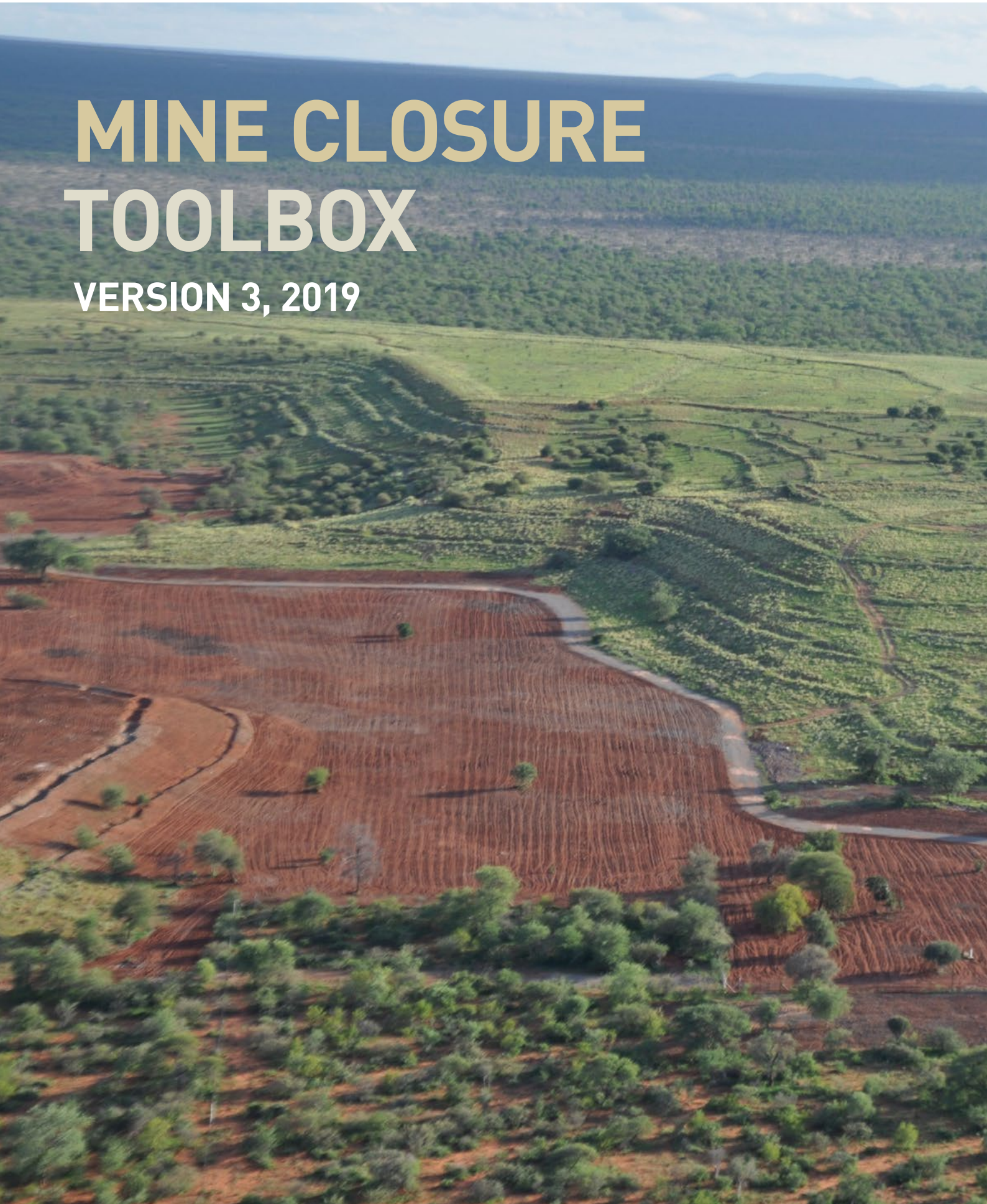
AngloAmerican

Real Mining. Real People. Real Difference.

MINE CLOSURE TOOLBOX

VERSION 3, 2019



FOREWORD

Anglo American's (AA) burning ambition is to be the most valued mining company in the world by 2023. The purpose of AA is to reimagine mining to improve people's lives.

Mining plays a significant role in human and economic development and, without the mining sector, society would not enjoy a large number of the benefits that it does today. The mining industry's rich history also carries some important lessons and one of these is the poor closure or abandonment of mines by the industry worldwide. If AA is to achieve its burning ambition and purpose, the closure team must deliver value through integrated, risk and opportunities based closure planning and execution, to establish safe, stable and non-polluting post-mining landscapes that leave a positive and sustainable legacy for stakeholders.

The updated Mine Closure Toolbox (MCT) (v3) has incorporated the Integrated Closure Planning System (ICPS) that was developed in 2015 and built on the existing toolbox (v2) that was released in 2013. Importantly, a Group wide closure standard was endorsed in June 2018 and this updated version of the MCT provides the guidance for AA operations to achieve the requirements outlined in the standard. The updated version of the MCT increases the emphasis on the importance of designing, planning, operating and executing closure at AA operations, with a focus on integration with Life of Asset Planning (LoAP). The updated MCT is targeted at people in our operations across a range of disciplines, the tools provide practical support as to how to achieve the desired integrated outcomes for AA. It is also important that a preferred future for the mine footprint post-production is developed in partnership with communities.

The tool reinforces our desire for improved community relationships and engagement. Some of the more immediate benefits from our updated MCT are increased integration with LoAP, potential lower closure liabilities, lower rehabilitation costs, more effective social investment and engagement, and enhanced value to AA and its stakeholders.

Together, we create sustainable value that makes a real difference.

Mark Cutifani
Chief Executive
November 2019

FRONT COVER:
Aerial view of the closed Oaks Mine in South Africa.

ACKNOWLEDGEMENTS

The original report "Version 1, 2007" was developed by Peter Coombes and Rudolph Botha from the then Anglo Technical Division. The second version of the MCT was developed by Rudolph Botha of AA's Technical Solutions with the support and inputs of various AA technical resources. This third version of the MCT was developed by Carl Grant and Rudolph Botha from AA's Group Technical and Sustainability.

The authors would like to thank the various individuals across the Group who provided comment, examples and factual data for incorporation into this revised document.

For more information contact:

Dr Carl Grant
Head of Mine Closure
Group Technical and Sustainability
201 Charlotte St
Brisbane, 4000

Email: carl.grant@angloamerican.com

Telephone: +61 7 3834 1215

or

Mr Rudolph Botha
Lead Mine Closure
Group Technical and Sustainability
45 Main Street
Johannesburg, 2001

Email: rudolph.botha@angloamerican.com

Telephone: +27 11 638 2254

Published by Anglo American plc

Designed and produced by Creativity

CONTENTS

INTRODUCTION

Mining has played an instrumental role in the development of modern society. These benefits have associated impacts and risks that must be managed by mining companies to retain their social licence to operate. A critical risk remains the ability to sustainably close mining operations. The concept of planning and executing mine closure has existed for a number of decades with the overarching philosophy "that closure should be considered throughout the lifecycle of a mine, from cradle to cradle" (Grant 2018). Regardless, there remain very few examples worldwide of successful mine closure and subsequent lease relinquishment, with notable exceptions (e.g. Grant 2006; Lacy & Bennett 2015). A major part of the challenge is that closure planning is rarely seen within the culture of the industry as a core business activity, and subsequently it is rarely integrated with other mine-planning activities more relevant to the day-to-day operation of the mine (e.g. short and medium mine planning, LoAP). This is generally due to the lack of ownership of closure issues by the site mine management teams, as closure is either seen as being too far into the future or someone else's problem. This is despite the establishment of clear closure policy by most mining corporations and the many changes in mine closure related regulation around the globe.

The AA MCT was first released in 2007, with an updated second version released in 2013. The MCT has therefore been the cornerstone of mine closure in AA for well over a decade. Importantly, the MCT was published in three languages (i.e. English, Spanish and Portuguese) and was made publicly available. By the end of 2018, more than 95% of AA operations had closure plans that were fundamentally aligned with the MCT. Grant and Botha (2015) provided three case studies from Anglo operations around the globe where integrated closure planning opportunities had been realised generating value in excess of $US 200 M through eliminating risks or prevention of value destruction. Based on the success of these case studies, Anglo commenced the development of an ICPS in 2014, noting that the existing MCT did not sufficiently emphasise the importance of operational integration. The preliminary development of the ICPS involved the identification of current and target condition, and an initial maturity assessment across more than 50 operations as described in Grant and Lacy (2016). The objective of the ICPS is to combine the various mine planning regimes, internal and external requirements, financial considerations and systems from a people, process and technology perspective, over the life cycle of operations, to ensure Anglo optimises use of its resources and leaves a positive and sustainable legacy for their host communities' post closure. Implementation of the ICPS has now commenced at 12 AA operations around the world, with initial pilots completed at Kolomela Mine in South Africa (Grant et al. 2016) and Drayton Mine in Australia.

In June 2018, a Group Closure Technical Standard was endorsed (see Appendix 1). The closure standard contained the critical elements of the MCT and ICPS. This third version of the MCT amalgamates the MCT v2 and the ICPS to form a single guidance document to support the closure standard. This new guidance will be implemented across all AA operations over the coming years.

Distant view of the Tumela One Shaft, South Africa.

KEY CHALLENGES

There are a number of key challenges associated with mine closure across the mining industry that have been taken into consideration in the development and update of this Toolbox.

- Mine closure should be integrated with LoAP. While this is often recognised as desirable, it is rarely fully realised. This third version of the MCT has an increased focus on integration into LoAP.
- Mine closure planning and execution should be from 'cradle to cradle'. The first cradle term relates to the importance of commencing planning for the end of the mine as early as possible, generally in the exploration phase but certainly through the FEL project stage gates. The second cradle reflects the rebirth of the mine in a new form reflective of the identified sustainable PMLs.
- Mine closure is multi-disciplinary in nature. This represents both an opportunity and a risk. Disciplines that should be involved in closure planning and execution include short/medium/LoAP, environment/rehabilitation, financial, legal, engineering/technical services, social/community, tailings management and safety/health. In many instances, the role that these disciplines have to play in closure is not clearly articulated. If it is clarified, it can also be seen as an additional responsibility that may be in conflict with other operational priorities.
- The sale of mines to junior operators is often an alternative to closure implementation, particularly where the junior may be able to extend the life of the asset. Regardless of whether disposal is an option, good closure planning and concurrent rehabilitation will add value to the asset.
- Closure requirements change with time and regulators are often risk adverse. Community expectations and regulatory controls will change over the life of a mine and the mine closure planning process needs to accommodate these changes. There is no such thing as a zero risk closure, however, many regulators see this as the only acceptable outcome.
- Insufficient attention is often paid to the cost of closure during the mine design and for much of the operating life. This is because the closure cost is to be expended in a future time horizon, making the NPV of this cost negligible, and hence not a significant factor in decisions. Furthermore, the cost of closure, deferred by two or more decades, could be incorrect by orders of magnitude and still make no difference to the threshold NPVs and IRRs. Mine closure planning needs to actively avoid a solely NPV approach, and instead also focus on ultimate cash cost and cost variance.
- Closure liabilities are often under-represented until the last few years before closure. A large increase in closure costs are often seen in the last few years of the operational life, often when cash flows and profits from continuing operations are rapidly decreasing. This can lead to a focus on decreasing costs without adequately considering the risk of these decisions.
- Mining is often associated with higher salaries and levels of dependency, particularly in developing countries. These levels of wealth can rarely be sustained through the transition to the PML. Regardless, it is of critical importance that sustainable livelihoods aligned with the underlying opportunities and constraints that the environment offers at closure are implemented, and complement the PML to generate a positive legacy.
- Stakeholder consultation related to closure has historically been absent or of poor quality. As concerning, more recently, the level of influence of external stakeholders has not been made clear during engagements leading to decreased levels of trust. It is critical that stakeholders are engaged in a timely manner, with the level of influence clearly identified.
- The required duration of the monitoring and maintenance phase is often under-estimated, with some regulators pushing in-perpetuity funding of residual risks. While relinquishment may not be possible or desirable in all cases, it should be possible in most cases to develop lower risk mine closures, not involving active water treatment.
- Closure planning and execution should be risk and opportunity based. However, with constantly changing economic circumstances, mines can be put into care and maintenance or prematurely closed, meaning that activities planned over the full LoA are not realised.
- The same level of project management rigour that is applied through the FEL process for project development should be applied to closure. Historically, the transition of a mine into closure was largely the domain of environmental professionals with little planning or implementation through the mine cycle. It is important to recognise that end of mine transitioning ideally requires the involvement of people with project management experience with teams similar to FEL projects being formed. This would involve personnel with expertise in fields such as project management, planning, scheduling, finance, safety and health, human resources, environment, legal, document control and administration. It is important to note that the senior leadership personnel at a mine during its operating phase are not necessarily the best people to be involved in the transition phase because of a production only focus. There is, of course, a trade-off between site knowledge and required skills in the transition phase, but a combination of project people and site people often achieves the best results.

Return to Contents page

PURPOSE OF THE TOOLBOX

The purpose of this updated version of the MCT is to provide AA's global operations with the required guidance to meet the requirements of the Global Closure Technical Standard. The two existing guidance documents (MCT v2 and ICPS) have been merged in this process to provide clarity about expectations.

STRUCTURE OF THE TOOLBOX

The MCT consists of the following six Tools:

- **Tool 1 Strategic Planning:** This Tool identifies the legal and regulatory requirements, a risk assessment framework, collates physical, biophysical, social and economic baselines, and identifies a post-closure vision and associated PMLs with draft success criteria.
- **Tool 2 Rapid Assessment:** This Tool identifies knowledge gaps in the mine's existing closure plan and defines what level of detail the closure plan should contain relative to the remaining life of the asset.
- **Tool 3 Closing the Gaps:** This Tool identifies the approach to closing the gaps identified in Tool 2, through the development of a master action plan, with a schedule, RACI and resource planning.
- **Tool 4 Integration:** This tool focusses on integrating mine closure into LoAP to realise value and/or de-risk closure.
- **Tool 5 Execution:** This tool focuses on planning related to mine closure execution in the last five years of operation, through the closure phase, and into the monitoring and maintenance phase, to facilitate relinquishment where appropriate. It also covers operational closure execution such as concurrent rehabilitation.
- **Tool 6 Review and Continuous Improvement:** This tool focuses on the cyclical nature of closure planning and execution, including the acceptability of the closure plan to the various stakeholders.

The Tools follow a logical sequence as shown in Figure 1. A key element of this approach is that the post-closure vision is defined upfront to ensure that the mine is designed and operated in a manner that is geared towards closure. This means that mine closure is defined during the conceptual and pre-feasibility phases of a mine and achieved during the design and operational phases. It is important to note that the MCT (v3) is risk and opportunity based and should not be viewed in isolation, but rather as complementary to the existing management processes at the operation.

For each Tool, an Introduction is provided followed by the approach which is broken into steps outlining the purpose (Figure 2). Each step then has a process that is broken into sub-steps (see Tool 1-6). The Rapid Assessment Tool (2) is broken into items namely physical, biophysical, social, financial and other (Figure 2).

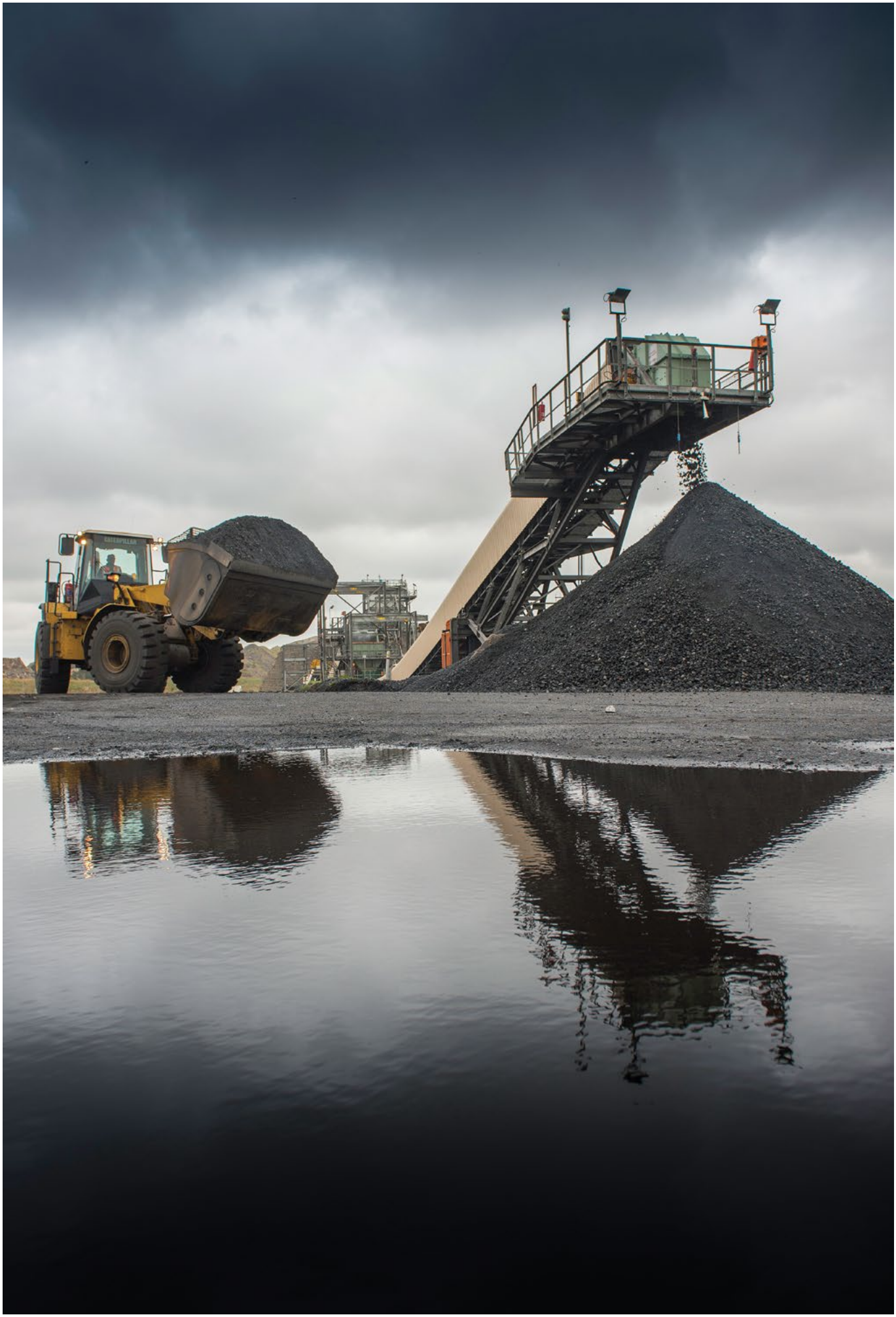
The main document of the MCT (v3) is supported by an 'Examples' document that contains case studies for many of the steps in the main document.

SUPPORTING POLICIES AND PRINCIPLES

The Toolbox is underpinned by the AA 'Code of Conduct', the International Council on Mining and Metals' (ICMM) principles and commitments as well as the Good Practice Guidance for Integrated Mine Closure, and the AA Safety Health and Enviornment (SHE) Policy and Guidelines. The Toolbox also dovetails with the AA Social Way (AASW), as it is the vehicle for social transition during the operational phase.

WHO SHOULD USE THE TOOLBOX (V3)?

The MCT (v3) has been produced for use by AA operations to assist them in the development and execution of mine closure plans that are aligned with the Group Technical Standard. It is envisaged that the Toolbox will be used broadly across an operation but should provide specific assistance in the areas of mine planning, environmental management, social management, human resources, health impacts on employees, their dependants, and on the surrounding communities, and financial provision for closure. The Toolbox is risk and opportunity based and should be used throughout the whole life cycle of a mine. The updated version of the MCT will also be made available to external stakeholders to assist in moving the discipline forward at an industry level.



A mined coal stockpile at Zibulo Colliery Opencast section near Oogies in South Africa.

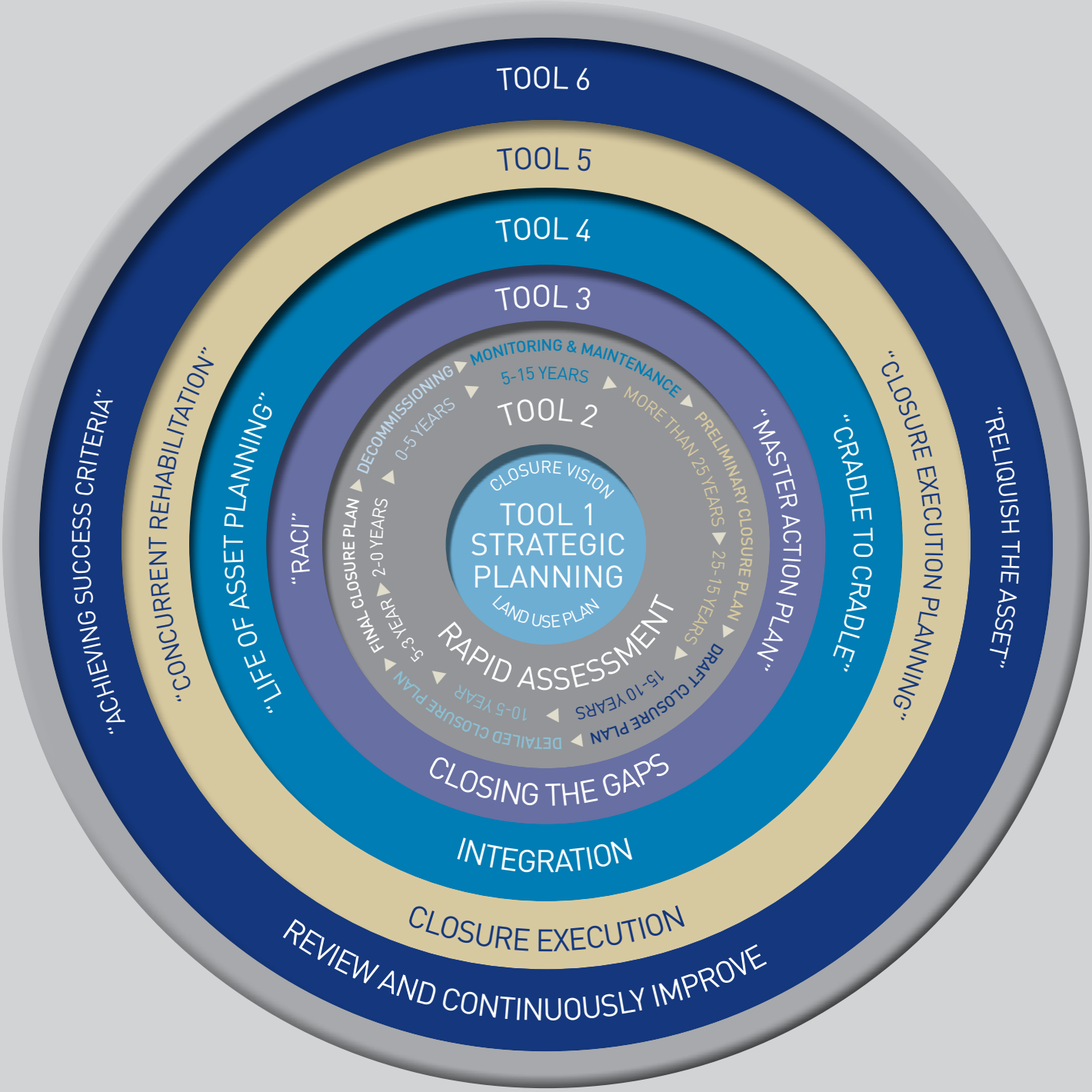


Figure 1: Structure of the MCT (v3).

Figure 2: MCT (v3) tools, steps and items.

Return to Contents page

Mogalakwena North Concentrator in South Africa.

TOOL 1: STRATEGIC PLANNING

INTRODUCTION

It is critical that a mine's closure plan is defined and driven by the wider physical, biophysical, social and economic contexts within which an operation is located. This will ensure that the broader environment, including its inherent risks and opportunities, influences mine closure decisions. The aim is to follow a holistic approach by understanding the broader environmental and social context and then to align the mine to this landscape. The earlier this approach is followed in the life of a mine, the greater the opportunity for proactive planning.

Identifying internal and external stakeholder requirements is a key element of planning for mine closure. This ensures that the subsequent closure plan addresses all of these commitments. A further aspect of the strategic planning involves investigating potential PMLs and the subsequent identification of the closure vision. The closure vision provides the overall direction for the development of the closure plan.

Undertaking a closure risk assessment is one of the cornerstones of the MCT. The risk assessment assists in identifying closure criteria and identifies those areas requiring further investigation where residual risk is at an unacceptable level (broadly defined as where residual risk is rated as significant or high). It also assesses the effectiveness of the selected closure criteria and clearly demonstrates the business case for the inclusion of each closure activity, either based on reducing an unacceptable risk to an acceptable level or optimising an opportunity. Climate change impacts should be considered during the closure risk assessment process. Conducting a benchmarking exercise assists in identifying alternative closure criteria that may be more effective in reducing the residual risk to an acceptable level.

Success criteria (also known as completion criteria) are the agreed standards that must be met to facilitate lease relinquishment. They include physical, biophysical and socio-economic parameters and are generally defined through engagement with regulators and other external stakeholders. Success criteria must complement and fully align with the closure vision, objectives and closure criteria. They should be SMART. Success criteria should be identified in the early stages of the development of an operation and should become more quantitative over time as concurrent rehabilitation is undertaken and success criteria are tested. During engagement with regulators, it should be made clear that success criteria will change over time as they are tested, but this should not be used as an excuse to not attempt to develop them early in an operations life. Success criteria should be drafted for the planning phase given the often lacking supporting information relating to the operational phase.

APPROACH

Step 1.1: Understand the physical, biophysical, social and economic context within which the operation is located.

PURPOSE

Physical and biophysical context is required to:

- Establish the wider environmental context, and constraints and opportunities on likely closure options and outcomes.
- Observe and record changes in the baseline environment (control sites linked to success criteria).
- Set the baseline for achieving the closure vision.
- Contribute to the establishment of closure objectives, closure criteria and success criteria.
- Provide the data to manage potential long term environmental impact on the local operational area, the region and the community.

The social and economic context is required to:
- Determine the social and economic impacts and opportunities on the closure vision and plan.
- Establish the industry standards and guidelines required to meet the company's signatory commitments and obligations.
- Identify interested and affected parties.
- Manage stakeholder expectations and focus on achievable long-term goals.

PROCESS

- Step 1.1.1: Identify the physical and biophysical context including physical site infrastructure and operational areas, mining method, catchment water status, tailings and waste rock dump design, rainfall, temperature, wind, air quality, noise, surface water, groundwater, geochemistry and water quality, geology, land capability and land-use, soils, topography, fauna, flora, heritage and cumulative impacts.

- Step 1.1.2: Identify the social and economic context including demography, land tenure, housing, infrastructure and services, development priorities, employment, poverty, health, education, stakeholder mapping, community safety and security (see AASW Section 2: Review and Planning).

- Step 1.1.3: Establish the Zone of Influence (ZoI) of the project by overlaying the extent of influence of each physical, biophysical, social and economic impact onto a map (see the Examples document – Example 1).

The ZoI is the area within which a development has material impacts or can influence impacts due to the development and/or other developments. The ZoI is required to be identified so that the appropriate spatial areas are considered for physical, biophysical, social and economic considerations.

- Step 1.1.4: Develop a stakeholder map (see AASW Section 3A: Stakeholder Engagement).

Step 1.2: Identify internal and external requirements, and develop a commitments register.

PURPOSE

The internal and external requirements are required to:
- Ensure the company vision, policies and standards are met.
- Ensure all the legal commitments for the operation are known and met.
- Ensure that all industry standards and guidelines required to meet the company's signatory commitments and obligations are known.
- Understand and manage the expectations of stakeholders (what can and cannot be achieved at closure).

The commitments register captures all of the internal and external requirements in a format that allows compliance to be tracked. This commitment register is a live document that will be maintained throughout the life of the operation (see AASW Section 2: Review and Planning).

PROCESS

- Step 1.2.1: Engage with internal and external stakeholders to seek their input on key items related to mine closure such as the closure vision, PMLs, closure criteria, acceptable residual risk profile, success criteria and social issues (understanding the opportunities and the constraints of the environment from Step 1).

- Step 1.2.2: Identify all of the internal and external requirements for the operation.

- Step 1.2.3: Develop a commitments register that identifies all of the requirements for the operation and assigns a responsible person, due date and status.

Step 1.3: Identify the most suitable PMLs and define the closure vision.

PURPOSE

All areas disturbed by an operation need to be rehabilitated to an agreed post mining state. The land-use prior to disturbance may not always be the most appropriate land-use following rehabilitation. It is important to investigate a range of existing and novel land-uses and then compare these to the land capability following rehabilitation. There may be a single land-use identified for the whole operation, or different land-uses for different domains on the site. Identification of PMLs is required to define the closure vision and inform the required rehabilitation prescriptions (see the Examples document – Examples 1 and 2).

A closure vision is a perspective of the legacy which an operation wants to leave behind in terms of the physical, biophysical, social and economic conditions. A realistic closure vision is required to frame the development of the closure objectives, closure criteria and success criteria.

PROCESS

- Step 1.3.1: Identify the preferred PMLs by investigating existing land-uses in the ZoI (using the outputs from Step 1 and 2) as well as novel land-uses that may be appropriate to particular disturbance areas at the operation (see Figure 1).

- Step 1.3.2: Develop a PML plan by evaluating the possible identified land-use options assessed against land capability.

- Step 1.3.3: Based on the land-use plan, draft a closure vision and have it endorsed by senior leadership at the operation.

EXAMPLE CLOSURE VISION

To leave safe, stable, non-polluting and sustaining landforms and associated existing and innovative land-uses, that are consistent with the surrounding landscape and leaving a positive legacy for the community that optimises utilisation of the existing infrastructure, allowing timely and cost effective relinquishment of the lease.

Step 1.4: Undertake a closure risk assessment.

PURPOSE

A closure risk assessment is required to:

- Ensure that the risks to successful closure of the operation are identified.
- Identify the effectiveness of the closure criteria;
- Ensure alignment with achieving the PMLs and closure vision.
- Compare the residual risk profile and the associated liability estimate.

Figure 1: Example of PML options map. Different colours refer to different land-uses.

- Determine what closure criteria should be used to mitigate and minimise the risks.
- Identify what further mitigation options or studies are available to reduce the risk where the residual risk is not acceptable.

PROCESS

- Step 1.4.1: Undertake a closure risk assessment according to the process identified in the 'Examples' document (see Example 3) (also see AASW Section 3C: Social and Human Rights Impact and Risk Analysis).

- Step 1.4.2: Develop and cost high level closure criteria (mitigation measures) as part of the risk assessment process, where existing closure criteria have not already been developed. Include additional or revised closure criteria where unacceptable residual risks have been identified.

Step 1.5: Undertake a benchmarking exercise.

PURPOSE

For closure risks that have an unacceptable residual risk with the existing proposed closure criteria and/or excessive costs, benchmarking should be undertaken to identify other potential options. Benchmarking of the closure criteria are required to:

- Ensure leading practice options both internally and externally are being considered relative to closure criteria.
- Ensuring the lessons learnt from other closures (internally and externally) are incorporated within the closure plan.
- Ensure that unacceptable risk is evaluated against other options to identify alternative closure criteria.
- Ensure that high cost closure criteria are replaced by more financially executable measures.

PROCESS

- Step 1.5.1: Undertake a benchmarking exercise at international, national, regional and local scale for risks that have an unacceptable residual rating and/or excessive costs (see the Examples document – Example 4).

- Step 1.5.2: Identify alternative closure criteria that are assessed from the benchmarking exercise as the options that are most likely to reduce risk or cost, investigate the applicability of the new criteria and substitute in the closure plan if appropriate.

Step 1.6: Update post closure land-use plan and vision.

PURPOSE

Once the risk assessment and benchmarking exercise have been completed, it is important to review the land-use plan and closure vision to ensure that it is still appropriate.

PROCESS

- Step 1.6.1: Update the post closure land-use plan and closure vision based on the results of Steps 1.4 and 1.5.

Step 1.7: Develop draft success criteria for the planning phase.

PURPOSE

Success criteria should be drafted as early in the closure planning process as possible (see the Examples document – Example 8).

PROCESS

- Step 1.7.1: Develop high level principles relating to the success criteria.

- Step 1.7.2: Define suitable time categories for the success criteria.

- Step 1.7.3: Draft success criteria for the planning time category stated as a question, the relevant domains, guidelines for acceptance, the accepted standard and potential corrective actions should then be developed, using the identified commitments as a starting point.

Truck hauling waste at the Minas-Rio Plant, Conceição do Mato Dentro, Minas Gerais State.

CASE STUDY: TERRACE MINING AT DAWSON DECREASES OPERATIONAL COST AND CLOSURE LIABILITY

1. Background to Dawson Mine

Dawson Mine is one of two large open cut coal mining operations owned by AA and is located near the township of Moura in central Queensland, Australia. The natural topography of the area has gently rolling hills at an elevation of 150 masl with cattle grazing the predominant pre-mining land-use. The mine was opened in 1961 with both underground and open cut operations with various owners over the subsequent half a century. AA acquired the mine in 2002 from Shell as a joint venture with Mitsui (51:49). Dawson was the first Australian operation to use draglines in 1963 to best exploit the multi seam deposit. The steeply dipping coal seams result in increasing overburden volumes for every strip. The mine currently extends over 50 km, with a footprint over 10,000 ha and mines, 10 Mt of metallurgical and thermal coal per annum, employing more than 1,000 people.

2. Business case drivers

Dump space in certain areas of the Dawson Mine was becoming limited. This was due to the presence of infrastructure to the east of existing dumps and future reserves to the west. A range of options were therefore investigated involving an eastern out of pit dump, a western out of pit dump or terrace mining with trucks/shovels incorporating backfilling of existing voids. The age of the existing draglines assisted in making the capital expenditure case to change the fleet. A lack of historic progressive rehabilitation with continuing new disturbance was also leading to ever increasing closure liabilities.

3. Operational change

Dawson Mine has historically been operated as a large strip mine with multiple draglines exposing coal in a westerly direction and dumping spoil to the east (Figure 1). A change in mining strategy was implemented to realign mining operations by 90 degrees and use operational expenditure to backfill mining voids. This involved changing the fleet for this part of the mine to truck and shovel (Figure 1). A number of snapshots of the pit at various stages of development over a 10 year period are provided below (Figure 2). This simulation provides a compelling visualisation of the development of the pit area over time using the Deswik software which was instrumental in facilitating the operational change.

4. Value realised

The change to terrace mining at Dawson was undertaken with a reduction in operational expenditure of more than $A10/t. This was due to the relatively short haul distance that planners achieved by increasing the height of existing waste dumps and minimising the open pit area. However, this did require a period of 18 months establishment where costs were slightly increased from historical levels as

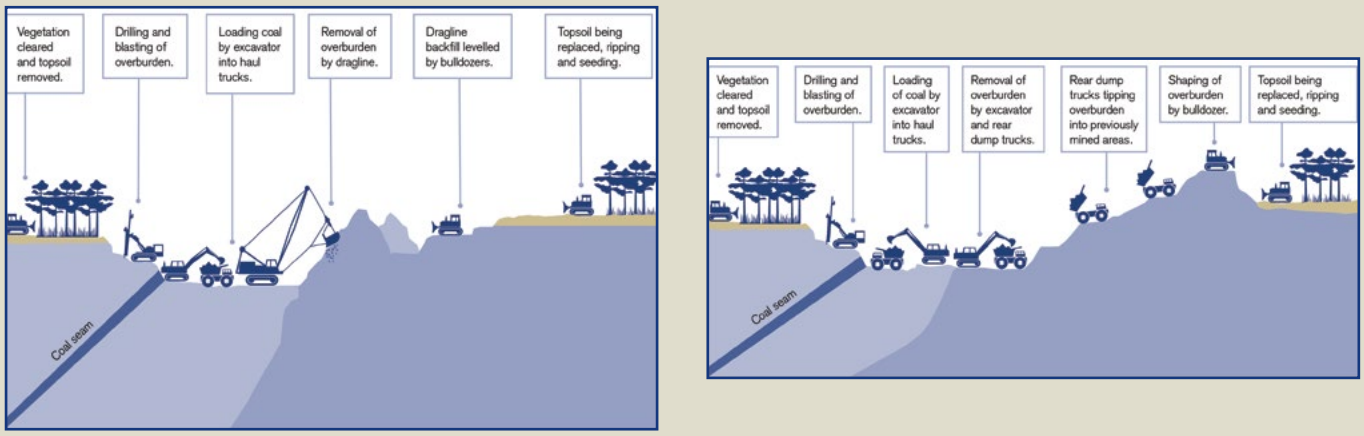


Figure 1: Hypothetical dragline (left), and truck and shovel coal mine (right)

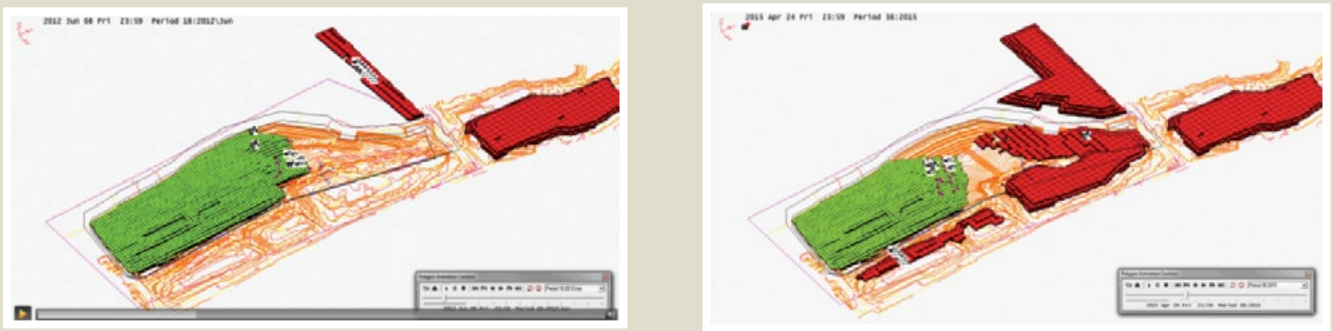


Figure 2: Deswik simulation of terrace mining at Dawson (green is spoil to be moved and red is spoil that has been moved).

pre-stripping operations to establish in-pit dumping were completed. The pit backfill eliminated the requirement on closure to fill and reshape substantial portions of the final mining void realising a reduction in the mine closure liability This decrease in liability was significant (multiple tens of millions of dollars) and was realised immediately with release of the NPV held on the provision that contributed to profit that year at Dawson Mine.

5. Learnings

The case study outlined above has potential learnings that can be applied to other operations to realise value namely:

- **Multi-faceted business case:** This case study had a very sound financial business case from an operational expenditure and closure liability perspective. In addition, there were non-financial benefits of this integrated planning project including compliance with regulatory requirements, social licence to operate from external stakeholders, reputational development and facilitating project approval through demonstrated performance.
- **Compelling visual and spatial outputs:** This is critical to making the business case to senior leaders who are more likely to be convinced if they can visualise the proposed mine plan changes.
- **Multi-disciplinary teams:** This case study involved multidisciplinary teams identifying, planning and implementing the operational changes, including site and corporate staff in the disciplines of mine planning, mining engineering, finance and environmental. Critically, individuals were prepared to cross departmental and perceived boundaries. Equally important was the overall site ownership of the project.

Otavio Lopes samples water quality above Barro Alto, Brasil.

Return to Contents page

TOOL 2: RAPID ASSESSMENT

One of the bird hides on the Zibulo Mine Property, South Africa.

INTRODUCTION

Closure liability varies over the life of a mine. Typically the closure liability will increase rapidly in the early establishment stages, thereafter the liability tends to plateau due to rehabilitation that is undertaken concurrently with mining (see Figure 1 of Tool 4). At decommissioning, the aim is to have a remaining liability that encompasses mainly the closure of items that could not be undertaken during the operational phase of the mine. Due to the significance of rehabilitation in the context of closure, it is important to ensure from the outset that the rehabilitation objective as well as the success criteria and associated monitoring programme are in line with the post-closure vision and PMLs, and that I&APs and relevant authorities have been consulted and are in general agreement.

This Tool provides a model against which a mine's current closure plan can be evaluated and from which the following key aspects relating to closure can be determined:

- The required level of closure planning that the operation should ideally be at, in relation to the remaining LoA.
- The gaps in a mine's current closure plan when compared against the required level of closure planning.
- The requirements to address gaps identified in the current closure plan.

An example of a completed gap analysis is contained in the 'Examples' document (see Example 6) that forms part of this Toolbox.

APPROACH

The rapid assessment model consists of a spreadsheet (pages 16-35) with the time remaining to scheduled closure along the horizontal axis, and the items relating to 1) physical closure; 2) biophysical closure, including rehabilitation; 3) social transition (including health); 4) others including success criteria, monitoring programme and risk assessment; and 5) financial requirements and risk assessment along the vertical axis.

The individual cells specify the minimum requirements that should be met for the items along the vertical axis, depending on time remaining to planned mine closure. The information required for each of the closure items increases in detail and accuracy as the mine moves closer to closure, resulting in a preliminary mine closure plan, when closure is more than 25 years away, to a draft mine closure plan, a detailed mine closure plan and eventually a final agreed mine closure plan, when closure is within five years. The required level of detail associated with the post production phases, called the decommissioning phase, and the subsequent monitoring and maintenance phases, is also reflected in the spreadsheet. The approach to using the evaluation model consists of the following four steps:

Step 2.1: Provide a short description of the physical, biophysical or socio-economic item.

PURPOSE:

The purpose of this step is to have a short description of each of the items under physical, bio-physical and socio-economic areas to provide context to facilitate the evaluation against the various levels of the closure criteria.

PROCESS:

- Step 2.1.1: Group items together that will be closed in a similar fashion (e.g. infrastructure that that will be demolished regardless whether it is on-site or off site).
- Step 2.1.2: Include a short description in the "Item description" column of each of the items (as grouped) under physical closure, bio-physical closure, social transition other items (success criteria, monitoring and risk assessment) and economic requirements.
- Step 2.1.3: Review the item description column to make sure all activities and items that forms part of the operation have been described.

Step 2.2: Evaluate the site's current status with respect to each identified item.

PURPOSE:

The purpose of this step is to evaluate the current level of confidence of each item.

PROCESS:

- Step 2.2.1: Scan along each row and identify the cell that most closely reflects the current status of the item, based on the requirements as listed.
- Step 2.2.2: Select the most appropriate cell for each row to reflect the current level of confidence.
- Step 2.2.3: Highlight the cell using the same color as the column heading and include a short description, including some remaining gaps.

Step 2.3: Identify the appropriate column along the horizontal axis based on the operation's remaining LoA.

PURPOSE:

The purpose of this step is to select the appropriate column based on the current agreed LoAP.

PROCESS:

Step 2.3.1: Select the appropriate column that will reflect the current required level of confidence for the operation based on the current agreed LoAP (e.g. 15-10 years remaining LoA – Draft mine closure plan required).

Step 2.4: Identify the items that are not at the appropriate level of confidence

PURPOSE:

The purpose of this step is to identify the items that are not at the required level of confidence. To satisfy the minimum requirements for the current stage of closure planning (i.e. preliminary, draft, detailed or final), all the cells in the relevant column should be highlighted.

PROCESS:

- Step 2.4.1: Identify the gaps as highlighted by the cells in the columns to the left of the column selected in Step 2.3.1 indicate.
- Step 2.4.2 Identify the items where the closure plan is at a higher level of confidence, as highlighted by the cells to the right of the selected column in Step 2.3.1.
- Step 2.4.3: Using Tool 3, develop a master action plan to address the gaps as identified in Tool 2.

EVALUATION SPREADSHEET:

Time remaining to scheduled closure	More than 25 years	25-15 years	15-10 years	10-5 years
Item description	**Preliminary Closure Plan**		**Draft Closure Plan**	**Detailed Closure Plan**
Physical closure				
Physical closure criteria				
Infrastructure (on and off-site). Reference:	Following a risk-based approach, a complete set of closure criteria has been developed and costed. The criteria used (BoE) in the closure cost estimate are based on experience and available information.	Relevant discipline experts have undertaken a desktop investigation into the closure methodology and criteria, to confirm the current criteria or to establish more appropriate criteria (BoE).	The closure criteria recommended by the relevant discipline experts have, where appropriate, been reviewed and updated by undertaking a site-specific investigation into the closure methodology. The granularity of the criteria (BoE) has improved and also includes infrastructure maintenance requirements, waste disposal and recycling requirements, asset disposal categories and an associated register.	The criteria have through onsite or industry execution been demonstrated and accepted to be successful. I&APs and authorities have been consulted and are in the majority satisfied with the closure and success criteria. A detailed asset register is available that differentiates between demolition, disposal and retention. An asset management strategy and plan, including the Stakeholder Engagement Plan (SEP), master action plan and schedule with cashflow, have been developed.

5-0 years		0-15 years	
5-3 years	2-0 years	0 - 5 years	5 - 15 years
Final Closure Plan		Decommissioning	Monitoring and Maintenance
Closure execution planning, scheduling and costing have been completed to a Prefeasibility B "PFS-B" level, as per the AA Investment Development Model (IDM) requirements with the key execution documents being (but not limited to): • Project Charter, Study Execution Plan, Project Execution Plan, Work Breakdown Structure (WBS), Detailed Execution Schedule, Project Risk Register; SEP, Legal Register, Financial Plan, Model and Report. • Cost benefit analyses have been undertaken on alternative uses for infrastructure and equipment post closure (in line with the final land-use plan). • Work packages have been costed and the execution plan scheduled and resourced. The trade-off study between owner vs. contractor execution has been completed. • The relevant authorities have signed off the closure and success criteria. Other I&APs have been engaged to the appropriate level of influence.	The detailed closure execution planning, scheduling and costing have been completed and all execution documentation have been completed by improving the PBS-B study to that of a Feasibility Study (FS) level, as per the AA IDM requirements, that will contain the following additional deliverables (but not limited to): • Logistics Management Plan, Change Management Plan, Engineering Management Plan, Procurement Management Plan; Environmental Management Plan, and Document Control Management Plan. • Where appropriate, some of the work packages have gone out to tender and are ready for order placement and execution (especially the work as scheduled for the 1st year of decommissioning).	The decommissioning plan includes all the project management and risk controls associated with effective project execution and tracking in place. The success of the project is tracked against Key Performance Indicators (KPIs), such as budget, progress, community and regulatory acceptability and meeting the overall agreed success criteria. **See Tool 5 for details on project execution planning and management.**	A detailed post decommissioning monitoring and maintenance plan is in place that tracks risk management, financial performance, ongoing progress, stakeholder engagement, success criteria and ultimately relinquishment of assets. **See Tool 5 for details on project execution planning and management.**

Time remaining to scheduled closure	More than 25 years	25-15 years	15-10 years	10-5 years
Item description	**Preliminary Closure Plan**		**Draft Closure Plan**	**Detailed Closure Plan**
Physical closure				
Physical closure criteria				
Mineral Waste Landforms: Reference:	Following a risk-based approach, the closure criteria and conceptual final landform designs are available and based on the planned LoA tonnage/volume of mineral residue and stockpile material. The landform designs also consider the following key components: *1) Material volumes and characterisation:* A high-level material balance is in place, reflecting key mineral residue volumes over the LoA, including the required growth medium for rehabilitation purposes. Material characterisations have been undertaken at a high level to identify and quantify inert material vs. hostile material (e.g. potential Acid Metalliferous Drainage (AMD), spontaneous combustion, dispersive material, saline material). *2) Management of hostile material:* The required management measures and closure criteria have been included in the landform design to address the long-term impacts of hostile materials (e.g. selective placement vs. capping and/or lining). *3) Availability of footprint:* The landform design does take into consideration the current and future footprint requirements, especially considering final slopes. The requirements of the final landform designs are included in the LoAP parameters. *4) Landform stability:* Landform stability has been evaluated through geotechnical and erosional studies. Key considerations include typical erosion challenges, possible flooding and where applicable earthquake conditions. *5) Water management:* Conceptual water management planning has been undertaken and the closure requirements of these facilities included in the design and costing.	Relevant discipline experts have improved the landform designs. High-level cost benefit analysis has taken place to evaluate significant technical, environmental and operational considerations, and the potential impact on mining operations and costs. The landform designs were improved by undertaking the following: *1) Material volumes and characterisation:* A detailed balance is in place for hostile and non-hostile material, reflecting all current and future mineral waste volumes and requirements. *2) Management of hostile material:* Geochemical testing (at least static and kinetic tests) has been completed on the various hostile materials. *3) Availability of footprint:* The final landform designs compliment the final land-use plan. Operational deposition strategies allow for reduction in future material double handling and optimisation of concurrent rehabilitation. *4) Landform stability:* Landform stability has been re-evaluated, based on erosion modelling results and more detailed long-term flooding designs. A monitoring programme is in place to validate landform stability predictions. *5) Water management:* Water management design ensures clean and dirty water separation post closure (e.g. storm water diversions).	Relevant discipline experts have undertaken a site-specific investigation into the closure methodology and criteria, to confirm the current criteria or to establish more appropriate closure criteria. The executability of the closure criteria and the cost effectiveness of the designs have been demonstrated by onsite execution and rehabilitation. The landform designs were improved by undertaking the following: *1) Material volumes and characterisation:* A detailed balance is maintained for hostile and non-hostile material (live system), reflecting no shortfall in materials to execute the closure plan. *2) Management of hostile material:* Additional kinetic testing has been completed where required and the monitoring programme is demonstrating successful onsite containment and remediation. *3) Availability of footprint:* Final landform execution is tracked to ensure it is aligned with the plan and sufficient space is available for concurrent rehabilitation. LoAP allows for sufficient available areas to undertake landform closure execution (shaping and rehabilitation). *4) Landform stability:* Effectiveness of management measures and closure criteria are being tracked and monitored and required changes made to improve long-term stability and reduce costs. *5) Water management:* The effectiveness and long-term sustainability of water management structures and measures are tracked and improved as required.	Final post closure landform design and execution is fully integrated into LoAP, as part of the ongoing deposition strategies. The cost of closure execution is tracked as part of the operational financial reporting and the benefit of integrated LoAP and closure strategies measured. The landform designs were improved by undertaking the following: *1) Material volumes and characterisation:* Detailed balance is in place for hostile and non-hostile material and it can be demonstrated that the landform development sequencing considers scheduled material movements by waste type and costs are supported by equipment requirements. *2) Management of hostile material:* Ongoing monitoring can prove landform stability and provides seepage analyses, as well as drainage/effluent water quality projections. *3) Availability of footprint:* I&APs and authorities have been engaged to the appropriate level of influence on the final landform designs and are satisfied with the closure and success criteria (majority agreement). *4) Landform stability:* Final capping and or reshaping designs have been completed and costed, including construction sequencing requirements to maintain long term physical and chemical stability. *5) Water management:* The effectiveness and long-term sustainability of water management structures can be demonstrated.

5-0 years		0-15 years	
5-3 years	2-0 years	0 - 5 years	5 - 15 years
Final Closure Plan		Decommissioning	Monitoring and Maintenance
Closure execution planning, scheduling and costing have been completed to a PFS-B level, as per the AA IDM. The specific mineral residue and landform deliverables being (but not limited to): • Final post closure landform designs, supported by detailed mine equipment requirements. • Seepage analyses and the landform water balance and water management plan, for facilities and surrounding areas. • Description of water management and diversion works in a post-closure condition, including risk assessment, and risk mitigation plan. • The trade-off study between owner execution vs. contractor execution. • The relevant authorities have signed off the closure and success criteria and other I&APs have been consulted. • Execution planning, scheduling and costing have been undertaken and key execution documentation have been completed (see Infrastructure section for more details).	The closure execution PFS-B study has been improved to that of a FS level, as per the AA IDM. requirements. The specific mineral residue and landform deliverables being (but not limited to): • Final agreed detailed landform designs, including selective placement of various closure phase related waste types (hostile and non-hostile material, generated due to closure activities, e.g. demolition rubble, contamination below infrastructure, etc.) and the geochemical stability of the facilities. • Detailed engineering designs, including contact and non-contact water diversion and management, landform water balance, stability and seepage analyses, water quality and water treatment requirements, are included in the final design and costed. • The detailed execution planning, scheduling and costing have been undertaken and all execution documentation have been completed (see Infrastructure section for more details).	(See Infrastructure section for detailed requirements).	(See Infrastructure section for detailed requirements).

Time remaining to scheduled closure	More than 25 years	25-15 years	15-10 years	10-5 years
Item description	**Preliminary Closure Plan**		**Draft Closure Plan**	**Detailed Closure Plan**
Physical closure				
Physical closure criteria				
Non-Mineral Waste: Reference:	Following a risk-based approach, a complete set of closure criteria has been developed and costed for the non-mineral waste facilities including long-term management. *Waste Identification and classification:* Key non-mineral waste streams are known and estimated current and future volumes have been predicted. *Regulatory requirements:* Regulatory requirements related to the various waste stream are known (e.g. permit conditions) and forms part of the closure criteria. *Waste disposal options:* A decision on undertaking onsite or offsite disposal form part of the closure planning and costing. *Waste management and facilities:* Non-mineral waste management procedures are in place, including the management of onsite waste disposal facilities.	Relevant discipline experts have improved the non-mineral waste strategy and plan by undertaking the following: *Identification and classification:* All non-mineral waste streams have been identified and current and future volumes have been calculated. *Regulatory requirements:* Regulatory requirements related to the various waste streams are known (e.g. permit conditions) and forms part of the closure criteria. *Waste disposal options:* A high-level trade-off study has taken place to compare onsite vs. offsite disposal and the closure planning and costing have been updated accordingly. *Waste management and facilities:* Operational costs associated with non-mineral waste management is known. Onsite waste disposal facilities are managed. The current capacity of off-site waste disposal facilities is known. *Closure criteria:* The closure risk assessment has been updated and all risks have been classified as either significant, insignificant or unknown. The complete set of closure criteria have been updated to align with the success criteria.	Relevant discipline experts have improved the non-mineral waste strategy and plan by undertaking the following: *Identification and classification:* A Non-mineral waste register is in place and is actively managed. *Regulatory requirements:* Regulatory requirements related to the various waste streams are tracked in a live legal and permitting system and forecasted changes in legislation are considered in the updated closure criteria (e.g. more stringent future legislation). *Waste disposal options:* A detailed cost benefit analysis has taken place and the closure planning and costing have been updated accordingly. *Waste management and facilities:* Operational success can be demonstrated and the costs associated with non-mineral waste management is tracked and used to improve the costing in the closure liability. Onsite waste disposal facilities are managed and the effectiveness of closure criteria is tracked. The current and future capacity of off-site waste disposal facilities have been investigated and forms part of the updated closure criteria. *Closure criteria:* The closure risk assessment has been updated and all previous unknown risks have been re-classified as either significant or insignificant. The complete set of closure criteria have been updated to align with the success criteria.	Relevant discipline experts have improved the non-mineral waste strategy and plan by undertaking the following: *Identification and classification:* Studies have been completed on waste beneficiation and alternative solutions to waste disposal and management (e.g. reclassification of waste). A non-mineral waste register is in place and is actively managed. *Regulatory requirements:* The authorities have been consulted to obtain agreement on the success criteria. *Waste disposal options:* The final waste management and disposal strategy (including permission for onsite disposal of inert waste) has been agreed with the authorities and the closure planning and costing have been updated accordingly. *Waste management and facilities:* Discussion has taken place with offsite waste disposal operators to secure future waste disposal capacity and corporate social investment projects are in place to facilitate future offsite disposal capacity. *Closure criteria:* The closure risk assessment has been updated and improved to be more quantitative than qualitative and by including I&APs inputs. The complete set of closure criteria have been updated accordingly.

5-0 years		0-15 years	
5-3 years	2-0 years	0 - 5 years	5 - 15 years
Final Closure Plan		Decommissioning	Monitoring and Maintenance
Closure execution planning, scheduling and costing have been completed to a PFS-B level, as per the AA IDM. The specific non-mineral waste deliverables being (but not limited to): • Final non-mineral waste disposal strategy and option analysis. • Detailed quantitative risk assessment (pre and post mitigation ranking) with appropriate closure criteria. • Detailed specialist studies used to quantify risk and impacts (e.g. seepage analyses, geochemistry analysis, future predictive modelling). • The relevant authorities have been involved in the finalisation of the closure and success criteria and other I&APs have been consulted. • Detailed liability estimate covering decommissioning and post closure periods. Liabilities estimate to differentiate between latent, residual and current closure liabilities. • Execution planning, scheduling and costing have been undertaken and key execution documentation have been completed (see Infrastructure section for more details).	The closure execution PFS-B study has been improved to that of a FS level, as per the AA IDM. requirements (see Infrastructure section for detailed requirements).	(See Infrastructure section for detailed requirements).	(See Infrastructure section for detailed requirements).

Time remaining to scheduled closure	More than 25 years	25-15 years	15-10 years	10-5 years
Item description	**Preliminary Closure Plan**		**Draft Closure Plan**	**Detailed Closure Plan**
Physical closure				
Physical closure criteria				
Mining areas (surface/ underground/ seaborne): Reference:	A complete set of closure criteria has been developed and costed following a risk-based approach. The criteria used (BoE) in the closure cost estimate are based on experience and available information. The focus being on leaving behind safe, secure, chemically and physically stable structures, that will not continue to pollute the environment post long-term mitigation. The key critical closure criteria that must be covered includes long-term geotechnical and geochemical stability, safety, security and long-term impacts on the environment (e.g. ground and surface water) and people, and alignment with the final closure vision and land-use plan.	Relevant discipline experts have undertaken a desktop investigation and benchmarking (on high risk and high cost components), into the closure methodology and criteria, to confirm the current criteria or to establish more appropriate criteria (BoE). The key critical closure criteria must cover (but is not limited to) the following: *Stability:* Specialist studies will be undertaken on long-term geochemical stability, using high level designs and available geochemical information. *Safety and security:* Initial investigations into long-term relaxation zones (~breakback zones), covering people and the environment, including components such as possible solutions for long-term access control. *Relaxation:* Relaxation zone is the geotechnical prediction of failure of pit walls based on an identified Factor of Safety defined by AA as 1.5. *Bio-physical (see bio-physical and social sections in Tool 2):* Long-term impacts on surface and ground water resources (e.g. pit water quality, future decant management, interconnectivity of groundwater between pits/underground workings, long-term health impacts on people) are investigated. *Land-use:* The impacts of the mining areas (i.e. final voids, shafts, adits) on the final closure vision and land-use plan needs to be assessed and aligned.	The previous closure criteria recommended by the relevant discipline experts have, where appropriate, been reviewed and updated by doing a site-specific investigation into the closure methodology as well as focused benchmarking. The granularity of the criteria (BoE) has improved and includes decommissioning, closure and long-term monitoring and maintenance requirements, and costs for each of the mining areas. The previously identified key critical closure criteria has been improved by undertaking the following: *Stability:* Detailed geotechnical and geochemical stability design requirements, must form part of LoAP and execution, and a predictive model has been developed to quantify and manage the associated risks (e.g. identification of pit relaxation zones identification, subsurface support deterioration and subsequent surface settlement, long-term metal leaching due to AMD). *Safety and security:* Detailed operation and closure designs to identify and maintain long-term relaxation zones, covering people and the environment, needs to be in place. Detailed security plans need to be in place to not only address operational risks but also the projected future closure and post closure risk components such as long-term access control and others safety and security risks. *Bio-physical (see bio-physical and social sections in Tool 2):* Detailed studies must be completed, and plans must be in place to address long-term impacts on surface and underground water resources (e.g. pit water quality, future decant, interconnectivity of groundwater between pits/underground workings, health impacts on people). *Land-use:* The closure criteria as defined and costed for the mining areas (final voids, shafts, adits) must align fully with final closure vision and land-use plan.	The criteria have through onsite or industry execution been demonstrated and accepted to be successful. I&APs and authorities have been engaged at the appropriate level of influence and are in the majority satisfied with the closure and success criteria. A detailed decommissioning and closure management strategy (including the SEP; master action plan/schedule with cashflow) have been developed to facilitate the successful execution of the mining areas. The previously identified key critical closure criteria have been improved by undertaking the following: *Stability:* Long-term geotechnical and geochemical stability modelling has been improved by ongoing calibration to improve the predicted long-term impacts and to demonstrate the success of implemented closure criteria. *Safety and security:* The successful management of long-term safety and security has been proven by continuously improving the delineation of the various zone of influences, covering people and the environment, including components such as long-term access control (e.g. sealing of shafts, installation of berms and fencing, dense vegetation and cut off trenches around final voids), prevention of illegal mining, and safety and security risks. *Bio-physical (see bio-physical and social sections in Tool 2):* Long-term impacts on surface and underground water resources, and people have been monitored and the closure criteria updated to ensure an acceptable residual risk profile. *Land-use:* The closure criteria as defined and costed for the mining areas (final voids, shafts, adits) are updated in line with the final agreed closure vision and land-use plan.

5-0 years		0-15 years	
5-3 years	2-0 years	0 - 5 years	5 - 15 years
Final Closure Plan		Decommissioning	Monitoring and Maintenance
Closure execution planning, scheduling and costing have been done to a PFS-B level, as per the AA IDM requirements with the key execution document being (but not limited to): • Project Charter, Study Execution Plan, Project Execution Plan, Work Breakdown Structure (WBS), Detailed Execution Schedule, Project Risk Register, SEP, Legal Register, Financial Plan, Model and Report.	The detailed closure execution planning, scheduling and costing have been done and all closure execution documentation have been completed by improving the PFS-B study to that of a FS level, as per the AA IDM requirements.	The decommissioning plan includes all the project management and risk controls associated with effective project execution and tracking in place. The success of the project is tracked against the KPIs, such as budget, progress, community and regulatory acceptability and meeting the overall agreed success criteria. **See Tool 5 for details on project execution planning and management.**	A detailed monitoring and maintenance plan is in place that tracks risk management, financial performance, ongoing progress, stakeholder engagement, success criteria and ultimately relinquishment of assets. **See Tool 5 for details on project execution planning and management.**

Time remaining to scheduled closure	More than 25 years	25-15 years	15-10 years	10-5 years
Item description	**Preliminary Closure Plan**		**Draft Closure Plan**	**Detailed Closure Plan**
Physical closure				
Physical liability estimate				
Physical closure liability estimate: Reference:	Class 5 estimate. L: -30% to -50%. H: +50% to +100%. Contingency (P50) of 30%-50%.	Improved class 5 estimate. L: -20% to -50%. H: +30% to +100%. Contingency (P50) of 25%-40%.	Class 4 estimate. L: -15% to -30%. H: +20% to +50%. Contingency (P50) of 20%-30%.	Class 4 estimate. L: -15% to -30%. H: +20% to +50%. Contingency (P50) of 20%-30%.
Biophysical closure/rehabilitation				
Biophysical closure criteria				
Land-use and capability: Reference:	High-level land-use plan has been developed based on assumed impacts, primarily focused on the local land capability before mining. The land-use plan aligns with the initial closure vision. (See AASW Section 4F: Land access, displacement and resettlement)	A detailed land-use plan has been developed by the relevant discipline experts and the impacts have been assessed. The land-use plan aligns with the updated closure vision (internally and externally developed).	The assessed impacts have been confirmed through additional studies and the land-use plan updated by also including focused inputs from I&APs and authorities. The land-use plan aligns with the agreed closure vision (internally agreed and broadly external acceptance).	The final land-use plan has been developed with I&APs and authorities through the appropriate level of engagement and influence and the closure criteria and success criteria updated accordingly. The land-use plan aligns with the agreed closure vision (internally agreed and majority external acceptance).
	The suggested rehabilitation methods to achieve the land-use plan are based on experience and known methods from other sites. The landform designs allow sufficient flexibility to accommodate future changes to the final land-use (e.g. benches are constructed wide enough to accommodate for increased shaping of batters to flatter slopes), concurrent rehabilitation and rehabilitation trials are taking place, as appropriate.	The suggested rehabilitation methods to achieve the land-use plan have been assessed by means of concurrent rehabilitation and/or rehabilitation trials on site (concurrent rehabilitation if LoM is more than 25 years) and improved or modified as required.	The improved or modified rehabilitation methods to achieve the land-use plan have been tested through on-site trials and/or concurrent rehabilitation, from which it can be demonstrated that they are successful. Appropriate research programmes are in place to investigate methods to establish required species (e.g. seed dormancy, plant propagation methods).	The preferred rehabilitation method to achieve the land-use plan from the testing phase that was demonstrated to be successful is selected, and I&APs and authorities have been engaged at the appropriate level of influence and are, in general, satisfied with the rehabilitation method and results.
Rehabilitation (Strategy): Reference:	A concurrent rehabilitation strategy and associated plans have been developed and signed off by site senior management, and action has been taken to ensure these are included in the closure planning process and implemented.		A concurrent rehabilitation strategy and associated five year plans with procedures (including the post production period) have been developed for ongoing inclusion in the closure planning process and relevant components implemented annually. Concurrent rehabilitation plans are included in the operational budgets and progress is measured, adaptively managed with mitigation as required and ongoing reporting is taking place.	
Surface and Groundwater: Reference:	The potential closure and post-closure impacts on surface and groundwater are based on general experience and are not supported by detailed technical investigations or significance ratings (unless it formed part of regulatory requirements for mines with a LoA of more than 25 years). The potential closure and post closure impacts have not been discussed in detail with the authorities or other I&APs, other than through the normal regulatory processes.	The potential closure and post-closure impacts have been identified and assessed through an environmental impacts assessment of the mine closure plan and specialist investigations. All high, significant, medium, low and unknown risks have been identified. Hydrogeological and geochemical surface and groundwater models are in place and are calibrated on a regular basis with operational data.	The potential closure and post-closure impacts have been confirmed through additional specialist studies and post-closure environmental assessments, and the significant and insignificant risks have been communicated to I&APs for comment. All unknown risks have been rated. A detailed solute transfer model with integrated surface and groundwater numerical components and geochemical model and associated storm water management structures and systems that are costed in the closure liability are in place.	The required closure criteria associated with significant surface and groundwater risks can be considered proven if historical evidence is available, reflecting that they have been successfully implemented in similar circumstances elsewhere, or the proposed closure criteria to address high and significant risks have been tested on site and demonstrated to be successful. I&APs and authorities are satisfied in the majority with the closure criteria. Numerical solute models are updated with further field data as it becomes available.

5-0 years		0-15 years	
5-3 years	**2-0 years**	**0 - 5 years**	**5 - 15 years**
Final Closure Plan		**Decommissioning**	**Monitoring and Maintenance**
Class 3 estimate. L: -10% to -20%. H: +10% to +30%. Contingency (P50) of 15%-20%.	Class 2 estimate. L: -5% to -15%. H: +5% to +20%. Contingency (P50) of 10%-15%.	Class 1 estimate. L: -3% to -10%. H: +3% to +15%. Contingency (P50) of 5%-10%.	Class 1 estimate. L: -3% to -10%. H: +3% to +15%. Contingency (P50) of 5% -10%.
The authorities have agreed to the final closure vision and related rehabilitation methods to achieve the land-use plan and other I&APs have been engaged at the appropriate level of Influence, and majority agreement obtained.		**See Tool 5 for details on project execution planning and management.**	
Closure execution planning, scheduling and costing have been undertaken to a PFS-B level, as per the AA IDM requirements.	The detailed closure execution planning, scheduling and costing have been undertaken and all closure execution documentation have been completed by improving the PFS-B study to that of a FS level, as per the AA IDM requirements.	The success of the project is tracked against the KPIs and meeting the overall agreed success criteria. **See Tool 5 for details on project execution planning and management.**	A detailed monitoring and maintenance plan is in place that tracks the success criteria and ultimately relinquishment of leases. **See Tool 5 for details on project execution planning and management.**
A concurrent rehabilitation strategy and associated five year plans with procedures (including the post production period) have been developed for ongoing inclusion in the closure planning process and relevant components implemented annually. Concurrent rehabilitation plans are included in the operational budgets and progress is measured, adaptively managed with mitigation as required and ongoing reporting is taking place.		The post production component of the rehabilitation strategy and associated plans (including maintenance and management plans) have been approved and executed accordingly. Plans are included in closure budgets and progress is measured and reported. **See Tool 5 for details on project execution planning and production period) have been developed for ongoing inclusion in the closure planning process and relevant.**	
The relevant authorities have signed off on the surface and groundwater closure criteria and other I&APs have been engaged at the appropriate level of influence, and the majority agree with the closure criteria.		The post production component of the ground and surface water strategy and associated plans have been approved and executed. Plans are in closure budgets and progress is measured and reported. Long-term residual and latent Impacts are known and are being monitored. **See Tool 5 for details on project execution planning and management.**	

	More than 25 years	25-15 years	15-10 years	10-5 years
Item description	**Preliminary Closure Plan**		**Draft Closure Plan**	**Detailed Closure Plan**
Biophysical closure/rehabilitation				
Biophysical closure criteria				
Visual/aesthetic: Reference:	Assumed visual and sense of place impacts were based on available information of the local mining area.	An environmental impact assessment (including social) was undertaken and the visual, sense of place and heritage impacts were assessed, covering the full life cycle of the operation, including post closure phase impacts.	All gaps and unknown risks have been addressed through additional specialist studies, including landscape studies (if, appropriate), and all unknown risks and gaps have been closed with appropriate mitigation identified.	The closure criteria have been proven to be successful by means of successful onsite execution, and I&APs and authorities have been engaged at the appropriate level of influence and there is majority acceptance of the success and appropriateness of the mitigation measures.
	The required closure criteria have been developed based on available information on similar rehabilitation requirements in the industry.	Operational management measures are in place, and the closure criteria have been developed and costed.	Operational management measures and closure criteria have been updated, and trials have taken place to demonstrate the effectiveness of the mitigation measures.	Operational management measures and closure criteria have been updated, and successful onsite execution has taken place with majority acceptance of I&APs.
Biophysical liability estimate				
Biophysical closure liability estimate: Reference:	Class 5 estimate. L: -30% to -50%. H: +50% to +100%. Contingency (P50) of 30%-50%.	Improved class 5 estimate. L: -20% to -50%. H: +30% to +100%. Contingency (P50) of 25%-40%.	Class 4 estimate. L: -15% to -30%. H: +20% to +50%. Contingency (P50) of 20%-30%.	Class 4 estimate. L: -15% to -30%. H: +20% to +50%. Contingency (P50) of 20%-30%.
Social transition (including health)				
Social transition criteria				
Employees and their dependants: Reference:	The requirements of employees and social transition criteria aligned with the final land-uses have been assumed and only a rapid Health Impact Assessment (HIA) has been carried out at project commencement (see the Examples document – Example 10). Only an initial profile of the operation's employees has been generated. The needs of employees have been assumed and appropriate social transition criteria developed and costed.	A current HIA is in place and is updated as required, with ongoing occupational HRA conducted. The needs of employees have been assessed and appropriate social transition criteria developed and costed (mostly operational expenditure and possibly some closure liabilities).	The previously identified socio-economic needs, including an in-depth HIA, as well as the closure vision are well recognised. These aspects have been discussed with employees and updated accordingly. A future forum consisting of management, representative employees, union representatives and community members is in place. The operation's employees' capabilities and career aspirations are known and there is alignment with the operations' business plan. The needs of employees have been reassessed and appropriate social transition criteria developed and costed (mostly operational expenditure and possibly some closure liabilities).	The confirmed social transition requirements and final land-use objectives have been identified in more detail through social transition planning and re-confirmed by means of employee involvement. A comprehensive, portable skills plan (development and redeployment), taking into account the requirements of the remainder of the business plan, as well as employees' individual and community members' social needs, are in place. The needs of employees are known and appropriate social transition criteria developed and costed (mostly operational expenditure and possibly some closure liabilities).
	No consultation specific to mine closure planning is required at this stage, as there is typically not a sufficiently detailed closure plan around which to consult. Discussion around mine closure with employees is focused on high level key messages.	Employees have been engaged at the appropriate level of influence related to the mine closure plan by providing them with balanced and objective information to improve their understanding of the issues, alternatives and/or solutions and to enable them to raise issues and concerns.	Employees have been given the opportunity to review the revised mine closure plan and be part of the closure plan development, by means of ongoing engagement with the operation. Feedback from stakeholders on issues, alternatives and/or decisions has been considered and incorporated into the closure plan, where appropriate.	Employees are directly engaged at the appropriate level of influence throughout the process, to ensure that issues and concerns are consistently understood and considered, and offered the opportunity to make substantive changes to the closure plan and its criteria, where appropriate.

5-0 years		0-15 years	
5-3 years	2-0 years	0 - 5 years	5 - 15 years
Final Closure Plan		Decommissioning	Monitoring and Maintenance
The final landform designs are aligned with the closure vision and final land-uses and the authorities have agreed on the mitigation and rehabilitation methods and I&APs have been engaged at the appropriate level of Influence and there is majority agreement.		The mitigation measures have been successfully executed according to closure execution plan.	The residual risk profile is acceptable to I&APs and the authorities and the long-term sustainability of the solution have been proven to be successful (e.g. through monitoring).
Closure execution planning, scheduling and costing have been done to a PFS-B level, as per the AA IDM.	The detailed closure execution planning, scheduling and costing have been done and all execution documentation have been completed by improving the PFS-B study to that of a FS level, as per the AA IDM requirements.	The closure and post closure component to address the visual impacts, as well as the associated plans (including maintenance and management) have been approved an executed. Closure budget is available, and progress is measured and reported. Long-term residual and latent Impacts are known and are being monitored. **See Tool 5 for details on project execution planning and management.**	
Class 3 estimate. L: -10% to -20%. H: +10% to +30%. Contingency (P50) of 15%-20%.	Class 2 estimate. L: -5% to -15%. H: +5% to +20%. Contingency (P50) of 10%-15%.	Class 1 estimate. L: -3% to -10%. H: +3% to +15%. Contingency (P50) of 5%-10%.	Class 1 estimate. L: -3% to -10%. H: +3% to +15%. Contingency (P50) of 5%-10%.
Closure execution planning, scheduling and costing have been done to a PFS-B level, as per the AA IDM requirements with the key social transition deliverables being (but not limited to): • Detailed Human Resources (HR) ramp down profile aligned with the decision on contractor vs. owner execution. • Detailed reskilling and training programme. • Detailed health plan, covering exit medicals and post closure health care plans. • A review of the health components as conducted by an independent agency.	The detailed closure execution planning, scheduling and costing have been done and all closure execution documentation have been completed by improving the PFS-B study to that of a FS level, as per the AA IDM requirements.	The closure and post closure component to address employee impacts, as well as the associated plans have been approved and executed. **See Tool 5 for details on project execution planning and management.**	Post closure budget is available for monitoring and maintenance phase, and progress is measured and reported long-term residual and latent Impacts are known and are being monitored. **See Tool 5 for details on project execution planning and management.**
The employees have been engaged at the appropriate level of influence in each aspect of the decision-making process, through which majority agreement with the mine closure plan and its final post-closure goals has been obtained.		SEP is in place to manage expectations and mitigate impacts during the decommissioning phase.	SEP is in place to manage expectations and mitigate impacts during the monitoring and maintenance phase.

Time remaining to scheduled closure	More than 25 years	25-15 years	15-10 years	10-5 years
Item description	**Preliminary Closure Plan**		**Draft Closure Plan**	**Detailed Closure Plan**
Social transition criteria				
Interested and Affected parties (I&APs): Reference:	The requirements of I&APs and the social transition criteria and final land-use have been assumed and no community HIA has been completed (see the Examples document – Example 10). The needs of I&APs have been assumed and appropriate social transition criteria developed and costed.	Information on community health is obtained from appropriate sources *(see AASW Section 4C: Community Health and Safety Management)*. The needs of I&APs have been assessed through a Social Impact Assessment (SIA). Appropriate social transition criteria (e.g. economic diversification and reduced long-term dependency on mining being a focus area) have been developed and costed (mostly operational expenditure and possibly some closure liabilities). *(see AASW Section 4: Socio-economic Development (SED).)*	The previously identified socio-economic needs, health needs and the closure vision are well recognised. These aspects have been discussed with I&APs and updated accordingly. The operational budgets are geared towards addressing the social transition mitigation measures (e.g. economic diversification), by using current vehicles such as the AASW. The intention is to address all social transition requirements through operational management and not have any closure liabilities. Social transition criteria have been updated and costed (mostly operational expenditure).	The confirmed social transition requirements and final land-use objectives have been identified in more detail and re-confirmed by means of I&APs involvement. Impacts on community health and well-being are managed (mitigated and/or enhanced) in partnership with key stakeholders. The social transition process is managed through the AASW and success is tracked and measured to ensure an acceptable residual social risk profile post closure.
	No consultation specific to mine closure planning is required at this stage, as typically there is not a sufficiently detailed closure plan around which to engage at the appropriate level of influence. If an appropriate plan does exist, engagement at the appropriate level of influence should be from cradle to cradle. High level key messages related to closure should be developed.	I&APs have been engaged at the appropriate level of influence related to the mine closure plan by providing them with balanced and objective information to improve their understanding of the issues, alternatives and/or solutions and to enable them to submit their issues and concerns.	I&APs have been given the opportunity to review the revised mine closure plan and be part of the closure plan development, by means of ongoing engagement with the operation at the appropriate level of influence. Feedback from stakeholders on issues, alternatives and/or decisions has been considered and incorporated into the closure plan, where appropriate.	I&APs are directly engaged at the appropriate level of Influence throughout the process, to ensure that issues and concerns are consistently understood and considered, and offered the opportunity to make substantive changes to the closure plan and its criteria, where appropriate.
Authorities: . Reference:	The requirements of authorities are known from the various legal processes, but the social transition criteria and final land-use have been assumed. The needs of the authorities have been assumed to align with the current legal commitments and no additional closure criteria have been developed. A basic legal risk register is in place covering the operational and closure phases.	Additional environmental and social studies have been conducted to improve the confidence in the closure plan, and the potential changes in closure impacts and associated closure criteria. Information on community health is available from public sources. The baseline environmental conditions are known, and the wider strategic socio-economic opportunities and constraints have been identified. A closure vision with underlying principles has been reviewed and improved. A legal risk register to ensure legal compliance during the operational, closure and post closure periods is in place including management plans and tracking tools.	The previously identified environmental mitigation requirements and socio-economic needs, including health, and the closure vision are well recognised. These aspects have been discussed with authorities and updated accordingly. The legal risk register is maintained and continuously updated (live system).	The confirmed social transition/closure requirements and final land-use objectives have been identified in more detail through closure planning and re-confirmed by means of authority involvement. Impacts on community health and well-being are managed (mitigated and/or enhanced) in partnership with key stakeholders. The legal risk register is maintained and continuously updated (live system).

5-0 years		0-15 years	
5-3 years	2-0 years	0 - 5 years	5 - 15 years
Final Closure Plan		Decommissioning	Monitoring and Maintenance
Execution planning, scheduling and costing have been done to a PFS-B level, as per the AA IDM requirements with the key social transition deliverables being (but not limited to): • A review of the community health components by an independent agency (*see Section AASW 4C: Community Health and Safety Management*). • The operational management of the social transition can be demonstrated (e.g. economic diversification, reduced dependency on mining) and residual post closure social risk and costs have been identified.	The detailed execution planning, scheduling and costing have been done and all execution documentation have been completed by improving the PFS-B study to that of a FS level, as per the AA IDM requirements.	The residual closure components to address the social transition, as well as the associated plans have been approved an executed. **See Tool 5 for details on project execution planning and management.**	Post closure budget is available for monitoring and maintenance phase, and progress is measured and reported Long-term residual and latent Impacts are known and are being monitored. **See Tool 5 for details on project execution planning and management.**
The I&APs have been engaged at the appropriate level of influence in each aspect of the decision-making process, through which majority agreement with the mine closure plan and its final social transition and post-closure goals has been obtained.		SEP is in place to manage expectations and mitigate impacts during the decommissioning phase.	SEP is in place to manage expectations and mitigate impacts during the monitoring and maintenance phase.
Closure execution planning, scheduling and costing have been done to a PFS-B level, as per the AA IDM requirements with the key regulatory deliverables being (but not limited to): • An updated legal risk register including a management plan to ensure legal compliance during the closure and post closure periods (e.g. any new legal requirements due to changes in final closure plan). • Master project execution schedule that outlines the regulatory process and key deliverable and milestones to achieve asset relinquishment.	The detailed closure execution planning, scheduling and costing have been done and all closure execution documentation have been completed by improving the PFS-B study to that of a FS level, as per the AA IDM requirements.	The closure and post closure components to address the regulatory requirements, as well as the associated plans have been approved an executed. **See Tool 5 for details on project execution planning and management.**	Post closure budget is available for monitoring and maintenance phase to track and ensure legal compliance and asset relinquishment. **See Tool 5 for details on project execution planning and management.**

Time remaining to scheduled closure	More than 25 years	25-15 years	15-10 years	10-5 years
Item description	**Preliminary Closure Plan**		**Draft Closure Plan**	**Detailed Closure Plan**
Social transition (including health)				
Social transition criteria				
Social transition (including health)				
	Authorities have been engaged through the various legal processes and the associated regulatory closure commitments made in this regard.	Authorities have been engaged at the appropriate level of influence and given the opportunity to develop and review the revised mine closure plan (where appropriate), by means of ongoing engagement with the operation.	Authorities have been engaged at the appropriate level of Influence and given the opportunity to develop and review the revised mine closure plan (where appropriate), by means of ongoing engagement with the operation. Feedback from stakeholders on issues, alternatives and/or decisions has been considered and incorporated into the closure plan, where appropriate.	Authorities are directly involved throughout the process, to ensure that issues and concerns are consistently understood and considered, and offered the opportunity to make substantive changes to the closure plan and its criteria, where appropriate.
Stakeholder engagement: Reference:	The operation's SEP must be in place and must include key concepts of closure planning, such as the closure vision, land-use plan, residual risk profile post closure the management of dependencies, and expectations including the requirement for socio-economic diversification. No detailed engagement on a closure plan is expected at this stage, as typically there is not a sufficiently detailed closure plan around which to engaged (except for operations with a very long LoA – more than 25 years). If an appropriate plan does exist, engagement at the appropriate level of influence should be from cradle to cradle.	The operation's SEP must be updated to cover the current closure plan as a whole, focusing on getting general I&AP acceptance of the closure plan and associated closure criteria with the intent of delivering a set of acceptable "success criteria" linked to an acceptable closure vision and land-use plan. This will be achieved through ongoing engagement with I&APs and authorities at the appropriate level of influence and might also include capacity building around some technical subjects (e.g. AMD, landform design).	The operation's SEP will focus on the updated closure plan, including the closure execution components, aiming to transfer ownership of the closure plan from the operation to the I&APs that will remain in the area post closure by getting approval for the "success criteria" linked to an agreed closure vision and land-use plan. This will be achieved through engagement with I&APs at the appropriate level of nfluence and by directly involving authorities throughout the process, to ensure that issues and concerns are consistently understood and considered and offered the opportunity to make substantive changes to the closure plan and its closure and success criteria, where appropriate.	
Social liability estimate				
Social transition liability estimate: Reference:	Class 5 estimate. L: -30% to -50%. H: +50% to +100%. Contingency (P50) of 30%-50%.	Improved class 5 estimate. L: -20% to -50%. H: +30% to +100%. Contingency (P50) of 25%-40%.	Class 4 estimate. L: -15% to -30%. H: +20% to +50%. Contingency (P50) of 20%-30%.	Class 4 estimate. L: -15% to -30%. H: +20% to +50%. Contingency (P50) of 20%-30%.
Other				
Success criteria (physical, bio-physical, social and financial): Reference:	Indicative success criteria, covering the physical, bio-physical, social and financial components of closure planning have been developed (internal process only). The success criteria reflect the legal requirements, closure vision, the post-mining land-use, closure objectives and criteria, with an initial monitoring programme.	Success criteria have been improved to not only reflect the legal requirements, closure vision, post-mining land-use, closure objectives and criteria, but also include parameters for measuring the level of success through a monitoring programme that has been communicated to the authorities.		Updated success criteria have been established to reflect any changes to the post-mining land-use and include monitoring parameters including SMART targets to a defined level of success, and has been approved by authorities, with guidelines for acceptable standards and corrective actions.

5-0 years		0-15 years	
5-3 years	2-0 years	0 - 5 years	5 - 15 years
Final Closure Plan		Decommissioning	Monitoring and Maintenance
The authorities have been engaged at the appropriate level of influence in each aspect of the decision-making process, through which majority agreement with the mine closure plan and its final post-closure goals has been obtained.		SEP is in place to also manage regulatory engagements during the decommissioning phase.	SEP is in place to also manage regulatory engagements during the monitoring and maintenance phase.
The current operational SEP have been updated to a PFS-B and subsequent FS level, as per the AA IDM requirements to focus on the closure and post closure phases, covering (but not limited to): • A detailed communication strategy and plan, including key messaging, single lines of communication and clear understanding of the success criteria. • Authorities and I&APs have been engaged at the appropriate level of influence in each aspect of the decision-making process, through which majority agreement with the mine closure plan and its final post-closure goals has been obtained.		The SEP is in place to manage to manage regulatory and I&AP engagements during the decommissioning phase.	The SEP is in place to manage to manage regulatory and I&AP engagements during the monitoring and maintenance phase.
Class 3 estimate. L: -10% to -20%. H: +10% to +30%. Contingency (P50) of 15%-20%.	Class 2 estimate. L: -5% to -15%. H: +5% to +20%. Contingency (P50) of 10%-15%.	Class 1 estimate. L: -3% to -10%. H: +3% to +15%. Contingency (P50) of 5%-10%.	Class 1 estimate. L: -3% to -10%. H: +3% to +15%. Contingency (P50) of 5%-10%.
Updated success criteria have been established to reflect any changes to the post-mining land-use and include monitoring parameters including SMART targets to a defined level of success, and have been approved by authorities, with guidelines for acceptable standards and corrective actions.		Progress against achieving the approved success criteria are being monitored and tracked by the operation and authorities, and corrective actions (e.g. maintenance) undertaken as required.	The achievement of the targets (success criteria) are being signed-off by the authorities, to enable the relinquishment of the leases.

Time remaining to scheduled closure	More than 25 years	25-15 years	15-10 years	10-5 years
Item description	**Preliminary Closure Plan**		**Draft Closure Plan**	**Detailed Closure Plan**
Other				
Risk Assessment: Reference	A mine closure and post closure risk assessment was undertaken (see the Examples document – Example 3 and Tool 1) covering the pre and post closure criteria ratings. Unknown risks have been identified and an action plan developed to close the gaps (see the Examples document – Example 3 and Tool 1).	The closure and post closure risk assessment has been updated and previous gaps closed, so that most risks can be classified as either significant or insignificant and limited unknown risks remain. Significant and high residual risks have been identified and additional or alternative closure criteria or actions investigated and/or included to reduce the unacceptable residual risks to an acceptable level.	The closure and post closure risk assessment has been updated and all previous unknown risks have been re-classified as either significant or insignificant. Remaining significant and high residual risks have been identifying and additional or alternative closure criteria or actions investigated and/or included to reduce the unacceptable residual risks to an acceptable level.	The closure and post closure risk assessment has been updated and improved by including I&APs and authority inputs. The effectiveness of the controls (i.e. closure criteria) are measured (see the Examples document – Example 13).
Monitoring programme: Reference:	An initial monitoring programme has been developed that covers all potential impact and risk areas identified in closure plan, but may not have been linked to success criteria. A high-level operational maintenance and management plan is in place to address potential issues (e.g. erosion, invasive species).	A detailed monitoring and data management programme has been developed that covers all potential impact and risk areas identified in the closure plan, is implemented, regularly reviewed and linked to success criteria as communicated to the authorities. A detailed operational maintenance and management plan is in place to address issues (e.g. erosion, invasive species, bare areas) with identified mitigation measures.		A detailed monitoring and data management programme that covers all potential impact and risk areas identified in the closure plan, is implemented, regularly reviewed, adapted according to current mine status and linked to the success criteria, as approved by the authorities. A detailed operational maintenance and management plan is in place to address issues (e.g. erosion, invasive species, bare areas), with identified adaptive measures to improve on the success of concurrent rehabilitation and to develop an optimal solution (sustainable in the long-term, executable and at acceptable costs). Actual costs of concurrent closure activities are tracked and reported in the operations financials.
Financial requirements and risk assessment				
Overall Cost Estimate (Accuracy vs. Maturity level): Reference:	Class 5 estimate. L: -30% to -50%. H: +50% to +100%. Contingency (P50) of 30%-50%.	Improved class 5 estimate. L: -20% to -50%. H: +30% to +100%. Contingency (P50) of 25%-40	Class 4 estimate. L: -15% to -30%. H: +20% to +50%. Contingency (P50) of 20%-30%.	Class 4 estimate. L: -15% to -30%. H: +20% to +50%. Contingency (P50) of 20%-30%.
	Estimate is based mainly on assumed closure criteria: 1) Low level of confidence in closure plan with 50% or more assumptions related to the closure criteria in the basis of the estimate.	Estimate is based on reviewed closure criteria: 1) Medium level of confidence in closure plan with between 30% - 40% assumptions related to the closure criteria in the basis of the estimate.	Estimate is based on tested closure criteria: 1) High level of confidence in closure plan with between 20%-30% assumptions related to the closure criteria in the basis of the estimate.	Estimate is based on tested closure criteria: 1) High level of confidence in closure plan with between 15%-20% assumptions related to the closure criteria in the basis of the estimate.

5-0 years		0-15 years	
5-3 years	**2-0 years**	**0 - 5 years**	**5 - 15 years**
Final Closure Plan		**Decommissioning**	**Monitoring and Maintenance**
The detailed closure and post closure risk assessment has been done to a PFS-B level, as per the AA IDM.	The detailed closure and post closure risk assessment is completed by improving the PFS-B study to that of a FS level, as per the AA IDM requirements.	The decommissioning plan includes all the risk controls associated with effective project execution and tracking in place. **See Tool 5 for details on project execution planning and management.**	The monitoring and maintenance plan include all the risk controls associated with effective project execution and tracking in place. **See Tool 5 for details on project execution planning and management.**
A detailed monitoring and data management programme that covers all potential impact and risk areas identified in the closure plan, is implemented, regularly reviewed, adapted according to current mine status and linked to the success criteria, as approved by the authorities. A detailed operational maintenance and management plan is in place to address issues (e.g. erosion, invasive species, bare areas), with identified adaptive measures to improve on the success of concurrent rehabilitation and to develop an optimal solution (sustainable in the long-term, executable and at acceptable costs). Actual costs of concurrent closure activities are tracked and reported in the operations financials.		A detailed monitoring and data management programme that covers all potential impact and risk areas identified in the closure plan, is implemented, and success tracked and reported to the authorities.	The achievement of the success criteria is monitored via the data management programme and reported to the authorities, to enable the relinquishment of the asset.
Class 3 estimate. L: -10% to -20%. H: +10% to +30%. Contingency (P50) of 15%-20%.	Class 2 estimate. L: -5% to -15%. H: +5% to +20%. Contingency (P50) of 10%-15%.	Class 1 estimate. L: -3% to -10%. H: +3% to +15%. Contingency (P50) of 5%-10%.	Class 1 estimate. L: -3% to -10%. H: +3% to +15%. Contingency (P50) of 5%-10%.
Estimate is based on proven closure criteria: 1) High level of confidence in closure plan with between 10%- 15% assumptions related to the closure criteria in the basis of the estimate.	Estimate is based on proven closure criteria: 1) High level of confidence in closure plan with less than 10% assumptions related to the closure criteria in the basis of the estimate.	Estimate is based on actual historical onsite execution costs: 1) High level of confidence in closure plan with less than 5% assumptions related to the closure criteria in the basis of the estimate.	Estimate is based on actual historical onsite execution costs: 1) High level of confidence in closure plan with less than 5% assumptions related to the closure criteria in the basis of the estimate.

Time remaining to scheduled closure	More than 25 years	25-15 years	15-10 years	10-5 years
Item description	**Preliminary Closure Plan**		**Draft Closure Plan**	**Detailed Closure Plan**
Financial requirements and risk assessment				
Overall closure schedule: Reference:	Level 1 Schedule, top down planning using high level milestones and key project events.	Level 2 Schedule, top down planning using high level milestones and key project events.	Level 2 Schedule, top down planning using high-level milestones and key project events. Semi-Detailed.	Level 3 Schedule, top down planning using high-level milestones and key project events. Semi-Detailed.
	Target Schedule Accuracy of ±50%.	Target Schedule Accuracy of ±40%.	Target Schedule Accuracy of ±30%.	Target Schedule Accuracy of ±25%.
Overall financial model and cash flow: Reference:	The initial cashflow is linked to the closure schedule.		Detailed cash flow linked to the closure schedule.	
	(Class 5).		(Class 4).	
Financial provision: Reference:	Select funding method.	Financial provision (Class 5).	Financial provision (Class 4).	
Mine closure plan (Based on overall confidence): Reference:	Preliminary mine closure plan.		Draft mine closure plan.	Detailed mine closure plan.

5-0 years		0-15 years	
5-3 years	2-0 years	0 - 5 years	5 - 15 years
Final Closure Plan		Decommissioning	Monitoring and Maintenance
AA IDM requirements with the key scheduling deliverables being (but not limited to): • Level 4 Schedule, top down planning using key project events. Detailed with focus on identifying and verifying the critical path, key milestones and critical dependencies, long lead items and planning of early works.	Level 4 Schedule, top down planning using key project events. The detailed execution planning, scheduling and costing have been done and all execution documentation have been completed by improving the PFS-B study to that of a FS level, as per the AA IDM requirements.	Level 4 execution schedule, bottom up planning. Detailed, focused on accurately managing and verifying the critical path, near critical path(s), long lead items and planning of ongoing works.	
Target Schedule Accuracy of ±20%.	Target Schedule Accuracy of ±15%.	Target Schedule Accuracy of ±10%.	Target Schedule Accuracy of ±10%.
Final cash flow linked to the closure schedule.	Final cash flow linked to the closure schedule.	Final cash flow linked to execution schedule.	Final cash flow linked to monitoring and maintenance schedule.
(Class 3).	(Class 2).	(Class 1).	(Class 1).
Financial provision (Class 3).	Financial provision (Class 2).	Financial provision/Budget (Class 1).	Financial provision/Budget (Class 1).
Final mine closure plan and associated closure execution plan (PFS-B Level).	Final mine closure plan and associated closure execution plan (FS Level).	Closure execution plan, with detailed annual plans, budgets and schedules.	Detailed closure monitoring and maintenance execution plan with detailed annual plans, budgets and schedules.

CASE STUDY: INTEGRATED PLANNING AT KOLOMELA MINE

1. Background to Kolomela Mine

Kolomela Mine is located within the Northern Cape Province of South Africa south-east of Postmasburg. This open cut iron ore mine commenced operations in 2008. There are three open pits established to access ore and a number of waste landforms. The mine's production rate is between 9 and 12 Mtpa with an expected LoA to 2033. The mining process entails exploration drilling and modelling, topsoil removal and stockpile, drilling, blasting of overburden and retrieving the ore. Overburden is hauled to waste rock dumps. The ore is hauled to the plant where it is crushed, sieved, sorted, and beneficiated before transport by rail to local and international markets via the port at Saldanha Bay on the west coast.

2. Business case drivers

Kolomela was the first operation to fully implement the ICPS. An opportunities analysis utilising the Kepner Tregoe (KT) tool was undertaken (see Example 11). Twelve opportunities were originally identified and these were narrowed down to five based on the 'must' criteria identified in the KT analysis (Figure 1). Plans to further investigate the opportunities were developed on the basis of the output of the KT analysis to further investigate the option and decide whether to adjust the base case in the LoAP. The chosen opportunities were centred around pit backfilling and concurrent rehabilitation activities.

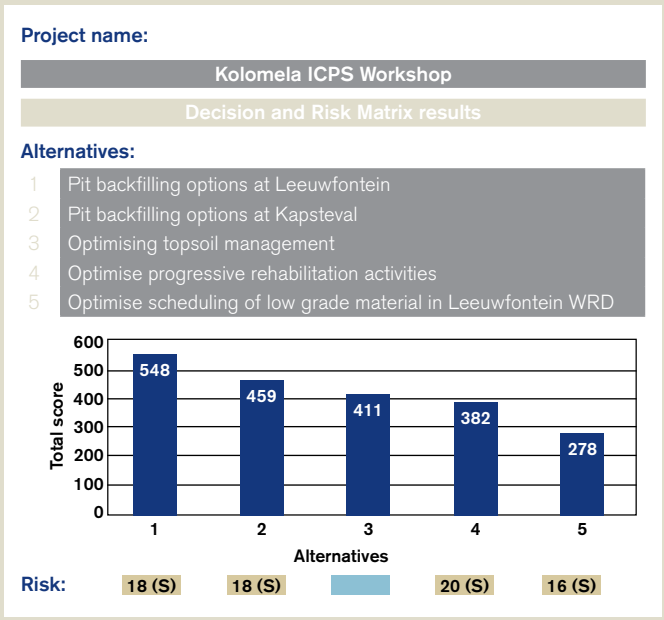


Figure 1: Integration opportunities identified at Kolomela mine using the KT analysis process.

3. Operational change

The implementation plans that were drafted as part of the opportunities workshop were executed and all four led to operational changes namely:

- Pit backfilling at both Leeuwfontein and Kapsteval pits had a compelling business case and so were incorporated into the Kolomela LoAP (Figure 2).
- Topsoil inventory was updated and proposed movement of topsoil from stockpiles to rehabilitated areas optimised based on haul distance.
- Formal analysis was udertaken to determine the best model for provision of concurrent rehabilitation activities (i.e. contractor or in-house), which reinforced the existing model using contractors had the strongest business case.

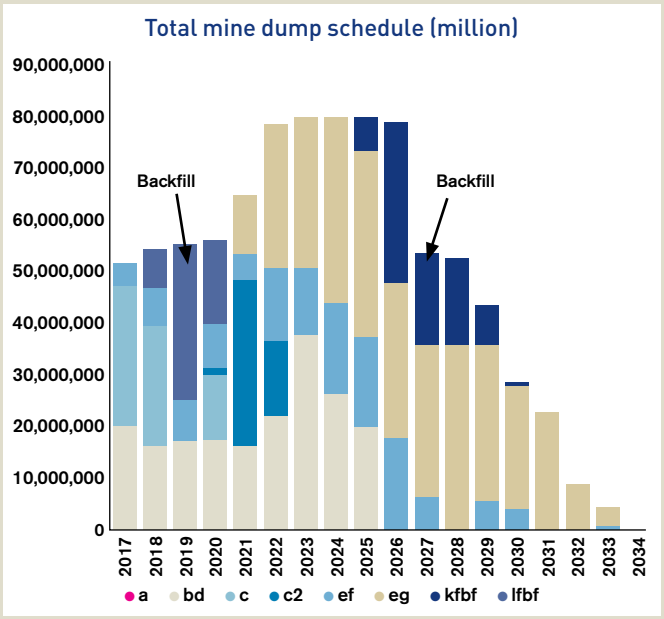


Figure 2: Identified backfill opportunities across the LoA at Kolomela

4. Value realised

The following value was realised at Kolomela by implementing the action plans from the integrated planning opportunities:

- Increasing pit backfilling at Leeuwfontein and Kapsteval realised over $US25 M in operational savings and decreased closure liability.
- Optimising topsoil stockpiling and utilisation led to savings in transport costs and increased quality of rehabilitation through identification of direct return opportunities.
- Investigation of the best model for undertaking concurrent rehabilitation reinforced the contractor model realising value though improved productivity in execution and completion of planned hectares.

5. Learnings

The case study outlined above has potential learnings that can be applied to other operations to realise value namely:

- **Integrated planning:** Early implementation of integrated planning at Kolomela has generated significant value through realisation of identified opportunities.
- **Project based approach:** Taking a project-based approach to the implementation of integrated planning has provided the necessary rigour to facilitate execution of the plan. Regular face-to-face interaction and tightly managed monthly updates are important to maintain the focus on implementation given competing priorities on site.
- **Alignment of KPIs and quantifying value realisation:** Ensuring alignment of KPIs across a site that drive value realisation associated with tracking of actual versus forecast cost and full quantification of the financial benefit are critical for future planning and changing operational behaviour.

Judah Mojalefa at an environmental audit at Der Brochen Mine, South Africa.

Return to Contents page

General view showing Concentrator, Borwa Shaft and Lebowa Shaft – Mototolo, South Africa.

TOOL 3: CLOSING THE GAPS

BACKGROUND

Tool 2 identifies where there are knowledge or implementation gaps related to the closure of the operation across the physical, biophysical and socio-economic aspects of closure based on the remaining LoA. Tool 3 focuses on identifying and prioritising the required actions to close the identified gaps. The following example demonstrates the potential outcome of the Tool 2 evaluation of a mine that is 10-15 years from closure, requiring the closure plan to be at the "Draft" stage (Table 3.1). An up-to-date Draft Closure Plan will have all the cells in the 15-10 year column highlighted, indicating that the item as described in the "Item Description" column has been satisfied. Where the cell is not highlighted in the "Draft" column, it constitutes a gap if a cell to the left of the "Draft" column is highlighted. If a cell to the right of the "Draft" column is highlighted, it indicates that this closure item is ahead of the 10-15 year Draft Closure Plan requirement. The associated Examples document (see Example 5) contains a detailed case study of how to complete the rapid assessment (Tool 2) and how to close the gaps using Tool 3.

APPROACH

Step 3.1: Assign priority, responsibility, timelines, sequencing and resources for all identified actions.

PURPOSE

Assigning priority, responsibility, timelines, sequencing and resources is required to ensure all actions can be executed on

Table 3.1: Example of identified gaps from Tool 2.

	Remaining years to closure							
					5-0 years		0-15 years	
	More than 25	25-15	15-10	10-5	5-3	2-0	0-5	5-15
Item Description	Preliminary	Draft	Detailed	Final	Decommis-sioning	Monitoring and Maintenance		
Item 1			On track					
Item 2			On track					
Item 3				Ahead				
Item 4		Gap						
Item 5			On track					
Etc.		Gap						

time and in budget, with the appropriate allocated resources. The actions are prioritised based on those that need to be completed before the next update of the closure plan (annually for three years) and those that are longer term (> 3 years).

PROCESS

- Step 3.1.1: Identify a responsible person who will be assigned to each of the actions.
- Step 3.1.2: Identify the resources (e.g. consultants, budgets) required to complete the identified action.
- Step 3.1.3: Identify the appropriate duration and timelines for the completion of the actions, as well as the interdependencies between actions.
- Step 3.1.4: Prioritise the identified actions into those required to be completed in each of the next 3 years and > 3 years.
- Step 3.1.5: Develop a schedule (level 4 schedule for year 1; level 3 schedule for year 2 and a level 2 schedule for year 3) for the actions required to be completed in the next three years, focusing on appropriate sequencing of related actions.
- Step 3.1.6: Capture actions that are required beyond three years in an appropriate management system and include them in the overall schedule (level 1 schedule for years 4 to 5).

Step 3.2: Obtain approval for action plans and budgets, and track progress.

PURPOSE

Approval and tracking of all closure action plans are required to ensure:

- Senior leadership endorsement of the proposed actions.
- Resources are available to implement the action plans and personnel appropriately informed.
- Compliance with the company's expenditure approvals standards and management systems.
- Tracking and timely close-out of actions, with escalation if required and subsequent updating of relevant plans.

PROCESS

- Step 3.2.1: Present proposed action plans, timelines, responsibilities and budgets to the appropriate approval body, normally the senior site leadership team and ExCo if appropriate.
- Step 3.2.2: Obtain formal approval from the relevant body for the detailed annual plan to be executed and in principal approval for the rest of the forecasted five-year plan to be included in the LoAP.
- Step 3.2.3: Track and report on action completion on a monthly basis to ensure that timelines and deliverables are met and to allow for escalation if timelines are not being met.
- Step 3.2.4: Close out completed actions and update relevant documentation.

CASE STUDY: OPERATIONAL EXCELLENCE THROUGH INTEGRATED PLANNING AT SENDELINGSDRIF MINE

1. Background to Sendelingsdrif Mine

Sendelingsdrif Mine is located along the Orange River in the south of Namibia about 20 km south of Rosh Pinah and 80 km north-east of Oranjemund. Mining started in 2014 with an expected LoA of 2023. The mine is located in the Tsau/Khaeb (Sperrgebiet) National Park that is known for its spectacular landscapes, geology, fossils, historical, archaeological and unique plant and animal life that it supports. The resource is allocated in a biodiversity hotspot area, in particular where the vulnerable white flowered *Juttadinteria albata* occurs.

2. Business case drivers

Considering the sensitivity of the area in which the Sendelingsdrif Mine operates, the integration of concurrent rehabilitation and conservation of biodiversity into the life cycle of the mine became major business case drivers. Three key objectives were identified:

- Adopt an integrated LoA and closure approach that would result in the development of a feasible mine that managed biodiversity impacts and which is aligned with the future land-use of nature-based tourism for the area.
- Ensure the licence to operate in this area, through integration of biodiversity management throughout the life cycle of the mine by developing partnerships and capacity building.
- Prevent future value destruction by using an innovative mine design to reduce the LoA and premature closure liability by implementing concurrent rehabilitation during mining operations.

3. Operational change

During the Project stage, various options were investigated of which the two key implementable options investigated were:

- A conventional mine design that catered for earthwork rehabilitation and the back dumping into mined out areas only after the mine has closed. In this case the material would have been moved from the dump to the worked out areas post mining. This is an additional circuit with a longer hauling distance and double handling of material.
- A dynamic mining/in-pit dumping design that included the development of a small waste dump that was only required during initial mining (Figure 1). The oversize waste from the treatment plant is loaded and hauled from the trommel and tailings from the Density Media Separator (DMS) tailings conveyor to the adjacent mined out blocks as part of the mining circuit.

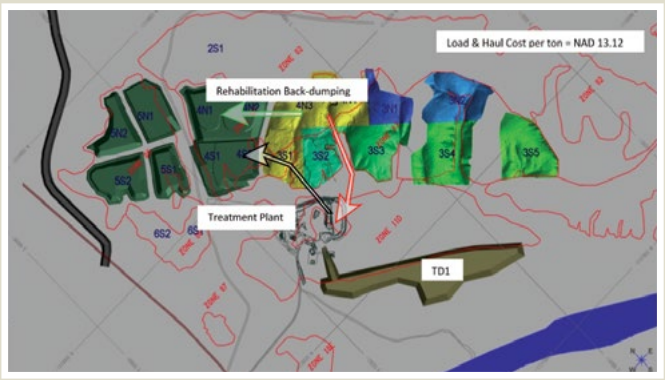


Figure 1: Dynamic in-pit dumping at Sendelingsdrif.

By selecting the integrated planning approach and implementing the dynamic mining and in-pit dumping design, significant value was realised. To facilitate successful implementation, the following operational changes were implemented:

- Including the closure and rehabilitation cost component as part of the anual operational cost of the mine.
- Instituting sound controls and aligned operational and closure KPIs such that the culture ensures that the vision is realised.
- Structuring a fully integrated mine plan at inception, to ensure significant areas for in-pit dumping were available early in the operations life to facilitate concurrent rehabilitation.
- Planning trucks moving ore from the mining pits to return with plant tailings that go into adjacent worked out pits to maximise the efficiency of the fleet.

4. Value realised

The value proposition for integrated planning at Sendelingsdrif Mine was multi-faceted including:

- Minimising waste oversize rock material to be loaded and hauled from the treatment plant to the waste dump. This prevented extensive double handling of material and the need for an additional circuit to be added at the end of the LoA.
- Eliminating the requirements for a dedicated fleet for loading and hauling the material back into the mined out voids during the closure phase and the associated costs.
- Keeping the mining footprint to a minimum and thereby reducing the closure liability of the mine (21ha versus 51ha).
- Planning that allows for the optimum use of resources during operations. The financial comparison between the viable options indicates an overall cost benefit of 35%.
- Continuing to build stakeholder confidence that enables the company to retain its license to operate in a national park.

5. Learnings

The case study outlined above has potential learnings that can be applied to other operations to realise value namely:

- **Integrated planning:** Early implementation of integrated planning at Sendelingsdrif has generated significant value through realisation of identified opportunities.
- **Structured approach to closure planning:** Sendelingsdrif Mine had a closure plan aligned with the AA MCT. The associated process involves risk assessment, gap analysis and action plans which assisted in identifying the opportunities in the first place.
- **Concurrent rehabilitation:** Rehabilitation activities have been integrated with other operational site activities at Sendelingsdrif Mine, with the associated cost and management discipline.

Drone view of operations at Niquelândia, Brasil.

TOOL 4: INTEGRATION

BACKGROUND

In early 2015, AA finalised the ICPS to complement the existing MCT. The ICPS has since been piloted at a number of operations. The unique components of the ICPS relate to integration of mine and closure planning, and involvement of multiple disciplines at an operation. This new tool of version 3 of the MCT V3 has been created to capture these unique components of the ICPS focused on integration.

The key benefit of integrated closure lies in the elimination of future closure activities and associated liabilities by changing the current operational activities (e.g. waste rock placement, tailings capping) to incorporate those activities at no or limited additional operating cost (Figure 1). Another key component of managing closure liabilities is to ensure that concurrent rehabilitation opportunities are optimized throughout the life of the operation to decrease liability, test sustainable rehabilitation prescriptions, build stakeholder confidence and assist with managing other environmental impacts (e.g. water, dust, visual amenity).

APPROACH

Step 4.1: Evaluate the LoAP, designs and schedules to integrate closure considerations.

PURPOSE

Evaluation of the LoAP, mine design and schedules are required to:

- Ensure alignment of the LoA and closure plans, including the closure vision, objectives and criteria.
- Ensure closure liabilities are adequately represented in the LoAP.
- Incorporate landform design for rehabilitated areas into the LoAP .
- Identify opportunities to integrate LoA and closure planning through optimisation of waste movement to decrease closure liabilities.
- Capture key closure elements in the LoAP.

PROCESS

- Step 4.1.1: Engage mine planners and evaluate the LoAP, designs and schedules for relevant closure related aspects and key opportunity areas.

- Step 4.1.2: Incorporate or update rehabilitation landform designs and closure costs into the LoAP.

- Step 4.1.3: Identify opportunities that decrease operational expenditure or closure liability (e.g. pit backfill, capping/buttressing of tailings, dumping to final landform), and feed into Step 2.

Step 4.2: Undertake a formal analysis to prioritise integration opportunities and assess the business case.

PURPOSE

Undertaking a formal analysis on integration opportunities is required to:

- Prioritise the opportunities to ensure those with the most compelling case are assessed first.

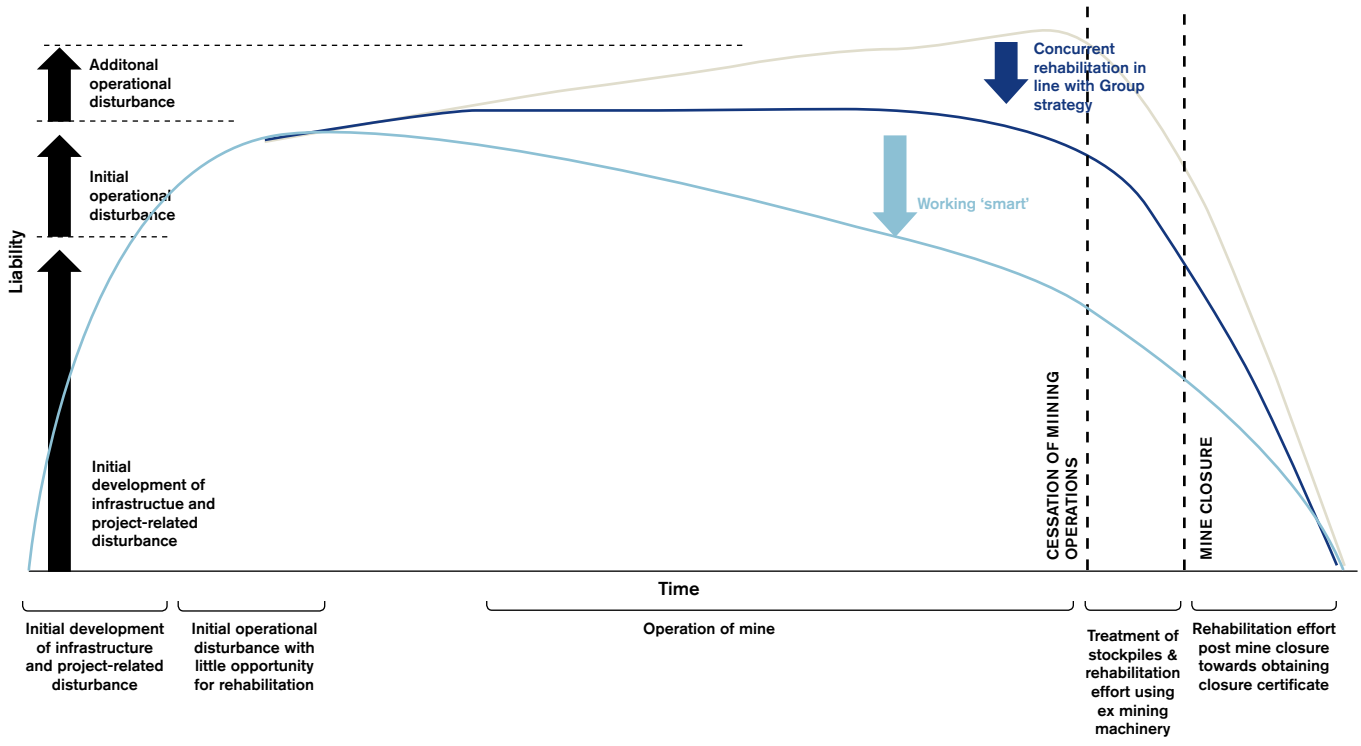


Figure 1: Closure liability for three scenarios across the life of an operation.

- Obtain input from the variety of disciplines involved in closure and clarify their roles.
- Maximise the value generated through the implementation of the opportunities.
- Assess whether there is a justifiable business case.
- Ensure timely implementation of those opportunities with a compelling case to realise value.

PROCESS

- Step 4.2.1: Identify and prioritise opportunities through a workshop with relevant internal stakeholders (see the Examples document – Example 11).

- Step 4.2.2: Develop detailed action plans including responsibilities to analyse the business case for the selected high priority opportunities.

- Step 4.2.3: Execute the detailed actions plan that typically involves modeling of scenarios and cost benefit analysis, and develop and present a clear business case to the appropriate leadership team.

- Step 4.2.4: Implement the opportunities that have a compelling business case, including updating the LoAP and other relevant operational plans.

- Step 4.2.5 Update the closure criteria and residual risk assessment to reflect the reduction in premature and LoA closure liabilities and/or the reduction in the residual risk profile.

Step 4.3: Develop closure related KPIs for all relevant personnel.

PURPOSE

Closure KPIs are required to ensure personal accountability and responsibility is established for relevant personnel and rewarded for positive performance in closure planning and execution across the various disciplines in the organisation that have responsibilities.

PROCESS

- Step 4.3.1: Develop formal closure planning KPIs and objectives at site, business unit and group level (see the Examples document – Example 12).

- Step 4.3.2: Identify relevant personnel to include closure KPIs and objectives in performance contracts or equivalent.

- Step 4.3.3: Obtain support from senior leaders for inclusion of relevant closure KPIs and objectives in performance contracts.

- Step 4.3.4: Include closure KPIs and objectives in relevant team objectives performance contracts and monitor progress, linking it to performance rating and associated bonuses.

Step 4.4: Incorporate relevant closure components into an integrated technology platform.

PURPOSE

Incorporation of closure considerations into a technology platform is required to:

- Assist in the integration of mine and closure planning.
- Streamline processes and responsibilities through the use of relevant software
- Manage the large number of processes, documents, records and actions involved in closure planning.

PROCESS

- Step 4.4.1: Assess the existing technology being used at the operation for suitability as a closure platform.

- Step 4.4.2: Select an appropriate existing platform or introduce new software (e.g. Deswik™, PRAC™) to incorporate closure planning processes included in the MCT.

- Step 4.4.3: Develop and execute an implementation plan for the preferred closure platform.

- Step 4.4.4: Update the content of the platform on a regular basis.

CASE STUDY: OPTIMISING WASTE ROCK DEPOSITION AT SISHEN MINE

1. Background to Sishen Mine

Sishen Iron Ore Mine is located in South Africa in the Northern Cape Province near to the town of Kathu, 200 km east of Upington. Sishen Mine is a large open cut iron ore mine with a land holding of approximately 36,000 ha and land within the mining fence of approximately 11,000 ha. The pit is about 2 km wide (east to west) and 10 km long (north to south) and more than 100 m deep. The mine's production rate is between 32 and 37 Mtpa. The mining process entails exploration drilling and modelling, topsoil removal and stockpiling, drilling, blasting of overburden and ore. Overburden is hauled to waste rock dumps. Iron ore is hauled to the plant where it is crushed, sieved, sorted and beneficiated before transport by rail to the local and international markets via Saldanha Bay harbour. Mining started in 1953 and Anglo American (Kumba Iron Ore) took ownership of the mine in December 2003. The current LoA is 2033. The Mine currently employs more than 10,000 people.

2. Business case drivers

Through the MCT risk assessment process, it was identified that the deposition of waste rock was a critical value driver; given the waste rock volumes moved at Sishen Mine and its contribution to the closure liability (>70% of total liability). The existing dumping strategy at Sishen was the conventional method (Figure 1). It is important to note that the outers shell of the waste dumps need to be constructed of calcrete to ensure the erodible clay waste can be accommodated on the inside of the walls. By changing the way the current waste rock dumps were being constructed (moving to the outer shell method), significant value has been identified and realised through facilitation of concurrent rehabilitation activities.

A significant opportunity was identified in an opportunities workshop conducted at Sishen to increase the amount of in-pit dumping. In-pit dumping is generally shorter haul leading to operational savings, as well as decreasing rehabilitation costs of ex-pit dumps and the associated closure liability carried as a provision on the balance sheet.

3. Operational change

There was increased focus at Sishen to address the rehabilitation backlog, the optimisation of concurrent rehabilitation and the resultant decrease in the mine's closure liability. As part of the process, the Mine has actively implemented a five year rehabilitation plan which is linked to the mine's five year business plan and an overall long-term rehabilitation plan. Construction of current waste rock dumps follow the outer shell method, that facilitates concurrent rehabilitation and a reduction of premature and LoA closure liabilities at effectively no additional operating costs.

The amount if in-pit dumping in the current 2018 LoAP represents an 80% increase compared to the 2014 baseline prior to the opportunities workshop (Figure 2). These opportunities were created by removing perceived barriers within the planning functions, exhausting economic reserves in pits identified with potential for in-pit dumping of waste, and improving the design and dumping techniques for in-pit disposal.

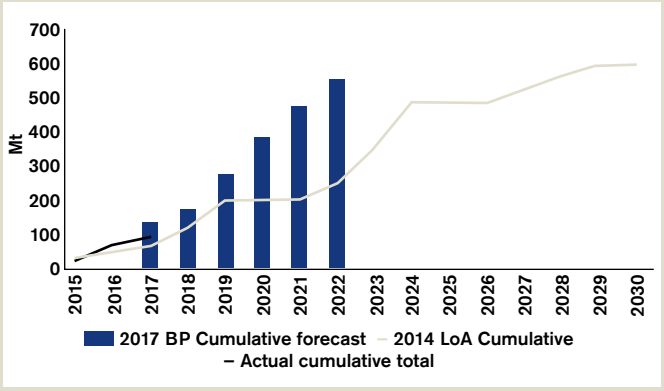


Figure 2: Increase in in-pit dumping at Sishen over the LoA.

4. Value realised

The following value was realised by optimising waste rock deposition at Sishen:

- The outer shell waste rock dump construction method has facilitated completion of more than 200 ha of

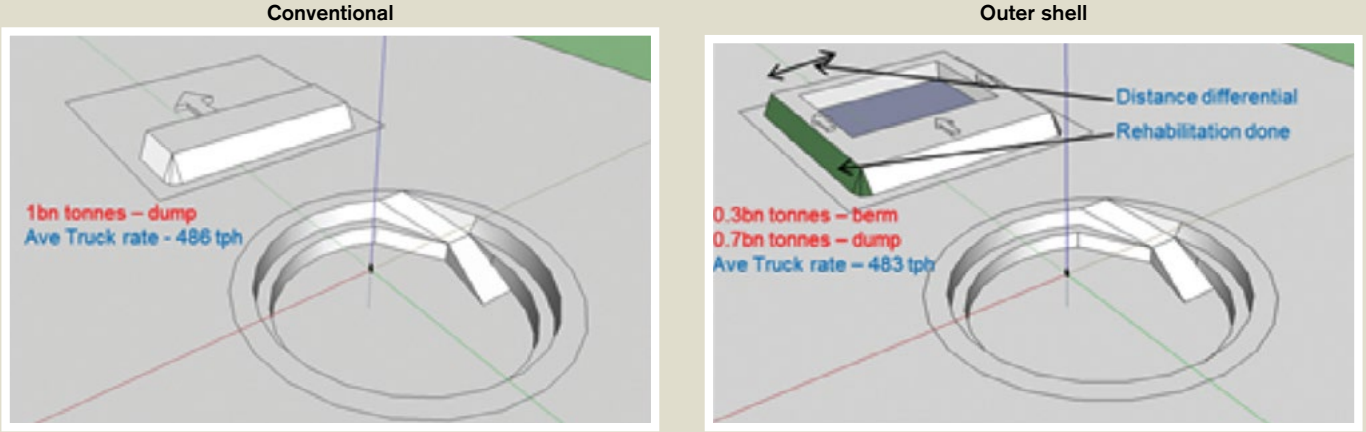


Figure 1: Conventional waste rock placement (left) compared to the outer shell concept (right).

rehabilitation over the last three years, compared to less than 50 ha completed in the first 60 years of operation. This is driving the development of cost-effective rehabilitation prescriptions that are increasing the accuracy of closure liability estimates.
- Increasing in-pit dumping by 80% has decreased operational costs due to reduced haul distances, decreased emissions, reduced fleet requirements as well as associated maintenance. This has also led to decreases in closure liability and associated rehabilitation costs, as well as decreasing the footprint of the mine due to reduced requirements for ex-pit dumping space. This has realised a combined value of almost half a billion $US500 M compared to the 2014 base case.

5. Learnings

The case study outlined above has potential learnings that can be applied to other operations to realise value namely:

- **Structured approach to closure planning:** The Sishen Mine had a closure plan aligned with the AA MCT and implemented the ICPS. The associated processes involve risk assessment, gap analysis and action plans which assisted in identifying the opportunities in the first place.
- **Realisation of opportunities:** A structured approach was used at Sishen Mine to identify and prioritise opportunities that were then rigorously assessed and those that were value adding were implemented. Some of these opportunities had been identified previously but had not been implemented due to a lack of challenge to existing paradigms.
- **Alignment of KPIs and quantifying value realisation:** Ensuring alignment of KPIs across a site that drive value realisation associated with tracking of actual versus forecast cost and full quantification of the financial benefit are critical for future planning and changing operational behaviour.

Night view of the jig plant at Sishen Mine, South Africa.

TOOL 5: CLOSURE EXECUTION

BACKGROUND

Mine closure consists of a planning phase, operational execution phase, an execution phase (decommissioning phase), and a subsequent monitoring and maintenance phase. The planning phase has been covered in tools 1-4. This tool focuses on the remaining three phases.

OPERATIONAL CLOSURE EXECUTION

The two key components associated with operational closure execution are concurrent rehabilitation and social transition. A concurrent rehabilitation strategy and associated plans/procedures (including the post production period) needs to be developed for ongoing inclusion in the closure planning process and operational plans that are annually implemented. Social transition is also seen as an operational activity, ensuring that social activities and associated spend also focusses on achieving an acceptable residual risk profile and in doing so leaving behind a positive legacy. Tool 4 focuses on operational integration and resulting closure execution during the LoA, with additional guidance and specific requirements described in Tool 2.

APPROACH

Step 5.1: Develop a concurrent rehabilitation strategy and plan.

PURPOSE

The purpose of a rehabilitation strategy and rolling five-year rehabilitation plans are to ensure closure liabilities are managed on an ongoing basis, proven rehabilitation prescriptions are established, and alignment with the closure vision and PML plan is achieved. The plan will also show commitment to integrating rehabilitation considerations into the business planning cycles.

PROCESS

- Step 5.1.1: Develop an overarching rehabilitation strategy that aligns with the closure vision and land-use plan (see the Examples document – Example 7).
- Step 5.1.2: Develop a five-year rolling rehabilitation plan that aligns with the rehabilitation strategy, and the baseline environmental conditions and legal commitments.
- Step 5.1.3: Develop the success criteria for the rehabilitation plan in consultation with internal and external parties (also see tool 2 and the Examples document – Example 8).
- Step 5.1.4: Implement rehabilitation trials to test assumptions and ensure cost-effective rehabilitation prescriptions.
- Step 5.1.5: Develop a detailed monitoring programme to track and record the rehabilitation plan execution.
- Step 5.1.6: Develop a maintenance and management plan and associated procedure to address gaps in the rehabilitation plan (e.g. unsuccessful rehabilitation) as required to ensure a continuous improvement loop (see the Examples document – Example 19).
- Step 5.1.7: Integrate the rehabilitation plan into the LoAP to ensure that operational budgets and resources are in place and progress is measured.

Step 5.2: Develop a social performance strategy and plan (social transition plan).

PURPOSE

The purpose of a social performance strategy and plan is to ensure that social transition activities and associated

Night views of the Amandelbult complex, South Africa.

spend (AASW process) also focuses on achieving an acceptable residual risk profile and in doing so leaving behind a positive legacy (see the Examples document – Example 9).

PROCESS

- Step 5.2.1: Develop a social performance strategy using the guidance of the AASW.
- Step 5.2.2: Develop a social performance plan that aligns with the strategy.
- Step 5.2.3: Develop the success criteria for the social performance plan in consultation with internal and external parties.
- Step 5.2.4: Develop a detailed monitoring programme to track and record the execution of the social performance plan.
- Step 5.2.5: Develop a mitigation plan and procedure to address gaps in the social performance plan (e.g. unsuccessful socio-economic diversification) as required.
- Step 5.2.6: Integrate the social performance plan into the LoAP to ensure that operational budgets and resources are in place and progress is measured.
- Step 5.2.7: Update the risk assessment (see Tool 1) to track changes in the residual risk profile and to demonstrate the effectiveness of projects in achieving economic diversification).

CLOSURE EXECUTION PLANNING (YEARS 5 TO 0)

Closure execution planning focuses on how the closure plan Scope of Work (SoW) will be executed. This takes place in the last five years of the remaining LoA (Tool 2 – Years 5 to 0 "Final mine closure plan"). The level of detail and confidence in the closure execution planning will vary with the requirement for a PFS-B according to AA IDM requirements to be undertaken in remaining years five to three of LoA, that will then be improved to a FS according to AA IDM in the last two years. A project management approach similar to that for a capital investment project is followed to ensure sufficient rigor and confidence is built into the execution planning and associated financials. The key deliverable from this phase is a financially viable, executable plan that will deliver the agreed success criteria as defined in the integrated mine closure plan, with an acceptable residual risk profile.

Closure projects inherently will have a lower confidence level in their financial estimates than a typical capital project because the final closure execution plan may still need to be approved by regulators and I&APs at the end of LoA. A well-structured SEP and communication strategy with key messages for each of the external stakeholder groups (i.e. authorities, I&APs, interested parties and shareholders) will be required. Additional management plans might be required for the key components of the closure execution plan and these need to be developed during this phase (see the Examples document – Examples 14, 15, 16 and 17).

APPROACH

Step 5.3: Develop a closure execution plan to the level of PFS-B in remaining years 5 to 3 of LoA.

PURPOSE

The purpose of the closure execution plan to the PFS-B level is to ensure that the most cost-effective methods and solutions for closure are analysed and selected.

PROCESS

- Step 5.3.1: Develop a Project Charter with a clear mandate and a dedicated project team to be appointed with a detailed RACI.

- Step 5.3.2: Develop a study execution plan based on the signed-off Charter, describing how the dedicated project team will develop the closure execution plan.

- Step 5.3.3: Develop a detailed project execution schedule (MS Project or equivalent), reflecting the project timelines, durations and key milestones, as well as the critical path.

- Step 5.3.4: Develop a detailed WBS using the execution schedule to at least level 3 (work package level).

- Step 5.3.5: Develop the closure execution model that reflects the practical execution of the closure plan, considering the methods, rates, task durations, equipment efficiencies and availabilities, and any other key components.

- Step 5.3.6: Investigate the following key alternative studies:
  - Contractor execution compared to owner execution or a combination.
  - Alternatives associated with the key cost items should be investigated (e.g. allowing pit to fill naturally with water compared to active pumping of the water).
  - Alternatives related to the scheduling and subsequent execution of closure activities to de-risk the execution plan (e.g. not all legal approvals might be in place in a premature closure scenario).
  - Re-evaluation of items that will have an unacceptable residual risk profile and identification of alternatives, as appropriate, to achieve an acceptable residual risk profile.
  - Alternatives associated with redeployment of people compared to retrenchment and possible reskilling and utilisation in the closure phase.
  - Investigation of appropriate alternatives to manage the expectations and perceptions of key stakeholders (social transition).

- Step 5.3.7: Develop the financial plan and model by running the various scenarios to reflect the alternatives associated with the closure execution plan, to select the most appropriate option (minimal cost at an acceptable residual risk profile).

- Step 5.3.8: Complete a QRA to identify appropriate contingency of the project and the possible requirement of a management reserve or other method to ensure the uncertainties in the project will be managed appropriately (see Example 15).

- Step 5.3.9: Update the commitments register (developed using Tool 1) to identify any additional legal requirements and processes as part of mine closure execution (e.g. permits, agreements, and other regulatory requirements).

- Step 5.3.10: Update the risk register (developed using Tool 1), highlighting the project execution risks, as well as the anticipated residual risk profile of the project.

- Step 5.3.11: Conduct a closure phase SIA and update the Social Management Plan (SMP) and its associated SEP (see Social Way Sections 2A: Social Performance Planning, 3A: Stakeholder Engagement).

.• Step 5.3.12: Develop a detailed HR plan and associated costs to reflect the ramp down or ramp up profiles of employees and contractors.

- Step 5.3.13: Develop a detailed SHE plan with associated resources, focusing on delivering a closure plan that can be executed safely, considering the impacts on people and the environment.

- Step 5.3.14: Develop a detailed logistics plan that will align with the selected execution strategy that includes the appropriate procurement plan.

- Step 5.3.15: Develop the PEP that will explain in detail, how the closure plan will be executed, using the outcomes of steps 3.3 to 3.14.

- Step 5.3.16: Develop the most optimal executable closure plan through an ongoing review and refinement process.

Step 5.4: Develop a closure execution plan to the level of FS in the final two years of LoA.

PURPOSE

The purpose of the closure execution plan to the FS level is to ensure that a final executable closure plan is developed, by improving the PFS-B deliverables, especially with a focus on inmproving the overall confidence and subsequent level of accuracy of the cost estimate.

PROCESS

- Step 5.4.1: Develop a SEP describing how the dedicated project team will develop the final closure execution plan (e.g. timelines, budget and key milestones and RACI) as part of the approval of the PFS-B.

- Step 5.4.2: Update the PFS-B deliverables to achieve a higher level of confidence (fewer unknowns and higher confidence in cost estimates).

- Step 5.4.3: Develop the following management plans:
  - Change management plan.
  - Engineering management plan, including demolition and maintenance (see Step 5.6 and 5.7).
  - Logistics management plan, including equipment and people.
  - Procurement management plan.
  - Environmental management plan, including monitoring.
  - Document control management plan.

- Step 5.4.4: Through an ongoing review and refinement process develop the final executable mine closure plan.

CLOSURE EXECUTION (YEARS 0 TO 15)

Closure execution can be split into operational execution, and subsequent monitoring and maintenance leading to relinquishment. The closure execution components are decommissioning and remaining rehabilitation (years 0 to 5 post production), and the subsequent monitoring and maintenance phase (years 5 to relinquishment).

APPROACH

Step 5.5: Evaluate the existing operational procedures and systems to determine applicability for the closure execution phase.

PURPOSE

Evaluation of existing procedures and systems is required to ensure that they are applicable to the closure phase to allow safe and efficient execution of the closure plan.

PROCESS

- Step 5.5.1: Review all the current operational procedures and systems and determine their applicability to the closure execution phase.
- Step 5.5.2: Revise existing procedures (e.g. simplified procurement procedure) and systems and develop new ones (e.g. decommissioning) and systems, as required, to ensure safe and efficient execution of activities.
- Step 5.5.3: Ensure technical and financial support for the systems are in place (e.g. information management systems, software upgrades).

Step 5.6: Develop a demolition and decommissioning plan.

PURPOSE

The purpose of a demolition and decommissioning plan is to ensure the safe, effective and efficient removal or re-purposing of operational equipment (see the Examples document – Example 18).

PROCESS

- Step 5.6.1: Review and update the current asset register to ensure all assets (movable and fixed) are accurately captured.
- Step 5.6.2: Undertake a detailed evaluation of all the assets (i.e. cost benefit analysis, market value evaluation) to determine which of the assets will have resale value.
- Step 5.6.3: Develop a detailed asset disposal plan for those assets with resale value.
- Step 5.6.4: Develop a detailed schedule and cost estimate to reflect the process of dismantling and preparing assets for disposal.
- Step 5.6.5: Develop a separate work package for the rest of the infrastructure that has no resale value but potential scrap value, including a demolition procedure, value estimation process and disposal methodology.
- Step 5.6.6: Develop a separate work package for the rest of the infrastructure that has no resale value and no potential scrap value, including demolition procedure, disposal strategy (i.e. on-site vs. off-site) and the disposal methodology.
- Step 5.6.7: Develop a detailed risk-based safety and security plan for the dismantling and disposal process to prevent injuries and protect the assets.
- Step 5.6.8: Collate all three key work packages into an integrated demolition plan and master schedule to ensure the process can be undertaken effectively and safely (see the Examples document – Example 18).

Step 5.7: Develop a monitoring programme, maintenance action plan and post closure management plan.

PURPOSE

Monitoring of success criteria is required to ensure progress is tracked and the level of compliance is measured, to facilitate the ultimate relinquishment of the asset (where appropriate), post the monitoring and maintenance period.

PROCESS

- Step 5.7.1: Update the formal monitoring plan to measure success in collaboration with the regulators (see Tool 2). The operational monitoring programme has to be developed and implemented with full consideration of the requirements of the success criteria (see Tool 1 and 2), and the programme must be regularly reviewed and improved through a continuous improvement process.
- Step 5.7.2: Monitoring results must be routinely reviewed against the success criteria and areas not meeting expectations maintained.
- Step 5.7.3: Regularly review success criteria as additional monitoring data informs the achievability of the identified targets.
- Step 5.7.4: Develop a maintenance action plan to ensure that the success criteria, closure vision and end land-use goals are on track and will be achieved. Add required actions to the MAP. Make sure the plan is budgeted and implemented and includes all activities required to be undertaken over the execution of the closure plan (see the Examples document – Example 19).
- Step 5.7.5: Develop a post closure land management plan (e.g. fire, fencing, stock, weeds, feral animals) to ensure that the mine is reducing liability and moving toward lease relinquishment to a third party (see the Examples document – Example 19).
- Step 5.7.6: Develop an internal and external reporting system to ensure that all stakeholders are fully informed on the progress of implementation of the closure plan including expenditure, progress of the closure actions, post closure monitoring and maintenance.
- Step 5.7.7: Ensure document management and record keeping are in place as part of an effective process to reduce closure liabilities and facilitate relinquishment, that must be linked to KPIs (see Tool 4) at all levels.

CASE STUDY: INTEGRATED WASTE ROCK DEPOSITION AT VENETIA

1. Introduction

De Beers currently operates the Venetia Diamond Mine in the Limpopo Province of South Africa, approximately 80 km west of Musina, 40 km north-east of Alldays and approximately 50 km north of Johannesburg (Figure 1). Venetia Mine has been operational since 1992 and is the largest diamond producing mine within De Beers Mining South Africa, now part of AA Venetia Mine currently exists as an open pit operation with a LoA until 2023, where after it will be an underground mine that will see the LoA extended beyond 2040. The mine currently employs around 3,200 employees and contractor employees, with an additional 1,100 employees working on the Venetia Underground project. The current production rate ranges between 4 and 6 M tpa. The current pit dimensions are approximately 1 km wide (north to south) and 2 km long (east to west). The final open pit will extend to approximately 450 m below surface and future underground mining will extend to about 900 m below surface.

2. Business case drivers

During 2012, the EXCO of the then De Beers Consolidated Mines (DBCM) issued a directive across the company, including Venetia Mine, clearly outlining the company's expectations with regard to concurrent rehabilitation as a non-negotiable stay in business expectation. The directive was clear in that the following objectives formed part of the project brief:

- Development of mechanisms to track progress against:
- Deposition and reshaping to plan for waste rock and residue;
- Reshaping to plan for waste rock and residue;
  - Rehabilitation to plan (growth medium and seeding);
  - Budget spent (target vs. actual);
  - Reduction in Premature and LoA closure liability.
  - Involvement of a multi-disciplinary team of leads to participate in the development of reporting dashboards to track progress against set targets;
- Undertaking concurrent rehabilitation during LoA operations;
- Achievement of a rehabilitation efficiency rate (reduction in liability vs. total spend) of > 1.

Through this process, Venetia Mine identified that the integrated solution to reducing liabilities involved 'smart' waste rock deposition and increased concurrent rehabilitation (see Tool 4, Figure 1).

3. Operational change

Changing the waste rock deposition strategy focussed on:

- Maximising concurrent rehabilitation activities and eliminating future reshaping and waste rock handling by undertaking selective and well planned waste rock placement;
- Increasing the stability and operational flexibility of the FRDs through waste rock impoundment; and
- Capping of the CRD as an operational activity.

The new waste rock deposition strategy resulted in the prevention of significant future value destruction at effectively no additional operating cost. The fundamental shift in philosophy resulted in waste being hauled to the extent of the LoA deposition footprint and deposited systematically towards the open pit, as opposed to the traditional method of waste deposition in close proximity to the pit in an outward direction. It also involved in-tipping to reduce the extent of waste rock dump faces to be rehabilitated as well as waste rock impoundment of the FRDs and CRD, which in many cases had a shorter hauling distance than the original waste rock deposition plan.

4. Value realised

The value proposition for integrated waste deposition at Venetia was multi-faceted including:

- Waste material was able to be deposited in benches as opposed to advancing 'end tipping', facilitating the concurrent rehabilitation of bench slopes once deposited.
- Bull-dozers were required to move significantly less material to achieve the same slope angles, and operated within a distance that optimised their efficiency, resulting in maximised concurrent rehabilitation effort and significantly reduced LoA closure liabilities.
- The waste rock dump shaping as well as the cladding of the CRD and the FRD was undertaken using operational expenditure and will be completed prior to cessation of open cut mining at basically no additional operating cost (Figure 1).
- The stability of the FRD will be improved significantly during the operational and post closure phases due to waste rock impoundment, and there will be an improvement in operational flexibility (increased rate of rise, which means that more tailings can be placed on the current facility in a year).
- The rock impoundment of the FRD not only resulted in the LoA closure liability significantly reducing, but that potentially no additional FRD facilities will be required for the underground operation, resulting in a significant upfront capital saving to the project.
- Increasing concurrent rehabilitation allowed the mine to demonstrate tested and sustainable rehabilitation methods over the life of the mine.
- Ultimately, the reduction of the overall LoA closure liability by 35% and premature closure liability by 24%.

5. Learnings

The case study outlined above has potential learnings that can be applied to other mine sites to realise value namely:

- **Structured approach to closure planning:** Venetia Mine had a closure plan aligned with the MCT. The associated process involves risk assessment, gap analysis and action plans which assisted in identifying the opportunities in the first place.
- **Waste as a resource:** At Venetia Mine, a shift in focus to view waste or tailings material differently led to the realisation of significant value.
- **Concurrent rehabilitation:** At Venetia Mine, rehabilitation activities have been integrated with general mine site activities, with the associated cost and management discipline. The focus needs to be on eliminating future closure activities (i.e. rehabilitation of large areas of land) rather than deferral.

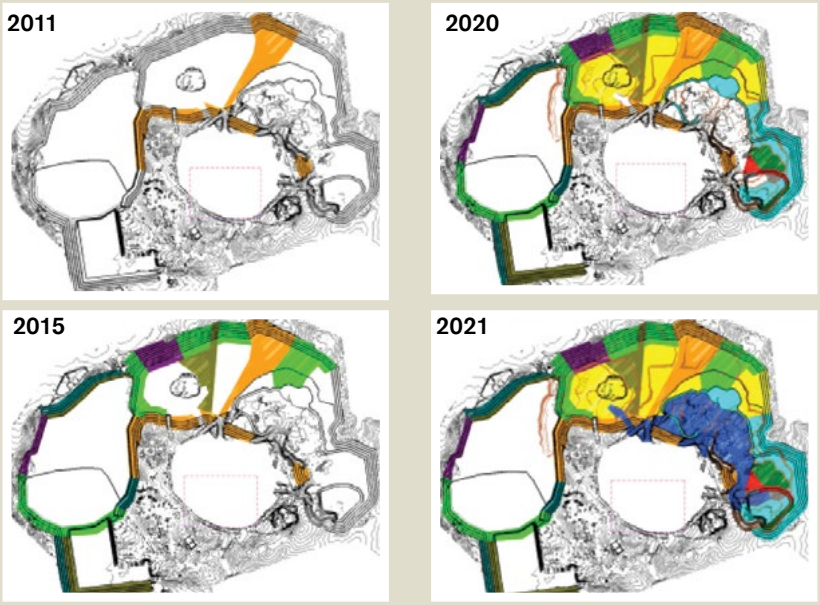
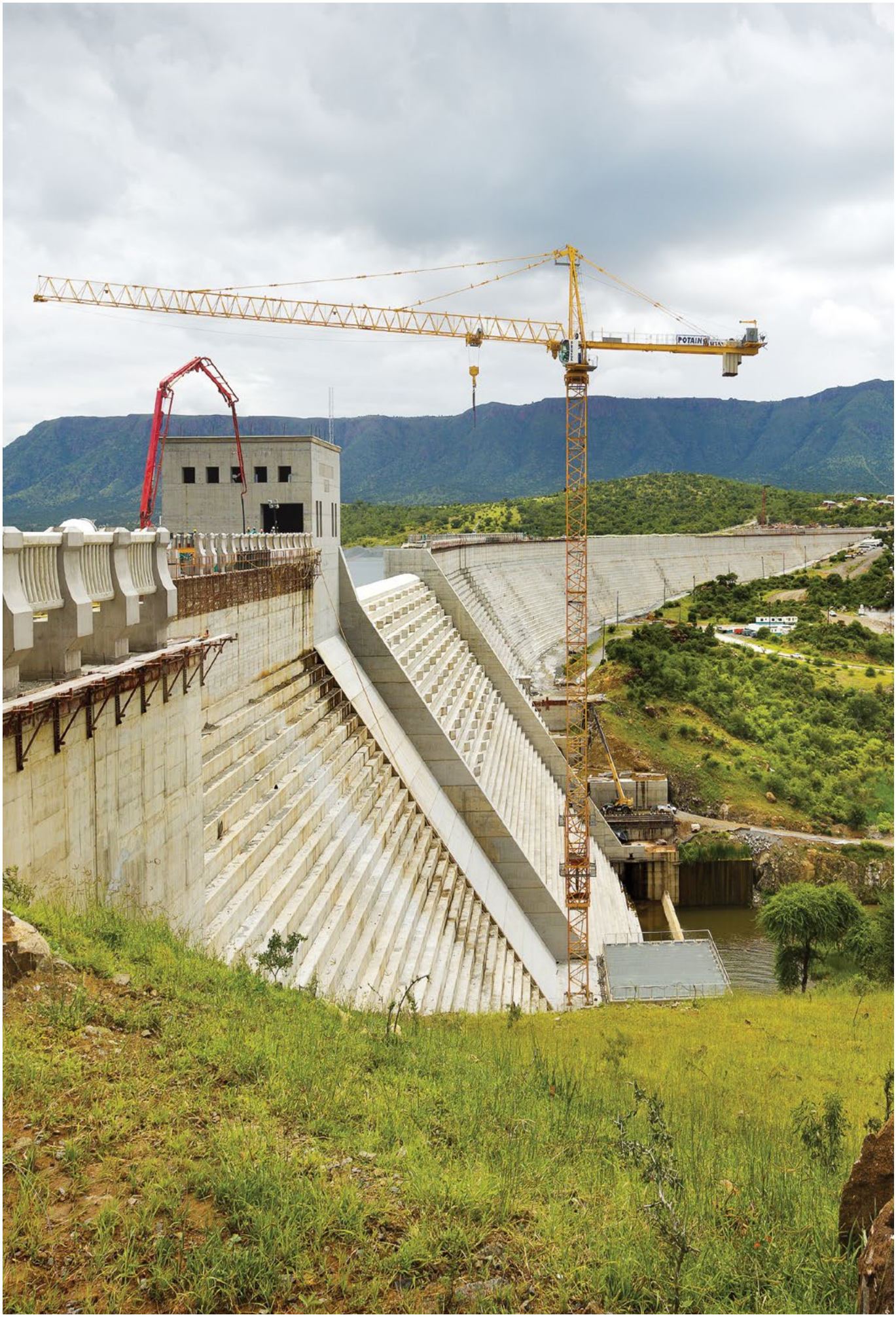


Figure 1: Concurrent waste rock deposition from 2011 to 2021 at Venetia Mine.

De Beers Venetia Mine, South Africa.



De Hoop Dam, Limpopo, South Africa.

TOOL 6: REVIEW AND CONTINUOUS IMPROVEMENT

BACKGROUND

Closure planning and implementation is not a linear process. While the MCT is presented as six tools in numerical order, in reality there is a PDCA cycle occurring almost continuously within and between each tool. It is therefore important that closure plans are updated regularly as required in the AA closure standard, utilising the tools provided in the MCT. The process should be seen as live and dynamic, not static. Furthermore, while aspects of the process may be undertaken by consultants, ownership by site personnel is critical.

This tool focuses on the continuous review and improvement of the closure plan (e.g. closure criteria effectiveness, residual risk profile, knowledge gaps), as well as on the acceptability of the closure plan to the various stakeholders. This requires the ongoing improvement of the technical solutions (benchmarking – see Tool 1), as well as appropriate stakeholder engagement to firstly get acceptance of key closure criteria (as well as success criteria) and secondly to get external ownership of the closure plan over time.

APPROACH

Step 6.1: Review the close-out of actions to ensure that the identified issue has been addressed.

PURPOSE

Actions are identified through a number of processes in the MCT including risk assessment, benchmarking (Tool 1), gap analysis (Tool 2), closing the gaps (Tool 3) and opportunities analysis (Tool 4). It is important that these actions are assigned to an appropriate person with a timeline and adequate resources (Tools 3 and 4). It is equally important that once the action is complete that the loop is closed to ensure that the original issue has been addressed.

PROCESS

- Step 6.1.1: Ensure an appropriate data management system is in place and can be used to track and manage the closure related actions.
- Step 6.1.2: Obtain a list of completed actions from the management system for the previous 12 months.
- Step 6.1.3: Review the outputs from the action and compare to the original identified issue.
- Step 6.1.4: If the action has addressed the issue, update the relevant aspect of the closure plan.
- Step 6.1.5: If the action has not completely addressed the issue, identify the required further action and re-examine through the tool 3 and 4 process.

Step 6.2: Validate closure criteria effectiveness.

PURPOSE

Validation of closure criteria is required to:

- Ensure that they are effective in reducing closure risks to predicted and acceptable levels.
- Identify potential improvements to the closure criteria if they are not fully effective.

PROCESS

- Step 6.2.1: Identify critical closure criteria (those with a significant or high residual risk) based on the risk assessment (see Tool 1).
- Step 6.2.2: Review critical closure criteria for effectiveness using a structured approach (see the Examples document – Example 13).
- Step 6.2.3: Develop appropriate corrective actions to address gaps and track implementation.
- Step 6.2.4: Update the applicable documents to reflect improvements from this step.

Step 6.3: Review internal and external reporting.

PURPOSE

An internal and external reporting system is required to ensure that:

- All stakeholder needs and concerns are known and tracked and that expectations are managed throughout the operational life and beyond.
- Internal management are fully informed of the progress of implementation of the closure plan including required expenditure.
- Regulators are fully informed on the progress of the closure actions including post closure monitoring and maintenance.
- Community stakeholders are fully informed of the progress of the closure planning and implementation for the site (see AASW Sections 2A: Social Performance Planning 3A: Stakeholder Engagement).

PROCESS

- Step 6.3.1: Complete stakeholder mapping to identify the key stakeholders that will form part of the closure planning process and the ongoing improvement process (See AASW Section 3A: Stakeholder Engagement).
- Step 6.3.2: Update the operation's SEP (see AASW Section 3A: Stakeholder Engagement) to ensure that the closure requirements are included (see also commitments register in Tool 1).
- Step 6.3.3: Identify and implement the required engagement forums to keep internal stakeholders involved and committed (see AASW Section 3A: Stakeholder Engagement).
- Step 6.3.4: Ensure that appropriate reporting systems are in place and that KPIs are aligned to include closure (see AASW Sections 1: Governance, 2A: Social Planning and Tool 4).

- Step 6.3.5: Incorporate relevant feedback from internal and external stakeholders in the regular updating of the closure plan.

Step 6.4: Keep the MCP process live and update at least every three years.

PURPOSE

The MCP and associated implementation process is dynamic and the associated documentation should be kept as current as possible. Even though the closure liability must be updated annually, the mine closure plan does not need to be updated for every single small change, but key components of the MCP that are the focus of actions should be kept as live as possible.

PROCESS

- Step 6.4.1: Update critical components of the closure plan as actions are completed between successive total plan reviews.

- Step 6.4.2: At least every three years (or when there is a significant change in the LoAP or operational footprint), update the entire closure plan utilising the guidance of the MCT and calculate closure liability from first principles.

Step 6.5: Lease relinquishment and/or land sale.

PURPOSE

The ultimate objective of mine closure is to relinquish the mineral lease and transfer or sell land to facilitate realisation of the PMLs, thereby leaving a positive legacy.

Lease relinquishment is not always possible, as there may be residual risks that prevent this from occurring (e.g. AMD, underground workings). In some circumstances, the most appropriate way to facilitate the PMLs may be to sell land with the necessary caveats on the title outlining commitments that must be met into the future (e.g. contaminated site management, rehabilitation monitoring to meet success criteria, management of AMD).

PROCESS

- Step 6.5.1: Determine whether full lease relinquishment is possible and facilitate the process. Demonstrate that all success criteria have been met and provide evidence to the regulator.

- Step 6.5.2: Determine alternative options to facilitate the PMLs where full lease relinquishment is not possible. Investigate the necessary legal requirements on a case by case basis and consider necessary caveats on land titles as required. Develop a maintenance and management plans (Tool 5) to assist the new land owner or user to meet ongoing requirements for success criteria that may not be able to be fully met.

- Step 6.5.3: Relinquish the lease and/or sell or transfer the land.

- Step 6. 5.4: In cases where relinquishment or sale are not possible, establish an appropriate financial vehicle (e.g. trust fund) to support the ongoing costs associated with the closed operation.

Kolomela Iron Ore Mine – Operations in the Kapsteval Pit, South Africa.

CONCLUSION

To shift the paradigm on closure planning and execution requires an increased focus on integration.

This should involve the following:

- Cradle to Cradle Mentality.
- Risk and Opportunity Approach.
- Integration into LoAP.
- Project Management Rigour.
- Social Transition to Sustainable Livelihoods.

Through this focus, we can make 'Closure' redundant as it will be fully integrated in the LoAP process and be managed with the same operational rigour as any other discipline at an operation.

REFERENCES

Botha P.R. (2013). Anglo American Mine Closure Toolbox Version 2, 2013. Compiled for Anglo American Public Listed Company by Anglo Technical Solutions.

Botha P.R., Coombes P. (2007). Anglo American Mine Closure Toolbox Version 1, 2007. Compiled for Anglo American Public Listed Company by Anglo Technical Division.

Anglo American Social Way (2019). Anglo American, London, UK.

Grant, C. D. (2006) 'Decommissioning Alcoa's first bauxite mine in the Jarrah Forest of Western Australia: Cradle to grave', Proceedings First International Seminar on Mine Closure, 13-15 September 2006, Perth, Western Australia, A. Fourie and M. Tibbett (Eds.), Australian Centre for Geomechanics, Perth, Australia, pp. 287-297.

Grant, C.D. and P.R. Botha (2015) 'Integrated closure planning: case studies on changing operational strategies to reduce closure liabilities', Proceedings Tenth International Seminar on Mine Closure, 1-3 June 2015, Vancouver, Canada, A. Fourie, M. Tibbett, L. Sawatsky and D. van Zyl (Eds.), Australian Centre for Geomechanics, Perth, Australia, pp. 1-14.

Grant, C.D. and H.W.B. Lacy (2016) 'Developing Anglo American's integrated closure planning system; requires people, process and technology working together', Proceedings Eleventh International Seminar on Mine Closure, 15-17 March 2016, Perth, Australia, A. Fourie and M. Tibbett, (Eds.), Australian Centre for Geomechanics, Perth, Australia, pp. 581-594.

Lacy H.W.B and Bennett K.E. (2015) 'Updating Australia's leading practice sustainable development (LPSD) mine closure handbook for 2015: Closing the gaps and understanding the mineral resource legacy', Proceedings Tenth International Seminar on Mine Closure, 1–3 June 2015, Vancouver, Canada, A. Fourie, M. Tibbett, L. Sawatsky and D. van Zyl (eds), Australian Centre for Geomechanics, Perth, Australia, pp. 1-14.

ICMM (2019). Integrated Mine Closure: Good Practice Guide (2nd ed.). International Council on Mining and Metals, London.

APPENDIX 1: MINE CLOSURE STANDARD

Victor Mine in Canada – Heavy equipment in the pit at Victor South West.

1. PURPOSE AND OBJECTIVES

This Group Technical Standard defines the minimum requirements for mine closure to ensure that all AA projects and managed operations pro-actively plan for closure to manage risks and opportunities.

2. SCOPE

AA has sites around the globe with variable remaining years of operations. All of these sites will eventually need to be closed to the satisfaction of internal and external stakeholders. Consideration of closure should be integrated into decision making at planning and operational levels, rather than being left until the last few years of production. This closure standard applies through the part of the mine life cycle from the commencement of operations to relinquishment, and includes operations under care and maintenance. The IDM contains the mine closure requirements relevant to the exploration and studies phases of projects.

The MCT contains more detailed guidance on how to meet the minimum requirements outlined in this Standard. This Standard shall be applied in conjunction with local legislation or applicable national standards of specific countries, regions and/or districts. Where the requirements of such legislation are in conflict with information in this standard or exceed provisions of this standard, such local regulations or standards shall apply.

3. PLANNING AND DESIGN

3.1 A closure plan, including a liability estimate, shall be developed that is fundamentally aligned with the MCT and be reviewed at least every three years or when there is a significant change that would lead to material misalignment with the existing closure plan. The closure plan shall identify the roles and responsibilities of personnel for implementation of closure activities.

3.2 A closure vision shall be established and maintained with associated specific closure objectives and land-use plans endorsed by the site leadership team.

3.3 A risk assessment and gap analysis aligned with the MCT shall be undertaken in all updates of the closure plan. The risk assessment shall also align with other processes used at the site. Where practical, relevant actions should be implemented to close identified gaps and decrease the rating of all significant and high closure risks, between successive closure plans.

3.4 Closure plans shall consider and address regulatory conditions and community and stakeholder commitments identified during stakeholder engagements and social/environmental impact assessments and licencing.

3.5 Where appropriate, closure liabilities shall be minimised through proactive integrated planning throughout the operational life cycle, involving formal opportunities analysis.

3.6 Closure requirements shall be integrated into the Business Planning and LoA planning processes to evaluate the impact of mine plan modifications on proposed closure activities.

3.7 Sites shall have at least a five year concurrent rehabilitation plan with clearly defined targets that is integrated into the Business Planning and LoA planning processes.

4. IMPLEMENTATION AND MANAGEMENT

4.1 Beneficial re-use of infrastructure shall be promoted post closure where there is a business case.

4.2 A proven rehabilitation technique that meets the closure vision and associated land-use shall be demonstrated as early as possible.

4.3 Concurrent rehabilitation shall be planned based on the availability of disturbed areas no longer required for ongoing operations. Each site shall have agreed annual rehabilitation targets which their performance is measured against.

4.4 Success criteria shall be developed as early as possible, but a minimum of ten years prior to planned closure, and be based on a proven rehabilitation prescription. Success criteria shall be developed with appropriate input from internal and external stakeholders.

4.5 Minimising post closure active treatment requirements shall be considered through integrated closure planning and concurrent rehabilitation.

4.6 Dependencies of relevant surrounding communities shall be managed and reduced through the life cycle of the operation in order to leave behind a sustainable post closure legacy.

4.7 Social costs shall be included as an operational expense until the mine ceases production after which it should be provisioned.

4.8 Premature and planned closure liabilities shall be calculated and updated annually utilising the remaining LoA from the approved LoAP and following the Group Finance Guidance. The estimate shall be reviewed independently every three years (exemptions from the independent review may be granted for low risk operations or those whose liability has not materially changed).

4.9 Closure liability estimates shall be supported by a Bill of Quantities with accuracy appropriate to the remaining LoA as per the MCT requirements.

4.10 Financial provision shall be provided to cover premature closure costs as required by the regulatory requirements of the relevant country.

4.11 Records related to design, construction, operation, closure and rehabilitation planning, implementation and monitoring shall be maintained.

5 PERFORMANCE MONITORING

5.1 Post production monitoring and maintenance costs shall be included in the closure liability estimate and must allow sufficient time for realistic relinquishment (minimum of 10 years post the decommissioning phase unless otherwise agreed with the Group closure team).

5.2 Performance using concurrent rehabilitation and closure related metrics shall be reported against site annual targets.

5.3 A reconciliation of actual versus planned rehabilitation executed during the year shall be provided with an associated variance analysis to the Group closure team.

5.4 Annual performance monitoring against the regulatory requirements and success criteria shall be undertaken, with required maintenance activities identified and implemented.

5.5 Early relinquishment of areas that meet all identified success criteria shall be actively pursued where allowed by regulators.

APPENDIX A: REFERENCED DOCUMENTS

Document Number	Previous Number(s)	Title
AA TS 701 002	AA RP 26 109	Mine Closure Toolbox
None, dated July 2017		Group Guidance Memo: Restoration & Decommissioning Provisions https://eureka.angloamerican.com/community/group-finance/reporting/financial-reporting/group-financial-reporting-policies-&-guidelines

APPENDIX B: RECORD OF AMENDMENTS

GLOSSARY

TERM	DEFINITION
Accounting Provision	The NPV of the estimate of funds required to cover the cost associated with existing disturbance over the remaining LoA and allocated as a liability on the balance sheet.
Back-End Loading	The various stage gates that the project associated with the transitioning of an operation through closure must pass through to ensure optimal implementation and project management.
Closure Criteria	Agreed sequential steps that must be undertaken as part of closure including physical, biophysical and socio-economic parameters defined through engagement with regulators and other external stakeholders. The closure criteria forms the basis of the closure liability cost estimate.
Closure Criteria Effectiveness (CCE) Review	Process that assesses the effectiveness of existing closure criteria in reducing closure risk to the predicted level.
Closure Objectives	Statement of the broad aims associated with the closure of an operation that expands on components of the closure vision.
Closure Plan	Standalone document addressing the physical, bio-physical, social and economic factors related to the closure of an operation.
Closure Risk Assessment	A process involving identifying risks and rating their probability and consequence. Closure risk assessments involve rating the risk before and after the implementation of closure criteria.
Closure Vision	A perspective of the legacy which an operation wants to leave behind in terms of the physical, biophysical, social and economic conditions. Generally, a one sentence statement.
Concurrent Rehabilitation	Rehabilitation that is undertaken while the mine is still operating.
Decommissioning	Shut-down and dismantling of a facility followed by the removal of process equipment, buildings and structures.
Disturbance Footprint	Total area (in hectares) of company managed land where the original characteristics have been altered by mineral extraction and ancillary operations.
Domain	A group of landforms or infrastructure that has similar rehabilitation, and closure requirements and objectives.
Financial Guarantee	Funds secured through an appropriate financing method (e.g. trust fund, bank guarantee, cash or other means) that are required to be held in some jurisdictions by regulators to cover costs associated with premature closure.
Gap Analysis	A process in the MCT that assesses the current level of closure planning across the physical, bio-physical, social and economic aspects against the required level based on the remaining LoA.
Integrated Life of Mine Planning	The process of integrating closure planning with LoAP to manage risk and realise opportunities throughout the operational life to optimise required activities when operations cease to meet the identified PMLs. Infers implementation of plans.
Kepner-Tregoe® Analysis	Decision making tool for team evaluation of opportunities, with detailed analysis and prioritisation processes.
Interested and Affected Parties (I&AP's)	All people affected or interested in a mining operation and its closure including NGO's and government organisations.
Integrated Closure Planning System (ICPS)	A system that combines the various planning regimes, internal and external requirements, financial considerations and systems from a people, process and technology perspective over the life cycle of operations to ensure that they leave a positive and sustainable legacy for their host communities post-closure.
Integrated Planning System Corporate Platform (ICPS-CP)	Technology platform that provides visibility across the entire AA portfolio in relation to closure and enables access through a single portal the performance of every operation in the portfolio.
Integrated Planning System Site Platform (ICPS-SP)	Technology platform that provides individual mines functional requirements to initiate, implement, develop and manage a site based ICPS.
Lease Relinquishment	The relinquishment of the mining lease to the relevant authority signaling that all closure requirements and associated success criteria have been met.
Licence to Transition	The intangible right that operations earn through their operating cycle through stakeholder engagement to cease operations and relinquish leases to be used for the identified PMLs.
Life of Asset (LoA)	The estimated number of years that an operation will continue based on a published plan that considers current influencing factors and forecasted economic factors.
Life of Asset (LoA) Plan	The agreed plan of the activities across the remaining LoA of an operation.
Life of Asset Closure Liability	An estimate of the closure liability assuming that the site operates for its full LoA.
Master Action Plan (MAP)	A spreadsheet or equivalent that records, tracks and manages actions, including assignment of responsibilities and timelines.
Mine Closure	The period following cessation of productive mining activities, and prior to the site being relinquished, within which mine closure activities are undertaken.
Mine Closure Planning (MCP)	Consideration of mine closure requirements throughout the lifecycle of an operation in order to achieve the closure vision.
Mine Closure Toolbox (MCT)	The AA Mine Closure Framework for undertaking closure planning for mining and processing operations, consisting of six tools namely strategic planning, rapid assessment; closing the gaps, integrated planning; execution planning and review/continuous improvement tools.

TERM	DEFINITION
Mine Transition	The transition of a mine from the operating phase to its PMLs.
Opportunities Analysis	A formal analysis involving all relevant internal stakeholders to examine opportunities to integrate planning across the entire life of the asset.
Post Closure	The period after decommissioning, demolition and rehabilitation that constitutes monitoring, maintenance and ultimately lease relinquishment where appropriate.
Post Closure Management Plan	Document that describes all mitigation, treatment and rehabilitation methods required as part of managing the post-closure residual risks.
Premature Closure	Mine closure occurring in advance of the scheduled life of an asset due to unforeseen changes in the physical, bio-physical, social or economic environment.
Premature Closure Liability	An estimate of the closure liability assuming that the site closes immediately.
Rehabilitation	Process of returning the land disturbed by operations to a safe, stable, non-polluting and sustainable condition aligned with the identified final PMLs.
Relinquishment	A state when agreed success criteria have been met, with government "sign-off" achieved. All legal obligations associated with the mining lease have been removed, and the proponent has been released from all forms of security, and responsibility has been accepted by the next land-user or manager.
Residual Risk	The estimated level of risk remaining after the closure criteria have been implemented.
Social Transition	The process of transitioning communities from the operational mining phase to the post-mining phase through the collaborative establishment of sustainable livelihoods where practicable.
Socio Economic Assessment Tool (SEAT)	A tool developed by AA that provides a structured approach to the management of social impacts.
Stakeholder Engagement Plan (SEP)	A plan that lists identified internal and external stakeholders and the communication techniques that have been identified to engage them.
Success Criteria	Agreed standards that must be met to facilitate lease relinquishment including physical, biophysical and socio-economic parameters defined through engagement with regulators and other external stakeholders. Also referred to as completion criteria in some jurisdictions and other countries.
Unacceptable Risk	Residual risk that is rated as significant or high according to the AA risk matrix.
Zone of Influence (ZoI)	The area within which a mining operation has material impacts or can influence other impacts.

ACRONYMS

AA	Anglo American
AASW	Anglo American Social Way
AMD	Acid and Metalliferous Drainage
BoE	Basis of Estimate
CRD	Coarse Residue Deposit
DCM	De Beers Consolidated Mines
DMS	Density Media Separator
FEL	Front-End Loading
FRD	Fine Residue Deposit
FS	Feasibility Study
HIA	Health Impact Assessment
HRA	Health Risk Assessment
HR	Human Resources
I&APs	Interested and Affected Parties
ICMM	International Council on Mining and Metals
ICPS	Integrated Closure Planning System
IDM	Investment Development Model
IRR	Internal Rates of Return
KPI	Key Performance Indicator
KT	Kepner Tregoe®
LoA	Life of Asset
LoAP	Life of Asset Planning
MAP	Master Action Plan
MCP	Mine Closure Planning
MCT	Mine Closure Toolbox
NPV	Net Present Value
PDCA	Plan, Do, Check and Act
PEP	Project Execution Plan
PFS	Pre-Feasibility Study
PMF	Project Management Framework
PMLs	Post-Mining Land-Uses
QRA	Quantitative Risk Analysis
RACI	Responsible, Accountable, Consulted, Informed
SEAT	Socio Economic Assessment Tool
SED	Socio-Economic Development
SEP	Stakeholder Engagement Plan
SHE	Safety, Health and Environment
SIA	Social Impact Assessment
SMART	Specific, Measurable, Attributable, Realistic and Time-framed
SMP	Social Management Plan
SoW	Scope of Work
WBS	Work Breakdown Schedule
ZoI	Zone of Influence

Anglo American
20 Carlton House Terrace,
London,
United Kingdom,
SW1Y 5AN

www.angloamerican.com