Foreword

Planning for mine closure is a critical component of environmental management in the mining industry. Nationally and internationally, industry leading practice requires that planning for mine closure should start before mining commences and continue throughout the life of the mine until final closure and relinquishment. This approach makes for better environmental outcomes; it is also good business practice since it should avoid the need for costly remedial earthworks late in the project lifecycle resulting in less financial burden.

Recognising the importance of this issue, the Department of Mines and Petroleum (DMP) and the Environmental Protection Authority (EPA) have jointly prepared the *Guidelines for Preparing Mine Closure Plans*.

The objective of these guidelines is to ensure that, for every mine in Western Australia, a planning process is in place so the mine can be closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed post-mining outcomes and land uses, and without unacceptable liability to the State.

The information contained in the appendices is an integral part of the guidelines and should be referred to in the preparation of mine closure plans.

The draft guidelines have been approved by DMP and the EPA for stakeholder consultation.

Director General
Department of Mines and Petroleum

Chairman
Environmental Protection Authority

Contents

1. THE PURPOSE OF THESE GUIDELINES

These guidelines are designed for mining companies in Western Australia to assist in clarifying the information required for regulatory approval of mine closure plans.

Consistent with industry leading practice, the guidelines are based on the principle that planning for mine closure should be treated as an integral part of mine development planning and should start "up front" as part of mine feasibility studies, before mining begins. Closure planning is progressive and a Mine Closure Plan will continue to be adapted as necessary throughout the life of a mine.

The fundamental objective of these guidelines is to ensure that, for every mine in Western Australia, a planning process is in place so that the mine can be closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed post-mining outcomes and land uses, and without unacceptable liability to the State.

All Mine Closure Plans must present a convincing case that environmentally sustainable closure can be achieved. This is an essential requirement from the project approval stage onwards.

These guidelines provide a standardised set of instructions to mining companies detailing how DMP and the EPA expect mine closure plans to be structured and the type of information required in all plans, to enable DMP and the EPA to assess how mine closure is to be managed and to provide them with confidence that the proposed closure methods and outcomes are acceptable and achievable.

These guidelines also identify a number of serious concerns to government in regard to the closure of historic mines and closure management in current mining operations. Information is provided in these guidelines to inform and reinforce the need to deal with such issues in the initial mine feasibility and planning stages before mining commences. This will prevent these problems occurring or continuing in the future.

Both DMP and the EPA accept that closure planning is a complex process which takes time to develop the necessary detail for final closure. It may require flexibility to account for unexpected changes in operations, facilities and structures. However, both DMP and the EPA are seeking certainty in the delivery of closure outcomes supported by factual and reliable information.

Mine Closure Plans are living documents and will undergo on-going review, development and continuous improvement, from the beginning of project planning, throughout mining operations and up until closure. These guidelines outline the level of detail and content required in this process.

Considerable work has been published by government and industry on planning for mine closure both locally, nationally and internationally. The following references have been used extensively in preparing these guidelines:

- *Strategic Framework for Mine Closure*; Australian and New Zealand Minerals and Energy Council and the Minerals Council of Australia (ANZMEC/MCA 2000);
- *Mine Closure and Completion, Leading Practice Sustainable Development Program for the Mining Industry*; Department of Industry, Tourism and Resources (DITR 2006a);
- *Mine Rehabilitation, Leading Practice Sustainable Development Program for the Mining Industry*; Department of Industry, Tourism and Resources (DITR 2006b); and
- *Planning for Integrated Mine Closure: Toolkit*; International Council on Mining and Metals (ICMM 2008).

A list of definitions and terms used in the guidelines is provided in Appendix A.

2. OBJECTIVES FOR MINE CLOSURE PLANS

This section explains what is expected from mine closure planning and from Mine Closure Plans.

Proponents are expected to follow the principles and key objectives identified in the Strategic Framework for Mine Closure (ANZMEC/MCA 2000) and refer to the methodology and approaches described in the Leading Practice Sustainable Development booklets prepared by DITR (DITR 2006) and the Planning for Integrated Mine Closure: Toolkit prepared by ICMM (ICMM 2008) in the preparation of their Mine Closure Plans.

To develop a suitable Mine Closure Plan:

- **Planning for mine closure should start in the project feasibility stage (before mining commences) and should continue through the life of the mine up to final closure and relinquishment.**

- **Effective consultation should take place between proponents and stakeholders which should include acknowledging and responding to stakeholder's concerns. Information from effective consultation is central to closure planning and risk management.**

- **Mine closure plans must be project-specific and site-specific. Generic "off-the-shelf" closure plans will not be acceptable.**

- **Proposed post-mining land uses need to be identified and agreed upon through consultation before approval. This should also include consideration of possibilities for improved management of the wider landscape.**

- **Mine closure plans submitted for project approval and at subsequent stages need to make a convincing case that ecologically sustainable closure can be achieved without unacceptable liability to the State.**

- **Characterisation of materials needs to be carried out prior to project approval (ie in the project feasibility stage) to a sufficient level of detail to develop a workable and convincing closure plan. This is fundamental to effective closure planning. Characterisation of materials should include materials with potential to produce acid, metalliferous or saline drainage, dispersive materials, fibrous and asbestiform materials, and radioactive materials**

- **Closure planning must be based on risk assessment. The risk assessment process should be based on results of materials characterisation, data on the local environmental and climatic conditions, and consideration of potential contaminant pathways and environmental receptors.**

- **Closure planning must be based on continuous improvement. Closure plans submitted at project approval stage should identify relevant experience and research, lessons learned from that experience and research, and how these have been applied.**

- **Continuous improvement depends on record keeping and retention of corporate knowledge. Closure plans should demonstrate that appropriate record keeping systems are in place.**

The following diagram (Figure 1) is provided to assist the proponent, DMP and the EPA assessors in evaluating if the Mine Closure Plan meets these objectives, either before the proponent submits the Mine Closure Plan or before DMP or the EPA accept the Mine Closure Plan for assessment.

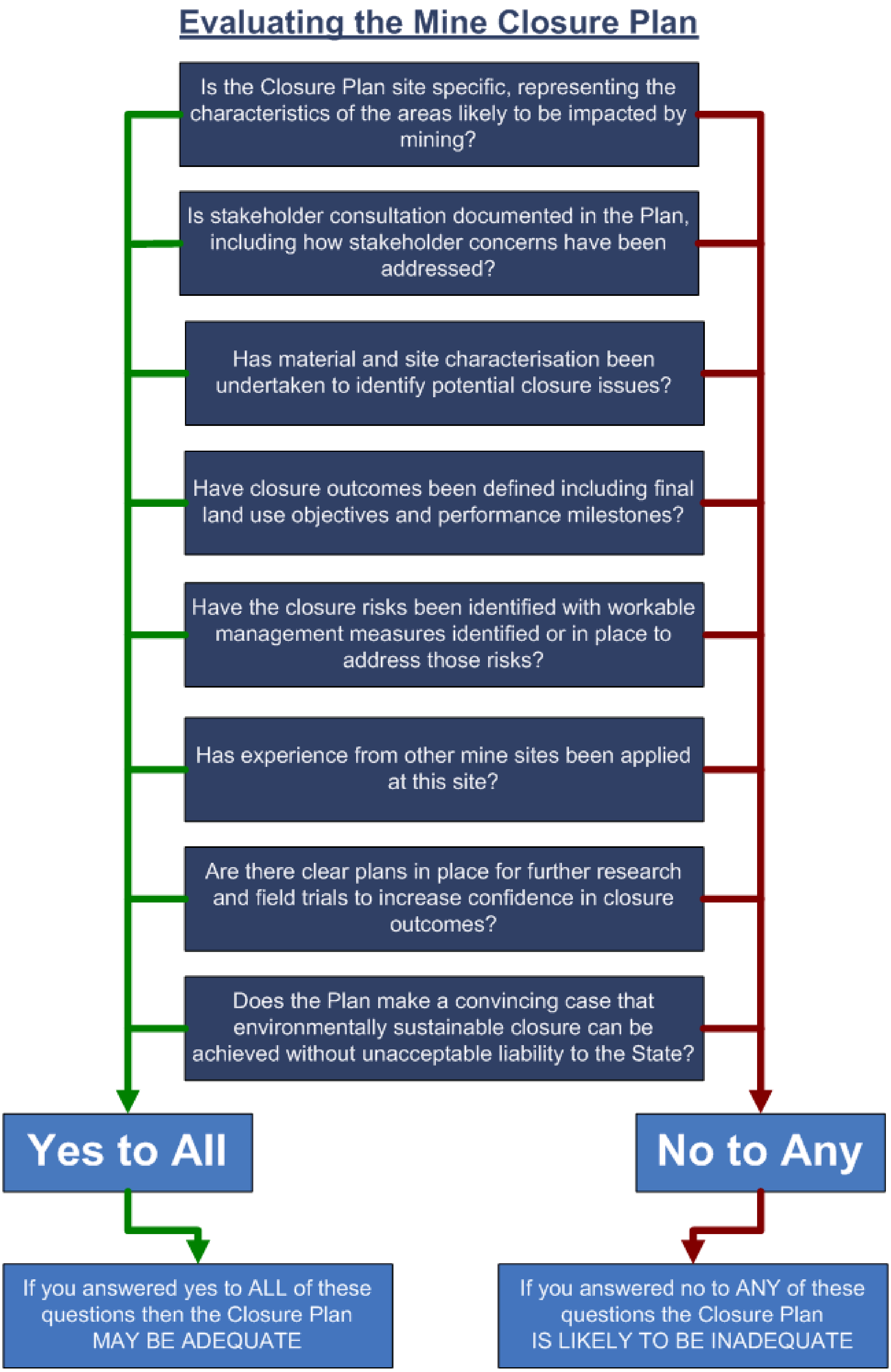

Figure 1: Mine Closure Plan Evaluation Process

3. REGULATORY APPROVAL PROCESSES

The following sections describe how the requirements for Mine Closure Plans will be dealt with by government.

3.1 Key regulators

DMP is the lead regulator and decision-making authority for mining projects in Western Australia under the *Mining Act 1978*. DMP also has an advisory role in relation to the environmental management aspects of mines which are regulated under State Agreement Acts and/or the *Environmental Protection Act 1986*.

The EPA is the Government's chief advisor on environmental issues and is responsible for carrying out environmental impact assessment (EIA) of significant proposals under Part IV of the *Environmental Protection Act 1986*.

The Department of State Development administers State Agreement Act projects. Some of these projects are not administered under the *Mining Act 1978.*

3.2 New mining proposals/projects

In 2010 amendments to the *Mining Act 1978* provide for the requirement of a Mine Closure Plan to be submitted to DMP for approval as part of the Mining Proposal application. The Mine Closure Plan must be prepared according to these guidelines and must be reviewed on a tri-annual basis or as determined by DMP. DMP then has the role of regulating the industry to ensure the closure conditions applied and commitments made are implemented during the life of the mining project.

Where a mining proposal has the potential for significant environmental impacts, DMP is required to formally refer the proposal to the EPA. The EPA will then make a decision as to whether the proposal requires a formal environmental impact assessment (EIA). Following the EPA decision, a Mine Closure Plan is prepared according to these guidelines and is required to be submitted as part of the EIA documentation.

Projects not subject to the *Mining Act 1978* usually undergo formal assessment by the EPA under Part IV of the *Environmental Protection Act 1986.* The EPA will now require a Mine Closure Plan prepared according to these guidelines as part of the EIA documentation for new mining proposals if assessed.

Current approval processes and procedures in place for the assessment and approval of Mining Proposals (and EIA documents) will apply to Mine Closure Plans submitted as part of these documents.

For proposals subject to public environmental impact assessment by the EPA, DMP and the EPA will ensure that parallel processing is carried out to avoid unnecessary delays. It is important that proponents consult with both DMP and the EPA throughout this process as each agency may require additional or different information on specific aspects of the proposal relevant to their jurisdiction.

Mine Closure Plans that fail to provide the necessary information or requirements specified in these guidelines will not be accepted by DMP or the EPA, and could result in a delay in the assessment and approval of a mining proposal.

3.3 Existing mining proposals

For an existing mining proposal or Notice of Intent (NOI) that was approved under the *Mining Act 1978*, DMP will require a Mine Closure Plan prepared according to these guidelines to be submitted when an addendum to the approved mining proposal/NOI is submitted, or by October 2013, whichever comes first, unless otherwise specified in writing by DMP.

For an existing mining proposal that is not administered under the *Mining Act 1978* (such as Pre-1899 Title (minerals to owner), Hampton lands or State Agreement Act projects), any requirement for a Mine Closure Plan will be subject to Ministerial Conditions imposed under Part IV of the *Environmental Protection Act 1986*, or those imposed under the respective State Agreement Act.

Where inconsistency occurs, the requirements of a Mine Closure Plan and its review under Part IV of the *Environmental Protection Act 1986* will take precedence over the requirements under other statutes.

3.4 Low Impact Mining Operations

Low impact mining operations (LIMOs) are small scale operations that have a minimal or low impact upon the environment. The level and detail of information required to assess the environmental impact of these operations is much less than that required for a typical mining operation. To accommodate the reduced information requirements of these operations, DMP has produced a LIMO pro forma and a LIMO Closure Plan pro forma.

It is essential for proponents to contact the relevant DMP environmental officer for the mineral field (Appendix B) in which the mining operation is proposed for advice on whether the intended operation can be classified as a LIMO and whether the pro forma forms can be used to submit the mining proposal and the associated closure plan.

The contacts for environmental officers for particular mineral fields can be found on the Environmental Regional Inspectorate Map at:

http://www.dmp.wa.gov.au/documents/ED_InspectorateMapSeptember2010.pdf

3.5 Review of and changes to approved Mine Closure Plans

All Mine Closure Plans approved by Government will require regular review over the life of the project. The *Mining Act 1978* requires a review every three (3) years or as specified in writing by DMP. For projects subject to formal EIA, the Mine Closure Plan must be reviewed in accordance with conditions of approval under the *Environmental Protection Act 1986*, particularly in relation to public access to documents.

Any significant change to an approved Mine Closure Plan, such as changes to post mining land use options and their closure objectives, or significant changes to an approved mining proposal, must be submitted in writing for approval by DMP or the Minister for Environment. The existing government processes and procedures to deal with changes to an approved mining proposal will apply to changes to an approved Mine Closure Plan.

Any minor change or further refinements to an approved Mine Closure Plan must be reported and explained in an Annual Environmental Report or the updated Mine Closure Plan submitted for review.

3.6 Tenement Relinquishment

Proponents should be aware that under s114B of the *Mining Act 1978* the tenement holder may retain liability for environmental impacts caused by the project after the tenement has been relinquished.

It should be noted that the *Contaminated Sites Act 2003* requires that appropriate investigations be carried out to identify, assess and manage any contaminated site before tenement relinquishment. This Act also has enduring powers relating to the operator or tenement holder causing contamination.

A “Closure Notice” may be issued under Part V of the *Environmental Protection Act 1986* to require monitoring, reporting and active management of a decommissioned facility after a licence has ceased to have effect. This would apply particularly to tailings storage facilities.

Although the guidelines do not cover the safety obligations required under the *Mines Safety and Inspection Act 1994*, mine operators need to take into account the requirements of sections 42 and 88 of this Act relating to mine suspension or abandonment in the closure planning process.

3.7 Submission of Mine Closure Plans

Directions on how to submit a Mine Closure Plan to DMP or the EPA, and a flow diagram on its approval processes are shown in Appendix C.

3.8 Public Availability of Documents

Mine Closure Plans submitted as part of the Mining Proposal application, and the reviewed Plans will be made available to the public after they have been assessed and approved by DMP.

Mine Closure Plans submitted to the EPA as part of the EIA document, or in accordance with the approval condition under Part IV of the *Environmental Protection Act 1986* will be subject to the public access provided under this Act.

4. KEY STAGES FOR MINE CLOSURE PLANNING

Planning for mine closure should be treated as an integral component of operations planning (ANZMEC/MCA 2000), as operational decisions made during the mine planning process have the potential to impose significant impacts on rehabilitation and mine closure outcomes. Mine closure planning needs to be adaptive to accommodate new information/practices and the different stages of the life of a mine (Figure 2).

Mine closure planning must include strategies and contingency plans to identify how unplanned or temporary closure of mining operations will be managed. This will provide the mine operators with the ability for timely evaluation of the unknowns and risks associated with closure and develop an appropriate plan, such as Decommissioning Plan or Care & Maintenance Plan (ICMM 2008).

The Mine Closure Plan is an essential management tool to the industry in mine closure planning. Progressive development of a Mine Closure Plan through the mine lifecycle is critical to the successful implementation of mine closure plans. The Plan is a dynamic document and will be progressively refined over time, through a process of continuous improvement. Regular review and update of the Mine Closure Plan is seen as essential to ensure detail in the Plan reflects current knowledge and is updated as new information becomes available.

The four key stages in mine closure planning, as shown in Figure 2 are:

- Project Approval Stage
- Operational Stage
- Decommissioning Stage
- Closure Completion Stage

A brief description of the key activities to be undertaken at these closure planning stages is provided in the following sections (DITR 2006a).

Project Approval Stage:

This is the most important stage for mine closure planning. The early consideration of mine closure in the project feasibility phase is essential to plan and design a project to avoid or minimise adverse environmental impacts and potentially reduce the cost of rehabilitation and environmental management at closure. Project approval is often sought during the feasibility stage, adding additional reason to plan for mine closure early in the process to enable submission with the mining proposal.

Proponents are expected to undertake the following key activities during this early stage of the closure planning process

- Identify and engage with stakeholders and regulators to demonstrate the inclusion of stakeholder input in development of the Plan
- Identification and assessment of land use options and opportunities

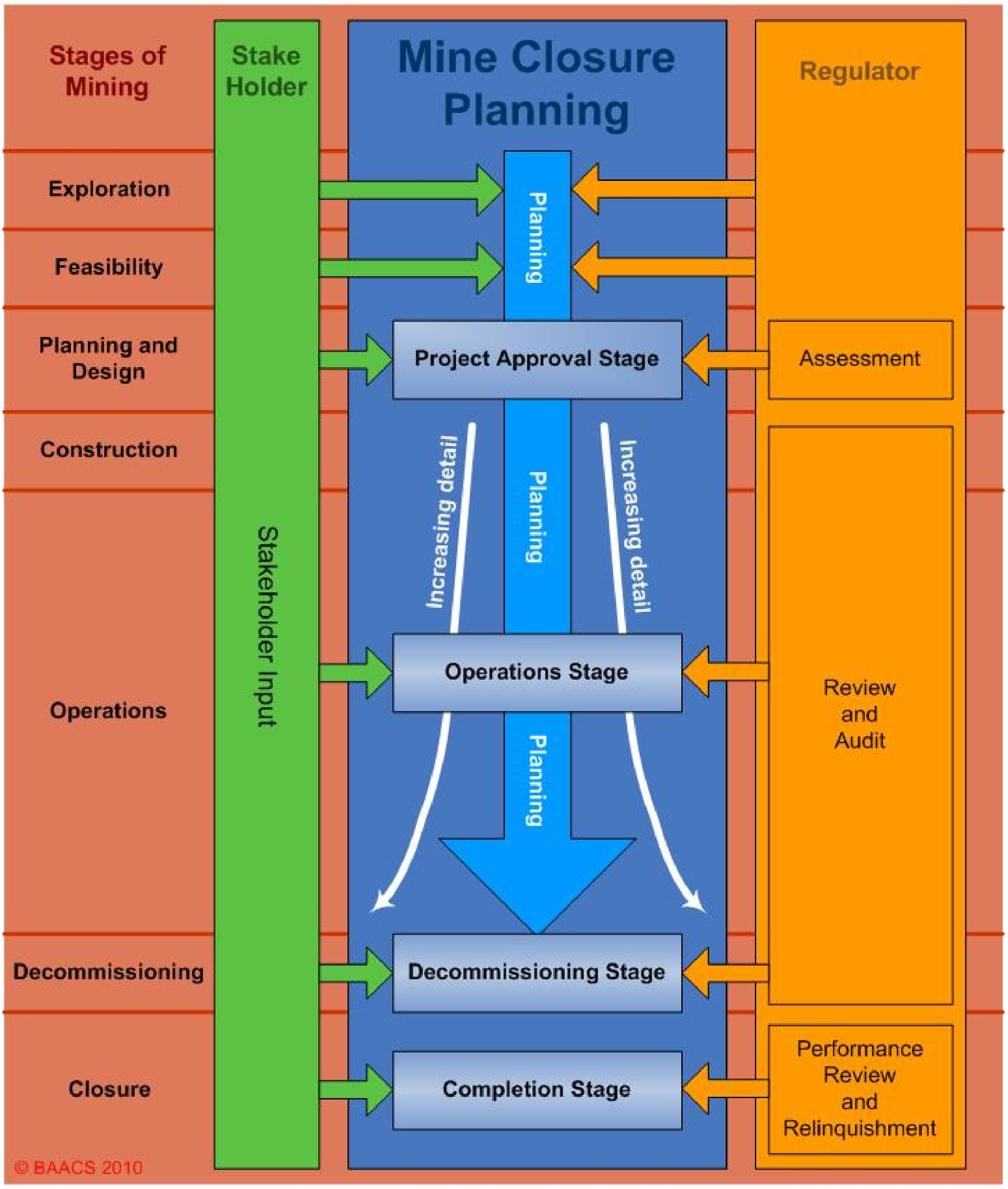

Figure 2: The Relationship between Stages of Mining and Mine Closure Planning

- Collection and analysis of environmental baseline data including surface and ground water quality and quantity, soil types, vegetation types, fauna habitat and meteorological data affecting closure outcomes
- Preliminary assessment and characterisation of materials including static and kinetic testing for acid-based accounting and metals leaching
- Estimate of closure costs

The Mine Closure Plan prepared at this stage enables DMP and the EPA to understand the issues that require management at closure. DMP and the EPA must be confident that all relevant issues have been identified and have been adequately addressed in the plan.

Operational Stage

DMP and the EPA expect operators to plan for and undertake progressive rehabilitation during mining operations to reduce the final closure liability and provide the opportunity to test, develop and refine rehabilitation and closure methodologies prior to actual closure. Where progressive rehabilitation is not possible then rehabilitation methods should be trialled and tested during this stage to demonstrate closure outcomes can be achieved. It is expected the process will reflect that developed by the ICMM (ICMM 2008).

At this stage, proponents are expected to undertake the following activities:

- Further analysis and review of residual risk
- Refinement and definition of management domains
- Addition of detailed closure plans for each domain
- Detailed scheduling of waste rock and other materials to meet the objectives of the closure plans
- Outcomes of ongoing stakeholder consultation
- Refinement of:
  - closure outcomes and goals
  - methodologies to achieve closure outcomes and goals
  - Completion criteria and performance indicators
  - Performance milestones
- Closing of knowledge gaps
- Preparation of detailed decommissioning, remediation, land forming, rehabilitation, monitoring and maintenance plans.
- Review and update of closure costs

In operations that extend over more than three years the following detailed plans should be prepared and submitted at least two years prior to planned closure:

- Decommissioning plant and infrastructure
- Final landforms and drainage structures
- Rehabilitation
- Closure monitoring and maintenance

Short term projects (three years or less) must provide this information at the project approval stage.

Decommissioning Stage

This is the stage where the Mine Closure Plan is implemented to deliver the closure outcomes. Activities undertaken during this stage include:

- The demolition and decommissioning of plant and infrastructure
- Remediation of contaminated areas in compliance with the requirements of the *Contaminated Sites Act 2003*
- Construction of final landforms and drainage structures
- Completion of rehabilitation
- Commence monitoring and measurement against completion criteria.
- Ongoing consultation with stakeholders
- Handover of infrastructure requested by other parties
- Finalise the post closure monitoring and maintenance program

Closure Completion Stage

This is the final stage and is the commencement of post closure performance monitoring and maintenance against the agreed outcomes and closure criteria. DMP and the EPA will seek evidence that outcomes and closure criteria are being met and reporting where maintenance and management intervention has been required should aspects of the closure fail to meet the required standards.

Where agreed outcomes have been met securities may be progressively returned[1] and consideration given to relinquishment of tenure. Stakeholder involvement in these processes is essential at this stage to ensure the agreed outcomes are achieved or where necessary outcomes may be reviewed.

It is likely to take significant time from mine closure to achieving relinquishment, therefore, is it important that provision should be made in closure planning for an adequate period of maintenance and monitoring. Of particular importance is the development of support mechanisms for the maintenance and monitoring phase, when operational support (accounting, maintenance, earthmoving equipment, etc) are no longer readily available (ANZMEC/MCA 2000).

Relinquishment may require the transfer of ownership to other parties, the mine operator/tenement holder will be required to demonstrate that all parties with a stake in the process have been involved, are in agreement with the transfer and understand their responsibilities and liabilities associated with the transfer.

5. CONTENT AND STRUCTURE OF A MINE CLOSURE PLAN

At all stages, from the project approval stage onwards, the Mine Closure Plan must make a convincing case that ecologically sustainable mine closure can be achieved without unacceptable liability to the State. Closure should not lead to regulators or the community having to take on responsibility for ongoing management, maintenance or monitoring.

The Mine Closure Plan must be comprehensive and pertinent and must be accompanied by site plans (surveyed), aerial photographs, and appendices with detailed information supporting the plan.

[1] Details of the management of bonds and securities are available on the DMP website (www.dmp.wa.gov.au).

Where a Mine Closure Plan is submitted as part of a Mining Proposal or an EIA document, to remove duplication, cross references can be made in the plan to the relevant closure information provided in the Mining Proposal or in the EIA.

DMP and the EPA require the Mine Closure Plan to be structured in the following format:

1. Cover Page
2. Checklist with corporate endorsement
3. Project Overview
4. Identification of Legal Obligations
5. Stakeholder Consultation
6. Closure Risk Assessment and Management
7. Collection of Closure Data
8. Post-Mining Land Use and Closure Objectives
9. Development of Completion Criteria
10. Closure Implementation Programs
11. Closure Costing
12. Decommissioning
13. Closure Monitoring and Maintenance
14. Management of information and data

5.1 Cover Page

The cover page must include:

- Project Title
- Company Name
- Contact Details
- Document ID and version number
- Date of submission
- Endorsement of company executive officer

5.2 Mine Closure Plan Checklist

DMP has prepared a checklist for a Mine Closure Plan which is designed to assist the proponent to ensure that all required information has been provided and to enable an efficient and accurate assessment without the need for the assessing officer to seek further information or clarification. If critical issues have not been adequately addressed in the Mine Closure Plan the assessment may be discontinued and the Mine Closure Plan returned.

The checklist provided in Appendix C must be completed with corporate endorsement and placed after the title page of the Mine Closure Plan document. If the checklist is incomplete or is found to be incorrect the Mine Closure Plan will not be accepted for assessment.

5.3 Project Summary

This section provides background information on the history and status of the project including proposed and/or existing mining operations. This information is necessary where the Mine Closure Plan is a stand alone document.

Required information includes:

- Land ownership including occupancy, mining tenure, postal and site address, and contact details
- Location of the operation, including the location of the mine in relation to the local and regional setting with maps and a list of tenements
- An overview of the operations and description of the major mine components and operation
- A comprehensive site plan for identification of all disturbed areas, tenement boundaries and proposed or existing disturbance types within each tenement (coloured aerial photos with an overlay of tenement boundaries and disturbance types are preferred)

5.4 Identification of Legal Obligations

All legal obligations relevant to rehabilitation and closure at a given mine site must be identified and provided in a tabulated format, usually referred to as a Legal Obligations Register. An example template for the Register is provided in Appendix D.

The Register must include legally binding conditions and commitments and/or legal obligations applicable under relevant State and Federal legislation. The Register must also include references to individual tenement conditions, Mining Proposals, Notices of Intent, Letters of Intent, Programmes of Work, Ministerial Statements, Commitments, licence conditions and all other legally binding documents.

The Register may include the safety obligations and non-legally binding commitments pertaining to closure.

The Register provides a valuable tool when setting closure criteria, as environmental commitments can be cross referenced. Compliance with closure conditions is an absolute requirement for government sign off before relinquishment. At closure this tool can be used as a checklist to demonstrate that all conditions, commitments and obligations have been met.

5.5 Stakeholder Consultation

Stakeholder identification and on-going consultation are key components of the mine closure process. Early engagement in this process enables companies/operators to better understand and manage the stakeholders' expectations and the potential risks associated with closure.

The consultation process must follow the five ANZMEC/MAC 2000 principles:

- Identification of stakeholders and interested parties is an important part of the closure process
- Effective consultation is an inclusive process which encompasses all parties and should occur throughout the life of the mine
- A targeted communication strategy should reflect the needs of the stakeholder groups and interested parties
- Adequate resources should be allocated to ensure the effectiveness of the consultation process
- Wherever practical, work with communities to manage the potential impacts of mine closure

For the purpose of the guidelines, the term "stakeholders" include both internal and external stakeholders who are likely to affect, to be affected or to have an interest in mine closure planning and outcomes. The internal stakeholders must include mine managers, mine planners, engineers and relevant staff. The external stakeholders must include the government (such as regulatory agencies, local authorities), land managers/owners (such as private land holders, indigenous land holders, lease holders, Pastoral Lands Board, State land managers), local community members or groups and interested Non-Government Organisations (NGOs).

The Mine Closure Plan must contain sufficient information to demonstrate that an effective communication strategy has been in place and meaningful engagement has taken place to identify mine closure issues and risks and how these can be managed at different stages of mine closure planning. Recognising that effective communication is a necessary ingredient for effective risk management, the Minerals Council of Australia developed a set of recommended principles and approaches to risk communication specifically for the mining industry (MCA, 2008). Such a risk communication framework and principles can be applied to the management of risks associated with mine closure.

It is important that all stakeholders have their interests and concerns considered, and the key stakeholders have an opportunity to provide feedback on the response or proposed action to address their interests and concerns.

Written acknowledgement by current and/or future land owners/managers that they have been consulted in the preparation of the Mine Closure Plan being submitted must also be provided.

The stakeholders' interests/concerns must be captured in the development of the plan particularly in the process to determine post-mining land use, closure objectives and outcomes (sections 5.8 and 5.9). Failure to undertake an effective consultation program will compromise the approval process and mine closure outcomes.

Appendix E provides an example of a Stakeholder Consultation Register.

5.6 Closure Risk Assessment and Management

A large number of risk assessment and management frameworks already exist, many of which are utilised by the mining industry.

The Risk Management Standard developed by the Council of Standards of Australia and New Zealand (AS/NZS 31000:2009) and the *Environmental Risk Management – Principles and Process* (HB 203:2006) provide key processes and principles to identify, assess, manage and review risks.

The risk standards require communication and consultation with internal and external stakeholders as appropriate all the way through the risk assessment and management process. More detail on application of the risk standards to mining and mineral processing operations is provided in the Leading Practice Handbook (DITR 2008) and summarised in Appendix G.

The International Council on Mining & Metals guideline on *Planning for Integrated Mine Closure: Toolkit* (ICMM 2008) identifies a number of useful techniques for undertaking a risk (and opportunity) assessment.

Undertaking a risk based approach to mine closure reduces both cost and uncertainty in the closure process (ANZMEC/MCA 20000). The benefits of a risk based mine closure process include:

- Early identification of potential risks to successful closure;
- Development of acceptable and realistic criteria to measure performance;
- Orderly, timely and cost-effective closure outcomes;
- Reduced uncertainty in closure costs; and
- Continual improvement in industry rehabilitation standards (e.g. cover design, and management of AMD, erosion and seepage).

A structured risk assessment framework and a meaningful stakeholder consultation process enables identification early in the planning process of mine closure risks and opportunities associated with closure. This will allow robust assessment and review of closure designs in the years leading up to closure (G. Bentel *et al* 2003). The outcomes of the risk/opportunity assessment conducted during the project approval stage can be used to identify potential issues that could elevate closure risks, so strategies and mitigation measures can be developed to control such risks (ICMM 2008).

Some key closure issues currently facing government include, but are not limited to the management and control of:

- Hazardous materials;
- Hazardous and unsafe facilities;
- Contaminated sites;
- Acid drainage;
- Metalliferous drainage,
- Radioactivity;
- Asbestiform and other fibrous minerals;
- Non-target metals and target metal residues in mine wastes;
- Mine pit lakes;
- Adverse impacts on surface and groundwater quality;
- Dispersive and sodic materials;
- Dust emissions;
- Flora and fauna diversity/threatened species;
- Visual amenity; and
- Heritage Issues.

Detailed guidance on how to identify and manage these issues is widely available, supported references include the leading practice handbooks on mine rehabilitation and mine closure and completion (DITR 2006a & 2006b). Further information from DMP and the EPA on some of the key issues (acid and metalliferous drainage, mine pit lakes, radioactivity, dispersive materials and rehabilitation) is provided in Appendix H.

The Mine Closure Plan must demonstrate to DMP and the EPA that all closure associated risks are being effectively managed as appropriate at each stage of the closure planning process (Section 4). The Plan must provide adequate information on the process, methodology and outcomes of the risk assessment and management undertaken to identify the key closure issues, their potential environmental impacts, likelihood and consequence, risk ranking, mitigation measures and management of residual risk. The outcomes should be presented in order of risk ranking in table format and included as an appendix with the major risks and management mitigation measures summarised in the text. All key stakeholder concerns need to be incorporated into the risk table.

Depending on the complexity of the project this may be done across the whole project or broken down into domains (Appendix I).

5.7 Collection of Closure Data

Environmental Data

Information from baseline studies undertaken prior to the commencement of mining operations is required to provide the information necessary to:

- Establish achievable closure outcomes and goals in a local and regional context;
- Establish baseline conditions for closure monitoring programs, including the identification of control and reference sites;
- Identify the issues to be managed through the mine closure process.

It is important that the collection of pre-mining environmental data is continued and expanded throughout the project life to cover the spatial and temporal variations in the surrounding environment. These data assist in the setting of trigger values for management intervention, and the refinement of closure objectives and completion criteria (DITR 2006b).

The Mine Closure Plan must provide a summary of details on the physical and biological environment that can challenge or compromise mine closure outcomes, including the following information:

- Local climatic conditions and projected future climate change for the area
- Local environmental conditions –topography, geology, hydrogeology, seismicity and geotechnical data
- Local and regional information on flora, fauna, ecological communities and their habitats
- Local water resources details – type, location, extent, hydrology, quality, quantity and environmental values (ecological and beneficial uses)
- Soil and waste materials characterisation – solubility, mobility and bioavailability of hazardous materials (heavy metals, radioactive substances), soil structure and erodibility, growth medium type and block modelling of waste materials.

As discussed in section 5.6, there are a number of issues that continue to challenge effective closure. The EPA and DMP require that sufficient work is undertaken prior to mine commencement to ensure that all key environmental issues and workable management machanisms relevant to mine closure are identified in the early phases of the life of the mine.

Other Closure related Data

Other available information should be collated with the objective of building a ‘base’ of information important to the rehabilitation and closure of a particular landform or infrastructure. Information may include, but not be limited to, spatial datasets and databases, design and construction of landforms and voids, mathematical models to predict long term performance or environmental impacts, learning from experience in closure of other mines, seed mixes used in rehabilitation and any information on trials. All technical reports are to be provided as appendices.

Knowledge Gaps

Identifying and understanding available information and knowledge pertinent to the project, and using this information to identify knowledge gaps are a critical element in closure planning (ICMM 2008). Once all the closure related information for each domain or feature has been obtained, the next step is to review the information and identify any 'information gaps' that still exist, which may potentially result in unsuccessful rehabilitation and closure. As each gap is identified, the risk associated with not closing the gap should also be investigated and documented. This will enable the gaps to be prioritized and acted upon accordingly.

5.8 Agreed Post-mining Land Use and Closure Objectives

The Mine Closure Plan must identify post-mining land use options and should set out site-specific closure objectives consistent with these land use options. The land use options and closure objectives can be broadly identified upfront at the project planning phase (see Figure 1) and further defined in the stakeholder consultation process. The land use options must be:

- Relevant to the environment in which the mine will operate;
- Acceptable to stakeholders before progress can be made on defining closure objectives and outcomes; and
- Sustainable within the local and regional environment.

Proponents are encouraged to consider applying resources to achieve improved land management and ecological outcomes on a wider landscape scale, and to take into account the following hierarchy in the consultation process to determine agreed post-mining land use options:

1. Reinstate "natural" ecosystems as similar as possible to the original ecosystem.
2. Develop an alternative land use with higher beneficial uses than the pre-mining land use.
3. Reinstate the pre-mining land use.
4. Develop an alternative land use with other beneficial uses than the pre-mining land use.

Closure objectives must be developed based on the agreed land use option(s) and, be as specific as possible to provide a clear indication to government and the community on what the proponent commits to achieve at closure. The ability to specify closure objectives will depend on the amount and quality of the environmental data collected at the time. Therefore it is essential that adequate baseline data, including materials characterisation is available for this purpose.

As a general guide, the Government's broad closure objectives are physically safe to humans and wildlife, geo-technically stable, geo-chemically non-polluting, and capable of sustaining an agreed post-mining land use. Appendix J provides some examples of closure objectives.

The agreed land use option(s) and closure objectives then establish the basis for developing completion criteria and performance indicators (Section 5.9).

Once established and agreed to, the land use option(s) and closure objectives will form the basis on which the EPA and DMP approve a mining proposal. Where variations to these objectives are proposed subsequent to the environmental approvals of the project, the proponent must submit a request to the EPA and/or DMP supported by suitable evidence to justify the proposed changes. These changes may be considered by DMP and/or the EPA to be a substantial change to the originally approved project or mining proposal if they have the potential to significantly compromise the intent and objectives of the mine closure outcomes (section 3).

5.9 Development of Completion Criteria

Completion criteria are required in the Mine Closure Plan to provide the basis on which successful rehabilitation and mine closure is determined, and must be developed in consultation with stakeholders, particularly regulators. Accordingly completion criteria should be (ANZMEC/MCA 2000):

- Specific enough to reflect a unique set of environmental, social and economic circumstances;
- Flexible enough to adapt to changing circumstances without compromising objectives;
- Include environmental indicators suitable for demonstrating that rehabilitation trends are heading in the right direction;
- Undergo periodic review resulting in modification if required due to changed circumstances or improved knowledge; and
- Based on targeted research which results in more informed decisions (EPA, 2006).

In developing completion criteria the proponent must identify criteria that reflect the designs of final landforms and voids, and upon being met, will demonstrate successful rehabilitation and closure of a site. The final landforms and voids and rehabilitation of infrastructure must be designed in the context of the agreed land use and closure objectives (section 5.8). The completion criteria must include performance indicators to demonstrate that rehabilitation trends are following the predicted performance, particularly where mathematical modelling is utilised to predict any long term environmental impact. Details on the mathematical modelling including assumptions and limitations must be provided as an appendix to the Mine Closure Plan.

The completion criteria and associated performance indicators must be outcome based (EPA 2009), as well as being Specific, Measurable, Attainable, Relevant and Time specific (SMART) to allow an objective measurement of success, and provide certainty for reporting and auditing to define rehabilitation endpoints (EPA, 2006).

Completion criteria and performance indicators must be developed up-front in the project approval stage, then reviewed and refined throughout the development and operation of the project to ensure they capture changes to mining operations, environmental standards, technology and community expectations and respond to monitoring and research information. Indicative completion criteria may be accepted by DMP and the EPA in the project approval stage, when it is not possible or practicable to obtain detailed information, providing that they are based on site-specific data and address the minimum closure requirements.

Some example of completion criteria are provided in Appendix K.

Once established and agreed to by the key stakeholders, completion criteria and performance indicators will form the basis on which mine closure performance is measured and reported to government and the community. Where variations to the completion criteria/performance indicators are proposed subsequent to approval of the Mine Closure Plans, the proponent must document the proposed change together with suitable justification in the subsequent Annual Environmental Report and/or Mine Closure Plan to be submitted to DMP or the EPA (section 3).

5.10 Closure Implementation

The Mine Closure Plans must contain a summary of closure implementation strategies and activities for the whole site or project, and Closure Implementation Programs or work programs for each closure domain and/or feature. This level of information will enable the operator to focus on identifying the requirements for each aspect of the operation, and assist in identifying potential knowledge gaps and ensure adequate lead time to investigate these gaps.

The Implementation Programs must set specific objectives and closure outcomes for each domain and/or feature, and a schedule of activities for research and trials, progressive rehabilitation, unexpected or unplanned closure, decommissioning and performance monitoring for each domain or feature.

A Closure Implementation Program must include but not be limited to the following information:

- Description of domain and/or feature (including area of disturbance, status, estimated closure date);
- Agreed final land use objectives;
- Closure completion criteria and performance indicators;
- Closure material sources;
- Information gaps;
- Research and trials activities and timing;
- Progressive Rehabilitation activities and timing;
- Unexpected or unplanned closure activities;
- Decommissioning activities and timing;

- Performance monitoring activities and timing;
- Contaminated sites remediation activities; and
- Post closure maintenance activities.

The availability and volumes of certain materials such as competent waste rock, subsoil, topsoil and low permeability clays (i.e. encapsulation material) must be identified in the work programs. Measures to ensure these resources are appropriately managed to ensure their availability when required for rehabilitation must also be provided.

Although practical planning for unplanned or temporary closure (under Care and Maintenance) cannot be done in detail, consideration must be given for how a company plans to deal with the unexpected closure which may arise from economic, environmental, safety or other external pressures in the Mine Closure Plan. In particular, this should include confirmation that appropriate materials are available on site and contingencies provided to make landforms such as tailings storage facilities and waste dumps secure and non-polluting in the event of temporary or unplanned closure.

5.11 Closure Costing

The process and methodology for calculating the cost estimates must be transparent and verifiable. Refining closure cost estimates will be a key component of the review of the Mine Closure Plan required under the *Mining Act 1978* or as defined by the EPA.

Estimated costs must take into account all aspects of closure costs. The estimate should include:

- Earthmoving and land forming
- Management of problematic materials where relevant
- Research and trials
- Decommissioning and removal of infrastructure
- Remediation of contamination
    - Survey program
    - Remediation program
    - Maintenance and monitoring
- Progressive and final rehabilitation
- Maintenance and monitoring programs (including post closure phase)
- Ongoing stakeholder consultation process
- Closure project management costs
    - Administration
    - Specialist and consultant fees

  - Legal requirements
- Provision for unplanned closure / care and maintenance
- Need to allow for earthmoving machinery to be available on site after closure for remedial earthworks (or else provide funding for remobilisation of equipment if required)

The Mine Closure Plan must contain a summary of mine closure costing methodology, assumptions and financial processes to demonstrate to DMP and/or the EPA that the proponent has properly considered and fully understood the costs of meeting closure outcomes identified in the plan, and made adequate provisions in corporate accounts for these costs.

Reference to the detailed closure costing report must be provided in the Plan. DMP and/or the EPA may require a full/detailed closure costing report to be submitted for review, and/or an independent audit to be conducted on the report to certify that the company has adequate provision to finance closure.

Note

It should be noted that the costs for mine rehabilitation and closure are recorded as a liability in a company's balance sheet. Australian companies are required to comply with *Australia Accounting Standards Board 137: Provisions, Contingent Liabilities and Contingent Assets*. These require a company to provide the costs of closing a mine based on the actual disturbance at the reporting date. Mining companies listed on the US Stock Exchange (this includes many Australian mining companies) are required to comply with *FAS 143: Accounting for Asset Retirement Obligations* (DITR, 2006).

5.12 Decommissioning

Although the decommissioning phase takes place at the end of mine life, appropriate detail on the strategy and activities being considered for decommissioning of infrastructure must be included in all stages of mine closure planning (section 4) and closure implementation (section 5.10).

At least two years prior to the planned end of mine operations,DMP will require the Mine Closure Plan to contain a detailed Decommissioning Plan. The Decommissioning Plan will include detail on the demolition and removal (or approved burial) of all structures not required for other uses, the removal, remediation or encapsulation of contaminated materials, and the rehabilitation of plant and infrastructure areas.

The Decommissioning Plan must give due regard to the safety requirements of the *Mine Safety Inspection Act 1999,* and the management of any contaminated sites required under the *Contaminated Sites Act 2003*.

Detailed cost estimates for the decommissioning of infrastructure are required to be included in the Decommissioning Plan to ensure adequate provisions are set aside.

5.13 Closure Monitoring and Maintenance

Mine Closure Plans must include appropriate detail on closure performance monitoring and maintenance framework, including the methodology, quality control system and remedial strategy.

The result of closure monitoring will be reported to government in an Annual Environmental Report (AER). The report must show progress against the agreed completion criteria and rehabilitation targets. Any remedial action taken where the results are outside the agreed targets must also be reported. The Guidelines for preparation of an AER are available on the DMP website (HYPERLINK).

As the operations approach closure, DMP will require the Mine Closure Plan to contain a detailed Post-closure Monitoring and Maintenance Program The measurement techniques considered in the program must be able to demonstrate that the site specific completion criteria and environmental indicators have been met (ANZMEC/MCA 2000). Evidence that adequate resources have been set aside to implement the program is required. This will account for the expectation that the monitoring and maintenance period will extend for many years after closure, until closures outcomes and completion criteria have been met.

The closure monitoring and maintenance programs must be designed and implemented to meet the following minimum requirements:

- Use of recognised and/or acceptable methodology and standards;
- Recognising the wider receiving environment, receptors and exposure pathways;
- Incorporating quality control system and procedures consistent with ISO 9000 in the sampling, analysis and reporting of results;
- Showing trends against expected or predicted performance based on statistically robust data; and
- Providing intervention and contingency strategies if key environmental indicators move outside agreed parameters.

5.14 Management of Information and Data

The Mine Closure Plan must include management strategies for the retention of mine records and all information and data relevant to mine closure. These records are valuable to governments and future land users (and stakeholders) as they provide:

- A history of past developments;
- Information for incorporation into state and national natural resource data bases; and
- The potential for improved future land use planning and /or site development,

Proponents are encouraged to establish an information database for each domain and/or feature, where all available information is collated and reviewed with the objective of building a 'base' of information for that particular domain/feature. Information may include, but not be limited to, the current status of the domain/feature, information from spatial datasets and databases, design and construction information, operation and monitoring information or other information that meets a specific purpose (e.g. maps, area statistics, species lists or modelled environmental impacts). All technical reports are to be provided as appendices.

For example, for a waste dump domain/feature, an information search should be carried out on all the information available on the waste dump(s), such as the year of construction, angle of batter slopes, waste rock mineralogy types, chemical and physical properties of the waste material, status of rehabilitation, seed mixes used in rehabilitation and any information on trials that have been carried out on the waste dump(s).

The availability and volumes of certain materials such as competent waste rock, subsoil, topsoil and low permeability clays (i.e. encapsulation material) must be identified to ensure their availability when required for rehabilitation. Consideration of specific radioactivity management measures must be provided. Such information needs to be gathered as part of early drilling programmes at the conceptual stage, and continues to be expanded and updated throughout the operations.

The value of site knowledge should not be underestimated. It is important to have a system in place to capture all relevant closure knowledge in the event of key personnel leaving the site.

6. REFERENCES

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International Network for Acid Prevention (INAP), 2009. *Global Acid Rock Drainage Guide (GARD Guide).* (http://www.gardguide.com/)

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List of Appendices

APPENDIX A: Definitions

When preparing the Mine Closure Plan, it is suggested that the following definitions are used. If you require further clarification please contact your Regional Environmental Officer (see Appendix B).

Care and Maintenance	Phase following temporary cessation of mining operations where infrastructure remains intact and the site continue to be managed. All mining operations suspended, site being maintained and monitored.
Closure	A whole-of-mine-life process, which typically culminates in tenement relinquishment. It includes decommissioning and rehabilitation.
Community	There are many ways to define "community". In mining industry terms, community is generally applied to the inhabitants of immediate and surrounding areas who are affected by a company's activities. 'Local community' usually indicates a community in which operations are located and may include Indigenous or non-Indigenous people. Local communities may be considered stakeholders, however, the two terms are not interchangeable, as some people consider this to be a generic term that does not apply to people living locally (DITR, 2009).
Completion	The goal of mine closure. A completed mine has reached a state where mining lease ownership can be relinquished and responsibility accepted by the next land user (DITR 2006a)
Consultation	The act of providing information or advice, on and seeking responses to, an actual or proposed event, activity or process.
DEC	Department of Environment and Conservation.
Decommissioning	The process that begins near, or at, the cessation of mineral production and ends with removal of all unwanted infrastructure and services.
DEWHA	The Commonwealth Department of Environment, Heritage, Water and Arts.
DoW	Department of Water.
Disturbed	Area where vegetation has been cleared and/or topsoil (surface cover) removed.
Disturbance Type	A feature created during mining or exploration activity, e.g. waste dumps, haul roads, access roads, ROM, plant site, tailings storage facility, borrow pits, drill pads, stockpiles, office blocks,

	accommodation village, etc.
DMP	Department of Mines and Petroleum Western Australia.
Domain	A group of landform(s) or infrastructure that has similar rehabilitation and closure requirements and objectives.
Earthworks	Reshaping, capping, water/wind erosion control, rock armouring.
Ecologically Sustainable	Meeting the goal and principles of the National Strategy for Ecologically Sustainable Development, endorsed by all Australian jurisdictions in 1992, to ensure that development improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.
Environment	Living things, their physical, biological and social surroundings and interactions between all of these.
EPA	Environmental Protection Authority Western Australia.
Environmental Value	A beneficial use and/or an ecosystem health condition.
Kinetic testing	Procedure used to measure the magnitude and/or effects of dynamic processes, including reaction rates (such as sulphide oxidation and acid generation), material alteration and drainage chemistry and loadings that result from weathering. Unlike static tests, kinetic tests measure the behaviour of a sample over time.
Legal Obligations Register	A register of legally binding conditions and commitments relevant to rehabilitation and closure at a given mine site.
Life Of Mine (LOM)	Expected duration of mining and processing operations.
Mineral Processing Facilities	Includes all processing facilities for ore treatment including crushing plants, grinding, vat leach, heap leach, dump leach and tailings disposal facilities.
Orthophotography	Use of aerial photography to measure areas of disturbance
Pits	All open excavations including active mineral rock, gravel, sand, clay, bauxite and salt-pan extraction areas.
Post-mining land use	Term used to describe a land use that occurs after the cessation of mining operations.
Preliminary Earthworks	Reshaping, capping, water/wind erosion control, rock armouring
Project	The total integrated mining operations in which a number of sites contribute to the overall operation to supply ore, processing facilities and disposal of waste products.

Rehabilitated	Areas are safe, have demonstrated stability under representative climatic conditions, non-polluting and support a functioning, self sustaining ecosystem comprising local native species.
Rehabilitation	The return of disturbed land to a stable, productive and self-sustaining condition, consistent with the post-mining land use.
Relinquished	Agreed closure criteria met, government “sign-off” achieved, all obligations under the Mining Act removed and bonds retired.
Revegetation	Establishment of self sustaining vegetation cover after earthworks have been completed.
Safe	A condition where the risk of adverse effects to people, livestock, other fauna and the environment in general has been reduced to a level acceptable to all stakeholders.
Stable	A condition where the rates of change of specified parameters meet agreed criteria.
Stakeholder	A person, group or organisation who have an interest in a particular decision, either as individuals or representative of a group, with the potential to influence or be affected by the process of, or outcome of, mine closure.
Static testing	Procedure for characterising the physical or chemical status of a geological sample at one point in time. Static tests include measurements of chemical and mineral composition and the analyses required for Acid Base Accounts.
Tailings Storage Facility	An area used to store and consolidate tailings, and may include one or more tailings dams.
Tenement	Land tenure granted under the Mining Act 1978 e.g. Mining Lease, Exploration Licence, Prospecting Licence, Miscellaneous Licence and General Purpose Lease.
Waste Landforms (or Dumps)	Includes all mullock and waste rock disposal areas (also called Overburden Storage Area, Waste Rock Landform, or Waste Rock Storage/or Area).

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APPENDIX B : Contact Details

Contact details for the Department of Mines and Petroleum Minerals Branch Regions

South West Team
Minerals Manager
Phone: +61 8 9222 3097
Mineral House
100 Plain Street
EAST PERTH
Western Australia 6004

North West Team
Minerals Manager
Phone: +61 8 9222 3593
Mineral House
100 Plain Street
EAST PERTH
Western Australia 6004

Kalgoorlie Team
Environmental Co-ordinator
Phone: +61 8 9021 9429
48 - 52 Brookman Street
KALGOORLIE
Western Australia 6430

Other contact details include:

Office of the Environmental Protection Authority
Online information provided at www.epa.wa.gov.au select *Contacts*

Department of Water
Online information provided at www.water.wa.gov.au select *Contact us*

Department of Environment and Conservation Online information provided at www.dec.wa.gov.au select *Contact us*

APPENDIX C: Mine Closure Plan Submission and Approval Processes

Mine Closure Plans required under the *Environmental Protection Act 1986* must be lodged and approved by the EPA or the Minister for Environment.

Mine Closure Plans required under the *Mining Act 1978* must be lodged and approved by DMP. Until an on-line lodgement system for submission of a MCP is developed, DMP requires a MCP to be submitted in hard copy, with a copy on a CD contained within, to:

Two copies to:
Minerals Branch, Environment Division
Department of Mines & Petroleum
100 Plain Street
EAST PERTH WA 6004

Or if your project is based in the Goldfields (see inspectorate map):

3 copies to:
Minerals Branch, Environment Division
Department of Mines & Petroleum
Locked Bag 405
KALGOORLIE WA 6433

For further assistance, DMP contact details for each region in Western Australia are given in Appendix B.
The approval, review and change processes for Mine Closure Plans are provided in the flow diagram below:

Approval Processes for Mine Closure Plans

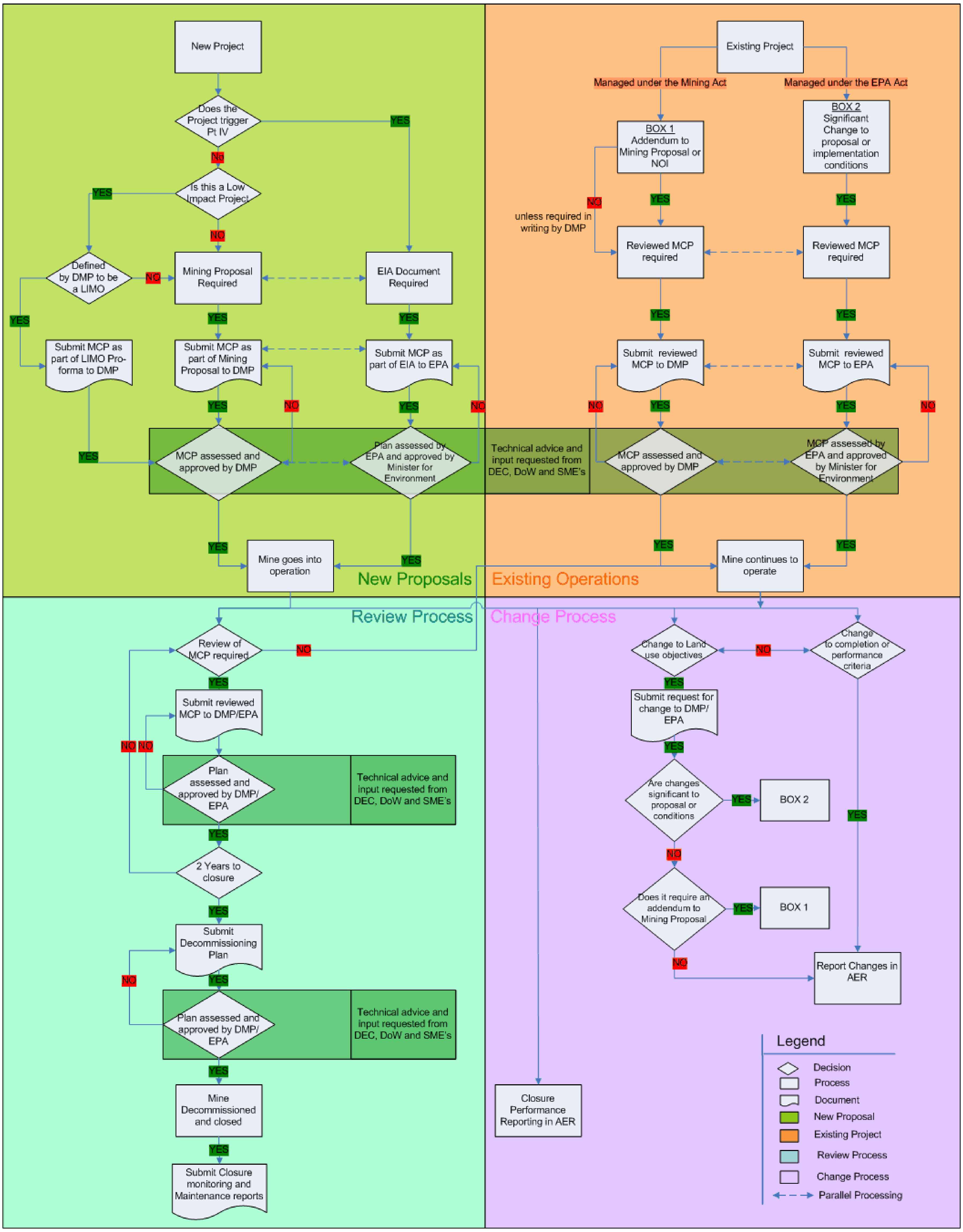


Figure C1: Approval Processes Flow Chart foe Mine Closure Plans

APPENDIX D: DMP Mine Closure Plan Checklist.

Please cross reference page numbers from the Mine Closure Plan where appropriate.

Q No	Mine Closure Plan checklist	Y/N NA	Page No	Comments
	Contact Details			
1	Who authored the mine closure plan?			
2	State who to contact for enquiries about the mine closure plan? Including telephone number and email			
3	Have you included the name, address and contact of the tenement holder(s) and operator?			
4	Has the mine closure plan been endorsed by a senior representative within the tenement holder/operating company? (See bottom of Checklist.)			
5	How many copies were submitted to DMP? (Section 1 for requirements)	Hard copies =		
		Electronic =		
	Cover Page and Project Summary			
6	Does the cover page include; a) all tenement number(s), b) site name, c) proponent's name d) Date (month, year) (needs to match the date of this checklist)			
7	Does the project summary include; • Land ownership details; • Location of the project; • Comprehensive site plan(s); • Background information on the history and status of the project.			
	Legal Compliance			
8	Has a legal compliance register been included? (Section 5.2)			
9	Have you checked for compliance against tenement conditions?			
10	Have you included a consolidated list of rehabilitation and closure commitments?			
	Community consultation			
11	Have you identified all stakeholders involved in closure?			
12	Have you included a stakeholder consultation register which details who has been consulted and the outcomes of any consultation?			
	Closure Risk Assessment			
13	Has a risk matrix been provided in the mine closure plan?			

Q No	Mine Closure Plan checklist	Y/N NA	Page No	Comments
14	Does the risk matrix include; a) Potential impacts, b) Consequence, c) Likelihood, d) Proposed mitigation options, e) Rationale for the adopted method of contingency.			
	Closure Data Collection			
15	Have the history and information relevant to mine closure been collected for each domain or feature (including pre-mining baseline studies, environmental and other data)?			
16	Has a gap analysis been conducted to determine if further information is required in relation to closure of each domain or feature?			
	End land use(s) and Closure Objectives			
17	Does the mine closure plan include proposed end land use(s) and closure objectives ?			
18	Does the mine closure plan identify all potential (or pre-existing) environmental legacies, which may restrict the post closure plan use (including contaminated sites)?			
	Closure Criteria			
19	Does the mine closure plan include a set of specific closure/relinquishment targets (closure criteria).			
20	Does the mine closure plan include commitments to conduct research and rehabilitation trials?			
	Closure Implementation Programs			
21	Does the mine closure plan include a closure implementation program for each domain or feature?			
22	Have site layout plans been provided to clearly show each type of disturbance?			
23	Does the closure program contain a schedule of research and trial activities?			
24	Does the closure program contain a schedule of progressive rehabilitation activities?			
25	Does the closure program include details of how unexpected closure (including care and maintenance) will be handled ?			
26	Does the closure program contain a schedule of decommissioning activities?			
27	Does the closure program contain a schedule of closure performance monitoring including post closure monitoring and maintenance framework ?			
	Closure Costing			
28	Does the mine closure plan include a summary of			

Q No	Mine Closure Plan checklist	Y/N NA	Page No	Comments
	the estimated costing to resource all closure and monitoring activities?			
29	Does the mine closure plan include a detailed closure costing report and/or an independent verification/audit of the report?			
	Closure Information and Data Management			
30	Does the mine closure plan include strategies for the retention of mine records			

Corporate Endorsement:
"I hereby certify that to the best of my knowledge, the information within this Mine Closure Plan and checklist is true and correct and addresses all the requirements of the Guidelines for the Preparation of a Mine Closure Plan approved by the Director General of Mines.

Name: ________________________ **Signed**: ________________________

Position: ________________________ **Date**: ________________________

(NB: The corporate endorsement must be given by a senior representative from the tenement holder/operating company, for example the Registered Mine Manager or higher).

APPENDIX E : Legal Obligations Register Templates

MINE NAME – Legal Compliance Register		
Relevant DMP Tenement Conditions		
Tenement No:	**Condition:**	**Closure Conditions:**

Ministerial Approval document (CER / PER Doc. No and Date etc)	
Commitment	**Relevant Closure Conditions**

Environmental Protection Act 1986 **Licence No: Category:**		
Condition No	**Date**	**Closure Condition:**

Ministerial Statement No … Date …..	
Commitment	**Closure Condition**

Works Approval No
Relates to Tenement No

Condition	Aspect related to Closure

Licence to Take Water - GWL No		
Tenement:	**No.**	**Condition**

NOI /Mine Proposal	
Document Name and Relevant Tenements	
Page no.	**Closure Commitment**

(may be numerous sections – related to each approval document)

	Non Legally Binding Commitments and Promises (letters, references, verbal and dates – acquire records and documents)
Document Name- No	
	Closure Commitment

APPENDIX F: Example of Stakeholder Consultation Table

XYZ Mining - Stakeholder Consultation Register 2010					
Date	Description of Consultation	Stakeholders	Stakeholder comments/issue	Proponent Response and/or resolution	Stakeholder Response
2010 - ongoing	Provide mine development progress reports to the Shire newsletter	Residents of the Local Shire	No formal comments received.	Continue to contribute to the Shire newsletter to keep the local community informed.	N/A
date	Neighbour rang to complain about unusual dust levels from mine-site effecting laundry hanging on line.	Name of pastoralist neighbour	Dust complaint in early December	Resident Mine Manager contacted complainant. Nuisance dust related to high westerly winds which are not common. Vegetation growth over summer has reduced dust impacts. Future establishment of the vegetation corridor will reduce long term impacts. Short term possible measures include the use of water as dust suppression to reduce dust during westerly winds conditions	Will continue to monitor situation and report any issues directly to the Mine Manager
2010 - ongoing	ongoing informal discussion between Resident Mine Manager and neighbour	name of neighbour	Ongoing relationship with regular communication. No complaints or issues.	Continued open dialogue	Acceptable

day/mth/2010	Discussion with DEC over changes to proposal for Works Approval and Part V Licensing requirements	Department of Environment and Conservation, Name and position, e.g. Manager, Environmental Regulation Division	DEC advised that new Works approval and Licence will be required but no issues expected given minimal changes to current mine plan.	Works approval application to be submitted to DEC prior to construction.	Works Approval granted

APPENDIX G: Risk Management Process

Summary of risk management process (DITR 2008)

The main elements of risk management are:

(1) Communicate and consult
Communicate and consult with internal and external stakeholders as appropriate at each stage of the risk management process and concerning the process as a whole. AS4360 requires this all the way through the risk process.

(2) Establish the context
Establish the external, internal and risk management context in which the rest of the process will take place. Criteria against which risk will be evaluated should be established and the structure of the analysis defined.

(3) Identify risks
Identify where, when, why and how events could prevent, degrade, delay or enhance the achievement of the objectives.

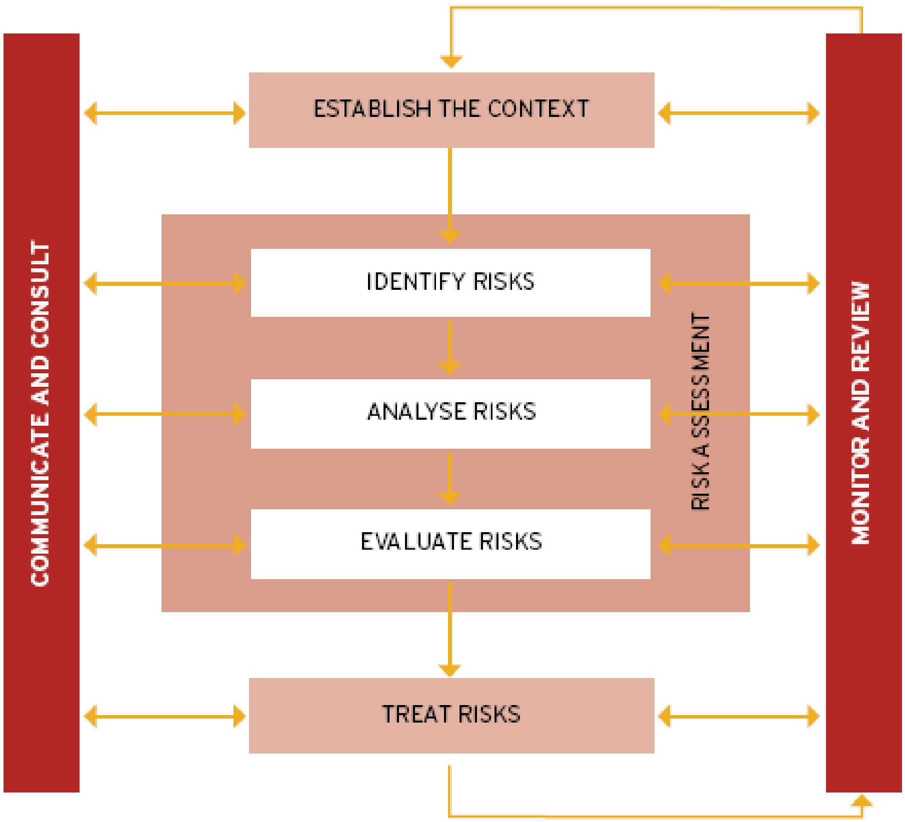
(4) Analyse risks
Identify and evaluate existing controls. Determine consequences and likelihood and, therefore, the level of risk. This analysis should consider the range of potential consequences and how these could occur.

(5) Evaluate risks
Compare estimated levels of risk against the pre-established criteria and consider the balance between potential benefits and adverse outcomes. This enables decisions to be made about the extent and nature of treatments required, and about priorities.

(6) Treat risks
Develop and implement specific cost-effective strategies and action plans for increasing potential benefits and reducing potential costs.

(7) Monitor and review
It is necessary to monitor the effectiveness of all steps of the risk management process. This is important for continuous improvement. Risks and the effectiveness of treatment measures need to be monitored to ensure changing circumstances do not alter priorities.

Risk management process



Source: Australian/New Zealand Risk Management Standard (AS/NXS 4360)

APPENDIX H: Supplementary Technical Information

To ensure an effective mine closure process, it is important that all key environmental issues relevant to mine closure are identified in the early phases of a life of mine Detailed guidance to identify and manage these issues can be sought from the DITR leading practice handbooks.

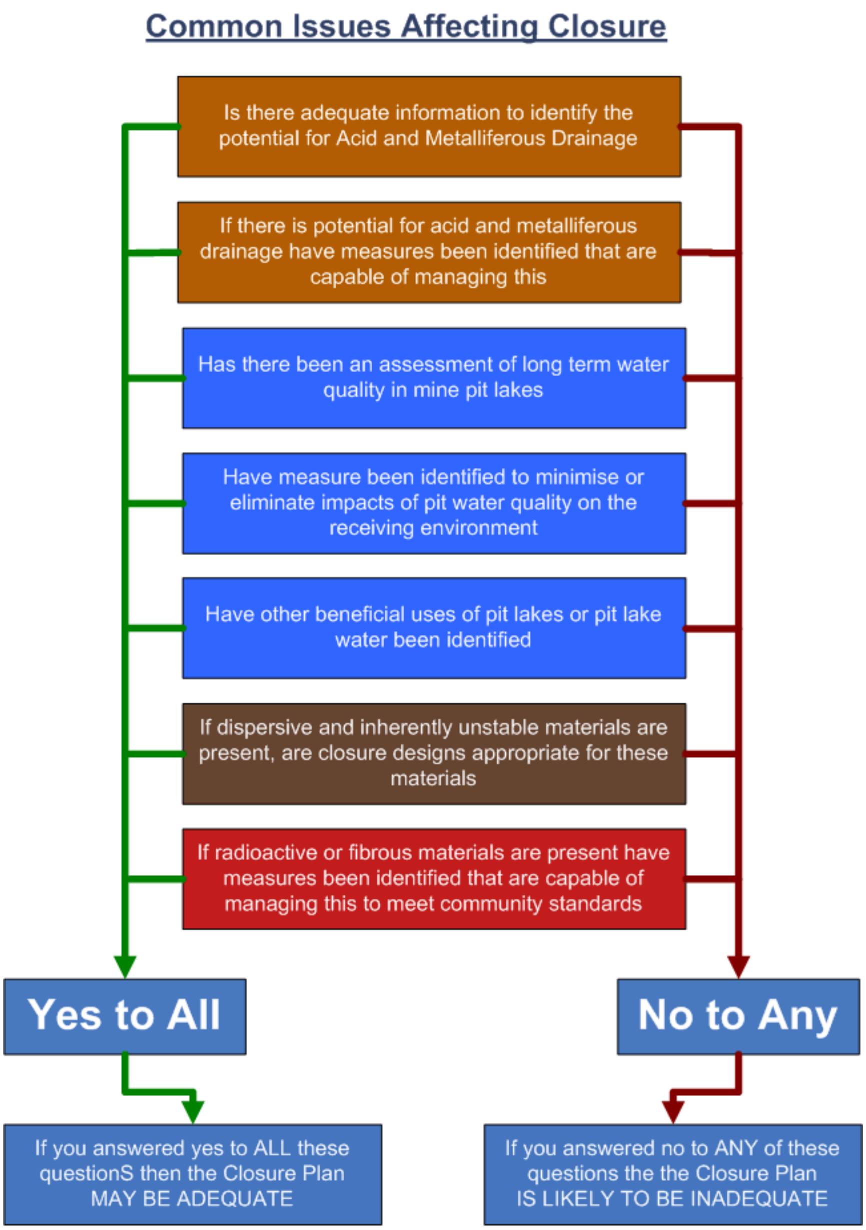


Figure H1

Common issues and decision path

Some of these issues are discussed further below.

Acid and metalliferous drainage

The term acid and metalliferous drainage or ADM is preferred instead of the older term acid mine drainage in order to emphasise that contaminated mine drainage may consist of acid drainage and/or metalliferous drainage.

Internationally and in Australia, AMD is recognised as one of the most serious environmental issues associated with mining. The website of the International Network for Acid Prevention (an international research initiative funded by the mining industry) notes that:

"Acid drainage is one of the most serious and potentially enduring environmental problems for the mining industry. Left unchecked, it can result in such long-term water quality impacts that it could well be this industry's most harmful legacy. Effectively dealing with acid drainage is a formidable challenge for which no global solutions currently exist." (http://www.inap.com.au accessed 2 March 2008).

The leading practice handbook on AMD (DITR 2007) states that:

"At decommissioned and older operating mines sites where Acid and Metalliferous Drainage characterisation and management has been poor, high remediation and treatment costs continue to impact on the profitability of mining companies. The term .treatment in perpetuity has entered the mining vernacular as a result of intractable Acid and Metalliferous Drainage issues that prevent the relinquishment of mining leases, despite the closure of mining operations. Such situations are inconsistent with sustainable mining and must be avoided."

Acid and metalliferous drainage from old mine sites can cause ongoing pollution lasting for centuries or even millennia. For example Bronze Age mining of sulphide deposits in 5000 ago is still causing pollution of the Rio Tinto River in Spain (Davis *et. al.* 2000).

In addition to acid drainage, it is important to note that metalliferous drainage from mine sites can have serious environmental impacts. Trace metals such as zinc, cadmium and copper which may occur in mine drainage are toxic at extremely low concentrations and may act synergistically to suppress algal growth and affect fish and other aquatic life (DITR 2009).

Cadmium is a substance of particular concern. Research in North America has shown that cadmium can cause serious effects on wildlife populations by causing bone necrosis, kidney disease and death (Larison *et. al.* 2000). Overseas, particularly in Japan, there are well documented historical cases of cadmium pollution from mine sites causing severe human health impacts (Jarup L 1998). Selenium is another substance of particular concern which may occur in contaminated mine drainage. Selenium rapidly bio-accumulates and causes reproductive failure in fish (Lemley AD 1996 and 2004) and teratogenic effects (birth deformities) in water birds (Lemley AD 1996 and 2004).

A recent detailed review of the reliability of water quality predictions in environmental impact assessments for hard rock mine proposals in North America (Kuipers *et al* 2006) concluded that the actual impacts of mining on water quality are nearly always significantly underestimated in the environmental assessment process. The review concluded that:

"Lack of adequate geochemical characterisation is the single most identifiable root cause of water quality prediction failures. Improvements in geochemical characterisation can provide the greatest contribution to ensuring accurate water quality predictions at Hardrock mine sites..the same geochemical test units should be used for testing of all sources and parameters used to predict water quality impacts. In addition, more extensive information on mineralogy and mineralisation should be included in EISs, and more attention should be paid to uncertainties in geochemical and hydrologic characterisation."

The AMD leading practice handbook (DITR 2007) stresses that it is critical that sampling for geochemical testing be representative of geological materials at the project site (including country and host rock) and provides further specific information on sampling procedures (including sample sizes and maximum intervals between drill holes).

In assessing the potential for acid generation, care needs to taken in relying on limestone to neutralise acid drainage because of the phenomenon of armouring (i.e. the limestone becoming coated with non-reactive material) which results in rapid loss of neutralising capacity (Hammarstrom *et al* 2003).

The AMD leading practice handbook (DITR 2007) states specifically that, for the purpose of approvals:

"A mine closure plan must be developed and seen to be workable andconvincing." (DTIR 2007 page 18).

Consistent with that approach, if the geology of the area is such that acid and/or metalliferous drainage may be an issue, the results of appropriate geochemical testing and risk assessment for *both* acid drainage *and* metalliferous drainage (noting that metalliferous drainage can occur in the absence of acid drainage) must be presented upfront in the Conceptual Closure Plan. Appropriate methods of geochemical testing and risk assessment are set out in the US AMD handbook (Maest *et al* 2005), the Australian national AMD handbook (DITR 2007) and the international AMD handbook known as the .GARD Guide (INAP 2009).

Geochemical testing is time consuming, as noted in the leading practice handbook:

"Kinetic leach tests need to operate for at least 6 months and typically 12 to 24 months before sufficient data are available for effective interpretation of the AMD characteristics of a material. Longer time frames may be involved for evaluating the performance of specific treatments or soil/rock blends.. (DITR 2007, page 36)."

To avoid the need to carry out extensive additional drilling for AMD risk assessment and possible delay in environmental approval processes, the leading practice handbook (DITR 2007) specifies that static geochemical testing should be carried out during exploration and resource definition drilling, and that geochemical test work (static and kinetic testing) should be completed *prior* to submitting the project for environmental approvals.

If testing shows there is a significant risk of acid drainage or other contaminated mine drainage, the proponent to should demonstrate in the Conceptual Closure Plan that the proposed closure strategy will provide a sustainable walk away solution. This includes sustainable closure of mine rock waste dumps, tailings facilities and mine pit lake(s).

The risk of generating AMD through the mine dewatering process also needs to be assessed and managed appropriately. AMD can be generated through dewatering because, as the water table is lowered, chemical changes can occur as rock strata dry out, resulting in acid and/or metalliferous drainage being generated.

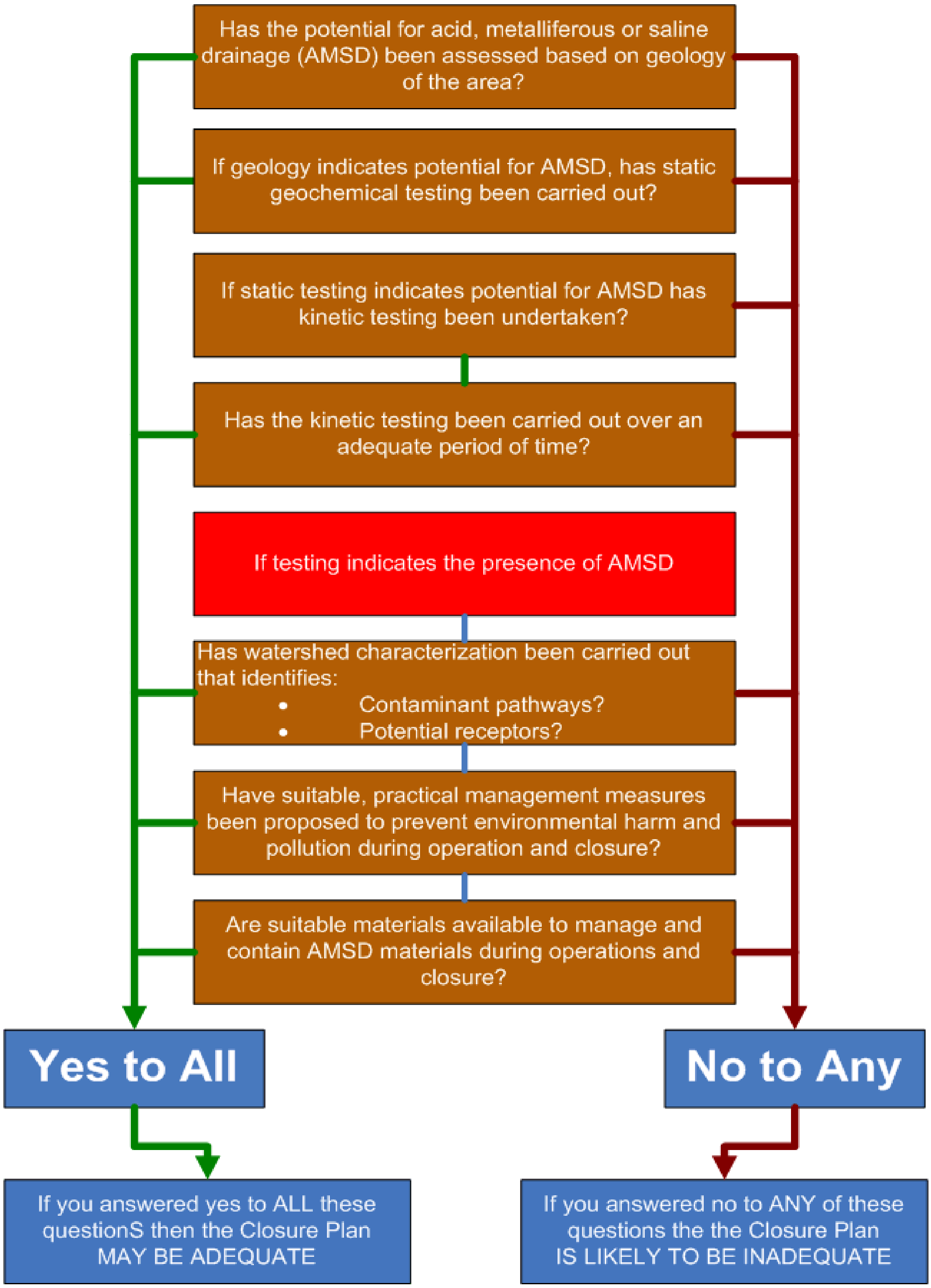
Common misconceptions about AMD

A common misconception is that metalliferous drainage and acid mine drainage are one and the same thing and that, if there is no potential for acid drainage, there will be no metalliferous drainage. However it is important to note that metalliferous drainage may occur even in the absence of acid drainage (INAP 2009). As an example, recent research has shown that elevated concentrations of cadmium and selenium can occur in mine pit water after iron ore mining in Western Australia under alkaline conditions, that is, in the absence of acid mine drainage (Gardiner SJ 2003).

Another common misconception is that rock with total sulphur values less than 0.3 percent does not pose a water quality risk. However a recent review by Rio Tinto (Richards *et al* 2006) of AMD risk at its mines noted that:

"…at several Rio Tinto mines, acidification risks have been noted, and special handling has been implemented, for materials at sulphur values as low as 0.05 percent, especially where there are special conditions in receiving environments."

Acid, Metalliferous and Saline Drainage



<u>Mine pit lakes</u>

If a pit lake or lakes will form after mine closure, and the lake water will be saline and/or contaminated (for example from acid drainage or metalliferous drainage) the proponent will provide technical information / results of modelling to assess whether the lake(s):

- may cause significant salinisation or contamination of surrounding groundwater (Johnson SL & Wright AH 2003) or surface water; and

- may cause significant harm to wildlife, birds or stock which may come in contact with contaminated pit lake water.

On the other hand, if the mine pit after closure will contain water of good quality, this may well provide a useful water resource. However the possibility of negative environmental impacts still needs to be considered. Negative impacts from good quality water in a pit lake may occur because the lake will:

- attract increased numbers of kangaroos, cattle or other grazing animals which may cause over-grazing of surrounding vegetation; and/or

- attract increased numbers of predators (e.g. foxes, wild dogs) which may kill native wildlife in the area.

Table 1 (below) summarises potential environmental impacts from mine pit lakes and potential management options.

Table 1: Management considerations for mine pit lakes[2]

Pit lake scenario	Potential negative environmental impacts	Potential management options
Saline and/or contaminated pit lake.	If there is ground water flow-through (i.e. pit lake is not a groundwater sink) and surrounding groundwater is good quality there may be potential to significantly contaminate ground water.	• Backfill pit to above water table; or • Remediate pit lake water to meet national water quality guidelines (ANZECC 2000). Note remediation may need to be ongoing.
Contaminated pit lake water.	Sickness or death of stock, native animals or birds which come in contact with the pit water.	• Backfill pit to above water table; or. • Physical barriers to prevent stock or wildlife access[3]; or • Remediate pit lake water to meet national water quality guidelines (ANZECC 2000). Remediation may need to be ongoing
Good quality pit lake water.	Water attracts more grazing animals (kangaroos, stock) causing over-grazing of surrounding vegetation. Predators may also be attracted and eat native fauna.	• Backfill pit to above water table; or • Physical barriers to prevent access by stock, wildlife or predators[2].

Note:
[1] Consideration also needs to be given to the potential for pit lakes to act as breeding areas for mosquitoes, including risk of spread of mosquito-born diseases. If mosquitoes are likely to be a significant issue, proponents will need to make arrangements for ongoing management.
[2]Proponents would need to make arrangements for ongoing maintenance of barriers after closure. Note physical barriers unlikely to be practical to prevent bird access

More detail information on mine pit management is provided in a document titled “Mine void water resource issues in Western Australia” (DoW 2003), and a copy is available on the DoW website (http://www.water.wa.gov.au/PublicationStore/first/42100.pdf).

In addition to safety and environmental considerations, the potential economic value of any remaining mineralisation should be considered before a decision is made to backfill open mine pits. A sterilisation report must be submitted to DMP

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where any resources are likely to be sterilized by infilling of pit. A copy of the "Sterilization report submission form for In-pit waste/tailings disposal proposals" is available on the DMP website. The form is not required for shallow deposits such as mineral sands, bauxite or nickel laterite where resources are not likely to be sterilized.

Radioactivity

For uranium mines, as well as other types of mines where radioactivity may be an issue (for example mineral sands mines), management of radioactivity will clearly be a key consideration for closure planning. The World Nuclear Association document *Sustaining Global Best Practices in Uranium Mining and Processing – Principles for Managing Radiation, Health and Safety, Water and the Environment* (*www.world-nuclear.org/WorkArea/linkit.aspx* accessed 21 February 2010) includes the following principle (principle 11):

"In designing any installation, plan for future site decommissioning, remediation, closure and land re-use as an integral and necessary part of original project development. In such design and in facility operations, seek to maximize the use of remedial actions concurrent with production. Ensure that the long-term plan includes socio-economic considerations, including the welfare of workers and host communities, and clear provisions for the accumulation of resources adequate to implement the plan. Periodically review and update the plan in light of new circumstances and in consultation with affected stakeholders. In connection with the cessation of operations, establish a decommissioning organisation to implement the plan and safely restore the site for re-use to the fullest extent practicable. Engage in no activities – or acts of omission – that could result in the abandonment of a site without plans and resources for full and effective decommissioning or that would pose a burden or threat to future generations".

This approach is consistent with the principles of the *Strategic Framework for Mine Closure* (ANZMEC/MCA 2000).

It is imperative that all radiation protection measures in WA adopt the Australian Radiation Protection and Nuclear Safety Agency or ARPANSA Codes of Practice and Safety Guidelines for Radiation Protection, as a minimum regulatory requirement.

The ARPANSA guidelines are prepared and approved by the Radiation Health Committee, under the provisions of the ARPANSA legislation, in consultation with industry, unions and the Governments of States and Territories. They are based on best practice international radiation protection standards and guidelines established by the International Atomic Energy Agency (IAEA) – a United Nations body, but are relevant to Australian conditions. The IAEA standards and guidelines are based on worldwide scientific findings and recommendations by the International Commission on Radiological Protection (ICPR) – a non-governmental scientific organisation, and the United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR).

Radiation management should demonstrate compliance with the two important internationally agreed guiding principles in radiation protection, the “as low as reasonably achievable” or ALARA principle and the “best practicable technology” principle:

- *“The ALARA principle has the meaning stated in Clause 117 of International Commission on Radiological Protection (ICRP) Publication 60 (ICRP 1991, p.29, Item 4.3.2). The broad aim is to ensure that the magnitude of the individual doses, the number of people exposed, and the likelihood of incurring exposures where these are not certain to be received, are all kept as low as reasonably achievable, economic and social factors being taken into account” (ARPANSA, 2005).*
- *“‘best practicable technology’ is that technology available from time to time, and relevant to the project in question, which produces the minimum occupational doses, member-of-public doses both now and in the future, and environmental detriment that can be reasonably achieved, economic and social factors taken into account”* (ARPANSA, 2005).

The ARPANSA Code of Practice and Safety Guide on Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (ARPANSA, 2005) has been adopted in the WA *Radiation Safety (General) Regulations 1983.* The objective is “*to provide a regulatory framework to manage protection of workers, members of the public and the environment from mining or mineral processing and from the waste resulting from these activities both now and in the future*”.

It should be noted that the system of radiation protection described in the ARPANSA Recommendations does not specifically refer to the protection of other species or to the environment because *“it is generally believed that the standard of environmental control required for protection of people will ensure that other species are not put at risk*” (ARPANSA, 2002). This view is consistent with the current view of the ICRP that “*the standards of environmental control needed to protect the general public would ensure that other species are not placed at risk*.” (ICRP, 2007).

Accordingly consideration should be given to the establishment of standardised methodology and minimum requirement for environmental monitoring of radioactive substances, before, during and after mining, to ensure minimal impacts on the environment including potential impacts on indigenous groups and non-human species. The potential impacts of radiation on the non-human species are (Tsurikov, pers com):

- Flora (plants):

  - External gamma-radiation;
  - Surface contamination (absorption of dust settling on leaves/ branches and radon);
  - Waterborne radioactivity (uptake of radionuclides via the root system).
- Fauna (animals and insects):
  - External gamma-radiation;
  - Airborne radioactivity (inhalation of dust and radon);
  - Waterborne radioactivity (ingestion of radionuclides);
  - Surface contamination (on direct contact with a contaminated material);
  - Ingestion of contaminated flora.
- Ground/soil/groundwater – subterranean organisms:
  - External gamma-radiation;
  - Waterborne radioactivity (ingestion of radionuclides).
- Surface water – aquatic organisms (flora):
  - Immersion – exposure to external gamma-radiation;
  - Uptake of radioactivity from both sediments (via roots) and water itself.
- Surface water – aquatic organisms (fauna):
  - Immersion – exposure to external gamma-radiation;
  - Ingestion of aquatic flora.
- Atmosphere (fauna):
  - Airborne radioactivity (inhalation of dust and radon);
  - Ingestion of contaminated flora and fauna.

More detailed information on radiation protection to mining operations is provided in the WA guidelines on Naturally Occurring Radioactive Material (NORM) in Mining and Mineral Processing or WA NORM Guidelines, available on DMP website (http://www.dmp.wa.gov.au/836.aspx). The WA NORM Guidelines are regarded as the “most comprehensive and up-to-date” set of guidelines for the management of radiation. The Guidelines include guidelines for preparation of a radiation management plan, guidelines on radiation monitoring, radiation dose assessment and reporting, and guidelines on management strategies for radioactive dust and waste.

Uranium mining using the in situ leaching (ISL) or in situ recovery (ISR) must be designed, constructed, operated and rehabilitated in accordance with the Australia’s In Situ Recovery Uranium Mining Best Practice Guide: Ground waters, Residues and Radiation Protection (DRET/GS/DEWHA 2010).

Dispersive Materials

Ensuring that constructed landforms have adequate resistance to erosion is a major component of mine site rehabilitation works. The presence of soil materials susceptible to tunnelling or piping has large impacts on landform stability and rehabilitation. In general, the development of tunnel erosion has been attributed to the presence of dispersive soils or mine wastes. Tunnel erosion can lead to gully erosion being the dominant erosion mechanism, leading to the failure of engineered structures aimed at controlling erosion. The presence of tunnel erosion also typically means that site remediation and stabilisation are extremely difficult, and that erosion problems are likely to be particularly persistent.

Dispersion occurs when the individual particles in a soil are separated from each other when excess water is supplied. Soils containing high levels of exchangeable sodium (Na^+), known as 'sodic' soils, are widely recognised to be particularly susceptible to dispersion. Saline soils may initially be non-dispersive, but continued leaching of the contained salts can result in the material becoming dispersive over time. Materials susceptible to tunnelling fall into three groups:

- saline sodic
- non-saline sodic
- fine, non-sodic materials of low cohesive strength

Dispersion tests are the most useful laboratory tests for identifying the susceptibility of a soil to tunnelling, though it should be noted that tunnel formation is not entirely confined to dispersive materials.

There are strong interactions between the design of constructed landforms and the development of tunnel erosion. Water ponded on saline sodic materials can result in: the leaching of salt by the ponded water; reduced soluble salt; increased dispersion, followed by development of tunnel erosion. For non-cohesive materials, long durations of ponding are also a major factor in developing tunnel erosion.

In order to predict the mid to longer term performance of landforms ('as mined' materials can have properties that change after placement in landforms), it is essential that the inevitable microstructural, chemical and mineralogical evolution of wastes can be predicted and the impact of these changes on erosion hazard determined. Initial soil parameters that provide information on tunnel erosion potential are:

i) Electrical Conductivity (EC) to assess potential salinity constraints on dispersion;

ii) Exchangeable cations, with particular emphasis on exchangeable sodium percentage (ESP) to assess dispersion potential;

iii) Potentials for slaking and dispersion (Emerson test)

iii) Particle size distribution (to provide an indication of soil cohesion and liquefaction contributions to tunnel formation/failure), and

iv) Clay mineralogy (for swelling influence).

Based on the data obtained, a judgment can be made on which subsequent tests are most appropriate. Leaching column tests provide a good indication of the hydraulic conductivity of a material and of its potential for sealing or blockage of soil pores to occur. Erodibility measurements provide an indication of the potential for continued development of tunnels (and tunnel gullies). Characteristics contributing to high erodibility are also factors in the initiation (dispersive and poor structural strength nature) and potential progression and severity of tunnelling when it has occurred.

The best management option available to mine sites that excavate materials susceptible to tunnelling is to avoid the problem, by ensuring that those materials are not exposed to ponded runoff or through drainage. Therefore, the importance of early diagnosis of potential tunnelling problems and adoption of strategies to prevent such long-term instability is essential for successful mine closure.
More information on identification and management of dispersive soil is provided in a study report coordinated by the then Australian Centre for Mining Environment Research (C.A Vacher et al, 2004).

Rehabilitation

EPA guidance note No. 6 *Rehabilitation of Terrestrial Ecosystems* (EPA 2006) sets out the EPA's general expectations about re-establishing biodiversity values where a site is to be rehabilitated back to native vegetation. Guidance note No. 6 is particularly relevant to rehabilitation of mine sites in the south west of the State in cases where the requirement is to reinstate high quality native vegetation as close as possible to that which existed prior to mining.

For more general information on mine rehabilitation, including environmentally sustainable design of artificial landforms, proponents should refer to the leading practice handbook (DITR 2006b).

The Conceptual Closure Plan should demonstrate that closure planning is being carried out to optimise rehabilitation outcomes, consistent with the proposed post-mining land use. This will include:

- Demonstrating that suitable land forms, soil profiles and soil characteristics will be reinstated consistent with the proposed final land use; and

- Demonstrating that any risk of uptake of toxic materials by vegetation or pasture will be managed to avoid harm to native animals or stock which may feed on the vegetation or pasture.

Minesite Restoration Guidelines (K Dixon)

Introduction
Successful post-mining restoration in the biodiverse and unique ecosystems of Western Australia is complex and often site-specific with few applicable templates from overseas operations.

A key to the successful creation of compliant post-mining restoration is the incorporation of restoration and rehabilitation considerations from the commencement of exploration through to mine-closure – the 'whole of mine life' approach. Such an approach has been highly successful for the mining and extraction activities of Alcoa and Rocla who operate facilities in southwest Australia and successfully reinstate high levels of biodiversity.

Knowledge Gaps: For many operations developing restoration as part of mine closure planning requires significant investment in site-specific ecological restoration research. For example, in WA, sites where significant knowledge gaps in restoration capability exist include the arid zone, biodiverse 'hotspots' (BIF, ultramafics, sandplains, rocky areas), shallow soils (so-called 'shallow-soil' endemics), coastal systems and the Kimberley.

The Restoration Toolkit: Successful restoration is about maximising available resources particularly topsoil, seed and soil substrate (growing medium). For many operators, correctly managed topsoil represents an outstanding resource for restoration with up to 10,000 seeds per square metre in some biodiverse topsoils. However, due to the long-term nature of the majority of mining operations (iron ore, gold, uranium, coal) significant deficits in available topsoil exist (due to the area requiring restoration including waste rock dumps, spoils, roads and infrastructure being greater than the vegetation 'topsoil footprint').

As a result companies may need to invest in significant seed collection, storage and sowing programs in addition to investigating how mine waste materials can be reconstituted to form a suitable 'growing medium' . Again, these are areas that may be site and regionally specific and require investment in research.

The following represent summaries of *current* practice. However, approaches to successful ecological restoration are rapidly evolving in WA and companies are encouraged to keep abreast of current research and development advances in minesite rehabilitation and restoration.

<u>Towards leading practice in post-mining restoration</u>

The restoration of sustainable native vegetation communities using local species requires consideration of a number of key components including identifying the community's constituents and their attributes, and identifying abiotic (soil, geology, hydrology, aspect, topography, micro-niche) conditions necessary for the establishment and persistence of the community.
Biotic components in restoration after mining include optimising use of available plant (topsoil, seed and plants) and soil substrate (plant growth medium and parent material).

Species and community identification – vegetation surveys
Information that is necessary for benchmarking and establishing species/community restoration targets should include:

- A full list of species for the impacted area and associated communities.
- Clear delineation of communities, including species whose presence / absence or variation in abundance defines each community.

- The appropriate spatial scale at which to assess communities.
- The range of variation for species richness and cover that can be expected.
- The relative abundance of the most important species in each community.
- Post-restoration monitoring to inform operators of the level of success in re-establishing appropriate plant communities and to assist in the refinement of restoration procedures.

Topsoil

Soil seedbanks have many advantages as sources of material for restoration, they are species rich, genetically representative of original populations, and may be relatively easy to manage. Topsoil is therefore a vital and highly effective medium for restoring terrestrial ecosystems in WA. Research has demonstrated that the following key considerations are critical for effective use of topsoil to maximise soil seedbank retention, seedling germination and seedling establishment:

- Stripping: seeds of native species mostly reside in the top 10cm. Thus stripping should focus on retrieving this layer to a maximum depth of 20cm (due to technical limitations).
- Timing of stripping: always strip dry soil and ensure soil remains dry at all times including transfer, storage and replacement phases.
- Topsoil storage: dry topsoil piles can be maintained in windrows or bins up to 5 m high without impacting upon seed viability. Covering topsoil to retain it in a dry state is critical otherwise germination and anaerobic conditions will substantially decrease the effectiveness of the topsoil.
- Topsoil spreading: replace topsoil at the depth of emergence capability of seeds – and no greater than 5cm.

Growing Medium

For most minesites there will be a deficit in growing medium that will need to be met by investigating the use of waste mine materials to support plant establishment. Plant growth and function is therefore an appropriate indicator of potential long-term sustainability of restoration sites. The growing medium of restored sites should reflect the functional nature of the pre-mined landscape and provide:

- Seasonal groundwater dynamics allowing for comparable plant water use and acquisition strategies with pre-mined systems.
- Comparable plant nutrition potential with pre-mined systems and include chemical attributes that are: non-toxic; non-acid producing; non-saline; non-sodic; and of suitable pH.
- Comparable structural attributes with pre-mined systems ensuring environmental stability and non-hostility for plant growth characterised by: low erosion potential; suitable air filled porosity; suitable bulk density and being non-dispersive.

Seed Collection and use standards

For areas where topsoil does not or is not capable of returning the stipulated level of biodiversity, the reliance on seed to achieve targets is increased. The seed supply chain (Figure 1 1) provides the key steps that are critical for considering how wild seed is sourced and utilized correctly. However, for most regions, information on site and species-specific requirements is not available.
Procedures to optimize seed resources should focus on those below (summarised also in Figures 2 and 3):

Collection and Storage

- Correct species identification (all seed must be represented by a herbarium-quality voucher specimen).
- Adequate genetic provenance identification (consult relevant authorities).
- Timing of seed harvest to maximise seed quality, viability, and storability.
- Correct seed handling to ensure seed is not damaged during the collection and cleaning phases.
- Processing approaches that optimise seed quality and purity.
- Ensuring adequate and appropriate storage of seed in an appropriately designed and managed seedbank facility.
- Developing seed production systems where seed supply or collection capability does not or cannot meet seed demand.
- Ensuring adequate and appropriate storage of seed in a purpose-designed and managed seedbank facility preferably with seed equilibrated to 15% relative humidity stored for short to medium-term (1-5y) at 15C; long-term (>5y) at -18C.

Seed use

- Understanding seed dormancy and germination limitations of target species.
- Utilising seed-germination enhancement technologies including seed priming, seed cueing, seed dormancy release and seed dormancy control, seed coatings, delivery-to-site techniques, germination and establishment optimization, stress control.
- Understanding interactions of seed use technologies with post mined landscapes (biotic and abiotic) to optimise plant regenerative capacity.

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Figure 1**:** The seed supply chain outlining the key steps that are critical for considering how wild seed is sourced correctly, quality assured, cleaned and stored in a suitable seedbank environment and exits the seedbank in a state suitable for germination.

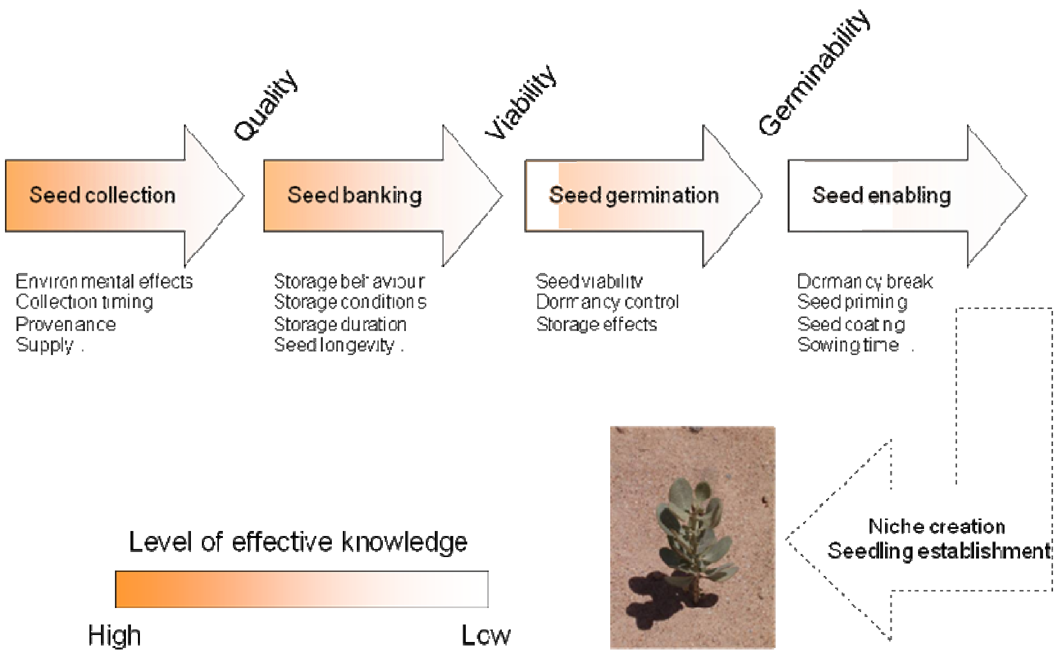


Figure 2: A systematic approach to developing whole-of-mine restoration techniques. Integration of each research and development theme is necessary to achieve efficient and effective use of biological resources.

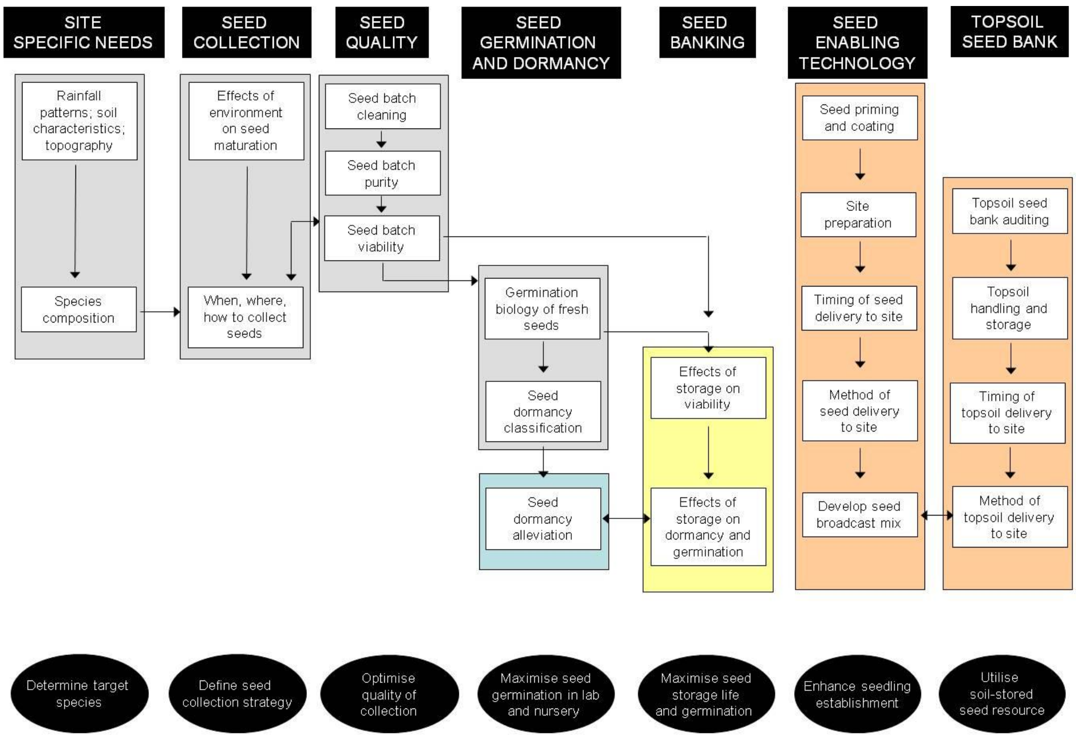
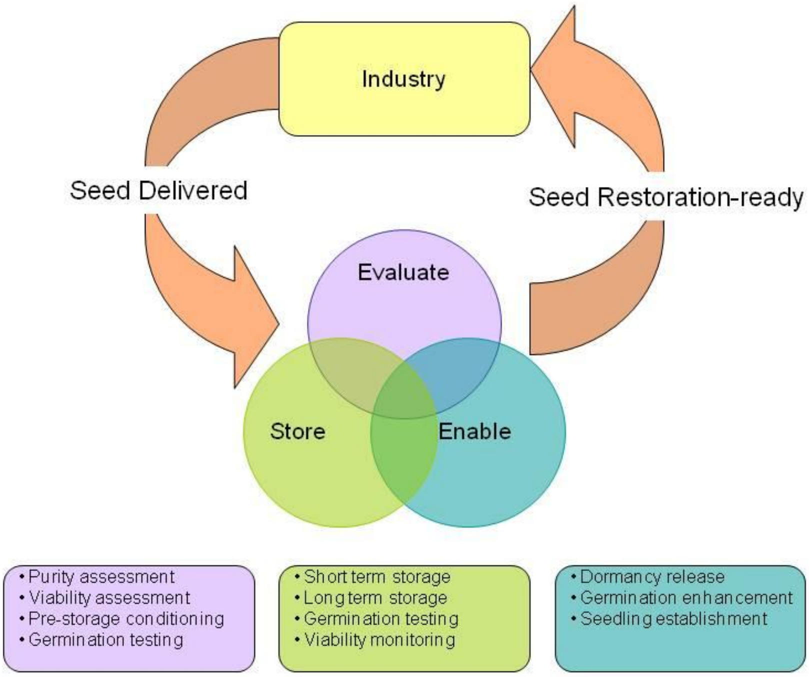


Figure 3: Operational model for restoration seed banking highlighting the steps involved in seed quality assurance, appropriate storage and testing, and seed pre-treatments and enabling technology necessary for optimising plant establishment.



APPENDIX I: Domain Model

A useful approach to mine closure planning and implementation is to divide up the closure work to be carried out and segregate the facility into specific areas or domains (ICMM 2008). Each domain is treated as a separate entity within an overall plan and includes landforms or infrastructure that has similar rehabilitation, decommissioning and closure requirements/objectives.

The domain model provides a good focal point for developing strategy for closure implementation.

Examples of domains at a mine are:

- Ore processing area
- Infrastructure
- Tailings storage facility
- Waste dumps
- Process and raw water facilities
- Open voids and declines/shafts

An example of a typical mine layout showing the allocation of domains is provided in Figure 2 below:

Figure 2: An example of the allocation of domains (DITR 2006a)

For accuracy, it is recommended that the operation should use Geographical Information System (GIS) digital terrain models and aerial photos to illustrate the domain features and boundaries; 3D models of waste dumps, voids, tailings dams and other structures (ICMM 2008)

Each domain should have its own closure plan and the following factors should be taken into account when developing a plan for each domain (ICMM 2008):

- The amount and area of disturbance

- Applicable legislation
- Hazardous areas and risk assessments
- A plan for deconstruction and decommissioning
- Contamination and mitigation
- End land use
- Required earthworks and capping
- Control of erosion
- A rehabilitation plan
- Monitoring
- Cost estimates
- Research

As each minesite is unique, domain specifications will vary, therefore the closure plan should provide a description of the domain, (including a map) detailing its specific rehabilitation requirements. The domain model 'helps to facilitate structured risk assessment and management, systematic closure cost estimation and successful closure implementation.

APPENDIX J: Examples of Closure Objectives

The following information provides guidance and examples only of the types of closure objectives that may be considered, as each operation will have its own specific set of objectives.

Compliance

- The disturbed mining environment shall be made safe; and closure requirements of the regulatory authorities are to be met; and
- All legally binding conditions and commitments relevant to rehabilitation and closure will be met.

Landforms

- Dispersive materials will not be located where there is the potential for run off to occur;
- Constructed landforms and soils will be geotechnically stable and geochemically safe
- Maintain soil structure and function of constructed landforms;
- Constructed landforms will be non-polluting and toxic or other deleterious materials will be permanently encapsulated to prevent environmental impacts;
- Any remaining overburden or residue storage areas provided with drainage systems to prevent sediment transfer into natural waterways; and
- Any boreholes, mine shafts, costeans, ventilation shafts or similar below ground excavations filled in or sealed unless demonstrated as necessary to support an end land use.

Vegetation

- Self sustaining vegetation comprised of local provenance species;
- Reaching agreed numeric targets (abundance or plant cover) for vegetation recovery;
- Reaching agreed species or ecosystem diversity targets;
- Establishment of habitats capable of supporting regional biodiversity;
- Species diversity appropriate to surrounding environment, or agreed end land use;
- Revegetation that demonstrates viability through propagule development, and effective recruitment;
- No new species of weeds introduced and no greater coverage of weeds than occurred prior to mining; and
- Effective disease control.

Fauna

- Fauna utilisation, abundance and diversity appropriate to surrounding environment;
- Reaching agreed numeric targets (animal or habitat diversity); and
- Effective pest control.

Hydrology

- Surface and Groundwater hydrological patterns/flows not adversely affected;
- No area of rehabilitation creating unacceptable erosion and/or ponding due to surface water flow;
- Flood events incorporated into mine site and rehabilitation designs; and
- Surface and groundwater levels and quality reflect original levels and water chemistry as much as practicable;

Erosion

- Mitigate erosion into surrounding environment;
- Mitigate erosion of landform; and
- Maintain a safe and stable landform.

Infrastructure and Waste

- During decommissioning and before closure, wastes will be managed to meet the requirements of all regulators and consistent with the waste minimisation principles;
- No infrastructure left on site unless agreed to by regulators and post mining land managers/owners;
- Disturbed surfaces rehabilitated to facilitate future specified land use.
- Minimise erosion into surrounding environment;
- Minimise erosion of landform;
- Maintain integrity of waste landform structures; and
- Safe and stable landform.

APPENDIX K: Examples of Closure Completion Criteria

Landforms

- Upon completion of mining of pit "a", the final landform of waste rock dumps "b and c" will have 3x 20m high lifts with concave slopes at maximum angles of 20 degrees, and two berms with a minimum width of 30m.
- Upon completion of mining of pit "a", the final landform of Tailings Storage Facility "d" will have outer embankments constructed at a maximum angle of 14 degrees and armoured with at least 1m of competent rock materials.
- The Tailings Storage Facility "d" will be designed and constructed to allow consolidation of the tailings materials within 10 years of this facility being decommissioned.
- After seeding the waste rock dumps "b and c", erosion rates from these landforms will be within 20% of the erosion rates from an analogue or reference site.
- During operation, all identified AMD materials will be classified and stored appropriately to minimise on-going impact on surface and groundwater.
- The waste rock dump "b" will be designed and constructed to allow the placement and encapsulation of selected AMD materials with a suitable cover of at least 2m thick.

Vegetation

- Within 12 months of decommissioning, ore stockpiles and ROM pads will be deep ripped on the contour and seed with Goldfields provenance species.
- No more than 100mm of topsoil will be stripped, appropriately stockpiled and spread across the rehabilitated areas as soon as possible, to minimise any deterioration in seed viability, soil biota and nutrient;
- Following the seeding of each waste rock dump, appropriate flora monitoring will be conducted to evaluate the progress of revegetation towards fulfilling the agreed land use objectives (or against a suitable analogue/ reference site).
- Reaching agreed species or ecosystem diversity targets, such as areas to have at least one legume/m2 except for areas less than 0.5 ha and their total areas are less than 10% of the rehabilitated areas.

Fauna

- Within 2-3 years of the revegetation of each waste rock dump, fauna habitats will be provided/created to encourage native fauna re-establishment.
- Within 4 to 5 years of the revegetation of each waste rock dump, appropriate fauna monitoring will be conducted to evaluate the progress of revegetation towards fulfilling the agreed land use objectives (or against a suitable analogue/ reference site).
- Reaching agreed numeric targets (animal or habitat diversity).

Hydrology

- Surface and Groundwater monitoring will be conducted on an ongoing basis throughout the life of mine and at least 5 years after closure to validate the mine water quality prediction.
- Appropriate data from recognised climate change models affecting hydro-geological processes impacting surface water and groundwater will be incorporated into mine site and rehabilitation designs.
- Seepage from all tailings storage facilities will meet the National Water Quality Management Strategy guidelines (available online at www.environment.gov.au/**water**/policy-programs/nwqms/ , papers 4, 6, 7 & 8).
- Where excavations near *sensitive water resources* (available online at www.water.wa.gov.au) no exposed water bodies created or allowed to remain unless authorised in writing by regulatory bodies (DEC, DoW, OEPA).

Infrastructure and Waste

- Before relinquishment, all wastes will be removed from site or appropriately buried if non-polluting.
- Before closure scrap metal will be broken up and recycled where possible.