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From compliance to closure maturity: a customised tool linking regulatory requirements, standards and international good practices

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Abstract

Statutory closure requirements and corporate standards are converging on similar principles of integrated mine closure planning. Mining companies actively embed these expectations within internal closure standards, and many, not only those that are members of the International Council on Mining and Metals (ICMM), have adopted the ICMM's Integrated Mine Closure guidance and concepts. However, mid-tier and junior mining companies, some without formal internal closure standards or ICMM membership, face the same statutory expectations but generally have fewer internal resources and tools available.

This paper presents the practical application of a customised tool founded on the ICMM Closure Maturity Framework (CMF). The customisation incorporates company-specific closure standards, statutory requirements, and other relevant criteria into a single scale to assess closure maturity. Rather than being a box-ticking exercise to check where requirements are simply met or not met, the tool identifies gaps and the associated priority actions needed to minimise or close those gaps. For each key closure requirement or domain identified, the tool defines the statutory requirements that apply in the company's jurisdiction, the internal standards requirements, and the maturity level that an operation currently achieves and realistically seeks to reach. The integration of these items within a single tool allows users to directly compare compliance obligations, internal expectations and maturity gaps, and to prioritise and consolidate the action plan.

The tool can be applied by mining companies to benchmark the closure maturity of assets across business portfolios, and by mid-tier and junior mining companies as a step in assessing a site's closure objectives against international good practice and to organise existing closure requirements into a clear checklist and action plan throughout the mine life. In an industry that is actively navigating automation, artificial intelligence, and other technological advances, this case example shows how simple tools can still be effective in identifying, prioritising and actioning closure aspects to satisfy statutory compliance, systematically build closure knowledge, and integrate multiple disciplines and departments to improve closure maturity over time.

Keywords: *closure maturity assessment, compliance, closure standards, statutory closure compliance*

1 Introduction

A growing number of mines worldwide are expected to close over the next decade, and expectations of what constitutes adequate closure planning are evolving significantly (CSIRO 2023). Closure is now widely regarded not just as an end-of-life regulatory requirement, but as a process that must be integrated into mine planning from the earliest stages to deliver meaningful environmental and social outcomes (ICMM 2025). This is evident in statutory requirements across major mining jurisdictions – as reflected in closure guidelines such as in Western Australia and Queensland (DETSI 2024; DMPE 2025) – and in the way many mining companies have embedded closure integration into their internal standards.

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This paper presents a diagnostic tool developed for a company with an established corporate closure standard operating in a in Papua New Guinea, where closure regulations were still evolving (Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development 2019) and had historically not been clearly prioritised at site level. The tool was designed to provide an integrated assessment of the operation's closure planning performance against 3 frameworks simultaneously: the company's corporate closure standard, the ICMM Closure Maturity Framework (CMF) (Brock et al. 2019; ICMM 2019), and applicable statutory obligations. While the case study involves a company with formal internal governance, the approach was designed to be transferable. Operators without formal internal standards can apply the same framework using the ICMM CMF domains directly as the organising structure, making it accessible to the full spectrum of mining operators.

Rather than treating closure maturity as an optional enhancement once compliance is reached, the tool is built on the premise that building a consistent and durable closure planning system, with statutory compliance as a predictable outcome of that maturity, is more effective than pursuing compliance and maturity as separate exercises. This reframing is the central design principle of the tool and the primary contribution of this paper.

The tool provided a structured way to assess the existing mine closure plan (MCP) against the different frameworks, and the resulting combined assessment represented the first integrated evaluation of its kind for the operation. By showing, domain by domain, which requirements were not met, what maturity level was currently achieved, and what would be required to reach the aspirational level, the tool made prioritisation of closure-related actions more transparent. This enabled the site to determine which gaps to address first and how best to allocate resources, defining a clearer pathway aligned with company, industry and regulatory expectations.

2 Approach and tool customisation

2.1 Case study

The case study focuses on a long-life gold operation located in a jurisdiction where regulatory closure requirements are still evolving and where, historically, there has been limited prescription of integrated mine closure planning. The operation has been in production for more than 30 years, during which it has experienced multiple ownership changes, high turnover of staff, loss of institutional knowledge, and a sudden period of care and maintenance. In this context, the primary focus of the operation was on restoring and sustaining production, and closure planning was not consistently prioritised or embedded in day-to-day operational processes.

Although a global corporate closure standard was in place, closure planning at site level remained fragmented and reactive. The need for a clearer understanding of the site's closure planning maturity, the extent to which existing governance and technical work aligned with corporate expectations, and how best to position the operation to manage closure-related risks and to integrate closure considerations into operational and life of asset planning was the first step to change the closure planning process in the operation.

2.2 Tool development approach

Three requirements converged simultaneously:

1. aligning the updated MCP with the corporate closure standard
2. assessing whether the updated plan would satisfy regulatory obligations
3. understanding the operation's closure planning maturity relative to the ICMM CMF.

A document-based review was undertaken as a first step. Key governance and technical knowledge base documents, including the most recent MCP, specialists and technical reports, closure cost estimates,

management plans, and closure risk assessments were reviewed against the requirements of the corporate closure standard and the CMF domains. Findings from this review were entered into the tool, with each relevant requirement coded as 'in MCP' where the requirement was covered in the MCP, 'in other document' where the information was available in a supporting document, or 'not available' where the requirement was not addressed. This process allowed the governance documents to be evaluated consistently and provided an evidence base for the maturity ratings assigned to each domain.

The expected outcome was a clear understanding of how the closure planning process could be improved and, as a result, how regulatory obligations could be met by implementing the prioritised action plan that emerged from the assessment.

2.3 Domain structure and maturity mapping

The domain structure of the tool was developed following a deliberate sequence that reflects how closure requirements interact in a well-governed company. The corporate closure standard served as the primary organising framework, defining the domains against which the assessment was structured. Relevant elements of the ICMM CMF were then mapped against each corporate standard domain to establish maturity descriptors expressed in language consistent with the company's governance expectations. Regulatory requirements were reviewed last, not because they were least important, but to identify any regulatory obligations not already captured by the corporate standard and CMF mapping.

This sequencing reflects the tool's core design principle: that a company operating at sufficient maturity against a well-constructed internal standard should find regulatory compliance largely achieved as a natural consequence rather than as a separate exercise. Mapping CMF elements onto corporate standard domains ensures that the maturity language used in the tool reflects internationally recognised good practice, rather than only internal governance expectations.

Table 1 illustrates the example of this mapping using the progressive closure domain, showing how the corporate standard requirement, the corresponding CMF elements, and the comparative assessment results are aligned within the tool structure. The goal was to group related requirements into practical domains and to understand – for each domain – both the gap relative to the corporate standard and the current maturity level. This provided a basis for identifying priority actions to both improve the closure planning process and move towards the desired maturity level. The iterative process not only enabled a more thorough evaluation but also supported clear identification of areas requiring attention, driving accountability and continuous improvement of closure planning practices over time.

Table 1 Corporate standard versus corresponding Closure Management Framework – mapping example

Corporate closure standard requirement	Corresponding CMF elements	Comparison of assessment results
Progressive closure: identify progressive closure opportunities and potential savings	**Progressive closure:** the implementation of closure activities during the life of asset (LoA) to reduce liability and improve the knowledge base	**Corporate standard:** requirement largely not available; no systematic register or plan of progressive closure opportunities in the MCP
	Closure activities: execute progressively through LoA	**CMF:** all elements are classified as 'nascent'
	Integration into LoA planning: opportunities integrated into mine plans to reduce liability	**Progressive closure is under-developed in both assessments' outputs**

Figure 1 presents the results from the initial ICMM CMF assessment, undertaken as the first step in understanding where the operation stood relative to international good practice. The results show an uneven

maturity picture across domains, with most domains assessed at 'nascent' or 'basic approach' levels, and the gap between current maturity and the aspirational level identifying the areas requiring priority attention.

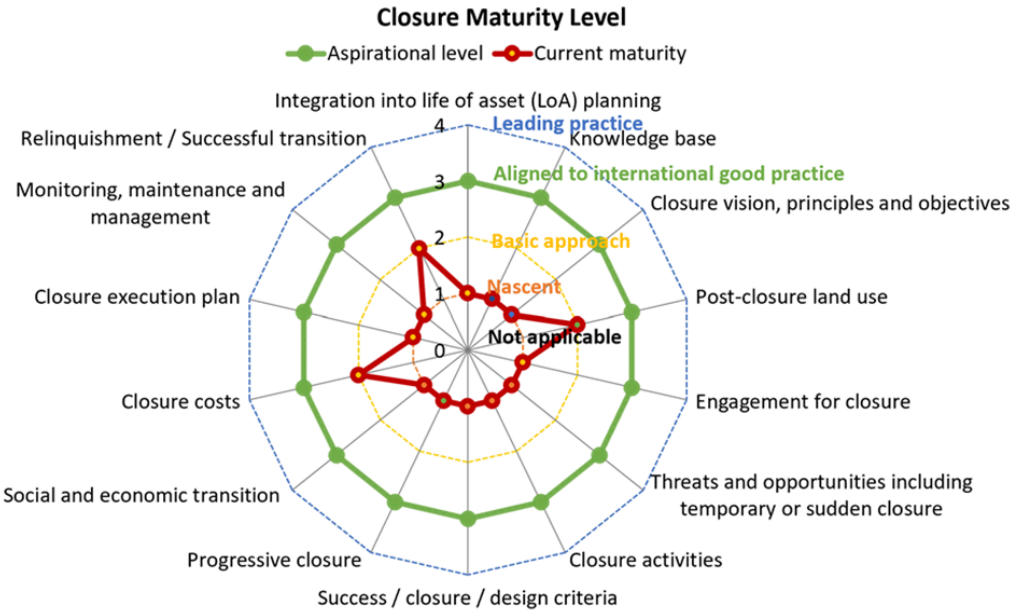

Figure 1 Result of the maturity assessment using the ICMM Closure Management Framework tool

Figure 2 presents the results from the corporate standard coverage assessment, showing the extent to which requirements were addressed in the MCP or supporting documents, represented by the percentage to which each item is addressed in the MCP (blue dots) or addressed in other requirements (orange dots) under the overall requirement. The radial axis of the diagram represents the percentage of closure domains met for each element, ranging from 0% (no criteria addressed) to a maximum of 100% (full compliance). The scale on the chart extends to 60%, reflecting the highest compliance score achieved across all elements assessed. Domains with low MCP coverage and nascent maturity consistently emerged as the areas where the closure planning system was most fragile, where requirements were neither documented nor embedded in operational practice.

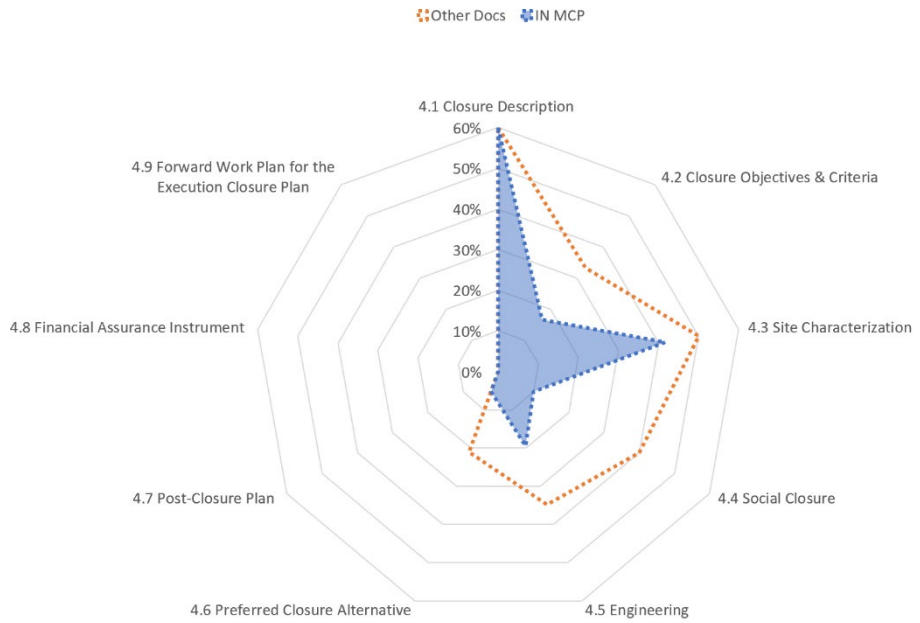

Figure 2 Corporate standard coverage assessment results, showing mine closure plan coverage versus information available in other documents across all assessed closure requirements

Together, the 2 assessments provided the integrated view that underpins the prioritisation of actions. By layering CMF maturity levels over corporate standard coverage across the same domains, the tool identified where gaps were most significant. It distinguished between domains requiring immediate action to achieve compliance and those needing medium-term investment to close knowledge gaps, reduce uncertainty and build genuine closure planning capability. This, in turn, enabled the site to develop a clear, evidence-based action plan to guide iterative improvement in closure planning.

2.4 Compliance versus maturity

The same domain structure used to assess corporate standard coverage and CMF maturity was then applied to evaluate regulatory compliance. Known regulatory obligations not already captured by the initial mapping were identified as explicit compliance gaps. Requirements that were present but only partially implemented appeared as areas where maturity fell below the compliance threshold, meaning the requirement existed in form but lacked the integration, consistency or evidence needed to be reliably met in practice.

This distinction between compliance in form and compliance in practice is important. Regulatory compliance is typically assessed at a point in time, confirming whether a requirement has been addressed in the closure plan as submitted. Maturity, by contrast, reflects the durability and integration of the closure planning system over time and considers whether the processes, knowledge and governance structures are in place to sustain compliance as site conditions evolve, ownership changes, or closure execution begins. A low maturity rating in a domain where compliance appears to be met is therefore a signal of fragility, not reassurance. It indicates that compliance may not be robust under changing conditions or during the transition to active closure.

This allows the diagnostic to answer 2 questions within a single assessment:

1. How mature is closure planning relative to the corporate standard and international good practice?
2. Where does the operation stand relative to its regulatory obligations?

Where these questions diverge and maturity is below what is needed for compliance, or where compliance is met but maturity remains low, that domain becomes a priority action for improving both compliance and long-term closure performance simultaneously.

Table 2 provides an example of this comparison using the regulatory requirement for progressive rehabilitation, illustrating how a gap between regulatory obligation, corporate standard coverage and CMF maturity level translates directly into a prioritised action.

Table 2 Example of comparison between regulatory requirements and maturity level

Regulatory obligation	Corporate closure standard requirement	Corresponding CMF elements	Gaps/alignment status
Where progressive rehabilitation is possible, detail the conditions and phases of completion	**Progressive closure:** identify progressive closure opportunities and potential savings	Progressive closure Closure activities Integration into life of asset planning Closure execution plan	**Gap:** the closure plan does not identify specific progressive closure opportunities, conditions for completion, or a consolidated progressive closure register aligned with the closure schedule and costs

2.5 Findings and suggestions

2.5.1 Diagnostic findings

The assessment demonstrated that closure planning maturity was uneven across domains. Some domains were more developed and reflected requirements that had long been established through corporate governance or external requirements. Other domains remained at an early maturity level, driven by requirements that were relatively recent or not yet fully embedded in operational processes, and therefore showed substantial gaps relative to both corporate and regulatory expectations.

The assessment also revealed that formal documentation, although compiled with good intentions, can fall short of what the business requires when closure-related information is dispersed across multiple documents, departments and systems. Key elements required by the corporate standard were partially addressed in supporting management plans, monitoring reports or risk assessments, but were not consistently referenced or integrated into the MCP. This fragmentation limited the robustness of the closure plan as a single source of truth for both regulators and internal decision-makers. Without this integration, the closure plan remains a compliance document rather than a practical operational tool that the site can use to progressively address and manage closure across the mine life.

Overlaying regulatory obligations onto the corporate standard and CMF mapping confirmed that compliance and maturity are related but not identical. In several domains, regulatory requirements were broadly met in form, but the underlying maturity remained low, indicating that compliance may not be robust under changing conditions or during closure execution. Notably, the assessment also identified domains where internal governance was driving improvements ahead of current regulation, where the corporate standard and CMF expectations extended beyond existing statutory requirements. This finding is significant because it demonstrates the tool's value beyond compliance checking: it identifies areas where the company is investing in closure planning quality proactively, and where that investment can be recognised and built upon.

Finally, the combined assessment made prioritisation of closure planning actions more transparent. By classifying each domain against all 3 frameworks simultaneously, the tool clarified which domains required immediate action to achieve compliance and which needed medium-term investment to move from nascent or basic maturity towards alignment with international good practice. The assessment also helped identify the domains where targeted work could most effectively improve the closure planning process and minimise the potential for future increases in uncertainty. As a result, the list of priority domains can be used by the company to support and inform the site's annual planning and budgeting cycle, supporting the prioritisation of study and implementation funds towards the highest-priority gaps. This application demonstrated that, rather than requiring complex tools, interpreting existing assessments and data in an integrated way can simplify the process considerably and sharpen the operational focus on improving closure planning implementation and sustaining ongoing compliance.

2.5.2 Suggestion for further application

Based on this first application, some practical suggestions emerge for further use of this approach:

- Begin by mapping closure requirements in the corporate standard to CMF elements, and then overlay regulatory obligations. This preserves internal language and governance while ensuring that maturity descriptors reflect international good practice.
- A periodic maturity review cycle should be embedded into the closure planning process. Reapplying the assessment at key planning milestones, such as closure plan updates or major project changes, allows the operation to track progress against aspirational CMF levels and to update the action plan as knowledge, conditions and regulatory expectations evolve.
- The tool can be adapted for different operator profiles. For major companies with established internal standards, the tool supports portfolio-wide benchmarking of closure maturity across

assets. For operators without a formal closure standard, the same method applies by using CMF domains directly as the organising framework, with statutory requirements serving as the primary reference point for the compliance threshold.

Across all operator types, this approach supports a shift from a document-driven view of closure planning to a system-oriented, maturity-based approach, one in which compliance is achieved as a consequence of building robust closure planning capability rather than as a separate exercise.

3 Conclusion

Expectations for integrated mine closure are converging across regulators, financiers and communities, while internal governance capacity and resourcing remain uneven across the industry. This paper has presented the rationale, configuration and application of a customised tool that integrates corporate closure standards, the ICMM CMF and regulatory obligations into a single structured assessment. Developed in response to an operational need for a clear and consolidated view of closure obligations and performance, the tool treats closure planning maturity as the primary mechanism for understanding where an operation stands, what gaps exist, and which actions should be prioritised. In doing so, it shifts the emphasis from preparing compliant documents towards building a robust, durable closure planning system across the life of the asset.

The application demonstrated that closure planning maturity is uneven across domains. Domains where requirements have long been embedded in corporate governance and regulation showed greater development, while others remained at early maturity levels where newer expectations had not yet been fully integrated into planning processes. Overlaying obligations onto the corporate standard and CMF mapping confirmed that compliance and maturity are related but not identical; in some domains, regulatory requirements were met in form while the underlying planning system remained fragile. The combined assessment made prioritisation more transparent, distinguishing between immediate actions needed to secure compliance and medium-term investment required to move from nascent or basic maturity towards alignment with international good practice.

For operators, the primary value of the tool lies in how it structures decision-making. At the domain level, it clarifies what the internal standard requires, what different maturity levels look like in practice, and which obligations apply, consolidating this into a single prioritised action plan. The results suggest that combining a maturity-based lens with explicit mapping against internal standards and obligations can make closure planning more transparent, strategic and accessible, supporting a shift from late-stage, document-driven compliance towards genuinely integrated mine closure practice.

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