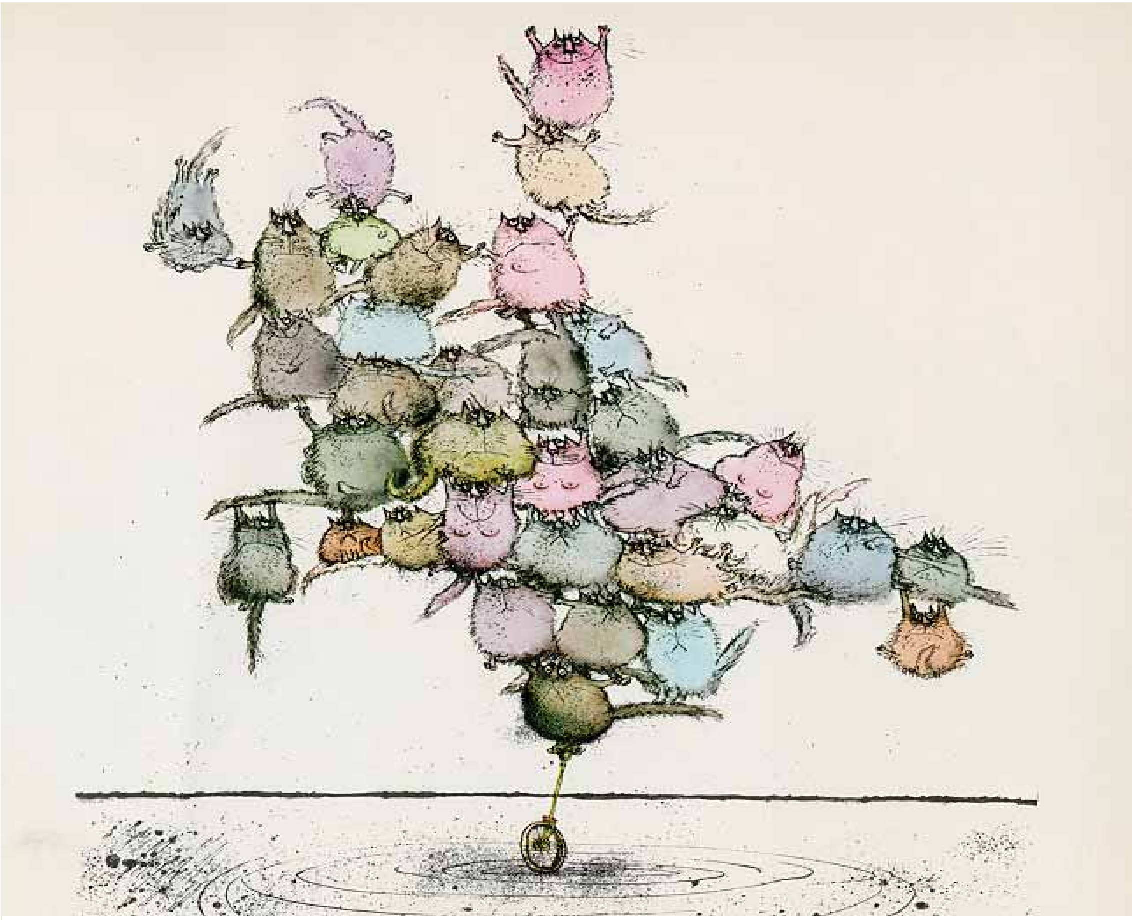
Crop growth and yield, in relation to climatic conditions, should be recorded for all crops and improved pastures grown on rehabilitated land. This is to build up evidence of the relative "capability" of the new profile to support crops, in relation to the previous unmined condition. This is done by recording the numbers of grazing days, hay bales produced and their average weight, or by recording mass of grain or other crop produced per unit area.



Hay baling on rehabilitated land

13. MANAGEMENT SYSTEM DURING MINING (HOW TO ENSURE NO UNNECESSARY LOSSES OCCUR DURING THE PERIOD BETWEEN CONSTRUCTION AND CLOSURE)

While some mines have a short lifespan, the majority are in existence for 20 years and more. There are many mines with lifespans that exceed 40 years – longer than the full working life of the ordinary man. The key challenge is the loss of corporate memory over such long time-frames when it comes to such things as topsoil stockpiles and planned methods of rehabilitation and closure. It is essential that some system of continual "memory refreshment" is employed and that progress is continually checked.



The Environmental Management System, a balancing act that ensures long-term sustainability

It is a requirement for granting permission to mine that the mine will have an Environmental Management Plan/Programme (EMP) in place to ensure that key risks are managed effectively and that ongoing monitoring is undertaken. While it is not specified that certification to a formal environmental management system such as ISO 14001 is required, *de facto* ISO 14001 is the system most commonly used in South Africa. Where mining companies adopt the ISO 14001 standard, maintenance and management and document control for rehabilitation activities are usually under control. This is because rehabilitation failure is one of the key environmental risks facing the operation and, therefore, must be fully addressed in Environmental Risk Register and Environmental Management Plan which are essential components of any ISO 14001 compliant system.

For those mining entities that have not formally adopted the ISO 14001 system, there is a need to develop an in-house risk assessment and risk management system, with systems and protocols in place, maintenance and monitoring systems, and regular review of performance leading to correction of the system to eliminate non-conformances in respect of the rehabilitation risk. Whatever the protocol selected, good environmental management practice is underpinned by having good environmental management procedures in place and monitoring regularly to ensure that these procedures are fully implemented.

Government requires regular audits of rehabilitation progress. Regulation 55 does not require annual auditing, but an annual audit is usually advisable. The need to report regularly to government ministries should ensure that appropriate review of rehabilitation performance and maintenance takes place throughout the mining period.

With respect to ensuring that the rehabilitation process remains on track throughout the life of the mine, the EMS should contain the following:

- A listing of the physical attributes of the mine site.
- A listing of the mine objectives with respect to rehabilitation.
- A listing of all activities that are to be undertaken throughout the life of the mine.
- An assessment of how each activity may impact on the potential for the mine to achieve its rehabilitation objectives.
- An evaluation (rating) of the risk of rehabilitation failure occurring as a result of each action, or failure to act.
- For those risk items rated "high", methods of prevention, mitigation, avoidance – and, if all else fails, treatment – must be identified and operational management procedures developed to manage each key risk.
- Performance in relation to these policies and procedures must be monitored and the efficiency with which the procedures work must be assessed regularly.
- For the system to be certified there is a requirement for continual improvement with time. This can either refer to improvement in performance in managing the key risks identified at each site, or a progressive incorporation of the lower-rank risks into the formal management, prevention and mitigation regime provided by the EMS.
- Finally, regular review of the system and its procedures must be done to ensure that all objectives are being met.

13.1. Develop a list of key aspects related to mine rehabilitation and rank these

The listing of key aspects related to rehabilitation, and the significance ranking, should have been done during the EIA/EMP process. The key here is to abstract the key impacts and to enter them into the EMS risk register.

13.2. Ensure that all key rehabilitation aspects, and the management protocols to reduce the risks associated with those aspects, are formally included in the mine EMS

Key aspects, such as soil stripping, stockpiling, landform re-creation, soil replacement, land preparation and seeding, monitoring, maintenance and review should be included, with rehabilitation-specific objectives and management procedures, in the mine EMS.

Also included will be aspects such as the potential for generation of Acid Rock Drainage (ARD). While not directly a rehabilitation issue, the actions that have to be taken to minimise ARD include encapsulation of acid-generating materials and the location of materials either within, on or above the ultimate water table (depending on their nature). All these requirements will impact on the nature of the final topography developed and, hence, on the rehabilitation activity.

13.3. Generate a link between the mine's management of change procedure and the mine's EMS

Changes in the mine plan are a regular occurrence and frequently these changes, which can radically affect the rehabilitation plan, are not communicated effectively to the rehabilitation team. Most mines have Management of Change (MOC) procedures in place and these should include the necessity to communicate changes timeously to the rehabilitation team. This will ensure that all changes in the mining plan are fully assessed for their potential impact on land rehabilitation PRIOR to their implementation. There should, accordingly, be a formal link between the mine's MOC protocol and the mine's EMS.

13.4. Ensure that there is a work procedure in place to manage all significant rehabilitation risks

For each rehabilitation risk that has been listed as significant in the risk register, a work procedure should be developed to manage and mitigate that risk. All such work procedures should be stored in the EMS.

13.5. Develop a monitoring list to ensure that rehabilitation activities remain on track

For each activity, monitoring should ensure that the work has been done to specification. Monitoring should cover both the monitoring of the activities done to ensure that correct work procedures are being followed and also monitoring of the results of the work done, to ensure that the procedures themselves are actually sound. Monitoring is covered in more detail in section 13 of these guidelines.

13.6. Use of web-based e-systems to ensure that all activities remain on track

Managing to a set standard is frequently simplified by having an electronic, usually web-based, EMS in place. Several companies have utilised these systems and find that they improve performance.

With the web-based EM systems currently in place in some mines, the person scheduled to do work is reminded through e-mail that work is due. If the work is not done, then the work request is escalated through the management chain until the task is formally recorded as having been done. Similar systems can be run manually, but require a significant amount of paperwork.

13.7. Review process and implementation of continual improvement

Regular review and modification of the policies, protocols and monitoring procedures is required to ensure that the rehabilitation process remains effective. This review should both assess whether the existing procedures have been followed and whether those existing procedures fully meet the rehabilitation objectives.

A key facet of the certification requirements for ISO 14001 is the need to demonstrate continual improvement. Thus there is a continual need to review existing procedures and outcomes to look at ways of doing things better.

The time interval for formal review is not set, but in most organisations an annual review is logical. In some organisations external auditors are used to evaluate rehabilitated areas' performance against objectives on an annual basis. Improvement opportunities are thus identified and addressed timeously.

13.8. ISO 14001 – to certify, or not?

There is no legal requirement to certify the mine EMS to any standard, ISO 14001 or otherwise. In general, the benefits from certification cannot be guaranteed. Management's commitment to making the system work is much more important. That said, there are major benefits to be derived from having regular external scrutiny, with "fresh eyes" to ensure that the system is working effectively. In other words, it is possible to be certified and still have very poor performance – but if the spirit is right, and the certifying group has the appropriate experience, most mines benefit significantly from undergoing the certification process. In addition, many customers for mining product require assurance that the product has been produced in an environmentally sensitive manner. Certification is one way of providing assurance that a system is in place that should manage all key environmental issues.

14. FINAL CLOSURE PLANNING

Although mine closure planning should be done prior to mining beginning, the long lifespan of some mines means that major societal changes may have occurred that will preclude the original planned use. This usually relates to the issue of urban sprawl. Mines which were totally rural at the beginning of mine life may, some 40 years later, be within the town boundaries. Accordingly, it is essential that the mine closure plans be revised periodically throughout the life of mine, but especially during the last seven years of life.

- Review the mine closure plan at least once every two years during the mine operation period.
- Take into consideration the probable end land use in relation to changing social conditions.
- As far as possible, ensure that the key objective of rehabilitation, that of minimisation of loss of land capability, is retained. In this way, a larger range of closure use options is retained for closure.
- Recognising that it is difficult to predict future needs, time should be spent evaluating alternative potential uses for the mined-out land as social conditions change. An example of this is the value of mined-out clay pits as landfill sites – a use which was not envisioned during the lifetime of the clay pits.
- Review the mine closure plan annually during the last 7 years of mine life.

14.1. Review the mine closure plan at least once every two years during the mine operation period

While some mines have a relatively short lifespan (5 to 10 years), the majority exist for much longer. This is because cost/price ratios change, equipment and mining methods evolve that affect the viability of extraction of marginal ore, and also because geological definition improves and identifies additional reserves that extend mine life. Thus, while early closure is on occasion an issue, later closure also frequently occurs. In addition, some mineral reserves are so large that their exploitation is planned for periods in excess of 50 years. Where the lifespan of an operation is long it is probable that the surrounding land uses and the social conditions will have changed significantly and the previously agreed closure plan may no longer provide a sustainable solution.

To deal with this situation, it is recommended that the mine closure plan be reviewed once every two years to ensure that it remains valid. The revision should take into consideration the probable end land use in relation to changing social conditions. There may be a case to be made for extending the period between reviews to once every three years. However, the closure plan is part of the EMP and, in terms of Regulation 55, the closure plan should be updated as specified in the EMP or, alternatively, every two years. Thus, unless there are compelling reasons to go to three years, the two-year cycle should be set as the norm for closure plan review.

14.2. Ensure that loss of land capability is minimised

Originally a key point in the closure planning for coal strip-mines; current closure planning emphasises the need to have consensus on post-closure land uses. However, the philosophy of ensuring that land capability loss is minimised remains valid, particularly when a mine will have a long life-span before closure. While the requirements of local communities and the guidance of the government regional development plans do currently provide a framework for generating post-mining land use plans, the fact remains that community structure and needs change radically with time. Retaining as much as possible of the previous land capability classes should maximise the potential for varying the end land use if such changes become necessary to ensure long-term sustainability.

14.3. Evaluating alternative potential uses for the mined-out land

Recognising that it is difficult to predict future needs, time should be spent evaluating alternative potential uses for the mined-out land as social conditions change. An example of this is the use of mined-out clay pits as landfill sites – a use which was not envisioned during the lifetime of the clay pits. Other alternative use examples include the use of underground workings for mushroom production. Notwithstanding the requirement to negotiate any change in closure conditions through the Public Participation Process, the potential exists to develop alternative end uses for the mined-out areas that may differ significantly from those originally planned and that both reduce closure cost and enhance financial sustainability of the areas post-closure.

14.4. Review the mine closure plan annually during the last seven years of mine life

While an interval of two years may be adequate during the life of mine, closure planning and the beginning of closure work requires much more detailed planning and management in the last few years prior to closure. Seven years has been selected as a realistic time frame, but this should be extended to 10 years for complex closures and may possibly be reduced to five years for simple ones. In most cases, the formal appointment of a closure manager, with sole responsibility for ensuring that the closure process remains on track, will pay dividends. The mine closure plan and its associated costing should be reviewed formally, annually, during this final phase before termination of mining activities. The time-frame may seem long, but key benefits can be derived from having the full staffing and equipment complement of the mine available to do final closure work during this phase.

15. DEFINITION OF FINAL CLOSURE IN RELATION TO LAND REHABILITATION ACTIVITIES

"Final closure" is the condition whereby the rehabilitated land has reached stability such that the regulators and the interested communities are satisfied that the land will not pose significant additional risk into the long-term future.

Currently, very few mines receive final closure status in South Africa and the key issue hinges on residual risk and how to manage it. When the mine has completed the rehabilitation actions required and all appears acceptable, the mine wishes to free resources so that it can continue with its key activity of exploiting new mineral reserves. However, the resources must remain tied up in the maintenance of rehabilitated properties until such time as final closure has been granted.

From the legislator's side, the issue is that, while the short-term success is evident, there is concern that long-term issues will emerge that will pose a severe and ongoing load on the fiscus.

In this respect, both Latent and Residual impacts have been defined in the Regulations:

- "Latent environmental impact" means any environmental impact that may develop from natural events or disasters after a closure certificate has been issued, while
- "Residual environmental impact" means the environmental impact remaining after physical closure and before a closure certificate has been issued.

In both cases, reluctance to issue closure certificates is related to lack of certainty as to how these issues will be managed in perpetuity.

The method of defining final closure, and of obtaining final closure certificates, is currently a key debate in South Africa. This is unlikely to be resolved in the near future. For the purposes of this guideline, the definition of "final closure" is the condition where the mining lease can be relinquished, the legislators provide a final closure certificate and responsibility for the land can be taken over by the next land user.

Developing generally-accepted criteria for closure is the key to obtaining a closure certificate. These criteria must be acceptable to the mining industry, the responsible government departments and to the interested and affected parties. The essence of the issue is the management of residual risk associated with the closed operations. Usually, those risks relate to:

- pollution effects
- suitability, in the long term, of the reconstituted land for its ultimate land use, and
- vegetation issues.

While the situation with respect to these issues can be closely monitored at the time of application for the closure certificate, the concern of the authorities lies with the potential for development of problems in the future. While modelling and previous experience will provide indications of the probable future of the rehabilitated land, there remain the issue of uncertainty and how to deal with this without loading government with the additional costs associated with the latent defects which may be present.

The criteria for closure that are developed and agreed to will fall into four broad categories:

- Surface and groundwater quality compliance with agreed conditions
- Reconstructed landform stability and ability to support the intended final land use
- Vegetative cover health, sustainability and suitability for final land use
- Managing residual or latent risk.

15.1. Surface and groundwater quality compliance with agreed conditions

It is essential that surface and groundwater qualities leaving the property meet the agreed objectives, both at the time of closure and into the future. The requirement, then, is for detailed monitoring to have been done for an agreed period post-cessation of mining and for detailed modelling to have been done of potential future water impacts of the rehabilitated area. Modelling of pollution plumes and their dispersion is an essential component of the development of closure criteria, and these models should be developed by independent experts. Key to this is an understanding of the implications of the re-establishment of the water-tables within the rehabilitated land and the development of a management plan for the likely quantities and qualities of water emanating from the site. This may include the provision of capital and operating costs, in perpetuity, for water treatment facilities.

15.2. Reconstructed landform stability and ability to support the intended final land use

The reshaped topography must be such that it conforms to the requirements of the ultimate land use and of the post-closure water-balance requirements. Topography, soil thickness and other conditions, such as levels of compaction, must be such that they do not unnecessarily restrict the activities of the next land user. Key to this is the understanding of the long-term stability of the re-created land form. Will the surface soils applied withstand erosion? Will differential subsidence result in failure of drainage structures? The answers to such questions, which will quantify residual risk, will enable the development of methods of managing the residual risk associated with the re-created land form.

15.3. Vegetative cover health, sustainability and suitability for final land use

The vegetative cover health issue is not related to the status at a point in time but rather to the dynamics of the ecosystem that has been established. Are desirable species increasing with time, and undesirables decreasing? Detailed assessment of ecosystem composition and dynamics are required so that an assessment of the long-term stability can be made. In addition, the level of control of alien invasive species should be at least as good as that found in neighbouring non-mined properties.

15.4. Managing residual or latent risk

There is a major difference between residual risk and latent risk (see definitions above) and both provide major concern to the authorities. Uncertainty regarding these two risk types is one of the main stumbling blocks to attaining closure certificates.

An example of residual risk is the risk that invasive species seed that is known to be present in the rehabilitated land may be present in sufficient quantity, and remain sufficiently viable, to cause future infestation of the rehabilitated land. The risk is understood, and can be managed by the ongoing application of existing management interventions.

An example of a latent risk is the possibility that, at some stage in the future, waters emanating from the rehabilitated land may become acid. It is not certain that the waters will turn acid, but there is a possibility that they could, depending on the relative rates of generation of acid from oxidation of sulphides and of neutralisation from the release of carbonates.

In both cases, there will be a need to manage the risk into the future. How this can be done is a major area for debate, both in South Africa and internationally. One proposed solution is the development of "insurance" funds, where risks can be grouped and covered by the payment of an insurance premium; the other is to have a facility for transferring the liability to an independent third party, who will accept the liability and manage it into the future.

16. LEGAL COMPLIANCE FRAMEWORK

The legal compliance framework for the rehabilitation of mined land has been developed by Cameron Cross Incorporated. A memorandum defining the legal compliance framework applicable to the rehabilitation of mined land is appended as Appendix 15. The South African legal system is dynamic. Significant changes relating to mined land rehabilitation have occurred in the recent past and others are likely to occur in the near future. This legal framework reflects the situation that pertained as at the end of October, 2006. It also contains a section on emerging legal issues.

The abbreviated summary of key legal aspects affecting rehabilitation activities given below is not in any way exhaustive, but is intended to provide a basic outline for mine management of the rehabilitation-related issues they may have to face during the life of the operation. The information contained in Appendix 15, to which this section's information is linked, is more comprehensive – but any lawyer will advise that a full interpretation of the legal framework is only possible through the reading of the complete Acts themselves.

South African legislation imposes a clear obligation on mining companies to prevent environmental damage and defines clear obligations/responsibilities associated with mine rehabilitation and closure. Rehabilitation activities should be guided/controlled by legal requirements contained in many South African Acts and Regulations. However, the essence of these requirements is contained in three key pieces of legislation:

- The Constitution (Act 108 of 1996)
- The Mineral and Petroleum Resources Development Act (MPRDA) (Act 28 of 2002)
- National Environmental Management Act (NEMA) (Act 107 of 1998)

The Constitution states that everyone has the right to an environment that is not harmful to health and well-being, and the Bill of Rights enables members of the public to enforce that right. In addition, section 24 (b) of the Constitution tasks government (national, provincial and local) with a constitutional duty to ensure that the environment is protected in the public interest, and the other statutes are merely providing a means to enforce application of this duty.

The MPRDA is the central legislation governing the mining industry. Its objectives, in the context of mined land rehabilitation, are to give effect to the constitutional environmental rights. This is done through "provisions" relating to the rehabilitation of mined land that apply prior to commencement of mining, during construction and operation, and during the closure process and beyond (the "cradle to grave" concept).

The Environmental Conservation Act (ECA) formalised the concepts of Environmental Impact Assessment (EIA), Integrated Environmental Management (IEM) and listed activities, with potential significant detrimental effect on the environment, for which environmental authorisation has to be applied and obtained. The formal authorisation system initiated by the ECA is presently being continued on a similar, but arguably more refined, basis in the NEMA.

Although the authorisation of listed activities was traditionally largely incorporated into the authorisation processes and EMPR required in terms of the now-repealed Minerals Act, NEMA now expressly provides that "Reconnaissance, prospecting, mining or retention as per the MPRDA, as well as the construction of various mining related infrastructure" are included as listed activities as from April 2006.

This means that the legal requirement to obtain an environmental authorisation could be applicable to the undertaking of rehabilitation and closure activities at a mine. While the possibility exists of a co-operative agreement between the relevant national and provincial governments and the DME regarding the streamlining of applications under NEMA and MPRDA, no such arrangement exists at present. This results in the possibility that multiple legal authorisations will be required, in addition to any additional requirements that may surface in terms of the NWA.

From the perspective of these guidelines, the key issue relates to the process of obtaining permission to mine and developing management systems on a mine that will ensure compliance with the two main Acts (MPRDA and NEMA) concerned. While rehabilitation, by its very nature, is the activity that takes place after the mineral has been extracted, the type of rehabilitation work required is dependent on the full suite of environmental impacts that may occur and the method of mitigating those impacts. For example, impacts on water pollution can often be minimised by the selective placement of toxic materials within the pit, or by designing surface water drainage patterns to maximise water runoff. These types of mitigating rehabilitation work can only occur if they have been defined and planned prior to mining commencing. The planning phase of any proposed mining activity, therefore, is critical in identifying potential long-term impacts and designing rehabilitation systems that will minimise or prevent those impacts in the long term. The provisions of NEMA are designed to ensure that ALL potential impacts, including socio-economic ones, are considered and mitigated during the permitting process.

Other legislation having significant impact on mining and rehabilitation activity includes:

- The National Water Act (NWA) and in particular GN R 704, which acknowledges the principle of co-operative governance between the three key ministries (DME, DEAT, DWAF) that legislate key aspects of mining activity,
- The National Forests Act (NFA),
- The National Heritage Resources Act (NHRA), and
- The Conservation of Agricultural Resources Act (CARA).

The latter is particularly important because it defines requirements for control of alien plants.

The legislative framework relating to mining activities is not "cast in stone". It is dynamic, and the current brief outline defines the situation as at the end of 2006. Several changes are likely to occur in the future. These relate to biodiversity and to the definition of certain soil systems as being unique and, accordingly, too valuable to be disturbed by mining.

Various portions of various Acts become applicable at different stages in the life-cycle of a mine. To simplify the understanding of the legal requirements applicable to a mine, the list below attempts to define the key requirements that must be met to ensure legal compliance at each stage in a mine's life-cycle.

It must be borne in mind that this simple check-list is not conclusive. All mines should consult the full information contained in the Acts relevant to their activities, and also should conduct legislation compliance audits at regular intervals.

16.1. Legal issues to be dealt with prior to commencement of mining (the planning and permitting stage)

16.1.1. Obtain permission to mine

As currently constituted, obtaining permission to mine is dependent on completion of the EIA/IEM/EMP and water use licences processes for DEAT (or the relevant provincial environmental departments), DME and DWAF.

Depending on the potential impacts of the mine, either the DME (small impact) or both DME and DEAT (large impact) routes will have to be followed. In terms of the law, the more detailed route has to be followed unless an exemption has successfully been applied for. To complete the process usually takes between 6 months and one year and may be considerably longer. Adequate provision should be made for these time periods.

The requirement is to identify, predict and evaluate the potential impacts of the activity on the environmental, socio-economic and cultural heritage conditions, and define management methods to prevent or mitigate the significant impacts.

There must be adequate opportunity for public participation in making decisions that may affect the environment. Rehabilitation clearly plays a major role in the mitigation process and may also be a key component of the prevention process.

16.1.2. Financial provision

The applicant must make financial provision for the prevention, management or rehabilitation of negative environmental impacts. This provision may be an approved contribution to a trust fund, a financial guarantee, or a deposit into a DME-specified account, and must be made before mining commences.

16.2. Legal issues applicable to the construction and operation phase

16.2.1. Financial provision

The quantum of financial provision must be reviewed, updated and reported to DME annually.

16.2.2. Integrated environmental management

Principles of integrated environmental management must be put into effect, as laid down in Ch 5 of NEMA. These requirements may seem to be met if the mine is certified as being in compliance with ISO14001. However, the ISO protocol has no legal standing.

If there is no externally certified EMS in place, there is a requirement for annual review of the financial provision, and for auditing on a two-yearly basis to ensure that the requirements for IEM are in place and are being complied with, unless a longer period has been stipulated in the EMPR.

16.2.3. Meeting or modifying rehabilitation commitments

The affected environment must be rehabilitated as far as reasonably practicable to its natural state or to an alternative, sustainable, land use. The rehabilitation requirements will have been set out in the mine EMP. The legal requirement, in this case, is to comply with the planned programme of rehabilitation.

In the event that some major change in mining method or other factor occurs that prevents the rehabilitation from being conducted as originally planned, there is a legal requirement to submit a modified EMP/EMPR and to obtain authorisation for the changes. This EMP addendum process should be completed before the changes are made.

16.2.4. Remediation of environmental damage

The directors of a company may incur "joint and several liability" for any unacceptable negative impact on the environment. This means that directors may be held personally liable for environmental damage. Due to the personal risk involved, it is recommended that management familiarise itself with closure goals and commitments to ensure that these are achieved through adequate financial resources being made available.

16.2.5. Development and submission of the bi-annual EMP Performance Assessment Report

The DME strategy for EMP Performance Assessment requires the regular evaluation of environmental performance against the commitments contained in the mine's EMP. Results of the evaluation are to be reported at least bi-annually to DME.

16.2.6. Decommissioning of facilities or infrastructure during the life of the operation

It frequently happens, during the life of a mine, that certain facilities or infrastructure becomes surplus to requirements and should be decommissioned or demolished. This is acceptable, unless the items concerned happen to be over 60 years old (in which case, permission must be obtained in terms of the NHRA), or if the structure concerned is a dam where the highest part of the dam wall is 5 metres or higher or where the high water mark of the dam covers an area of more that 10 hectares, constituting a listed activity requiring authorisation in terms of NEMA.

16.2.7. Measures to prevent rehabilitation "failures"

Measures to prevent rehabilitation failure in terms of section 24 of NEMA include the need to provide employee education, in addition to other measures stated in broad terms. These measures are required to be "reasonable"

16.2.8. Actions required to prevent pollution or potential pollution in terms of the NWA

Section 19 of the NWA provides for the prevention of water pollution. Frequently, land rehabilitation activities are listed as measures to be used to prevent (e.g. encapsulating acid-generating spoils within overburden) or to minimise (e.g. maximise runoff from rehabilitated land) water pollution. As such, these activities fall under the National Water Act and directives issued under section 19 can be used to enforce compliance.

16.2.9. Reporting requirements in terms of the NWA

Annual reporting to DWAF is required in terms of all water use licences issued. While rehabilitation is obviously not a water use, several aspects of land rehabilitation impact directly on the water retained on the mine property and this is thus deemed as use, because such water is excluded from the general recharge to surface streams.

In addition, rehabilitation activities may result in pollution, in particular particulate pollution. Hence, there may be a requirement to include reporting on rehabilitation activities in the annual reporting to DWAF, both for water use and for pollution charge allocation reasons.

16.2.10. Obtaining a licence to disturb, damage or destroy a protected tree

All protected trees should have been identified during the pre-mining EIA phase and licences obtained for their removal at that stage. However, during ongoing rehabilitation activity, situations may arise that require the destruction or removal of a protected tree. This can only be done once a licence has been granted by the Minister of Water Affairs and Forestry. The list of protected trees was published as GN R 1012 of August 2004 but was superseded by GN R 897 of 8 September 2006.

16.2.11. Obtaining permission to disturb a heritage site or demolish structures in terms of the NHRA

Both the South African and the Provincial heritage resource authorities may identify and declare, as heritage sites, places which have special significance. This may occur during the operational life of a mine.

Once declared, the site may not be destroyed, damaged, excavated or removed without a permit. No structures older than 60 years may be destroyed without a permit.

16.2.12. South African Heritage Resources Agency (SAHRA) permission to relocate graves

Known graves should have been identified and permission to relocate these obtained during the planning phase of the mine. However, if an unknown grave is identified during the process of rehabilitation (typically during soil stripping or overburden removal), the activity must cease immediately and the discovery must be reported to the responsible heritage resources authority.

16.2.13. Protection of archaeology, palaeontology and meteorites

During the course of rehabilitation activities (and in particular the stripping of soil and removal of overburden) it is possible that archaeological or palaeontological objects or meteorites may be discovered.

Such finds should be reported immediately to the nearest local authority offices or museum. As such finds may not be disturbed without a permit from the SAHRA, this may involve some delay in the continuation of the rehabilitation process.

16.2.14. Control of weeds and invader plants in terms of CARA

Weeds and invader plants are defined in GN R 1048. These plants are categorised and any category 1, 2 or 3 plants occurring on mine land must be controlled by the methods set out in Regulation 15E of GN R 1048. The methods used must also deal with "propagating material" – seeds, roots, rhizomes – and with plant regrowth. This requirement applies to both unmined and rehabilitated land and continues through the life of the mine – and beyond closure! Accordingly, eradication of weeds and invader plants during the lifetime of the mine is a key component in eliminating a continual post-closure liability.

16.3. Closure phase

16.3.1. Closure process is a "cradle to grave" concept

Regulation 56 of the MPRDA states that the closure process must start at the commencement of the operation and continue throughout the life of the operation. This means that mine closure and rehabilitation plans must be reviewed on a regular basis.

16.3.2. Risk-based approach to closure

All risks must be identified and managed pro-actively, and residual and possible latent risks must be identified and quantified – again in terms of Regulation 56 of the MPRDA.

16.3.3. All pollution control structures in place

Before closing a mine, all pollution control structures must be in place, in order to ensure that reasonable measures are continuously taken to prevent pollution of water resources in the post-closure phase.

16.3.4. Notification of DWAF 14 days before closure

DWAF must be notified in writing 14 days before closure so that the pollution control structures, which will frequently include rehabilitated land, can be inspected.

16.3.5. Demolition of structures

A permit is required in terms of sect 34 of the NHRA before any building older than 60 years may be demolished.

16.3.6. Refund of financial provisions

While it is possible for funds contained within a trust fund to be released for the performance of rehabilitation work to be done during the closure process, it is unlikely that this will happen unless the closure cost has already been fully provided for. It is more likely, as provided for in section 46 (2) of the MPRDA, that a portion of the funds may be returned once a closure certificate has been issued by the Minister of Minerals and Energy. The amount returned will depend on the portion retained to cover latent and residual impacts

16.3.7. Transfer of environmental liabilities to a competent person

Section 43 (2) of the MPRDA provides for the transfer of environmental responsibilities and liabilities to another person. Application for transfer must be done in terms of Form O, and the person to whom the liabilities are transferred must be a competent person, in terms of Reg. 59. These regulations define the expertise, financial and other resources that the competent person must have.

16.3.8. Application for closure

Application for closure should be completed in accordance with form P, as specified in Reg. 57 of the MPRDA. Documentation required is closure plan, environmental risk report, final performance assessment report and, if applicable, an application to transfer liabilities to a third party. Application must be made within 180 days of cessation of activity, to the appropriate Regional Manager, DME.

REFERENCES

The following references have been used in these guidelines:

1. AMIRA International, Australia (1998). Mine Rehabilitation handbook.

2. Chamber of Mines, South Africa (1981). Guidelines for the rehabilitation of land disturbed by surface coal mining in South Africa.

3. Department of Industry, Tourism and Resources, Australia (23 June 2006). Mine closure and completion booklet: stakeholder comment draft.

4. Department of Industry, Tourism and Resources, Australia (23 June 2006). Mine rehabilitation booklet: stakeholder consultation draft.

5. Department of Minerals and Energy, South Africa (Sept. 2004). Guideline document for the evaluation of the quantum of closure-related financial provision provided by a mine.

6. Hannan, J C (1984). Mine rehabilitation: A handbook for the coal mining industry. Sydney: New South Wales Coal Association.

7. International Council on Mining and Metals (2006). Good Practice Guidance for Mining and Biodiversity.

8. Marshall, T J and Holmes, J W (1979). Soil Physics. Cambridge University Press.

9. Schaefer, M; Elifrits, D and Barr, D J (December 1979) Sculpturing reclaimed land to decrease erosion.

10. Wischmeier, W H; Johnson, C H and Cross, V A. (September-October 1971). A soil erodibility nomograph for farmland and construction sites. Journal of Soil and Water Conservation, Vol. 26, No 5, pp 189-193, September-October 1971.

APPENDIX 1:
REHABILITATION PLANNING, AUTHORISATION AND FINANCING

A. Rehabilitation planning, including planning for final closure

The current standard practice is for the mine planner to design the mine using various optimisation techniques, which are usually based on geological reserve parameters and optimising cost efficiency of mining methods. Environmental considerations must be taken into account during this process. The ideal planning process includes rehabilitation effectiveness and long-term maintenance cost implications as full components. Closure objectives should be outlined so that the planning can ensure that all activities are planned with the end use in mind. In this way final closure costs will be minimised and design flaws that will prevent full compliance with the legal commitments made in the mine EMP/R will be avoided.

The key planning phase activities are as follows:

- Clearly define the nature and scope of the baseline environmental studies that must be done. The studies required will be determined by the scoping phase of the permitting process.
- Baseline environmental studies (soil, flora, fauna, hydrology, etc) should be completed early in the planning process. This will permit the identification of "no go" or "special rehabilitation requirement" areas on a realistic basis before mine planning begins.
- Mine planner generates initial outline mine plan.
- Rehabilitation specialist to evaluate mine plan, to assess extent to which the current plan will debase land use capability, ecological status, or result in long-term (i.e. post-closure) maintenance liabilities.
- This should be based on a risk/opportunity analysis of all rehabilitation options and should balance short-term cost considerations against long-term maintenance considerations.
- Rehabilitation specialist to propose mine plan modifications to mitigate environmental impacts.
- Mine planner to re-assess the mine plan, to determine the extent to which the rehabilitation specialist's requirements can be accommodated.
- The residual impacts and the likely end product to be agreed between mine planner and rehabilitation specialist.
- This information to be included in the mine Environmental Management Plan, for submission to the Interested and Affected Parties (I&APs) and to the authorities (see permitting section).
- Concerns of the I&APs and of authorities to be considered by mine planner, in association with rehabilitation specialist. To what extent is the mine viability compromised by these additional requirements? An agreed course of action and mine plan modification are to be done. The likely end product and residual impacts to be submitted again to authorities (and interested and affected parties, if required) for final approval.
- Mining activities that will have any significant impact on the ultimate rehabilitated product should be identified and included in the mine environmental management plan.

A.1. Defining the scope of baseline environmental studies

Baseline environmental studies are almost invariably carried out by independent environmental consultancies, rather than by in-house technical experts. It is essential, in this case, that clear definition of the scope and deliverables of these studies is provided to the independent consultants, so that the end product is directly related to the issue at hand – that is, each study should identify key environmental components of the area to be mined, assess the likely impact of the proposed mining activity on those environmental components, rank those impacts and develop potential mitigatory measures for the key impacts identified. The studies should, usually, also re-assess the impact level with the mitigatory measures in place

The studies required will be determined by the scoping phase of the permitting process.

A.2. Complete the baseline environmental studies (soil, flora, fauna, hydrology, etc) in the early stages of the planning process

This will permit the identification of "no go" or "special rehabilitation requirement" areas on a realistic basis before mine planning begins. It will also permit the identification of key aspects of landform reconstruction that will be required to meet legal environmental commitments – such as, for instance surface drainage patterns or isolation of toxic materials – that would be expensive to engineer at the end of life of the mining operation.

A.3. Mine planner to develop initial outline mine programme

Mine planning is an integrated, iterative process. From the rehabilitation perspective, it is essential that environmental constraints and legal requirements be included in the initial process, in combination with the geological and mining method factors. Frequently, initial planning will be done after the environmental scoping report has been completed, which will have identified the key issues that will have to be addressed, but before the detailed environmental studies have been completed.

However, the initial scoping process includes a Public Participation Process (PPP) and this will highlight the issues of primary concern. The initial outline plan should, therefore, include standard planning items such as landform creation, surface drainage and handling of potentially toxic overburden horizons. This initial plan will provide the basis for the mitigatory measures that will be included in the Mine Environmental Management Programme, to be submitted as part of the Permitting process.

A.4. Revision of the initial mine plan

The mine rehabilitation specialist should evaluate the initial mine plan, to assess extent to which the plan will meet legal and corporate environmental commitments. At this stage, the planning process for the operation is in its infancy.

In this first iteration of the mine plan, general concepts have to be used based on existing knowledge to determine whether there are any "fatal flaws" in the plan. The proposed plan generated by the mine planner must be scanned for potential impacts on all aspects of the environment (such as topography, soils, land use capability, ecological status), and for factors that may result in long-term (post-closure) maintenance liabilities. This assessment should be based on a risk/opportunity analysis of all rehabilitation options, and should balance short-term cost considerations against long-term maintenance considerations.

Based on the findings of the environmental assessment of the initial plan, the rehabilitation specialist should suggest modifications to the plan that will result in full compliance to the norms expected of full rehabilitation.

The mine planner should re-assess the mine plan, to determine the extent to which the rehabilitation specialist's requirements can be accommodated. After revision of the plan and the residual impacts the likely rehabilitation end product should be agreed between mine planner and rehabilitation specialist.

A.5. Submission and modification of mine plan as part of the environmental authorisation process

The information generated by the mine planner and rehabilitation specialist is to be included in the Mine Environmental Management Plan, for submission to the interested and affected parties, and to the authorities (see permitting section).

Concerns of I&APs and of authorities as outlined in the scoping phase should already have been considered by the mine planner, in association with the rehabilitation specialist, in the initial mine plan. However, the EMP will contain the mine's formalised commitments and plans for rehabilitation, and there may be further requests for modification from either government or I&APs, which arise during the permitting process reviews and PPP.

If this is the case, the mine planner should assess the extent to which the mine financial viability is compromised by these additional requirements. An agreed course of action, and mine plan modification, is to be done. After revision, the revised plan should again be submitted to authorities (and interested and affected parties if required) for final approval.

B. Rehabilitation authorisation

The mine authorisation process is the official way in which the mine proponent gains the acceptance of the mining activity plan by both the people affected by the mining activity (the interested and affected persons, or I&APs), and by government. These two groupings have the major influence in the acceptance or rejection of the mining proposal.

The I&APs are usually more concerned with net benefit or loss to their sections of society. The authorities, ideally, should be more concerned with the longer-term issues, and should see the proposal in relation to regional or national resource constraints.

De facto, in South Africa, authorities place great importance on the proposal having the approval of the directly affected parties, and hence the permitting process has to focus with equal intensity on meeting the requirements of the local communities and of the authorities.

For this guideline, we assume that the exploration and assessment of the mineral resource have been successfully completed using the correct interactive approaches and, accordingly, that the local communities and authorities are both fully aware that the area has been identified as a mining prospect. The South African mining authorisation process has been undergoing legal modification in recent months.

As at the end of 2006, the authorisation process should include the following activities:

- The probable mineral resource boundaries and the probable boundaries of the impacts of the mining activity should be identified.
- All parties likely to be affected by the mining activity in the area should be listed and contacted regarding the proposed mining activity. This will initially be done as part of the scoping process required in the current DME Mine Environmental Management (MEM) guidelines.
- A scoping EIA should be generated, based on the initial mine plan, and this should be presented to the I&APs and to the authorities.
- Concerns of the I&APs and authorities in relation to the mining proposal should be identified by the PPP as part of the scoping process.
- These concerns should be collated and addressed by mine planning, in association with the rehabilitation specialist.
- The mine plan and environmental management plan should be revised, as far as practicable, to meet the reasonable requirements of I&APs and authorities. This revised mine planning information should be included in the mine Environmental Management Programme (EMP).
- The revised EMP should be communicated to I&APs for comment.
- The finalised plan should be submitted to the authorities as the final EMP.
- If the issues raised during the scoping process have been fully addressed, then approval, and permitting, should follow. However, it is better to allow for a further round of mine plan revision and contact with I&APs and authorities prior to permitting being finalised.

The permitting process covers all aspects of the mine's environmental and socio-economic impacts, both positive and negative. Accordingly, while these guidelines are concerned solely with the aspects of permitting related to rehabilitation of mined land, the process is an iterative on in which there may be some playoff required to attain approvals.

Primary concerns with the need for development may, in some instances, result in less than perfect rehabilitation solutions being accepted in relation to the "greater good". However, these guidelines will continue to focus on the requirements for rehabilitation related to best practice.

B.1. The mineral resource boundaries and the probable boundaries of the impacts of the mining activity should be identified

Following the prospecting phase, the approximate mine boundary can usually be delineated. There may be some future variation of the mine boundary, as the practical limits of exploitation will vary depending on cost/price changes and on the results of infill geological drilling. However, provided a conservative approach is taken, it should be possible to define the limits beyond which mineral exploitation will not take place.

In addition to the zone where mineral extraction will take place, other areas will also be affected by the ancillary actions associated by mining. In close proximity to the mining area (usually) will be the mineral processing, mine workshop and administrative facilities, servitudes related to services such as electricity, water supply and roads, and to the area of impact in relation to labour supply for the mine (the labour sending area). All these areas need to be identified and delineated, so that the requirements for the generation of the mine EMP and Social and Labour Plan (SLP) can be defined.

B.2. All parties likely to be affected by the mining activity in the area should be listed and contacted regarding the proposed mining activity. This will initially be done as part of the scoping process required in the current MEM guidelines

While the initial process of listing I&APs should focus on those persons directly affected by the mining activity, the permitting process will be facilitated if all groupings with an interest in the possible impacts are also involved in the process from the outset. Thus interested groupings, such as institutes (such as the South African National Biodiversity Institute, SANBI) and NGOs (such as the Succulent Karoo Environmental Programme, SKEP) should be listed and contacted regarding the mining activity, preferably during the scoping phase of the process. Their early input will assist in identifying key environmental and rehabilitation aspects to be considered during the detailed EIA and EMP generation phases of the permitting process.

B.3. A scoping EIA should be generated, based on the initial mine plan, and this should be presented to the I&APs and to the authorities

The scoping EIA should be generated, based on the current understanding of the mine exploitation limits, and of the probable location of ancillary infrastructure. At this stage the environmental report and baseline studies will be based on existing knowledge with limited field truthing.

With respect to the rehabilitation sections of the process, general information on soils, vegetation, animal, surface and ground water should be generated from available reports and previous detailed studies in adjacent areas. The proposed method of mining and of construction of ancillary structures should be defined. This information should be adequate for the generation of a draft (scoping) EIA, in which the likely major impacts and the mining proponent's suggestions for mitigation of those key impacts, would be included. The report would also identify knowledge gaps that would have to be filled in for the generation of the full EIA.

The scoping EIA should be communicated to the full range of identified I&APs.

B.4. Concerns of the I&APs and authorities in relation to the mining proposal should be identified by the Public Participation Process as part of the scoping process

There is clear definition of the way in which this communication is to be conducted through the PPP. It includes both direct communication with the persons identified as interested and affected, and the publication in the media of the proposed mining activity, with clear instructions of how to participate in the public review process. In the scoping process, any additional concerns raised by the participants concerning the probable effectiveness of the rehabilitation measures proposed in the project should be listed.

B.5. These concerns should be collated and addressed by mine planning, in association with the rehabilitation specialist

Concerns regarding the efficacy of the proposed rehabilitation measures may be expressed by government officials or other I&APs. All concerns should be listed and their validity assessed by the mine proponent (while some concerns may not be valid, the fact remains that there is perception that the proposed rehabilitation methodology may be inadequate). Even if the concern is not valid, it should be addressed by detailed communication of the reasons why it was found not to be valid. This early communication, if done effectively and sensitively, should speed up the subsequent formal permitting process.

For those comments found to be valid, the mine plan and environmental management plan should be revised to meet the reasonable requirements of I&APs and authorities.

B.6. This revised mine planning information should be included in the mine Environmental Management Programme (EMP) and should be submitted to the authorities and to the I&APs for comment

If the issues raised during the scoping process have been fully addressed during the generation of the EMP, then approval, and permitting, should follow. However, it is better to allow for a further round of mine plan revision and contact with I&APs and authorities prior to permitting being finalised, as some of the remedial actions proposed by the mine may not be acceptable to the authorities or to key I&APs.

C. Rehabilitation financing

Rehabilitation is an expensive business, which can account for as much as 10% of mining costs in certain circumstances. As the majority of this cost is usually incurred after mine closure, or at least after a significant portion of mining has been completed, some form of guarantee is usually required by authorities to ensure that these costs are met. In addition, there is now a requirement to provide financial assurance that the costs of rehabilitation will be met in the case of early or unplanned closure. The question is, how will the costs of rehabilitation be funded if the mine closes prematurely, either due to mining issues or to changes in commodity prices?

There are a number of financial vehicles that can be used to meet the cost of rehabilitation. However, for all of them, there needs to be an accurate estimate of the cost of rehabilitation, and of when that rehabilitation is going to be done.

Actions currently in use or proposed for the cost estimation and financing of land rehabilitation in the mining industry are:

- An estimate of the cost of rehabilitation should be developed based on the current mining plan.
- Ideally, cost estimates should be made by a qualified QS. DME guidelines are available to generate estimates, but while these will be legally acceptable, these need to be tempered by local knowledge.
- The phasing of rehabilitation expenditure during the life of mine should be planned, recognising that delays or accelerations may occur.
- The method of funding of the rehabilitation should be clearly stated.
- Financial instruments should be evaluated to determine the most cost-effective method of funding. This may be internal trust fund, external trust fund, payment into the government account, or independent financial guarantee.
- Additional costs incurred as a result of early or unplanned closure should be identified. The authorities' standard cost checklist may be used for this purpose, unless better costings that can be fully validated are available.

- The method of funding the additional cost of early closure (typically, the difference between amounts in a trust fund and actual early closure cost, which declines with time) need to be identified.
- Formal authority approval for the method of funding has to be obtained. This approval usually comes with conditions (annual audit and report on rehabilitation progress, for instance).
- Annual review of funds available for rehabilitation, and of rehabilitation requirements, should be undertaken, to ensure that ongoing activities are not incurring additional liabilities for later in the mine life, for which finance has not been allocated.

C.1. Estimate the cost of rehabilitation based on the current mining plan

This should, as a minimum, be agreed between the mine planner and the rehabilitation specialist. Ideally, cost estimates should be made by a qualified QS. DME guidelines are available to generate rough estimates, but these need to be tempered by local knowledge. If the proponent's cost estimates are lower than those estimated by use of the DME standard, full justification for the reduced cost must be given to ensure acceptance by the authorities.

C.2. The phasing of rehabilitation liabilities and expenditure during the life of mine should be planned, recognising that delays or accelerations may occur

During the early stages of mine development rehabilitation liabilities increase rapidly as there is little possibility of performing concurrent rehabilitation. In this situation, the early closure liability increases rapidly. In order to comply with the legal requirement for financial coverage of the risk, an independent assessment of the outstanding rehabilitation liability is required, and the financial instrument providing coverage of the deficit must be regularly revised. It is evident that the larger rehabilitation backlog will increase cost of coverage, and there is significant financial benefit to be obtained from an accelerated rehabilitation programme.

While costs will usually be minimised in those cases where rehabilitation can be done concurrently with mining (as, for example, in coal strip-mining) there will be situations where the bulk of rehabilitation cannot commence until mining ceases. The timing of rehabilitation is therefore crucial to effective financial management. It should preferably be done sooner rather than later, it should significantly reduce rehandling requirements, but it should not be accelerated to the point where the rehabilitation drive interferes with the achievement of the planned rehabilitation land forms – which in turn, will result in added cost at closure to attain the land forms committed to in the planning phase.

C.3. The method of funding of the rehabilitation and of closure costs should be identified

Ongoing annual rehabilitation costs are usually funded from a mine's operating cost budget. Longer-term and closure-related rehabilitation costs are usually covered by some other financial instrument. Financial instruments should be evaluated to determine the most cost-effective method of funding. This may be internal trust fund, external trust fund, or financial guarantee.

In the larger mining groups, where mines have long lives, trust funds have proved popular instruments for funding rehabilitation at closure. This is both because contributions to such a trust fund are pre-tax, and because contributions can be invested to ensure growth at rates which usually exceed inflation significantly.

Annual contributions to such a trust fund are usually based on the difference between the quantum of cash in the fund and the cost of rehabilitation at closure, divided by the number of years of mine life remaining.

However, there remains the issue of early closure, and government demands some form of assurance that the differential between what is in the fund, and the cost that will be incurred in the event of early closure, be covered by some other form of financial assurance.

While a company’s track record may be taken into account in determining the quantum of cover required, there have been no exceptions to the requirement to ensure coverage of the early closure liability, and all mines are required to demonstrate that the full rehabilitation liability will be covered in the event of early closure.

Usually, trust funds provide significant tax benefits. However, as a consequence of this, releasing funds from a trust fund prior to final mine closure is difficult. It can only be done with government approval and this is unlikely to be given unless the work to be done falls fully and clearly under the definition of closure work and the fund has reached full funding for all rehabilitation requirements in the future.

C.4. Additional costs incurred as a result of early or unplanned closure should be determined

The authorities’ standard cost checklist may be used for this purpose, unless better costing, that can be fully validated, is available. Early closure results in increased cost, in comparison to closure at full term, because:

(a) In normal closure, a significant portion of rehabilitation will have been completed using annual operational costs.

(b) With premature closure, the availability of mine equipment to undertake closure work cannot be guaranteed, and costs of doing the work, using contractors, have to include site establishment costs.

C.5. Identify, and obtain formal authority approval for, the method of funding the additional cost of early closure

Currently, three methods of guaranteeing the funding of the early closure liability are acceptable to government. They are:

- Contribution of the full quantum to an approved mine closure trust fund
- Contribution of the full quantum to the government trust fund
- Obtaining an independent financial institution’s guarantee for the full quantum.

None of these options are popular with the current major corporations because they result in the sterilisation of significant capital sums (in the case of contributions to trust funds) or in the continued expenditure of an annual fee to the financial institution guaranteeing early closure funding, for which no long-term benefit is derived.

C.6. Review of rehabilitation requirements, and of funds available for rehabilitation

Reviews should be undertaken annually both of the mining activity and the outstanding rehabilitation liabilities, and of the funds available in the trust fund, where the trust fund is the vehicle used to fund closure rehabilitation cost. This will ensure that additional liabilities, for which finance has not been allocated, are not incurred. While internal review is acceptable in the short term, independent external assurance should be sought on a regular basis, both for the determination of the rehabilitation liability, and of the funds available in the trust fund (where that is the funding vehicle used).

APPENDIX 2:
PRE-MINING SOIL SURVEYS, AND EXAMPLE SOIL STRIPPING AND SOIL USE REPORTS

Detailed soil surveys should be done in all cases where the mining activity or infrastructure development will result in significant soil disturbance. This is both to determine land capability, so as to provide a logical target for post-mining land capability, and also to define the materials that will be available for rehabilitation.

The information derived form the soil survey is usually also used to define pre-mining land capability and the field inspection is used as an opportunity to determine pre-mining land use, as both factors are required for completion of the EIA/EMP documentation.

A. Scope of work for soil surveys and reporting

- The survey should be done on a 100 m grid for pits <100 ha (or for areas to be disturbed for waste rock dumps, tailings dams, or surface infrastructure, e.g. shafts, haul roads, etc), but this may be increased to a 150 m grid on larger pits, provided the soil variability is such that this increased spacing does not significantly downgrade the usefulness of the final report. (Required grid is always specified when asking for quotes).
- The survey should include a 100m or 150m "fringe" around the footprint of the pit (to cater for outsloping of box cut spoils etc.). Where the survey is done on 100mx100m grid a narrower fringe (100m) is used. The larger fringe distance is used with the larger grid spacing.
- For underground mines where surface impacts could manifest, a “reconnaissance” type soil survey should be done with a 250m x 250m grid being applied.
- A representative soil profile pit should be excavated for each major soil type identified. The pits should be photographed and the usable soil horizon/s should be sampled for physical (texture & bulk density) and chemical analysis (pH, resistance, Ca, Mg, Na, P, K, and organic matter content). All results should be properly documented.
- The data obtained should be processed to provide detailed plans showing soil mapping units, with usable soil depths (the soil stripping plan), and with land capability classes.
- Land capability classes, as defined in Appendix 3, should be determined and mapped.
- Present land use must be assessed and mapped during the field assessment. From the information gathered comment should be made on existing soil erosion and evidence of land misuse such as alien invasive plant infestation.

B. Deliverables

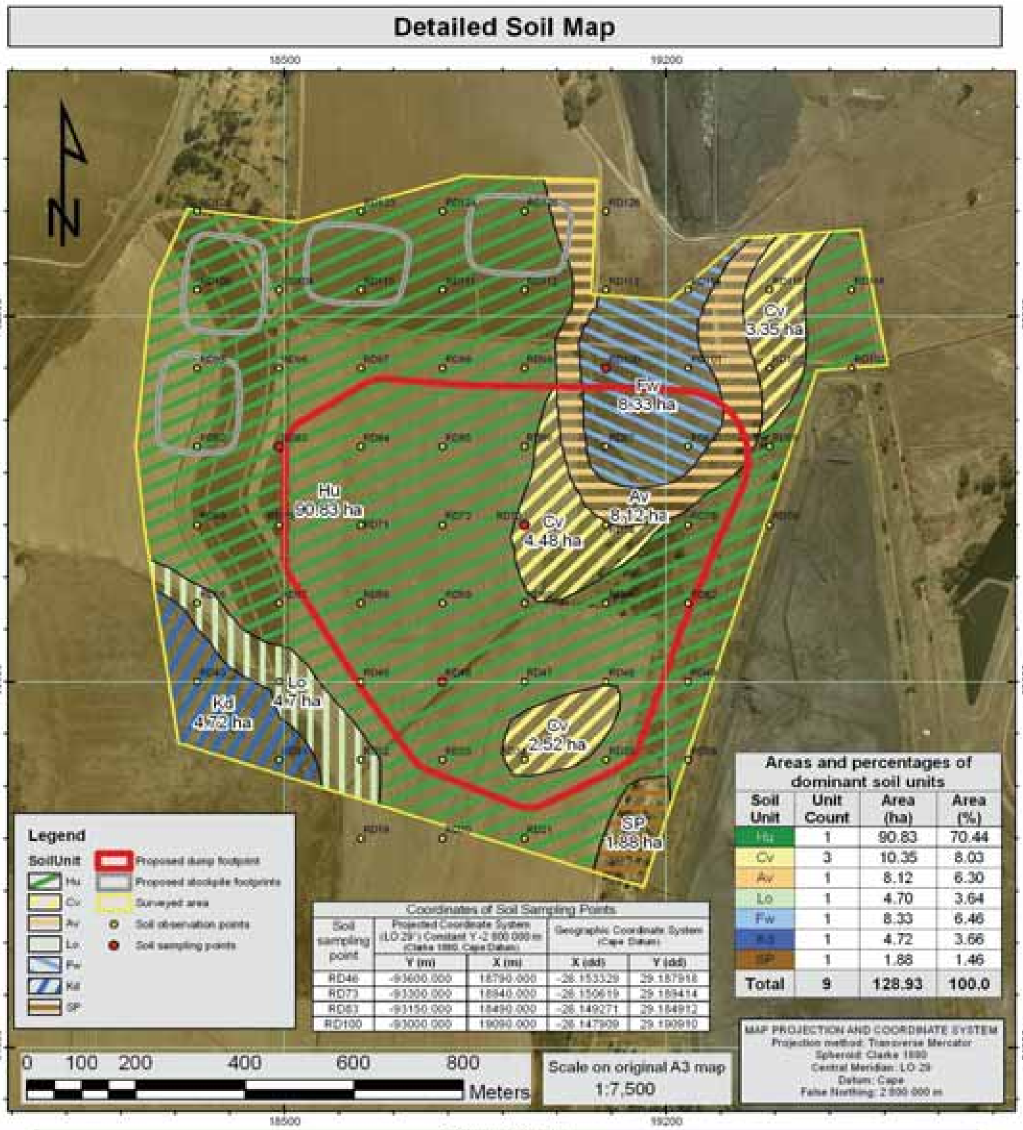
The survey deliverables should include:

- a comprehensive report. This should follow the structure of the Aide Memoire – so as to assist mine staff in compiling their EMP document – and should include:
    - a table showing all soil forms in the survey area, their aerial extent, and the volume of each soil type that is available for stripping
    - comment on the erodibility of the different soil types

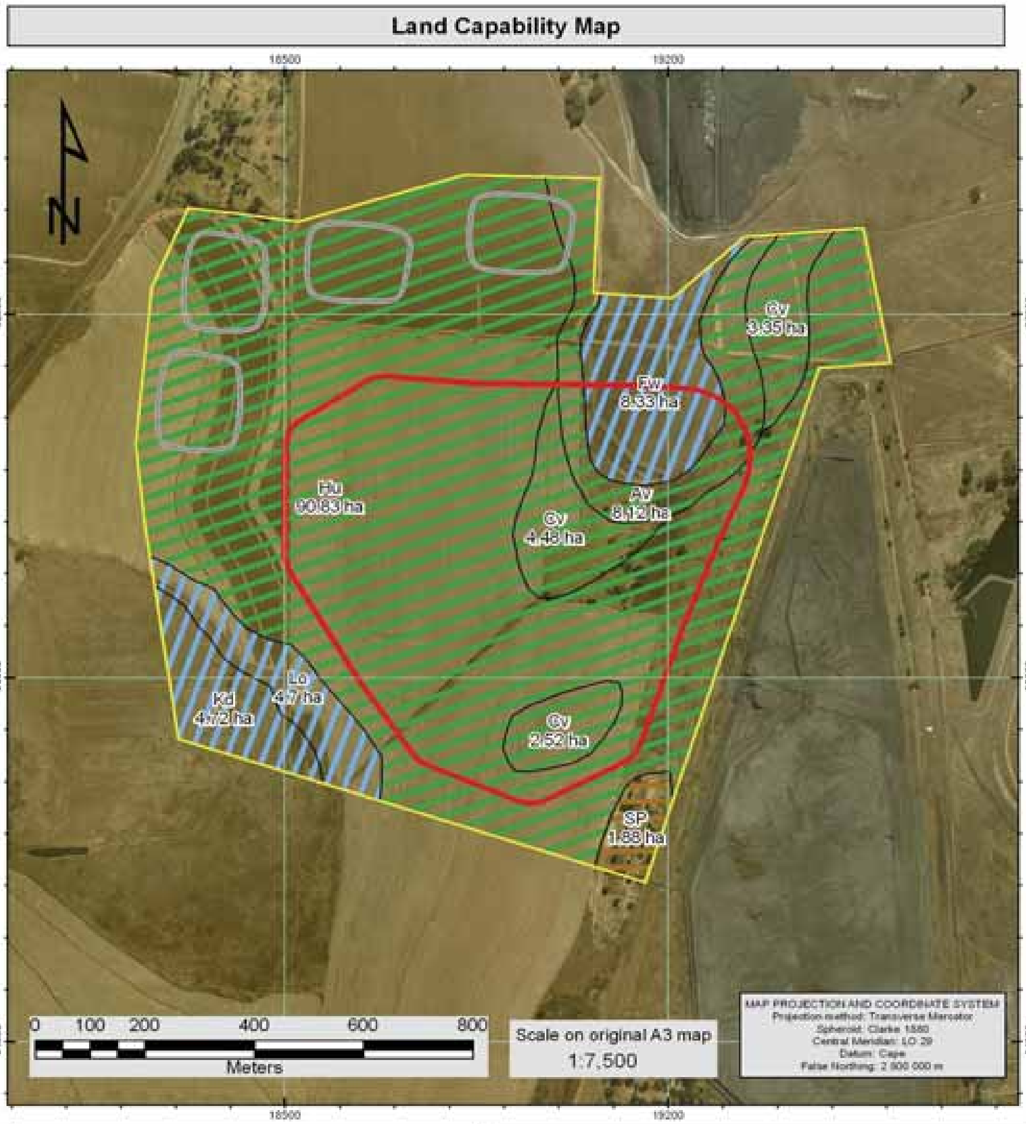
- the following maps (3 hard copies of each, and the same in electronic format – preferably in DGN and SHP file format for easy import to Microstation and Arcview, but DXF format is also acceptable):
  - Map 1: Soil mapping units (soil types)
  - Map 2: Stripping plan showing areas of uniform “usable soil” depth – areas differentiated at 10cm soil depth intervals (include a table showing areas and volumes of soils to be stripped in each depth class)
  - Map 3: Land capability units as defined in Appendix 3 of these Guidelines
  - Map 4: Present land use

Note: Soil surveys can be done at any time of the year, but should preferably be done from April to September when conditions are drier and areas are easily accessible.

Typical examples of the required maps are provided on the following pages.



SOIL LEGEND							
Soil Unit	**Dominant Soil Form & Family**	**Subdominant Soil Forms**	**Average Depth (mm)**	**Texture Class**	**Summarized Description of Dominant Soil Form**	**Land Capability**	**Agricultural Potential**
Hu	Hutton 2100	Clovelly 2100	1500-1800	Sandy loam - sandy clay loam	Deep, red, well-drained, structureless, sandy loam to sandy clay loam soils underlain by weathered rock.	Arable	High
Cv	Clovelly 2100	Glencoe2100 Avalon2100	900-1200	Sandy loam	Deep, yellow brown, well-drained, structureless, sandy loam soils underlain by weathered rock.	Arable	High
Av	Avalon 2100	Glencoe2100 Clovelly 2100	600-900	Sandy loam	Deep, yellow brown, well-drained, structureless, sandy loam soils underlain by weathered rock.	Arable	Moderate
Lo	Longlands 2000	Fernwood 2110 Kroonstad 1000	600-900	Sandy	Moderately deep, grey, imperfectly drained, sandy soils underlain by soft plinthite with clear evidence of seasonal wetness and lateral movement of water in the soil profile.	Wetland	Low-none
Fw	Fernwood 2110	Longlands 1000 Kroonstad 1000	1200-1500	Sandy	Deep, grey, imperfectly drained, structureless, sandy soils with clear evidence of seasonal wetness and lateral movement of water in the soil profile.	Wetland	Low-none
Kd	Kroonstad 1000	Longlands 1000 Katspruit 1000	400-700	Sandy	Shallow, grey, imperfectly to poorly drained, sandy soils underlain by gleyed clay with clear evidence of permanent wetness and fluctuating water tables.	Wetland	Low-none
SP	-	-	0	-	Subsoil and soft overburden stockpile.	Wilderness	None



Legend

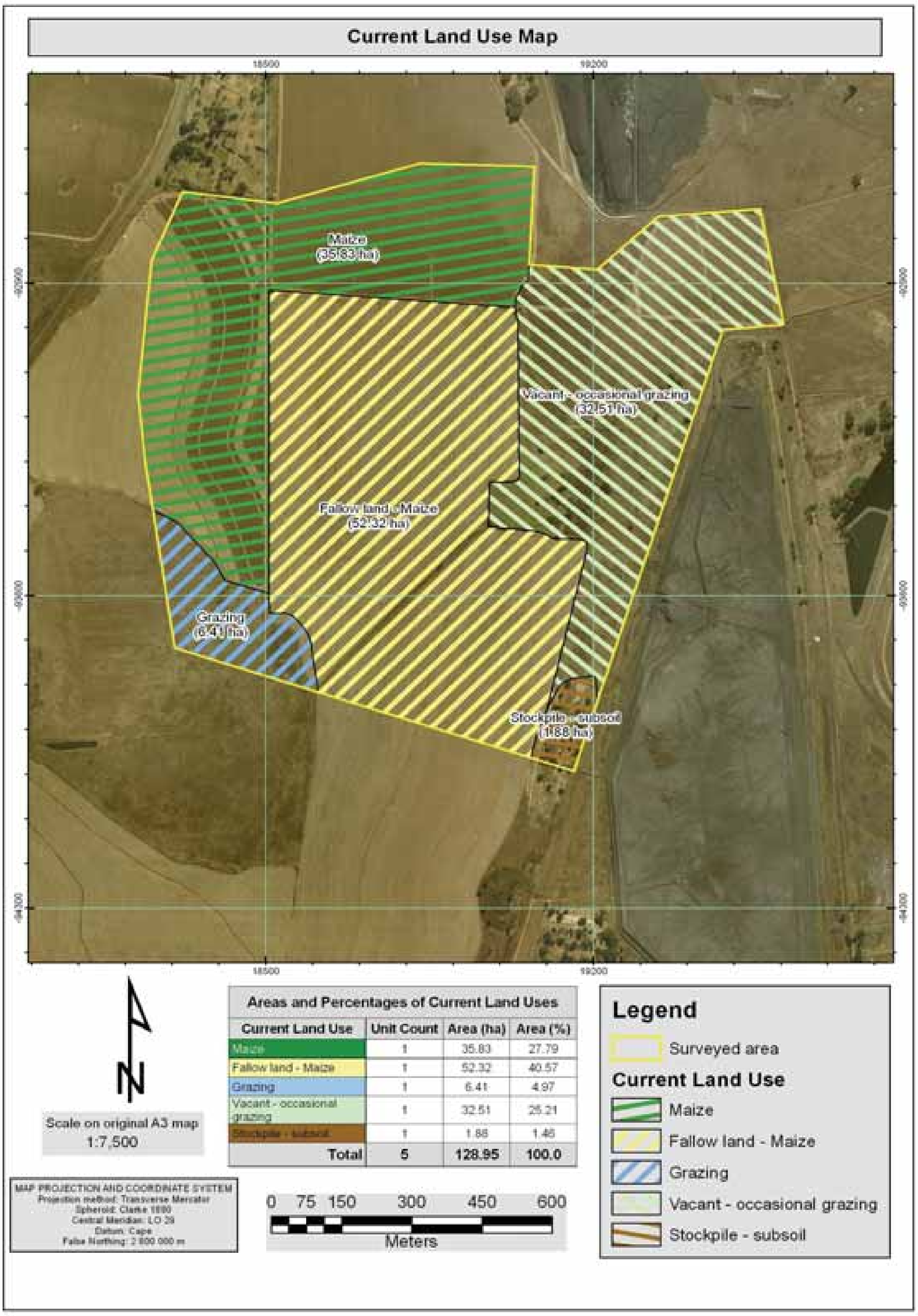
- Proposed dump footprint
- Proposed topsoil stockpile footprints
- Surveyed area

Land Capability

- Arable (Soil units Hu, Cv and Av)
- Wetland (Soil units Lo, Fw and Kd)
- Wilderness (Soil unit SP)

Areas and Percentages of Land Capability Classes

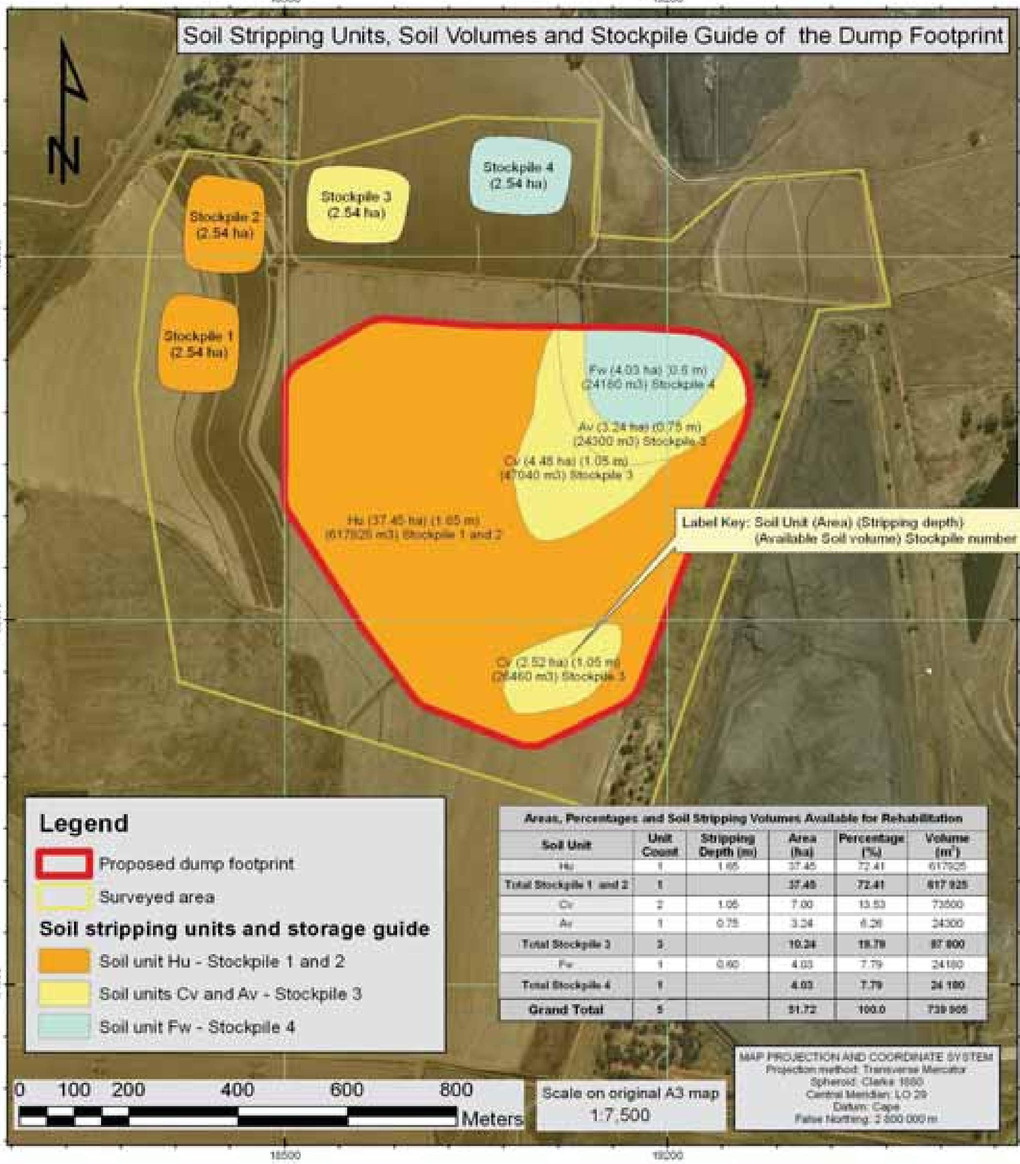
Land Capability Class	Soil Unit	Unit Count	Area (ha)	Area (%)
Arable	Hu, Cv, Av	1	109.31	84.78
Grazing	None	0	0.00	0.00
Wetland	Lo, Fw, Kd	2	17.75	13.77
Wilderness	SP	1	1.88	1.46
Total		4	128.94	100.0



Areas and Percentages of Current Land Uses

Current Land Use	Unit Count	Area (ha)	Area (%)
Maize	1	35.83	27.79
Fallow land - Maize	1	52.32	40.57
Grazing	1	6.41	4.97
Vacant - occasional grazing	1	32.51	25.21
Stockpile - subsoil	1	1.88	1.46
Total	5	128.95	100.0

Soil Utilization Guide Map



Areas, Percentages and Soil Stripping Volumes Available for Rehabilitation

Soil Unit	Unit Count	Stripping Depth (m)	Area (ha)	Percentage (%)	Volume (m^3)
Hu	1	1.65	37.45	72.41	617925
Total Stockpile 1 and 2	**1**		**37.45**	**72.41**	**617 925**
Cv	2	1.05	7.00	13.53	73500
Av	1	0.75	3.24	6.26	24300
Total Stockpile 3	**3**		**10.24**	**19.79**	**97 800**
Fw	1	0.60	4.03	7.79	24180
Total Stockpile 4	**1**		**4.03**	**7.79**	**24 180**
Grand Total	**5**		**51.72**	**100.0**	**739 905**

Soil Legend of Soil Units Within Proposed Dump Footprint

Soil Unit	Dominant Soil Form & Family	Subdominant Soil Forms	Average Depth (mm)	Texture Class	Summarized Description of Dominant Soil Form	Land Capability	Agricultural Potential
Hu	Hutton 2100	Clovelly 2100	1500-1800	Sandy loam - sandy clay loam	Deep, red, well-drained, structureless, sandy loam to sandy clay loam soils underlain by weathered rock.	Arable	High
Cv	Clovelly 2100	Glencoe2100 Avalon2100	900-1200	Sandy loam	Deep, yellow brown, well-drained, structureless, sandy loam soils underlain by weathered rock.	Arable	High
Av	Avalon 2100	Glencoe2100 Clovelly 2100	600-900	Sandy loam	Deep, yellow brown, well-drained, structureless, sandy loam soils underlain by weathered rock.	Arable	Moderate
Fw	Fernwood 2110	Longlands 1000 Kroonstad 1000	1200-1500	Sandy	Deep, grey, imperfectly drained, structureless, sandy soils with clear evidence of seasonal wetness and lateral movement of water in the soil profile.	Wetland	Low-none

APPENDIX 3:
LAND CAPABILITY CLASSIFICATION FOR MINED LAND*

A. Pre-mining land capability classification for land to be mined

Land performs many functions that are vital to society. Any particular area of land may be rated according to its relative or absolute capability vis-à-vis specified functions. This section assumes that the land is in agricultural use before mining commences and will revert to agricultural use after mining has been completed. In some cases, the end-use of disturbed land may be non-agricultural (e.g. for urban, industrial or transportation purposes, or for recreation or nature conservation). Such exceptional cases will need special treatment.

A detailed evaluation of agricultural capability is probably the most important component of the pre-mining land inventory because it provides the only objective basis for establishing the post-mining land use capability targets. It is not sufficient to state merely that land will be rehabilitated to an "agricultural capability". This is far too wide a concept and is susceptible to too many different interpretations for the term "capability" to be left unqualified. Similarly, in the undisturbed state, land capability may vary extremely widely, often over short distances, as a function of climate, soil characteristics, topography, surface and near-surface geology, and vegetation. Some classification of capability is therefore essential.

The system of land evaluation that is set out below has been designed specifically for surface mining in South Africa. It is not intended, and due to its simplicity is probably not appropriate, for use in non-mining situations, although it incorporates features of other systems, notably some of the criteria for identifying prime farmland developed by the soil conservation service of the United States Department of Agriculture.

It is proposed that four classes be recognised to accommodate all land. These are:

- Wetland
- Arable land
- Grazing land, and
- Wilderness land.

The criteria for identifying each are presented in the form of an eliminating key. It must be emphasised that capability, and not present or past use, is the basis for allocating land to a particular category. Furthermore, assessment is an interpretive exercise using the raw data on soils and topography assembled during the pre-mining data collection period.

Class I: Wetland

Although all land performs hydrological functions, that termed Wetland is particularly important in regulating subsurface storage and drainage of excess precipitation on a continual rather than sporadic basis. It is made up of vleis, swamps, marshes, peat-bogs and the like. There is usually a water table present at shallow depth in the soil with the result that it is difficult or impossible to recover soil material for later use because heavy

* As defined in "Guidelines for the rehabilitation of land disturbed by surface coal mining in South Africa", COM, 1981

machinery becomes bogged down, unless the soils are drained. Land assigned to Class I: Wetland, has one of the following characteristics:

- a diagnostic[3] organic (O) horizon at the surface
- a horizon that is gleyed throughout more than 50 percent of its volume and is significantly thick, occurring within 75 cm of the surface.

Class II: Arable land

Land which conforms to all of the following requirements is designated as Class II: Arable:

- does not qualify as wetland
- has soil that is readily permeable[4] to the roots of common cultivated plants throughout a depth of 0.75 m from the surface
- has a soil pH value between 4,0 and 8,4
- has electrical conductivity of the saturation extract less than 400mS/m at 25°C and an exchangeable sodium percentage less than 15 through the upper 0,75 m of soil
- has a permeability of at least 1,5 mm per hour in the upper 0.5 m of soil
- has less than 10 percent by volume of rocks or pedocrete fragments larger than 100 mm in diameter in the upper 0,75 m of soil
- has a slope (in percent) and erodibility factor[5] (K) such that their product is less than 2,0
- occurs under a climate regime which permits, from soils of similar texture and adequate effective depth (0,75 m), the economic attainment of yields of adapted agronomic or horticultural crops that are at least equal to the current national average for those crops
- or
- is either currently being irrigated successfully or has been scheduled for irrigation by the Department of Water Affairs.

Class III: Grazing land

Grazing land conforms to all of the following requirements:

- does not qualify as wetland or as arable land
- has soil or soil-like material, permeable to the roots of native plants, that is more than 0.25 m thick and contains less than 50 % by volume of rocks or pedocrete fragments larger than 100 mm diameter
- supports or is capable of supporting a stand of native or introduced grass species or other forage plants utilisable by domesticated livestock or game animals on a commercial basis.

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[3] Diagnostic horizons and materials referred to in this discussion are as defined for the South African soil classification system (Macvicar et al, 1977)

[4] Materials and diagnostic horizons which are not readily permeable and should therefore not be encountered within 0.75 m of the surface include:- hard rock, pedocretes (calcrete, ferricrete and silcrete) in sheet form, any soil material that is strongly cemented, dorbank, fragipans and diagnostic hard plinthic, gleycutanic and prismacutanic B horizons.

[5] K may be obtained from the soil erodibility nomograph of Wischmeier, Johnson and Cross (1971), details of which appear in Appendix 8

Class IV: Wilderness land

This is land which has little or no agricultural capability by virtue of being too arid, too saline, too steep or too stony to support plants of economic value. Its uses lie in the fields of recreation and wildlife conservation. It does, however, also include watercourses, submerged land, built-up land and excavations. Wilderness land is defined by exclusion, namely:

- land which does not qualify as wetland, arable land or grazing land.

A land capability map of the area destined for disturbance must be made at a scale no smaller than 1:10,000.It is suggested that wetland be shown in blue, arable land in green, grazing land in yellow and wilderness land in brown. The hectarage in each of the four classes must be tabulated and expressed as a percentage of the total area.

B. Post mining land use capability

Capability refers to the general kind and level of activity to which land is suited. Almost invariably, land will be in agricultural use or have a potential for agriculture prior to mining. The operator of a mine cannot be required to upgrade the original capability during rehabilitation. The operator should be expected to ensure that undue reduction of capability is not the result of the mining operation. Therefore, agricultural land capability prior to mining will be the primary criterion for determining the standard of rehabilitation to be attained in any particular instance. The land use capability assessment made prior to commencement of mining thus assumes fundamental importance in determining the rehabilitation plan.

The post-mining land capability standard uses pre-mining land capability as the starting point. In the final analysis, a mined-out area – less that occupied by spoil from the initial boxcut and by final voids – should have the same relative proportions of arable and grazing land as were present in the affected area before commencement of mining. Currently, most prior wetland and wilderness land is rehabilitated to a wilderness standard, and the boxcut spoils to a grazing standard. However, due to increasing pressure, more effort is devoted to the rehabilitation of wetlands, especially pans and free-draining wetlands.

The original spatial distribution does not have to be replicated and may be improved on, for example, by engineering arable land into consolidated blocks where it might originally have occurred in a fragmented pattern.

The criteria for post mining arable, grazing, wilderness and wetland capabilities classes are as follows:

- ARABLE: soil depth will exceed 0,6 m, the soil material must not be saline or sodic and the slope (%) will be such that when multiplied by the soil erodibility factor K, the product will not exceed 2,0 (see the soil erodibility nomograph in Appendix 8). In using the nomograph, a nominal value of 1% organic matter should be used)
- GRAZING: soil depth will be at least 0,25 m
- WILDERNESS: soil depth is less than 0,25 m but more than 0,15m.
- WETLAND: depths as for grazing but use wetland soils which have been separately stockpiled

It is, of course, essential to compile, progressively, a post-mining land capability map showing the distribution of the three capability classes.

APPENDIX 4:
DEMOLITION OF INFRASTRUCTURE

The methodology for demolition of infrastructure is based on the following key assumptions:

- The removal of infrastructure will occur at the time of general mine closure. Special measures to protect adjacent structures which may otherwise remain operational have not been considered.
- Infrastructure will be removed to a depth of 1m below ground level, or if more cost effective foundations will be covered to a depth of 1m, provided this does not affect surface water runoff. Sub-surface structures will be backfilled or sealed off.
- All infrastructure will be demolished with the view that the only salvage will be scrap value.
- Should any structure or item have intrinsic value at closure greater than the scrap value, it could be recovered as long as the total rehabilitation cost is not increased. This option can only be evaluated at closure.
- Structures will not be dismantled but will be pushed over, or dropped using explosives and then loaded for removal using mechanical equipment. This has a significant safety advantage in largely avoiding the necessity of workmen having to operate at heights.
- Underground workings will be sealed with shaft plugs.
- Underground infrastructure will be left in place unless the resale value warrants removal.
- Inert rubble will be removed to tailings dams or disposed of underground.
- Contaminated rubble will be assessed for degree of contamination, and disposed of in the appropriate hazardous waste disposal sites.

A. Civil Work

A.1. Brick and concrete structures up to 8m in height

- Demolish structure by means of 28 ton excavator fitted with a hydraulic hammer.
- Cut reinforcing where relevant.
- Stockpile rubble ready for carting.
- Load by means of 28 ton excavator onto 10 m^3 tipper trucks and remove rubble to the tailings dam or underground.
- Level and rip infrastructure footprint.
- Replace topsoil, and rehabilitate.

A.2. Brick and Concrete structures up to 15m in height

- Demolish structure by means of 43 ton excavator fitted with a hydraulic hammer.
- Cut reinforcing where relevant.
- Stockpile rubble ready for carting.
- Load by means of 28 ton excavator onto 10 m^3 tipper trucks and remove rubble to the tailings dam or underground.
- Level and rip infrastructure footprint.
- Replace topsoil and rehabilitate.

A.3. Headgears, stacks and high concrete structures

- Blast by means of explosives to reduce height of structure or else fell the structure by means of explosives.
- Thereafter, an excavator fitted with a hydraulic hammer will be used.
- Cut reinforcing where relevant.
- Stockpile rubble ready for carting.
- Load by means of 28 ton excavator onto 10 m^3 tipper trucks and remove rubble to the tailings dam or underground.
- Level and rip infrastructure footprint.

A.4. Foundations, plinths, retaining walls, bases and slabs

- Demolish structures by means of 28 ton excavator fitted with a hydraulic hammer.
- Remove rubble to tailings dam or underground.
- Replace topsoil and revegetate.

A.5. Railways

- Remove railway lines, sleepers, railway electrification including sub-stations and signalling.
- Remove ballast to waste rock dump. It is assumed that the removal of ballast and associated rehabilitation of the surface will mitigate any historical spillages (including hydrocarbons) along railway lines and that no additional clean up is necessary.
- In the event that this is not the case, additional removal of polluted materials is obligatory. Hydrocarbon spills can usually be biodegraded *in situ*
- Currently, there is no legal requirement to remove culverts, bridges or other concrete structures.
- Reshape embankments and other disturbed areas to minimise erosion risk.
- Rip affected areas and revegetation.

A.6. Roads

- Remove surface of tarred roads (200 mm).
- Rip surface (tarred and gravel roads).
- Regrade surface.
- Apply 300 mm of usable topsoil material and revegetation.

B. Steelwork

It is assumed that all steelwork will be scrapped and the demolition process is based on this assumption. However, mild steel scrap and more expensive metals such as copper and aluminium fetch high prices and there are significant amounts of these metals in the average mine infrastructure

B.1. Structures up to 12m in height

- By means of 43 ton excavator fitted with a bucket, push the structure, slowly collapsing it.
- Make collapsed structure safe by spreading the steelwork for gas cutters to proceed. Hydraulic shears fitted to excavators will also be utilised.
- Any civil structure e.g. suspended floor slabs, columns, beams, ground floor slabs, plinths, bases and foundations will be removed by means of hydraulic hammer.

B.2. Structures greater than 12m in height

- In some cases explosives will be used either to reduce heights or fell sections of the structure. In the case of stacks these will be felled by means of explosives.
- Mobile cranes will be used where applicable.
- Make collapsed structure safe by spreading the steelwork for gas cutters to proceed. Hydraulic shears fitted to excavators will also be utilised.
- Any civil structure e.g. suspended floor slabs, columns, beams, ground floor slabs, plinths, bases and foundations will be removed by means of hydraulic hammer.

B.3. Roof Sheeting and Cladding

- Where it is safe and economical to remove roof sheeting and cladding this will be carried out. Life lines and safety harnesses will be used at all times.

C. Recovery of Machinery and Equipment

- Prior to demolition, existing craneage will be used as much as possible to remove machinery and equipment that has resale value.
- Where no existing craneage is available, then mobile cranes will be utilised.
- Machinery and equipment with no resale value will only be removed prior to demolition if this facilitates the process. Equipment containing oils must be drained and the used oils sent for recycling

APPENDIX 5:
FINAL LANDFORM, MODELLING, DRAINAGE AND SUSTAINABILITY

A. Shaping the topography

The general guideline is to regrade spoiled areas to approximate pre-mining contours and to ensure that the rehabilitated topography links seamlessly to the surrounding topography.

However, a combination of factors such as mining method, type of earth-moving machinery and cost will determine the extent to which these ideals can be approached. Decisions taken at an early stage in the planning of a mine may impose constraints on later levelling operations so that, as far as existing mines are concerned, it may not be feasible to achieve this guideline without excessive expense.

The reconstructed surface may differ from the original in the following respects:

- In general angle, form and length of slopes are modified.
- Depending on stripping ratio and the volume expansion characteristics of overburden material, average elevation of the mined area will be lowered or raised.
- Spoil from the initial box cut forms an elevated ridge.
- A void remains after the final cut has been taken.
- Haulage ramps, depressed below the general level of the mined area, may persist.

A.1. Slope stability

Slope is one of the main parameters of erodibility and, as such, is of considerable importance in rehabilitation. Natural slopes and drainage patterns may be regarded as (quasi)equilibrium responses to the erosional forces of the particular environment and thus as relatively stable.

By altering them, a degree of instability will almost certainly be introduced and there will be a tendency for readjustment to take place by mass movement. This may take the form of rapid catastrophic failure (sliding, slumping) which occurs internally at some depth within the material, or more gradual erosion which is confined to the surface.

The former represents a safety hazard, is a feature of over-steep slopes, and can easily be remedied. The latter is more insidious and more difficult to prevent. Both will hamper successful rehabilitation.

a) Catastrophic failure

Sudden movement along a discrete failure surface occurs when the shearing resistance of the material and, more particularly, that of the foundation upon which it rests, is exceeded.

There are two mechanisms of failure: the sliding wedge type of failure (two intersecting rectilinear failure planes) which may occur when cohesionless fissile material (e.g. shale debris) is placed on a shallow foundation such as thin soil.

The other is rotational failure or slumping (failure plane rectilinear becoming arcuate; typical of deep, soft foundations). The angle of repose of dumped overburden spoil is in the region of 37^{o}. Such material will normally not fail by shear unless failure occurs through the foundation.

The current practice of reducing outslopes of spoil dumped on level to gently sloping terrain to a gradient of at least 1v:3h (18,4^{o} or 33%) makes them perfectly safe provided that the following precautions are observed:

- The foundation is stripped of soil (this is recommended in any event in order to provide topsoil for covering the outslope).
- Vertic, gley or any other materials containing high activity, smectite clays are avoided as foundations (information obtained from the soil survey).
- Over-steepening by undercutting of the toe of the slope is precluded.
- Vleis or poorly-drained stream fringes should be strictly avoided as foundations.

Although 1v:3h is the maximum permissible gradient, other considerations suggest the strong desirability of lesser gradient to reduced erosion and permit mechanisation of revegetation and maintenance operations (agricultural tractors can be operated with most implements up to 20% (1v:5h) slope).

b) Erosion of slope

The three primary slope forms are concave, convex and rectilinear. The action of a bulldozer tends to produce convex or rectilinear slopes. On the other hand, in semi-arid to sub humid climates, natural slope tend to be predominantly concave with pediments having characteristic angles usually between 0,5 and 5^{o} (being least in desert areas and increasing with rainfall). From the drainage line upwards, the rate of increase in angle remains very low for the greater part of the length of the pediment, increasing in an exponential manner close to the upper limit of the slope. Reduction in slope angle in the direction of the toe of the pediment accommodates the increasing volume of rainfall runoff without undue erosion.

The following generalisations are probably valid (Schaefer, Elifrits and Barr, 1979):

- Concave slope form is most stable, is least affected by erosion, and yields the least amount of sediment to streams. Convex slopes erode most rapidly, yield most sediment and tend to change shape fastest. Rectilinear slopes are intermediate in behaviour, although long rectilinear slopes can be severely eroded in a single heavy rain-storm.
- Slopes on spoiled material will tend to develop concave profiles in their mid to lower sections over time. Therefore, if not shaped to this form initially, erosion will be aggravated.

Areas planned for rehabilitation to an arable standard must be graded to a slope (in %) which, multiplied by the erodibility factor (K) of the new soil, gives a product of 2.0 or less. A contour survey of the new topography should be carried out.

A.2. Large stones and boulders

These should as far as possible be buried below the final level of graded spoil so as to permit ripping and scarifying operations

A.3. Final high wall, void and access ramps

If it is not feasible to fill in the final void, then the high wall which remains, after mining is completed, should be graded or blasted to 1v:3h, or flatter from the surface down to the level of the permanent water table after rebound. The spoiled side of the void should be similarly graded to the base of the highwall and an area containing the highwall fenced off. The void may lend itself to wildlife or recreational purposes particularly if a water body can be formed. All slopes must be revegetated.

Several options exist as far as haul ramps are concerned. They would appear, in most cases, to have a minimal actual or potential utility except, possibly for discharging excess water from the mine area. Their catchments will normally be small unless considerable volumes of spoil are moved. Depending upon their elevation in relation to ground water levels, they may contain free water which could be linked to that in the final void to form a small lake system. At a minimum, their sides should be graded no steeper than 1v:3h. Clearly, it is preferable to fill them as far as possible and slope the sides to produce a gentle swale in the topography. This can be achieved by leaving spoil in reserve on either side of the ramp for use at closure

B. Planning surface drainage

The eventual drainage pattern of a mined-out area will be a function of original topography, mining method and regrading strategy. It is difficult, but nevertheless important, to anticipate the permutations that may arise through variations in these three interrelated factors of which the last is amenable to the greatest degree of control.

In general, mine operators pay adequate attention to immediate problems of intercepting and diverting flow away from the working pit, haul roads and waste impoundment.

In recent years, more thought has been given to the progressive development of what must be a fully integrated and erosion-minimising drainage system for optimal disposal of surface water.

Without an overall drainage plan in mind, *ad hoc* regrading of increments of rehabilitated land may produce dislocations which will become apparent later. Problems generally arise from:

(a) a tendency to produce a drainage density lower than that which existed previously, with fewer distinct drainage channels and convex rather than concave slope profiles. This will encourage erosion and it may be anticipated that, to re-establish equilibrium, rills and gulleys will develop, erode headwards, and superimpose a new drainage pattern on the area. The guideline here is to regrade the distributed area to approximate pre-mining contours and drainage density (although not necessarily replicating the original pattern), to emphasise the formation of concave rather than convex slopes, or to introduce contour drainage structures which will intercept overland flow and reduce the length of slopes .

(b) a tendency, particularly on relatively level terrain, to create an undulating topography with frequent blind hollows. Such “basin and ridge” topography will retard run-off but may, depending on rainfall, result in a mosaic of swampy areas and increase recharge of groundwater within the pit confines. Revegetation, water management, as well as future land utilisation and management may be prejudiced.

(c) under-design of water disposal structures that are constructed in the early stages of mining if final discharge volumes are not anticipated.

The design of drainage systems should receive early attention from experienced conservation engineers and hydrologists in conjunction with an engineering approach to spoil disposal, taking consideration for the proposed final topography.

C. Designing with the final water balance in mind

As fuller understanding develops of the costs associated with managing water that has percolated though rehabilitated lands, surface drainage design has increasingly focused on ensuring that water landing on the rehabilitated surface drains off the mined land as quickly and as completely as possible, to minimise the quantities of in-pit water that have to be managed, and frequently desalinated, post-closure. Final voids could be sized to ensure that evapo-transpiration from the voids balances water “make”, thus minimising seepage of affected waters from the mined area. Because evaporation is a water use in terms of the National Water Act, this needs to be authorized and permitted during the mine design/EIA stages.

D. Use of modelling to generate post-mining topography plans

Increasingly, mines are generating post-mining topography plans at very early stages in the development of mine plans using a range of computer modelling packages. These assist in preventing major dislocations, and also in ensuring that runoff from the final rehabilitated surface is maximised.

APPENDIX 6:
SURFACE DRAINAGE STRUCTURE DESIGN

Surface drainage systems may require a variety of structures to control the flow of water. Among these are drains of various kinds, contour-bank canals, waterways lined with grass or other materials, berms, drop structures, energy dissipaters and sedimentation ponds. These structures should be designed and constructed according to conventional engineering practice and will not be elaborated on here. Contour-bank canals, grassed waterways and toe berms merit special discussion in the context of the rehabilitation of disturbed land.

Bearing in mind the propensity for rehabilitated lands to undergo differential subsidence, and the problems that this causes with respect to the sustainability of the contour banks, it is usually best to ensure the survival of these banks by increasing the within-contour slope to 1 to 2%. This may increase the scouring effect within the contour channel, but will greatly decrease the possibility of the contour banks overtopping and causing severe erosion.

A. Contour systems and grassed waterways

These are anti-erosion measures designed to shorten the hydraulic length of slopes by intercepting overland flow (contour structure) and to conduct the latter to a safe discharge point (waterways). It should be emphasised that the two are complementary and that waterways must be provided if contour bank are installed. The following general design procedures and standards are proposed with the recommendation, however, that any system which has not been professionally designed should be subjected to competent review by an agricultural engineer before being implemented.

A.1. Establish the vertical interval of spacing between canals

This first step in design should be based on the nominated soil loss that can be tolerated. Soil loss is a function of the kinetic energy of the prevailing rainfall, grade of slopes, erodibility of the particular soil and anticipated plant cover. In view of the extreme importance of topsoil on rehabilitated land and the expense of providing it, the aim should be to contain soil loss to a minimum. A conservative annual loss of less than 10 tonnes ha^{-1} would seem to be appropriate.

Tables are available[6] for obtaining appropriate canal spacing from input values for the following variables:

- nominated soil loss,
- rainfall energy,
- slope,
- soil erodibility index, and
- percent cover.

[6] Soil loss estimator for Southern Africa. Natal Agricultural Research Bulletin No. 7, 1976. Obtainable from the Director, Natal Region, Department of Agriculture and Fisheries, Private Bag X9059, Pietermaritzburg 3200, South Africa.

Soil erodibility values of mine soils for use with the tables should be arrived at as follows:

- Starting with a value of 4,5
- Add -0,5 if clay content of topsoil is less than 15% or +0,5 if greater than 35%
- Add -0,5 if topsoil depth is between 25 and 50 cm or -1,0 if less than 25 cm
- The cover percentage may be taken as:
  - 80% for sod-type grasses
  - 70% for tufted grasses where annual rainfall exceeds 700 m, and
  - 60% for tufted grasses where annual rainfall exceeds 700mm.

A.2. Determine the size of channel by solving the equation A=Q/V

By deriving the values Q = runoff intensity (m^3 sec^{-1}) for the catchment of contour-bank canal and V= the average velocity of water flowing in the canal (m sec) for the type of channel planned, the equation can be solved for ”A”, which is the required cross sectional area of the channel.

A.2.1. Runoff intensity, Q

Since the ground slope distance between canals is known and the canal length can be determined, the area of the catchments served by each canal can be calculated. Note that canal length should not exceed 600 metres for good conditions and 400 metres for poor conditions. Since one will usually be dealing with small catchments, the modified USLE soil conservation service procedure may be used to determine runoff. A publication[7] by the Division of Agricultural Engineering of the Department of Agriculture and Fisheries contains details of this procedure including a map showing maximum 24-hour rainfall intensities for South Africa and a series of graphs for determining Q. One of the parameters used is a so-called “curve number”, determined by soil type and ground cover. It is recommended that a curve number of 85 be used for mined land that is bare of vegetation, if topsoil depth is more than 50 cm, and clay content is greater than 15%. If either or both of these conditions are not met, then use the maximum curve number of 90.

A.2.2. Velocity of flow in the canal, V

This is related to the hydraulic radius of the channel (R), its hydraulic gradient (S) and a coefficient of roughness (n), by Manning’s equation:

$$V = \frac{R\,.S^{0,5}}{n} \text{ m sec}^{-1}$$

The maximum permissible velocity must be non-scouring and standard limiting values for V exist for various soil and basal cover conditions (see, for example, Contourbank systems design data, Dept of Agriculture and Fisheries, Undated). V is thus selected as is S (0,2 to 0,4% for contourbank canals but may be steeper for broader structures such as waterways). Values for Manning’s n corresponding to various channel conditions are widely available (e.g. Beasley, 1972, Han and Barrie, 1978). The hydraulic radius R can thus be found from Manning’s equation. Since the cross sectional area of the canal can be found from A=Q/V and R is known, various combinations of depth and width can be

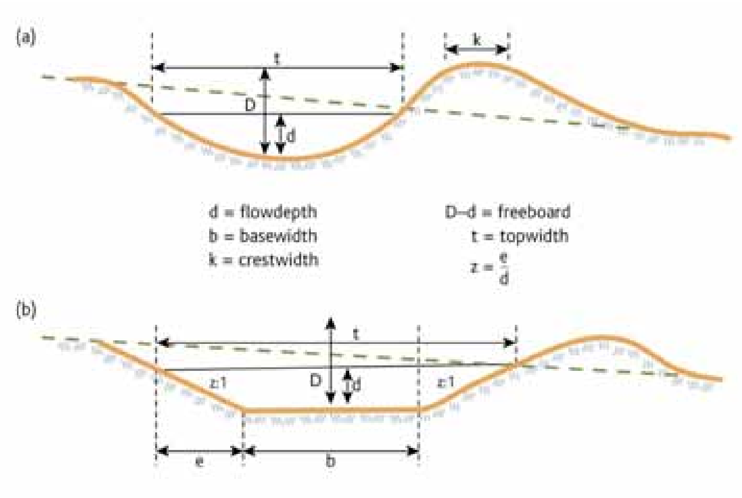
[7] “Die beraming van afloopintensiteit” (Eerste uitgawe, geldig tot 1981–07-01). Available from the Division of Agricultural Engineering, Private Bag X515, Silverton, 0127, RSA.

calculated, or derived from nomographs (e.g. Beasley, 1972). Dimension will depend on the cross-sectional shape or type of channel.

Tables and nomographs which solve A = Q/V and Manning's equation simultaneously have been prepared and these may be used to arrive directly at dimensions. "Contour-bank systems design data" may be consulted for canals of low gradient, and Green (1980) for larger waterways.

A.3. Cross-sectional shape

The following diagram illustrates two typical cross-sectional shapes and gives the dimensional inter-relationships of each. An approximately parabolic section is recommended for narrower cross-slope channels whereas larger and steeper structures, such as waterways, should have a trapezoidal or rectangular shape.



	Cross-sectional area (a)	Wetted perimeter (P)	Hydraulic Radius $R = \frac{a}{P}$	Top width (t)
(a) Parabolic	$\frac{2}{3}td$	$t + \frac{8d^2}{3t}$	$\sim \frac{2d}{3}$	$\frac{a}{0{,}67d}$
(b) Trapezoidal	$bd + zd^2$	$b+2d\sqrt{z^2+1}$	$\frac{bd + zd^2}{P}$	b + 2dz

Properties of:
(a) parabolic and
(b) trapezoidal channels

A.4. Safety factor

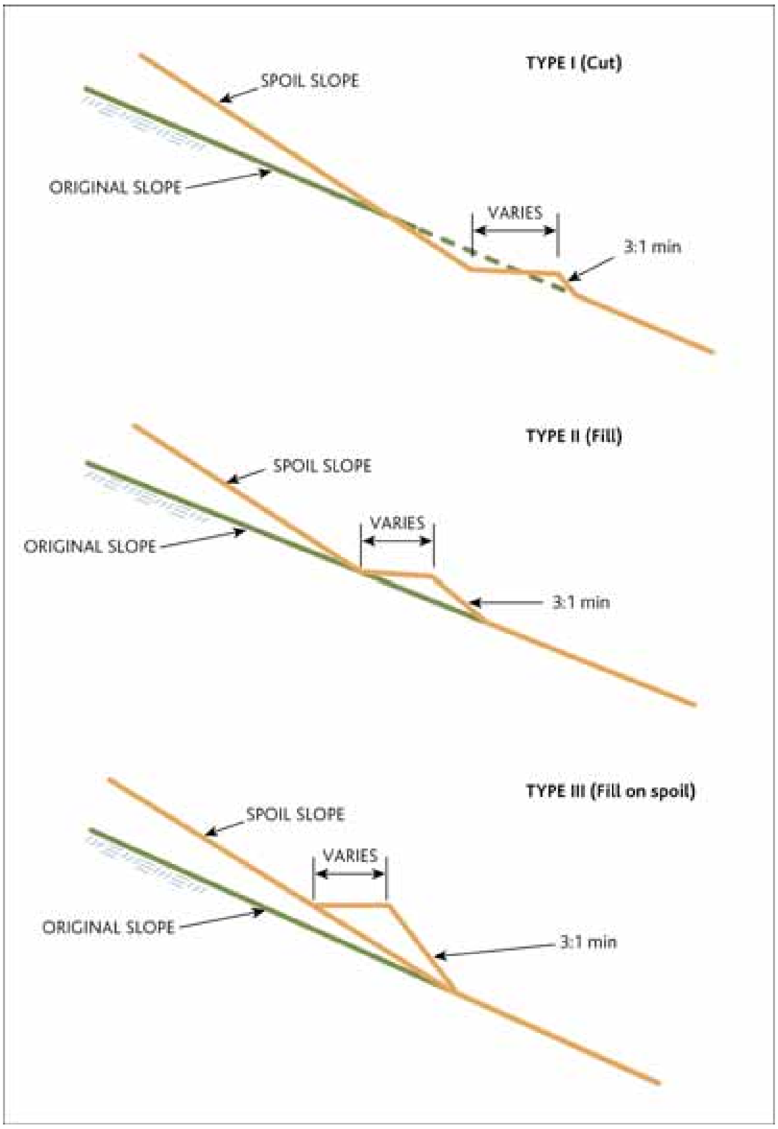
Differential subsidence of spoiled material poses a threat to contour structures. Consequently, they should be over-designed to give a larger safety factor than is normally allowed. Care should be taken to compact the material that is used to provide freeboard prior to covering with soil and grassing. Structures should be inspected regularly and modified or reinforced, where necessary, to avoid breaching.

A.5. Grassing

Under Highveld conditions, a range of grasses provide quick cover and superior erosion control. Those recommended are *Digitaria decumbens* (pongola or lowveld finger grass), *Pennisetum clandestinum* (Kikuyu, seeded), *Chloris gayana* (Rhodes grass, seeded) and *Cynodon dactylon* (Kweek, Puerto Rico, seeded). Adequate fertiliser must be applied at planting and maintenance dressings given annually

B. Toe berm

This is a berm or bench of compacted and vegetated soil constructed at the toe of the outer slope for the purpose of reducing the velocity of run-off and trapping sediment (see diagram).



Sections illustrating toe berm construction
(Reclamation Manual for Coal Surface Mining, State of Virginia, USA)

It is useful to control excessive erosion until the slope has been stabilised by vegetation. The width of the berm should be 1metre for every 10 metres of slope length. The bench section of the berm should be sloped a minimum of 1% and maximum of 3% away from the slope and its outer slope should be 1v:2h or flatter. It should be compacted and vegetated immediately.

APPENDIX 7:
SOIL COMPACTION AND ITS ALLEVIATION

Soil compaction is a major factor limiting post-rehabilitation land capability in the South African mining industry. In the Mpumalanga coalfields, for example, approximately 40,000ha of land have been rehabilitated, and surveys conducted on these lands indicate that the great majority have bulk densities that severely restrict plant rooting. It is clear that the currently-used technology to loosen soils after rehabilitation is unsatisfactory, and an industry-sponsored research initiative is currently investigating alternative methods of compaction alleviation.

A. Causes of compaction

Soil compaction is caused by the techniques and equipment used in the stripping, transport, stockpiling and replacement of soil materials during the mining and rehabilitation processes. Additional compaction occurs during the levelling of the replaced soil and during its preparation for planting.

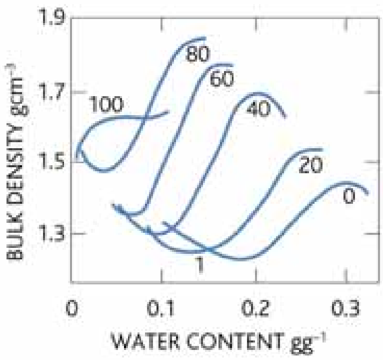
Apart from compaction of the replaced soil, compaction also occurs in the overburden materials that are handled and thus disturbed during the mining process. During disturbance, overburden expands in volume. This is then followed by a degree of natural recompaction as the material slowly settles. The degree of this recompaction is variable, leaving an overburden material with zones of differing bulk density and porosity, which become susceptible to differential settlement over the long term. Compaction frequently occurs at the overburden surface because of the heavy machinery that is used for the grading of the spoils materials. The soil/spoil interface is consequently a major barrier to root (and water) penetration.

A.1. Factors affecting the compaction of materials

Rigorous quantitative relationships that can be applied universally to predict the behaviour of loose materials when subjected to loading do not exist. Nevertheless, the following qualitative relationships are well known and may be used to guide rehabilitation practice.

(a) Compactibility varies with particle size distribution. Sandy materials other than pure sands, and particularly those having a high proportion of fine sand (0,2-0,02 mm diameter), are most susceptible to compaction and the formation of high bulk densities. A reliable indication of the comparative susceptibility of soil and other finely divided materials to compact under loading may thus be obtained from particle size analysis.

(b) In general, for a given material and external load, the resulting bulk density yields an S-shaped curve when plotted against moisture content (see diagram). Moisture contents for both minimum and maximum bulk densities are not fixed values for all materials and thus need to be determined in each individual case. In order to avoid excessive compaction (or *achieve* a high degree of compaction where this is required) it is clearly important, especially in susceptible materials, to determine the optimum moisture content and operate at or near to this value. In the context of



Effect of water content on the compaction of mixtures of fine sand and a silty clay. Percentages of fine sand are shown. (Taken from Marshall and Holmes, 1979) topsoiling, however, this implies a seasonal operation which would rarely be a practical possibility. Consequently, a greater degree of compaction may be expected in areas topsoiled during the wet summer months, so plan to strip and replace soils in the drier winter months (except in the Western Cape province).

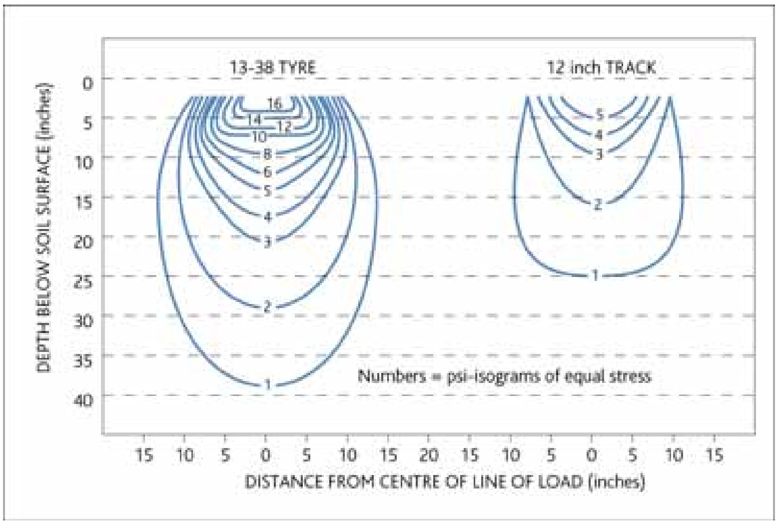
(c) Clay particles tend to take up preferred parallel orientation under pressure, the effect increasing with moisture content. This results in a decrease of shear strength. Low-activity clays orientate more readily than high-activity clays due to their smaller interparticle forces.

(d) Since the mineralogy, as well as texture, of a material influences its compactibility, it is predictable that sandy kaolinitic soils (e.g. the high sand series of Hutton, Bainsvlei, Griffin, Avalon and Clovelly forms) will be more susceptible to compaction and associated problems.

(e) There is some evidence that gleyed materials are highly compactible.

(f) Due to point loading and slip, wheeled vehicles cause greater stresses at comparable depths than do tracked vehicles (see diagram) and it is obviously preferable to use the latter wherever the option exists.

(g) By increasing vehicle speed, the duration of stress is reduced and total compactive force is thus lessened.



Equal vertical stress lines perpendicular to the direction of travel for an equally loaded tyre and track. (Marshall and Holmes, 1979)

B. Problems caused by compaction

B.1. Differential subsidence

An initially well-graded surface may subside differentially due to the presence of relatively under-compacted zones in the spoil. The effect of differential subsidence is to downgrade the standard of rehabilitation in two ways:

- Localised hollows ("melon holes") may become wet spots which cause management problems irrespective of whether the land is destined for grazing or arable use. In extreme cases, sink-holes may develop in the rehabilitated topography.
- Subsidence on sloping topography will cause failure of anti-erosion structures such as banks and furrows that have been aligned according to immediate post-levelling contours. This will lead to aggravated rill and gully erosion at points of failure.

In practice, differential subsidence is unavoidable. Remedial measures consist of levelling hollows using additional soil material, and over-designing surface water interception structures.

B.2. Drainage impedance

Saturated flow of moisture through soil varies with porosity and thus inversely with bulk density. An increase in bulk density not only reduces total porosity but usually also shifts the pore size distribution in the direction of a smaller average pore size. Because flow rate of water through soil decreases as the fourth power of pore radius (i.e. halving pore size decreases flow rate by a factor of 16), compaction at the soil/spoil interface or at any other shallow depth can have a profound effect on internal drainage and thus on plant growth and land use.

The consequence of having a compacted layer near the surface which underlies a more permeable layer is as follows:

- The limit to the rate of flow of water through the profile as whole is imposed by the least permeable layer.
- As soon as water infiltrates at the surface faster than it can be conducted through a less permeable layer, it starts accumulating at the contact between the two layers. This water may discharge in a lateral direction by sub-surface flow to accumulate in topographic lows, including "melon holes" and other surface irregularities, with the resulting problem of wet or marshy spots. On the other hand, on relatively level topography where lateral discharge is slow, a seasonally fluctuating, perched water table may develop. This will provide a barrier to root development, thus reducing even further the effective depth of soil. The perched water table may even reach the surface and discharge by overland flow with an attendant erosion hazard.
- Therefore, possible hydrological effects of over-compaction at shallow depth include drowning of bottomlands and depressions, killing of roots by a rising water table, restricted soil depth available for rooting, and heightened flood and erosion hazards.

B.3. Root impedance

It has already been pointed out that compaction decreases the proportion of larger pores. It is usually also accompanied by an increase in soil strength. Large pores function in aeration and root penetration, i.e. roots are dependent on large pores for their oxygen supply, and will only elongate if large pores are present or if soil strength is sufficiently low to allow active displacement of soil by root pressure. Therefore compaction has both a mechanical and physiological effect on rooting to the extent that the latter is progressively inhibited and eventually prevented by increasing bulk density. Unfortunately, it is not possible to specify a critical upper limit of bulk density applicable to all materials. The effect of bulk density on plant growth is progressive, varies with the type of plant being considered and is modified by soil characteristics such as particle size distribution, soil strength and type of clay mineral. However, as a very general guide, roots will fail to penetrate materials compacted to bulk densities of greater than about 1,500 kg m^{-3} for clays (>35% clay) and about 1,700 kg m^{-3} for sands (<15% clay). These and intermediate values for intermediate clay percentages should not be exceeded within the top 1 m of soil or spoil.

C. Alleviation of compaction

Prevention is better than cure. However, the rehabilitation techniques currently in use in the South African mining industry have been singularly unsuccessful in preventing compaction of rehabilitated profiles. General guidelines for the minimisation of compaction are contained in the body of the guidelines. This Appendix focuses on methods of amelioration of the compaction once created. The principal focus is on the use of tillage as this has been proven to be effective internationally; however, brief mention is made of the potential for use of ameliorants and biological agents.

C.1. Disruption of compacted layers by deep tillage

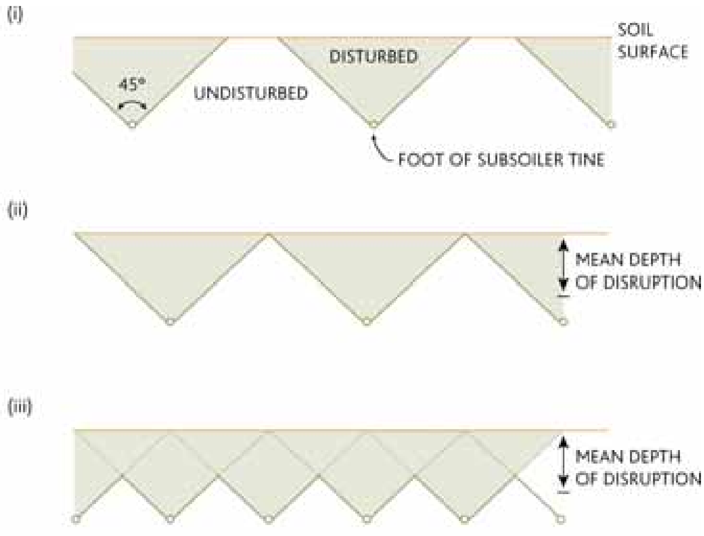
Because compaction in the surface layers is largely unavoidable (although it can be minimised by planning vehicle routes to reduce the extent of overpass and by working in the drier months) and has such serious implications for successful revegetation and future land use, ripping or subsoiling becomes more or less mandatory. This operation should be carried out as a matter of routine, unless it can be shown conclusively that bulk densities do not approach critical limits anywhere in the topsoil or at the soil/spoil contact. The efficiency of ripping/subsoiling tends to be highly variable in practice, however, and care should be taken to ensure that it has the desired disruptive effect. In this connection, the following observations may be helpful:

(a) Successful subsoiling depends on shattering the compacted material. Wet soils will deform plastically without shattering. Moisture content at the time of subsoiling should therefore be low, preferably nearer to the permanent wilting percentage than to the field moisture capacity. In practice, this means that subsoiling will be a seasonal operation, confined to the dry months of the year.

(b) When a subsoiler tine is drawn through a material, the cross sectional area of disturbance, viewed along the axis of travel, is a V with its apex at or close to the point of the subsoiler. The break-out angle of each arm of the V from the vertical has a maximum (and common) value of 45^{o} (see diagram). Depending upon the depth to which the subsoiler point is inserted and the distance between adjacent tine paths, the Vs will

(i) not intersect
(ii) intersect at the surface, or
(iii) intersect below the surface to form a sawtooth profile above which overlap of the disturbed zones occurs.

Mean depth of soil disturbance for a break-out angle of 45^{o} is the vertical distance from the soil surface to a parallel plane through half amplitude of the sawtooth profile. Mean depth of soil disturbance is thus always less than subsoiler depth.



Zones of subsoiler disturbance resulting from different tine path spacings (viewed end-on to direction of travel)
From: COM Guidelines, 1981 surface coal mining

(c) Subsoiler depth and tine path spacing will be determined by

(i) the depth of the compacted layer which is to be disrupted,
(ii) the desired degree of disruption, and
(iii) the actual break-out angle achieved.

If the latter is 45°, then for any particular compacted layer a suitable subsoiler depth tine spacing combination can be arrived at by plotting the sawtooth profiles resulting from several feasible subsoiler depth-tine spacing combinations on a chart as illustrated in this diagram. Should the break-out angle be less than 45°, an appropriate adjustment to either depth or tine spacing should be made. It must be emphasised that the procedure outlined above should be used only to arrive at a first approximation of subsoiler setting; the actual subsoiling effect should be checked in trenches dug at 90° to the path of the subsoiler.

(d) In practice, compaction may be expected usually in the immediate vicinity of the soil/spoil contact and the subsoiler point should, therefore, be put in below this contact wherever possible (large stones and boulders in the spoil may preclude this). Disturbance of the contact and some mixing of soil and spoil are important for keying the soil to the spoil and establishing hydraulic continuity between the two.

C.2. Recompaction and the need for re-ripping

There is some evidence that, despite soils having been ripped, the soils resettle and remain excessively compact. Monitoring of soil strength and bulk density should be used to confirm the existence of this phenomenon, which may be related to soil "memory" and the destruction of micro-aggregate structures during the soil handling processes. There is no certainty, however, that the phenomenon is not simply due to ineffective ripping in the first place. In any event, the problem should probably be dealt with by the inclusion of organic matter into the profile and the encouragement of soil biota to re-establish soil structure and porosity, in addition to the physical ripping process.

C.3. Use of chemical and organic amendments

Most replaced soil in South African rehabilitated land is a mixture of top and sub-surface horizons, which consequently has a lower organic matter content than normal topsoil. Soils treated with organic amendments, such as biosolids, compost, sawdust etc generally have greater resilience and resistance to compaction. The problem lies in the development of practical methodologies for the application and incorporation of such amendments. Such equipment has not yet been developed for use in South Africa.

Crusting soil – unsuitable mix of top and sub-surface horizons

Chemical ameliorants such as phospho-gypsum have been used to reduce surface crusting, and a number of ameliorants (humic products, polyacrylamide, for example) are known to stabilise soil aggregates. They are not known for their ability to ameliorate existing compaction.

C.4 Plant root abilities to penetrate compact soils

Certain plant species are reported to be more tolerant of high bulk densities than others. Of the legumes in common use in South Africa, soybeans, cowpeas and vetch are reportedly more tolerant, while of the grasses, *Cynodon dactylon* and *Paspalum notatum* possess dense rooting systems capable of penetrating compact subsoils. In addition, Vetiver grass (*Vetiveria zizanioides*), and Napier fodder (*Pennisetum purpureum*) produce dense rooting systems with a greater than average ability to penetrate compact soils. While these species may prove beneficial in cases of marginal compaction, there is little doubt that for the most compact soils, physical loosening by appropriate tillage to the correct depth is the only solution.

C.5. The effect of fauna or micro-fauna

Termite burrows in extremely compact soil

Termite mounds on rehabilitated land (+/- 10 years old)

Various burrowing animals have been observed to loosen the surface horizons of soil, but their activities do not extend on any significant scale to the subsoil. While earthworms may play a significant role in the moister temperate parts of the world, there is no evidence of them doing so in South Africa. A case could be made, however, for bioperturbation by termites, as tunnels have been observed penetrating through highly compact soil materials, and the numbers of termitaria have been observed to be increasing on many mature rehabilitated profiles in Mpumalanga. Progress, however, would be exceedingly slow, and there is no current replacement for the requirement to loosen compact replaced growth media using deep physical tillage.

APPENDIX 8:
DETERMINING THE SOIL ERODIBILITY FACTOR, K

Soil erodibility factor, K

The specification that the product of percent slope and soil erodibility factor (K) must not exceed 2.0 for land to be classed as arable (Appendix 3) represents a fairly stringent limit. Areas which meet this criterion (in addition to others specified in Appendix 3) will be truly sustainable arable land. Undoubtedly, there is much land which fails to meet these requirements but which can be or is being safely cultivated. However, an erosion hazard exists and conservation methods are required for protection.

The nomograph (overleaf) uses the following five soil parameters, which have been shown by research to have a major effect in determining erodibility:

1. The mass percentage of the fraction between limiting diameters of 0.1 mm and 0.002 mm (very fine sand plus silt)

2. The mass percentage of the fraction between 0.1 mm and 2.0 mm diameter (residue of sand fraction)

3. Organic matter content obtained by multiplying the organic carbon content (g per 100g soil, Walkley-Black method) by a factor of 1.72

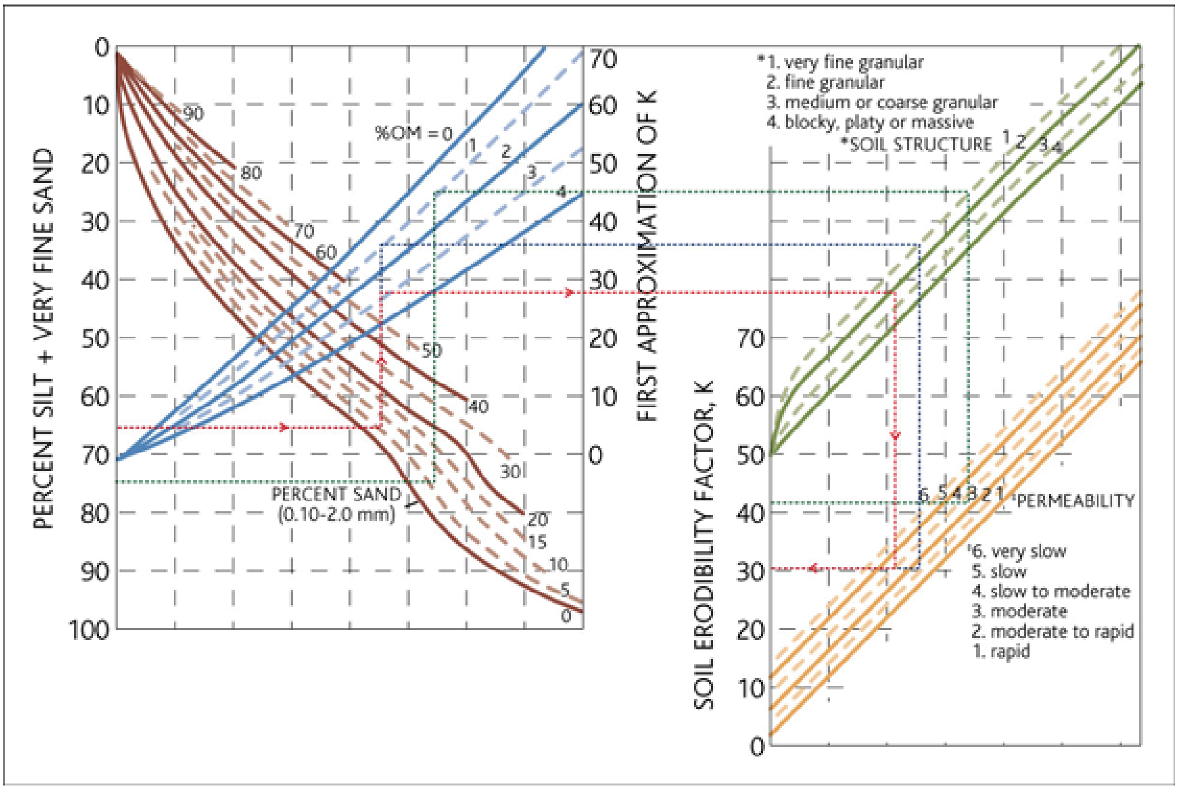
4. A numerical index of soil structure, and

5. A numerical index of soil permeability (as indicated on the nomograph).

Different K values may often be found for various horizons of a soil, but that for the surface horizon is to be used. It should be noted, however, that the index of soil permeability (which is the most subjective of the five parameters) refers to the soil profile as a whole. For permeability, the controlling layer is often below the surface and the authors have given the following guide for codes 4, 5 and 6.

- Soils with a fragipan or cemented subsoil horizon are coded 6.
- Permeable surface soils underlain by massive clay or silty clay are coded 5.
- Moderately permeable top soils overlying a silty clay or silty clay loam with weak blocky structure are coded 4, or 3 if subsoil structure is moderate or strong and texture is coarser than silty clay loam.

To use the nomograph, enter the left-hand scale with the silt plus very fine sand content and proceed to points representing the % sand, % organic matter, structure, and permeability in that sequence as illustrated by the dotted line on the nomograph. Interpolate between the plotted curves.



The soil erodibility nomograph of Wischmeier, Johnson and Cross (1971)

APPENDIX 9:
SAMPLING FOR SOIL ANALYSIS

In the case of rehabilitated land, there is likely to be greater heterogeneity of a more random short-range nature than occurs in nature. As it is not practical to vary fertiliser application rate to meet short-range variations in nutrient requirements, recommendations must aim at satisfying some average requirement for the rehabilitated field. In most cases, land has been top-soiled with mixtures of top- and sub-soils and, accordingly, soil fertility levels are usually low.

A. Sampling procedure

A.1. Initial sampling after rehabilitation

The following procedure is recommended:

- The area to be sampled must first be assessed for its uniformity. If there are obvious differences in replaced soil type, slope or plant growth, the field should be split up into uniform sampling units.
- Draw one composite topsoil sample made up from at least 20 sub-samples taken at random points within the uniform area selected. Obvious atypical situations (e.g. local depressions and drainage lines) should be avoided.
- Sampling depth should be 0-150 mm for the initial fertility survey after topsoiling and prior to establishment of vegetation.
- Sub-samples are most conveniently taken by means of a Beater sampler, bulked, thoroughly mixed after breaking up clods, spread thinly on clean paper or plastic sheeting and portions scooped representatively for the whole area into a plastic bag, sufficient to give at least 500 g of composite sample.
- This should be appropriately labelled with reference to a sampling plan and submitted for analysis.

A.2. Sampling in the second and subsequent years after rehabilitation

After the initial fertilisation and plant establishment year, it is frequently possible to amalgamate sampling units that show similarities in fertility analysis.

- Sample unit size should not exceed 20 ha, and samples should be made up of at least 20 sub-samples for each field or uniform part of a field.
- For monitoring purposes under a grass cover, sample to a depth of 100 mm (revert to 150 mm if and when annual cropping is commenced).
- Sub-samples are most conveniently taken by means of a Beater sampler , bulked, thoroughly mixed after breaking up clods, spread thinly on clean paper or plastic sheeting and portions scooped representatively for the whole area into a plastic bag, sufficient to give at least 500 g of composite sample.
- This should be appropriately labelled with reference to a sampling plan and submitted for analysis.

A.3. Frequency and timing

Initial topsoil samples must be taken after levelling and prior to the application of basal fertiliser and lime. Thereafter it is recommended that sampling and analysis be carried out annually until the requisite P and K status has been built up. Once the desired nutritional status has been achieved, intervals of three to four years can be allowed between sampling. Naturally, if growth problems should develop that are not attributable to some obvious cause, *ad hoc* sampling and analysis is necessary. It is also recommended that the spoil material immediately below the topsoil be sampled for analysis of exchangeable acidity and potassium once the vegetation has become well-established (say in the third year). A single sample (not composite) per 20 hectares should suffice for diagnostic purposes.

Sampling should always be carried out at the same time of the year. For soils under pasture, the best period is between March and June, at least six weeks after the last fertiliser application.

APPENDIX 10:
SOIL FERTILISATION AND LIMING

Management of soil fertility is an important aspect of revegetation for the following reasons:

a) Rapid establishment of a vigorous plant cover should never be prejudiced by avoidable deficiencies or imbalances of plant nutrients; disorders must be detected and rectified at the outset;
b) As many South African mining areas have infertile, acid soils, it follows that topsoiling materials will often. although not always, require extensive amelioration;
c) Because of mixing of soil horizons and substrata, and possible contamination by acid –producing pyrite from spoil and waste, materials used for topsoiling will have nutrient and acidity levels that are far more unpredictable than natural soils;
d) Amelioration of subsoil acidity (often a serious agricultural problem in Highveld areas) is difficult and expensive under normal circumstances. An opportunity exists for incorporating lime throughout the rooting depth during topsoil spreading.

Fertiliser requirements are dictated by several considerations, the most important of which are:

- the type of vegetative cover or crop to be grown,
- its manner of utilisation (ranging from complete removal to use on the land by animals),
- the production level or yield target that may be set taking into account soil and climatic potential, and
- the nutrient status of the soil.

Despite some limitations, conventional soil analysis (soil testing) provides the best guide to the latter and a sound monitoring programme is regarded as essential for proper rehabilitation. In any fertilisation programme, a distinction must be made between basal application of fertiliser and lime designed to correct disorders and raise the fertility status to a suitable level prior to vegetation establishment, and maintenance dressings applied for the purpose of making good losses and keeping up nutrient levels. This distinction is especially relevant to rehabilitation of disturbed land where the initial deficit is likely to be greater than on comparable undisturbed agricultural lands. Sampling procedures and methods for monitoring soil fertility are to be found in Appendix 9.

A. Lime

A.1. Determining application rate

In normal agricultural practice, three factors determine the amount of lime required to ameliorate soil acidity in any particular situation. These are:

- the degree of soil acidity,
- the acid tolerance of the crop to be grown (varies widely between species), and
- the neutralising ability of the liming material to be used.

The first factor is most conveniently measured as exchangeable acidity. The second factor is taken into account by specifying the extent to which exchangeable acidity must be reduced for the particular crop in question. It is usually recommended that for all grasses, excluding *E. curvula,* exchangeable acidity should be reduced to a level at which it is equivalent to 50% of total exchangeable cations. The corresponding upper limit for temperate legumes is 25% although for *Trifolium* spp 5-10% is probably safer. Lucerne reputedly requires a value of 1% (i.e. virtually complete neutralisation of exchangeable acidity), although there are examples of successful establishment and survival of Lucerne in soils with greater levels of acidity than this.

Although liming is not normally recommended for *E. curvula* or for tropical legumes, the former, at least, has been known to show a response. In view of this and the desirability of stimulating an active microflora to aid in the development of stable soil aggregates (neutral pH is optimum in this regard), it is recommended that soil be treated in the same way for *E. curvula* as other grasses and limed to 50% acid saturation.

It is further recommended that, where land is being rehabilitated to an arable standard, all topsoil replaced be limed to 1% acid saturation. Lime requirement must be carefully assessed from laboratory determinations of exchangeable acidity and exchangeable cations in order to preclude under- or over-liming. Over-liming can induce deficiencies in certain essential minor elements. Actual application rate must take into account the neutralising equivalent (relative to $CaCO_3$ = 100) of the liming material used.

Dolomitic rather than calcitic lime should be employed to provide magnesium (in addition to calcium) wherever the value for exchangeable magnesium is less than 50mg kg^{-1} soil or 0,42 me per 100g topsoil. Ideally, the ratio of exchangeable Ca to Mg should be in the vicinity of 3.

This liming strategy is applicable only to soils that are not contaminated with sulphide minerals. Where the possibility exists of significant acid generation as a result of sulphide oxidation, required application rates for lime will be much greater and should be determined using acid-base accounting methodologies.

A.2. Method of application

Since the neutralising effect of lime is strictly localised, application in the usual way (broadcasting and ploughing or discing in) ameliorates only the surface layer to the depth of incorporation. The acidity of deeper material will remain unaffected. Subsoil acidity is a serious problem in many Highveld soils. Deep incorporation of lime is improved if it is spread prior to deep ripping, but deep ploughing is costly and not very efficient. The possibility exists of reducing subsoil acidity on rehabilitated sites by broadcasting lime in appropriate quantities on the soil *prior* to soil stripping. Relatively thorough incorporation should be ensured during handling and spreading operations resulting in amelioration throughout the entire depth of the new soil at very little additional cost. Lime may also be applied to spoils recognised as having an acid-forming potential prior to scarifying and topsoiling.

B. Nitrogen

B.1. Determining application rate

Soil tests for nitrogen are unavailable on a routine basis in this country. Amount and frequency of application is often a matter of experience although a reasonable figure for total seasonal requirement in the case of grasses may be arrived at as follows:

(i) Decide on the production level desired (say Y kg of dry matter per hectare)

(ii) Calculate the internal N requirement (= X kg per ha) of the crop from $X = \frac{C}{100} \times Y$

where C is the percent N in the herbage on a dry mass basis (in the absence of specific herbage analysis, a value for C of 1,5% N for a low production level rising to 2% for a high production level may be used

(iii) Assume that the natural nitrogen supplying power of disturbed soil will be zero

(iv) Assume a recovery factor (to compensate for leaching and volatilisation losses) of 70%

(v) For zero grazing (i.e. complete removal as hay or by fire) calculate the N requirement as the internal crop requirement adjusted by the recovery factor:

$$N\ requirement = X \times \frac{100}{70} kg\ \ per\ ha$$

(vi) For grazed pasture, treat as zero grazed for two years after establishment and then reduce the amount calculated for zero grazing by 30%.

B.2. Method of application

Water-soluble forms of nitrogen (as present in most fertilisers) are highly mobile in the soil and are subject to loss by leaching and volatilisation. Consequently, the beneficial effects of a single dressing will last for a limited time only.

This, together with the fact that plant requirement varies with stage of growth and climatic conditions, accounts for the recommended practice of splitting the total nitrogen application into two or more dressings, provided that each of the latter exceeds a certain minimum quantity. It is generally regarded as uneconomic to apply a split dressing of less than 75 kg N per hectare unless it coincides with the application of other nutrients.

B.3. Nitrogen at establishment

The nitrogen requirement of pasture grasses during the first month after establishment is low. Under normal farming conditions, the natural supply from the soil is usually adequate and nitrogen is not applied at establishment. However, on freshly topsoiled land, vigorous early growth will be promoted by a small pre-plant application of 25 to 50 kg N per ha, irrespective of the species used. This may most conveniently be applied in conjunction with basal P and K through a suitable mixture which is broadcast and disced in during final seedbed preparation immediately prior to planting.

B.4. Annual maintenance dressings of nitrogen

Pasture plants other than legumes require a continuous supply of nitrogen from the soil during the period of active growth if vigour and palatability are to be maintained. A nitrogen budget should be worked out as described earlier and the pasture top-dressed with split applications starting one month after emergence and terminating about six weeks before the anticipated end of the growing season.

Grass-legume pastures that are grazed do not require regular nitrogen applications. They should, however, be kept under observation for signs of nitrogen deficiency. Zero grazed grass-legume pastures may have a small requirement of some 100 kg N/ha/annum.

To avoid acidification, limestone ammonium nitrate is the preferred N carrier.

C. Phosphorus

Phosphorus is invariably deficient, often acutely so in acid soils of high rainfall areas.

C.1. Determining basal application rate

A soil is capable of supplying adequate P to a high producing crop should analyse at about 36 ppm P using the Bray No.1 procedure. Lower levels, about 20 ppm P (Bray) should be adequate for restoration of lower productivity grasslands.

Mine soils will invariably test lower than this and the deficit should be made good prior to the establishment of vegetation. Approximately 5 kg of P per hectare is required, on average, to raise the soil test value by 1 ppm. This rule of thumb may be used to calculate the basal dressing which should be in the water-soluble form.

Less soluble forms (e.g. sedimentary phosphate rock) are often recommended for basal (but not surface) application for pastures on acid soils in which case the total quantity of P applied should be doubled. To avoid damage to seed and emerging seedlings through direct contact with unreacted water-soluble P fertilisers, the latter should be applied prior to planting and must be thoroughly incorporated with the soil. All basal phosphorus applications should be thoroughly incorporated by ploughing into the plant rooting zone.

C.2. Annual maintenance dressing of phosphorus

Although the P content of herbage is low (0,2-0,3 %), an annual topdressing using a water-soluble P carrier is necessary even on grazed pastures because applied P tends to become decreasingly available to plants with time. The amount required should be assessed by soil analysis and will vary with the utilisation profile of the pasture. As a general guide, zero grazed pastures should receive at least 25, 35 and 40 kg of water-soluble P per hectare for low, medium and high levels of production, respectively. Legume-based pastures require 40 kg P irrespective of level of production.

D. Potassium

Grasses and legumes take up relatively large amounts of potassium and the level of exchangeable K in the soil should be in the vicinity of 120 ppm for high production levels. Analysis is particularly important in managing soil K status for the following reasons:

- fairly wide fluctuations may occur as a result of leaching (particularly on sandy soils), fixation of applied K by clay minerals, and pasture utilisation pattern,
- an oversupply of K is wasteful because of luxury uptake by plants,
- low topsoil K levels may be compensated for by subsoil reserves – a phenomenon that may be particularly relevant in the case of weathering spoil.

D.1. Potassium at establishment

The soil should receive a basal application designed to raise exchangeable K to a value of 120 ppm irrespective of subsoil reserves.

D.2. Annual maintenance dressings

In general, for zero grazing, soil levels should be kept at about 120 ppm exchangeable K by means of a single annual topdressing applied in the autumn to loams and clays, and split into two in the case of sandy soils (< 15 % clay). In the absence of soil analysis, 150, 250, and 300 kg K per hectare may be applied for low, medium and high productivity, respectively.

Where spoil material is within rooting depth of the established pasture, its K status should be investigated as this, if high, may permit downward adjustment of the application rate determined using the above norms. Where pastures are grazed, recycling of K may be appreciable but will depend on the extent of occupancy. In this case K should be applied only on the basis of analysis.

E. Sulphur

In the industrialised areas of South Africa, and in areas close to the sea, general sulphur contamination of the environment through coal waste and dust, and aerosolic emissions of sulphur from coal burning power stations occurs. Sulphur deficiencies in these areas are highly unlikely to develop. Consequently, low- sulphur fertilisers (double superphosphate instead of single supers, and LAN instead of ammonium sulphate) can be used without risk of incurring a sulphur deficiency. In some other areas of South Africa, where industrialisation levels are lower, there may be a need to use fertilisers with higher sulphur content.

F. Calcium and magnesium

Calcium will not normally be limiting in well-fertilised pastures (due to additions through lime and phosphatic fertilisers) but magnesium may fall below the threshold of 50 ppm. This may be rectified by the use of dolomitic lime.

G. Minor elements

Molybdenum is the only minor element to limit growth on acid soils. Legume seed must be given a standard treatment of sodium molybdate equivalent to not more than 300g of molybdic acid applied to the quantity of seed used per hectare.

However, applications of lime to neutralise acidity may well induce other micronutrient deficiencies. Zinc deficiency is frequently observed and, less frequently, copper and boron deficiencies may develop.

Plants will normally grow out of minor zinc deficiencies, which manifest under overcast conditions and clear up when sunny conditions return. However, on some sandier soils and on those that have been over-limed, zinc deficiencies persist. These need to be ameliorated by the addition of zinc, either as zinc oxide, or as zinc-containing compound fertilisers. Likewise, boron deficiencies can be treated by the application of boron-containing compound fertilisers.

APPENDIX 11: VEGETATION SELECTION

A. Objectives of revegetation

Having reshaped a suitable topography and covered this with soil material, it is vital to establish, as rapidly as possible, permanent vegetation cover to protect the surface from water and wind erosion. The primary objective of revegetation is therefore to reduce soil movement to a minimum.

Revegetation also has other objectives. In the most mining operations the material used for topsoiling will be a blend of various soils horizons and possibly some saprolite. As a medium for plant growth such materials are invariably inferior to natural soil in that they are relatively low in organic matter, poorly aggregated, and probably contain a depleted microbial population. As a result, they tend to be less fertile, more droughty and more erodible than the natural soil, subject to compaction, and susceptible to the formation of surface crusts that inhibit seed germination and retard gas exchange between the soil and the atmosphere.

In order to ameliorate these unfavourable conditions it is essential to re-establish carbon and nutrient cycles by keeping the land under a permanent vegetative cover for a number of years. Organic residues should as far as possible be retained in the cycle and not be removed. This paves the way for eventual crop or pasture production, or re-establishment of habitat as required by the biodiversity targets set for the area where appropriate.

Finally, there is the aesthetic consideration of restoring to the landscape a pleasing “natural” appearance and reducing the contrast between disturbed and undisturbed areas.

To summarise, the aims of revegetation are:

- to stabilise the soil and minimise erosion
- to prevent pollution of streams and air by particulate matter
- to re-establish nutrient cycles
- to ameliorate soil physical properties
- in the longer term, to re-establish naturally sustaining native plant ecosystems.

B. Criteria for selecting plants

Various practical considerations will determine the eventual success and sustainability of rehabilitation. Those relating to the choices of plant species for revegetation are among the most critical in determining sustainability. The application of the following criteria in each individual situation will assist in choosing a suitable type of plant cover, irrespective of whether the final objective is the generation of pastures for animal production, or the generation of a sustainable, biodiverse and natural habitat.

(1) Only plants that are well-adapted to prevailing climatic conditions and post-establishment method of use should be used.

(2) Plants of perennial habit must form the main basis of any revegetation programme. Annual species may have some role but only in providing rapid temporary cover in the initial stage of revegetation or as a component of mixtures containing perennials.

(3) Among the species used, at least one must be fast-growing and capable of providing a good ground cover during the first growing season, given normal climatic conditions. Dryland establishment will usually be required.

(4) The species chosen for any specific area of land must be tolerant of adverse soil conditions likely to be present there (for example, subsoil acidity and metal ion toxicities, salinity, droughtiness in sandy materials, high water table and surface soil crusting).

(5) Good quality planting material and preferably seed (e.g. Government-certified) must be readily available with an assured source of supply.

(6) Local agricultural experience regarding establishment, persistence, management and response to management is important, and no species should be considered for use unless or until such experience is available.

(7) Preferred species are those known to have regenerative effect on soil through a prolific root system and large biomass, and a capacity to slow down water movement across the soil, i.e. they should preferably be sod forming.

(8) In planning a revegetation programme, it is important to bear in mind the incremental nature of strip mining. The total area to be managed on a mine may become very large and species which require a sustained high level of management will present logistic and cost problems. Consequently, the plant species or succession of plant species employed should as far as possible be selected to fit into a system of management that requires low inputs. Generally they should provide forage acceptable to animals so that they can be grazed.

(9) Because the cost of inputs (fertiliser, labour, machinery) required to maintain a vegetative cover cannot reasonably be debited to rehabilitation for an indefinite period of time, they should at some stage become recoverable from an economic agricultural enterprise. Consequently, the plants chosen should not only have agricultural value (e.g. as forage or fodder) but they should also fit into a viable production system which may include a livestock component. Hence, they should produce forage of reasonable quality.

C. Choice of species

Considerable experience has been gained over the past 25 years regarding the suitability and sustainability of the various species used for planting rehabilitated land. The key objectives of rehabilitation have also changed. While 25 years ago, key objectives were the establishment of permanent pastures for intensive exploitation by grazing or the introduction of ley crops prior to the return to arable cropping, in recent times much greater emphasis has been placed on the re-establishment of biodiverse native grasslands. This is being done either by the introduction of the native species into existing pastures or, in some instances, by the re-establishment of the native species directly. This is easiest to achieve where soil containing the native seed-bank is stripped and returned in a single action. The seed bank in stockpiled topsoil is usually severely depleted and requires reinforcement by the introduction of selected grasses, either by plug planting, thatching, or by planting of seed using gel planters.

The plant species that was most commonly used for rehabilitation 25 years ago, *Eragrostis curvula*, has fallen into disfavour because of the difficulty of managing it sustainably. While it establishes easily and provides good erosion protection, it proved problematic unless managed intensively by regular defoliation.

The following is a list of species in common use for rehabilitation in South Africa.

C.1. Tropical-subtropical grasses

The so-called tropical-subtropical grasses have traditionally offered the best means of revegetation in the surface coalfield areas of this country.

Digitaria eriantha (Smuts finger grass) and *Chloris gayana* (Rhodes grass) are currently the pasture grasses of choice for rehabilitation on the Highveld and KwaZulu-Natal, with the inclusion of *Eragrostis tef* as an annual nurse crop. Seed quality in the finger grass is often poor, while the seedling Rhodes grass is slow to develop and the grass sometimes does not persist under grazing. However, where it will grow well, Rhodes grass is an excellent choice. It is acceptable to livestock, it is nutritious, and has the added advantage of being stoloniferous.

The most common pasture grass mix used is that of Smuts finger, Rhodes and teff. The teff provides good cover in the first season; Rhodes tends to dominate in the second year, but thereafter, Smuts Finger becomes dominant, depending on the soil fertility levels.

In drier and warmer areas (e.g. the Springbok Flats), *Cenchrus ciliaris* may be the most suitable species. However, the seed is such that it is difficult to sow, and establishment is often poor. Because of this, Star grass, which unfortunately has to be established vegetatively, i.e. from runners, is more reliable. It is nutritious, acceptable to livestock, and strongly stoloniferous. Its lack of seed is really its only major disadvantage, and this may confine its use to steep slopes where establishment from seed is in any event generally unsatisfactory. In such sites, Star grass may be planted at intervals along the slope. Provided conditions for growth are adequate, it will rapidly cover the inter-row areas.

Cynodon dactylon is frequently used in seed mixes. While it is rare for *Cynodon* to dominate the resultant sward, it frequently develops profusely in less favoured niches and provides a valuable erosion control function.

C.2. Temperate grasses

These are not well adapted to the summer rainfall areas except where the feasibility for irrigation exists. There are two situations where the use of temperate grasses may be indicated:

- Steep and highly erodible sites and waterways may be established to grass during the autumn and thereby stabilised prior to the commencement of the rainy season;
- Where the management system includes a livestock factor, it may be desirable to produce, from a limited irrigated area, a supply of green feed for the winter period, particularly in the cooler areas. In such cases, oats and Italian ryegrass are valuable annuals. Apart from these two situations, the use of temperate grasses is not indicated.

C.3. Legumes

Generally, temperate legumes will not do well on Highveld sites but some of the tropical legumes, in particular the trailing types, could be usefully incorporated in the planting mixture. Species like *Desmodium uncinatum*, *D. intortum* and *Glycine wightii* will provide an erosion-resisting cover and a supply of valuable forage. The nitrogen provided by these legumes will accelerate the build-up of biological activity within the soil. Such legumes are, however, suited only to relatively warm areas. They should be utilised leniently for they are intolerant of intense defoliation. They have not shown significant success over the past 25 years.

Although usually regarded as intolerant of acid soil conditions, lucerne has shown considerable success on rehabilitated land on the Highveld, but like the tropical legumes it requires specialised management if it is to survive. Although it should preferably be cut for hay, it will survive rotational grazing.

Where conditions are too droughty for lucerne, American Sweetclover or some of the vetches may do well. Sweetclover in particular, is an interesting possibility being extremely hardy, but it is less acceptable to livestock than lucerne. Unfortunately it has an annual or biannual habit. It should not be used as a hay crop since mouldy sweetclover hay is poisonous to stock. Arlington lespedeza (*Lespedeza cuneata*) could possibly be used in acid, low-fertility situations in the Highveld.

C.4. The use of annuals

Annual grasses and legumes may be useful as a “nurse crop” with perennial species, but they should be *sparsely* planted so that they do not compete excessively. *Eragrostis tef (*summer) is extremely valuable for this purpose, but other annuals like Italian ryegrass (*Lolium multiflorum*) and oats (*Avena* spp) (autumn and winter), and buckwheat (*Fagopyrum sagittatum*), cowpeas (*Vigna* spp), babala (*Pennisetum typhoides*) and forage sorghums (summer) may also be used. The latter two species are, however, rather too tall-growing for this purpose and, if they are used, very light seeding rates should be employed. It is worth stressing again that populations of these plants should not be so high that they offer severe competition to the perennials.

C.5. Trees and shrubs

Trees and shrubs are not particularly effective in soil stabilisation and should under no circumstances be used alone (i.e. without a grass under-story that has been previously established) because they will not protect the soil from water erosion. Trees and shrubs should, in particular, be excluded from use on steeply sloping impoundment walls and in containment areas for waste materials, because their rooting habit may result in early failure of the containment structure.

While trees and shrubs are not recommended for rehabilitation from the point of view of stabilising the surface, they do have a role to play in landscaping rehabilitated areas and in proving shade and shelter belts for stock; certain species may even be used to provide fodder. They should, however, be planted sparsely, particularly evergreen types which continue to use water in the winter and thus desiccate the soil excessively.

The choice of trees and shrubs that do well is extremely wide. However, a number of trees that were previously acceptable for rehabilitation use (e.g. Black locust, *Robinia pseudoacacia*) are now classified as category 2 or 3 invader plants, and care must be taken to consult the NBI Declared Weeds and Invader Plants lists before selecting plants for use on rehabilitation.

The following is a short list of acceptable trees.

Acer buegerianum (Chinese maple)
Cedrus deodarus (Deodar cedar)
Craetagus pubescens (Mexican hawthorn)
Cupressus sempervirens var. horizontalis (Mediterranean cypress)
Cupressus sempervirens var. stricta (Churchyard cypress)
Eucalyptus fastigata
Eucalyptus melliodora (Yellow box)
Fraxinus spp. (Ash)
Hakea saligna (Willow hakea)
Prosopis justiflora
Quercus palustris (Pin oak)
Quercus robur (English oak)
Tamarix gallica (Tamarisk)

APPENDIX 12:
DEFINING BOUNDARIES OF RESPONSIBILITY FOR BIODIVERSITY MITIGATION, REHABILITATION OR ENHANCEMENT
(FROM GOOD PRACTICE GUIDANCE FOR MINING AND BIODIVERSITY, ICMM, 2006)

Irrespective of how successfully biodiversity mitigation, rehabilitation or enhancement efforts are done within the mine boundaries, mining operations run the risk of being associated with the loss of biodiversity beyond the fence-line unless they engage in broader, more inclusive biodiversity conservation strategies. At the same time, there are limits to the extent that companies can and should assume responsibility for biodiversity protection and enhancement beyond their boundaries. Operations should consider the following points to help define the boundaries of their biodiversity responsibility:

- Mining companies should assume full responsibility for the mitigation and rehabilitation of the direct impacts of their activities.
- The extent of the mining company's direct influence of the management of land in the mining concession area, and the level of involvement of other parties in land use planning. For example, is the concession area used by other parties for agriculture, recreation, conservation?
- The extent of environmental and social influence of the project should be considered. Areas disturbed by mining and ancillary activities, receiving waters for effluents, deposition zones for stack emissions and dust from dumps or stockpiles are directly impacted and should be mitigated. But indirectly affected areas, including local communities and communities with cultural attachment to the land should also be considered in developing enhancement initiatives.
- The intractability of biodiversity threats and the capacity of potential partners, which determines the biodiversity context.
- The existence of and potential linkages to biodiversity initiatives at the regional and national level, where mining operations might play a supportive role.

Further points for consideration are:

- Within the fence-line, overall responsibility lies with the mining company, but this does not preclude involvement of other parties, particularly in ecosystem establishment, monitoring and review activities.
- Within the wider concession area, the mining company retains the main responsibility for biodiversity.
- Within the surrounding areas, where the mining company has social and environmental interactions, allocation of responsibility for biodiversity issues is more complex, and is likely to be shared with a combination of stakeholders such as government, NGOs, communities or other industries. Here, understanding the conservation context is critical for assessing the prospects for success of conservation or enhancement initiatives.
- Beyond the area of environmental and social interactions, primary responsibility for biodiversity protection lies with other parties. In this situation, companies should limit their activities to providing a supporting role for regional or national initiatives.

APPENDIX 13:
BIODIVERSITY OFFSETS

Where permanent destruction of a valuable ecosystem is unavoidable, biodiversity offsets may be considered as a compensatory measure of last resort.

Offsets might involve the funding of protection of a local nature conservation area, or the purchase of an equivalent area of land for protection. The offset amounts to a “payment” to protect biodiversity within a designated area.

They have, however, attracted considerable controversy, and should be approached with caution. The ICMM, in its Good Practice Guidance for mining and biodiversity, recommends the following approach:

- Offsets should never be used to justify or compensate for poor environmental management or performance.
- The compensatory protected area should be ecologically similar to the affected natural habitat.
- The compensatory area(s) should be of equivalent value and on no smaller area than the affected area.
- Where possible, the offsets should complement other government/partner programmes.
- Offsets should result in net gain for biodiversity over time, and this should be evaluated by scientific study.
- They must offset the impact not only for the period in which the impact occurs, but be sustainable in the long term.
- The offsets should be located appropriately – preferably within the same area as the impact.
- Offsets should be supplementary – that is, they should be funded in addition to existing commitments.
- They should be enforceable through the development of consent conditions.
- The determination of the acceptability of offsets requires consultation with stakeholders. They will, of necessity, be site- and project-specific.

APPENDIX 14:
REHABILITATION MONITORING AND RECORD-KEEPING

A.1. Introduction

Monitoring and record-keeping are the essential ingredients of corporate memory – and are frequently neglected in the management of mining rehabilitation. All too often, there will be rehabilitation successes and failures for which there is no written record of what was done. The problem, then, is one of not being able to repeat the good, or avoid the bad. Basic record-keeping should record exactly what was done to each section of rehabilitated land, and when.

- Monitoring measures both inputs and outputs and, when correctly documented, provides the corporate memory necessary to ensure that the right things are repeated, and the wrong things are not.
- Monitoring is required throughout the life of the mine, to ensure that resources are not lost or degraded unnecessarily, and to ensure that the rehabilitation, once complete, meets the specifications laid down in the rehabilitation plan.
- Finally, monitoring is required for several years post-rehabilitation to provide surety that a sustainable end product has been achieved.

A.2. Rehabilitation monitoring and documentation requirements

Several key aspects require monitoring and documentation on all rehabilitated areas. These are:

A.2.1 Running topsoil balance

A running "life of mine" topsoil balance is required to monitor the recovery of topsoil against available reserves, and to track the handling of this important resource through stockpiling and subsequent placement, or by direct placement alone. Surveyed measurements of volumes of soil stripped, volumes of soil stockpiled, and volumes placed should be recorded and reconciled against the volumes of available soil recorded in the pre-mining soil survey. Topsoil balances should be updated and reconciled at least once a year.

A.2.2. Topographical reshaping

After reshaping the resultant topography must be surveyed to determine the degree to which the final topography meets planned objectives, particularly in terms of surface drainage and in terms of slope required to meet land capability objectives. Deviations from plan must be documented, and the final reshaped surface should be signed off by the responsible person prior to the replacement of topsoil. The topographic information needed to sign off the final topography as acceptable, and to complete the land capability assessment, should come from the mine surveyor.

A.2.3. Verification of post-mining soil depth

This information is required to determine post-mining land capability, to enable the mines to check rehabilitation performance against EMPR commitments. Soil depth verification and classification work is time-consuming and is best done by a soil specialist. Most soil consultants will do a good job of classifying rehabilitated soils according to Professor de Villiers' mined soils classification system, verifying soil depth, as well as giving an indication of soil physical properties (texture, bulk density, etc), biological properties (rooting depth), and chemical properties (pH, resistance, organic matter content, major salts, nutrients, etc. Soil depth verification on any land unit is a once-off activity, and can be signed off after land capability has been determined and recorded on plan. A "Land Unit" map should be generated for the mine that shows areas topsoiled each year. This map should be updated annually.

A.2.4. Soil fertility sampling on all rehabilitated land units

Soil sampling should be done annually for the first three years after rehabilitation, after which sampling interval may be increased to once every 3 years. An understanding of soil fertility status on the different rehabilitated land units is essential to optimise annual fertiliser applications, and to determine when target levels of soil fertility have been attained that would result in a self-sustaining vegetation cover. Soil sampling/monitoring for fertility status can be done by mine staff, but analysis should be done by a professional soil analysis laboratory. Interpretation of the results of the soil analyses is simple and can be easily taught to mine environmental personnel.

A.2.5. Establishment and maintenance records

For each rehabilitated unit the following should be recorded:

1. Details of subsoiling, including depth achieved, tyne spacing used and soil moisture at the time of subsoiling.
2. Method of seedbed preparation.
3. Fertiliser and lime application rates, types and method of application and incorporation.
4. Species planted and weight of seed used.
5. Rainfall and other relevant climate in the weeks after planting, together with the date of germination.
6. First, second and third season rehabilitation monitoring records. Here the "take" and performance of pasture species is recorded in a semi quantitative manner. This can be done by mine environmental staff. The information is critical to understanding the performance of mature pastures, as a poor "take" in the first season is often the reason for poor performance in the long term. Other parameters such as soil erosion and remedial action taken are also reported in this spreadsheet.
7. Pasture maintenance records. Detailed records should be kept of annual fertiliser application rates on different rehabilitation paddocks. These records are required to substantiate EMPR commitments, and to allow correlations to be made between soil fertility status and mass of fertiliser applied. This information also allows auditing of fertiliser purchased against fertiliser applied.

A.2.6. Pasture composition, basal cover and production monitoring

The ability to determine pasture species composition and basal cover requires specialist training. Experts use a range of techniques to track species composition and basal cover change with time, but one of the most reliable is the establishment of permanent sampling stations. The sampling stations should be located in pastures of different ages (stages of maturity), and different land capability classes if possible.

Appropriate siting of the stations would be done in collaboration with a pasture consultant, but would not include pastures younger than 3 years (because of the known dynamic status of establishing pastures). A good target would be to have at least one station per every 50-100ha. Regular (3-yearly) monitoring of the permanent sampling stations will provide us with valuable information on changes in pasture composition (increasing or decreasing biodiversity?), as well as an indication of the impact of our rehabilitation management/maintenance strategies on the performance of rehabilitated pastures.

Meticulous records need to be kept of pasture production on all rehabilitated land units or paddocks, either as bales of hay removed, or as animal grazing days (in the latter case, production can be back calculated). Mine staff should be responsible for monitoring pasture production because they are on site throughout the year.

For areas that have been rehabilitated to arable status and have been planted with crops, yield and quality of grain should be recorded.

APPENDIX 15:
LEGAL COMPLIANCE FRAMEWORK FOR THE REHABILITATION OF MINED LAND

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MEMORANDUM: GUIDELINE FOR THE REHABILITATION OF MINED LAND

Prepared for: Coaltech 2020

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1. INTRODUCTION

South African Legislation imposes a clear obligation on mining companies to remedy environmental damage associated with mining operations. The legal obligation exists throughout the life of a mine and could include the undertaking of actions of remediation and/or rehabilitation[1]. The legal obligation generally translates into a requirement to perform rehabilitation and restoration of land and water resources when a mine closes. We have set out below the environmental-legal framework provisions pertaining to the closure and rehabilitation of mined land. We have also set out and briefly discussed the aspects relating to administrative law which governs the taking of decisions by government.

For the purposes of this document, we have not covered the legislative aspects which are applicable to mining waste and waste disposal sites. In this regard, it is important to take note of the fact that mining waste and general or industrial waste is generally regulated separately and by different statutory provisions.

This document is set out in four parts.

- Part 1 deals with the Constitutional aspect pertaining to the closure and rehabilitation of mined land.
- Part 2 deals with the central legislation in the mining industry being, the Mineral and Petroleum Resources Development Act 28 of 2002 and its associated regulations, with specific reference to those provisions pertaining to the closure and rehabilitation of mined land.
- Part 3 deals with environmental legislation which must be considered, in particular, during the course of the closure and rehabilitation of mined land.
- Part 4 pertains to administrative law and its association with the closure and rehabilitation of mined land.

2. PART 1: CONSTITUTIONAL ASPECTS

2.1 The Constitution of the Republic of South Africa Act 108 of 1996 ("The Constitution")

Although the Constitution does not specifically set out provisions pertaining to the closure and rehabilitation of mined land, it should be noted that the rights afforded in the Bill of Rights, insofar, as they for example, relate to capacity or standing to institute litigation proceedings, access to information and administrative justice, all become relevant within the context of the protection and management of the environment at all stages of the life cycle of a mining project. For example, one or more of these provisions may be utilized by interested and affected parties requiring information regarding the closure and rehabilitation of mined land and questioning the administrative and official deliberation processes of the relevant authorities in reaching closure.

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[1] "Remedial" is defined in the Oxford Advanced Learners Dictionary so as to relate to the providing or intention to provide a remedy or cure while "rehabilitation" is defined in the Oxford Advanced Learners Dictionary as to restore to its former position. Accordingly, in applying these definitions within the context of the mining industry, the remediation of mined land refers to the providing of a remedy to pollutants or other environmental impacts which have occurred on the land due to the mining operations, for example, taking measures to remove any pollutants or other environmental impacts caused by the mining operations from the land so mined. Rehabilitation in turn refers to the restoring of the mined land to its former natural state.

Section 24 of the Constitution states that everyone has the right to an environment that is not harmful to health or well-being. Section 24 of the Constitution also states that everyone has the right to have the environment protected, through reasonable and other legislative measures that prevent pollution and ecological degradation, promote conservation and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

Section 24 of the Constitution, read with the rights in the Bill of Rights referred to above, will enable members of the public to enforce the rights contained in Section 24(a) of the Constitution in the interest of the environment and the protection of their constitutional environmental right. Similarly, government (National, Provincial and Local) has a constitutional duty to ensure that the environment is protected in the public interest in accordance with the legal obligations created by Section 24(b) of the Constitution.

By including environmental rights as a fundamental human right, environmental considerations must be accorded appropriate recognition and respect in the administrative process which underlies the legal processes associated with closure and rehabilitation of mined land[2].

3. PART 2: THE MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT 28 OF 2002 AND ITS ASSOCIATED REGULATIONS

3.1 The Mineral and Petroleum Resources Development Act 28 of 2002 ("The MPRDA")

The MPRDA is currently the central legislation regulating the mining industry in South Africa.

The objects of the MPRDA are, *inter alia,* to recognise the internationally accepted right of the state to exercise sovereignty over the mineral and petroleum resources in the Republic and to give effect to the constitutional environmental right, referred to above.

Prior to the MPRDA, the mining industry in South Africa was regulated by the Minerals Act 50 of 1991 ("the MA"). Although the MA aimed to address various environmental concerns which were previously neglected, the provisions pertaining to the closure and rehabilitation of mined land were limited and not comprehensive enough to effectively and efficiently regulate the closure and rehabilitation of mined land. In comparison, the provisions contained in the MPRDA, together with the Regulations promulgated in terms of the MPRDA, referred to as the *Mineral and Petroleum Resources Development Regulations* published under GN R 527 of 23 April 2004 ("the Regulations") pertaining to the closure and rehabilitation of mined land are more comprehensive and detailed and serve to more effectively and efficiently regulate the closure and rehabilitation of mined land.

3.1.1 Provisions Pertaining to the Rehabilitation and Closure of Mined Land at the Commencement of Prospecting or Mining

2 *Director: Mineral Development, Gauteng Region and Another v Save the Vaal Environment and others* 1999(2) SA 709 (SCA).

3.1.1.1 Application for a Prospecting Right or Mining Permit

With regard to the application of a prospecting right, consideration should be given to sections 16 and 17 of the MPRDA and the accompanying regulations. Section 16 states that where an application for a prospecting right has been accepted, the applicant must submit an environmental management plan. In terms of the Regulations, in particular regulation 52 thereof, closure and environmental objectives must be recorded in the environmental management plan.

Section 17 of the MPRDA refers to the core considerations to be taken into account by the Department of Minerals and Energy ("DME") in granting a prospecting right. One of the factors to be taken into account is that the prospecting will not result in unacceptable pollution, ecological degradation or damage to the environment. Furthermore, the Regulations which regulate the contents of the application for a prospecting right (i.e. regulation 5) state that documentary proof of the applicant's technical ability or access thereto to mitigate, manage and rehabilitate relevant environmental impacts must accompany the application for a prospecting right. Furthermore, the prospecting work programme to be submitted in terms of regulation 7 must contain a cost estimate of the expenditure to be incurred for each phase of the proposed prospecting operation where the expenditure must be broken down into costs pertaining to the rehabilitation and management of environmental impacts. Issues pertaining to the financial provision are more fully discussed in paragraph 3.1.1.2.

With regard to the application of a mining right, consideration should be given to sections 22 and 23 of the MPRDA as well as the accompanying regulations. Section 22 states that where an application for a mining right has been accepted, the Regional Manager of the DME will notify the applicant to conduct an environmental impact assessment and submit an environmental management programme for approval in terms of section 39 of the Act. The provisions of section 39 of the Act pertaining to environmental management programmes and environmental management plans are more fully discussed hereunder. In terms or the Regulations, in particular regulation 51 thereof, closure and environmental objectives must be recorded in the environmental management programme.

Section 23 of the MPRDA refers to the core considerations to be taken into account by the DME in granting a mining right. One of the factors to be taken into account is that the mining will not result in unacceptable pollution, ecological degradation or damage to the environment. Furthermore, the Regulations which regulate the contents of the application for a mining right (i.e. regulation 10) state that detailed documentary proof of the applicant's technical ability or access thereto to conduct the mining activities and to mitigate and rehabilitate relevant environmental impacts, must be submitted in support of the said application.

It follows that goals and commitments associated with rehabilitation and closure of land subjected to prospecting and mining operations must be identified at the pre-mining stage, prior to the approval of prospecting and mining rights that authorise the undertaking of these operations.

3.1.1.2 Financial Provision

In addition to the above, it is to be noted that the financial provision for the environmental rehabilitation and closure requirements of mining operations forms an integral part of the MPRDA. The obligation for financial provision, as provided for in terms of the MPRDA and the Regulations, also applies at the stage prior to the commencement of prospecting and/or mining operations when application is made to for the authorisation of the rights associated with these. The obligation continues through the operational and closure phases.

Section 41 of the MPRDA provides that before the Minister of Minerals and Energy ("the Minister of M&E") will approve an environmental management plan or environmental management programme for a prospecting right, mining right or mining permit, the applicant must make financial provision for the rehabilitation or management of the negative environmental impacts. The Minister of M&E may use all or part of this financial provision to rehabilitate or manage the negative environmental impact if the holder of a prospecting right, mining right or mining permit fails to rehabilitate or manage, or is unable to undertake such rehabilitation or to manage any negative impact on the environment.

Regulation 53 of the Regulations provides for the various methods in which the financial provision contemplated in Section 41 of the MPRDA may be provided, namely:

- An approved contribution to a trust fund as required in terms of Section 10 (1)(cH) of the Income Tax Act 58 of 1962 and must be in the format as approved by the Director-General for the Department of Minerals and Energy ("the DME") from time to time;

- a financial guarantee from a South African registered bank or any other bank or financial institution approved by the Director-General for the DME guaranteeing the financial provision relating to the environmental management programme or environmental management plan in the format as approved by the Director-General for the DME from time to time;

- a deposit into the account specified by the Director-General for the DME in the format as approved by the Director-General for the DME from time to time; or

- any other method as the Director-General for the DME may determine.

Furthermore, in terms of Regulation 54(1) of the Regulations, the quantum of the financial provision will be determined according to a guideline which will be published by the DME from time to time[3].

[3] "*The Guideline Document for the Evaluation of the Quantum of Closure-Related Financial Provision Provided by a Mine*" dated January 2005 was originally published by the DME on 23 April 2004 and updated January 2005.

The quantum of financial provision must include a detailed itemization of all actual costs required for:

- premature closure regarding:
  - the rehabilitation of the surface of the area;
  - the prevention and management of pollution of the atmosphere;
  - the prevention and management of pollution of water and the soil; and
  - the prevention of leakage of water and minerals between sub-surface formations and the surface.
- decommissioning and final closure of the operation; and
- post-closure management of residual and latent environmental impacts.

It follows that the identification of financial commitments in relation to environmental rehabilitation as well as closure is required at the pre-mining phase prior to the commencement of the prospecting or mining operations. As will be more fully indicated herein below, the financial commitments continue after the commencement of prospecting or mining operations.

3.1.2 Provisions Applicable throughout the lifetime of a Mine

We have set out below those provisions applicable throughout the lifetime of a mine, from the commencement of the mining operations until closure and rehabilitation of mined land.

3.1.2.1 Financial Provision

Following on the initial commitments associated with financial provision referred to above, the holder of a prospecting right, mining right or mining permit must annually update and review the quantum of the financial provision. The holder of a prospecting right, mining right or mining permit must annually assess his/her/its environmental liability and increase his/her/its financial provision to the satisfaction of the Minister of M&E. In this regard, provision has been made to empower the Minister of M&E to appoint an independent assessor to conduct the assessment of the environmental liability and determine the financial provisions if the Minister of M&E is not satisfied with the assessment and financial provision by the relevant holder.

An important aspect of the financial provision is that the obligation to maintain and retain the financial provision remains in force until the Minister of M&E issues a certificate of closure in terms of Section 43 of the MPRDA, discussed below. In this regard, the Minister of M&E may retain such portion of the financial provision as may be required to rehabilitate mined land in respect of latent or residual[4] environmental impacts after he or she has issued a closure certificate.

As is set out further below, upon the issuing of the closure certificate, the Minister of M&E must return such portion of the financial provision as he or she deems fit, but may retain such portion of the financial provision for latent and residual environmental impacts which may only become known in the future.

[4] The Mineral and Petroleum Resources Development Regulations legally defines *"latent environmental impact"* to mean the environmental impact that may result from natural events or disasters after a closure certificate has been issued and "*residual environmental impact"* to mean the environmental impact remaining after a closure certificate has been issued.

Therefore, once a closure certificate has been issued by the Minister of M&E, as is discussed further below, the obligation with regard to the financial provision ceases and the Minister of M&E must return such portion of such financial provision as he or she deems fit to the relevant holder of a prospecting right, mining right or mining permit. It must be borne in mind that the full remainder of the financial provision may not be returned due to the fact that the Minister of M&E is entitled to retain such portion of the financial provision for any environmental impacts which may become known in the future, such as the costs associated with the implementation of measures to be taken to prevent and remedy any negative impacts on the environment as is contemplated in Section 46(2) of the MPRDA, which provision is discussed below.

3.1.2.2 Monitoring and performance assessments of environmental management programme or environmental management plan

Regulation 55 states that as part of the general terms and conditions for a prospecting right, mining right or mining permit and in order to ensure compliance with an environmental management programme or environmental management plan and to assess the continued appropriateness and adequacy of the environmental management programme or environmental management plan, a holder of such permit or right must—

- conduct monitoring on a continuous basis;
- conduct performance assessments of the environmental management plan or environmental management programme as required; and
- compile and submit a performance assessment report to the Minister in which compliance with the environmental management programme and environmental management plan is demonstrated.

The regulations furthermore stipulate that the frequency of performance assessment reporting shall be in accordance with the period specified in the approved environmental management programme or plan or every two years or as agreed to, in writing, by the Minister. It follows that goals and commitments with respect to rehabilitation and closure should apart from the financial updates to be provided, also be monitored in accordance with the regulations stipulated above, at the prescribed times and throughout the life of the mine.

In addition, regulation 55(8) states that when the holder of a prospecting right, mining right or mining permit intends closing an operation, a final performance assessment must be conducted and a report submitted to the Minister. This requirement is more fully discussed herein below when the statutory provisions applicable at the closure phase are considered.

3.1.2.3 Rehabilitation

Inherent to the issue of the prospecting or mining authorisation is the requirement that the holder of the relevant right is responsible for the remediation and/or rehabilitation of the mined land.

In the White Paper entitled: "*A Minerals and Mining Policy for South Africa October 1998, Pretoria*"[5] provision is made for the following aspects which are of relevance to the closure and rehabilitation of mined land:

- It should be ensured that the rehabilitation of land for post-mine use is carried out to standards that permit its use for the purpose set out in the Environmental Management Programme ("EMPR") and that closure be granted only after it has been established that there are no foreseeable residual impacts that will be inherited by parties acquiring such land.

- Mining companies will be required to comply with the Local Development Objectives, Spatial Development Framework and Integrated Development Planning of the municipalities within which they operate and will be encouraged to promote social participation by conducting their operations in such a manner that the needs of local communities are taken into consideration. On closure of a mine, every opportunity must be taken to ensure the continued availability of useful infrastructure.

- The principles of Integrated Environmental Management ("IEM") will be applied to environmental management in the mining industry. These must be amplified to include cradle-to-grave management of environmental impacts in all phases of a mine's life, effective monitoring and auditing procedures, financial guarantees for total environmental rehabilitation responsibilities, controlled decommissioning and closure procedures, procedures for the determination of possible latent environmental risks after mine closure and the retention of responsibility by a mine until an exonerating certificate is granted[6].

3.1.2.4 Integrated Environmental Management and Responsibility to Remedy

Section 38 of the MPRDA sets out a number of obligations on the holders of reconnaissance permissions, prospecting rights, mining rights, mining permits, or retention permits. These are as follows:

- effect must at all times be given to the general objectives of integrated environmental management laid down in Chapter 5 of the National Environmental Management Act 107 of 1998 ("NEMA");

- the impact of the holder's prospecting or mining on the environment as contemplated in Section 24(7)[7] of the NEMA must be considered, investigated, assessed and communicated;

- all environmental impacts must be in accordance with the holder's environmental management plan or approved environmental management programme, where appropriate and as an integral part of the reconnaissance, prospecting or mining operation;

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5 It must be noted that guidelines generally have no legal standing and any guidance provided by any guideline must be interpreted within the context of the statutory legislation it is giving guidance to.

6 Paragraph 4.4 in Chapter 4 of the White Paper.

7 Following amendments to the NEMA in terms of the National Environmental Management Amendment Act 8 of 2004, this section is now referred to as section 24(4)

- the environment affected by the prospecting or mining operations must as far as it is reasonably practicable be rehabilitated to its natural or predetermined state or to a land use which conforms to the generally accepted principle of sustainable development; and

- the holder is responsible for any environmental damage, pollution or ecological degradation as a result of his or her reconnaissance prospecting or mining operations and which may occur inside and outside the boundaries of the area to which such right, permit or permission relates.

With regard to the general objectives of integrated environmental management laid down in Chapter 5 of the NEMA, as referred to in Section 38 of the MPRDA above, Section 23 in Chapter 5 of the NEMA sets out the principles of integrated environmental management and aims to promote the application of appropriate environmental management tools in order to ensure the integrated environmental management of activities.

Section 23(2) of the NEMA provides that the objective of integrated environmental management is to:

- promote the integration of the principles of environmental management set out in Section 2 of the NEMA, discussed below, into the making of all decisions which may have a significant effect on the environment;

- identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage, the risks and consequences and alternatives and options for mitigation of activities, with a view to minimising negative impacts, maximising benefits, and promoting compliance with the principles of environmental management set out in Section 2 of the NEMA, discussed below;

- ensure that the effects of activities on the environment receive adequate consideration before actions are taken in connection with them;

- ensure adequate and appropriate opportunity for public participation in decisions that may affect the environment;

- ensure the consideration of environmental attributes in management and decision making which may have a significant effect on the environment; and

- identify and employ the modes of environmental management best suited to ensuring that a particular activity is pursued in accordance with the principles of environmental management set out in Section 2 of the NEMA.

Therefore, in referring to the above obligations, Section 38 of the MPRDA clearly imposes an obligation on the holders of reconnaissance permissions, prospecting rights, mining rights, mining permits, or retention permits for the rehabilitation of the environment affected by these operations, as far as it is reasonably practicable, to its natural or predetermined state or to a land use which conforms to the generally accepted principle of sustainable development. This concept is discussed further below.

An important provision to take note of within the context of rehabilitation and closure is Section 38(2) of the MPRDA which provides for joint and several liability of the directors of a company or the members of a closed corporation. This Section provides as follows:

> *"Notwithstanding the Companies Act, 1973 (Act No. 61 of 1973), or the Close Corporations Act, 1984 (Act No. 69 of 1984), the directors of a company or members of a close corporation are jointly and severally liable for any unacceptable negative impact on the environment, including damage, degradation or pollution advertently or inadvertently caused by the company or close corporation which they represent or represented"*

Accordingly, Section 38(2) of the MPRDA imposes the possibility that the directors of a company or the members of a closed corporation may be held personally liable for any environmental damage caused by the operations of the company or the closed corporation. Under these circumstances it is recommended that directors of companies as well as members of closed corporations familiarise themselves with the corporate's closure objectives and ensure that, upon closure, management support is rendered in achieving such goals.

3.1.2.5 Minister's Power to Recover Costs in the Event of Urgent Remedial Measures

As was set out above, the holder of a prospecting right, mining right, retention permit or mining permit remains responsible for any environmental liability, pollution or ecological degradation, and the management thereof, until the Minister of M&E has issued a closure certificate to the holder concerned. Accordingly, it is important to note that the provisions contained in the MPRDA pertaining to the recovering of costs in the event of urgent remedial provisions will remain effective against such holder until the Minister of M&E has issued a closure certificate.

Section 45 of the MPRDA provides that if any prospecting, mining, reconnaissance or production operations causes or results in ecological degradation, pollution or environmental damage which may be harmful to the health or well being of anyone and requires urgent remedial measures, the Minister of M&E may direct the holder of the relevant right, permit or permission to -

- investigate, evaluate, assess and report on the impact of any pollution or ecological degradation;
- take such measures as may be specified in such directive; and
- complete such measures before a date specified in the directive.

If the holder fails to comply with the directive, the Minister of M&E must first afford the holder an opportunity to make representations and upon consideration of such representations, may take such measures as may be necessary to protect the health and well-being of any affected person or to remedy ecological degradation and to stop pollution of the environment, the costs of which can be recovered by the Minister in the following ways:

- the Minister of M&E may by way of an *ex parte* application apply to a High Court for an order to seize and sell such property of the relevant holder as may be necessary to cover the expenses of implementing such measures and in addition, the Minister of M&E may use funds appropriated for that purpose by Parliament to fully implement such measures; or

- The Minister of M&E may recover an amount equal to the funds necessary to fully implement the measures from the holder concerned.

3.1.2.6 Minister's Power to Remedy Environmental Damage in Certain Instances

Section 46 of the MPRDA provides that if the Minister of M&E directs that measures contemplated in Section 45 of the MPRDA, discussed above, must be taken to prevent pollution or ecological degradation of the environment or to rehabilitate dangerous occurrences but establishes that the holder of the relevant reconnaissance permission, prospecting right, mining right, retention permit or mining permit, as the case may be, or his/her/its successor in title, is deceased or cannot be traced or, in the case of a juristic person, has ceased to exist, has been liquidated or cannot be traced, the Minister of M&E may instruct the Regional Manager[8] concerned to take the necessary measures to prevent further pollution or degradation, or to make the area safe. In such instances, the costs of such measures must, in terms of Section 46(2) of the MPRDA, be funded from the financial provision made by the holder of the relevant reconnaissance permission, prospecting right, mining right, retention permit or mining permit in terms of Section 41 of the MPRDA, where appropriate, or if there is no such provision or if it is inadequate, from money appropriated by Parliament for that purpose.

Once the relevant Regional Manager has completed the measures contemplated in Section 46 of the MPRDA, he or she must apply to the Registrar concerned for the endorsement of the title deed of the land in question to the effect that such land has been remedied.

3.1.3 Provisions Applicable at Closure of a Mine

3.1.3.1 Principles for Mine Closure

Regulation 56 of the Regulations sets out that the holder of a prospecting right, mining right, retention permit or mining permit must ensure that -

- the closure of a prospecting or mining operation incorporates a process which must start at the commencement of the operation and continue throughout the life of the operation;

- risks pertaining to environmental impacts must be quantified and managed pro-actively, which includes the gathering of relevant information throughout the life of a prospecting or mining operation;

- the safety and health requirements in terms of the Mine Health and Safety Act 29 of 1996 are complied with;

8 The Regional Manager is the officer appointed by the Director-General of the Department of Minerals and Energy in terms of Section 8 of the MPRDA as the regional manager for a specific area. In terms of Section 7 of the MPRDA, the Minister of M&E must divide the Republic into regions, which regions were published under GN R 7960 of 30 April 2004.

- residual and possible latent environmental impacts are identified and quantified;
- the land is rehabilitated, as far as is practicable, to its natural state, or to a predetermined and agreed standard of land use which conforms with the concept of sustainable development[9]; and
- prospecting or mining operations are closed efficiently and cost effectively.

3.1.3.2 Liability until Closure Certificate

Section 43 of the MPRDA provides that the holder of a prospecting right, mining right, retention permit or mining permit remains responsible for any environmental liability, pollution or ecological degradation, and the management thereof, until the Minister of M&E has issued a closure certificate to the holder concerned. Such closure certificate will only be issued once all the provisions relating to health and safety and the management of potential pollution to water resources have been addressed. Accordingly, the holder of the relevant right or permit should aim to reduce his/her/its liability by ensuring that all negative impacts on the environment are prevented and remedied. However, it must be noted that Section 43 of the MPRDA does provide some relief in that the holders of the relevant rights or permits may make a written application to the Minister of M&E for the transfer of environmental liabilities and responsibilities to another person. The transfer of such environmental liabilities and responsibilities is discussed further below.

3.1.3.3 Closure Certificate

Section 43(1) of the MPRDA provides that the holder of a prospecting right, mining right, retention permit or mining permit or the person to whom the Minister of M&E has transferred such environmental liabilities and responsibilities for any environmental liability, pollution or ecological degradation, and the management thereof, as provided for in Regulation 58 of the Regulations, discussed further below, as the case may be, must apply for a closure certificate upon -

- the lapsing, abandonment or cancellation of the right or permit in question;

[9] This is in line with Section 23 of the NEMA, as is discussed above. The rehabilitation of mined land to its natural state is a high threshold and often unachievable, however, provision has been made for the rehabilitation of mined land to its natural state as far as it is practicable, or for the negotiation for the rehabilitation of the mined land to a standard or land use which conforms to the concept of sustainable development. With regard to the negotiation for rehabilitation, it is important to make a link between the baseline information a holder includes in the environmental management programmne or environmental management plan, as the case may be, and the identified latent and residual impacts, which will form a basis for the negotiation. The definition of "*practicable*" is not provided for in the MPRDA or the Regulations. The Oxford Advanced Learners Dictionary defines "*practicable*" as something which can be put into practice or is workable. The Atmospheric Pollution Prevention Act 45 of 1965 for example defines "*best practicable means*" so as to include "*the adoption of any methods which, having regard to local conditions and circumstances, the prevailing extent of technical knowledge and the cost likely to be involved, may be reasonably practicable and necessary for the protection of any section of the public against the emission of poisonous or noxious gases, dust or any such fumes*". Within this context, the NEMA in section 1 defines "*best practicable environmental option"* to mean the option that provides the most benefit or causes the least damage to the environment as a whole, at a cost acceptable to society, in the long term as well as in the short term. In applying these definitions, it appears that in referring to the term "*practicable*", the surrounding circumstances and the costs involved are important elements to be considered. However, one must bear in mind that specific reference is made to sustainable development and it is clear that any practicable means for the rehabilitation of mined land or for the negotiation of the standard for rehabilitation, must conform to the concept of sustainable development, which is defined in the MPRDA as "*the integration of social, economic and environmental factors into planning, implementation and decision making so as to ensure that mineral and petroleum resources development serves present and future generations*" Accordingly, any rehabilitation of mined land, whether by utilizing practicable measures or by negotiating a standard, must conform to the concept that anything so done must "*ensure that the mineral and petroleum resources development serves present and future generations*".

- cessation of the prospecting or mining operation;
- the relinquishment of any portion of the prospecting of the land to which a right, permit or permission relate; or
- completion of the prescribed closing plan to which a right, permit or permission relates.

3.1.3.3.1 Issuing of a Closure Certificate

Section 43(4) of the MPRDA provides that an application for a closure certificate must be made within 180 days of the occurrence of the lapsing, abandonment, cancellation, cessation, relinquishment or completion contemplated in Section 43 of the MPRDA, set out above. An application for a closure certificate must be made to the Regional Manager[10] in whose region the land in question is situated and must be accompanied by the prescribed environmental risk report, which is discussed below.

It is important to note that no closure certificate may be issued without written confirmation from the Chief Inspector of Mines[11] and the Department of Water Affairs and Forestry ("the DWAF") that the provisions pertaining to health and safety and management of potential pollution to water resources have been addressed[12].

As discussed above, upon the issuing of a closure certificate, the Minister of M&E must return such portion of the financial provision as he or she deems appropriate to the holder of the prospecting right, mining right, retention permit or mining permit in question but may retain any portion of such financial provision for latent and or residual environmental impacts which may only become known in the future.

3.1.3.3.2 Application for Closure Certificate

Regulation 57 of the Regulations sets out the requirements for an application for a closure certificate and provides that such application must be completed in accordance with Form P. Form P requires information pertaining to the name of the applicant applying for a closure certificate the number of the permission, permit or right the region within which the relevant mine occurs the type of permission, permit or right type of mineral(s) details of land, area or offshore licence block; and the reason for the application for a closure certificate[13]. Form P must be accompanied by the following documentation:

- a closure plan contemplated in Regulation 62 of the Regulations;
- an environmental risk report contemplated in Regulation 60 of the Regulations;
- a final performance assessment report contemplated in Regulation 55(9) of the Regulations; and

[10] The Regional Manager is the officer appointed by the Director-General of the DME in terms of Section 8 of the MPRDA as the regional manager for a specific area. In terms of Section 7 of the MPRDA, the Minister of M&E must divide the Republic into regions, which regions were published under GN R 7960 of 30 April 2004.
[11] Appointed in terms of Section 48(1) of the Mine Health and Safety Act 29 of 1996.
[12] Section 43(5) of the MPRDA.
[13] The reason to be provided relates to the occurrences of one of the events set out in Section 43(1) of the MPRDA, discussed above.

- a completed application form contemplated in Regulation 58(1) of the Regulations to transfer environmental liabilities and responsibilities, if the transfer of such liabilities has been applied for.

➢ **Closure plan**

A closure plan forms part of the environmental management programme or environmental management plan, as the case may be. Regulation 62 of the Regulations provides that a closure plan must include:

- a description of the closure objectives and how these relate to the prospecting or mine operation and its environmental and social setting;
- a plan contemplated in Regulation 2(2) of the Regulations[14], showing the land or area under closure;
- a summary of the regulatory requirements and conditions for closure negotiated and documented in the environmental management programme or environmental management plan, as the case may be;
- a summary of the results of the environmental risk report and details of identified residual and latent impacts;
- a summary of the results of progressive rehabilitation undertaken;
- a description of the methods to decommission each prospecting or mining component and the mitigation or management strategy proposed to avoid, minimize and manage residual or latent impacts;
- details of any long-term management and maintenance expected;
- details of a proposed closure cost and financial provision for monitoring, maintenance and post- closure management;
- a sketch plan drawn on an appropriate scale describing the final and future land use proposal and arrangements for the site;
- a record of interested and affected persons consulted; and
- technical appendices, if any.

With regard to the plan in terms of Regulation 2(2) of the Regulations as set out in Regulation 62 of the Regulations, Regulation 2(2) of the Regulations provides that an application for any permission, right or permit in terms of the MPRDA must be accompanied by a plan of the land in accordance with generally accepted standards and must contain:

- the co-ordinates and spheroid (Clarke 1880/Cape Datum, WGS84/WGS84, WGS94/Hartebeesthoek94) of the land to which the application relates;
- the north point;

[14] Regulation 2(2) of the Regulations is discussed further below.

- the scale to which the plan has been drawn;
- the location and where applicable, the name and number of the land to which the application relates;
- the extent of the land to which the application relates:
- the boundaries of the land to which the application relates:
- surface structures and registered servitudes where applicable; and
- the topography of the land to which the application relates.

Accordingly, in terms of Regulation 62 of the Regulations, a plan as is provided for in Regulation 2(2) of the Regulations must be included in a closure plan.

Regulation 61 of the Regulations provides further that closure objectives, as provided for in Regulation 62 of the Regulations, discussed above, must:

- identify the key objectives for mine closure to guide the project design, development and management of environmental impacts;
- provide broad future land use objective(s) for the site; and
- provide proposed closure costs.

➢ **Environmental risk report**

Regulation 60 of the Regulations sets out the requirements of the environmental risk report which must in terms of Regulation 57 of the Regulations, accompany the application for a closure certificate and provides that an environmental risk report must include:

- the undertaking of a screening level environmental risk assessment where:
  - all possible environmental risks are identified, including those which appear to be insignificant;
  - the process is based on the input from existing data;
  - the risks that are considered are qualitatively ranked as –
    - a potential significant risk;
    - a uncertain risk; or
    - an insignificant risk;
- the undertaking of a second level risk assessment on issues classified as potential significant risks where:
  - appropriate sampling, data collection and monitoring be carried out;
  - more realistic assumptions and actual measurements be made; and

- a more quantitative risk assessment is undertaken, again classifying risks as posing a potential significant risk or insignificant risk;
- an assessment of whether risks classified as posing potential significant risks are acceptable without further mitigation;
- risks classified as uncertain risks be re-evaluated and re-classified as either posing potential significant risks or insignificant risks;
- documenting the status of insignificant risks;
- identifying alternative risk prevention or management strategies for potential significant risks that have been identified, quantified and qualified in the second level risk assessment; and
- agreeing on management measures to be implemented for the potential significant risks that must include:

  - a description of the management measures to be applied;
  - a predicted long-term result of the applied management measures;
  - the residual and latent impact after successful implementation of the management measures;
  - time frames and schedule for the implementation of the management measures;

- responsibilities for implementation and long-term maintenance of the management measures;

  - financial provision for long-term maintenance; and
  - monitoring programmes to be implemented.

➢ **Final performance assessment report**

In terms of Regulation 55(8) of the Regulations a holder of a prospecting right, mining right or mining permit who intends closing an operation, must conduct and submit to the Minister of M&E a final performance assessment setting out that –

- the requirements of the relevant legislation have been complied with;

- the closure objectives as described in the environmental management programme or environmental management plan have been met; and

- all residual environmental impacts resulting from the holder's operations have been identified and the risks of latent impacts which may occur have been identified, quantified and arrangements for the management thereof have been assessed.

This final performance assessment report must either precede or accompany an application for a closure certificate[15].

3.1.4 Removal of Buildings, Structures and Other Objects

Section 44 of the MPRDA provides that when a prospecting right, mining right, retention permit or mining permit lapses, is cancelled or is abandoned or when

[15] Regulation 55(9) of the Regulations.

any prospecting or mining operation comes to an end, the holder of any such right or permit may not demolish or remove any building, structure or object:

- which may not be demolished or removed in terms of any other law (please refer to the National Heritage Resources Act 25 of 1999, discussed below);
- which has been identified in writing by the Minister of M&E for purposes of this section[16]; or
- which is to be retained in terms of an agreement between the holder and the owner or occupier of the land, which agreement has been approved by the Minister of M&E in writing.

However, any *bona fide* mining equipment may be removed.

3.1.5 Application to Transfer Environmental Liabilities to Competent Person

As is set out above, the holder of a prospecting right, mining right, retention permit or mining permit remains responsible for any environmental liability, pollution or ecological degradation and the management thereof until the Minister of M&E issues a closure certificate. However, Section 43(2) of the MPRDA provides that such a holder may make a written application to the Minister of M&E to transfer such liabilities and responsibilities to another person.

Regulation 58 of the Regulations sets out the procedure in making an application to transfer environmental liabilities and responsibilities to a competent person, as provided for in Section 43(2) of the MPRDA, and provides that such an application must be completed in the form of Form O. Form O must be signed by both the relevant holder and the person to whom the environmental liabilities and responsibilities are to be transferred to. Form O must be lodged with the Minister of M&E for consideration. In considering an application to transfer the liabilities and responsibilities to another person in terms of Section 43(2) of the MPRDA, the Minister of M&E may consult with relevant Government Departments or Organs of State which administers any law relating to matters affecting the environment[17].

Upon consideration of the aforementioned application, the Minister of M&E may transfer liabilities and responsibilities as identified in the environmental management plan or the environmental management programme, as the case may be, and the required closure plan to a competent person, which person must meet the requirements as are set out in Regulation 59 of the Regulations, discussed below.

3.1.5.1 Qualifications of Person Regarding Transfer of Environmental Liabilities and Responsibilities

Regulation 59 of the Regulations sets out the qualifications which a person to whom the responsibilities and liabilities in terms of Section 43(2) of the MPRDA are transferred to, must comply with. Such a person must;

- have the expertise, resources and organisational abilities to integrate risk assessment, risk management and risk financing to ascertain the cost of environmental management;

[16] No notices have as yet been published in this regard.
[17] Regulation 58(3) of the Regulations.

- have the expertise, financial and other resources to meet his or her obligations to carry out actions necessary to fulfil the environmental obligations as set out in the environmental management plan or the environmental management programme, as the case may be, or any closure plan concerned;

- have appropriate experience in environmental management, prospecting or mining operations and mine health and safety matters;

- have direct access to insurance products and alternative risk financing services appropriate to financing of exposure to risks;

- have the ability to manage trusts set up in terms of Section 10(1)(cH) of the Income Tax Act 58 of 1962; and

- have expertise and experience or proven access thereto to interpret and manage the findings of an environmental risk assessment.

4. PART 3: ENVIRONMENTAL LEGISLATION WHICH MUST BE CONSIDERED

4.1 Environmental Legislation

It is important to note that although the MPRDA and the Regulations are the central legislation in the mining industry, other environmental legislation will also find application to the undertaking of prospecting and mining operations. It must be emphasized that it is important that such other environmental legislation be considered and applied, where appropriate, within the context of rehabilitation and closure of mined land.

As was set out above, it must be noted that for the purposes of this document, we have not set out the environmental legislative provisions applicable to mining waste and waste disposal sites.

4.1.1 Undertaking of Listed Activities Identified as Activities having a Detrimental Impact on the Environment and requiring an Environmental Impact Assessment and Authorisation

4.1.1.1 National Environmental Management Act 107 of 1998

Sections 21 and 22 of the Environment Conservation Act 73 of 1989 ("ECA"), read with the regulations promulgated in terms of these provisions, legally formalised the concept of Environmental Impact Assessment ("EIA"). In terms of these provisions, government identified certain listed activities, the undertaking of which may have a substantial detrimental effect on the environment. Accordingly, prior to the undertaking of these activities an environmental authorisation had to be applied for and obtained.

The process by which such an authorisation could be obtained is generally referred to as the EIA process. Both the identified activities as well as the EIA process were prescribed in regulations promulgated in terms of the abovementioned sections and this system was utilised for almost a decade until its effective repeal on the 3rd of July 2006 by provisions in the National Environmental Management Act 107 of 1998 ("NEMA") pertaining to the identification of "new" listed activities as well as authorisation processes.

Section 24 of the NEMA headed "*Environmental Authorizations*", sets out the provisions which are to give effect to the general objectives of Integrated Environmental Management ("IEM"), laid down in Chapter 5. In terms of section 24(1), the potential impact on the environment of listed activities must be considered, investigated, assessed and reported on to the competent authority charged by the Act with the granting of the relevant environmental authorisation.

It should also be noted that the underlying rationale for environmental management and protection, based on the undertaking of listed activities, has considerably been broadened in section 24(2) of the NEMA. This section now provides that the Minister of Environmental Affairs and Tourism ("Minister") as well as every Member of the Executive Council of a Province ("MEC"), with the concurrence of the Minister may identify:

> *"(a) activities which may not commence without environmental authorisation from the competent authority;*
> *(b) geographical areas based on environmental attributes in which specified activities may not commence without environmental authorisation from the competent authority;*
> *(c) geographical areas based on environmental attributes in which specified activities may be excluded from authorisation by the competent authority;*
> *(d) individual or generic existing activities which may have a detrimental effect on the environment and in respect of which an application for an environmental authorisation must be made to the competent authority."*

As was stated above, the process as well as the various "new" listed activities have been identified and promulgated in various notices published in the Government Gazette during April 2006. While the listed activities have been identified for purposes of the application of section 24(2)(a) and possibly section 24(2)(d), the geographical areas as referred to in sections 24(2)(b) and (c) have not at the time of writing, been identified. Once designated, the planning of operations associated with mine rehabilitation and closure will also have to take cognisance of any specified or excluded activities identified in respect of geographical areas where environmental authorisations particular to such area may have to be obtained.

It is to be noted that if listed activities will be undertaken as part of rehabilitation and closure operations, an authorisation will be required prior to the undertaking of such listed activities. Within this context, we do not refer to all the listed activities promulgated in terms of two separate notices being GN R 386 and 387 and limit our discussion to those activities which may find application to closure and rehabilitation operations only, as referred to in the respective notices. We recommend that planning of mine rehabilitation and closure operations consider the potential applicability of all the listed activities on a site or area specific basis.

4.1.1.2 The Listed Activities

By way of example, listed activities referred to in GN R 386 that may be relevant to rehabilitation and closure operations at a mine include activities such as:

- The construction of facilities or infrastructure, including associated structures or infrastructure in terms of item 1 for:

- any purpose in the one in ten year flood line of a river or stream, or within 32 metres from the bank of a river or stream where the flood line is unknown, excluding purposes associated with existing residential use, but including –

  i. canals;
  ii. channels;
  iii. bridges;
  iv. dams; and
  v. weirs (item 1(m));

- the treatment of effluent, wastewater or sewage with an annual throughput capacity of more than 2 000 cubic metres but less than 15000 cubic metres (item 1(s));
- The prevention of the free movement of sand, including erosion and accretion, by means of planting vegetation, placing synthetic material on dunes and exposed sand surfaces within a distance of 100 metres inland of the high-water mark of the sea. (item 3);
- The dredging, excavation, infilling, removal or moving of soil, sand or rock exceeding 5 cubic metres from a river, tidal lagoon, tidal river, lake, in-stream dam, floodplain or wetland. (item 4);
- The excavation, moving, removal, depositing or compacting of soil, sand, rock or rubble covering an area exceeding 10 square metres in the sea or within a distance of 100 metres inland of the high-water mark of the sea. (item 6);
- The decommissioning of a dam where the highest part of the dam wall, as measured from the outside toe of the wall to the highest part of the wall, is 5 metres or higher or where the high-water mark of the dam covers an area of more than 10 hectares. (item 11);
- The abstraction of groundwater at a volume where any general authorization issued in terms of the National Water Act, 1998 (Act No. 36 of 1998) will be exceeded. (item 13);
- The decommissioning of existing facilities or infrastructure, other than facilities or infrastructure that commenced under an environmental authorisation issued in terms of the Environmental Impact Assessment Regulations, 2006 made under section 24(5) of the Act and published in Government Notice No. R. 385 of 2006, for –

  - electricity generation;
  - nuclear reactors and storage of nuclear fuel;
  - industrial activities where the facility or the land on which it is located is contaminated or has the potential to be contaminated by any material which may place a restriction on the potential to re-use the site for a different purpose;
  - the disposal of waste;
  - the treatment of effluent, wastewater and sewage with an annual throughput capacity of 15 000 cubic metres or more;
  - the recycling, handling, temporary storage or treatment of general waste with a daily throughput capacity of 20 cubic metres or more; or
  - the recycling, handling, temporary storage or treatment of hazardous waste.

Items 8 and 9 in GN R 386 relate directly to reconnaissance, prospecting, mining or retention operations. Item 8 concerns reconnaissance, prospecting, mining or retention operations as provided for in the Mineral and Petroleum Resources Development Act in respect of such permissions, rights, permits and renewals thereof. Item 9 will apply in relation to permissions, rights, permits and renewals granted in terms of item 8, or any similar right granted in terms of previous mineral or mining legislation, the undertaking of any prospecting or mining related activity or operation within a prospecting, retention or mining area, as defined in terms of section 1 of the Mineral and Petroleum Resources Development Act. At the time of writing, the commencement of these items has been postponed to a date to be published and the general application and scope of these items as well as their application to rehabilitation and closure specifically, is yet to be determined.

With regard to the listed activities in GN R 387 similar types of listed activities, albeit with increased thresholds, capacities and volumes, may possibly apply within the context of rehabilitation and closure. Similarly, items 7 and 8 of GN R 387 also directly concern reconnaissance, prospecting, and mining or retention operations. These activities have also not yet been commenced with and the general application and scope of these items as well as their application to rehabilitation and closure specifically, is yet to be determined.

We must emphasise that the application of listed activities and the associated legal duties to authorise, has not been excluded from mining areas and mining operations which include mine closure or rehabilitation. Pending the commencement of items 8 and 9 in GN R 386 as well as items 7 and 8 in items GN R 387 or further statutory notice, all these listed activities must be applied to site specific rehabilitation and closure conditions, where applicable.

4.1.1.3 The New Application Process (GN R 385)

Chapter 3, more specifically regulations 13 to 38 of GN R 385 deals with the application process for environmental authorisations. Regulation 13 to 20 deals with the general requirements, the appointment of environmental assessment practitioners and the determination of applications. Regulation 21 *inter alia* differentiates between two processes:

- basic assessments; and
- scoping and environmental impact assessment (“EIA”).

Depending on whether a listed activity resorts under GN R 386 or GN R 387 either a basic assessment process or scoping and environmental impact assessment process must be undertaken. Generally the scoping and environmental impact assessment process represents a more detailed and extended process in order to cater for the higher thresholds, volumes and capacities associated with the listed activities in GN R 387. We recommend that the process requirements be identified and assessed and incorporated into financial, strategic and project planning associated with rehabilitation and closure of mining operations.

4.1.2 Duty of Care and Remediation of Environmental Damage

4.1.2.1 The National Environmental Management Act 107 of 1998 (“The NEMA”)

Section 28 of the NEMA provides for a general overarching statutory duty of care to take reasonable measures to protect the environment under certain circumstances in addition to any permitting, licensing or other closure and rehabilitation obligations. Section 28(1) of the NEMA states that, every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring. Where such pollution or degradation of the environment is authorised by law or cannot reasonably be avoided or stopped, the person must take reasonable measures to minimise and rectify such pollution or degradation of the environment.

It should be noted that the category of persons on whom this obligation is imposed is very broad in that it refers to "*every person*" and will therefore include juristic persons.[18] Section 28(2) of the NEMA nevertheless specifically includes three classes of persons (without limiting the generality of the duty in subsection 28(1) of the NEMA). The persons on whom Section 28(1) of the NEMA specifically imposes an obligation to take reasonable measures include an owner of land or premises a person in control of land or premises, such as a lessee or a person who has a right to use the land or premises, such as a sub-lessee, contractor or sub-contractor, on which or in which:

- any activity or process is or was performed or undertaken; or
- any other situation exists,

which causes, has caused or is likely to cause significant pollution or degradation of the environment. Although the status of a person (i.e. owner, controller or user) is indicative of who should attract the duty, causality nevertheless remains a prerequisite in order to attract the obligation to take reasonable measures.

A mining corporate which has for many years *inter alia* in its capacity as owner, controller or user of land or premises, been involved with activities which have caused or which may cause pollution is obliged to ensure that reasonable measures are taken to prevent "*… such pollution or degradation from occurring, continuing or recurring* …".

Section 28(1) of the NEMA furthermore refers to "*significant pollution or degradation*" and the question arises, what is "*significant*" within this context. It has been stressed that the word "*significant*" should be interpreted with reference to the relevant environmental management principles contained in Section 2 of NEMA, discussed below, Section 24 of the Constitution, discussed above, as well as the objectives of integrated environmental management contained in Chapter of NEMA, discussed above[19], and that these provisions read together indicate that the threshold for the term "*significant*" pollution is not likely to be set very high.[20]

The measures required to prevent pollution or degradation from occurring, continuing or recurring may include a variety of activities such as an environmental impact assessment (Section 24(3)(a) of the NEMA) or similar assessments and/or employee education (Section 24(3)(b) of the NEMA), to particularly onerous measures such as to cease, modify or control an activity or process causing pollution (Section 28(3)(c) of the NEMA), the containment or prevention of pollutants or the causant of degradation (Section 28(3)(d) of the NEMA), the elimination of a pollution or degradation source (Section 28(3)(e)) or the remediation of the effects of pollution or degradation (Section 28(3)(f) of the NEMA). Although these measures are extensive, they are stated in broad terms.

[18] *"Person"* is defined in section 1 of NEMA to include a juristic person.
[19] Refer to Section 23 of the NEMA, discussed above.
[20] Glazewski J, *"Environmental Law in South Africa"* 2nd Edition 2005 at 150

The inclusive nature of the “reasonable measures” opens up the possibility of negotiation.

It is of particular importance that the measures required have to be “*reasonable.*” The provisions of section 28(1) of NEMA are very similar to those of section 19(1) of the National Water Act 36 of 1998, discussed below, under which heading the interpretation of “*reasonable*” is more thoroughly discussed.

Section 28(4) of the NEMA states that the Director-General of the Department of Environmental Affairs and Tourism (“the DEAT”) or a Provincial Head of the DEAT may (after consultation with any other Organ of State concerned and after having given adequate opportunity to affected persons to inform him or her of their relevant interests), direct any person who fails to take such “*reasonable measures*”, as are provided for in Section 28 of the NEMA, to investigate, evaluate and assess the impact of specific activities and report thereon, or to commence taking specific reasonable measures before a given date.

The Director-General of the DEAT or the Provincial Head of the DEAT may also direct any person to diligently continue with those measures and complete them before a specified reasonable date. In this regard it should be noted that, unless the need for urgent action is proven by the DEAT, no such directions may be given to a person unless the Director-General of the DEAT or the Provincial Head of the DEAT has given any affected person the adequate opportunity to inform him or her of their relevant interests. It follows therefore that should a corporate at any point be issued with directives in terms of Section 28(4) of the NEMA, it should also generally have been given the opportunity to make representations to the DEAT in that regard, prior to the issue of the directive.

The Director-General of the DEAT or a Provincial Head of the DEAT may however not issue directives at will, and remains bound to various considerations including:

- the broad principles of environmental management as set out in Section 2 of NEMA, discussed below;
- the provisions of any adopted Environmental Management Plan or Environmental Implementation Plan, as the case may be;
- the severity of an environmental impact and the costs of the measures being considered;
- proposed measures to be instituted by the relevant person;
- the desirability of the State fulfilling its role as custodian of the environment; and
- any other relevant factors[21].

Failure to comply, or inadequate compliance with the directives given by the Director-General of the DEAT or Provincial Head of the DEAT to take reasonable measures to prevent pollution or degradation occurring, continuing or recurring, may result in the Director-General of the DEAT or the Provincial Head of the DEAT taking reasonable measures to remedy the situation in terms of NEMA[22].

[21] Section 28(5) of the NEMA.
[22] Section 28(7) of the NEMA.

The costs incurred as a result of measures so taken by the Director-General of the DEAT or a Provincial Head of the DEAT may be recovered from any or all of the following persons:

- Any person who is or was responsible for, or who directly or indirectly contributed to the pollution or degradation or the potential pollution or degradation;

- The owner of the land at the time when the pollution or degradation or the potential for pollution or degradation occurred, or that owners successor- in - title;

- The person in control of the land or any person who has or had the right to use the land at the time when the activity or the process which caused the pollution or degradation is or was performed or undertaken, or when the situation came about; or

- Any person who negligently failed to prevent the activity or the process being performed or undertaken, or the situation from coming about[23].

Section 28(9) of the NEMA further provides that the Director-General of the DEAT or the Provincial Head of the DEAT may in respect of the recovery of such costs, also claim proportionally from any other person who benefited from such measures.

Finally, any person may, after giving the Director-General of the DEAT or the Provincial Head of the DEAT thirty days notice, apply to a competent court for an order directing such Director-General of the DEAT or any Provincial Head of the DEAT to take any of the steps listed in Section 28(4) of the NEMA, as set out above, if the Director-General of the DEAT or the Provincial Head of the DEAT fails to inform such a person in writing that he has directed a person to take reasonable measures to remedy the pollution[24].

This section of NEMA is complicated when applied to the various practical scenarios anticipated and foreseen by the legislature in terms of interpreting its meaning and full implications within the context of rehabilitation and closure. It is to be noted that while it was generally accepted that this section has retrospective effect, obliging the persons referred to above to take reasonable measures to prevent historical pollution from occurring, continuing or recurring, making the section particularly relevant within the context of mine rehabilitation and closure, the court held in the matter of *Chief Pule Shadrack VII Bareki NO and Others vs. Gencor Ltd and Others*[25] that section 28 should not necessarily be regarded as retrospective. Any such directive (or the threat of such a directive) in terms of this section of NEMA should immediately be referred for specific legal advice to ensure that the Director-General of the DEAT or a Provincial Head of the DEAT is acting in accordance with the law.

4.1.2.2 The National Water Act 36 of 1998 ("The NWA")

Section 19 of the NWA provides for the prevention and remedying of the effects of pollution, which are extended to allow wider liability for pollution control measures and costs of remediation. In terms of Section 19 of the NWA, an owner

[23] Section 28(8) of the NEMA.
[24] Section 28(12) of the NEMA.
[25] 2005 JDR 1185 (T)

of land, a person in control of land or a person who occupies or uses the land on which:

- any activity or process is or was performed or undertaken; or
- any other situation exists,

which causes, has caused, or is likely to cause pollution of a water resource, must take all reasonable measures to prevent such pollution from occurring, continuing or recurring.

The measures referred to may include measures to:

- cease, modify or control any act or process causing the pollution;
- comply with any prescribed waste standard or management practice;
- contain or prevent the movement of pollutants;
- eliminate any source of the pollution;
- remedy the effects of the pollution; and
- remedy the effects of any disturbance to the bed and banks of a water course[26].

In terms of Section 19(3) of the NWA, when any person fails to take the required "*reasonable measures*", as set out above, the catchment management agency ("the CMA") may direct the defaulting person to:

- commence taking specific measures before a given date;
- diligently continue with those measures; and
- complete them before a given date[27].

Should a person fail to comply with a directive given under Section 19(3) of the NWA, the CMA may take the measures it considers necessary to remedy the situation, the costs of which may be recovered jointly and severally from the following persons:

- Any person who is or was responsible for, or who directly or indirectly contributed to, the pollution or the potential pollution;
- the owner of the land at the time when the pollution or the potential for pollution occurred, or that owner's successor in title;
- the person in control of the land or any person who has a right to use the land at the time when -
    - the activity or the process is or was performed or undertaken; or
    - the situation came about; or

[26] Section 19(2) of the NWA.
[27] Section 19(3) of the NWA

- any person who negligently failed to prevent -
  - the activity or the process being performed or undertaken; or
  - the situation from coming about.

Furthermore, the CMA may, in terms of Section 19(6) of the NWA, recover the costs from any other person who benefited from the reasonable measures undertaken to the extent of such benefit.

These "*reasonable measures*" may include measures to be undertaken before closure and rehabilitation of mined land.

The defaulting person is therefore given warning and/or a deadline to comply with certain directives and only on non-compliance may the CMA act on their own initiative as outlined later. Although not specifically stated in Section 19 of the NWA, directives given by the CMA to such a defaulting person must also be reasonable. It follows that, whether a person takes measures to prevent pollution from occurring, continuing or recurring in terms of Section 19(1) of the NWA or subsequent to directives issued by the DWAF, such measures must be reasonable.

In the matter of *Harmony Gold Mining Co Ltd v Regional Director: State Department of Water Affairs and Forestry and Others*[28] a directive in terms of Section 19 was successfully utilised by government within the mining industry where a situation existed which is likely to cause pollution of a water resource. It is to be anticipated that the remedy of a directive may be utilised more frequently in future within the context of rehabilitation and closure of mined land.

It is important to take note that the duty of care and the duty to remediate environmental damage in terms of the NEMA and the NWA, as is set out above, is applicable not only at the closure and rehabilitation of mined land, but is applicable throughout the lifetime of the mine and continues beyond such lifetime and arguably even after a closure certificate has been issued.

4.1.3 National Environmental Management Principles

As was set out above, the MPRDA specifically provides that the principles as are provided for in Section 2 of the NEMA are applicable to the MPRDA.

Section 2(1) states that the national environmental management principles apply throughout the country to the actions of all organs of State[29] that may significantly affect the environment and:

- apply alongside all other appropriate and relevant considerations, including the State's responsibility to respect, project, promote and fulfil the social and economic rights in Chapter 2 of the Constitution[30], and in particular the basic needs of categories of persons disadvantaged by unfair discrimination;

- serve as the general framework in terms of which environmental management and implementation must be formulated;

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28 2004 JOL 16740 (W). See also Harmony Gold Mining Co Ltd. V Regional Director: Free State, Department of Water Affairs and Forestry (2006) SCA 65 (RSA)

29 These principles therefore primarily bind organs of state when exercising discretionary powers

30 This Chapter contains the Bill of Rights including Section 24 of the Constitution pertaining to the environmental right, as discussed above.

- serve as guidelines by reference to which any organ of State must exercise any function when taking any decision in terms of NEMA or a statutory provision concerning the protection of the environment;

- serve as principles by reference to which a conciliator appointed under NEMA must make recommendations; and

- guide the interpretation, administration and implementation of NEMA and any other law concerned with the protection or management of the environment.

The principle of sustainable development is further elaborated on in sections 2(4)(a)(i-viii) of the NEMA. These subsections can be summarised as follows:

- that the disturbance of ecosystems and loss of biological diversity is avoided, or, wherever it cannot altogether be avoided, is minimised and remedied;

- that pollution and degradation of the environment is avoided, or where it cannot be altogether avoided, is minimised and remedied;

- that the disturbance of landscapes and sites that constitute a nations cultural heritage is avoided, or where it cannot be altogether avoided, is minimised and remedied;

- that a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions; and

- that negative impacts on the environment and on people's environmental rights be anticipated and prevented, and when they cannot be altogether prevented, are minimised and remedied.

The environmental management principles cover a wide range of aspects and reflect emerging environmental norms recognised in international environmental law, conventions and practise. The preventative principle is, for example, reflected in the principle that the disturbance of ecosystems and loss of biological diversity is to be avoided, minimised and remedied, in the directive that disturbance of the landscape and the nations cultural heritage is avoided, and when it cannot altogether be avoided, it must be minimised and remedied, and in the precept that the negative impacts on the environment and on people's environmental rights must be anticipated and prevented, and where they cannot be altogether prevented, these must be minimised and remedied.

The precautionary principle is manifest in the principle that a *"risk averse and cautious approach be applied that takes into account the limits of current knowledge about the consequences of decisions and actions"*[31].

The polluter pays principle is reflected in the principle that *"The costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution,*

[31] Section (2)(4)(a)(vii) of the NEMA.

environmental damage or adverse health effects must be paid for by those responsible for harming the environment".[32]

The public trust doctrine is manifest in the principle that "*The environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage*".[33]

Social equality and access to environmental resources is provided for in the principle that "*Equitable access to environmental resources, benefits and services to meet basic human needs and ensure human well-being must be pursued and special measures may be taken to ensure access thereto by categories of persons disadvantaged by unfair discrimination*".[34]

As indicated above, Section 2(1) of the NEMA states that the principles referred in Section 2 of the NEMA apply throughout the Republic to the actions of all Organs of State that may significantly affect the environment. Although it is clear that the principles referred to above apply to all Organs of State in terms of the NEMA, it is not altogether clear whether they also apply to private legal persons such as corporates (mining companies) or natural persons. It is submitted that the environmental management principles will at least find application to private entities in an indirect manner. Whenever a corporate requires an Organ of State to take an administrative decision as part of either a permitting process or licence application process, such as an application for a closure certificate in terms of the MPRDA or another permit or authorisation in terms of other legislation, the Organ of State is bound to apply the abovementioned principles whenever it needs to exercise an administrative discretion to allow a corporate to proceed with an activity which significantly affects the environment. Within this context, it is submitted that the environmental management principles bind private entities, although the legal obligation for its implementation lies with the relevant Organ of State.

Furthermore, as set out above, Section 38 of the MPRDA sets out a number of obligations which the holders of reconnaissance permissions, prospecting rights, mining rights, mining permits, or retention permits must comply with, one of which is that the objectives of integrated environmental management laid down in Chapter 5 of the NEMA must be given effect to. Section 23 of the NEMA which is contained in Chapter 5 of the NEMA specifically provides that one of the objectives of integrated environmental management is to promote compliance with the principles of environmental management as are set out in Section 2 of the NEMA. Accordingly, Section 38 of the MPRDA, read with Section 23 of the NEMA places an obligation on the holders of reconnaissance permissions, prospecting rights, mining rights, mining permits, or retention permits to promote compliance with the principles of environmental management as are set out in Section 2 of the MPRDA.

4.1.4. National Water Act 36 of 1998: Regulations on Use of Water for Mining and Related Activities (GN R 704 of 4 June 1999)

GN R 704 published in terms of the National Water Act ("NWA") dated 4 June 1999 specifically provides for regulations entitled: "*Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water*

[32] Section 2(4)(p)
[33] Section 2(4)(o)
[34] Section 2(4)(d)

Resources". The aim of GN R 704 is to specifically acknowledge the principle of co-operative governance and the respective roles for the DME, the Department of Environmental Affairs and Tourism ("DEAT") and the Department of Water Affairs and Forestry ("DWAF") in regulating pollution from mining activities.

Regulation 9 of GN R 704 concerns the temporary or permanent cessation of a mine and its related activities and provides that any person in control of a mine or related activity must at the temporary or permanent cessation of mining operations and its related activities, ensure that all pollution control measures have been designed, modified, constructed and maintained so as to comply with the regulations contained in GN R 704. Furthermore, any person in control of a mine or activity must at the temporary or permanent cessation of mining operations and activities, ensure that the in-stream and riparian habitat of any water resource, which may have been affected or altered by the mine or activity, is remedied so as to comply with the regulations contained in GN R 704.

A guideline document entitled *"A Guideline Document for the Implementation of Regulations on Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources"* was published by the DWAF in May 2000 ("the DWAF Guideline"). The DWAF Guideline serves as a guideline on how GN R 704 should be implemented and provides an explanation as to how GN R 704 is to be interpreted.

In explaining the interpretation of Regulation 9 of GN R 704, the DWAF Guideline provides that in terms of Section 19 of the NWA, as is discussed above, any person who undertakes any activity (whether existing or ceased), which causes, has caused or is likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring. Thus, before a mining or related activity is closed, whether temporarily or permanently, the necessary pollution control measures must be in place.

In terms of Regulation 2(2)(b) of GN R 704, any person in control of an existing mine or activity must notify the DWAF in writing 14 days before the temporary or permanent cessation of the operation of a mine or the conducting of an activity relating to the process of mining. Accordingly, any person in control of an existing mine must notify the DWAF 14 days before the closure of such mine. This notification enables the DWAF to inspect the relevant mine to ensure that the necessary water and pollution control measures are in place to protect the water resource.

4.1.5 National Forests Act 84 of 1998 ("NFA")

The NFA aims to, *inter alia,* promote the sustainable management and development of forests for the benefit of all and to promote the sustainable use of forests for environmental, economic, educational, recreational, cultural, health and spiritual purposes.

In terms of Section 12 of the NFA, the Minister of Water Affairs and Forestry ("the Minister of WA&F") may declare a particular tree a particular group of trees a particular woodland or trees belonging to a particular species, to be a protected tree, group of trees, woodland or species. A Notice of List of Protected Tree Species under the NFA was published under GN R 897 of 8 September 2006. The effect of this notice is that in terms of Section 15 of the NFA, no person may cut, disturb, damage or destroy any protected tree except under a licence granted by the Minister of WA&F. Accordingly, should the closure and rehabilitation of mined land involve the cutting, disturbing, damaging or destroying of any of protected trees species as identified in GN R 897 of 8 September 2006, as set out above, a licence in terms of Section 15 of the NFA will be required.

It is important to note that the NFA is not relevant only to the closure and rehabilitation of mined land but will apply throughout the lifetime of a mine, from commencement of mining operations to the closure and rehabilitation of mined land and will continue to be applicable beyond such closure and rehabilitation.

4.1.6 The National Heritage Resources Act 25 of 1999 (“The NHRA”)

The NHRA is the central legislation regulating the management of South Africa’s heritage resources. Its aim is to promote good management of the national estate, and to enable and encourage communities to nurture and conserve their legacy so that it may be bequeathed to future generations.

The national estate is defined in Section 3 of the NHRA and provides that those heritage resources of South Africa which are of cultural significance or other special value for the present community and for future generations must be considered part of the national estate and fall within the sphere of operations of heritage resources authorities.

It is important to note that the NHRA is not relevant only to the closure and rehabilitation of mined land but will find applicability through out the lifetime of a mine, from commencement of mining operations to the closure and rehabilitation of mined land and will continue to be applicable beyond such closure and rehabilitation. However, for the purposes of this document we have concentrated on the closure and rehabilitation of mined land.

- **National and Provincial Heritage Sites**

  In terms of Section 27 of the NHRA, the South African Heritage Resources Agency (“SAHRA”) and provincial heritage resource authorities may identify and declare places which have special national and provincial significance as national and provincial heritage sites. No person may destroy, damage, deface, excavate, alter, remove from its original position, subdivide or change the planning status of any heritage site without a permit issued by the heritage resources authority responsible for the protection of such site. That is to say, if the closure and rehabilitation of mined land involves such an aforementioned activity pertaining to a national or provincial heritage site, a permit in terms of Section 27 of the NHRA, issued by the heritage resources authority responsible for the protection of such site, will be required before the commencement of such activity.

- **Protected areas**

  Section 28(1) of the NHRA empowers the SAHRA to declare protected areas around a national heritage site with the consent of the owner of such land. Section 28(1)(c) of the NHRA specifically provides that the SAHRA may, with the consent of the owner, declare a mine dump as a protected area. Mine dumps are a special case because they may represent a historical feature in the landscape, but it is important to take note that it may be that the owner of the mine dump is not the owner of the land and in terms of Section 28 of the NHRA, the SAHRA, when declaring a mine dump as a protected area, must have the consent of the owner of the land and not the owner of the mine dump. Section 28(2) of the NHRA similarly provides that the provincial heritage resource authorities may, with the consent of the owner, declare protected areas around a provincial heritage site or around any archaeological or palaeontological site or meteorite.

The effect of the declaration of a protected area is that no person may damage, disfigure, alter, subdivide or in any other way develop any part of a protected area unless, at least 60 days prior to the initiation of such changes, he/she/it has consulted with the relevant heritage resources authority. Accordingly, should the mined land which is to be closed and rehabilitated occur on an area declared as a protected area in terms of Section 28 of the NHRA, consultation with the relevant heritage resources authority will have to be undertaken at least 60 days before commencing with any activities in respect of such protected area.

- **The Demolition of Structures**

  Section 34 of the NHRA must be read together with Section 44 of the MPRDA, as discussed above. Section 34 of the NHRA provides for the protection of immovable property by providing for a prohibition on altering or demolishing any structure or part of any structure, which is older than 60 years, without a permit issued by the relevant provincial heritage resources authority.

  Accordingly, should the closure and rehabilitation of mined land involve the altering or demolishing of any structure or part of any structure, which is older than 60 years, a permit issued by the relevant provincial heritage resources authority is required.

- **Archaeology, palaeontology and meteorites**

  Section 35 sets out the provisions pertaining to the protection of archaeological and palaeontological sites and material and meteorites. The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority, except wrecks in the territorial waters and the maritime cultural zone, the protection of which, is the responsibility of the SAHRA. In terms of Section 35(4) of the NHRA, no person may, without a permit issued by the responsible heritage resources authority:

  - destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;

  - destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

  - trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or

  - bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assists in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

Section 35(3) of the NHRA furthermore provides that any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

Accordingly, should the closure and rehabilitation of mined land involve an activity listed in terms of Section 35(4) of the NHRA, as set out above, in respect of any archaeological and palaeontological sites and material and meteorites, a permit in terms of Section 35 of the NHRA is required. Furthermore, any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of the closure and rehabilitation of mined land, must immediately report such discovery to the responsible heritage resources authority or to the nearest local authority offices or museum.

- **Burial Grounds and Graves**

Section 36 of the NHRA states that the SAHRA must conserve and generally care for burial grounds and graves protected in terms of the NHRA and it may make such arrangements for its conservation as it sees fit. SAHRA must furthermore identify and record the graves of victims of conflict and any other grave which it deems to be of cultural significance and may erect memorials associated with the graves referred to above and must maintain such memorials. In addition, Section 36(3) of the NHRA states that no person may, without a permit issued by SAHRA or a provincial heritage resources authority:

- destroy, damage, alter, exhume or remove from its original position or otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;

- destroy, damage, alter, exhume, remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; or

- bring onto or use at the burial ground or grave referred to above any excavation equipment or any equipment which assists in the detection or recovery of metals.

Section 36(6) of the NHRA furthermore states that, subject to the provision of any other law, any person who in the course of development or any other activity discovers the location of a grave, the existence of which was previously unknown, must immediately cease such activity and report the discovery to the responsible heritage resources authority:

Bearing the above in mind, should the closure and rehabilitation of mined land fall within the ambit of Section 36 of the NHRA pertaining to burial grounds and graves, a permit in terms of Section 36 of the NHRA will be required. Furthermore, should any person, during the closure and rehabilitation of mined land, locate a grave, the existence of which was previously unknown, such person must, in terms of Section 36(6) of the NHRA, cease all activities and immediately report such discovery to the responsible heritage resources authority.

- **Heritage Resources Management**

  Section 38 of the NHRA states that any person who intends to undertake developments categorised in this Section 38 of the NHRA must at the very earliest stages of initiating such development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development. The developments referred to in this Section 38 of the NHRA include:

  - the construction of a road, wall, power-line, pipeline, canal or other similar form of linear development or barrier exceeding 300 metres in length;

  - the construction of a bridge or similar structure exceeding 50 metres in length;

  - any other category of development provided for in regulations by SAHRA or the provincial heritage resources authority.

  Not all the developments are referred to in this guide and it is accordingly recommended that the developments categorised in the NHRA be considered prior to the undertaking of the activities associated with rehabilitation and closure in order to determine whether a Heritage Impact Assessment is required.

  Accordingly, from a strategic perspective, should the closure and rehabilitation of mined land involve the developments as are listed in Section 38 of the NHRA, set out above, the person who intends to undertake such developments must at the very earliest stages of initiating such developments, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development.

4.1.7 Conservation of Agricultural Resources Act 43 of 1983 ("the CARA")

The purpose of the CARA is to provide for the control over the utilisation of the natural agricultural resources of the Republic so as to promote the conservation of the soil, the water sources and the vegetation and the combating of weeds and invader plants.

Regulations were promulgated in terms of the CARA and published under GN R 1048 of 25 May 1984 ("GN R 1048"). Part II of GN R 1048 provides for the regulations pertaining to weeds and invader plants.

Regulation 15 of GN R 1048 provides for the declaration of weeds and invader plants, and these are set out in Table 3 of GN R 1048. Weeds are described as Category 1 plants, while invader plants are described as Category 2 and Category 3 plants.

In terms of Regulation 15A of GN R 1048, no Category 1 plants may occur on any land other than in biological control reserves[35], unless a written exemption has been granted by the executive officer[36]. If Category 1 plants do occur on any land, the person in control of such land must control such plants by means of the methods set out in Regulation 15E of GN R 1048, discussed below.

Similarly, no Category 2 plants may occur on any land other than a biological control reserve or a demarcated area[37], and no Category 3 plants may occur on any land other than a biological control reserve, unless a written exemption has been granted by the executive officer[38]. If Category 2 or Category 3 plants do occur on any land, the person in control of such land must control such plants by means of the methods set out in Regulation 15E of GN R 1048, discussed below.

In terms of Regulation 15E of GN R 1048, the methods for the control of the occurrence of Category 1, 2 or 3 plants includes the uprooting, felling, cutting or burning; treatment with weed killer registered for use in connection with such plants; biological control in accordance with legislation; or a combination of the aforementioned methods. Such methods must also be aimed at the propagating material and the re-growth of such plants.

Accordingly, the occurrence of any Category 1, 2 or 3 plants, as declared in terms of Regulation 15 of GN R 1048 and set out in Table 3 of GN R 1048, on mined land which is being closed and rehabilitated must be controlled by the methods provided for in terms of Regulation 15E of GN R 1048, unless a written exemption in terms of Regulations 15A, 15B or 15C of GN R 1048 has been granted by the executive officer.

It is important to note that the CARA is relevant not only to the closure and rehabilitation of mined land but will find applicability throughout the lifetime of a mine, from the commencement of mining operations to the closure and rehabilitation of mined land and will continue to be applicable beyond such closure and rehabilitation.

4.2 Legislation which may be Applicable to the Closure and Rehabilitation of Mined Land in the Future

4.2.1 National Environmental Management: Biodiversity Act 10 of 2004 ("The Biodiversity Act")

The Biodiversity Act was promulgated in June 2004 and its provisions have progressively been commenced with. The purpose of the Biodiversity Act is to provide for the management and conservation of South Africa's biodiversity within the framework of the NEMA so as to protect species and ecosystems that warrant national protection. The Biodiversity Act gives effect to ratified international agreements affecting biodiversity to which South Africa is a party, and which bind the Republic. The Biodiversity Act must be read together with the NEMA and in particular, must be guided by the principles set out in Section 2 of the NEMA, as set out above.

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35 Biological control reserve is defined in GN R 1048 as "*an area designated by the executive officer in terms of regulation 15D of the regulations for the breeding of biological control agents*".

36 An executive officer is defined in the CARA as the officer of the Department of Agriculture, designated as executive officer by the Minister of Agriculture in terms of Section 4 of the CARA.

37 Demarcated area is defined in GN R 1048 as "*an area of land approved by the executive officer in terms of regulation 15B of the regulations for the occurrence, establishment and maintenance of category 2 pants*".

38 Regulation 15B and 15C of GN R 1048 respectively.

While the Act has been promulgated and commenced with, no notices have as yet been published in terms of the Biodiversity Act and it is therefore not possible to identify those Sections in the Biodiversity Act which are applicable to the closure and rehabilitation of mined land, however, once the relevant notices have been published in terms of the Biodiversity Act, various sections of the Biodiversity Act may become relevant to various aspects during the closure and rehabilitation phase of mined land. Accordingly, we have set out below a brief discussion of the various sections of the Biodiversity Act which may find applicability to the closure and rehabilitation of mined land.

It is important to note that the Biodiversity Act is not relevant only to the closure and rehabilitation of mined land but will find applicability throughout the lifetime of a mine, from the commencement of mining operations to the closure and rehabilitation of mined land and will continue to be applicable beyond such closure and rehabilitation.

The Biodiversity Act provides for the publishing of various lists of species and ecosystems by the Minister responsible for national environmental management ("the Minister") as well as by the MEC responsible for the conservation of biodiversity of a province ("the MEC") in relation to which certain activities may not be undertaken without a permit.

- **Ecosystems**

  In terms of Section 52 of the Biodiversity Act, the Minister or the MEC may publish a list of ecosystems which are threatened and in need of protection and the Minister may, in terms of Section 53 of the Biodiversity Act identify any process or activity in such a listed ecosystem as a threatening process. Any threatening process so identified will be regarded as a specific activity contemplated in Section 24(2)(b) of the NEMA. Section 24(2)(b) of the NEMA provides that the Minister or the MEC may identify geographical areas based on environmental attributes in which specified activities may not be commenced with, without an environmental authorisation in terms of Section 24 of the NEMA[39], discussed above. Therefore, the commencing of a process or activity in an ecosystem listed in terms of Section 52 of the Biodiversity Act, which has been identified as a threatening process by the Minister in terms of Section 53 of the Biodiversity Act, as set out above, will require an environmental authorisation in terms of Section 24(2)(b) of the NEMA.

  As stated above, no notices identifying ecosystems or threatening processes in terms of the Biodiversity Act have as yet been published, however, it is important to bear in mind that when notices identifying ecosystems or threatening processes are published in terms of the Biodiversity Act, these may be applicable to the activities undertaken during the closure and rehabilitation of mined land. If the mined land which is undergoing closure and rehabilitation, falls within ecosystems identified in terms of Section 52 of the Biodiversity Act, and the activities undertaken during the closure and rehabilitation of mined land have been identified as "threatening processes" in terms of the Biodiversity Act, an environmental authorisation in terms of Section 24(2)(b) of the NEMA may be required before undertaking such threatening processes.

[39] The potential impact on the environment of the "specific activities" must be considered, investigated, assessed and reported on to the competent authority charged by this Act with granting the relevant environmental authorisation.

- **Endangered Species**

  In terms of Section 57 of the Biodiversity Act, no person may carry out any restricted activity involving any species which has been identified by the Minister as "critically endangered species", "endangered species", "vulnerable species" or "protected species"[40] without a permit. The Biodiversity Act defines "restricted activity" in relation to such identified species so as to include, but not limited to, hunting, catching, capturing, killing, gathering, collecting, plucking, picking parts of, cutting, chopping off, uprooting, damaging, destroying, having in possession, exercising physical control over, moving or translocating.

  The Minister has published a draft list of threatened and protected species in terms of section 56(1) for public information and comment in GN 151 in GG 27306 of 18 February 2005. It is important to bear in mind that once the relevant notices have been published, Section 57 of the Biodiversity Act may become applicable to certain activities undertaken during the closure and rehabilitation phase of mined land. For example, should the closure and rehabilitation of mined land involve a restricted activity, as defined in the Biodiversity Act, in respect of a species identified in terms of Section 56 of the Biodiversity Act, such as the translocation, damaging or uprooting of an endangered Fauna species, a permit in terms of Section 57 of the Biodiversity Act may be required.

- **Alien Species**

  Section 65 of the Biodiversity Act, provides that no person may carry out a "restricted activity" involving a specimen of an alien species without a permit and such a permit will only be issued after a prescribed assessment of risks and potential impacts on biodiversity is carried out. The Biodiversity Act defines *"restricted activity"* for the purposes of alien species so as to include, but not limited to, having in possession, having control over, conveying, moving or translocating. Section 66 of the Biodiversity Act, does however empower the Minister to exempt certain alien species from the requirement of permitting. That is to say, a person may carry out a "restricted activity" involving a specimen of an alien species without a permit if such specimen has been identified by the Minister in terms of Section 66 of the Biodiversity Act. Furthermore, Section 67 of the Biodiversity Act provides that the Minister may identify a list of alien species for which a permit may not be issued and restricted activities involving these alien species are totally prohibited.

  As was set out above, no notices in terms of the Biodiversity Act in respect of alien species have as yet been published, however, once the relevant notices have been published, the sections contained in the Biodiversity Act which regulate activities involving alien species may become applicable to the closure and rehabilitation of mined land. That is to say, any "*restricted activity*" undertaken in respect of an alien species, such as the occurrence[41] of an alien species on the mined land which is being closed and rehabilitated, may require a permit in terms of the Biodiversity Act, unless such alien species has been exempted from the permitting requirement in terms of Section 66 of the Biodiversity Act, or if such alien species has been

[40] Section 56 of the NEMBA
[41] "Occurrence" would fall within the ambit of "having in possession or having control over", and would accordingly fall within the definition of "restricted activity".

identified as an alien species for which a permit may not be issued, in terms of Section 67 of Biodiversity Act and restricted activities involving these alien species are totally prohibited.

- **Invasive Species**

  Section 71 of the Biodiversity Act provides that no person may carry out a restricted activity involving a specimen listed as an invasive species by the Minister or the MEC in terms of the Biodiversity Act[42], without a permit and such a permit will only be issued after a prescribed assessment of risks and potential impacts on biodiversity is carried out. For the purposes of listed invasive species, the Biodiversity Act defines *"restricted activity"* so as to include, but not limited to, having in possession, having control over, conveying, moving or translocation.

  As was set out above, no notices in terms of the Biodiversity Act in respect of invasive species have as yet been published, however, once the relevant notices have been published, the sections contained in the Biodiversity Act which regulate activities involving invasive species may become applicable to the closure and rehabilitation of mined land. That is to say, any "restricted activity" undertaken in respect of an invasive species, such as the occurrence[43] of an invasive species on the mined land which is being closed and rehabilitated, will require a permit in terms of the Biodiversity Act.

5. PART 4: ADMINISTRATIVE LAW AND ITS ASSOCIATION WITH THE CLOSURE AND REHABILITATION OF MINED LAND

5.1 Administrative Action

Administrative law is essentially concerned with administrative decision-making and environmental issues and conflicts frequently turn on the exercise of administrative decision-making powers. We have briefly set out below those provisions associated with administrative law which may be applicable to certain aspects of the closure and rehabilitation of mined land.

5.1.1 The Constitution

Section 33 of the Constitution states that:

"33 (1) Everyone has the right to administrative action that is lawful, reasonable and procedurally fair;
(2) Everyone whose rights have been adversely affected by administrative action has the right to be given written reasons;
(3) National legislation must be enacted to give effect to these rights, and must –
(a) provide for review of administrative action by a court or, where appropriate, an independent and impartial tribunal;
(b) impose a duty on the state to give effect to the rights in subsections (1) and (2); and
(c) promote an efficient administration".

42 Section 70 of the Biodiversity Act
43 "Occurrence" would fall within the ambit of "having in possession or having control over", and would accordingly fall within the definition of "restricted activity".

Any application for, for example, a closure certificate or an application for transfer of liabilities and responsibilities in terms of the MPRDA, or an application for any permit or authorisation in terms of any other legislation, that a corporate might submit must be considered by the relevant authority according to the criteria contained in Section 33 of the Constitution. Where the relevant authority has been given a discretion, that discretion must be exercised in a reasonable manner and without bias, prejudice or any personal agenda. The relevant authority must apply its mind to any such application and should they fail to do so, the decision may be set aside by way of an application to court or any internal procedures prescribed by the empowering legislation.

5.1.2 The Promotion of Administrative Justice Act 3 of 2000 ("The PAJA")

In line with the provisions of Section 33 of the Constitution, the PAJA was enacted in February 2000.

The purpose of PAJA as stated in its long title is:

> *"To give effect to the right to administrative action that is lawful, reasonable and procedurally fair and the right to written reasons for administrative action as contemplated in section 33 of the Constitution of the Republic of South Africa, 1996 ...."*

The PAJA provides a definition of administrative action. In summary, an action will qualify as administrative action under the PAJA if it is:

- A decision;
- Of an administrative nature;
- Made under an empowering provision;
- By an organ of state (or a private person when exercising a public power);
- That adversely affects rights;
- That has direct external legal effect;
- That is not specifically excluded by the list of exclusions in subparagraphs (aa) to (ii) of the definition of "administrative action".[44]

Administrative justice includes a right to be given reasons for decisions taken, procedural fairness and judicial review. The PAJA includes the specific right to reasons in Section 5 of the PAJA. Section 5 of the PAJA lays down the right to reasons in clear statutory terms and gives content to the fundamental human right contained in Section 33 of the Constitution. Section 6 of the PAJA deals with the right to judicial review.

5.1.3 Administrative Action in terms of the MPRDA

The MPRDA makes provision for a multi-tiered administrative framework. In terms of Section 6 of the MPRDA, subject to the PAJA, any administrative process or decision conducted or taken, as the case may be, under the MPRDA must be done within a reasonable period of time and in accordance with the principles of lawfulness, reasonableness and procedural fairness. Furthermore, Section 6(2) of the MPRDA provides that any such decision must be in writing and accompanied by reasons for such decisions.

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[44] De Waal, Currie, Erasmus: *"The Bill of Rights Handbook"*, 4th Ed, 2001, p 501

5.1.3.1 Internal Appeal Process

In terms of Section 7(2)(b) of the PAJA, no person may apply to court for the review of an administrative decision until that person has exhausted their remedies in terms of the Act in terms of which the administrative action was taken. Section 7(2)(b) of the PAJA provides that where a court is not satisfied that an internal remedy has been exhausted, it may direct the person to exhaust such remedy first before instituting judicial review procedures.
For example, section 96 of the MPRDA deals with appeals in terms of the MPRDA and provides that any person whose rights or legitimate expectations have been materially and adversely affected or who is aggrieved by any administrative decision, as defined above, under the MPRDA has the right to appeal in the prescribed manner. If the appeal is against an administrative action taken by the Regional Manager or an officer for the DME, the appeal must be directed to the Director-General of the DME, and if the appeal is against an administrative action taken by the Director-General for the DME, it must be directed to the Minister of M&E.

Section 96 of the MPRDA specifically provides that an appeal does not suspend the administrative decision, until it has been suspended by the Director-General for the DME or the Minister of M&E, as the case may be, and furthermore, no person may apply to court for the review of an administrative decision in terms of the MPRDA until that person has exhausted their remedies under section 96 of the MPRDA, that is to say, that a person must first lodge an appeal against an administrative action in terms of the MPRDA in terms of Section 96 of the MPRDA and should such a person still feel aggrieved by the administrative action appealed against after the consideration of such appeal by the Director-General for the DME or the Minister of M&E, as the case may be, such person may apply to court for a review of the relevant administrative action. It is submitted that just administrative action and the application of the appeal remedy where appropriate will also apply and available to decisions associated with closure and rehabilitation of mined land.

It is to be noted that other environmental specific legislation such as the NEMA (EIA – regulations referred to above) as well as the ECA, makes provision for administrative appeal proceedings.

5.1.3.2 Review by the Courts

As set out above, no person may apply to court for the review of an administrative decision until that person has exhausted their remedies under Section 96 of the MPRDA.

Any proceedings for judicial review in terms of Section 6 of PAJA must be instituted without unreasonable delay and not later than 180 days after the date:

- subject to certain provisos, on which any proceedings instituted in terms of internal remedies as contemplated above have been concluded; or
- where no such remedies exist, on which the person concerned was informed of the administrative action, became aware of the action and the reasons for it or might reasonably have been expected to have become aware of the action and the reasons.

The court in proceedings for judicial review may grant any order that is just and equitable. It follows that any administrative decision making process, such as the issuing of a closure certificate must be undertaken by the relevant government authority in terms of the legal principles associated with lawfulness, reasonableness and procedural fairness. If not, internal administrative appeal proceedings must be instituted where after judicial review proceedings can be considered.

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