ICMM
International Council on Mining & Metals

Planning for Integrated Mine Closure: Toolkit

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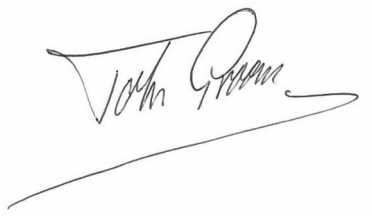
Foreword

Closure planning is a complex process. In many ways it is as complex as the project feasibility process that culminates in a constructed operation. The planning horizon is measured in decades, not months or years. Planners must deal with social, economic and environmental parameters that over a generation are bound to change.

In the past, closure planning has been the responsibility of operation management and focused on environmental aspects, with community involvement often limited to cursory consultation processes. Increasingly today, however, management looks to community ownership of the post closure goals as the well of energy that will permit closure initiatives to prosper when the mining company is no longer involved. To achieve this, community engagement is needed when scoping the challenge, conceptualizing the solution, implementing the design and verifying the outcomes. In addition to increasing the level of credibility, this establishes partnerships to drive success and, in doing so, creates a forum for transparency.

Fundamental to this approach is the need to consider closure as a core part of our business. The integration of closure considerations into an operation's planning and engineering processes is an important mechanism for a mine to create lasting value.

This Integrated Mine Closure Planning Toolkit has been developed to help site practitioners and their support groups make sound decisions based on a consideration of closure aspects in a holistic manner. The risks and opportunities that define the paths to closure are many and varied, and a disciplined, knowledgeable approach to closure planning is required to successfully negotiate these paths. It is our hope that this document provides practical guidance to negotiating them.



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Executive summary

This document presents an Integrated Mine Closure Planning Toolkit for the mining and metals sector. The toolkit is intended to be used to promote a more disciplined approach to integrated closure planning and to increase the uniformity of good practices across the sector. The concepts apply equally well to both large and small companies.

The document is not intended to be prescriptive; it provides a suite of tools that can be brought to bear in formulating well-considered decisions when planning for closure. It uses a risk and opportunity based process to guide the practitioner through the iterative process of preparing for planned closure.

The first section, with head office and mine management personnel as the primary audience, describes the participants of effective closure planning. Sections 2 and 3 provide the frameworks for a conceptual closure plan and a detailed plan. The key audiences for these two sections are mine management and head office personnel, financial modellers and estimators, governments, academics and non-governmental organizations. The forth section addresses decommissioning and post closure planning, and Section 5 draws together the conclusions and outlines several unresolved issues.

The five narrative sections are followed by Section 6 which outlines 13 tools, some of which are already available in earlier ICMM publications, member practices and other sector-affiliated publications. Others have been developed to cover identified gaps. These tools provide the practitioner with practical work processes, examples and contexts within which to apply closure planning discipline:

- **Tool 1:** Stakeholder Engagement
- **Tool 2:** Community Development
- **Tool 3:** Company/Community Interactions to Support Integrated Closure Planning (new)
- **Tool 4:** Risk/Opportunity Assessment and Management
- **Tool 5:** Knowledge Platform Mapping (new)
- **Tool 6:** Typical Headings for Contextual Information in a Conceptual Closure Plan (new)
- **Tool 7:** Goal Setting (new)
- **Tool 8:** Brainstorming Support Table for Social Goal Setting (new)
- **Tool 9:** Brainstorming Support Table for Environmental Goal Setting (new)
- **Tool 10:** Cost Risk Assessment for Closure (new)
- **Tool 11:** Change Management Worksheet (new)
- **Tool 12:** The Domain Model (new)
- **Tool 13:** Biodiversity Management

The process of closure planning using this toolkit advocates integration on a number of fronts, such as:

- Between the closure practitioner(s) from the distinct stages of a mining operation's development as they make decisions that affect closure at different times along the lifecycle (e.g., the exploration, feasibility, construction, operations, corporate and decommissioning teams);

- Between the different operational disciplines of a company during each particular stage, for example between the individuals/teams that deal with social and environmental planning, feasibility and design, financial management, risk management, budgeting and resourcing and, an important component, strategic planning; and

- Between the company and the various external stakeholders who provide input for, take ownership of and participate in the closure planning and execution processes required for successful outcomes.

The tools and guidance provided in this document bring community engagement, early closure planning, operational implementation of progressive closure planning and a cross-functional approach into effective exit strategies.

Introduction

This Integrated Mine Closure Planning Toolkit is intended to support an operation in achieving a post closure status that leaves behind an enduring positive legacy in the community. Health, safety, social, environmental, legal, governance and human resource considerations are addressed from exploration through to post closure. (See Box 1 at the end of this section for a definition of terms used in this report.)

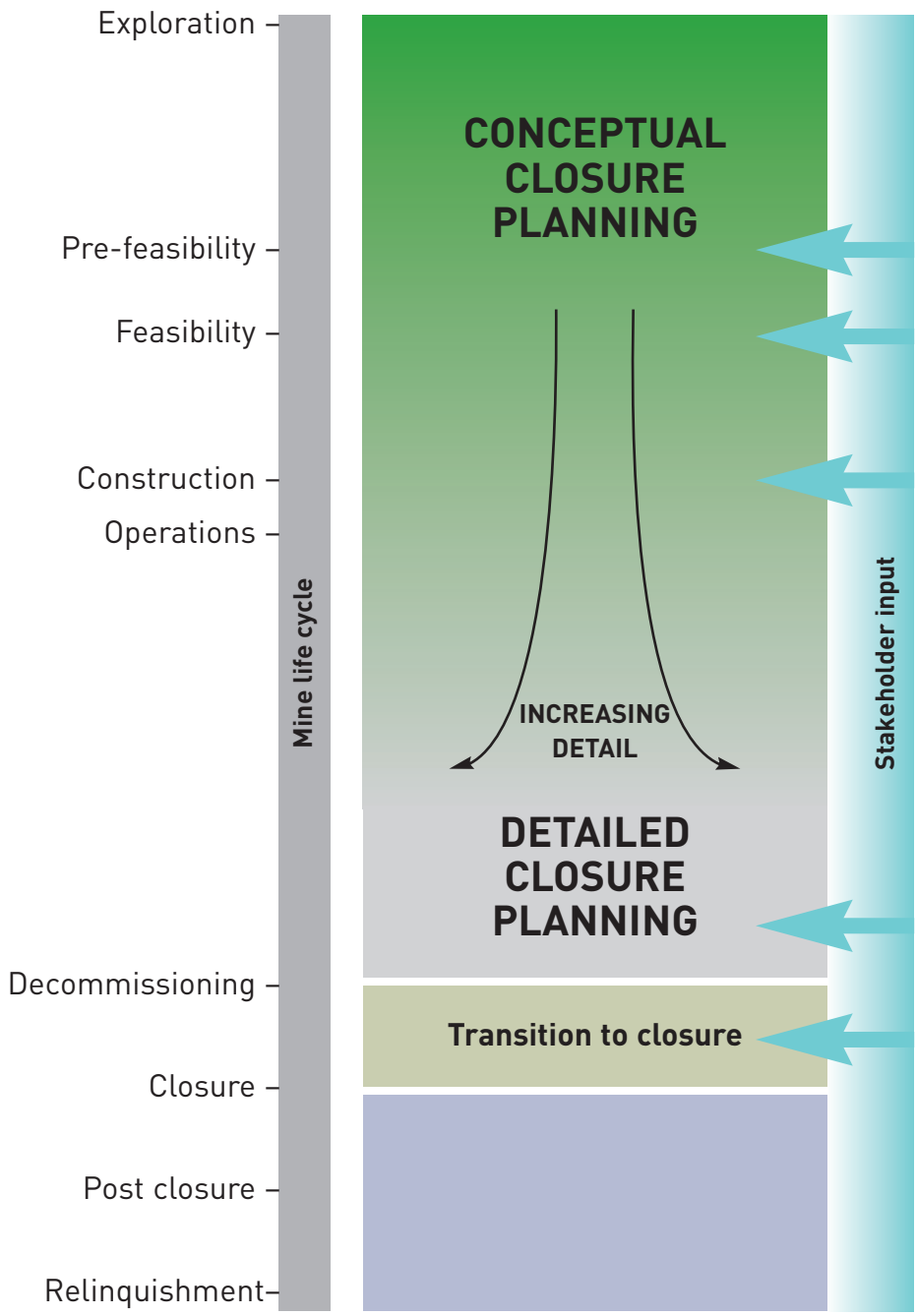
Planning for closure is about how to design a mine operation in order to facilitate closure. When a project is designed, there is a lot of scope to do so with closure in mind. For example, considering the need to re-vegetate a tailings facility when deciding its position, or designing mine infrastructure in relation to the community's requirements. There are often instances where simple changes up front can have profound implications for eventual site closure. This concept, and the supporting material in the report, apply equally well to both large and to small companies.

Positive outcomes of effective closure planning should mean that:

- Engagement with affected and interested parties will be more consistent and transparent;
- Communities will participate in planning and implementing actions that underpin successful closure;
- Closure decisions will be better supported by stakeholders;
- Planning for closure will become easier to manage;
- The accuracy of closure cost estimates will be improved;
- The risk of regulatory non-compliance will be minimized;
- Potential problems will be identified in a timely manner;
- There is more likely to be adequate funding for closure;
- Potential liabilities will be progressively reduced; and
- Opportunities for lasting benefits will be recognized and planned for adequately.

Closure planning is initially conceptual and progressively becomes more detailed (**Figure 1**). A closure plan in its conceptual stages may communicate an outcome and goals, whereas a detailed plan will include milestones, detailed methodologies of achieving these, monitoring and validation processes. Closure planning and the meeting of milestones and goals should be integrated into the systems and decision-making processes that support an operation throughout its life.

Figure 1: Closure planning

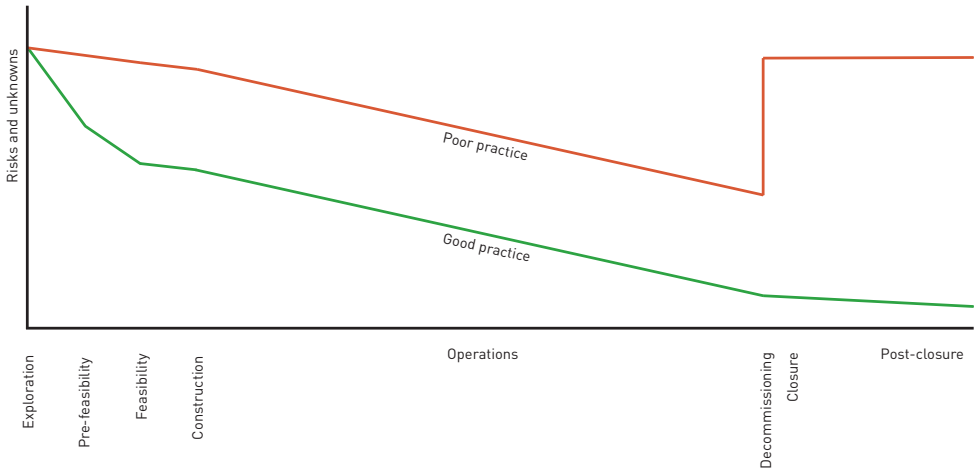


This concept of continuous closure planning is not the same as concurrent rehabilitation. The former is a process that extends throughout the life of the mine. The latter is only one part of the closure planning process which is usually accounted to operations.

Realizing closure goals requires a progressive reduction of risks and unknowns, as shown in **Figure 2**. The earlier that risks and unknowns are reduced, the greater the potential for meeting specific objectives. This is one reason that planning for closure should begin at the earliest opportunity.

The earliest possible time to plan for closure is at exploration, but the exploration phase may not result in an operating mine. In this circumstance, planning for a closure outcome that leaves a positive legacy may realistically mean the relatively straight forward process of environmental restoration of drill sites and tracks and the dismantling or handover of infrastructure such as exploration camp facilities. This publication does not deal specifically with restoration after exploration; it focuses instead on the closure challenges presented by a mine operation.

Figure 2. Reduction of risks and unknowns



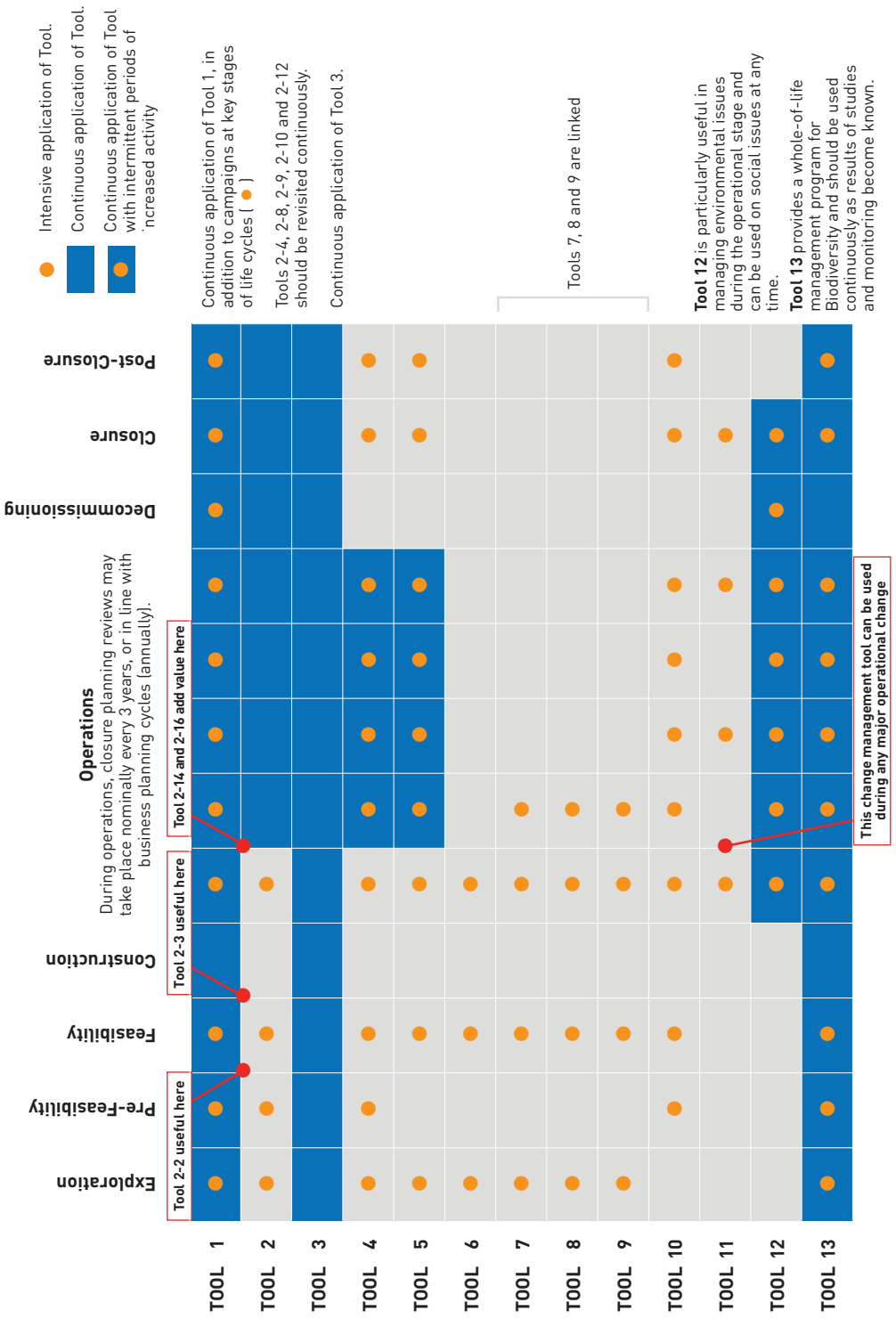
The Integrated Mine Closure Planning Toolkit can be applied throughout the life of an operation, as shown in **Figure 3**. The life cycle of the operation has been characterized as eight phases: exploration, pre-feasibility, feasibility (which includes planning and design), construction, operation, decommissioning, closure and post closure (which may include relinquishment of tenure and liability).

During each phase, a number of processes are recommended, and tools for undertaking these processes are supplied. Some of these processes are reiterated during the life cycle of the operation, both to capture changing community expectations or circumstances and to refine the closure plan.

There are three basic steps to developing an effective closure plan. If a mine makes closure planning part of its operational philosophy, these steps should blend into each other over time rather than being distinctive stages.

The first step is the development of a target closure outcome and goals, which are manifested in a **conceptual closure plan**. This plan is developed and used during exploration, pre-feasibility, feasibility/design and construction to guide the direction of activities. Its active life may be three to five years. If well-defined and based on effective community and stakeholder engagement, it may not change much during this time.

Figure 3. Application of tools during facility life cycles



The second step involves the ongoing development and implementation of a **detailed closure plan**, which increases the understanding and detail of specific goals and milestones as well as the actions and outcomes of activities to meet these. This plan is used continuously during operations, and has an active life that could range from 5 to 30 years or more, during which time it is updated. There is potential for expectations of the community and other stakeholders to change during this time. There is also potential for the mine plan to change, affecting operations as well as the facility life. If well defined at the start, specific goals may not change much during the life of the operation, but it is likely that the detailed closure plan will evolve in line with changing circumstances. Note that the detailed closure plan is effectively an increasingly detailed conceptual closure plan, with operational information serving to continually update and focus the plan. Some elements of the closure plan will need to progress faster than others in order to reduce risk in an effective manner, and these elements may vary from mine to mine.

The final step is the effective transition to closure, which may be manifest as a **decommissioning and post closure plan**. Its active life may be as little as a year or two, although depending on post closure responsibilities, it may extend many years past that time.

Successful closure depends on setting, continually reviewing and validating and finally meeting closure goals that align with company and stakeholder requirements. There should be minimal residual risk to the company, and the community should realize benefits that will continue to exist without further input from the company.

The text in this toolkit describes an ideal situation, where planning begins early in the operation's life cycle. However it is recognized that mines may have gone through their life without closure plans in place or without baseline conditions having been determined. The processes and tools in this toolkit are still valid in those circumstances, but more effort may need to be applied over a shorter span of time to allow the mine to develop the most detailed closure plan that is practical to develop with the knowledge available, to detail the knowledge still needed to progress the closure plan and to implement a plan to capture and use this knowledge effectively.

Box 1. Glossary

Care and maintenance – Period following temporary cessation of operations when infrastructure remains largely intact and the site continues to be managed.

Closure Planning – A process that extends over the mine life cycle and that typically culminates in tenement relinquishment. It includes decommissioning and rehabilitation. The term closure alone is sometimes used to indicate the point at which operations cease, infrastructure is removed and management of the site is largely limited to monitoring.

Decommissioning – The process that begins near or at the cessation of mineral production and ends with the removal of all unwanted infrastructure and services.

Deterministic estimates – Estimates of value (cost or benefit) of the outcome of an event occurring, expressed as a single mean or mode value and a range of single values (e.g., minimum, maximum).

Probabilistic estimates – Estimates of value (cost or benefit) that account for the likelihood of occurrence and the range of values of the outcomes. Values are expressed through a statistical analysis (e.g., Monte Carlo simulation) using a statistical distribution over the range of possible values accounting for the probability and timing of the event occurring.

Reclamation/Rehabilitaiton – Terms used interchangeably to mean the return of disturbed land to a stable and productive condition.

Relinquishment – Formal approval by the relevant regulating authority indicating that the completion criteria for the mine have been met to the satisfaction of the authority.

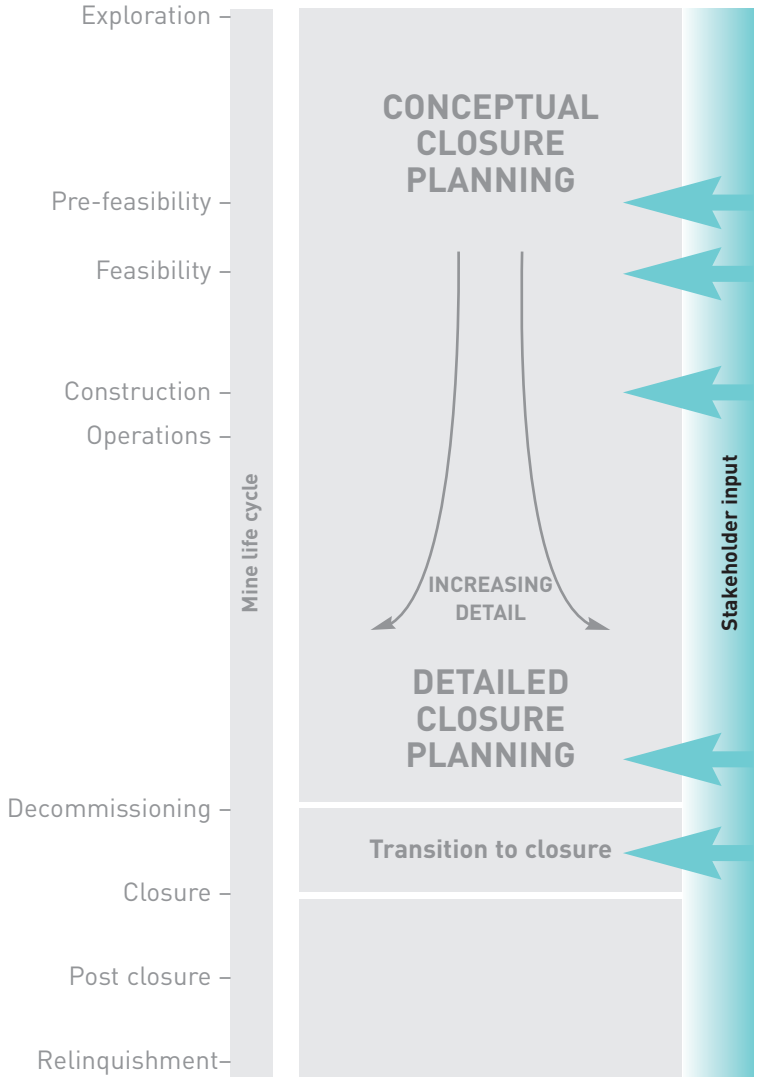
Stakeholder – A person, group or organization with the potential to affect or be affected by the process or outcome of mine closure.

Source: Based on Department of Industry, Tourism and Resources, Government of Australia, *Mine Closure and Completion*, October 2006.

SECTION 1:

Participants in effective closure planning

Section 1. Participants in effective closure planning



Effective closure planning involves bringing together the views, concerns, aspirations, efforts and knowledge of various internal and external stakeholders to achieve outcomes that are beneficial to the operating company and the community that hosts it. For a company, this involves:

- Incorporating closure planning into the early stages of project development (nominally pre-feasibility and feasibility) and operations;
- Collating the goals and views of various stakeholders (project owner, local community, government, and non-governmental organizations (NGOs)) at the early stage of project development and operations to inform closure and post closure goals;
- Acting to meet the goals by working with the relevant stakeholders within and outside the project owner's organization;
- Using the concepts of risk and opportunity to both minimize liability and maximize benefits to all relevant parties; and
- Using multidisciplinary expertise and multi-stakeholder processes to ensure that mitigation of risk in one area does not increase risks in another.

The process of engagement with internal and external stakeholders should be undertaken throughout the life cycle of the operation. The type of engagement may vary between life cycle phases, but engagement during the operational phase of a mine should be at an appropriate level of frequency throughout. The process of engagement may not result in full consensus on closure outcomes, but it should be considered successful if it leads to fully informed decisions.

External stakeholders

To achieve lasting benefits at a local and regional level, the views of external stakeholders must be understood. To ensure these benefits are delivered, the company or operation must be able to support them. This involves identifying the external stakeholders and then engaging with them to foster a two-way understanding of what mutually beneficial outcomes are. A number of useful references are available to assist in effective engagement. These include, but are not limited to:

- **Tool 1:** Stakeholder Engagement: Environmental Excellence in Exploration, the Prospectors and Developers Association of Canada (2007), which details tools for community engagement, including social impact assessment, community profiling and mapping, gap analyses, active listening, risk communication, partnerships and facilitation. Several models of community engagement are also presented, each of which adds different dimensions to the process of engagement, and each of which has its own advantages in developing mutual understanding. Although aimed at exploration activities, the tools in this reference are equally applicable throughout the operation's life cycle.

- **Tool 2:** Community Development: The ICMM Community Development Toolkit (2006), which addresses one of the primary vehicles of lasting benefits, namely the development of host communities. Seventeen tools are presented for the assessment, planning, relationship management, program management and monitoring of community development plans. (Individual tools are highlighted here within Tool 2 with the numbering system cross-referenced to the source document.) The description of community/company interactions at the various phases of the operation's life cycle provides a clear framework within which to capitalise on the key opportunities for engagement can be capitalized on. Specific tools, including the Stakeholder Identification Tool (2-1) and the Social Impact and Opportunities Assessment (2-2), can be used to identify the most meaningful benefits that are achievable.

Closure planning should acknowledge that communities have different levels of dependence on the operation. Dependent communities may have broader socio-economic risks and benefits that need to be addressed, whereas independent communities may display different risks and opportunities and a lower socio-economic sensitivity to the presence or absence of the operation.

It must be understood that the views and expectations of external stakeholders may change through the life of the operation and that effective engagement is as much about continuity and consistency of effort as it is about the tools that are used.

Questions to ask when considering external stakeholders include:

- Who in the area may be directly affected by the construction and operation of the mine site?
- Who in the area may be indirectly affected by the construction and operation of the mine site?
- Who within or outside the area may be indirectly affected by upstream activities that support construction and operation?
- Who may influence the ability of the project to gain or retain its license to operate?
- Who are the interested stakeholders?

Internal stakeholders

The resources of an organization can have varying input and responsibility, at different times, for the three stages of effective closure planning (conceptual closure planning, detailed closure planning and decommissioning/post closure planning). The need for integration between the various internal stakeholders at any one stage and between the stages is fundamental in ensuring that a mine operation is designed with closure in mind.

Table 1 shows an example of how important internal stakeholders can have key input to the closure planning process throughout the operation's life cycle. Note that some organizations may not have all of these internal divisions or teams to provide the requisite support, but much of the knowledge and expertise is usually drawn upon during the various stages of the development and operation of the facility. Note too that these responsibilities may overlap to some extent, depending on the organizational structure of a company.

Table 1. Influence of project teams in delivering integrated closure planning

Typical organizational involvement (guide only)								
Stage of operation life cycle	Time (nominal)	Exploration team	Corporate team	Feasibility team	Construction closure team	Operational team	Decommissioning/ closure team	Form of closure plan actively developed and used
Exploration	2–5 yrs	**CORE**	**SUPPORT**	N/A	N/A	N/A	N/A	Conceptual closure plan
Pre-feasibility	1–5 yrs	**HANDOVER**	**SUPPORT**	**CORE**	N/A	N/A	N/A	Conceptual closure plan (developed further)
Feasibility	1–5 yrs	**HANDOVER**	**CORE /SUPPORT**	**CORE**	ADVISORY	ADVISORY	N/A	Conceptual closure plan (developed further)
Construction	1–2 yrs	N/A	ADVISORY	**SUPPORT**	**CORE**	ADVISORY	N/A	Conceptual closure plan (developed further)
Operation	5–30 yrs	N/A	**SUPPORT**	ADVISORY	ADVISORY (initial)	**CORE**	N/A	Detailed closure plan
Decommissioning	0–1 yr	N/A	**SUPPORT**	N/A	N/A	**CORE**	**CORE**	Decommissioning and post-closure plan
Post-closure	5++ years	N/A	**SUPPORT**	N/A	N.A	N.A	**CORE /SUPPORT**	Decommissioning and post-closure plan

Definition of terms:

A core activity is one in which the involved party is required to drive the process and may hold accountability for the success of that process.
A support activity is one in which the involved party takes an active role, providing cross-functional expertise or management input.
An advisory activity is one in which the involved party provides contextual information that is of value to the planning.
A handover activity is a transitional role to ensure that continuity of the closure planning process is maintained.

A synthesis of Table 1 with the ICMM Community Development Toolkit's description of company/community interactions (Community Development Toolkit, Table 2.2, page 12) provides a simple framework for deciding how to leverage internal company resources towards the most effective and informed engagement processes at the most appropriate times.

Tool 3 shows an example of such a synthesis.

Balancing the expectations and viewpoints of participants

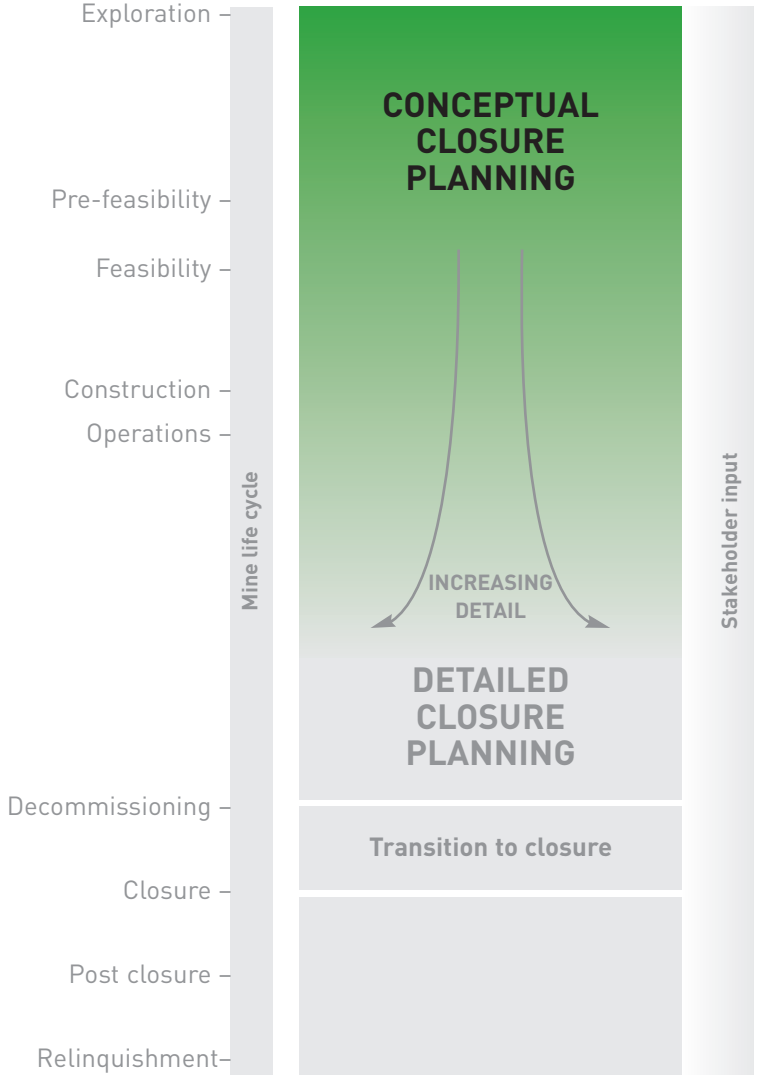
Participants in closure planning may initially hold different views on what can and what cannot be achieved in closure, and expectations may vary between stakeholders. Understanding these views and expectations (which may change over time) and formulating with stakeholders a balanced, realistic and achievable closure outcome that can be funded and supported by the relevant parties is a fundamental aspect of closure planning. These balanced closure outcomes, if arrived at by participants during closure planning, help create stakeholder ownership of the closure outcomes and ultimately help ensure successful closure.

Whereas many environmental closure outcomes rely on the mining company's expertise to conceptualize and deliver results, communities and governments play a pivotal role in social closure outcomes. It is the community that has the most local history and knowledge to inform the development of social closure outcomes. Local, provincial and national governments provide perspectives on institutional capacity, local and national economies, cultural and inter-community issues and the sustainability of social closure outcomes.

SECTION 2:

Framework of a conceptual closure plan

Section 2. Framework of a conceptual closure plan



The conceptual closure plan is the beginning of the process of planning for closure and is appropriate for the exploration, pre-feasibility, feasibility and construction phases of an operation's life cycle. It will evolve over time as more information becomes available and is refined into a detailed closure plan (see Section 3) as soon as possible after operations begin.

All closure planning should maintain an understanding of the risks and opportunities presented (**Tool 4** Risk/Opportunity Assessment and Management) and the knowledge with which decisions are being made (**Tool 5** Knowledge Platform Mapping). The latter should be used in conceptual closure planning, but it becomes more potent in subsequent iterations of the detailed closure plan.

Risk/opportunity assessment and management

A structured risk/opportunity assessment process should be used to:

- Minimize the negative consequences of closure;
- Maximize the positive benefits of closure;
- Minimize the likelihood that closure goals are not met; and
- Maximize the likelihood that opportunities for lasting benefits are captured.

Six types of risk have been outlined.[1] These are, in no order of priority:

- Health and Safety Risk
- Natural Environment Risk
- Social Risk
- Reputational Risk
- Legal Risk
- Financial Risk

When considering closure risks, all six types should be considered.

Tool 4 presents a risk/opportunity assessment process based on the Risk Management Standard developed by the Council of Standards of Australia and New Zealand[2].

The risk assessment process in a conceptual closure plan should identify the potential issues that could elevate the risk that undesirable closure outcomes are realized or could reduce the opportunity that lasting benefits are realized. These issues should be noted as risk factors that require control and monitoring in current and later versions of the closure plan. Broad strategies and approaches for the control of each risk should be presented.

[1] HB 436:2004, Risk Management Guidelines, Companion to AS/NZS 4360:2004

[2] AS/NZS 4360:2004 Risk Management

Contextual information

The conceptual closure plan should contain contextual information and a broad framework that helps inform decisions. Contextual information can be derived from social, environmental, health and human rights impact assessments, as well as from direct engagement with stakeholders and specific social, environmental and economic baseline studies.

Contextual information should include a wide variety of physical and social considerations such as settlement status, transport networks and existing environmental legacies. A number of typical headings for conceptual information are listed under **Tool 6**. For biodiversity, which can be a highly variable issue from site to site, **Tool 13** (Biodiversity Management) provides a useful way of consolidating contextual information.

Target closure outcome and goals

The conceptual closure plan should also set out the target closure outcome and as many goals as practical to allow the operation's development (which culminates in construction and commissioning) to proceed in a manner that does not inadvertently disadvantage the company's later ability to minimize social, environmental and economic liabilities and instill sustainable benefits beyond closure.

The setting of the target closure outcome must have buy-in from the local community and the government. There may be a considerable engagement process required to set a closure vision that meets the company's and the community's view of the future.

The target closure outcome may be a simple statement that encompasses the overall concept of closure, covering the specific local focuses that may dominate the considerations. For example, a target closure outcome for an industrial city in Western Europe might include such phrases as best practice environmental compliance and sustainable urban land use, whereas a target closure outcome for a rural area in sub-Saharan Africa might include concepts such as community development and health care. It may be as conservative or as ideological as the company wishes, but it should, at a minimum, portray the elements of lasting community benefits locally.

Closure goals should be as specific as possible. In a conceptual closure plan, the ability to specify closure goals is limited to the amount of information available and the extent of stakeholder engagement carried out. The conceptual closure plan should be revisited and updated at intervals beginning with the pre-feasibility and continuing with the feasibility and construction, as the amount of decision-making information available typically increases at a rapid rate during this project development period.

The ability to specify closure goals can be increased by undertaking the following activities:

- Developing terms of reference for baseline studies that focus on gathering relevant local and regional information on the key phrases encompassed in the target closure outcome (this might be done during exploration or pre-feasibility);
- Using a suite of stakeholder engagement strategies (Tool 2) to define desirable goals (this may be done several times through the project development phases); and

- Enhancing the terms of reference of environmental and social impact assessments to allow the scoping of, and testing the viability of, specific post closure goals by the various impact assessment study teams (during pre-feasibility or feasibility phases).

Considerations for goal setting are presented in **Tool 7**. Note that for conceptual closure plans, data limitations may preclude the full use of **Tool 5** (Knowledge Platform Mapping). Closure goals should be itemized and numbered for ease of reference and management in a conceptual closure plan.

Tool 8 and **Tool 9** are brainstorming support tools that may be used in workshops to help broadly define risk and goals for the social/socio-economic and environmental dimensions of closure planning.

Monitoring and evaluation

The conceptual closure plan should identify the types of monitoring programs that may have to be instituted to allow verification that the closure planning process is meeting pre-selected goals.

Monitoring programs can be determined under two categories: environmental monitoring and socio-economic monitoring. Both need to establish:

- Baseline conditions;
- A quantification of changes that might occur as a result of environmental and societal evolution without the mining operation;
- A quantification of changes that might occur as a result of the mining operation;
- How progression towards goals can be measured; and
- How the achievement of goals can be demonstrated.

The fourth and fifth items require a process for assessing information that validates if closure goals are being met. At the conceptual stage, it is not necessary to detail these processes, but it is important to confirm that these processes are practical and achievable.

Closure costs

Cost estimating, from pre-feasibility through to construction, should be owned at the project or site level with projected expenditures being factored into annual operating activities. As a closure plan evolves, it should have ownership at the site level, both technically and financially (versus simply higher level accounting entry). Such ownership can spur more accountability for accurate estimates.

At the conceptual stage, the closure costs are expected to be broad estimates only. It is useful to acknowledge the accuracy limits of each closure cost item. Closure costs with accuracy limits may be stated with a plus/minus (+/-) accuracy percentage, such as $200,000 +30%/-10% (known as deterministic limits). This acknowledges that the true cost of this closure item may be between $180,000 and $260,000.

A more robust and sophisticated alternative is a probabilistic assessment, which allows the users of the closure plan to understand the likelihood of a given cost being exceeded. This is covered in **Tool 10** (Cost Risk Assessment for Closure).

Acknowledging that closure costs may vary depending on a number of elements is important to managing the risks of closure costs. Reporting a variable cost allows this aspect to be managed more transparently.

Financial assurance requirements can accelerate the need to forecast conceptual and detailed closure cost estimates. This can add complexity and cost to early project planning[3].

Updating the conceptual closure plan

As noted earlier, a conceptual closure plan should be developed as early as possible. It may be possible to develop certain detailed elements of the plan at commencement, and this is appropriate. Conceptual closure plans should then be updated at the following junctures:

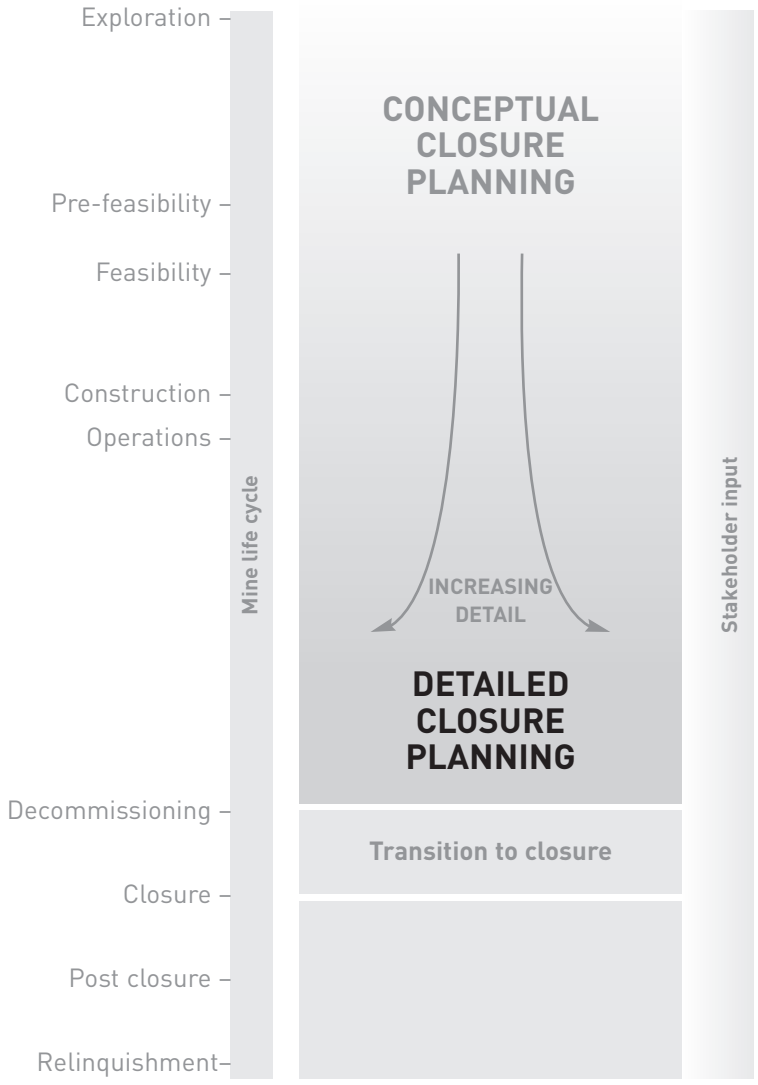
- **When pre-feasibility studies commence.** The scope of the plan may not have specific objectives or closure costs, but it should address the key aspects of a closure plan. At the very least, target closure outcomes, risks and opportunities should be documented. At this stage key closure factors that may influence the design of the operations should be identified. This may include constraints against or opportunities for future land use, the selection of utility supply schemes (water, power, sewerage, etc.) and the potential for re-mining if economically feasible. This input to operational design at the earliest pre-feasibility stages helps ensure that the design does not preclude closure outcome options and allows relevant data to be scoped and obtained to aid in detailed design.
- **When feasibility studies have yielded baseline and projected impact information** (after environmental and socio-economic studies have been completed). At this stage, when the operation is being designed in greater detail, design features that can support or enhance closure plans can be incorporated. There should be no gaps in the conceptual closure plan at this stage, indicating that all key issues have been considered to at least a conceptual level.
- **As soon as practical after construction**, to reflect any changes made during construction. This step is particularly useful in documenting construction changes that affect (primarily) environmental closure issues. Tailings dams, water supply infrastructure, catchment water management, roads and transport infrastructure and creek and river diversions are elements that are especially subject to changes during construction.

[3] Issues relating to financial assurance requirements are covered in *Guidance Paper: Financial Assurance for Mine Closure and Reclamation* (ICMM, 2006).

SECTION 3:

Framework of a detailed closure plan

Section 3. Framework of a detailed closure plan



The conceptual closure plan should be enhanced with detail as early in the operations phase as possible. Information supporting this detail may accrue during the first few years of the operation, and this should be captured and included in the plan. An active and detailed closure plan that is in effect during the early stages of operations represents good practice, although in reality the change of management through feasibility, construction and operations often results in sufficient resources being applied to closure planning only some years after operations commence.

From a purely logistical and planning standpoint, the existence of a fully detailed closure plan, incorporating an implementation plan and schedule, is necessary to achieve optimum outcomes three to five years before closure. However, better practice is shown by having a fully detailed closure plan earlier; in addition to allowing the mine plenty of time to fine-tune and optimize closure outcomes, this increases the ability of an operating mine to deal with issues such as unplanned closure.

Operations undertake some closure activities continually, such as the rehabilitation of disturbed land and stabilization of creeks and drainage channels. Closure activity does not therefore commence only towards the end of an operation, although the intensity of such activities increases substantially at this time. During operations, concurrent closure activities such as rehabilitation of disturbed land and the generation of small enterprises can be used to inform the detailed closure plan. Vegetation and biodiversity trials, microfinancing and other activities yield important information that serve to enhance and add detail to the closure plan.

The end of this chapter outlines when detailed closure plans should be updated.

Contextual information

The detailed closure plan should contain the same headings as the conceptual plan (see **Tool 6** Typical Headings for Contextual Information in a Conceptual Closure Plan). During the process of detailed feasibility and construction, the volume of contextual information should increase substantially. Construction and pre-construction activities such as the implementation of Relocation Action Plans, the actual uptake of local labor forces, compensation payments and increased community interest in the project contribute contextual information of value. Best practice closure planning would monitor and use the social and socio-economic data that becomes available during this changing phase to strengthen the foundations of the detailed closure plan.

Information can become available or change rapidly in a number of areas during the feasibility and construction phases. **Tool 11** shows some questions that should be asked when there are changes in the project for inclusion in the detailed closure plan.

Target closure outcome and goals

The detailed closure plan should revisit and restate the target closure outcome. The main difference from a conceptual closure plan is that the goals should be more detailed and the milestones more evident. This may not be possible for all goals in the first iteration of a detailed closure plan, as some feasibility assessments may need to precede the setting of specific goals (for example, hectares of arable land, turnover of small to medium-sized enterprises (SMEs)). However, the fundamental goals (rehabilitation of areas to arable land, development of SMEs in industries X, Y and Z, etc.) should be stated in the detailed closure plan.

Each goal should identify interim goals that allow the closure planning team to track progress. Each milestone or interim goal should have a means of objectively identifying if that goal has been met or not and ideally, if it has not been met, the shortfall associated with that goal.

A suggested process for defining and/or refining goals is as follows:

- Use **Tool 1** (Stakeholder Engagement) to revisit the conceptual closure plan with relevant stakeholders.
- Use **Tool 4** (Risk/Opportunity Assessment) to determine risk and opportunities associated with goals defined.
- Use **Tool 5** (Knowledge Platform Mapping) to characterize the knowledge basis upon which decisions are being made, which in turn allows scoping of Action Plans to improve the confidence that goals can be met.
- Use **Tool 8** to focus on social goal setting.
- Use **Tool 9** to focus on environmental goal setting.
- Use **Tool 2-9** (Opportunity Ranking) to refine the priorities associated with socio-economic development goals.
- Use **Tool 7** (Goal Setting) to define overall and interim goals. **Tool 2-15** (Logical Framework) will assist with developing interim goals
- Use **Tool 2-16** (Indicator Development) to specify objective means of assessing if interim and final goals are met.
- Use **Tool 2-14** (Overview of Monitoring and Evaluation Tools) to assist in developing the monitoring program.

Note that while **Tools 2-14, 2-15** and **2-16** are formulated for socio-economic goals, the same tools can be applied to environmental and economic goals.

At the end of this process, the detailed closure plan should specify:

- Goals targeted,
- Interim goals targeted,
- Indicators to verify that overall goals and interim goals are being attained and
- How these indicators will be obtained.

The detailed closure plan is an evolving document that should move the facility towards a sense of surety about the closure outcomes.

Tool 13 addresses the issue of biodiversity in a comprehensive way, allowing some of the key environmental considerations in sustainable post-closure outcomes to be scoped with rigour.

Action plans

The backbone of a detailed closure plan consists of the Action Plans for each goal, which should have the following elements:

- What is to be done,
- When this is to be done by,
- Who is responsible for the completion of this action,
- Resources required to complete the action and
- Cost to complete the action.

Table 2. An example of an Action Plan is as follows:

Closure goal 9 – Post closure water management

Task No	Task action	Timing (insert actual date)	Responsibility (insert name or role)	Resourcing	Cost
9-01	Conceptualise final landform and land uses	At feasibility	Feasibility study manager	Impact assessment team	$
9-02	Conceptualise surface water drainage systems for post closure	At feasibility	Feasibility study manager	Feasibility team	$
9-03	Determine monitoring regime	At feasibility	Feasibility study manager	Impact assessment team Feasibility Team	$
9-04	Re-cast final landform changes using mine planning changes to inform this	Annual 31 Dec xxxx	Site environmental officer	Site environmental officer	$
9-05	Evaluate monitoring of surface and groundwater resources to validate accuracy of post-closure surface water management and groundwater management assumptions	Annual 31 Dec xxxx	Site environmental officer	Site environmental officer	$

Task No	Task action	Timing (insert actual date)	Responsibility (insert name or role)	Resourcing	Cost
9-06	Re-conceptualise post-closure drainage	Annual 31 Dec xxxx	Site environmental officer	Site environmental officer Specialist consultant every 5 years	$ $ per 5 years
	Etc.				

Numbered and indexed goals provide a structured way of managing towards closure. The inclusion and updating of Action Plan costs promotes rigorous annual budgeting and planning to ensure that the resources required to execute elements of the Action Plan are made available.

Action Plans – particularly for environmental issues associated with mine infrastructure such as open pits, haul roads, tailings dams, maintenance bays, accommodation quarters and waste rock dumps – can be formulated using domain models. A domain model sets a series of goals for the closure of an infrastructure element and provides a good focal point for developing detailed Action Plans. The use of aerial photos and photographs makes the domain model more accessible to external stakeholders.

An example of a domain model is shown in **Tool 12**.

Closure costs

One of the primary aims of developing accurate closure costs is to allow the operation to accrue the funds required to bring about successful closure.

The accuracy of costing for a given closure goal or element depends on how much is known and how much is not known (its Knowledge Platform, **Tool 5**). It is important that accurate closure costs are developed as they impact the overall financial analysis of the operation.

The practice of estimating closure costs using a probabilistic approach (**Tool 10**) acknowledges that the potential variance in costs is linked to the type and amount of unknowns. Using a probabilistic approach, closure costs can be communicated, for example, as 'there is a 50 per cent likelihood that the closure cost will exceed $85,000,000 and a 15 per cent likelihood that the closure cost will exceed $117,000,000'.

This type of description communicates the 'spread' of costs and risk. For facilities with a low knowledge platform, the difference between these figures may be large, while for facilities with a high knowledge platform the difference is generally much smaller. As the difference gets smaller, the accuracy increases. During the life of the operation, the range of projected closure costs will narrow.

Note that **Tool 10** does not include the mechanics of calculating the percentage likelihood of exceeding the cost or the resulting cost-risk curves. Financial modellers should be consulted to undertake this step.

Closure costs often include annual post closure expenditures that may be necessary over a period of time to monitor outcomes. In some cases this may be needed for years or decades.

Updating the detailed closure plan

For best practice integration with business systems such as business planning and annual budgeting (including accrual), the closure plan should be reviewed annually. It subsequently transitions from a conceptual closure plan to a detailed closure plan as part of its normal operating process. The following questions should be asked in order to decide whether parts of the detailed closure plan should be revisited.

- Has the mine plan (e.g., mining process, scale or pace) changed?
- Have new environmental risks been identified (e.g., acid rock drainage, topsoil loss)?
- Have new social risks been identified (e.g., artisanal mining, social unrest)?
- Has the life of the mine been increased or decreased?
- Could re-mining occur in the future?
- Have laws and regulations changed?
- Have land use practices changed from original assumptions?
- Has the rate of rehabilitation been slower or faster than the rate planned?
- Have non-compliances or design changes occurred that indicate flaws in construction or operation (e.g., tailings dam leak, waste dump stability angles)?
- Have climatic conditions changed beyond impact assessment assumptions?
- Has new infrastructure been added to the mine footprint?
- Have community structures, including population and demographics, changed beyond predictions?
- Have impacts been greater or less than predicted at impact assessment?

An adequate closure planning process would result in a revision in the detailed closure plan (if only in revised closure costs and updating of risks, knowledge platform and Action Plans) once every three years. Note that financial provisions may need to be updated annually in some jurisdictions, and this may set the frequency of cost reviews.

Facilities with long and short lives

The process of detailed closure implementation activities may take several years, and for facilities with short lives (five to seven years) it becomes more pressing to have a detailed closure plan in place very early. For facilities with longer lives, the detailed closure plan may develop through several iterations, and there is some flexibility regarding when a detailed closure plan should be in place. However, it is more beneficial to have a detailed closure plan in place as early as possible.

During an operation's life there can also be changes in regulatory and/or social requirements which will generally increase with time and can have significant effects on the conceptual and detailed closure plans as well as related costs. This should be recognized as a risk, particularly for facilities with longer lives.

Sudden closure

Circumstances such as economic or market downturns, technical problems or civil unrest may cause an operation to close suddenly, perhaps several years or decades before its scheduled closure. Practical planning for sudden closure cannot be done in detail, as the circumstances surrounding the reasons for closure may dictate possible closure scenarios. Being prepared for sudden closure relies on having an updated detailed closure plan, which gives the closure planner the ability to rapidly evaluate the remaining unknowns and risks associated with closure and to develop an appropriate decommissioning plan. Issues that cannot be resolved during the short time span of sudden closure may become elements of a care and maintenance program pending the opportunity to re-enter the operation and implement a closure plan.

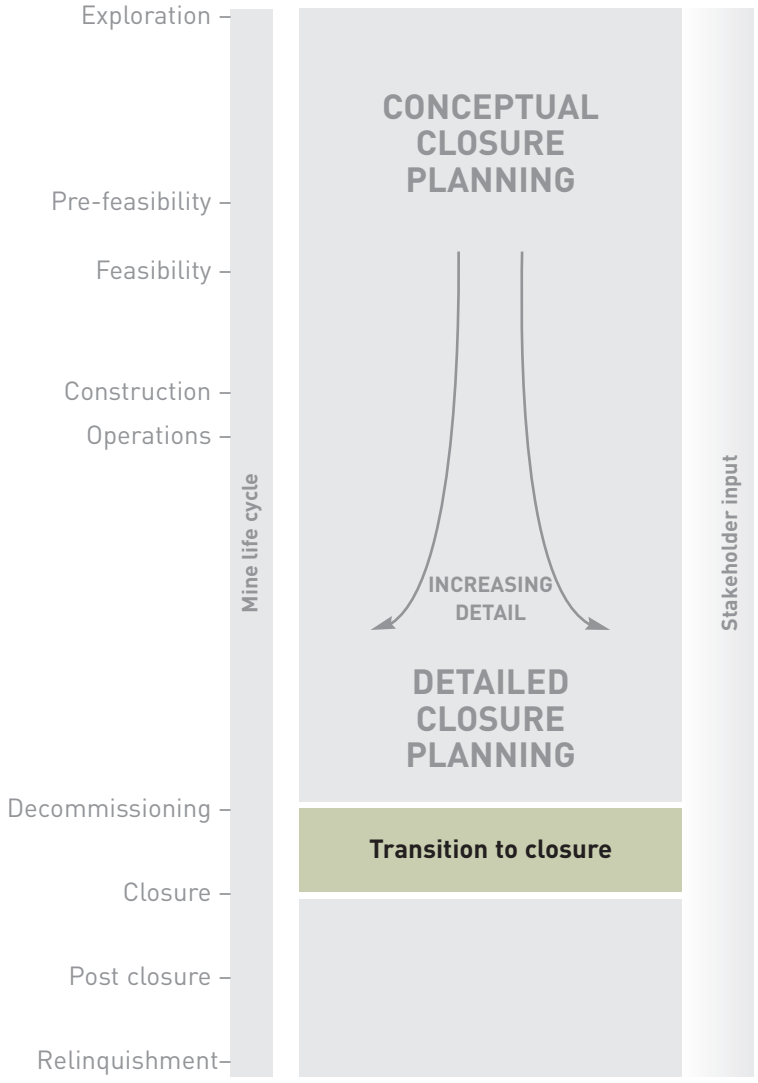
Application to existing operations

In cases of existing operations where a mine closure plan does not exist, the principles provided in this toolkit should be applied as far as possible. Early benefits, such as the inclusion of mine design principles to support certain closure outcomes, may have been lost at this stage, but a realistic and achievable closure plan can still be formulated with application of the principles and tools in this document. The process of gathering information to inform the development of a closure plan may take some time, and a detailed closure plan may need to develop from a conceptual closure plan over a number of years or months. In effect, the process described in this document for ideal closure planning can largely be compressed into a tighter schedule.

SECTION 4:

Decommissioning and post-closure planning

Section 4. Decommissioning and post-closure planning



Decommisioning and post closure planning

As the operation approaches the end of its life, there needs to be a clear transition from an operational phase to the closure and decommissioning and, ultimately, the post closure phase. This transition largely consists of the following:

- Engineering works to decommission and dismantle infrastructure, complete rehabilitation, grade landforms for effective drainage, cap and cover tailings facilities, implement post closure monitoring networks, etc.;
- Administrative works relating to the transfer of assets, labor force demobilization, relinquishment agreements and other government and NGO agreements; and
- Due diligence monitoring and reporting on the post-decommissioning status of environmental and social aspects of the site.

The decommissioning plan is predominantly a project-driven plan similar to a construction plan. However, it is important for the decommissioning and post closure planning to provide assurance that the closure goals have been met. Environmental examples include ongoing topsoil retention on post closure landforms, biodiversity, water quality and dust management. Social/community examples include the effectiveness of small to medium-sized enterprises, local unemployment rates, schooling and health care. Whereas the environmental examples are often reflected in statutory relinquishment considerations, the social examples are often not, although they may affect an organization's reputation as much as or more than the environmental examples.

This phase can be difficult for communities, as an entity that has contributed to household earnings and other local economic inputs is rapidly removed. It is important to increase the level of engagement (**Tool 1**) in the year or two leading up to decommissioning in much the same way as done prior to construction, to help communities prepare for changes to their environment. Transparency and full disclosure are important elements of this preparation.

The closure planning group should have detailed input to the decommissioning and post closure planning processes to ensure that the focus on environmental and social issues is maintained during and after the transition process of decommissioning. Failure to do so can undermine the many years of diligent work and closure planning that preceded this point.

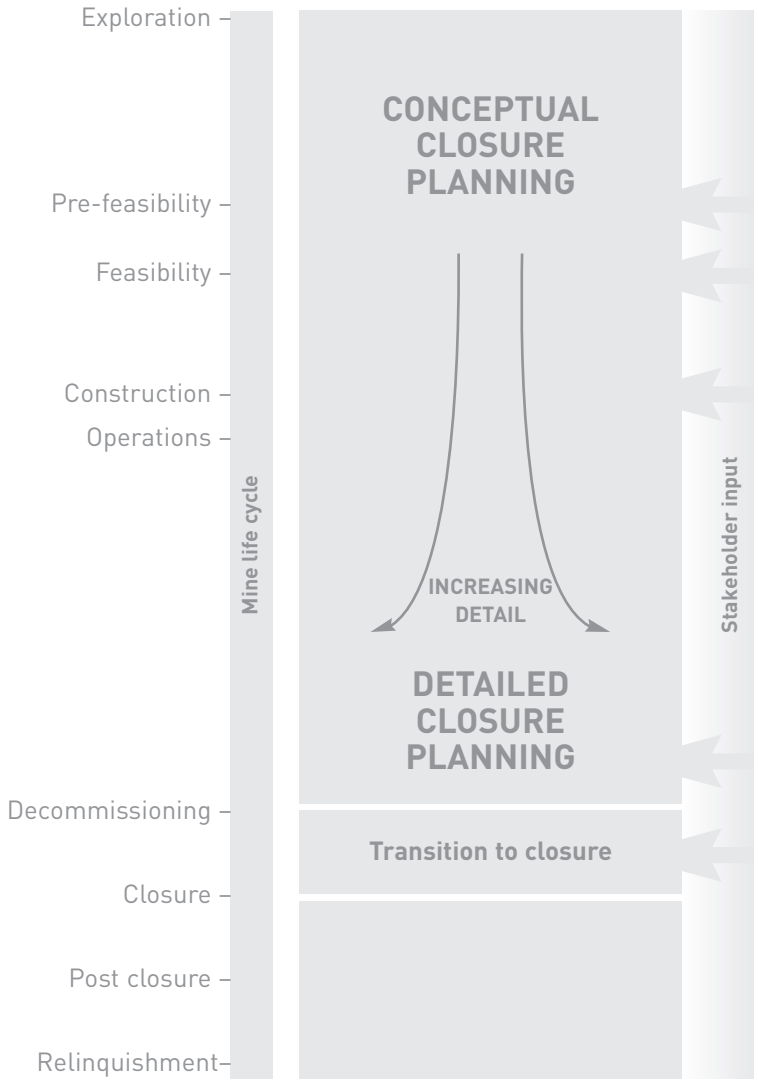
As with all plans, proof of the effectiveness of closure planning lies in reviewing the status of closure during the post closure period. The post closure phase can be the longest period of time for sites that cannot be relinquished. In fact, older sites can be in post closure longer than they were in operations. During this phase, it is useful to revisit the post closure goals and outcomes on a periodic basis.

There is also a great deal of learning available for companies in undertaking a detailed review of the closure planning processes and outcomes and in identifying the opportunities for improvement that could be realized during the next closure planning process. These lessons benefit not only the company but also the industry by addressing a challenging issue that presents unique opportunities and constraints at every site and that therefore relies on robust management systems and disciplined processes.

SECTION 5:

Challenges and conclusions

Section 5.
Challenges and conclusions



Mine closure remains a challenging subject, despite clear recognition of good practice by operations and external stakeholders and the technical ability of companies to achieve recognized good practice. Many of the challenges are posed by the context or situation of a mine or mine development rather than by technical challenges and further dialogue on these issues from the users of this document is needed.

Exploration

Closure planning could commence at exploration, yet for many companies this is a time of uncertainty. A mineable resource may not have been identified yet, and this creates a barrier to planning for the closure of a mining operation that may never exist. Increasingly, too, exploration companies look to selling the resource to a larger company with better access to capital for mine development. In these circumstances, exploration companies derive no direct benefit from planning for the closure of a mining operation.

So although planning for closure would ideally begin at exploration, possibly representing a best practice outcome, this is currently rarely practical.

Feasibility and closure planning

Most feasibility studies are focused on a number of key indicators, of which financial indicators feature prominently. It has long been recognized that the cost of closure can be substantial. At the feasibility study stage, however, the key financial indicators are often the net present value (NPV) of the project and the internal rate of return (IRR). The cost of closure may be substantial, but because it is often a distant future expense it has very little effect on the NPV or IRR in decision-making today. Thus, a cost for closure derived with little consideration of closure challenges is often unlikely to make a material difference to feasibility study financial outcomes even if the closure cost is misstated by orders of magnitude. There is therefore little financial motivation to quantify closure costs with any particular rigour at the feasibility stage.

Although financial motivation may be gained by undertaking a cashflow analysis for the life of the operation, this is rarely practical at the feasibility stage for mines with more than five to seven years of operational life. Target NPVs and IRRs would be assured of covering the cost of closure several times over, with the remaining challenge lying in the adequate provisioning of funds for closure.

Because there is no clear financial need to diligently assess the elements of closure at the feasibility stage, many feasibility studies invariably gloss over the challenges of closure.

Mergers and acquisitions

Increasingly in the current world economy, mines change owners at least once – and perhaps several times during a mine's life. The burden of closure therefore moves from owner to owner, and the challenges and costs of closure become a negotiating point in merger/acquisition deals. Management at a mine site may, quite pragmatically, preferentially allocate resources to production targets rather than closure – an activity that may not be the current owner's responsibility in future years. Closure therefore risks becoming a secondary planning consideration, and closure planning may drift down the hierarchy of priorities.

Changes in management

The manager accountable for the operation will change during the life of a mine. Accountability for closure planning may variously sit with the exploration manager, a feasibility study manager, a construction manager and several mine managers during the operating life of the mine. At least three changes in accountability may occur, and for many mines with longer lives, the accountability may change as much as 5 or 10 times. Under these circumstances, efforts in closure planning may vary considerably, depending on the buy-in to closure planning that the current head of accountability displays. In these circumstances, a current, robust closure plan combined with clear accountability will help improve closure planning by setting and regulating strong corporate mine closure planning processes.

Relinquishment

The concept of relinquishing a company's obligations on a closed mine is the subject of much debate, influenced by local laws as well as local community expectations. In general, the conditions of relinquishment should be clarified between the company and the regulating authority. Currently, the clarity of such conditions may vary widely between jurisdictions, and even between mines in a single jurisdiction. Clear, measurable and auditable conditions need to be agreed between companies and regulators that will allow relinquishment of obligations to be planned for and achieved.

As outlined in ICMM's report on financial assurance[4], when an operation has been successfully closed and the site has achieved the desired condition, further liability and financial responsibility associated with the site should be relieved. It may be necessary to monitor the closure outcomes, including chemical and physical stability, for several years following closure. Once such monitoring has established that no problems are apparent, operators should be able to expect relinquishment in a reasonable timeframe.

[4] *Financial Assurance for Mine Closure and Reclamation* (ICMM 2005)

Conclusion

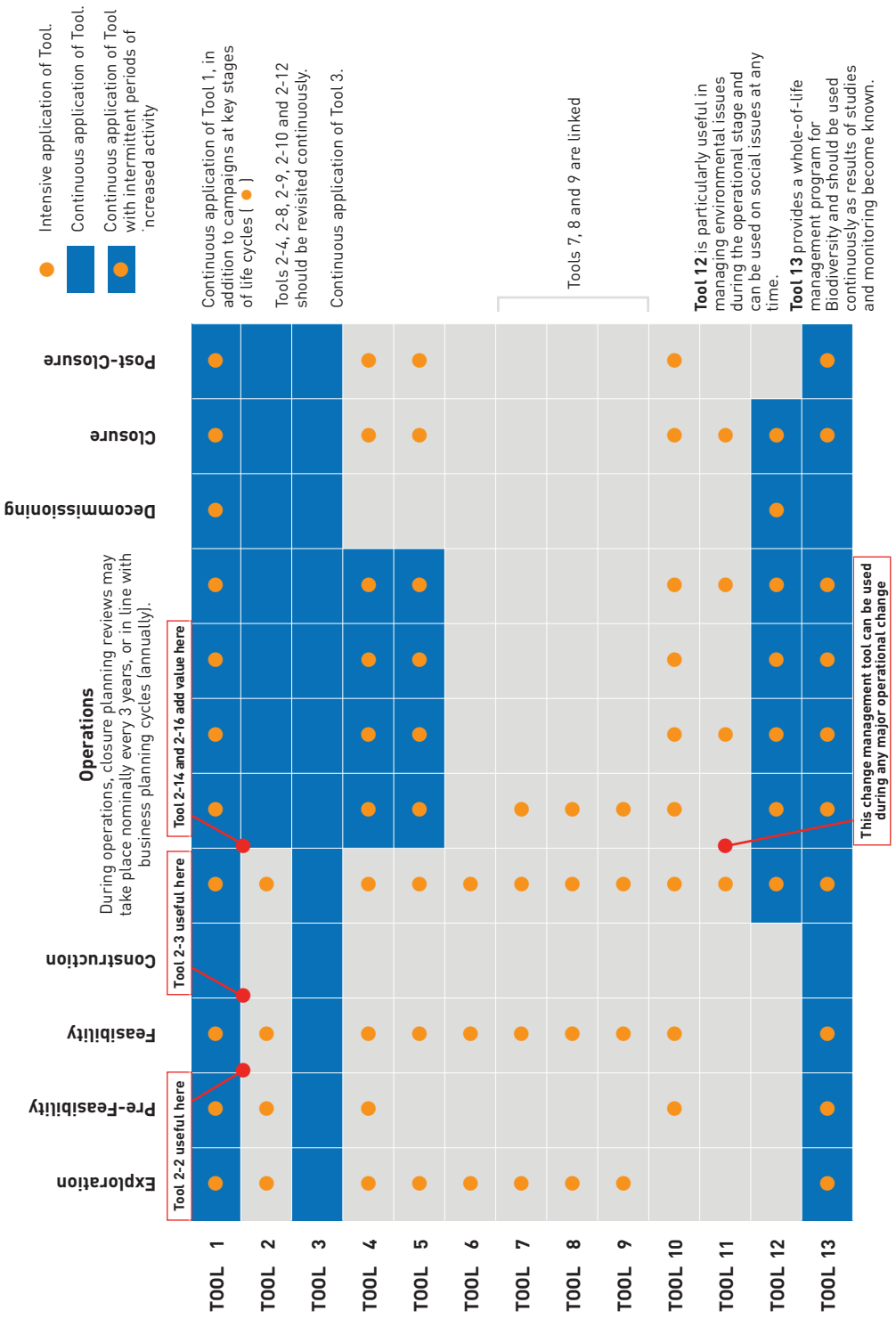
Mine closure today is less of a technical challenge and more of a management challenge. Challenges around physical closure have been replaced by challenges regarding the nature and acceptance of closure outcomes and the ability to 'operationalize' the process of arriving at acceptable closure outcomes by integrating closure considerations with everyday business practices. The physical activities that are needed to arrive at closure are relatively straightforward; the greater challenges are posed by aligning, scoping, implementing, reviewing and adjusting the closure plan to provide a sustainable exit strategy. With diligent application of thought, and engagement around this process, however, arriving at mutually beneficial closure outcomes could become a less daunting task for operating mines.

SECTION 6:

Toolkit

Section 6. Toolkit

Figure 3: Application of tools during facility life cycle



TOOL 1

Stakeholder engagement (a pre-existing tool)

***Environmental Excellence in Exploration* (E3), the Prospectors and Developers Association of Canada, March 2007**[5]

Stakeholder engagement, like any other activity in the mining industry, requires planning and delivery processes that underpin successful outcomes. The application of stakeholder engagement to complex issues requires bringing experience and expertise to bear on the issues. However, the scoping and planning of stakeholder engagement can be guided by informed views on the various project development and operational processes. The E3 publication by the Prospectors and Developers Association of Canada, Environmental Excellence in Exploration, provides guidance on this. Chapter 6 of Tool 13 (Biodiversity Management) also provides useful information.

Although the E3 publication is aimed at exploration, its tools and processes can be adapted to all stages of an operation's life, as they focus on the discipline of stakeholder engagement. It provides a best practice guide for exploration teams, including guidance on the types of community engagement processes and their usefulness and a distilled account of stakeholder engagement in indigenous communities (including norms and protocols used). Section 1.3.1 provides a strategic overview of engagement at different stages of an operation's life cycle.

[5] http://www.e3mining.com/index.cfm

TOOL 2

Community development (a pre-existing tool)

Community development toolkit, ICMM, 2006[6]

This is a comprehensive toolkit that, if used diligently, has the potential to substantially increase the effectiveness of closure planning for the social and socio-economic dimensions. It provides an integrated framework for improving a large variety of quality-of-life considerations in both dependent and independent communities. Individual tools are highlighted here, using the numbering system of the source document.

Tool 2-1 (Stakeholder identification tool) allows the key stakeholders to be identified. This tool should be used at all stages of conceptual and detailed closure planning to initially identify stakeholders and then to ensure that the stakeholder list is kept current.

Tool 2-2 (Social baseline study tool) lists various aspects of social baseline studies that should be covered. The social baseline study contributes vital information relating to the sustainability of closure goals, particularly as they relate to the social and socio-economic conditions of the local area and the region. Note that for facilities with a long life (20 years or more) the baseline information collected may become outdated, and consideration should be given to updating specific social and socio-economic data sets to better inform the closure planner of changes and trends that may have occurred.

Tool 2-3 (Social impact and opportunities assessment tool) is particularly potent in developing closure planning goals and milestones. Positive and negative impacts are assessed, and this provides the closure planner with information that assists in addressing sustainable improvements in communities. Note the value of assessing positive social and socio-economic impacts and focusing the closure plan on ways to enhance or sustain them.

Tool 2-4 (Competencies assessment) is useful in planning for the delivery of community development programs and assists in identifying the competencies required within the community to continue the functions within these programs after the facility has closed and its support terminated. The competencies assessment can also be used in addressing skilled, semi-skilled and unskilled worker remobilization at the end of a facility's lifespan.

Tool 2-8 (Problem census) provides a rapid means of assessing the priorities within communities and is suited to early engagement at the exploration phase of mining, for example, as it allows the organization to focus on immediate issues. It is also a useful tool to use between the formal reviews of the detailed closure plan, as it provides an efficient way of confirming that the closure planning activities still meet community requirements or of indicating where deviations might begin to occur. The Problem Census is particularly effective when used prior to the commencement of capital or labor intensive programs that represent a significant cost to the company, as it may forestall wasted effort or wasted capital.

[6] http://www.icmm.com/library_pub_detail.php?rcd=183

Tool 2-9 (Opportunity ranking) is useful in establishing priorities for community development programs, which allows better benefit/cost outcomes to be targeted early in the development of a mine. As with most social and community development agendas, priorities within communities can alter, and opportunities that previously represented high benefit/cost outcomes may lose their ranking.

Tool 2-10 (Stakeholder analysis) provides a useful set of questions to facilitate a strong foundation in the stakeholder engagement process. For ongoing processes such as closure planning, which need continuous engagement, revision and updates, the stakeholder analysis tool allows the closure planner to make informed decisions on which goals of the closure plan are likely to be stable, which are subject to external influences and the extent to which the external influences might dictate the work program and milestones set.

Tool 2-12 (Partnership assessment) allows the facility to more critically evaluate the prime vehicle for sustainable development in communities, the use of partnerships. The assessment tool is equally adaptable to community partners, industry partners, government and NGOs. Many community development programs falter because of inadequate partnering processes, requiring the company to take a more proactive stance and expend greater resources in achieving closure goals. The partnership assessment tool should be used to re-evaluate partnerships during review processes as well as at the outset of partnership development.

Tool 2-15 (Logical framework) should be used to develop the interim goals and milestones that underpin the overall goals and outcomes. Used in conjunction with **Tool 2-14 (Overview of monitoring and evaluation tools)** and **Tool 2-16 (Indicator development)**, it allows the systematic progression to post-closure outcomes and allows the user to define key performance indicators. The logical framework tool allows the execution strategy of closure planning to be managed. Because many of the closure planning activities are undertaken during operations, the logical framework tool suits a number of line management functions and can be used to complement ISO14001 programs for environmental management in operations when coupled with monitoring and evaluation tools and indicator development.

TOOL 3

Company/community interactions to support integrated closure planning (a new tool)

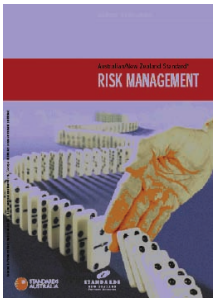
The relationship between a company and its neighbouring communities develops over time. In the mining industry, the company undergoes a series of transitions prior to its operational phase, and this requires the relationship to be built within a dynamic environment. Building trust and mutual respect, particularly during the usually rapid series of transitions between exploration and operation, is a challenging issue. It is also one of the most important activities to pursue. It is in this series of transitions that the tone of relationships for the first years of an operation's life is set.

The following table shows a suggested minimum platform for engagement and the actions that a company might take at the different phases of the operation's life to build trust and mutual respect in closure planning.

Phase	Charactersitics	Project owner actions that support integrated closure planning	Exploration team	Corporate team	Pre/Feasibility team	Construction team	Operations team	Decommissioing team
Exploration	• Short time frame • Little knowledge of continuity • First impressions • Rising community expectations	Engage with communities	Y					
		Understand expectations	Y					
		Build rapport	Y					
		Provide direction and standards		Y				
		Provide background information		Y				
Pre-feasibility	• Limited time • Intensive studies • Scoping activity • Ability to discuss continuity • 'First strategies' • Rising community expectations	Handover	Y					
		Engage with communities and stakeholders			Y			
		Develop target closure outcome			Y			
		Develop objectives			Y			
		Research and data			Y			
		Build rapport			Y			
		Estimate closure costs			Y			
		Multidisciplinary decision-making			Y			
		Provide direction and standards		Y				
		Provide background information	Y	Y				
Feasibility	• Extensive studies • Extensive engagement • Discuss needs and priorities • Discuss mine options • Discuss development scenarios	Handover	Y					
		Engage with communities and stakeholders			Y			
		Fill knowledge gaps			Y			
		Refine target closure outcome			Y			
		Refine objectives			Y			
		Begin achieving objectives			Y			

Phase	Characersitics	Project owner actions that support integrated closure planning	Exploration team	Corporate team	Pre/Feasibility team	Construction team	Operations team	Decommissioing team
Feasibility	• Real information to hand • Opportunities to inform meaningfully • Rising community expectations	Build rapport			Y			
		Multidisciplinary decision-making			Y			
		Refine closure costs			Y			
		Input to viability (e.g., infrastructure location, constructability)				Y		
		Input to viability (resourcing, capacity, operability)					Y	
		Provide direction and standards		Y				
Construction	• Short and intensive time frame • Influx of construction workers • High stress period • Local labor use • Intensive cash flow into community • Exposure to uncontrolled changes in plans	Review process			Y			
		Activity controls			Y			
		Monitoring			Y			
		Adhere to plans				Y		
		Early advice on variations to plans that may affect closure				Y		
		Engage with communities and stakeholders			Y	Y	Y	
		Confirm construction maintains ability to close successfully			Y		Y	
		Take ownership of closure plan					Y	
Operation	• Stabilization • Opportunities for continuity • Opportunities to develop long-term programs • Local labor use • Long-term capacity building • Opportunities for sustainable partnerships • Opportunity to generate familiarity and stable relationships	Provide direction and standards		Y				
		Review and advise		Y				
		Review assumptions for closure			Y			
		Document as-built information				Y		
		Engage with community and stakeholders					Y	
		Develop detailed plan					Y	
		Update plan every two to three years					Y	
		Implement plan					Y	
		Measure against goals					Y	
		Progressively improve costing accuracy					Y	
		Multidisciplinary decision-making					Y	
		Readiness for sudden closure					Y	
Decommissioning	• Local partnerships important • Risk of decline in community income • 'Last impressions'	Engage with communities and stakeholders					Y	Y
		Update plan					Y	Y
		Implement plan					Y	Y
		Implement decommissioning						Y
		Measure against goals					Y	Y
		Provide direction and standards		Y				
		Review and advise		Y				
		Monitor		Y				
Post-closure	• Long-term monitoring horizon • Signoff on attainment of goals • Relinquishment period	Engage with communities and stakeholders						Y
		Measure against goals						Y
		Provide direction and standards		Y				
		Review and advise		Y				
		Monitor		Y				Y
		Report		Y				Y

TOOL 4



Risk/opportunity assessment and management (application of pre-existing tool)

Risk Management Standard, Council of Standards of Australia and Council of Standards of New Zealand, 2004 (AS/NZS 4360:2004)[7]

AS/NZS 4360:2004 Risk Management has detailed instructions on how to set out and implement a risk assessment and management process. The following information shows how the standards can be applied to planning and operating for integrated closure, with a particular emphasis on how social opportunities may be captured using the same framework that is typically used to manage hazards or threats. Please note that the risk management standard is a comprehensive document with considerably more contextual information and should be referred to in association with this document. This tool details an application of the standard to closure.

This tool can be used in one of two ways:

- To evaluate, based on a specific issue (e.g., biodiversity, community health), the risk or opportunity associated with that issue (the traditional use) and subsequent management of the risk or opportunity or
- To evaluate, based on a specific closure goal, the risk that this goal will not be met (adapted for use with goal setting) and subsequent management of that risk.

Terms used in risk assessment

Term	Definition
Risk	A measure of the likelihood that a specific consequence may occur
Residual Risk	The lowest risk ranking achieved by a given set of management measures
Likelihood	A general description of probability or frequency
Consequence	The outcome or impact of an event
Event	The occurrence of a particular set of circumstances

[7] http://www.cqurire.com/htm/paper/risk/Aust_Standards_4360-2004.pdf

Consequence scales for risk and opportunity

Note that these are examples and suggestions; they can be redefined to suit the circumstances and risk sensitivity of any organization.

	Scale	Negative Consequence	Positive Consequence
C	Consequential	Related to, in consequence of. Not inconsequential, but no more severe than that.	Related to, in consequence of. Not inconsequential, but no more substantial than that.
L	Limited	Some consequence, generally reversible in a short term and/or with modest application of resources (similar to daily operating budget for mine, if financial comparisons are appropriate).	Some consequence, not sustainable without significant ongoing application of resources.
O	Overt	Consequences may be reversible, usually requiring some time and/or significant application of resources (similar to monthly operating budget, if financial comparisons are appropriate).	Consequences may be reversible but will generally be sustainable with only modest application of resources.
S	Significant	Generally irreversible consequences, with impacts apparent for a prolonged period of time (similar time scale to mine life, where time-scale comparisons are appropriate).	Generally sustainable consequences over a prolonged period of time, with little or no ongoing application of resources.
E	Extreme	Irreversible consequences, impacts exceeding period similar to life of mine (where time-scale comparisons are appropriate).	Generally sustainable consequences exceeding period similar to life of mine.

Likelihood scales

Note that these are examples and suggestions; they can be redefined to suit the circumstances and risk sensitivity of any organization.

Scale	Descriptor	Description
1	Improbable	It would require a substantial change in circumstances to create an environment for this to occur, and even then this is a rare occurrence in the mining and metals industry anywhere.
2	Unlikely	There are no specific circumstances to suggest this could happen, but it has happened before at least once in the mining and metals industry.
3	Possible	There is at least a 5 per cent chance it could happen, or it has happened occasionally in other areas before, or it has occurred (albeit infrequently) in the mining and metals industry in the recorded past or risk mitigation treatment cannot reduce the inherent likelihood further.
4	Likely	There is at least a 50 per cent chance it could happen, or it has happened several times in similar areas before, or this consequence is not uncommon in the mining and metals industry or any risk mitigation treatment cannot reduce the inherent likelihood further.
5	Almost certain	Has happened/will probably happen during mine life and there is no reason to suspect it will not happen again or it has occurred in this area before.

Combining likelihood and consequence to characterize risk and opportunity

Note that these are examples and suggestions; they can be redefined to suit the circumstances and risk sensitivity of any organization.

Likelihood Scale	Consequence Scale				
	Consequential	Limited	Overt	Significant	Extreme
1 (improbable)	Low	Low	Medium	Medium	High
2 (unlikely)	Low	Low	Medium	Medium	High
3 (possible)	Low	Medium	High	High	High
4 (likely)	Medium	Medium	High	High	Peak/Very High
5 (almost certain)	Medium	High	High	Peak/Very High	Peak/Very High

TOOL 5

Knowledge platform mapping (a new tool)

Understanding how much is known and, equally important, how much is unknown is a crucial element in closure planning. It is important to acknowledge the validity or potential invalidity of assumptions made, because long-term closure planning should reduce the unknowns and the corresponding risk of invalid assumptions.

In this simple model there are seven platforms of knowledge characterized by the information that is to hand to allow decisions to be made on whether goals are appropriate, whether they can be met, and whether the rate at which they are being met is adequate. These seven platforms are shown in the table below, with example numerical rankings assigned to these.

By placing metrics on the levels of unknowns, the closure planner is able to track, between review periods, the robustness of information being used to refine closure plans. In addition, the closure planner is able to focus resources such as research activity on reducing unknowns in high-risk areas between review periods.

Characteristic	Knowledge platform	Ranking
Common Knowledge	Decisions are based on information past history, namely similar sites, data on the experience of others and company's own experience.	20
General Data	Decisions are based on site-specific baseline information, including site-specific social, environmental and economic data gathered from representative areas.	30
Focused Data	Decisions are based on good-quality site-specific baseline information gathered from every specific location/aspect around the site that could be affected by moderate consequences or worse.	40
General Analysis	Decisions are based on completed studies, theoretical process or dialogue in representative areas of concern.	60
Focused analysis	Decisions are based on completed studies, theoretical processes or dialogue in every specific location/aspect around the site that could be affected by moderate consequences or worse.	70
General proof	Decisions are based on completed physical and logistical experiments on processes or trialled certain models that provide real information supporting the likelihood of success on representative areas of concern.	80
Focused proof	Decisions are based on completed physical and logistical experiments on processes or trialled certain models that provide real information supporting the likelihood of success in every specific location/aspect around the site that could be affected by moderate consequences or worse.	100

Each goal and the actions undertaken towards achieving it are characterized by the knowledge platform. Action Plans in the closure plan should be geared towards increasing the knowledge platform ranking. A set of goals can be assessed to define the average knowledge platform attained within a given iteration of the closure plan, and future iterations of the closure plan should show a higher knowledge platform.

Closure goal	Knowledge platform attained	Ranking
1	Common knowledge	20
2	Common knowledge	20
3	General data	30
4	Focused analysis	80
5	General analysis	60
6	Common knowledge	20
7	Common knowledge	20
8	Common knowledge	20
9	General analysis	60
10	Focused analysis	80
Average knowledge platform, Goals 1 to 10		41

TOOL 6

Typical headings for contextual information in a conceptual closure plan (a new tool)
The conceptual closure plan is primarily a vehicle for capturing and communicating the issues affecting closure. Contextual information is important in communicating these issues, as it lays out the constraints and opportunities under which the operation will develop and execute its closure plan. For practical purposes, although cross-references to key documents such as baseline studies and impact assessments should be used, a short synopsis of the key issues in the one closure planning document allows better access to these data by internal stakeholders (feasibility study managers, design teams, construction managers, etc.) as well as external ones.

Select only those that apply:

1. Site history
2. Locality and geography
3. Land tenure
4. Land use
5. Settlement status
6. Transport networks
7. Geology
8. Hydrology
9. Hydrogeology
10. Population and demographics
11. Household composition, density and distribution
12. Languages
13. Culture and Heritage
14. Community groups
15. Community organizations
16. Indigenous people
17. Livelihood and income streams
18. Industry and yield
19. Agriculture and yield
20. Per capita income
21. Employment rates and patterns
22. Artisanal mining
23. Educational facilities
24. Literacy and numeracy levels
25. Vocational skills and capacity
26. Health facilities
27. Health statistics (including HIV, malaria and tuberculosis)
28. Maternal health
29. Infant mortality
30. Community infrastructure
31. Government planning schemes
32. Biodiversity
33. Existing social legacies
34. Existing environmental legacies
35. Existing economic legacies
36. Water quality in surface and aquifer resources
37. Air quality
38. Social values requiring protection
39. Environmental values requiring protection
40. Economic values requiring enhancement

TOOL 7

Goal setting (a new tool)

The following worksheet tool can be used to set goals in the majority of contextual areas (see **Tool 6**) and new areas.

Aspect	What must be protected?	What can be enhanced?	Goals
Land tenure			
Land use			
Settlement status			
Transport networks			
Hydrology			
Hydrogeology			
Population and demographics			
Household composition, density and distribution			
Languages			
Culture and heritage			
Community groups			
Community organizations			
Indigenous people			
Livelihood and income streams			
Industry and yield			
Agriculture and yield			
Per capita income			
Employment rates and patterns			
Artisanal mining			
Educational facilities			

Aspect	What must be protected?	What can be enhanced?	Goals
Literacy and numeracy levels			
Vocational skills and capacity			
Health facilities			
Health status (including HIV, malaria and tuberculosis)			
Maternal health			
Infant mortality			
Community infrastructure			
Government planning schemes			
Biodiversity			
Existing social legacies			
Existing environmental legacies			
Existing economic legacies			
Water resources			
Air			
Societal values			
Environemental values			
Economic values			

Examples of goals that might result from this exercise are:

Examples of vague closure goals	Examples of well-defined closure goals
Land suitable for grazing	Land able to sustain grazing for nine months of the year (non-winter) for up to 100 head of cattle
Two SMEs	Two SMEs with total employment of 100 full-time equivalent local staff
Permanent health care facilities in village	30-bed (1% of population) permanent health care facilities with outpatient facility and maternity unit
Water supply to village	Reticulated potable water to a minimum of six standpipes in the village, with sustainable supply at 45 litres per person per day for the population of the village
Improvement in primary education	Achievement of greater than 70% attendance to Grade 4, with equivalent demographic representation of boys and girls

Where possible, the partial achievement of goals should be set as milestones, as the following example illustrates, so that there is a progressive means of assessing whether the facility is 'on track' to meet the defined closure goals.

Closure activity	Milestone – 0%	Milestone – 25%	Milestone – 50%	Milestone goal – 75%	Closure goal
Rehabilitation	Final land use plan formulated	100 hectares graded, topsoil applied and seeded	200 hectares graded, topsoil applied and seeded	300 hectares graded, topsoil applied and seeded	400 hectares graded, topsoil applied and seeded
Capacity building	Determine current and future skill base in village, including gender equality	Vocational training programs in place and full enrolment achieved	Transfer of vocational training admin to government-owned corporation	Self-funded,self-administered vocational training institution running at full enrolment	Future skill base achieved
Tailings dam closure	Tailings impoundment location and dimensions scoped	Capping options determined and testing program commenced	Capping option chosen and material selection confirmed	Capping instituted on 50% of the (completed) cells in the tailings facility and under validation testing	Capping completed, monitoring in place

TOOL 8

Brainstorming support table for social goal setting (a new tool to support tool 7)

The following table provides some suggested considerations for social goal setting and some trigger words at the bottom of the table that can be used to formulate specific and quantifiable goals to assist in closure planning.

The list is not exhaustive, and elements should be added or deleted to suit the local conditions of the operation being considered.

This format lends itself to facilitated workshops in multi-stakeholder forums and helps identify social risks and opportunities in closure planning.

Closure category	Typical open question
Poverty	What social and socio-economic values or gains can be achieved in poverty reduction?
Hunger	What social and socio-economic values or gains can be achieved in hunger reduction?
Education	What social and socio-economic values or gains can be achieved in education?
Gender equality	What social and socio-economic values or gains can be achieved in gender equality?
Child mortality	What social and socio-economic values or gains can be achieved in child mortality?
Maternal health	What social and socio-economic values or gains can be achieved in maternal health?
HIV/AIDS, malaria and other diseases	What social and socio-economic values or gains can be achieved in the management of HIV/AIDS, malaria and other diseases?
Health care	What social and socio-economic values or gains can be achieved in health care management?
Water supply	What social and socio-economic values or gains can be achieved in water supply?
Employment	What social and socio-economic values or gains can be achieved in the employment market?
Youth employment	What social and socio-economic values or gains can be achieved in youth employment?
Employability	What social and socio-economic values or gains can be achieved in the employability of people in the community?

Closure category	Typical open question
Technology	What social and socio-economic values or gains can be achieved in the application of technology?
Recreation	What social and socio-economic values or gains can be achieved in recreation?
Infrastructure	What social and socio-economic values or gains can be achieved through the adaptation of infrastructure?
Indigenous	What social and socio-economic values, gains or losses are inherent to indigenous affairs?
Cultural	What social and socio-economic values, gains or losses are inherent to the cultural heritage of the community?
Enterprise	What social and socio-economic values or gains can be achieved through the generation of enterprise?

Trigger words

Quantity, quality, availability, potential yield, productivity, historical, modern, cultural, recreational, tourism, amenity, subsistence, agriculture, cash crop, stability, shelter, longevity, drought, flood, famine, health, contamination, positive legacy, negative legacy, utility, proximity, adaptability, stability, resource value appreciation, resource value depreciation, safety, character, unique, benchmark, dermalogical, respiratory, carcinogenic, replenishment, depletion, insufficient, excess, low, high, minimum, maximum, educational, future value, future cost, past value, past cost, improve, worsen, develop, destroy, add, remove, increase, reduce, popular, unpopular, repute, disrepute, ethical, unethical, government, NGO, policy, standard, guideline, practice, throttle, block, bottleneck, controlled, uncontrolled, stability, variability, instability, success, failure, catastrophic, chronic, modulated, peaky, predictable, unpredictable, proactive, reactive, indigenous, wealth, poverty, education, illiteracy, health, disease, trauma, capital, revenue, funding, operating capital, wages, salaries, income, GDP, GNP, markets, distribution channel, subsidy, partnerships, equity, investment, finance, lending, interest, collateral, profit, loss, asset, liability, enterprise, business, service, supply, goods, labor, exchange, trading, economy, rights, expectations, responsibility, accountability, governance, life expectancy, quality of life, leisure, demography

TOOL 9

Brainstorming support table for environmental goal setting (a new tool to support tool 7)

The following table provides some suggested considerations for environmental goal setting and some trigger words at the bottom of the table that can be used to formulate specific and quantifiable goals to assist in closure planning.

The list is not exhaustive, and elements should be added or deleted to suit the local conditions of the operation being considered.

This format lends itself to facilitated workshops in multi-stakeholder forums and helps identify risks and opportunities in the environmental dimension of closure planning.

Closure category	Typical open question
Land resources	What environmental values, gains or losses are inherent to land resources?
Water resources	What environmental values, gains or losses are inherent to water resources?
Terrestrial flora	What environmental values, gains or losses are inherent to terrestrial flora?
Terrestrial fauna	What environmental values, gains or losses are inherent to terrestrial fauna?
Aquatic flora	What environmental values, gains or losses are inherent to aquatic flora?
Aquatic fauna	What environmental values, gains or losses are inherent to aquatic fauna?
Acid rock drainage	What environmental values, gains or losses are inherent to acid rock drainage?
Air	What environmental values, gains or losses are inherent to air?
Noise	What environmental values, gains or losses are inherent to noise?
Waste	What environmental values, gains or losses are inherent to waste?
Overburden dump	What environmental values, gains or losses are inherent to the overburden dumps?
Tailings dam	What environmental values, gains or losses are inherent to the tailings dams?

Closure category	Typical open question
Final pit void	What environmental values, gains or losses are inherent to the final pit voids?
Underground workings	What environmental values, gains or losses are inherent to the underground workings?
Heap leach pad	What environmental values, gains or losses are inherent to the heap leach pad?
Borefield	What environmental values, gains or losses are inherent to the borefield?
River diversion	What environmental values, gains or losses are inherent to the river diversion?
Sewage treatment plant	What environmental values, gains or losses are inherent to the sewage treatment plant?
Water treatment plant	What environmental values, gains or losses are inherent to the water treatment plant?
Contractor accommodation	What environmental values, gains or losses are inherent to the contractor accommodation complex?
Mine buildings and village	What environmental values, gains or losses are inherent in the mine buildings and village?

Trigger words

Quantity, quality, availability, potential yield, productivity, scarification, sterilization, species, biodiversity, habitat, historical, modern, cultural, recreational, tourism, amenity, grazing, subsistence, agriculture, cash crop, stability, shelter, longevity, drought, flood, famine, health, contamination, positive legacy, negative legacy, utility, proximity, adaptability, stability, resource value appreciation, resource value depreciation, safety, character, unique, benchmark, pH, metals, toxic, hazardous, dermalogical, respiratory, carcinogenic, velocity, volume, rate of flow, density, concentration, diffusion, dispersion, advection, replenishment, depletion, insufficient, excess, low, high, minimum, maximum, educational, future value, future cost, past value, past cost, improve, worsen, develop, destroy, add, remove, increase, reduce, popular, unpopular, repute, disrepute, ethical, unethical, government, NGO, policy, standard, guideline, practice, throttle, block, bottleneck, controlled, uncontrolled, stability, variability, instability, success, failure, catastrophic, chronic, modulated, peaky, predictable, unpredictable, proactive, reactive, repopulation, extinction, indigenous, dominant, passive, feral

TOOL 10

Cost risk assessment for closure (a new tool)

This tool should be read in conjunction with Financial Assurance for Mine Closure and Reclamation (ICMM, 2005). The costing of closure, particularly at the early stages of an operation's life, is aimed at adequate provisioning for closure. The contextual information in the financial assurance document should provide the practitioner with a sound understanding of why the cost of closure and the adequacy of provisioning are critical elements of closure planning.

There are four structural aspects to cost estimates for each element of the closure plan:

- The **quantity** of activity (which may be subject to variance);
- The cost **rate** per unit quantity of the closure activity (which may be subject to variance);
- An **allowance** that is sensible to apply (for example, using the quantities and rates for topsoil application over a four-month period leading to closure, it is sensible to expect that some rain days may cause the application of topsoil to cease, the standby time incurring a cost that is not captured in quantities and rates); and
- A **contingency**, which is called into play if something unplanned occurs that causes a negative consequence to be triggered, such as the unavailability of local topsoil or statutory rejection of the standard of capping.

The product of quantities and rates is the base cost. An allowance is added to the base cost for conditions known from previous experience are likely to occur. A contingency is added to the base cost plus allowance to account for the possibility that something could go wrong.

The following worksheet shows how this can be applied in the closure planning process to provide cost estimators and financial modellers with a context for conducting cost risk assessments for closure.

Cost Risk Worksheet for Closure Goal X

	Quantity			Rate		Allowance	Contingency
Activity	Is the quantity of activity being:			Is the unit cost or total cost being:		What variations, from experience, should be expected?	What could go wrong in this activity to increase costs?
	Measured/surveyed?	*Estimated from calculations?*	*Guessed?*	*Extracted from quotes?*	*Estimated from experience?*		
Goal X Activity 1							
Goal X Activity 2							
Goal X Activity 3							
Goal X Activity 4							

The following table shows how a specific closure cost element (tailings dam capping) can be broken down to provide a financial modeller with information to undertake a probabilistic cost analysis.

Item	Quantity	-Variance in Quantity	+Variance in Quantity	Rate	-Variance in Rate	+Variance in Rate	Allowance	Contingency
Clay sealing material source silty clay (SC) to clay (CL) material	50,000m^3	-5%	+30%[1]	$25/$m^3$	-0%	+10%	+10%	+50%[2]
Clay sealing material place at 95% compaction at optimum moisture content -1% +2% of OMC	50,000m^3	-5%	+30%[3]	$18/$m^3$	-5%	+20%[4]	+10%	+20%[5]
Capillary material source gravely sand d50=3mm	30,000m^3	-0%	+10%	$6/$m^3$	-0%	+20%	+15%	+10%
Capillary material place, wheel loading and levelling only	30,000m^3	-0%	+10%	$7/m3	-0%	+10%	+10%	+10%
Topsoil material source from stockpile	25,000m^3	-10%	+25%[6]	$5/$m^3$	-5%	+5%	+5%	+10%

Notes

1. Wide variance here because the final tailings dam facility dimensions are unknown.
2. High contingency because the estimator has not yet identified where the material will be sourced from, and whether or not the appropriate material can be found on site.
3. As per Note 1.
4. Wide variance on labor costs because it has not been decided whether this will be an internal or external (contractor) cost – base rate assumes internal cost.
5. High contingency because it is uncertain (see Note 2) that material exists, and there is a possibility for processes such as gypsum stabilization of local or import material to meet specifications.
6. High variance because topsoil stockpile balance has not been carried out accurately.

TOOL 11

Change management worksheet (a new tool)

At the juncture of the end of construction and the start of operations, many things may have changed between the pre-feasibility and operational stages. Although the impact assessment process may have been designed to scope out the majority of these changes, many actions deviate from their planned direction during the detailed design and construction periods. Design optimization, geotechnical constraints, social intervention, government statutes and other external factors can combine to ensure that one or more elements of the conceptual closure plan may have changed.

Status change during construction	Extent of change	Could the ability to meet goals have changed (Y/N)?	Should detailed closure plan be updated to capture (Y/N)?	How?
Did in-migration occur?				
Were there tenure changes and land use changes around the operation?				
Were there changes in the biodiversity around the site?				
Were fauna corridors altered or transected?				
Were the courses of creeks or rivers changed?				
Did household incomes change?				
Could these changes have resulted in variability in income per household?				
Did average household sizes increase or decrease during construction?				
Were compensation payments made during construction?				
Was household relocation affected during construction?				

Status change during construction	Extent of change	Could the ability to meet goals have changed (Y/N)?	Should detailed closure plan be updated to capture (Y/N)?	How?
Could local health conditions, including the incidence of sexually transmitted diseases, have changed?				
Did HIV/AIDs risk or exposure (e.g., incidence of prostitution) change?				
Did local service industries benefit from, or increase as a result of, construction?				
Did local materials and supply industries benefit from, or increase as a result of, construction?				
Did employment patterns change?				
Did community organizations change, or did new community organizations form?				
Did the construction period result in new stakeholders entering the arena?				
Were there changes to the size, position or construction method applied to infrastructure during construction?				

TOOL 12

The domain model (a new tool)

A useful approach to dividing up the work to be carried out on closure is to segregate the facility into specific areas or domains. Each domain is treated as a separate detailed entity within an overall plan that deals with common issues like drainage and site monitoring. The following factors should be taken into account when developing a plan for each domain:

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

Waste materials should be viewed as a resource to be used to rehabilitate other areas. For instance, benign overburden can be used to cap potentially acid-producing material. Proactive thinking can save the operation future liabilities.

Each domain should have its own plan (see attached example). Assumptions, inclusions and exclusions should be documented.

Examples of domains at a mine are:

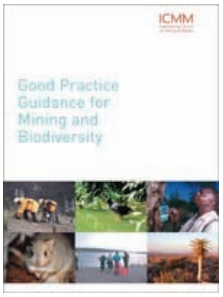
- Ore processing area
- Shaft hoisting and headgear (underground mines)
- Workshops
- Tailings storage facility
- Process and raw water facilities
- Open voids and declines/shafts
- Roads (infrastructure and haul and exploration)
- Camps and other offices

For accuracy, the operation should use Geographical Information System (GIS) digital terrain models and aerial photos to illustrate the domain features and boundaries; 3D models of waste dumps, voids, tailings dams and other structures are also very useful.

xxx AREA							
Description							
Area of Disturbance		**Void** xx hectares; **Waste Dumps** xx hectares					
Status		Active					
Closure Date		xx void and waste rock dumps will be closed in 200x					
Infrastructure to be Retained		Final void					
OBLIGATIONS RELATING TO CLOSURE							
Subject		**Obligation**			**Relationship to Closure**		
Regulatory Condition - Rehabilitation		(F4-1) Progressive rehabilitation must commence when areas become available within the operational land.			Incorporating details and requirements for leaving voids safe and stable after closure.		
Final Land Use Objectives **EXAMPLES**		**Void** (a) Safe with minimal risk to the public, native fauna and livestock (b) Conceptual land use options include water bodies or partially filled water bodies. A decision will be based on the results of detailed geochemical and hydrological studies **Waste Dumps** (a) Provide an acceptable post-disturbance land use capability/suitability (b) Provide acceptable, stable post-disturbance landforms (c) Protect surface and groundwater quality on-site and leaving the mining lease (d) Rehabilitated using technically effective and cost-efficient methods and proven engineering practices to ensure that no long-term maintenance is required beyond the post-closure phase of 5 years Make the area safe with minimal risk to the public, native fauna and livestock					
CLOSURE COMPLETION CRITERIA							
Description	xxx Void	**Area (ha)**	14	**Photo No.**	Photo 1	**Timing**	2008-12
Engineering and Rehabilitation Activities (a) Excavate and haul waste rock material to construct perimeter bund walls (b) Fencing of void perimeters (c) Purchase and erect warning signs (d) Final pit water balance and groundwater models (e) Geotechnical stability assessment for long-term pit wall stability							
Statutory Sign-off							
No	**Yes**	**Date**		**Document Reference No.**			
✓		-		-			
Description	xx Waste Dumps	**Area (ha)**	28	**Photo No.**	Photo 1	**Timing**	2008-12
Engineering and Rehabilitation Activities (a) Selective handling of acidic rock on outer dump face of xx Dump – dispose on top surface (b) Re-profile xx I/O stockpile to drain towards final void (c) Re-profile Central dump to drain towards final void (d) Xx I/O stockpile – stable, minor leaching, no activities (e) Excavate, load and haul inert oxide waste to the reshaped xx dumps (f) Moderate earthworks to place store and release cover system (inert oxide rock) over PAF, reshaped dump surface and rehabilitate (g) Re-profile and deep rip the balance of the waste dump surface (h) Minor erosion control works and seeding on the balance of the waste dump surface (i) Geotechnical assessment to demonstrate long-term dump stability							

Statutory Sign-off			
No	**Yes**	**Date**	**Document Reference No.**
✓		-	-
Post-Closure Activities		**Void** (a) Continue surface and groundwater quality monitoring for 5 years, including void water qualities and monitoring void water levels **Waste Dumps** Monitoring and maintenance of: (a) Revegetation works; (b) Soil erosion and soil erosion control structures; (c) Weed control in and around the rehabilitation area; and (d) Surface water quality in leachate collection ponds as per current monitoring schedules.	
Specific Closure Assumptions **EXAMPLES**		**Void** (a) The void will not be backfilled (b) The void will be allowed to flood naturally (c) Bunding and fencing will occur at closure (d) There will be no impact on groundwater as a result of water accumulating in the final void (e) The closure strategy adopted for this closure plan will be accepted by all stakeholders **Waste Dumps** (a) Geochemical testwork of the dumps will confirm the applicability of proposed rehabilitation methods	
Closure Material Sources **EXAMPLES**		**Void** (a) 4500 m^3 of inert waste rock to construct 2 m high perimeter bund walls (b) 2500 m of fencing (c) 50 warning signs **Waste Dump** (a) selective handling machinery for acidic outer dump waste rock face (b) 80,000 m^3 of inert waste rock from xx dump (c) Seed and fertilizer to rehabilitate 28 ha	
Waste Disposal Sites		Not applicable	
Other Issues		None identified	
REHABILITATION COSTS ($) Engineering and Rehabilitation Cost Closure Administration Cost Post-closure Management Cost **Total**		 $500,000 $20,000 $10,000 $530,000	
Costs Not Included		Consultant investigations on additional geochemical testwork	
Cost Saving Opportunities		(a) There may be an opportunity to generate additional cash flow by processing the I/O stockpile at the same time as reducing existing liabilities that would otherwise required re-profiling and rehabilitation. (b) Reduce existing liability by aiming to gain sign-off of the xx waste dump and final void as soon as regulators finalize the progressive rehabilitation policy.	
Further Investigation/Studies Required		Long-term water quality and groundwater impacts will be needed as well as investigations on geotechnical stability of the outer dump face and verification of cover depth to restrict infiltration before regulators accept the final landforms as they are	
Liabilities/Risks/Hazards		(a) The encapsulation method may not be effective in reducing acid leachate generation to acceptable levels (b) 'Hot spots' of PAF material may develop as acidic rock is exposed during any waste rock re-profiling	

TOOL 13



Biodiversity management (a pre-existing tool)

The ICMM Good practice guidance for mining and biodiversity, 2006[8]

Biodiversity impacts play a large part in the environmental scope of mining impacts. In many remote and rural areas, biodiversity management can become one of the key elements defining successful mine closure.

The *Good Practice Guidance for Mining and Biodiversity* (ICMM 2006) provides a detailed discussion on this issue.

Figure 2.2: Examples of the intersection of project development and biodiversity

POTENTIAL IMPACTS	MINING ACTIVITIES	Exploration and construction	Early stages of exploration	Exploration drilling	Access road construction	Land clearance	Obtaining construction materials	Construction (for construction, etc.)	Construction related infrastructure	Construction of ancillary infrastructure	Roads, rail & export infrastructure	Pipelines for slurries or concentrates	Energy/power & transmission lines	Water sources, wastewater treatment	Transport of hazardous materials
Impacts on terrestrial biodiversity															
Loss of ecosystems and habitats			●	●	●	●			●	●	●		●		●
Loss of rare and endangered species			●	●	●	●	●		●	●	●		●		●
Effects on sensitive or migratory species			●	●	●	●	●		●	●	●		●		●
Effects of induced development on biodiversity				●	●		●		●						●
Aquatic biodiversity & impacts of discharges															
Altered hydrologic regimes				●	●	●	●		●		●	●	●		●
Altered hydrogeological regimes			●			●									
Increased heavy metals, acidity or pollution			●		●	●	●		●		●	●	●		●
Increased turbidity (suspended solids)			●	●	●	●	●		●	●	●	●	●		●
Risk of groundwater contamination			●			●	●		●	●		●	●		●
Air quality related impacts on biodiversity															
Increased ambient particulates (TSP)			●	●	●	●	●		●		●		●		●
Increased ambient sulfur dioxide (SO_2)							●				●		●		●
Increased ambient oxides of nitrogen (NO_x)							●				●		●		●
Increased ambient heavy metals											●				
Social interfaces with biodiversity															
Loss of access to fisheries					●	●			●	●	●				
Loss of access to fruit trees, medicinal plants					●	●	●		●	●	●				
Loss of access to forage crops or grazing				●	●	●	●		●	●	●				
Restricted access to biodiversity resources					●	●			●	●	●				
Increased hunting pressures			●	●	●	●	●		●		●		●		●
Induced development impacts on biodiversity				●	●	●	●		●		●				●

Figure 2.2 of the Good Practice Guidance provides a useful scoping tool for capturing, for closure plan purposes, the potential impacts on biodiversity during the various stages of the facility life. Mapping of these potential impacts permits simpler access to the management, monitoring and evaluation processes that need to be included in the Conceptual Closure Plan. This Figure, with site-specific impact mapping, could be included in conceptual closure plans to focus the issue. Checklists 2.1 and 2.2 should be used in the exploration and pre-feasibility phases to distil issues of concern.

[8] http://www.icmm.com/library_pub_detail.php?rcd=195

Figure 3.2: Examples of the intersection of operations and biodiversity

POTENTIAL IMPACTS	MINING ACTIVITIES	Ore processing and plant site	Plant site, materials handling, etc.	Extraction and waste rock storage	Rock blasting and ore removal	Mine dewatering	Placer and dredge mining	Ore stockpiling	Pyrometallurgical processing	Hydrometallurgical processing	Use and storage of process chemicals	Tailings containment/disposals
Impacts on terrestrial biodiversity												
Loss of ecosystems and habitats			●	●			●					●
Loss of rare and endangered species			●	●			●					●
Effects on sensitive or migratory species			●	●	●				●	●		●
Effects of induced development on biodiversity												
Aquatic biodiversity & impacts of discharges												
Altered hydrologic regimes			●	●	●	●	●			●		●
Altered hydrogeological regimes				●	●	●				●		●
Increased heavy metals, acidity or pollution			●	●	●	●	●	●		●	●	●
Increased turbidity (suspended solids)			●	●	●		●	●		●		●
Risk of groundwater contamination			●	●	●	●		●		●	●	●
Air quality related impacts on biodiversity												
Increased ambient particulates (TSP)			●	●	●			●	●			●
Increased ambient sulfur dioxide (SO_2)									●			
Increased ambient oxides of nitrogen (NO_x)									●			
Increased ambient heavy metals			●	●	●			●	●			●
Social interfaces with biodiversity												
Loss of access to fisheries			●	●								●
Loss of access to fruit trees, medicinal plants			●	●								●
Loss of access to forage crops or grazing				●		●		●		●		●
Restricted access to biodiversity resources				●								●
Increased hunting pressures			●									
Induced development impacts on biodiversity												

Figure 3.2 of the Good Practice Guidance provides more detailed information on the intersection between various mining activities and potential biodiversity impacts. This Figure should be a standard part of any detailed closure plan, as it distils the closure planning issues into a practical focal point. It is particularly useful when linked to **Tool 12**, the Domain Model, as the Figure is largely mining-activity-based.

Chapter 4 of the Good Practice Guidance details many of the biodiversity-management-related activities associated with facility closure planning.

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