

An Approach to Closure Planning and Design

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This document provides guidelines for:

- Conceptual closure planning and design;
- Closure site characterization, analysis and evaluation, and
- Detailed closure design.

The guidelines incorporate key requirements of different corporate closure planning guidelines (acknowledging specifically RT and BHP Billiton closure planning guidelines), and the authors' experience in developing and auditing closure plans and closure design.

Conceptual Closure Planning and Design (Closure Scope Development)

1. Develop a site closure data base/library (i.e., existing technically valid data that characterizes site conditions potentially influencing, or potentially influenced by mine closure). Initial planning is performed using available data only (i.e., no additional characterization until it can be justified by the process). The libraries developed to date have been assets for both closure planning and continued operations. Example: Research Matrix identifying the potential pertinence of existing documents and data to specific closure elements/characteristics.
2. Identify all site facilities and based on available data, those which are potential sources of post-closure physical or chemical instability (i.e., potential source analysis).
3. Based on available data, document known and baseline, existing and future (at closure) characteristics of the site groundwater (physical and chemical), surface water (physical and chemical), climatologic conditions, soils and erosion potential, potential closure borrow sources, vegetation, avian and terrestrial wildlife, air quality, and if necessary, socio- economics. Where data are not available, make and document reasonable assumptions.
4. Perform a site regulatory analysis to identify regulatory closure criteria. This must be exhaustive in that it has to cover all pertinent regulatory bodies and regulations. This is the minimum criteria evaluation required and criteria identified are those required to be met in state and federal closure and reclamation plans. Any of the following four steps (Steps 5, 6, 7 and 8) are optional, depending on corporate policy.
5. Identify all existing and potential stakeholders and perform a site stakeholder analysis to document stakeholder issues and develop closure criteria to address these issues.
6. Identify corporate and site management goals (overarching goals) for closure including for example cash flow, asset preservation and financial reporting criteria.
7. Use criteria identified in Steps 4 through 6 to identify potential impacts of closure to health, safety, environment and community for conditions anticipated at the point operations cease ("zero-base"). Example: Impact Assessment Table.

8. Develop a site closure risk register that identifies and ranks potential risk issues resulting from potential impacts identified under Step 8, identify risk issues that require risk management to appropriately reduce the zero-base ranking, and develop “risk management criteria”.
9. Develop conceptual engineering options that provide solutions that at a minimum address the established “conceptual design” criteria established under Steps 4, 5, 6 and 8.
10. Develop a Basis of Cost Estimate that provides details of how quantities are measured and how unit rates are obtained. Example: Table of Contents –Basis of Cost Estimate.
11. Develop cost estimates to compare capital and operating costs for each conceptual option (that meet corporate financial reporting criteria).
12. Use the risk register developed under Step 8 to demonstrate that the closure options selected provide appropriate risk reduction, and evaluate the relative risk reduction benefits for each option.
13. Select and cost the conceptual closure design option that is judged to best meet all established criteria and risk reduction goals.

Closure Characterization, Analysis and Evaluation

1. Identify potential cost-reduction opportunities that may meet closure stabilization criteria, but can not be considered feasible as a conceptual closure design option based on a lack of data. Also identify key assumptions that need validation and any risk issues that require additional characterization data.
2. Identify additional targeted field characterization, analysis and evaluation required to demonstrate feasibility of potential cost-reduction opportunities, refine risk evaluation or validate key conceptual design assumptions.
3. Develop and implement detailed site characterization/operational monitoring plans to obtain the targeted data and analytical results, and perform evaluations necessary for demonstration of adequacy of conceptual closure options (including) cost reduction opportunities.

Detailed Closure Design

1. Integrate findings of Closure Characterization, Analysis and Evaluation into selected conceptual design (Conceptual Closure Design – Step 13) to define closure actions for which detailed engineering design is required, including incorporation where appropriate of cost-saving opportunities.
2. Revisit criteria assessments and refine to include specific additional engineering criteria required for inclusion in the detailed design.
3. Develop detailed closure engineering designs, including construction drawings, specifications, quantities and construction and post-construction maintenance schedules.
4. Revisit the Basis of Cost Estimate to update according to the detailed design scope of work, and use to develop detailed closure expenditure forecasts.