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## DRAFT

# Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories

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## Preface

Closure and reclamation planning for advanced mineral exploration and mine sites has always been necessary, but its prominence came as a result of certain Northwest Territories mining operations' closing without adequately addressing their clean-up and reclamation responsibilities, leaving hundreds of millions of dollars of clean up costs to the federal government and taxpayers. The public became increasingly concerned about the growing number of insolvencies and abandoned mine sites, which create significant environmental liabilities.

In 2002, Aboriginal Affairs and Northern Development Canada (AANDC), formerly known as Indian and Northern Affairs Canada (INAC), issued the *Mine Site Reclamation Policy for the Northwest Territories* which lays the policy foundation for the protection of the environment and the disposition of liability related to mine closure in the Northwest Territories. In 2006, AANDC released the *Mine Site Reclamation Guidelines for the Northwest Territories* to compliment the 2002 Mine Site Reclamation Policy. They were developed in consultation with Aboriginal governments/organizations, community members, scientific experts, mining industry representatives, federal and territorial governments, regulatory authorities, and other interested parties. The 2006 guidelines were updated in 2007.

There are four land and water boards in the Mackenzie Valley that are responsible for issuing water licences for advanced mineral exploration and mine sites: the Mackenzie Valley Land and Water Board, the Gwich'in Land and Water Board, the Sahtu Land and Water Board, and the Wek'èezhìi Land and Water Board (the Boards). The Northwest Territories Water Board issues water licences in the Inuvialuit Settlement Region. These Boards are responsible for approving closure and reclamation plans and have been requiring proponents to use AANDC's 2007 *Mine Site Reclamation Guidelines for the Northwest Territories* for several years. The guidelines have proven to be an invaluable tool for ensuring responsible closure and reclamation planning at mine sites in the Northwest Territories.

To assist proponents and to enhance consistency throughout the Northwest Territories, the Boards and AANDC have recently been working together to ensure the process for developing a closure and reclamation plan is clearly outlined for both advanced mineral exploration and mine sites requiring Type A or Type B water licences.

This document is in two parts:

**Part 1** - Closure and reclamation planning concepts and the regulatory process, including detailed templates outlining the type and quantity of information needed to develop closure and reclamation plans for advanced mineral exploration and mine sites.

**Part 2** - Technical considerations for reclamation of site-wide and individual mine components<sup>1</sup> including specific northern considerations.

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<sup>1</sup> Although these technical considerations are focussed on mine sites, several may be applicable to advanced mineral exploration operations.



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The following key concepts must be incorporated into the development of a closure and reclamation plan to ensure that impacts to land and water, including the plants, wildlife, and fish that Aboriginal people rely upon for their traditional lifestyles and survival, are not negatively impacted:

- Design closure and reclamation plans to prevent long-term active care requirements.
- Start with clear statements of measurable closure objectives which are designed to ensure that proponents will achieve the site's closure goal.
- Engage with stakeholders throughout the life of the project to ensure Traditional Knowledge and other scientific information are considered and incorporated in closure and reclamation planning.

These guidelines provide a template for proponents to develop a closure and reclamation plan for an advanced mineral exploration or mine site, while also serving as a benchmark for reviewers to evaluate the plan after it is submitted. It will ensure that closure and reclamation plans are submitted and reviewed in a consistent manner and that a technically and culturally sound plan is produced.



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## Introduction

These guidelines for development of closure and reclamation plans for advanced mineral exploration and mine sites in the Northwest Territories (NWT) (hereinafter referred to as “guidelines”) are provided by Aboriginal Affairs and Northern Development Canada (AANDC), formerly known as Indian and Northern Affairs Canada (INAC), and the Land and Water Boards (the Boards) of the Mackenzie Valley<sup>2</sup>.

AANDC and the Boards have developed these guidelines in support of the vision of an efficient and effective regulatory process. Closure and reclamation planning takes a significant amount of time and resources from regulators, reviewers, and the proponent. Following these guidelines will support a timely and efficient process in which the expectations for closure and reclamation planning are clearly outlined for all stakeholders.

## Purpose

The purpose of these guidelines is to:

- Provide guidance on the preparation of a CRP for advanced mineral exploration<sup>3</sup> and mine sites at various stages of operation;
- Outline specific regulatory requirements pertaining to closure and reclamation; planning for advanced mineral exploration and mine sites at various stages of operation;
- Clarify the roles and expectations of regulators and stakeholders in closure and reclamation planning;
- Present technical considerations relevant to the closure and reclamation of mine sites; and,
- Provide proponents with a single document that presents existing guidance from AANDC and the Boards.

## Authority

AANDC and the Boards have a collective responsibility for the development of these guidelines. AANDC, together with the Boards, is responsible for managing Crown land and waters in the NWT as well as the administration, inspection and enforcement requirements associated with the *Mackenzie Valley Resource Management Act* (MVRMA), the *Northwest Territories Waters Act* and *Territorial Lands Act*. AANDC Inspectors are responsible for ensuring compliance with legislation, regulations, and the terms and conditions that are part of water licences and land use permits issued by the Boards. The AANDC Minister's approval is required for Type A water licences.

The Boards' authority to develop these guidelines is granted under sections 65, 102(1) and 106 of the MVRMA:

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<sup>2</sup> The Northwest Territories Water Board is responsible for issuing water licences in the Inuvialuit Settlement Region.

<sup>3</sup> For small scale mineral exploration projects only requiring a land use permit, AANDC will be developing Land Use Guidelines for closure and reclamation in 2012.





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65. Subject to the regulations, a board [GLWB/SLWB/WLWB] may establish guidelines and policies respecting licences, permits and authorizations, including their issuance under this Part.

102. (1) The Board [MVLWB] has jurisdiction in respect of all uses of land or waters or deposits of waste in the Mackenzie Valley for which a permit is required under Part 3 or a licence is required under the *Northwest Territories Waters Act*, and for that purpose the Board has the powers and duties of a Board established under Part 3, other than powers under sections 78, 79 and 79.2 to 80.1, as if a reference in that Part to a management area were a reference to the Mackenzie Valley, except that, with regard to subsection 61(2), the reference to management area continues to be a reference to Wek'èezhii.

106. The Board may issue directions on general policy matters or on matters concerning the use of land or waters or the deposit of waste that, in the Board's opinion, require consistent application throughout the Mackenzie Valley.

In addition to these guidelines, there may be additional considerations for different mining operations. For example, for coal mines the Territorial Coal Regulations pursuant to the *Territorial Lands Act* should be consulted, while reclamation of uranium mines in Canada falls under the jurisdiction of the Canadian Nuclear Safety Commission pursuant to the *Nuclear Safety and Control Act* and regulations.

## How These Guidelines Were Developed

During the early 1980s, the public became increasingly concerned about the growing number of insolvencies and abandoned mine sites which create significant environmental liabilities, thus the Northwest Territories Water Board and AANDC (formerly INAC) began to include a condition that Abandonment and Restoration Plans had to be submitted for approval as a requirement of water licences and land leases (surface)<sup>4</sup>. This led to the development of the *Guidelines for Abandonment and Restoration Planning for Mines in the Northwest Territories* in 1990, and subsequently the issuance of the *Mine Site Reclamation Policy for the Northwest Territories* in 2002, by AANDC. This policy document laid the foundation for how environmental protection and the disposition of liability related to mine closure in the NWT are to be approached. In 2006, AANDC prepared the *Mine Site Reclamation Guidelines for the Northwest Territories* (updated in 2007), which were greatly expanded from the 1990 version and were intended to compliment the 2002 *Mine Site Reclamation Policy*. The 2007 AANDC guidelines were developed following extensive community engagement including a workshop focussing on incorporating community knowledge in mine reclamation planning, interviews with elders to provide input on the development of the guidelines, and a broader technical workshop. Many recommendations from the interviews and workshop were directly incorporated into the technical considerations portion of the 2007 guidelines and carried forward to the present joint AANDC and Board guidelines.

The 2007 AANDC guidelines provide key concepts related to closure and reclamation, an overview of the process that a proponent would need to follow during the closure and reclamation planning process,

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<sup>4</sup> During the early 1980's the Land and Water Boards of the Mackenzie Valley were not in place, thus the Northwest Territories Water Board performed their functions for the entire Northwest Territories.





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and important environmental issues that would likely need to be addressed (site-wide mine reclamation considerations). They also provide technical summaries of various issues and concerns that might be expected with individual mine components, including underground workings, open pit mine workings, waste rock and overburden piles, tailings containment areas, buildings and equipment, mine infrastructure, transportation routes, landfills and other waste disposal areas, and water management systems.

The 2007 AANDC guidelines do not, however, provide a step-by-step procedure at the level of detail that is expected in a closure and reclamation plan (CRP). As a result, over the last decade mining proponents have submitted a wide range of CRP's to the Boards with varying levels of detail and information. The inconsistencies are primarily a result of the lack of specific direction regarding the preparation of a CRP and the resultant varying interpretations of what should be included in a CRP. The inconsistencies are also due to variable project footprints, proponent approaches to mining and reclamation, and the type and level of reviewer (intervener) involvement. This has created complexities during the period of CRP preparation and review, causing inefficiencies and ultimately lengthening the review process.

The Boards developed draft *Closure and Reclamation Guidelines* in 2008 with the goal of providing proponents specific direction on the process for developing a CRP. They outline a framework for the level of detail, type, and timing for providing information and provided detailed annotated templates for the development of the actual CRP. The intent was to augment the 2007 AANDC guidelines and enhance clarity and consistency for proponents operating in the Mackenzie Valley. However following the stakeholders review of the Boards' draft 2008 document, it was clear that a single comprehensive guidance document regarding closure and reclamation would offer even greater clarity for proponents.

AANDC and the Boards have since been working together to create this single guidance document containing direction on the level of content required and the process for developing CRPs for advanced mineral exploration and mine sites, in addition to updated technical guidance on site-wide mine reclamation considerations and reclamation of individual mine components.

## Application

This document will be applied by the following Boards operating under the MVRMA:

- Mackenzie Valley Land and Water Board
- Gwich'in Land and Water Board
- Sahtu Land and Water Board
- Wek'èezhìi Land and Water Board

The proponents of advanced mineral exploration or mine projects requiring a Type A or Type B water licence must submit CRPs at various stages of the development as a condition of their water licence. Proponents are encouraged to contact the appropriate Board prior to preparing their CRPs.

## Monitoring and Performance Measurement for these Guidelines

Mechanisms will be required to monitor and assess performance and to evaluate the effectiveness of these guidelines. AANDC and the Boards will develop performance measures, and the guidelines will be



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reviewed and amended as necessary to determine if they are fulfilling their purpose. The involvement of stakeholders will be crucial in the evaluation and review process.

## Structure of this Document

The guidelines are composed of two distinct and equally important parts.

### **Part 1 – Closure and Reclamation Planning Concepts and the Regulatory Process – “What is Required”**

Closure and reclamation planning concepts, specific regulatory requirements, and public engagement and communication considerations for advanced mineral exploration and mine sites are presented. A template is provided to guide the proponent through the preparation of a CRP.

### **Part 2 – Technical Considerations for Effective Closure and Reclamation of Mine Sites**

Guidance is provided on new and updated technical concepts and considerations as well as specific northern considerations. Although these considerations are focussed on mine sites, many are applicable to advanced mineral exploration sites.

References and additional documents (Appendix A) and definitions and acronyms (Appendix B) are also provided to supplement the information presented in the guidelines.



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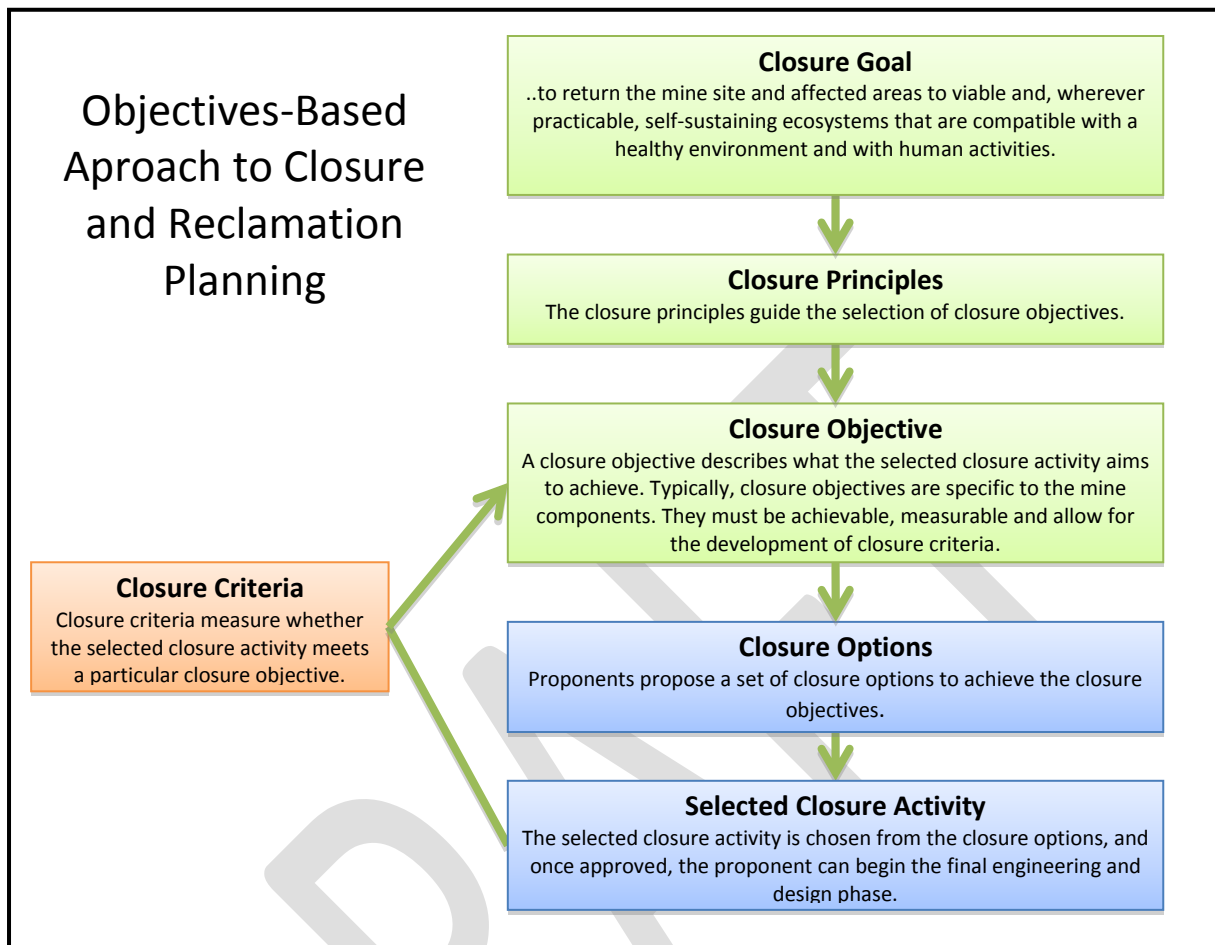
## Part 1 – Closure and Reclamation Planning Concepts and the Regulatory Process

The need to design a closure and reclamation plan (CRP) for an advanced mineral exploration or mine site with closure in mind is fundamental to successful closure and reclamation. The proponent must design, operate, close, and reclaim the site so that the risk of negative impacts on the environment, wildlife, aquatic life, and humans is minimized or eliminated. This is accomplished by developing a series of measurable and achievable closure objectives.

The objectives based approach to closure and reclamation outlined in section 1.1 describes the concepts and terms for closure and reclamation planning. Section 1.2 outlines required regulatory submissions for both advanced mineral exploration and mine sites. An overview of public engagement and communication expectations and considerations is summarized in section 1.3, while financial security requirements are briefly discussed in section 1.4. Lastly, a template for developing a closure and reclamation plan is presented in section 1.5.

### 1.1 Closure and Reclamation Concepts – An Objectives-Based Approach

A comprehensive CRP is a necessary and integral element of all advanced mineral exploration and mine developments. The development of a CRP needs to follow an objectives-based approach with the overarching closure goal at its foundation. The closure goal is supported by closure principles which in turn guide the selection of clear and measurable closure objectives for all project components. For each closure objective, proponents propose a set of closure options that could achieve the objective, and a selected closure activity is chosen from these options. Closure criteria measure whether the selected closure activity achieves the specific closure objective. Each of these steps will be further described below and are illustrated in Figure 1.



**Figure 1:** Objectives-based approach to closure and reclamation planning.

### 1.1.1 Closure Goal<sup>5</sup>

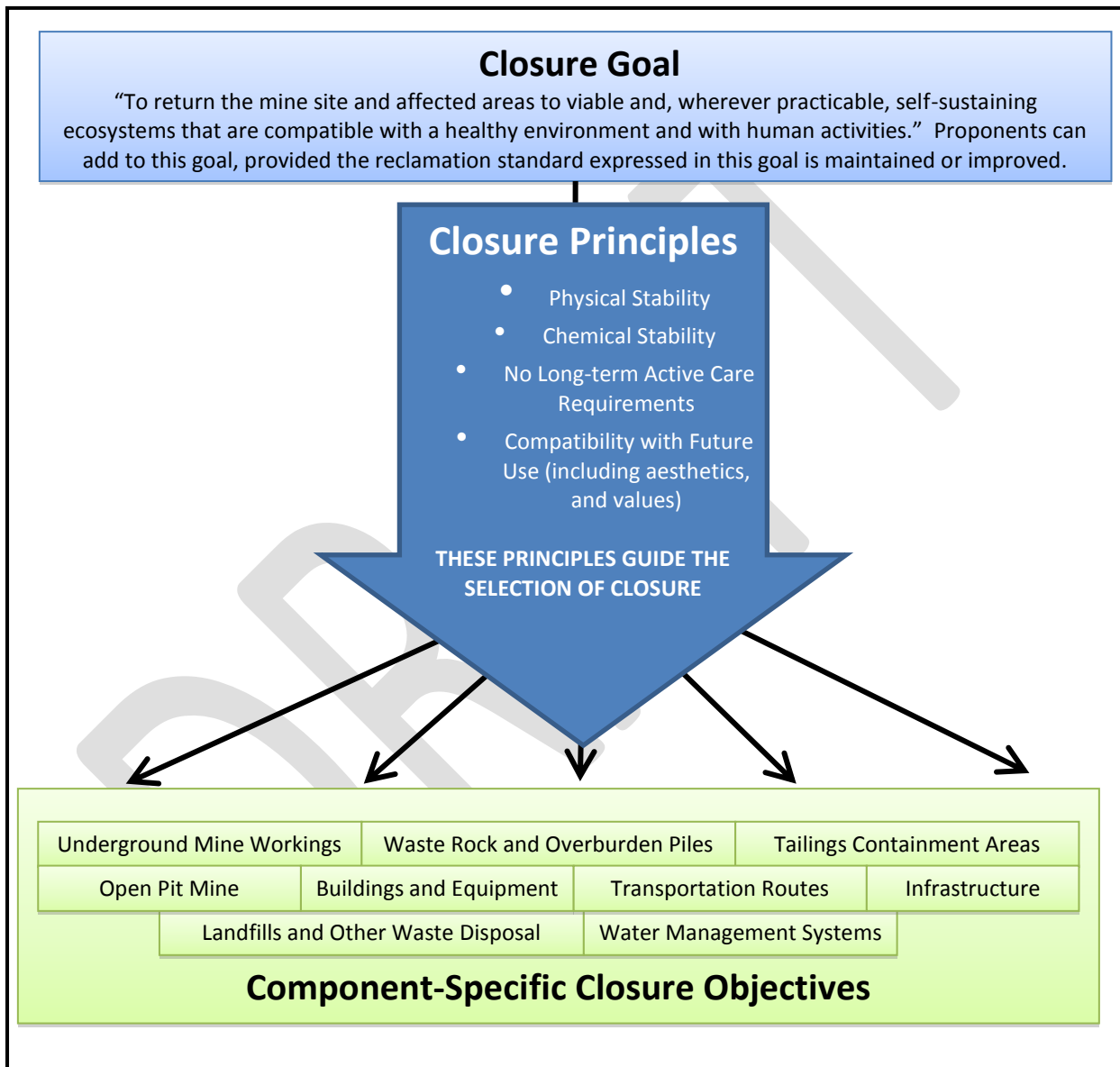
The closure goal is the guiding statement and starting point when beginning to plan for closure and reclamation. The closure goal at all mining operations is to return the mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities.<sup>6</sup> Proponents can add to this goal, provided the reclamation standard expressed in the goal is maintained or improved. The closure goal is met when the proponent has satisfied all closure objectives. This goal can also be applied to advanced mineral exploration projects.

<sup>5</sup> The term “closure goal” is used to represent the “closure and reclamation goal”. This is also the case with the terms: closure principles, closure objectives, closure options, selected closure activity, and closure criteria.

<sup>6</sup> As per AANDC’s required standard of reclamation in the NWT, as stated in 2002 *Mine Site Reclamation Policy for The Northwest Territories*.

### 1.1.2 Closure Principles

Closure principles guide the selection of closure objectives. Four core closure principles: physical stability, chemical stability, no long-term active care requirements, and future use (including aesthetics and values) are applicable to advanced mineral exploration and mine sites (Figure 2).



**Figure 2:** Closure goal, principles, and component-specific objectives.

*Physical Stability* - Any project component that remains after closure should be constructed or modified at closure to be physically stable, ensuring it does not erode, subside, or move from its intended location under natural extreme events or disruptive forces to which it may be subjected. Closure and reclamation



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will not be successful in the long-term unless all physical structures are designed such that they do not pose a hazard to humans, wildlife, aquatic life, or environmental health and safety<sup>7</sup>.

*Chemical Stability* - Any project component (including associated wastes) that remains after closure should be chemically stable; chemical constituents released from the project components should not endanger human, wildlife, or environmental health and safety, should not result in the inability to achieve the water quality objectives in the receiving environment, and should not adversely affect soil or air quality into the long-term.

*No Long-Term Active Care Requirements* – Any project component that remains after closure should not require long-term active care and maintenance. Thus post-closure monitoring would be required for a defined period of time only. Physical and chemical stability will help ensure this principle is achieved.

*Future Use (including aesthetics and values)* - The site should be compatible with the surrounding lands and water bodies once closure activities have been completed. The selection of closure objectives at a project site should consider:

- Naturally occurring bio-physical conditions, including any physical hazards in the area (pre- and post-development).
- Characteristics of the surrounding landscape pre- and post- development.
- Level of ecological productivity and diversity prior to development and intended level of ecological productivity and diversity for post-closure.
- Local community values and culturally significant or unique attributes of the land
- Level and scale of environmental impact.
- Land use of surrounding areas, including the proximity to protected areas, prior to site development.
- Potential future use for each area on site by humans and wildlife.

### 1.1.3 Closure Objectives

CRPs must include closure objectives for each project component at advanced mineral exploration or mine sites. These objectives must be guided by and directly relate to the closure principles. Closure objectives are statements that clearly describe what the selected closure activities aim to achieve. They must be measurable, achievable, and allow for the development of closure criteria.

When developing closure objectives, predictions from the environmental assessment phase should not be considered “pollute-up-to-limits”; rather, closure objectives should be set to achieve the best possible outcomes. During the project approval process, proponents must engage stakeholders to develop closure objectives. When site-specific factors (such as community concerns, physical or chemical conditions, and site history), or new information resulting from reclamation research

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<sup>7</sup> Health and safety considerations at advanced mineral exploration and mine sites are critical, and may influence what closure options are safe to implement and if other contingency measures or approaches need to be considered. The northern and mostly remote nature of most NWT sites makes this even more relevant, both in terms of the health and safety of workers as well as considerations for public access post-closure.



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necessitate modifications to closure objectives, proponents must engage stakeholders and submit proposed changes with supporting rationale to the appropriate Board for approval (usually as part of an interim closure and reclamation plan). Stakeholders may also present proposed changes with supporting rationale to the Board for approval if they believe the closure objectives need to be modified.

#### **1.1.4 Closure Options**

Proponents explore and discuss a set of closure options for each project component, in order to achieve the closure objective. After receiving feedback from stakeholders (both in writing and via workshops), a proponent will choose the selected closure activity for each component and present it to the appropriate Board for approval. Reclamation research, including necessary monitoring, may be required to determine appropriate closure options.

It is important to document all closure options considered throughout the life of a project to ensure there is a record of the rationale for why certain decisions were made and to learn from past deliberations. It is the responsibility of the proponent to ensure that the closure options proposed would achieve the stated closure objectives and comply with all closure and reclamation requirements.

#### **1.1.5 Selected Closure Activity**

The selected closure activity is chosen from the closure options for each project component and outlines specific actions and measures to be undertaken. The selected closure activity may change prior to the final closure and reclamation plan based on factors such as environmental considerations, stakeholder input, the availability of new technologies/practices, or the results of specific reclamation research. A contingency plan should be developed to outline how the selected closure activity will be modified if it is unsuccessful. Once the selected closure activity is approved by the appropriate Board, the proponent can begin the final engineering and design phase for each project component.

#### **1.1.6 Closure Criteria**

Closure criteria are developed for each closure objective for approval by the Board that issued the water licence. They are used to determine if selected closure activities meet the closure objectives for each project component. Closure criteria can be site-specific or adopted from territorial/federal standards and can be narrative statements or numerical values. Closure criteria must be meaningful, measurable, and achievable over time to ensure successful reclamation of project components. Closure criteria may also have a temporal aspect to consider (e.g., testing will be done for two, five, ten years).

Closure criteria should be discussed in the early stages of project development with input from stakeholders. For mine sites, closure criteria are normally explored in the conceptual closure and reclamation plan, expanded upon during the development of interim closure and reclamation plans, and





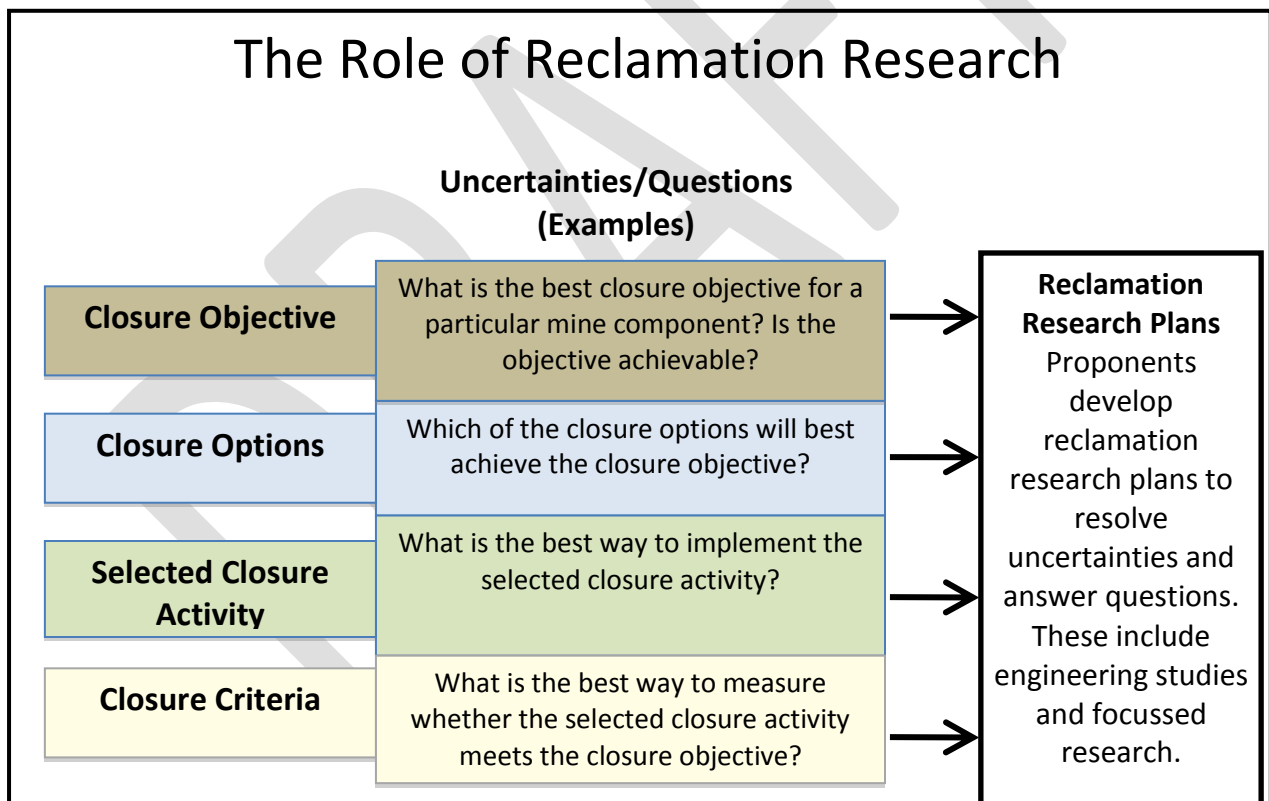
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finalized as closure and reclamation planning approaches the end of operations (final closure and reclamation plan).

In the early stages of project development, certain closure criteria will not be pre-established but rather will be determined based on the results of reclamation research. A brief description of the ongoing or future reclamation research related to the development of closure criteria should be provided.

### 1.1.7 Reclamation Research Plans

Proponents develop reclamation research plans to resolve uncertainties and answer questions pertaining to environmental risks for closure options or selected closure activities (Figure 3). Reclamation research includes engineering studies and/or focussed research undertaken with the intention of reducing uncertainties to an acceptable level. It is essential that reclamation research be initiated as early as possible and be fully supported such that the resulting information can be interpreted by stakeholders and the Boards in a timely manner and used in the closure planning process.



**Figure 3:** The role of reclamation research.

Reclamation research results will provide information that can lead to the development of appropriate closure criteria. For mine sites, the research is generally component-specific and can take several years to complete (e.g., revegetation studies, rock pile studies, etc.). Reclamation research will facilitate the



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transition from operations to closure and reclamation, as it will aid in determining which closure option will be chosen as the selected closure activity.

Reclamation research may be needed for the development of appropriate closure criteria that will be applicable to a site in a northern context. For example, closure standards and closure criteria for mine sites in southern Canada may not be applicable in the NWT due to the unique environmental setting (e.g., climate, permafrost, trophic level of lakes, etc.). Reviewing research of similar, nearby developments can be beneficial. Reclamation research can be cost effective since it will help finalize closure options and may also lead to modifications of initial closure objectives, leading to an approved closure plan.

## 1.2 Closure and Reclamation Plans (CRPs) – Required Regulatory Submissions

In the NWT, water licences and land use permits are issued by the Boards, along with the NWT Water Board (water licences only). In the Inuvialuit Settlement Region, land use permits are issued by AANDC for Crown lands and by the Inuvialuit Land Administration for private lands.

The CRP submissions required for advanced mineral exploration and mine sites are outlined in sections 1.2.1 and 1.2.2 respectively. The number of submissions and level of detail will vary depending on the scale of the project. Land leases (surface) issued by AANDC also have closure and reclamation requirements<sup>8</sup>.

Most applications for mine developments and some advanced mineral exploration projects will be required to undergo an environmental assessment or an environmental impact review with the Mackenzie Valley Environmental Impact Review Board (MVEIRB) in the Mackenzie Valley<sup>9</sup>. Once the application is approved by the review board or panel and recommendations are accepted by the AANDC Minister, the environmental assessment phase is complete, and the project returns to the licensing phase (see Figures 4 and 5 for depiction of the regulatory process).

### 1.2.1 Advanced Mineral Exploration

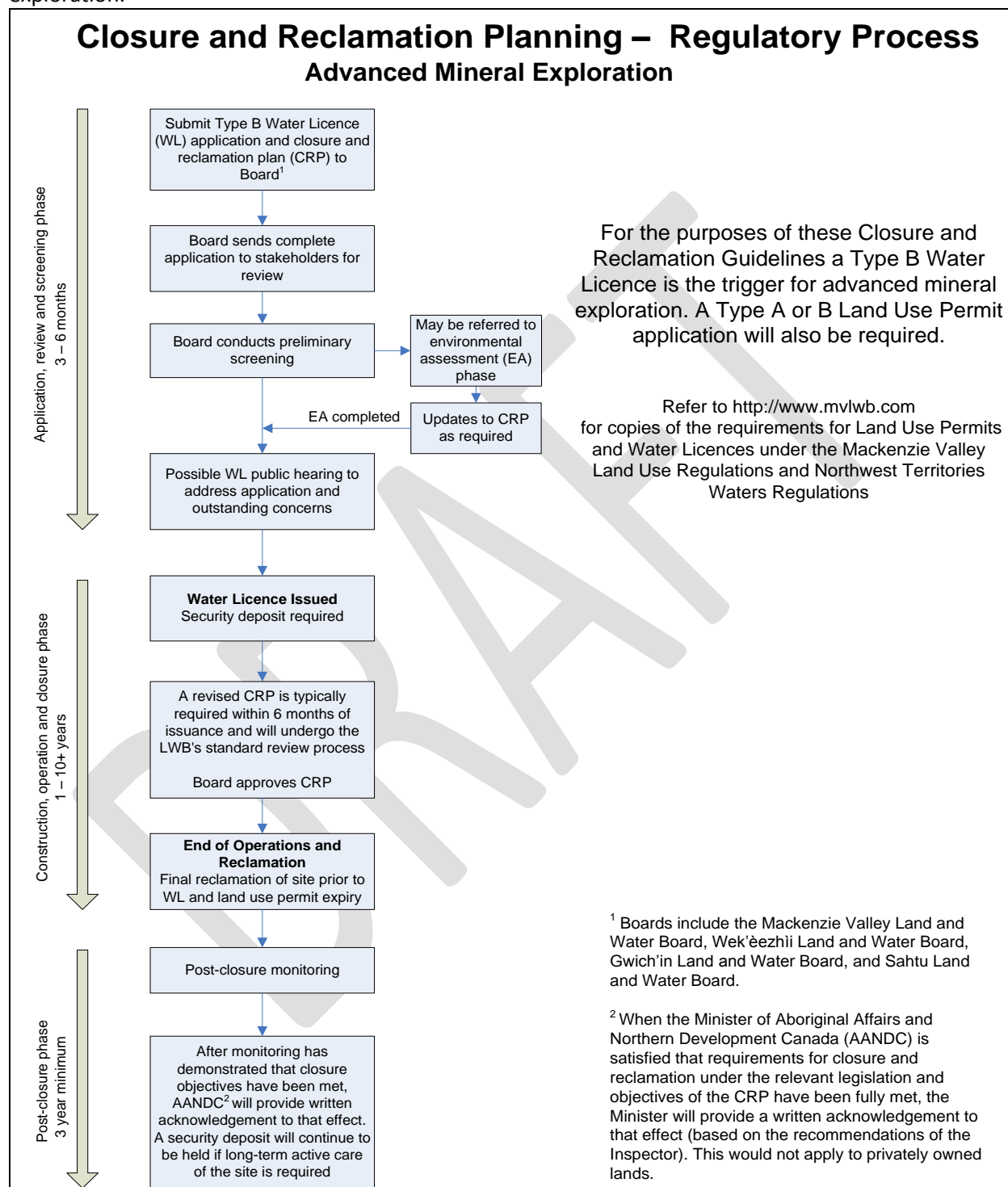
A Type B water licence application is the trigger for the CRP requirement for an advanced mineral exploration project. The intent of a CRP is to provide a description of the plan that would be followed to close and reclaim the site, either temporarily pending further exploration work, or permanently should the project not proceed to mine development.

During advanced mineral exploration, the results of a feasibility study may lead to the decision to proceed to mine development. If a proponent intends for their project to develop into a mining operation, it is necessary that they contact the appropriate Board to begin preparing their Type A water licence application well in advance of a planned

<sup>8</sup> For further information see AANDC Lands Division or refer to lease documents directly.

<sup>9</sup> The Canadian Environmental Assessment Agency and/or the Mackenzie Valley Environmental Impact Review Board undertakes the environmental assessment phase in the Inuvialuit Settlement region.

submission. Figure 4 provides an overview of regulatory process steps for advanced mineral exploration.



**Figure 4:** Advanced mineral exploration regulatory process general steps.



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A detailed template for developing the CRPs is provided in section 1.5. The template is intended to simplify the CRP development and review processes once an application is received by any one of the Boards. The template provides descriptions of all the information required in the CRP, including but not limited to the purpose of the plan, regulatory requirements, community engagement, project description, closure objectives and closure criteria, monitoring and reporting, progressive reclamation, and temporary closure activities.

### 1.2.2 Mine Development – Mining and Milling

A Type A water licence application is the trigger for the CRP requirement for mine developments. The intent of closure and reclamation planning for a mine site is to provide detailed descriptions of approaches that will be or are proposed to be used to close and reclaim the site while achieving the closure goal and objectives. It is also important to incorporate long-term local community values and cultural considerations.

The requirements for closure and reclamation planning and reporting listed below generally correspond to the mine development stages (i.e., mine design, construction/operations, reclamation), and are reflected in the following plans:

- A conceptual closure and reclamation plan (section 1.2.2.1).
- One or more interim closure and reclamation plan(s) (section 1.2.2.2).
- A final closure and reclamation plan (section 1.2.2.3).

Other required reports include: an annual closure and reclamation progress report (see section 1.2.2.4); a reclamation completion report documenting the reclamation work completed following mine closure (see section 1.2.2.5); and a performance assessment report comparing the documented closure objectives against the actual post-closure site conditions (see section 1.2.2.6). Figure 5 provides an overview of regulatory process steps for mine developments.

A detailed template for developing CRPs is provided in section 1.5. The template is intended to simplify the CRP development and review processes once an application is received. The template provides descriptions of all the information required in the CRP, including but not limited to the purpose of the plan, regulatory requirements, public engagement, “life of project” schedule, project description, closure objectives and closure criteria, monitoring and reporting, reclamation research, progressive reclamation, and temporary closure activities.

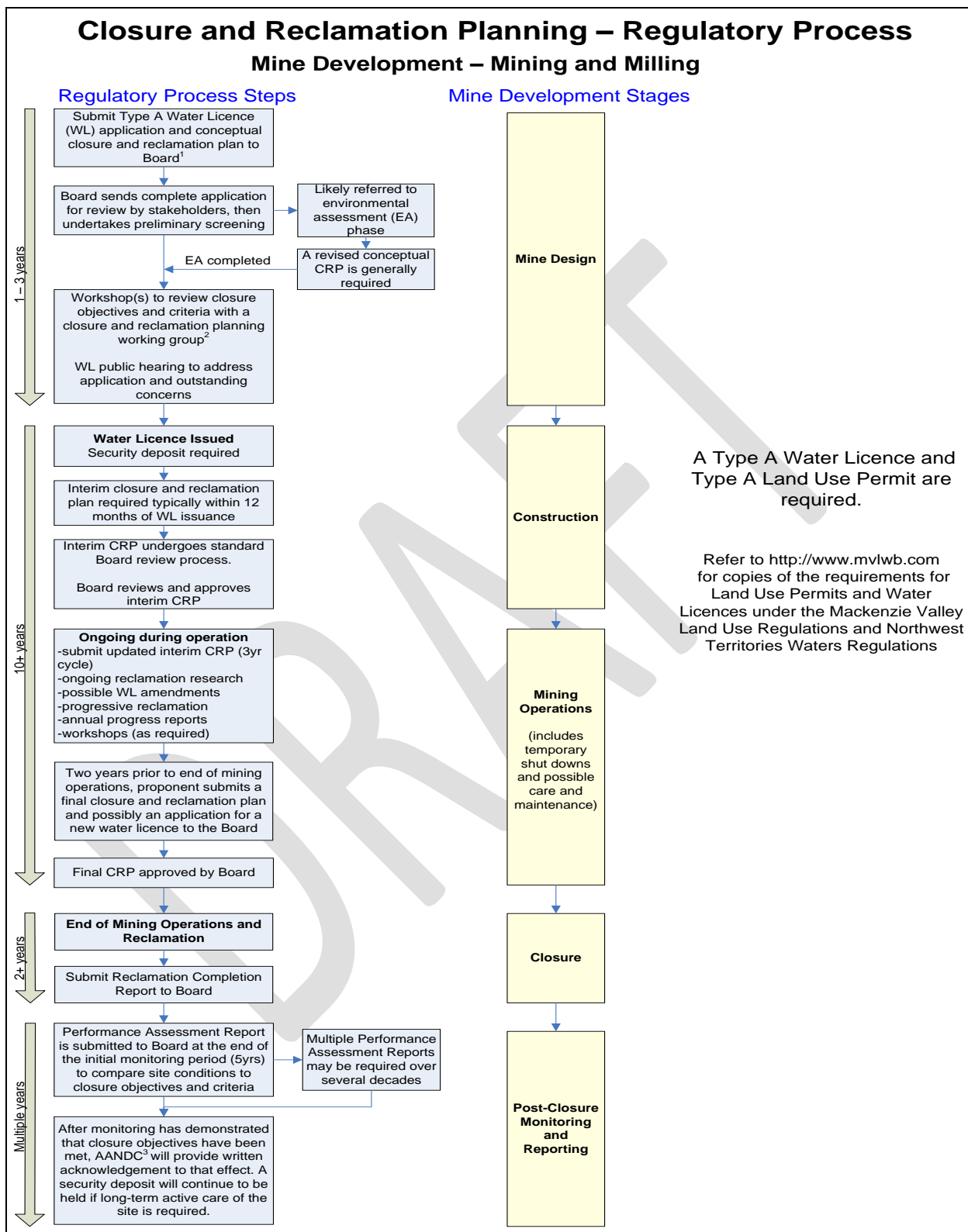
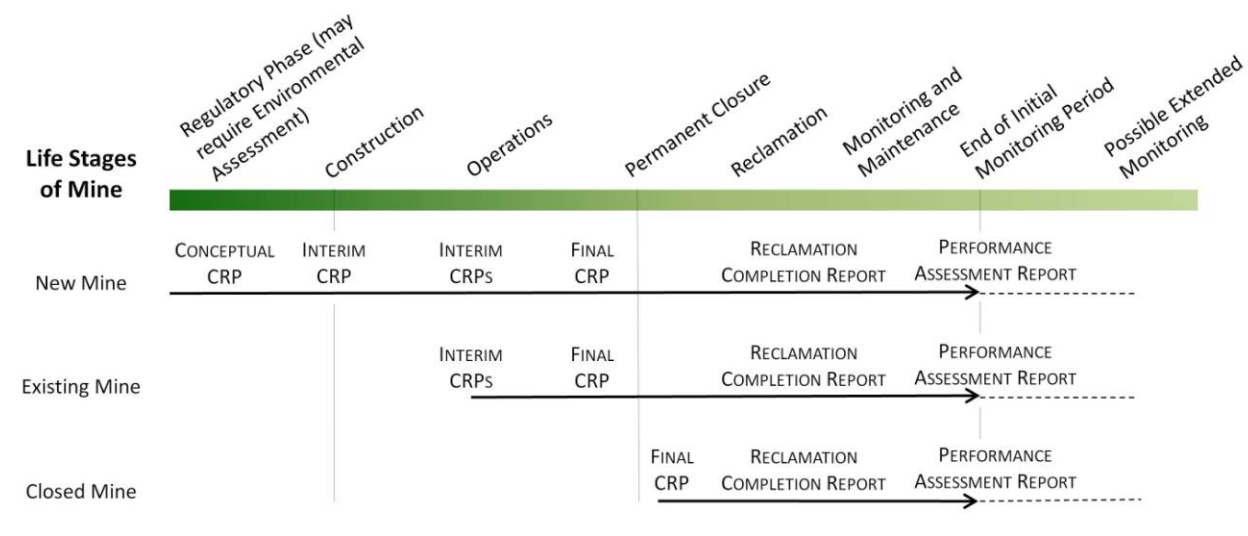


Figure 5: Mine development regulatory process general steps.

Closure and reclamation planning and reporting requirements for new, existing or closed mines are illustrated in Figure 6 as an example of how they relate to the life stages of a mine, and will be further discussed in the following sections.



**Figure 6:** Closure and reclamation planning through life of the mine.

### 1.2.2.1 Conceptual Closure and Reclamation Plan

For new mines, a conceptual closure and reclamation plan is prepared during initial mine planning prior to the actual construction at the mine site as a requirement of a Type A water licence application (see Figure 5). It is based on the proponent's proposed mine plan and to some degree on assumed future conditions. The general purpose of the conceptual CRP is to demonstrate how the mine site is projected to be closed and reclaimed and to describe the likely residual risks to human health and the environment.

As previously mentioned, most mine developments are required to undergo an environmental assessment or environmental impact review. During the environmental assessment phase, the conceptual CRP will be expanded and re-submitted as a requirement of the developer's assessment report<sup>10</sup>. Public engagement is necessary during the preparation of the conceptual CRP. It is advised that the proponent form a closure and reclamation stakeholder working group to ensure stakeholder input, public engagement, and thorough communication are considered during the early stages of mine planning and conceptual CRP development. The level of public engagement should focus on addressing

<sup>10</sup> See the Mackenzie Valley Environmental Impact Review Board website for details about the developer's assessment report and the environmental assessment process.





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specific issues and providing input into closure objectives, closure options, relevant reclamation research, and other key closure issues to produce an acceptable conceptual CRP (see Figure 5).

To be effective, the conceptual CRP should place emphasis on:

- Statements of closure objectives for the general site and individual mine components;
- Realistic descriptions and assessments of closure options related to temporary or indefinite closure;
- Identifying uncertainties related to closure objectives, options or criteria and potential reclamation research or engineering studies to address uncertainties;
- A review of similar case studies and a description of applicable lessons learned from other sites;
- Credible evidence that the stated closure objectives can be achieved through the selected closure activities;
- Photographs depicting what the site looked like before operations began;
- Identification of any likely post-closure monitoring requirements and responsibilities for the selected closure activities;
- Conceptual projections of the likely post-reclamation risks to environmental, human and wildlife health (risk assessment); and,
- Closure and reclamation liability costs and financial security estimates to a level of detail relevant to the available information.

#### **1.2.2.2 Interim Closure and Reclamation Plan**

An interim CRP is generally a requirement of a Type A water licence and is usually expected within 12 months of water licence issuance, or as directed by the Board (see Figure 5). The proponent's mine plan may have changed following the environmental assessment phase; similarly, sections of the conceptual CRP will change as the first version of the interim CRP is developed. Several iterations of an interim CRP may be necessary depending on the mine life as interim CRP's are generally revised on a three-year cycle. Consequently, the content and focus of the interim CRP will become more refined with a thorough review of closure objectives, closure options, selected closure activities, and closure criteria as the project progresses and subsequent versions of the interim CRP are produced.

The general purpose of the interim CRP is to update the preceding conceptual or interim CRP according to the current mine operating plan, ongoing public engagement, reclamation research results, progressive reclamation and/or advances in mine technology. Each subsequent interim CRP provides increasing levels of detail on the closure and reclamation of individual mine components and details for components which are to be progressively reclaimed during mine operation.

One of the main purposes of the interim CRP is to identify uncertainties surrounding closure options thereby guiding corresponding areas for reclamation research during operations. For example, during the early stages of mine life the following questions may be asked: What will water quality be in open pits if they are flooded to create pit lakes? If the tailings containment area was vegetated, would it be safe for wildlife? In these cases, research should begin early enough in the process so that there are acceptable levels of uncertainty at closure. Similar to reclamation research, the level of detail of an





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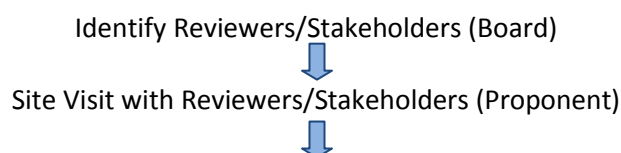
engineering study (e.g., to determine surface stability on a tailings facility after vegetative cover and rock capping are complete) will increase as proponents progress from the conceptual CRP to the last version of the interim CRP.

The interim CRP is also used to progress from the initial closure objectives, as outlined and intended in the conceptual CRP, into increasingly solidified closure objectives as input is received by stakeholders. The exercise of collectively developing closure objectives is particularly useful in that stakeholders have the opportunity to gain an understanding of the complexity of certain objectives and the difficulties in setting measurable closure criteria. The closure and reclamation stakeholder working group can provide input on the development of closure objectives, an analysis of alternatives or options, and the identification of closure activities and closure criteria. Proposed changes to closure objectives that were set in previous versions of the CRP should be well-supported by a full rationale.

To be effective, the interim CRP should place emphasis on:

- Renewed or updated statements of closure objectives for each mine component;
- Reclamation and progressive reclamation schedule;
- Detailed or updated descriptions of closure options related to temporary or permanent mine closure to a level of detail relevant to the information available (the level of detail should increase through the mine life as new information is made available);
- Detailed contingency plans for individual mine component (e.g., waste rock piles);
- An explanation of which closure options were considered and why selected closure activities were chosen for each mine component;
- Updated reclamation research plans;
- Evidence that the closure objectives can be achieved through the selected closure activities;
- Closure criteria for each closure objective;
- Updated photographs depicting the original landscape, what the site looks like during operations, and the anticipated landscape at final closure;
- Detailed report on progressive reclamation activities, including continued monitoring of closed mine components;
- Post-closure monitoring requirements and responsibilities (these should become more refined in the final version of the interim CRP);
- Updated descriptions of the likely post-reclamation risks to environmental, human and wildlife health (risk assessment); and,
- Updated closure and reclamation liability costs and financial security estimates to a level of detail relevant to the available information.

The Board will establish a process for the development of an interim CRP. This process will vary depending on the circumstances and stage of planning; an example process is provided below.





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Submission of Closure Goal and Proposed Closure Objectives (Proponent)



Closure Objectives, Options, and Uncertainties Workshop (Board and Proponent)



Consideration of Objectives, Options, Uncertainties (Board)



Submission of the Interim CRP (Proponent)



Review of the Interim CRP for Approval (Board)

### **1.2.2.3 Final Closure and Reclamation Plan**

The final CRP is required two years prior to the end of operations or as directed by the Board (see Figure 5). It must be approved before permanent closure takes place or immediately after an unplanned closure and provide detailed descriptions of the proposed reclamation activities for the mining operation. For large, multi-year projects, the final CRP may include a schedule for updates to the plan while the work is being implemented. These updates should be provided in the proponent's annual CRP progress report.

As a project advances, the level of analysis and deliberation regarding certain closure options will diminish as selected closure activities are carried out. Additionally, predicted residual effects of selected closure activities should be increasingly detailed in the final CRP since more information, including monitoring and research results, will be available to determine the duration, frequency, and magnitude of the effects. However, reclamation research and ongoing monitoring should continue as necessary to ensure appropriate closure criteria are finalized. The level of detail and certainty surrounding post-closure monitoring and contingency planning should be fully described in the final CRP.

To be effective, the final CRP should place emphasis on:

- Final statements of closure objectives for each mine component;
- A complete set of closure criteria that measure whether the selected closure activity meets the closure objective;
- Detailed descriptions of selected closure activities for each mine component to a "detailed engineering" or "issued for construction level of detail";
- Detailed descriptions and assessments of possible contingency plans;
- Updated detailed closure and reclamation schedule;
- Long-term information management in connection with post-closure activities;
- Updated photographs depicting what the site looked like prior to closure;
- Detailed post-closure monitoring and care and maintenance programs and responsibilities;
- Detailed descriptions of the projected post-reclamation risks to environmental, human and wildlife health (risk assessment); and,
- Detailed closure and reclamation liability costs and financial security estimates based on achieving approved closure objectives and closure criteria.



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#### **1.2.2.4 Annual Closure and Reclamation Plan Progress Report**

The annual CRP progress report provides an opportunity to all stakeholders to track, modify, and report on reclamation. The annual review of research results also provides an opportunity to identify missing research tasks which allows the research plans to continually evolve. The progress reports keep all stakeholders informed about closure planning and allows the Board to confirm that the proponent remains on schedule.

Each annual CRP progress report should include at a minimum:

- A description of important research results that will be used to inform closure planning going forward;
- Any engineering studies/designs or reclamation research completed or updated during the year;
- Progressive reclamation completed within the last year and proposed progressive reclamation for the upcoming year;
- A summary of residual risks on the site to environmental, human and wildlife health;
- Updated detailed closure and reclamation cost liability and financial security estimates; and,
- Any other information to ensure that stakeholders are aware of the closure planning process and timelines.

There should be a section within the annual CRP progress report that details any proposed changes to the CRP. These proposed changes, or any studies or designs the Board deems important, will be for Board approval.

#### **1.2.2.5 Reclamation Completion Report**

The general purpose of the reclamation completion report is to provide details, including figures, of the actual reclamation work completed, an explanation of any work that deviated from the original or approved CRPs, an inventory of the infrastructure removed and that remaining, all engineered “as-built” reports, descriptions of any work or monitoring that is still required, and expected completion dates. This facilitates future assessment, maintenance and, if needed, repair work. Necessary ongoing monitoring should continue during the closure and reclamation stage. The report should also provide a preliminary assessment on whether appropriate closure objectives and criteria have been achieved.

For smaller projects, a single reclamation completion report outlining how the site was reclaimed would be appropriate. For larger projects, where facilities or components are closed and reclaimed prior to the end of operations, a reclamation completion report would be expected following the closure of each of the facilities/components as well as a final reclamation completion report that summarizes all of the previous component-specific reports.

The final reclamation completion report should provide updated photographs of the components and of the site and a description and timeline for any environmental monitoring and mitigation plans.



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#### **1.2.2.6 Performance Assessment Report**

A performance assessment report is prepared at the completion of the reclamation work and following the submission of the reclamation completion report. The general purpose of the performance assessment report is to provide a detailed comparison of conditions at the site against the appropriate closure objectives and closure criteria. In some cases where the closure objectives and closure criteria have not been fully achieved or where this remains uncertain, there may be a need to carry out an extended monitoring and/or a care and maintenance program (e.g. water treatment).

A performance assessment should also be completed when environmental conditions were initially projected to demonstrate that certain closure objectives have been achieved, such as closure objectives requiring short term monitoring (e.g., five years) and those related to general site stability and construction-related issues. At this time, the closure criteria and any ongoing residual and/or environmental risks are re-assessed and the monitoring and maintenance plan is updated if subsequent performance assessment reports are required by the Board. This will likely be the case for longer term closure objectives (e.g. 20 years or more) for individual mine components that may remain on site in perpetuity such as tailings caps, waste rock piles, and landfills.

The performance assessment report should provide an updated closure and reclamation cost liability and financial security estimate, updated photographs of the components and of the site, human and wildlife health and safety conditions, and descriptions of public engagement and community participation in site monitoring and maintenance activities and management.

#### **1.2.2.7 Final Site Closure**

After monitoring has demonstrated that closure objectives and closure criteria have been met and this has been documented in one or more performance assessment reports, the AANDC Minister will provide written acknowledgement to that effect (based on the recommendations of the AANDC Inspector)<sup>11</sup>. A security deposit will continue to be held if long-term active care of the site is required.

### **1.3 Communication and Public Engagement**

Effective communication, along with thorough and frequent public engagement, needs to occur on various levels when developing CRPs for advanced mineral exploration and mine sites. It is important that all comments from stakeholders are clearly and accurately documented and considered in the CRP development and approval process.

The level of CRP public engagement will evolve through the life of the project. Input should be sought as early as possible - for example during the development of the conceptual CRP for a mine - and continue

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<sup>11</sup> This would not apply to privately owned lands.



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with the interim CRP(s) and final CRP, such that comments regarding closure objectives, closure options, selected closure activities, and closure criteria can build on earlier comments and lead to CRPs that are well understood and supported by stakeholders.

Below are several approaches that have been successfully undertaken by proponents developing CRPs in the NWT to ensure effective communication and public engagement.

- For mine sites, form a closure and reclamation stakeholder working group that meets periodically to share information and provide comments and guidance to the proponent.
- Talk to an assortment of community members such as Chiefs, elders, elected leaders, fishers/hunters, and youth for a fitting amount of time as determined by the community. Include both women and men to get a broad view of community view points and concerns on CRPs pertaining to culturally significant attributes of surrounding land, community values, and future land use scenarios (e.g., historical wildlife movement through the area and post-closure).
- Ensure translation is available to facilitate effective communication.
- Report back to Aboriginal governments, communities, and other stakeholders to discuss how their input was considered and to obtain feedback on the CRP development process.
- Employ local residents to conduct reclamation activities and carry out monitoring requirements.

It is important to note that some closure and reclamation planning recommendations made by Aboriginal governments and communities may not align with western scientists' ideas of best practices. In these cases, all the reasons for the recommendations being put forward should be examined carefully and communication efforts should respectfully build on existing perceptions related to environmental effects from the given project.

The Boards are currently developing public engagement guidelines which will outline specific public engagement requirements and best practices for proponents. Similarly, MVEIRB requires public engagement as well as incorporation of Traditional Knowledge during the environmental assessment phase, and certain Aboriginal governments have Traditional Knowledge policies and guidelines to be adhered to.

## 1.4 Financial Security Requirements

The requirement for a proponent to provide adequate financial security for their project is outlined in the terms and conditions of their water licence. The amount of security required by a proponent will depend on the nature and scale of the project and the level of uncertainty with respect to residual effects and impacts following operations. The closure and reclamation plan and associated research is intended to reduce the level of uncertainty and is expected to become more refined and accurate as the project approaches the end of operations.

The acts and regulations provide the Boards and the NWT Water Board with the authority to set the financial security amounts for land use permits and water licences. The *Territorial Lands Act* allows AANDC to issue land leases (surface) and require proponents to submit and maintain financial security.



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AANDC's Water Resources Division and Environment and Conservation Division administer and manage security deposits for water licences and environmental agreements<sup>12</sup> respectively for the NWT Region, while AANDC's Operations Directorate administers and manages land use permit and land lease (surface) security deposits.

## 1.5 Template for Developing a Closure and Reclamation Plan

The annotated template provided below identifies the minimum requirements for closure and reclamation plans (CRPs) submitted to the Boards for advanced mineral exploration and mine sites. The template includes the name of each required section within the plan and details about what proponents must include in that section. These requirements are based on current industry norms for CRPs, lessons learned by the Boards from projects in the NWT, and input provided by stakeholders during numerous closure planning processes.

The purpose of this template is to set realistic and consistent expectations for the content of a CRP, to simplify the review process for stakeholders, and to reduce ambiguities for proponents. The template is designed to be compatible with each stage of development, so as the operation evolves from advanced mineral exploration through to mine development, the same order and type of information is required but in more detail.

The template serves as a guide and proponents are encouraged to offer suggestions that may enhance how information is conveyed; however, if a proponent chooses to deviate from the templates, a thorough rationale should be provided along with the recommended changes to the format or content. It is recommended that all proponents contact Board staff prior to preparing a CRP.

The template should be used for both advanced mineral exploration and mine sites. Any differences in the Boards' expectations between these two types of projects are noted below. Where the type of project is not specified, proponents should assume the information is required for both advanced exploration and mine sites, although a greater level of detail is generally required for mine sites.

### ***Table of Contents***

Include lists of tables, figures, maps, photos, and appendices presented in the CRP.

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<sup>12</sup> Each of the NWT's three diamond mines has an environmental agreement, a legal contract among the mining company, federal and territorial governments, and Aboriginal organizations. The agreements set out requirements for the company's environmental management plans, monitoring programs, and closure and reclamation plans. Each of the environmental agreements for the diamond mines establishes a monitoring agency, funded primarily by industry. Aboriginal governments play a key role in these agencies. The agencies advise the company, communities, and the Minister of AANDC on environmental issues related to the project.





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## **1.0 Plain Language Summary**

Provide a plain language summary of the CRP with a level of detail dependant on the stage of the project. This summary is for the benefit of stakeholders that are reviewing the plan, including those who may not review the entire document. It can also be used as a stand-alone document, for example to brief communities at public events.

For all projects, the plain language summary should focus on the key aspects of the current CRP. Note any major uncertainties and how these will be addressed (e.g., research plans or engineering studies). For interim and final plans, note any differences from the previously approved plan and from the conceptual CRP discussed during the environmental assessment phase.

Proponents with CRPs that are more complex should consider providing summaries that are specific to each mine component. These proponents are also strongly encouraged to include summary tables which can be very useful for illustrating the connections between related closure concepts. For example, conceptual or early interim plans can include tables that present closure objectives, closure options, and selected closure activities. This allows the Board and stakeholders to understand how the selected closure activities will meet the closure objectives. CRPs for projects approaching closure can include a table that presents closure objectives, closure criteria, and monitoring. This table would demonstrate how the proponent's success in meeting objectives will be measured and assessed. Tables can be organized by mine component, and even further divided into valued ecosystem components (e.g., air, land, wildlife, etc.). Proponents should tailor these summary tables so that information is presented in the most useful way possible.

## **2.0 Introduction**

### **2.1 Purpose and Scope of the Closure and Reclamation Plan**

Provide statements describing the purpose and scope of the CRP as it relates to the Boards' requirements, stakeholders, and the public in general. Provide a general description of the project including a brief description of the proponent(s) and the overall spatial and temporal extent of the project (this will be described in more detail in section 4). State whether the plan is a conceptual CRP, a version of an interim CRP, or a final CRP. Provide the approval dates of any previous CRPs.

### **2.2 Goal of the Closure and Reclamation Plan**

The closure and reclamation goal (or closure goal) as described in Part 1 is to return the mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities. Proponents can add to this goal, provided the reclamation standard expressed in the goal is maintained or improved. The closure goal is supported by the four closure principles of physical stability, chemical stability, no long-term active care requirements, and future use (including aesthetics and values). This closure goal applies to both mines and advanced mineral exploration projects.





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### 2.3 Closure and Reclamation Planning Team

Describe, list, or show (e.g., with organizational chart) the important internal and external organizational relationships and specific responsibilities (e.g., accountability structure) that will facilitate and manage the closure and reclamation process; include any consultants working on behalf of the proponent and their reporting relationships.

### 2.4 Public Engagement

Describe the approach to public engagement and how local community values will be integrated into closure and reclamation planning, including any strategies for engaging communities into CRP development and implementation. The level of public involvement will be expected to increase based on the size and duration of the project and the complexity of facility development, traditional significance of the area to residents, and anticipated future use (see Part 1, Section 1.3 of these guidelines). Public meetings, face to face meetings, and workshops may be required at various stages; typically these occur prior to submission of a conceptual, interim, or final CRP. A community engagement log detailing all meetings, teleconferences, e-mails, workshops, etc., with the topics of discussion, the outcomes, persons involved along with a record of all files, letters, invitations, presentations, e-mails, etc. should be included in the appropriate appendix.

### 2.5 Closure and Reclamation Plan Requirements

Provide a detailed tabulated summary (see example below) of all existing and potentially required permits, authorizations, agreements, and note the authority with jurisdiction for closure and reclamation. Regulatory instruments being considered would include:

- Water licence(s)
- Fisheries and Oceans Canada authorization(s)
- Land use permit(s)
- Environmental agreement(s)
- Land leases (surface)
- Others

Example Table of Permits, Authorizations, and Agreements

List of Existing Permits, Authorizations, and Agreements	Responsible Authority and Contact Information
e.g., Type A Water Licence (MV2011L2-0001)	e.g., Mackenzie Valley Land and Water Board
e.g., Fisheries Authorization (11-HCAA-CA6-12129)	e.g., Fisheries and Oceans Canada

Also, provide a conformance table to demonstrate how the CRP satisfies the conditions of the water licence.

In addition to the above requirements, there may be guidelines that the proponent will have to follow (i.e., MVLWB *Guidelines for Developing a Waste Management Plan*, AANDC's *Guidelines for Spill Contingency Planning*). The proponent may also have their own company closure standards or want to reference relevant guidelines that are not specific to CRPs or the NWT.



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### **3.0 Project Environment**

Provide detailed descriptions of pre-disturbance conditions and the current development status of the project. The amount of information presented for each subsection should be sufficient to establish baseline conditions so that specific closure criteria can be developed to demonstrate that the closure objectives are being met. Much of this information may be derived from current/historic baseline data, the environmental assessment phase (if applicable), or updated with data and information from monitoring plans, studies, and reclamation research.

The project environment section should present the following five topics in this order (for uniformity and clarity among CRPs). Depending on the level of information available, it is likely that subsections will be necessary for each of the topics listed below; if so, the subsections should be organized so that the information is logically presented.

#### **3.1 Atmospheric Environment**

Provide an overview of the regional and local climate setting, temperature, and precipitation statistics and trends based on regional and project-specific climate stations. Provide general descriptions of regional and site air quality conditions and how the existing project is affecting air quality (e.g., due to emissions and fugitive dust). Use tables and figures to help summarize and depict data. Climate and air quality discussions should be presented in separate subsections.

#### **3.2 Physical (Terrestrial) Environment**

Provide an overview of the regional and local physiography (i.e., topography and relative relief and drainage basin – surface water - characteristics), surficial and bedrock geology, extent and distribution of permafrost, geologic hazards and hydrogeology; use maps, photo mosaics, tables, and figures to help summarize and depict monitoring stations or wells, and other data and information.

#### **3.3 Chemical Environment**

Provide an overview of regional and local soil and sediment chemistry, surface water quality (i.e., lakes, streams, springs), groundwater quality (i.e., from production and/or monitoring wells), and acid rock drainage/metal leaching potential. Use maps, tables, and figures to help summarize and depict sampling locations, data, and information.

#### **3.4 Biological Environment**

Provide an overview of vegetation (flora), aquatic life, terrestrial wildlife (fauna), avifauna and their respective habitats and the overall ecosystem(s); use maps, tables, and figures to help summarize and depict monitoring locations, biogeoclimatic zones, habitat extent and boundaries, and genera/species data and information.

#### **3.5 Cultural Environment**

Provide summaries of the potentially affected land uses including an overview of recent and traditional use sites, archaeological and cultural sites, protected and heritage sites, and future uses. Provide any relevant socio-economic information that may be affected by the closure and reclamation of the mine.



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## **4.0 Project Description**

### **4.1 Location and Access**

Describe regional and local contexts of affected areas, provide relevant reference coordinates where applicable; use detailed maps and photo mosaics. Describe access points and methods, with seasonal variations and limitations.

### **4.2 Site History**

Provide a relevant summary of the history of any ore discovery, exploration, and previous development and operations that have led to the current project. This would also include any ownership changes and a synopsis of the application, permitting, and licensing process to date. This information should be presented in chronological order. Use figures and photos to depict major site changes and tables where the site history is complex and extensive.

### **4.3 Site Geology**

Describe regional and local geology, including major rock types and structure, to the level of detail appropriate to depict the mining resource, extraction methods that were/will be used, and the rationale for footprint and specific target areas. Use tables, maps, cross sections, photos, and figures to help the presentation of relevant information.

### **4.4 Project Summary**

For advanced mineral exploration, provide a summary of the proposed activities including size/volume of sampling, areal extent and footprint of exploration activities. For a mine development, provide an overview of the mine site (describing total footprint) with a description of the operating plan through closure and reclamation as well as a discussion of the various options that were proposed by the proponent during the environmental assessment. More detailed descriptions of each project component will be provided in section 5.

## **5.0 Permanent Closure and Reclamation**

### **5.1 Definition of Permanent Closure and Reclamation**

This section should include the following definition of permanent closure: Permanent closure is the final closure of a mine site with no foreseeable intent by the existing proponent to return to either active exploration or mining. Permanent closure indicates that the proponent intends to have no activity on the site aside from post-closure monitoring and potential contingency actions. Permanent closure does not preclude renewed interest at the existing site or in the area at a time beyond the foreseeable future.

Proponents should indicate in this section the expected status of the project following closure by identifying whether the mine site (or components of it) is expected to be in a walk-away condition, and if so by when. Identify whether any components will require passive long-term care, and (although strongly discouraged) long-term active care.



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## **5.2 Permanent Closure and Reclamation Requirements**

Develop closure and reclamation requirements in detail for each individual component. Mine components should be categorized as follows unless proponents provide a rationale for a different categorization (see Part 2 for technical considerations):

- Underground mine workings.
- Open pit mine workings.
- Waste rock and overburden piles.
- Tailings containment areas.
- Buildings and equipment.
- Mine infrastructure.
- Transportation routes.
- Landfills and other waste disposal sites.
- Water management systems.

For each component include, at a minimum, the following subsections:

### **5.2.1 Project Component Description**

Provide a description of each mine component, including proposed components and historical components no longer in use. Provide the details of the project component (e.g., dimensions, material properties, footprints, and relative locations on a site map) with accompanying figures, maps, and photos as appropriate. Each project component should be presented in separate subsections for clarity. The descriptions should also include the status (operating, permitted, lifespan, temporary closure, and any progressive reclamation completed, etc.) of each component.

For example, for an open pit mine, describe mining methods and facilities in order to understand how ore and waste rock were/are removed and what the pit geometry will be at closure (reference dimensions with plan and cross section views) including access points, and any geotechnical stability issues and exposed rock types. Describe (quantify) dewatering requirements during operations and how this will differ from closure requirements. For an underground mine, describe mining methods and facilities in order to understand how ore and waste rock will be/were removed and what final geometries of the adit-tunnel system will be. Provide a map showing elevations and dimensions of portals, adits and tunnels; describe (quantify) dewatering requirements during operations and how these will differ from closure requirements.

### **5.2.2 Pre-Disturbance, Existing, and Final Site Conditions**

Using maps, photos, photo mosaics, etc. as appropriate, describe (compare and contrast) the pre-development (or pre-disturbance), existing, and projected site conditions. Show all relevant water bodies (including watershed boundaries), topographic modifications, vegetation changes, and changes to the built environment. Describe any important or unique environmental conditions (i.e., atmospheric, physical, biological, chemical, and/or social) for the project component that will have a bearing on closure.



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### **5.2.3 Closure Objectives and Criteria**

This section of the CRP should list the closure objectives and closure criteria for each project component. Conceptual CRPs and early interim CRPs may include minimal or no closure criteria as these take time to develop. Any uncertainties related to closure objectives and criteria should be noted along with a reference to the reclamation research plan associated with each.

A table may be helpful during certain stages of the project to illustrate the relationship between closure objectives, selected closure activities, closure criteria, reclamation research, etc. The content of these tables may depend on the planning stage. Summary tables presented in section 1.0 *Plain Language Summary* can be repeated here.

### **5.2.4 Consideration of Closure Options and Selection of Closure Activities**

This section presents “alternatives analyses” as appropriate, of various closure options, including a discussion of various risk scenarios and any unique or novel closure situations for the component being discussed. For example, explain how closure options are being developed for a complex mine that has more than one open pit in which one pit may close prior to the closure of the other open pits. In this case, an early closure date for one pit may occur prior to a full evaluation of all closure options for the other open pits have been fully evaluated.

The analysis should then be followed by a determination of the selected closure activity. Include the rationale for why the closure activity was selected and the other options were rejected. This section is dynamic in that it likely will be modified over time from development of the conceptual CRP through to interim CRPs and the final CRP.

### **5.2.5 Engineering Work Associated with Selected Closure Activity**

This section should describe all demolition, construction, or other engineering work that will be necessary to close and reclaim each mine component. As closure planning progresses, proponents should be able to provide a logical sequence and timing of the works (i.e., re-grading comes before revegetation). The conceptual CRP and the first interim CRP are not expected to have a great deal of detail regarding engineering work required for closure.

### **5.2.6 Predicted Residual Effects**

Conduct an assessment of any potential negative residual effects which may remain after the reclamation work for each component has been completed. Provide results of any relevant risk assessments to deal with the residual effects. Provide a comparison of the residual environmental impacts that are currently predicted to occur at the end of closure and reclamation for each component with those impacts that were predicted during the environmental assessment (if one has occurred).

### **5.2.7 Uncertainties**

Proponents must identify important uncertainties that arise during closure planning including uncertainties about what the risks of various closure options are and how to select the best closure activity, how to best implement a selected closure activity, how to define closure criteria, how Traditional Knowledge should inform closure planning, and more.



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Indicate also how each uncertainty will be addressed, whether through a specific reclamation research, (including Traditional Knowledge research) an engineering study plan, or another means. Reclamation research plans should be included in appendices as they are developed. See the appendices section of this template for a description of the content of reclamation research plans.

#### **5.2.8 Post-Closure Monitoring, Maintenance and Reporting**

Information for this section of the CRP is generally not well-defined in the conceptual or early stages of a project and will become more refined as the project progresses through operations towards closure.

The success of the closure and reclamation plan is contingent on the development and implementation of a functional monitoring program which likely began during the exploration stage, has continued during operations, and will continue to occur through post-closure. Provide a description of what will be monitored (e.g., fugitive dust, stream flow, wildlife and aquatic life movement) and their sampling locations, frequencies, and duration. Explain any maintenance activities that will occur during post-closure monitoring.

#### **5.2.9 Contingencies**

Describe how unforeseen events or conditions (e.g., something preventing the success of a selected closure activity) would be handled. Explain how any closure monitoring might be affected.

#### **5.2.10 Schedule of Closure Activities**

It is important that the Boards are confident that a proponent's planned schedule of activities will result in timely and successful closure and reclamation. Provide a component-specific schedule depicting operations, closure dates, and selected closure activities for each component for the life of the project. Include any progressive reclamation, initiation, and completion of research including pilot studies, expected completion of closure criteria, and monitoring and reporting phases. For interim and final CRPs, proponents must provide a Gantt-type chart or equivalent to depict temporal sequences of multiple tasks and identify critical paths (i.e., those that would impede the progress of inter-related tasks or the overall project process). The Board recognizes that schedules are subject to change as the mine plan adapts over time. Proponents should therefore discuss schedule uncertainties based on, for example, extent and success of progressive reclamation, temporary closure, and upset conditions.

### **6.0 Progressive Reclamation**

Progressive reclamation takes place prior to permanent closure to reclaim components and/or decommission facilities that no longer serve the project. Planning for progressive reclamation should begin during the design stage and continue throughout the life of the mine, using the best available technology suitable to the site. Progressive reclamation can take advantage of cost and operating efficiencies by using the resources available from an operation to reduce the overall reclamation costs. It also provides valuable information on the effectiveness of certain closure activities which might also be implemented during permanent closure. Progressive reclamation enhances environmental protection by minimizing the duration of environmental exposure and shortens the timeframe for achieving the





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closure goal and closure objectives. It can also reduce the financial liability of the site and allow portions of the security deposit to be returned. Any progressive reclamation should be an outgrowth of the overall stated closure objectives.

As the operation evolves through the different stages of the closure and reclamation planning process to final closure and reclamation, the CRP will be refined to reflect completed elements, lessons learned, and issues that are still outstanding.

While this section mostly pertains to mine sites, advanced exploration sites should include any relevant information in the subsections below.

### ***6.1 Definition of Progressive Reclamation***

This section should include the following definition of progressive reclamation: Progressive reclamation takes place prior to permanent closure to reclaim components and/or decommission facilities that no longer serve the objectives of the mine site. These activities can be completed during operations with the available resources to reduce future reclamation costs, minimize the duration of environmental exposure, and enhance environmental protection. Progressive reclamation may shorten the time for achieving closure objectives and may provide valuable experience on the effectiveness of certain measures which might be implemented during permanent closure.

### ***6.2 Opportunities for Progressive Reclamation***

Describe any progressive reclamation that will occur during the life of the project. Include the location and areal extent of the work, a description of the planned reclamation activities, and any planned monitoring that will be required. The level of detail in this section should increase as commencement of progressive reclamation approaches.

Describe any monitoring activities that will occur solely to assess progressive reclamation to ensure that the closure goal and closure objectives will be met. These may include components of an environmental baseline program or an existing surveillance network program.

Proponents should contact Board staff prior to undertaking progressive reclamation to discuss which submissions will be required before and after the progressive reclamation activities.

### ***6.3 Completed Progressive Reclamation***

Summarize all progressive reclamation activities that have occurred at the site including their locations. Provide a list of any reports submitted to the Boards that describe completed progressive reclamation. Describe any lessons learned from progressive reclamation that will inform closure planning at the site.

## ***7.0 Temporary Closure***

Temporary closure occurs when an advanced mineral exploration or mining operation ceases with the intent of resuming activities in the near future. Temporary closure could be due to an unplanned closure or a planned closure of certain facilities in a complex mining project. These closures can last for weeks or years based on planning, the need to analyze and understand the results of an on-going mining operation, as well as other economic, environmental, and social/cultural factors.





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Temporary closure activities must maintain all operating facilities necessary to protect humans, wildlife, and the environment, including necessary environmental monitoring. Proponents need to ensure appropriate financial resources are available to continue monitoring and reporting during temporary closure. Care and maintenance staff should be present at the site and sufficient in number and expertise to care for the site and any potential problems that may arise. Sufficient equipment and supplies/reagents should be left on site for any maintenance or reclamation activities that may need to take place. Compliance with all applicable federal and territorial laws and regulations must also be ensured.

### **7.1 Temporary Closure Goal and Closure Objectives**

State the closure goal and closure objectives of temporary closure if these differ during permanent closure.

### **7.2 Temporary Closure Activities**

Describe activities and their closure methods that will occur for each individual mine component to ensure the temporary closure objectives will be met and for maintaining the stability and integrity of existing facilities and structures.

The following activities should be implemented or completed upon temporary closure:

- Access to the site, buildings, and all other structures must be secured and restricted to authorized personnel only.
- All openings must be guarded or blocked and warning signs must be posted.
- All physical, chemical, and biological treatment and monitoring programs must continue according to water licences, land use permits, and land leases in order to maintain compliance.
- All waste management systems must be secured.
- An inventory of chemicals and reagents, petroleum products, and other hazardous materials must be conducted and secured appropriately or removed if required.
- Fluid levels in all fuel tanks must be recorded and monitored regularly for leaks or removed from the site.
- All explosives must be relocated to the main powder magazine and secured, disposed of, or removed from the site.
- All waste rock piles, ore stockpiles, tailings, waste water and other containment structures must be stable and maintained in an appropriate manner (including regular geotechnical inspections).
- Drainage ditches and spillways must be inspected and maintained regularly (e.g., seasonally depending on snow and ice accumulation and melting) during the closure period and included as part of geotechnical inspections.
- Facilities and infrastructure must be inspected regularly.
- The security deposit must be kept up to date.

### **7.3 Temporary Closure Monitoring, Maintenance and Reporting**

Describe any monitoring activities that will occur during temporary closure to ensure that the current CRP's closure goal and closure objectives will be met.

### **7.4 Temporary Closure Contingency Program**



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Describe how unforeseen events or conditions would be handled during temporary closure if the response would differ from operations. Explain how any monitoring activities could be affected and how this would be addressed.

### **7.5 Temporary Closure Schedule**

Describe the anticipated timing and sequence of events preparing for and occurring during temporary closure. Provide descriptions for each mine component. Use charts or tables if the nature of activities is complex. Provide an estimate of closure duration and indicate, to the best knowledge, if the temporary closure will be short-term or long-term.

### **8.0 Post-Closure – Monitoring and Reporting**

Provide a description or study design of how the residual environmental impacts of the entire project (as a whole) will be assessed once selected closure activities have been completed. This implies that impacts are evident and measurable.

The presentation should discuss (in separate sections depending on length of analysis) residual impacts. These can be organized by mine components and/or by valued ecosystem component such as the physical components (air, land, and water) and biological components (wildlife, avifauna and aquatic life and their habitat). The discussion needs to be integrated with the summary of residual effects from each mine component provided in section 5.2.5.

The process and timelines for the reclamation completion report and all performance assessment reports should be discussed here.

### **9.0 Financial Security**

Provide estimates of total liability associated with permanent closure including any costs associated with progressive reclamation and temporary closure. Break down costs associated with each component. Use tables where appropriate. The estimate should be presented to match the timing of closure and reclamation activities as depicted with the schedule provided in section 5.2.10, through to the end of post closure, including security and monitoring programs (see Part 1, Section 1.4).

### **10.0 References**

### **Appendices**

All CRPs must include the following appendices:



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**A) Glossary of Terms and Definitions** - Definitions section should include discipline-specific technical terms (e.g., processed kimberlite, esker, dewatering) and key closure and reclamation planning terms (e.g., closure goal, closure objectives, closure criteria, etc.) explained in plain language.

**B) List of Acronyms, Abbreviations, Units, and Symbols**

**C) Lessons Learned from Other Projects (mine sites only)** – provide a summary table of relevant on-site closure issues/concerns that have been dealt with successfully or unsuccessfully in particular focussing on those lessons which would have direct application to managing project closure and reclamation. For example, this table could take the form of the following:

Development	Activity Which Led to Lesson	Lesson Learned	Adaptive Management Result
Ekati Diamond Mine - NWT	Infrastructure development in caribou migration paths	Potential for caribou passage to be impeded or for caribou to be injured/killed by infrastructure	Provided wildlife access ramps on haul roads; inukshuks were constructed around perimeter of site.
Brewery Creek Mine - Yukon	Revegetation of reclaimed slopes	On-going fertilization over a period of three years was more important than rate of seed application.	Adjusted future revegetation programs to include maintenance fertilizing for additional years to develop stability and self-sustaining vegetation cover.
Polaris Mine and Nanisivik Mine - Nunavut	Management of hydrocarbon contaminated materials	Placement of hydrocarbon contaminated materials in the underground workings	Hydrocarbon contaminated materials stabilized by encapsulation within the permafrost zone.

**D) Supporting Documents** - List documents used that support the characterization of baseline environmental data, (e.g., terrestrial studies, hydrology and aquatic studies, climate and air quality studies), geochemical analyses and predicted acid rock drainage/metal leaching potential, and any relevant engineering work related to supporting the closure and reclamation plan.

**E) Reclamation Research Plans** - Interim CRPs will require reclamation research plans to address uncertainties. Proponents should follow the outline below. The level of required detail is higher for research that will occur prior to the next version of the closure plan as described below.

**1.0 Uncertainty** - States the uncertainty or the reclamation research or engineering study question that will be addressed. The uncertainty is defined as an outstanding question on how a physical, biological, chemical, and/or geographical aspect of the mine will be addressed through the research/study plan.



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**2.0 Research/Study Objective** - States the purpose and desired outcome of the research/study. Describe how the research/study will resolve the uncertainty identified above.

**3.0 Research/Study Tasks** – Describe the tasks required to complete the research/study as follows:

- 3.1 Tasks to be started prior to next version of the CRP (usually the interim CRP) is submitted
- 3.2 Remaining tasks
- 3.3 Tasks completed

Also, provide the rationale for the timing, sequencing, and prioritizing of the work to be completed.

**4.0 Remaining Research/Studies to be Completed** - Provide a detailed or conceptual level scope of work for each of the tasks described above in section 3.0. More detail is expected for those tasks to be completed before the next version of the ICRP is submitted. This section is presented in the following two subsections:

- 4.1. Detailed scopes of work (how and when the data/information or analyses will be conducted) for those tasks described in section 3.1 above
- 4.2. Conceptual scopes of work for those tasks described in section 3.2 above

**5.0 Findings of Research/Studies Completed** - Provide a summary of the status of the research/study to date (those tasks completed in section 3.3 above). This provides the basis for assessing which data and information are still required, and provides for the flexibility of incorporating these assessments into future iterations of the reclamation research plans (and appropriate CRP). This section may be presented in two subsections:

- 5.1 Summary of relevant results (from tasks described in section 3.3)
- 5.2 Application of lessons learned

**6.0 Linkages to Other Research/Studies** - Identify how this research/study project is linked to and affected by the results from other research plans/engineering studies.

**7.0 Project Tracking and Schedule** - Describe the tracking of research/study progress. (This should not be confused with post-closure monitoring which tracks progress toward meeting closure criteria). Describe how the timing of the research is linked to mining operations throughout the life of the project.

**8.0 Costs** - Provide the expected costs for the reclamation research/engineering study plan activities.

**9.0 References** - Include references for completed research/studies.



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## Part 2 – Technical Considerations for Effective Closure and Reclamation of Mine Sites

### 2.1 Introduction

This section of the guidelines provides a summary of technical considerations that need to be considered while planning and designing for mine site closure and reclamation. Although specifically developed for mine sites, many of the technical considerations outlined in Part 2 can be applied to advanced mineral exploration sites and should be considered by the proponent to ensure a smooth transition from the advanced mineral exploration phase to mine development. The technical considerations are separated into the following two categories:

1. Common site-wide mine closure and reclamation considerations (section 2.2)
2. Individual mine component closure and reclamation considerations (section 2.3)

The technical considerations will be organized under the following headings which are further described below<sup>13</sup>:

- Closure objectives (for individual mine components only – section 2.3).
- Closure and reclamation planning considerations in mine design.
- Closure options.
- Northern limitations and considerations.
- Post-closure monitoring.

#### 2.1.1 Closure Objectives

Closure objectives describe what the selected closure activities are aiming to achieve and must be measureable, achievable, and allow for the development of closure criteria (see Part 1, Section 1.1.3). The development of closure objectives is required for individual mine components; however, it is not needed for common site-wide mine reclamation considerations as these will be addressed with the respective individual mine component. Note that closure objectives may not be uniform across mine components at a given site. For example, access may be limited or prevented for one area but promoted or encouraged for another area depending on the selected future use.

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<sup>13</sup> All mines are unique and have project-specific challenges and issues that may arise during operation. Proponents of mining operations must be prepared to plan for site-specific needs and are cautioned not to consider only those items that are presented in this document. The information provided in this section is not exhaustive. The intent is to provide initial guidance on how to effectively plan for the closure and reclamation of a mine site. Additional reference and guidance documents are listed in appendix A.



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Examples of closure objectives are listed below for individual mine components (section 2.3); note that this is not an exhaustive list. Proponents should at the very least use these objectives as a starting point and tailor them as needed to reflect community and stakeholder input, physical or chemical conditions, project history, reclamation research, and other site-specific factors. When developing closure objectives, proponents must closely follow the closure principles of chemical stability, physical stability, no long-term active care requirements, and future use (including values and aesthetics). Ultimately, the objectives must be designed to ensure that proponents will achieve the closure goal for the site (see Part 1 – Section 1.1).

AANDC and the Boards recognize that closure objectives may change during the life of the mine, based on new information from reclamation research, operational monitoring data, or other sources. If a proponent wishes to change objectives that have already been approved by the Board, they must engage stakeholders and submit proposed changes with supporting rationale to the Boards for approval. If a stakeholder identifies the need for a change to an objective, they should bring this to the attention of the Board and the proponent as part of the review of a specific closure and reclamation plan, during the annual CRP progress report or at any time.

### **2.1.2 Closure and Reclamation Planning Considerations in Mine Design**

Closure and reclamation planning considerations need to be incorporated into mine design to best identify processes and forces that may act upon the mine components following closure and reclamation and ensure they are factored into design and operation.

Key considerations when designing for closure include: integrating both Traditional Knowledge and other scientific information; making use of the best available information and technology; promoting environmental protection; and, applying the precautionary principle in the absence of conclusive information.

The proponent must design, operate, close, and reclaim the site so that the risk of negative impacts on the environment, wildlife, and humans is minimized or eliminated. Where deterioration of some residual mine components is inevitable, the proponent should identify and plan for the required maintenance. There should be no necessity for ongoing intervention or operations, other than periodic inspections and minimal maintenance, following closure and reclamation. Designing for a 'walk-away' scenario and eliminating long-term active care requirements is particularly important in the NWT due to the isolation of mine sites, and ensuing high transportation costs.

Designing for closure and reclamation aims to achieve the following:

- Mine components are to be designed and constructed in such a way that they achieve or can readily be modified to achieve the closure objectives and closure criteria;
- Closure and reclamation costs are to be determined as part of closure planning and these costs must be borne by the proponent who must provide adequate financial security to cover the cost of reclamation over the life of the mine to ensure closure criteria can be met;





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- Closure and reclamation planning should interact regularly with planning for the development and operation of the mine site to ensure that regular operations do not unnecessarily increase the workload for reclamation or effectively compromise what might otherwise be promising closure options;
- Selected closure activities are incorporated into the design of the mine's operation;
- Progressive reclamation activities are incorporated into the mine's operation; and,
- There should be co-ordination among all the stakeholders Aboriginal, federal and territorial governments, land owners, local communities, regulatory authorities, proponents, and other interested parties to ensure the development of appropriate closure objectives and criteria.

### 2.1.3 Closure Options

Closure options are potential activities and associated measures that could be taken to ensure progressive and post-closure reclamation while achieving the stated closure objectives. They are subject to approval by the Board.

Progressive reclamation occurs during operations and can take advantage of cost and operating efficiencies by using the resources available from mine sites (thereby reducing the overall closure and reclamation costs), as well as demonstrating actual site-specific results under real field conditions, enhancing environmental protection, shortening the timeframe for achieving the closure objectives, and reducing financial security requirements and related uncertainties.

Closure options for post-closure reclamation are potential activities and associated measures that could be undertaken once mining operations have ceased indefinitely. These should utilize and adhere to the best available technologies suitable to the site for each of the mine components.

For certain mine components, many of the closure options suggested could be initiated during either the progressive or post-closure timeframe and are thus grouped together. Where a clear distinction exists for individual mine components, closure options are subdivided into progressive and post-closure categories.

### 2.1.4 Northern Limitations and Considerations

This section describes closure aspects that are unique to the NWT and to the North in general. These should be carefully considered and investigated during closure and reclamation planning and design as schedules for construction, operations, and subsequent closure and reclamation will be affected by the location, climate, water environment, and terrain, of the given site, in addition to permafrost and climate change as outlined below.

#### 2.1.4.1 Location

Mine sites in the NWT are often located in remote areas with restricted accessibility, limited road access, or seasonal access. Boat or barge access may be available for coastal projects, while other operations may be restricted to light aircraft and/or winter roads.



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There are few large communities across the NWT. It is not unusual for sites to be located several hundred kilometres away from the nearest community. The location of the site will often dictate the project's feasibility, and the potential high costs associated with reclamation need to be considered when planning for closure and reclamation. Accordingly, a low risk tolerance for the design criteria for engineered structures such as tailings cover systems or water management systems should be used.

#### **2.1.4.2 Climate**

The climate in the NWT is characterized by long, dark, cold winters and short, warm summers with extended hours of daylight. Lakes and rivers remain frozen for most of the year and the annual total precipitation is generally low. When temperatures rise, snowmelt is added to the spring freshet in a relatively short period and can result in rapid erosion.

Climatic factors can also limit the site's accessibility thus affecting reclamation activities or schedules. Periods of ice freeze and thaw may limit accessibility where operations utilize open lakes for aircraft landing in the summer and frozen ground and water for airstrips and roadways in the winter. Harsh weather conditions such as extreme cold, fog, and storms may also dictate site accessibility.

#### **2.1.4.3 Water Environment**

It is generally accepted that lakes, rivers, and other water bodies in the NWT are relatively pristine and can be sensitive to minor environmental changes such as a change in the lake-water chemistry. The effects of water body reactions from environmental changes are not fully understood at this point in time however, it is known that water plays a vital role in Aboriginal cultures, as hunting and fishing are key to substance living.

#### **2.1.4.4 Terrain**

The geological and geographic setting varies greatly across the NWT and may govern the degree of natural resources that are available for reclamation purposes. For example, much of the Precambrian Shield that dominates parts of NWT has only a veneer of soil cover - generally less than two metres. Consequently, construction materials suitable for reclamation activities may not be readily available on site or may be difficult to obtain. The supply will also be limited in regions affected by permafrost.

Topography and local surface conditions may also dictate the accessibility of a site. Mountainous regions can limit site access and potential seismic activity may also require additional planning considerations. The degree of vegetation, boulder, and water cover at a given site are other factors to consider in closure and reclamation planning.

#### **2.1.4.5 Permafrost**

Permafrost is defined as ground that remains at or below zero degrees Celsius for a minimum of two consecutive years. It may consist of bedrock, unconsolidated sediments (gravel, sand, silt or clay), organic materials (peat), and ground ice.

The presence of permafrost at a mine site requires additional considerations with respect to project planning, closure and reclamation. It is therefore important to understand what permafrost is, where it is likely to occur, and how it can affect mine infrastructure and reclamation activities. Permafrost is



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present throughout Canada and can be classified by zones that represent varying degrees of permafrost coverage. Permafrost is also characterized by temperature (mean annual ground temperature) which can vary by several degrees across the NWT. Thickness of permafrost can also vary from tens of metres in the southern NWT to hundreds of metres on the northern tundra. Permafrost derives its geotechnical significance from the presence of ground ice, which varies in amount depending on the soil type and, geological and thermal history of the environment. These characteristics of permafrost should be considered in the context of planning the development, management, maintenance, and closure and reclamation of the operation. Sources of additional literature and permafrost maps are included in the references section.

#### **2.1.4.6 Climate Change**

Proponents should consider the possible effects of climatic change at mine sites in the NWT, as the area has experienced the greatest rate of climate warming in the northern hemisphere during the late 20<sup>th</sup> century. The long-term effects of climate change on the annual temperature range, total precipitation, seasonal variation, increasingly variable precipitation, evaporation, permafrost degradation, changing ice conditions, and hydraulic routing are difficult to predict. Consequently, where individual mine components have a medium or high potential for environmental impact if failure occurs, it is necessary to select design parameters which are based on conservative interpretation of historic records and with consideration for the changes that may occur in the future.

Long-term changes in vegetation or those simply induced by human disturbance can feed back to influence permafrost temperature and terrain and infrastructure stability. Changes in water temperatures are also important factors which can be affected by climate change as they interact with permafrost to determine the stability of frozen core structures and shorelines.

Climatic changes may lead to permafrost degradation and the melting of frozen-cored structures; may instigate natural disasters such as flooding, landslides, or increased incidence of forest fires; may alter wildlife habitats and migration routes; and may affect the viability of winter roads.

#### **2.1.5 Post-Closure Monitoring**

Post-closure and environmental effects monitoring will be required to confirm that the closure objectives have been met once operations cease indefinitely. Closure criteria are important as they will assist in the development of post-closure monitoring programs and will provide clear interpretation of monitoring results.

If it is determined that closure objectives were not met for individual mine components (as demonstrated through the closure criteria not being met), ongoing monitoring, maintenance measures and possibly contingency plans will need to be implemented. Where a catastrophic event or natural disaster occurs, additional monitoring and maintenance may be necessary. Consideration should be given to establishing monitoring programs with involvement from local Aboriginal communities.



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If closure criteria are consistently achieved for a defined period of time, then a reduction in the monitoring frequency for the reclamation of an individual mine component may be approved by the Boards.

## 2.2 Common Site-Wide Mine Closure and Reclamation Considerations

Guidance on closure and reclamation considerations that may be common to several mine components is outlined below. Since these common site-wide considerations pertain to more than one mine component, specific closure objectives will not be listed in this section but rather will be recorded under the appropriate mine component in Section 2.3. The following site-wide mine closure and reclamation considerations are discussed:

- Acid rock drainage and metal leaching.
- Revegetation.
- Physical and geotechnical stability.
- Contaminated soil and groundwater.

### 2.2.1 Acid Rock Drainage and Metal Leaching

Mine sites by their very nature, are located on altered and mineralized sections of underlying bedrock, where minerals have been concentrated. To extract minerals, bedrock at mine sites is often exposed and disturbed, excavated (blasting and hauling), stockpiled and processed. The bedrock disturbance often results in a larger surface area due to the physical disintegration of the bedrock and an increased exposure to atmospheric conditions (e.g., water and oxygen). This may result in acid rock drainage (ARD) and metal leaching (ML) and the release of contaminants to the environment. ARD is a general term applied to any acidic leachate, seepage, or drainage arising from the weathering of undisturbed or excavated geological materials (rocks and soil) containing sulphide minerals or their weathering products. Weathering reactions intensify due to the acidity generated by the oxidation of sulphide minerals which results in the release of elements from rocks and soil. Under the prevailing acidic conditions (low pH) metals released from the solid phase (rocks, soil) remain in solution (ML). Although it should be noted that while most metals are mobile (remain in solution) under acidic conditions, some metals are only mobile under neutral or alkaline conditions.

To develop appropriate closure and reclamation plans, the ARD/ML potential of pit walls, tailings, overburden material, and other mine-related materials such as paste backfill, must be considered and evaluated in detail. For example, permanently exposed high walls may act as a continuous source of contaminants. Flooding of pit walls or stored materials such as process waste (tailings), that have been exposed for a period of time, may cause the dissolution and release of accumulated oxidation or weathering products. The geochemical assessment of ARD/ML potential can be complex and involve some long-term tests taking months or years to complete. Therefore, understanding the potential of ARD/ML in the early stages of mine planning and design (and continuing to enhance this understanding



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during the life of the mining operation) will ultimately improve the design of the closure and reclamation plan, and ensure the risks from ARD/ML occurrence are minimized.

### **2.2.1.1 Closure and Reclamation Planning Considerations in Mine Design**

The following items need to be considered during the mine design stage of the project to minimize post-closure reclamation efforts with respect to the control and treatment of ARD/ML:

- Develop plans for impact prevention, material characterization, material handling, waste disposal, site reclamation, site water management, monitoring, and maintenance.
- Consider modifications in mining and mineral processing (e.g., avoid mining of high sulphide ores, use gravity/flotation instead of cyanidation for extraction) to minimize the impacts on the environment.
- Assess methods that can be used to prevent ARD/ML at the site, including:
  - Limiting exposure to oxygen (e.g., water covers, dry covers, water saturation);
  - Chemical or physical intervention (e.g., coating to limit sulphide exposure, bactericides to reduce catalyzed oxidation reactions, blend or layer different materials to increase the distribution of buffering minerals, use alkaline additives, add covers);
  - Isolation of acid generating materials (e.g., segregate materials for controlled disposal, backfill waste rock or tailings into the underground workings or into the open pit, encourage cold temperatures and/or permafrost to reduce reaction rates); and,
  - Dry stack filtered tailings or storing paste tailings on the surface which minimizes potential future migration of contaminants from the area.
- If physical control measures are used to manage a chemical problem they should be designed to reduce the extent of the chemical risk rather than only contain or isolate the chemical problem (i.e, prevent the chemical reaction resulting in ARD from occurring, as opposed to simply collecting any runoff).
- Select a comprehensive set of geochemical analyses that characterize the various (waste) materials and then determine their potential for ARD/ML.
- Run static and kinetic ARD/ML prediction tests (e.g., acid base accounting, laboratory tests with humidity cells and columns, field tests with bins and piles), along with field tests and monitor site seepages from mine waste water.
- Evaluate the use of cover systems, diversion ditches, and berms to minimize exposure to surface water (infiltrations and runoff) and atmospheric oxygen.
- Design a site water management plan that avoids or minimizes the contact between good quality water and contaminated water.

### **2.2.1.2 Closure Options**

Closure options for progressive and post-closure reclamation to address ARD/ML may include, but are not limited to the following:

- Flooding of underground mine workings, provided permafrost conditions are not present.
- Control acidic and contaminated water at the source; prevent contaminated water flows.
- Divert or intercept surface and groundwater from potential sources of ARD/ML.
- Prevent or reduce water infiltration into materials stored above ground that could generate ARD/ML by installing cover systems or seals.



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- Utilize freezing conditions (ground or air) to limit the formation and discharge of leachate.
- Place potentially acid generating materials such that they are fully submerged under water or completely underground if appropriate.
- Place potentially acid generating rock within the centre of the waste pile so it is encapsulated by other host rock and/or permafrost if local conditions permit and if no other options for disposal are viable or available.
- Mitigate consequences of ARD by the use of passive and active treatment systems, preferably for in-situ conditions.
- Activities used in passive treatment systems can be:
  - Chemical (e.g., open limestone channels, adsorption and mineral precipitation in settling ponds and along flow paths).
  - Biological (e.g., sulphate reduction and precipitation of metal sulphides in natural wetlands).
  - Physical (e.g., particle settling in sedimentation ponds or along flow paths; filtration).
- Activities used in active treatment systems can be:
  - Chemical (e.g., chemical treatment involving neutralization or mineral precipitation; ion exchange and adsorption).
  - Biological (e.g., sulphate reduction and precipitation of metal sulphides in bioreactors; phytoremediation).
  - Physical (e.g., membrane filtration).

### **2.2.1.3 Northern Limitations and Considerations**

The following items should be considered when developing reclamation plans to address ARD/ML issues at northern mine sites:

- There is limited long-term experience with ARD/ML mitigation measures in northern environments. However, there is a large body of knowledge on best management practices and technologies to draw upon.
- Chemical reaction rates are often much slower due to very low temperatures; this delays the effects of potential ARD/ML which could benefit the selected mitigation measures.
- While low temperatures will slow chemical weathering processes during a large part of the year, there is also a large seasonal flush of accumulated contaminants during spring melt. Moreover, due to the scale of the waste rock piles after closure, infiltrating water from precipitation may be protected from freezing in the voids and result in increased drainage with poor water quality.
- There is increased oxygen solubility with decreasing water temperatures.
- Chemical reactions are dependent on the presence of water, which implies that reactive materials will remain inert during a considerable part of the year when freezing conditions with little precipitation prevail. However, there is evidence of acid generation reactions at temperatures below zero degrees, so cooling rock or tailings below zero does not guarantee acid generation will cease.
- Reduced water during the colder months will minimize the quantity of contaminated water that requires treatment.
- Once ARD/ML is being generated in the North, there can be a serious environmental impact because much of the NWT is relatively pristine and many lakes have low background levels of metals.
- The available cost effective mitigation and treatment options will be limited, given the distances and transportation costs.





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- Aspects of ARD/ML prediction, prevention, control and mitigation methods unique to cold climate environments include:
  - Effect of unfrozen water in tailings that can act as a transport mechanism of contaminants.
  - Effect of freezing point depression by process reagents and concentration of various ions and cations.
  - Design and use of practical cover systems in permafrost zones for various design purposes, including permafrost encapsulation.
  - Chemical reaction rates or incomplete oxidation reactions of stored materials under cold climatic conditions.
  - Scaling of laboratory test results performed under standard conditions (e.g., kinetic tests) to the field scale when it involves predicting the performance under cold climatic conditions.
  - Effects of cold climatic conditions on the efficiency of in-situ treatments such as lime addition and passive wetland treatment.

#### **2.2.1.4 Post-Closure Monitoring**

Post-closure monitoring with respect to ARD/ML issues may include, but is not limited to, the following:

- Inspect the physical and geotechnical stability of the mine site to ensure that no erosion, slumping or subsidence will occur that would cause exposure of potential acid generating material to atmospheric conditions (water, oxygen).
- Inspect any preventative and control measures (e.g., cover systems) to ensure that they operate according to their design specifications (minimize exposure to water and oxygen).
- Ensure that there is sufficient water supplied to maintain an appropriate water depth in designed water covers.
- Compare predicted water quality and measured water quality; improve water quality prediction if necessary or continue water quality monitoring.
- Evaluate existing monitoring locations and frequency on a site-by-site basis and make adjustments where necessary. This may involve new monitoring locations where possible contaminated drainage is generated, or removal of existing monitoring stations where drainage can be integrated in the water management system or released into the environment.

#### **2.2.2 Revegetation**

Revegetation of impacted areas on a mine site may include natural revegetation from colonization by native plants or enhanced revegetation where vegetation is planted for specific purposes such as erosion control, regulation of near surface moisture conditions, or aesthetics. Due to the geographic diversity present throughout the NWT, a broad range of vegetation types and conditions exists. In more northern locations, vegetation is sparse and generally limited to short shrubs and lichen. In more southern locations, particularly below the tree line, vegetation is generally more abundant in variety and robust in size. As such, revegetation (whether natural or enhanced), and its potential impact on the reclamation of individual mine components should be given site-specific consideration.



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### **2.2.2.1 Closure and Reclamation Planning Considerations in Mine Design**

The following items need to be considered during the mine design stage of the project to enhance post-closure reclamation efforts with respect to revegetation:

- Determine baseline ecological conditions prior to disturbance.
- Conduct local soil assessments to determine whether organic supplements should be used (e.g., peat, biosolids) if enhanced revegetation measures may be required.
- Include native plant collection and propagation methods, successional processes, and final plant communities that provide biodiversity and sustainability to reclaimed sites in the research plan.
- Conduct studies to characterize the local climate, temperature, precipitation, and wind as they relate to vegetation growth.
- Strip, stockpile, and properly cover organic and fine-grained soils from disturbed areas, such as open pits, waste rock piles, infrastructure and tailings facility footprints, consistent with the need to maintain permafrost and to keep for future use during progressive reclamation.
- Record volumes of soil strippings for later consideration in closure and reclamation planning.

### **2.2.2.2 Closure Options**

Closure options for progressive and post-closure reclamation with respect to revegetation may include, but are not limited to, the following:

- The introduction of seeded species should be avoided except in areas where immediate erosion control is required, since revegetation at many northern sites will naturally occur in the long-term.
- Selected closure activities need to accommodate the eventual development of vegetation on the surface without impacting their performance.
- In areas where revegetation is desired in the short term, begin revegetation efforts as soon as possible (progressively reclaim).
- Contour, scarify, and seed areas using seed mixes or cuttings from native vegetation to establish vegetative cover.
- Consider using organic stockpiles as a seed bank.
- It is preferable that non-native species not be introduced to establish vegetative cover of mine components. The Boards will consider the use of non-native species (e.g., for emergency erosion control) on a case-by-case basis.
- Consider the effect of vegetation on near-surface permafrost (e.g., tall shrub vegetation catches snow and may impact near-surface ground temperatures). This may be a concern if establishing tall shrubs on a tailings cover system that is designed to promote permafrost aggradation.
- Incorporate gravel layer (capillary break) within a cover system to control or limit upward migration of pore water from underlying mine wastes.
- Apply stripped/stockpiled soil or growth medium to a depth sufficient to maintain root growth and nutrient requirements.
- Incorporate organic materials, mulches, fertilizers, or other soil amendments based upon local soil assessment.
- Establish appropriate temporary or permanent wind breaks where necessary to establish vegetation.
- Transplant vegetation that would otherwise be lost to mine disturbance where feasible.
- Select native vegetation that has a low potential for metal accumulation.



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### **2.2.2.3 Northern Limitations and Considerations**

The following items should be considered when developing closure and reclamation plans that include revegetation efforts at northern mine sites:

- Revegetation success may be limited (rate of growth, aerial coverage, species) due to northern climatic conditions including, but not limited to, cold mean daily temperature, short frost free period, slope aspect, short growing season, low availability of moisture and nutrients, amount and timing of precipitation and runoff, and the prevailing wind.
- Succession of vegetation species in the North is generally slow.
- It is important to determine affinity for native vegetation to uptake metals, as well as to consider if these metals are bioavailable and if they have synergistic/antagonistic effects.
- Management of soil stockpiles for final reclamation needs to consider impacts of the northern climate (e.g., permafrost aggradation into soil stockpiles, and difficulty dealing with frozen stockpiles during the short, warm months).
- Use of fertilizers in northern environments needs to be carefully considered due to its potential to impact downstream water bodies.
- There may be a lack of viable/suitable soil and seed sources.
- Vegetation may not be appropriate for controlling erosion due to length of time required for the vegetation cover to develop.
- Information resources on revegetation of mine sites in the North (e.g., species, seed collection and availability, and soil development) may not be as readily available as southern sites.
- It is important to re-establish the sites' native species since there is a high reliance on the native vegetation by humans and wildlife as a food source.

### **2.2.2.4 Post-Closure Monitoring**

Post-closure monitoring where revegetation is planned or is occurring may include, but is not limited to, the following:

- Inspect revegetated areas periodically following initial planting until vegetation is successfully established and self-sustaining in accordance with the agreed criteria.
- Conduct soil analysis for nutrients and pH until the vegetation is successfully established and self-sustaining.
- Monitor metals uptake in vegetation and conduct risk assessment if needed to determine if uptake poses unacceptable risk to human, wildlife and environmental health.
- Monitor areas where growth of vegetation may be impacting the ground thermal regime.
- Monitor growth rates and succession of vegetation species.
- Monitor expansion of growth areas outside planted zones and determine if the impacts are beneficial or detrimental to performance of selected closure activities.
- Monitor for propagation of non-native or undesirable species.
- Inspect vegetated areas that may be obscuring possible cracks and other problems on dams and embankments.
- Inspect root systems of vegetation that are colonizing the surface of cover systems to observe if they are contained within the growth medium (e.g., soil, rock fill) and are not penetrating underlying cover materials.



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- Identify excessive vegetation stress or poorly established areas and implement contingency measures if required.
- Monitor wildlife use of revegetated areas to determine if viable wildlife habitat has been created.

### 2.2.3 Contaminated Soils and Groundwater

Fuel, chemicals, tailings, ore-associated metals and other substances can contaminate soils and groundwater through accident or failure of management systems<sup>14</sup>. Contaminated groundwater refers to water found underground between saturated soil and rock (e.g., associated pore water) that has been contaminated by the aforementioned substances. Reclamation of contaminated snow and ice follow the same principles for contaminated soils, however impacted snow and ice should be reclaimed immediately upon discovery (prior to melting).

#### 2.2.3.1 Closure and Reclamation Planning Considerations in Mine Design

The following items need to be considered during the mine design stage of the project to minimize post-closure reclamation efforts with respect to contaminated soils and groundwater:

- Consider environmental practices/operating procedures that eliminate or reduce the use of harmful substances or require materials less detrimental to the environment.
- Contain potentially environmentally harmful products such as fuel and other chemicals in properly designed facilities to limit the environmental impacts should an uncontrolled release occur.
- Identify the types of contaminants that will be present at the site (diesel fuel, heating oil, gasoline, etc.) and the types of media that will likely require treatment (soil, bedrock, groundwater, surface water, mine water, free product, ice, snow, or mixtures of these materials).
- Construct land farm or soil treatment pad/facilities in an appropriate location.
- Identify optional treatment and remediation technologies (destruction, immobilization, separation).
- Consider dusting, and its control, during the design of any tailings storage facility.

#### 2.2.3.2 Closure Options

Closure options for progressive and post-closure reclamation for contaminated soils and groundwater may include, but are not limited to, the following:

- Minimize the volume of contaminated soil that needs remediation and prevent the spread of contaminants to surface and groundwater by cleaning up all spills immediately.
- Remediate contaminated soil first before addressing the remediation of contaminated groundwater.
- Minimize contact between contaminated soil or source chemicals and non-impacted soil to mitigate increases in impacted soil volume.
- Excavate and remove contaminated soil and place into a designated and properly managed containment area onsite (e.g., land farm); subsequent treatment and off-site disposal may be necessary.

<sup>14</sup> The Canadian Council of Ministers of the Environment (CCME) Canada Wide Standards Phase I-III environmental site assessments are a recognized method for identifying and delineating impacted areas.



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- Treat contaminated soil without excavating (in-situ) using appropriate technologies such as bioremediation, soil leaching, and washing or excavate and remediate (ex-situ).
- Immobilize contaminants in soil (e.g., cement solidification, lime/silicate stabilization, etc.).
- Excavate and relocate contaminated soil to approved facilities off-site, assuming transportation risks can be managed.

### **2.2.3.3 Northern Limitations and Considerations**

The following items should be considered when developing closure and reclamation plans for contaminated soils and groundwater at northern mine sites:

- There may be climate challenges with respect to bioremediation of hydrocarbon-contaminated soils in the North (e.g., short cool summers reduce the ability for bioremediation).
- The presence of frozen soil may reduce the downward migration of contaminants, but overland transport of spills atop frozen soil in winter will be enhanced.
- Frozen soil is not an impermeable barrier to contaminants, it may need to be excavated and treated.
- Seasonal deep freezing, particularly in low moisture content materials, may impact contaminant transport in groundwater.
- Spills may alter the ground thermal regime by decreasing the albedo of the surficial materials and may result in increased thaw depths.
- Freezing ground conditions, either natural or enhanced, may be a potential way to assist containment in the short term; however, the impact of unfrozen water, air-filled voids, and altered ground thermal regime due to disturbance and climate change must all be considered.
- The movement of surface water and groundwater during spring melt is complicated by the process of thawing of the active layer.
- Some processes generate a large amount of heat which may cause permafrost degradation (an insulating pad constructed to reduce heat loss may be required) and enhance the ability for contaminants to migrate both vertically and laterally into the soil or groundwater.
- Due to the remoteness of many northern mine sites, removal of contaminated soils and treatment of contaminated groundwater can be logistically difficult (expensive and seasonally dependant).
- High degrees of mineralization around mines and ecological conditions may dictate that site-specific closure criteria are more appropriate than generic environmental criteria.

### **2.2.3.4 Post-Closure Monitoring**

Post-closure monitoring with respect to reclamation of contaminated soils and groundwater may include, but is not limited to, the following:

- Carry out periodic inspections to investigate the quality of air, groundwater, discharge water, and water body sediment where contaminated soils have occurred.
- Regularly assess trends in monitoring data to assess the effectiveness of selected closure activities.
- Visually monitor the physical stability of former contaminated soil excavation or containment sites (watching out for signs of erosion or thermal degradation of permafrost).
- Collect sufficient confirmation samples to ensure the impacted soils have been removed or impacted groundwater has been treated.
- Groundwater sampling using monitoring wells is complicated by permafrost and deep seasonal freezing. The technical feasibility of using groundwater monitoring wells in permafrost regions can



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be enhanced by installing a heat trace in the well to permit melting of any ice in the well prior to sampling.

- An assessment of residual contamination should be carried out to confirm the success of the remediation.
- Where complete contaminant removal is not possible and risk management approaches are implemented to minimize exposure (i.e., pathway control, limiting receptor access), periodic reviews must be undertaken to assess their effectiveness.
- Risk management options may be considered when remediation is impractical and risk management can be implemented for low to no maintenance inputs.

## **2.2.4 Physical and Geotechnical Stability**

In order to maintain the effectiveness of the selected closure activities and associated measures for landforms that remain on-site following mine closure, the physical and geotechnical stability of these landforms must be preserved. As such, designs need to be sufficiently robust to withstand potentially detrimental processes which relate to physical stability such as erosion (wind, water, waves) during extreme climatic events and processes which relate to geotechnical stability such as slope instability (i.e., related to high pore pressures or seismic loading), settlement and permafrost degradation. Examples of landforms that may remain on site following closure can include covered tailings and waste rock, remnant earthfill dams, and dikes which may be breached to restore drainage; spillways excavated into soil and rock,; and portal plugs constructed out of soil or rockfill.

### **2.2.4.1 Closure and Reclamation Planning Considerations in Mine Design**

The following need to be considered during the mine design stage of the project to enhance physical and geotechnical stability of landforms in closure:

- Minimize the number of landforms required at closure, especially those retaining water.
- In order to improve stability in closure landforms, the following measures should be considered:
  - Characterization of current and future permafrost conditions.
  - Impact of thawing of ground ice in permafrost, including instability due to thaw consolidation or rapid erosion due to thawing of ice rich permafrost. Methods to reduce thaw or promote freezing include insulation using natural materials, convection cooling, and in some cases mechanical/artificial ground freezing.
  - Designing landforms to ensure compatibility with future use of the site.
  - Designing landforms for geotechnical stability during operations and closure, including taking into account appropriate seismic values and safety factors.
  - Drainage measures including pumping from relief wells at the toe of a slope or installation of horizontal drains.

### **2.2.4.2 Closure Options**

Closure options for progressive and post-closure reclamation with respect to physical and geotechnical stability of landforms in closure may include, but are not limited to, the following:





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- Design landforms, such as covered tailings and waste rock, to maintain long-term stability and to blend in with surrounding landscape features.
- Implement construction control, including surveys, material quality control, compaction control, and instrumentation monitoring.
- Develop design criteria for dams, spillways, and cover systems that consider operational and closure scenarios.
- Closure and reclamation design criteria for dams, spillways, and cover systems should consider but not be limited to, the following:
  - All stability analyses should be based upon conservative estimates of material strengths and seismic accelerations.
  - Stability analyses should consider angle of friction and cohesion values obtained at critical moisture contents for the materials.
  - The character and shear strength of all structural components including rock, soil, liners, and sub-grade soils or rock should be presented in the site characterization and baseline data of the design report and all relevant test work should be fully documented.
  - Stability analyses should consider all kinematically possible failure modes and solifluction should be addressed for slope stability and cover system designs where frost susceptible soils are involved.
  - Consideration should be given to the potential for long-term changes in material strength due to weathering, frost action, degradation, seismic events, and chemical changes.
  - Maximum runoff should be the most critical runoff (precipitation plus snow melt).
  - All dams and associated structures should be designed, constructed, and maintained as stated in the procedures and requirements set out in the *Dam Safety Guidelines* published by the Canadian Dam Association.
  - Spillway design should include consideration of the effects of water diversion structure failure during the critical design events.
  - Where there is risk of thawing in the long-term, stability should be demonstrated for frozen, thawing, and fully thawed conditions.

#### **2.2.4.3 Northern Limitations and Considerations**

The following items should be considered when developing closure and reclamation plans that involve maintaining physical and geotechnical stability of landforms in closure at northern mine sites:

- There is a large range of seismic conditions across the North that should be considered.
- Ground thermal conditions are influenced by several factors including microclimate and proximity to surface water bodies which dramatically influence permafrost extent and temperature. Detailed characterization of ground thermal regime is required for every site.
- Thawing of ground ice, particularly in ice-rich permafrost, is a leading cause of instability in permafrost regions. This may include existing slopes, foundations, (of waste rock piles, roads, airstrips, and dykes), cut slopes, and borrow pits.
- Freezing of drainage structures and landforms must be considered. This includes surface drainage structures, such as ditches and culverts, and buried drainage landforms in dykes and waste rock piles.
- The effects of climate change could be more pronounced in permafrost regions, including both increased air and ground temperatures and increased precipitation.



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- Remote mine site locations and limited accessibility will present logistical challenges for closure and reclamation related construction.
- Recognizing that geosynthetic materials have a finite life span, their use should be carefully considered.
- Placement of geosynthetic materials at remote northern locations is expensive and challenging (particularly in the extreme cold) and may lead to poor performance.

#### **2.2.4.4 Post-Closure Monitoring**

Post-closure monitoring with respect to physical and geotechnical stability of landforms may include, but is not limited to, the following:

- Maintain a consistent monitoring record from a constant point of observation from construction through to post-closure.
- Inspect landforms to ensure there are no ongoing deformations that could lead to instability or unsafe conditions, or could compromise the effectiveness of selected closure activities or the post-closure use of the site.
- Remote sensing techniques, such as InSAR or LIDAR, may be used to assess large-scale deformations of individual mine components being reclaimed (e.g., settlement of tailings disposal area).

### **2.3 Individual Mine Component Closure and Reclamation Considerations**

Guidance with respect to closure and reclamation considerations that pertain to individual mine components will be outlined below. Closure and reclamation considerations are discussed for the following nine individual mine components:

- 2.3.1 Underground mine workings
- 2.3.2 Open pit mine workings
- 2.3.3 Waste rock and overburden piles
- 2.3.4 Tailings containment areas
- 2.3.5 Buildings and equipment
- 2.3.6 Mine infrastructure
- 2.3.7 Transportation routes
- 2.3.8 Landfills and other waste disposal areas
- 2.3.9 Water management systems

Guidance for each of the individual mine components is provided under the following headings:

- Closure objectives
- Closure and reclamation planning considerations in mine design
- Closure options for progressive and post-closure reclamation
- Northern limitations and considerations
- Post-closure monitoring



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It should be reiterated that the intent of the guidelines is to provide guidance on how to effectively close and reclaim a mine site in the NWT and is not intended to be a comprehensive list of prescriptive measures to be implemented. Each mine site is unique and closure and reclamation plans will be specific to that site and the associated individual mine components.

### **2.3.1 Underground Workings**

Underground workings, as well as the surface expression of these workings, can include shafts, raises, stop surface openings, portals, edits, declines and in some cases, subsidence or other surface disturbances.

#### **2.3.1.1 Closure Objectives**

Objectives for the closure and reclamation of underground mine workings may include the following:

- Limit access to underground workings from surface openings for the safety of humans and wildlife.
- Minimize surface water infiltration into underground workings.
- Maximize the stability of underground workings so that there is no surface expression of underground failure.
- Prevent collapse, stress transfer, and flooding of adjacent mines.
- Ensure that contaminated mine water from underground workings do not become a source of contamination to the surface environment, nearby taliks, surface water, or groundwater.
- Minimize potential for contamination from mine waters.
- Ensure areas surrounding mine openings are suitable for future use targets.

#### **2.3.1.2 Closure and Reclamation Planning Considerations in Mine Design**

The following items need to be considered during the mine design stage of the project to minimize post-closure reclamation efforts with respect to underground mine workings:

- Minimize the number of mine openings to the surface.
- Consider long-term geotechnical and geothermal stability in the design of mine openings and crown pillars.

#### **2.3.1.3 Closure Options**

Progressive reclamation options for underground mine workings may include, but are not limited to, the following:

- Remove hazardous materials from the underground when they are no longer required.
- Reclaim mine openings when mine operations are complete in individual areas (prior to development of ice plug).
- Progressively backfill underground mine workings.
- Progressively plug and flood portions of the mine workings as necessary to control the generation of acid rock drainage.
- Install hydraulic bulkhead where necessary to control water movement and infiltration.



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Post-closure reclamation options for underground mine workings may include, but are not limited to, the following:

**Backfilling:** Both vertical and horizontal mine openings can be backfilled with inert materials (e.g., overburden, waste rock) to prevent access to the underground mine workings.

- Where possible, backfilling with inert materials (e.g., overburden, benign waste rock) is generally the best option to permanently seal vertical mine openings, provided proper construction practices are followed to prevent bridging of backfill materials. Note some vertical openings will be open to such a depth that backfilling will not be practically possible.
- In the case of wood-lined shafts, backfilling may be susceptible to future settlement when the wood decays. As such, future maintenance may be required.
- Backfilling shafts and raises with demolition waste is not acceptable because of the potential for bridging and future settlement upon collapse of the bridged materials.
- The surface of portal and adit backfill plugs should be graded to establish natural drainage patterns and blend in with the surrounding topography or re-contour the surface to prevent natural surface and groundwater flow from becoming contaminated by mine water where appropriate.
- Rockfill/earthfill mounds may be left over backfilled vertical openings, such as raises to accommodate minor amounts of future settlement of the backfill.
- Care should be taken to ensure proper grading and sealing such that surface water run-off does not enter these openings if undesired.

**Concrete Seals:** A concrete seal can be constructed over mine openings to prevent access to the underground workings.

- Concrete seals for closure of mine openings need to meet the design criteria outlined in the *NWT Mine Safety Regulations*.
- Concrete has a finite design life and will require replacement at some future date.
- Concrete seals should be graded to prevent ponding of surface water.
- Concrete seals may be left exposed or may be covered but should remain accessible for future inspection, if possible.
- Sulphate resistant cement may be required depending on mine water geochemistry.
- In cases where the mine workings behind the plug are to be flooded, pressure relief/drainage measures should be provided at controlled locations where water quality can be monitored.

**Polyurethane Foam:** Polyurethane Foam (PUF) plugs may be an alternative option to be considered for approval for sealing of some mine openings.

- Design life of PUF plugs is typically 30 years and will need to be replaced at some point in the future.
- PUF plugs are susceptible to degradation by ultraviolet light and heat.
- The use of PUF plugs would require necessary approvals.
- The use of PUF plugs in northern/permafrost regions is relatively recent technology.

**Additional Considerations:**



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- For permanent closure, adit openings can be sealed using concrete, steel, rockfill, or by collapsing a section of the adit to control access for situations where water quality issues are not a concern; wooden barricades are only suitable for temporary closure.
- Consider the possibility of using compressed, recycled tires to block access to non-vertical mine openings.
- Construct a reinforced concrete wall or a plug of weakly cemented waste if the barricade is for access control only.
- Flood and plug workings to control acid generation and associated reactions if appropriate (engineered designs must consider hydrostatic heads and rock mass conditions).
- Fill pillars can be constructed to retain long-term structural stability after mining activities cease.
- Permanently support boundary pillar if practical and necessary.
- Crown pillars over stopes and underground mines may require stability assessment to determine risk of collapse in closure (could result in access creation to underground).
- Fencing and other barricades should only be used in temporary closure situations until operations restart or a more long-term option can be implemented.
- Signage may be required in short term, prior to implementation of the final closure and reclamation plan, to warn of potential underground hazards.
- Use inukshuks to deter wildlife where appropriate (guidance from local communities and Elders should be sought).
- Use ditches or berms as barricades except in areas of continuous permafrost; where continuous permafrost exists, inukshuks, fencing, or some other method may need to be considered.
- Remove all hazardous materials from the underground shops, equipment, and magazines (fuels, oils, glycol, batteries, explosives, etc.).

#### **2.3.1.4 Northern Limitations and Considerations**

The following items should be considered when developing closure and reclamation plans for underground mine workings at northern mine sites:

- Permafrost may provide an enhanced stability to the workings when freezing conditions are maintained.
- An ice plug may have developed in the underground workings in close proximity to the mine opening, especially if the mine workings have been abandoned or inactive prior to closure. Ice plugs will prevent effective backfilling for closure and cannot be counted on in the long-term to provide structural support.
- A change in local topography (e.g., re-contouring) may influence ground thermal regimes as a result of snow accumulation that in turn may lead to ponding and permafrost degradation.
- Flooding may result in instabilities due to the loss of the strength associated with ground thaw in areas of permafrost.
- In areas with permafrost, warm air or water flow into the underground openings will affect the thermal regime and may impact the stability of the rock mass surrounding the opening.
- Thermal regimes may be conducive to freeze-back where permafrost has been degraded depending on the amount of groundwater circulation and local heat balance.
- Underground mines located in permafrost may extend into the subpermafrost aquifer, depending on the depth of permafrost in the area. This may allow water from the unfrozen aquifer to migrate



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into the mine openings or, alternatively may permit water from the mine to migrate into the unfrozen aquifer.

#### **2.3.2.5 Post-Closure Monitoring**

Post-closure monitoring with respect to the reclamation of underground mine workings may include, but is not limited to, the following:

- Visually inspect reclaimed openings for signs of physical deterioration or settlement.
- Vary the frequency of inspections, with increased frequency following construction and decreased frequency once stable conditions have been established.
- Check for surface expression (subsidence) of underground failure.
- Test underground mine water quality and monitor volume from controlled discharge points of workings to ensure water quality is as predicted and not adversely affecting the environment.
- Identify mine related drainage discharge points (volume and quality) that were not anticipated.
- Install thermistors where appropriate to monitor the ground thermal regime in permafrost areas.
- Special monitoring provisions will be required for mines which have become flooded and are retaining water under pressure by means of plugs. These provisions can include visual inspection, piezometers, seepage measurement weirs, and sampling to check water quality parameters.
- Inspect passive water treatment systems for maintenance requirements.
- Periodic backfilling of surface areas where subsidence has been observed may be required.

### **2.3.2 Open Pit Mine Workings**

Open pit mine workings may include quarries, side hill cuts, and major trenches in areas where mining has occurred. Sand and gravel mines are not specifically addressed in these guidelines although some of the principles may also apply.

#### **2.3.2.1 Closure Objectives**

Objectives for the closure and reclamation of open pit mine workings may include the following:

- Limit access for the safety of humans and wildlife.
- Ensure physical and geotechnical stability.
- Minimize generation of poor water quality from open pits, including that from acid rock drainage and metal leaching (ARD/ML).
- Minimize and control migration and discharge of contaminated drainage.
- Meet future use target for pit area.
- Re-establish original or desired new surface drainage patterns.
- For flooded pits, establish in-pit aquatic habitat where practical and feasible (including riparian habitat and vegetation where appropriate).
- Allow emergency access and escape routes from flooded pits for humans and wildlife.
- During pit flooding, ensure decreased water levels in source water bodies do not adversely impact water uses.





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### **2.3.2.2 Closure and Reclamation Planning Considerations in Mine Design**

The following items need to be considered during the mine design stage of the project to minimize post-closure reclamation efforts with respect to open pit mine workings<sup>15</sup>:

- Insulate overburden slopes with rockfill to enhance stability and minimize erosion and permafrost degradation.
- Excavate rock and soil slopes that will remain above final predicted pit water level to their final stable slopes prior to deepening pit.
- Characterize the ground thermal regime in the pit walls.
- Have storage and treatment facilities in place prior to stripping of the open pit where overburden and/or overburden melt-water quality is poor.
- Divert surface drainage to minimize pit water handling and treatment requirements until the pit water reaches acceptable standards for discharge to the environment after closure.
- Consider the location of waste rock piles (if backfilling open pit).
- Select location and design that will have minimal impact on wildlife habitat and therefore require minimal reclamation effort.

### **2.3.2.3 Closure Options**

Progressive reclamation options for open pit mine workings may include, but are not limited to, the following:

- If multiple pits are excavated, sequentially backfill pits with waste rock and/or tailings as operations proceed.
- Alternatively, create pit lakes to manage and treat mine site water if backfilling is not feasible.
- Map exposures of mineralized rock in highwalls as they become apparent and conduct ARD/ML assessments.
- Identify and monitor seepage locations and water quality from highwalls during operations.

Post-closure reclamation options for open pit mine workings may include, but are not limited to, the following:

- Backfill open pits with appropriate materials (e.g., waste rock, tailings) and use a cover system to mitigate the environmental impacts of the underlying mine waste backfill.
- Flood the pit (natural or accelerated).
- Allow gradual slope failure of pit walls involving rock masses, or re-slope pit walls, if possible.
- Block open pit access routes with boulder fences, berms, and/or inukshuks (guidance from local communities and Elders should be sought).
- Post warning signs (with visible symbols placed close enough so they are visible from one to another) and fences or berms around the perimeters for actively managed sites (not acceptable for remote sites into the long-term).
- Long-term fencing to prevent access may only be appropriate if the mine site is located close to a community where regular access for maintenance is possible and where there is a higher risk of access by the general population.

<sup>15</sup> Refer to AANDC's *Northern Land Use Guidelines: Pits and Quarries* for additional considerations.



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- Measures such as boulder fences, berms, and fencing intended to limit access to open pit mine workings should be set back sufficiently such that the effectiveness of these measures will not be negatively impacted by slope instability of pit walls.
- Cover slopes with rockfill thick enough to provide insulation or stabilization to minimize erosion or permafrost degradation.
- Stabilize exposed soil along the pit crest or underlying poor quality bedrock that threatens to undermine the soil slope above the final pit water level. Use vegetation as necessary.
- Plug drill holes.
- Maintain a controlled access/egress ramp down to water level for flooded pits.
- Contour to discourage or encourage surface water drainage into pits where appropriate.
- Cover exposed pit walls to control ARD/ML reactions where necessary and possible.
- Collect waters in pit that do not meet the discharge criteria for passive treatment (active treatment is not acceptable for the long-term) (see Section 2.2.1.2 for examples).
- Establish aquatic life inflooded pits if possible and appropriate.

#### **2.3.2.4 Northern Limitations and Considerations**

The following items should be considered when developing closure and reclamation plans for open pit mine workings at northern mine sites:

- Changes in the permafrost and seasonal frost conditions, as well as groundwater regimes, may ultimately affect physical stability and site water balance.
- Thaw in permafrost regions is a critical consideration where slumping and sediment release could result in failure of upper pit slopes.
- In permafrost areas, there is the potential for initiating permafrost degradation by excavating trenches or ditches if adequate thermal and erosion protection is not present.
- Snow drifts in pits may alter the hydrology.
- High evaporation rates may exceed input rates for reclaimed pit lakes.
- Poor visibility of pits during winter conditions could be hazardous to travel in the North (mostly by snow machines).

#### **2.3.2.5 Post-Closure Monitoring**

Post-closure monitoring with respect to the reclamation of open pit mine workings may include, but is not limited to, the following:

- Monitor physical and geotechnical stability of remnant pit walls.
- Monitor the ground thermal regime in pit walls and backfill materials to confirm design objectives are being achieved.
- Sample ponded pit water including profiles where appropriate.
- Monitor water level in pit to confirm closure objectives are being achieved.
- Sample water quality and quantity (volume) at controlled discharge points of pit lakes.
- Sample quality of groundwater seeping from pit walls to assess potential for contamination of pit water due to melting permafrost and ARD/ML from pit walls.
- Identify and test water management points (including seepage) that were not anticipated.
- Inspect integrity of barriers such as berms, fences, signs, and inukshuks.
- Monitor wildlife interactions with barriers to determine effectiveness.



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- Inspect fish habitat in flooded pits where applicable.

### **2.3.3 Waste Rock and Overburden Piles**

This component is made up of waste rock, overburden, and low-grade ore material that may be extracted for the development and operation of the mine and supporting infrastructure. Waste rock and overburden are typically placed in piles for permanent storage unless used in the construction, operation, or closure of the site.

#### **2.3.3.1 Closure Objectives**

Objectives for the closure and reclamation of waste rock and overburden piles may include the following:

- Minimize release of contaminants related to acid rock drainage/metal leaching (ARD/ML) processes.
- Maximize long-term physical and geotechnical stability for human and wildlife safety following mine closure.
- Minimize erosion, thaw settlement, slope failure, collapse, and the release of contaminants or sediments.
- Balance the size of the pile's footprint with its height, taking into account future use targets, physical stability and other factors.
- Blend piles with current topography and revegetate as necessary to be compatible with wildlife use, and/or meet future use targets.

#### **2.3.3.2 Closure and Closure Planning Considerations in Mine Design**

The following items need to be considered during the mine design stage of the project to minimize post-closure reclamation efforts with respect to waste rock and overburden piles:

- Select the location and design for waste rock, overburden, and ore stockpiles to complement the desired closure objectives and selected closure activities.
- Select location and design that will have minimal impact on wildlife habitat and therefore require minimal reclamation effort.
- Characterize and segregate potentially acid generating materials for controlled disposal or cellular pile construction.
- Characterize and segregate inert waste rock and overburden materials for potential use in reclamation.
- Construct waste rock piles and overburden piles in lifts with slopes where individual lifts can be set back to provide long-term stability.
- Construct rockfill toe berms to contain overburden stockpiles and maintain stability.
- Select sites that avoid low-strength foundations, or take appropriate design measures (reduced slope angles, reduced slope heights, etc.).
- Construct runoff and sediment collection ponds for use during operation and possibly for the initial portion of the closure phase until seepage water quality is proven to be acceptable and stable.
- Consider drainage patterns and watershed boundaries when locating and designing waste rock and overburden piles.



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- If placing waste rock piles in drainage paths cannot be avoided, consider measures to minimize contact of clean water with contaminated materials.
- Consider locating a waste rock or overburden pile site within the same drainage catchment as the proposed tailings containment area.
- Open pits can be used as a collection point for impacted runoff from waste rock and overburden piles.
- Control surface water on the surface of overburden stockpiles to prevent erosion.
- Locate waste rock piles in areas where run-on volumes can be minimized, such as the upper portion of the watershed.
- Construct internal drains to prevent mounding of the water table.
- Consider use of seepage collection berms in permafrost environments.
- Consider how convective cooling will affect the ground thermal regime of the waste rock pile.
- Consider future use of the area to determine location, height, access, etc.

### **2.3.3.3 Closure Options**

Progressive reclamation options for waste rock and overburden piles may include, but are not limited to, the following:

- Design and operate waste rock piles during construction to promote permafrost aggradation if desired.
- Characterize geochemical attributes of waste rock during deposition.
- Backfill into underground mine workings or open pits.
- Access cover (e.g., from overburden piles) and distribute to areas requiring revegetation or backfilling.

Post-closure reclamation options for waste rock and overburden piles may include, but are not limited to, the following:

- Consolidate waste rock in underground mine workings or open pits as part of reclamation efforts of those elements.
- Re-grade waste rock to stable landform and leave in place if it can be proven that material is geochemically inert and will not provide a source of contamination due to ARD/ML processes.
- Re-grade waste rock and construct a cover system on the surface to limit generation and migration of contaminants from waste rock and overburden piles.
- Re-grade surface of waste rock and overburden piles to flatten the overall slope or construct a toe berm to enhance stability.
- Remove weak or unstable materials from slopes and foundations.
- Off-load materials from the crest of the slope.
- Leave waste rock piles composed of durable rock “as is” at the end of mining if there is no concern for deep-seated failure or erosion and if the future use targets can be achieved.
- Place riprap insulation/stabilizing layer.
- Encapsulate waste rock in permafrost and utilize ambient air temperatures to encourage permafrost aggradation within the waste rock pile and cover system.
- Place potentially acid generating rock underwater or underground if viable.



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- Place potentially acid generating rock within the centre of the waste pile so it is encapsulated by permafrost if conditions permit and underwater or underground disposal are not viable options.
- Construct collection systems to collect contaminated runoff or leachate.
- Construct diversion ditches to divert uncontaminated runoff.
- Install horizontal drains or pump leachate from relief wells at the toe of the slope.
- Passive treatment of contaminated waters where necessary (active treatment is not acceptable for the long term).
- Use benign waste rock as backfill in underground mine workings, to seal portals, to fill open pits, or for construction material for ramps or covers.
- Revegetate using native species or use other biotechnical measures (use of living organisms or other biological systems for environmental management) to reduce surface erosion, provide physical stability, and meet future use targets.
- Re-slope, contour, and/or construct ramps to facilitate wildlife access.
- Use inukshuks or other mitigations to deter wildlife where appropriate (guidance from local communities and Elders should be sought).

#### **2.3.3.4 Northern Limitations and Considerations**

The following items should be considered when developing closure and reclamation plans for waste rock and overburden piles at northern mine sites:

- Permafrost aggradation into overburden and rock piles can occur in permafrost regions.
- Introduction of ice and snow into rock piles during construction may lead to instability if thawing occurs.
- Convection cooling in waste rock piles may freeze the interior of the rock pile and the underlying foundation. Although this may be beneficial, climate change should be considered if it has the potential to result in the release of ARD in the very long-term due to thawing and subsequent water infiltration.
- Freezing of drainage control measures due to extremely cold and long freezing seasons may adversely impact drainage, both surface and subsurface.
- Thawing of permafrost in the foundation may cause instability.
- Collection ditches in permafrost environments are generally not desirable due to thermal disturbance. Seepage collection berms are generally preferable.
- Waste rock dumps and overburden stockpiles may alter wildlife routes or mobility; actions to improve safe wildlife passage may be required.

#### **2.3.3.5 Post-Closure Monitoring**

Post-closure monitoring with respect to reclamation of waste rock and overburden piles may include, but are not limited to, the following:

- Periodic inspections of areas where stabilization measures may be required.
- Periodic inspections by a geotechnical engineer to visually assess stability and performance of waste pile and cover systems, including possible sampling and testing of cover materials.
- In the case of water covers, ensure that there is sufficient water supplied to maintain an appropriate water depth.
- Periodic inspections of diversion ditches and berms.



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- Examine ground conditions to confirm predicted permafrost conditions are being established as predicted.
- Check thermistor data to determine thermal conditions within waste piles to confirm predicted permafrost aggradation/encapsulation where applicable.
- Test water quality and measure volume from controlled discharge points of workings to confirm that drainage is performing as predicted and not adversely affecting the environment.
- Identify water discharge areas (include volume and quality) that were not anticipated.
- Monitor revegetation activities such that they meet technical needs (maintains physical stability), aesthetic needs (blends with surroundings), and future use targets, and do not impact the effectiveness of selected closure activities or become a source of metals due to uptake.
- Monitor wildlife use to determine effectiveness of selected closure activities.

### **2.3.4 Tailings Containment Areas**

Tailings containment areas include: mine tailings; embankments such as dams or dykes that retain tailings or non-compliant water related to the tailings and slurry; surface paste; and dry stack facilities. Containment areas may contain a variety of materials tailings, waste rock, domestic sewage, or collected surface water in varying quantities and chemistry. Typically, tailings containment areas are the last point of control for the site water management system where discharge to the environment occurs. A good understanding of the contributions to the tailings containment area is needed to predict the volumes and quality of effluent that may need to be managed after operations.

#### **2.3.4.1 Closure Objectives**

Objectives for the closure and reclamation of tailings containment areas may include the following:

- Physically isolate the tailings from the environment, both in terms of airborne solid components and water borne components.
- Minimize wind migration of tailings dust.
- Maintain physical and geotechnical stability of remnant embankments and surface of tailings containment area.
- Blend with local topography and vegetation, where appropriate.
- Minimize effluent discharge impacts on downstream ecosystem.
- Minimize the threat that the tailings containment area becomes a source of contamination (e.g., tailings migration outside of contained area, contamination of water outside of contained area).
- Minimize the risk for the occurrence of acid rock drainage/metal leaching.
- Minimize catastrophic and/or chronic release of the tailings into the surrounding environment.
- Ensure that tailings containment areas are safe for human and wildlife access.

#### **2.3.4.2 Closure and Reclamation Planning Considerations in Mine Design**

The following items need to be considered during the mine design stage of the project to minimize post-closure reclamation efforts with respect to tailings containment areas:





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- Select the appropriate site location; tailings containment areas should be located towards the upstream end of the drainage catchment to minimize the volume of water that must be diverted around the facility and the volume of runoff that has to be handled from the adjacent slopes.
- Minimize environmental impacts by locating tailings containment areas within the same drainage catchment as other mine components such as open pit and waste rock piles rather than affecting a new watershed (this will also improve water use and treatment efficiencies).
- Locate tailings containment areas within water bodies or watersheds that have been naturally impacted by drainage from mineral deposits.
- Select location and design that will have minimal impact on wildlife habitat and therefore require minimal reclamation effort.
- Design dams and dykes that will be required in the long term using appropriate design parameters and benign materials.
- Freezing of tailings during winter months may generate a series of layers of frozen and unfrozen tailings, particularly on the beaches. The impact to long-term stability and water release must be considered and managed.
- Use a mill process that removes reactive materials from the tailings.
- Use a treatment method to remove contaminants from supernatant.
- Build decant towers and pipes such that they do not pass through or under tailings containment areas and cannot be adversely impacted by freezing.
- Thicken tailings to reduce the overall volume of tailings requiring transport to the containment area and volumes of water requiring recycling back to the mill.
- Stack dry filtered tailings to conserve water and limit required area for tailings storage.
- Ensure dust concerns are managed by water and/or soil cover use.
- Consider placing potentially acid generating rock or leachable materials into containment areas that will be permanently flooded, capped, or frozen.
- Separate potentially acid generating materials for controlled disposal elsewhere or blend with alkali material to control ARD/ML.
- Assess water chemistry and physical properties of the tailings to determine suitable closure and reclamation options.
- Avoid the use of pipes in and under embankments for the purposes of water management.
- Where the use of pipes cannot be avoided, assess the soil around pipes for stability under the hydraulic gradients through the embankment, as this may be a potential zone of piping failure.

#### **2.3.4.3 Closure Options**

Progressive reclamation options for tailings containment areas may include, but are not limited to the following:

- Modify process near end of operations to produce benign tailings for use as cover material.
- Consider final surface grade requirements as tailings placement nears completion to reduce overall cover material volumes.

Post-closure reclamation options for tailings containment areas may include, but are not limited to the following:



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- Stabilize embankments by removing weak or unstable materials from slopes and foundations and/or construct toe berms to flatten overall slope.
- Breach water retention dams and drain impoundments to avoid post-closure impoundment of water, where possible.
- Use a natural body of water that has sufficient storage capacity to hold the tailings and allow a natural unimpeded flow via the drainage outlet if a permanent water cover is used (this may not be viable if the supernatant water quality does not meet discharge water quality standards).
- Increase freeboard of embankment and/or upgrade spillway to prevent overtopping and to prepare for possible erosion of embankment by extreme precipitation events.
- Relocate and/or deposit tailings into underground mine workings or into flooded pits, depending on water quality considerations.
- Flood tailings to control acid generation and related reactions.
- Cover tailings with a cover system to control ARD/ML processes and migration of contaminants.
- Construct a cover system to prevent surface erosion and create a stable landform in the long-term.
- Promote neutralization reactions by use of alkaline materials for covering acidic tailings.
- Divert non-contact runoff away from the tailings facility to avoid contamination.
- Promote freezing of tailings mass into permafrost if suitable conditions exist.
- Collect waters that do not meet the discharge criteria for passive treatment (active treatment is not acceptable for the long term).
- Remove structures and decant towers, pipes, and drains where they already exist.
- If they cannot be removed, plug decant towers, pipes, and drains with high slump (relatively liquid concrete which will flow to fill all voids) or preferably, expansive concrete.
- Avoid using diversion structures and ditching, especially in permafrost soils (diversion structures are not the preferred option into the long term).
- Where diversion dams and channels are necessary, maintain them indefinitely to meet long-term stability and hydraulic design requirements.
- Design diversions and spillways for extreme events suitable for long-term stability.
- Provide a frost protection cap over the phreatic surface for water-retaining dams.
- Ditch, berm, fence, or use alternative methods, if compatible with future use plans, to deter access of motorized vehicles.
- Establish native vegetation, soil, riprap, or water cover to control erosion.
- Use vegetation to aid in re-establishing the original ground thermal regime.

#### **2.3.4.4 Northern Limitations and Considerations**

The following should be considered when developing closure and reclamation plans for tailings containment areas at northern mine sites:

- Ice/water depth, wave action, and ice scour need to be accounted for in tailings cover system design where the cover system interacts with surface water bodies.
- Ice scour and ice pans freezing to shallow tailings can impact water quality from suspended sediments.
- Fluctuations of the water level in adjacent water bodies will have impacts on the ground thermal regime, particularly along the shoreline.
- Permafrost may aggrade into the tailings, and freeze-back of thawed tailings needs to be properly monitored and accounted for.



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- Tailings placement under winter conditions may result in entrained ice which may melt in the long-term and may adversely impact stability of surface measures.
- Long-term climate change will need to be assessed for dams reliant on frozen cores.
- Tailings that are not flooded may freeze over time, concentrating residual contaminants in the unfrozen brine; 'cryoconcentration' can result in the eventual release of small volumes of higher concentration contaminated fluids.
- Physical disruption of cover systems may occur as a result of localized frost heave over time.
- There may be loss of containment capacity or space due to ice entrainment or build up within the tailings. This could be avoided with appropriate management of the tailings containment area (i.e., by depositing tailings in long, shallow beaches or moving the discharge pipe frequently).
- Wind erosion of tailings may be more significant in some areas of the North due to higher rates of sublimation and limited tree/vegetation cover.

#### **2.3.4.5 Post-Closure Monitoring**

Post-closure monitoring with respect to reclamation of tailings containment areas may include, but is not limited to, the following:

- Conduct periodic dam safety and stability reviews of structures that remain after closure.
- Inspect seepage collection systems for water flows and assess seepage water quantity and quality.
- Inspect and maintain dam structures and/or spillways associated with flooded tailings over the long-term.
- In the case of water covers, ensure that the minimum water cover design thickness is being achieved and that freeboard amounts are respected for inflow floods.
- Monitor the ground thermal regime in embankments and tailings deposits where permafrost was utilized in the design.
- Continue to monitor climatic conditions in closure, including air temperatures and precipitation, to confirm design assumptions regarding hydrology and air temperatures (particularly for selected closure activities utilizing permafrost) and related site climate conditions.
- Monitor pond-water level and quality to confirm predicted performance.
- Evaluate/confirm success of revegetation activities in meeting technical needs (maintain physical stability), aesthetic needs (blends with surroundings), and future use targets.
- Assess dust dispersion and vegetation uptake due to wind dispersion of tailings.

#### **2.3.5 Buildings and Equipment**

Mine site buildings are comprised of any surface or underground structures built to support mining activities and may include, but are not limited to, the following:

- Ore processing/concentrator plant.
- Concentrate storage shed.
- Head frame.
- Maintenance shops.
- Offices.
- Warehouses.
- Fuel tanks.



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- Fuel tank farms.
- Assay and analytical labs.
- Process reagent and explosive storage.
- Boiler houses.
- Power generation plants and camp facilities.

Mine equipment is comprised of any equipment used on site in support of mining activities and may include but is not limited to all surface and underground mobile equipment, shaft installations, distribution piping, and conveyors.

#### **2.3.5.1 Closure Objectives**

Objectives for the closure and reclamation of mine buildings and equipment may include the following:

- Restore, to the extent possible, surface areas occupied by mine buildings to pre-disturbance conditions or to a condition compatible with future use targets.
- Ensure that buildings and equipment do not become a source of contamination to the environment or a safety hazard to humans and wildlife.
- Re-establish the pre-mining ground cover (as necessary), which may involve encouraging self-sustaining native vegetation growth and the establishment of supporting media (soil, rock, sediment).

#### **2.3.5.2 Closure and Reclamation Planning Considerations in Mine Design**

The following items need to be considered during the mine design stage of the project to minimize post-closure reclamation efforts with respect to mine buildings and equipment<sup>16</sup>:

- Locate buildings on bedrock or thaw-stable soil foundations to minimize need for foundation preparation and disturbance of terrain.
- Use inert waste rock pads placed on top of ground/tundra surface for structures having low foundation loads such as camps, offices, and warehouses.
- Select locations that will have minimal impact on wildlife habitat and therefore require minimal reclamation efforts.
- Avoid stripping ground/tundra surface where possible.
- Design and locate heated structures to ensure that the underlying permafrost is not negatively impacted (e.g., degraded).
- Design and operate facilities such that possible contamination does not migrate below structures such as ore processing plants or concentrate storage sheds.
- Where possible, use sustainable and low toxicity building materials.
- Where possible, use portable or modular buildings so that they can be completely removed from the site following closure.

#### **2.3.5.3 Closure Options**

Progressive reclamation options for mine buildings and equipment may include, but are not limited to, the following:

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<sup>16</sup> Refer to AANDC's *Northern Land Use Guidelines: Camp and Support Facilities* for additional considerations.



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- Recycling or reusing building materials and equipment where possible to reduce waste and importation of materials to site.

Post-closure reclamation options for mine buildings and equipment may include, but are not limited to, the following:

#### **Mine Buildings**

- Dismantle all buildings that are not necessary to achieve the future use target.
- Raze/level all walls (including re-bar) to the ground surface.
- Remove foundations where possible, or cover with natural materials to blend into natural surroundings. Cover materials should be conducive to vegetation growth, where possible.
- Remove floor structures over basements and cellars.
- If disposing on site in a proper facility, decontaminate building materials prior to disposal (free of any batteries, fuels, oils, or other deleterious substances).
- Cut, shred, crush, or break demolition debris to minimize the void volume during disposal.
- Maintain photographic records of major items placed into landfills, as well as a plan showing the location of various classes of demolition debris (e.g., concrete, structural steel, piping, metal sheeting, and cladding).
- Remove and dispose of concrete in an approved hazardous waste landfill if it contains contaminants that may pose a hazard over time.
- Where approved, break or perforate concrete floor slabs and walls to create a free draining condition in order that vegetation can be established.
- Backfill/grade all excavations to achieve the final desired surface contours to restore the natural drainage or a new acceptable drainage.
- Backfill excavations in permafrost to limit permafrost degradation.
- Control dust emission during demolition of buildings that contain or contained asbestos, hazardous chemicals, or other deleterious material.
- Assess storage containers for leaks or contamination during removal.
- Remove buried storage tanks to prevent subsidence.

#### **Equipment**

- If possible, equipment should be transported off site for reuse at other locations. This may include sale or salvage to local communities if sufficient interest exists.
- If sale or salvage of equipment is not possible, dispose of decontaminated equipment in an approved landfill or as recommended by the regulatory authorities.
- If disposing on site in a proper facility, decontaminate equipment prior to disposal (free of any batteries, fuels, oils, or other deleterious substances).
- Cut, shred, crush, or break demolition debris to minimize the void volume during disposal.
- Maintain photographic records of major items placed into landfills as well as a plan showing the location of various classes of demolition debris (e.g., concrete, structural steel, piping, metal sheeting, and cladding).
- Leave non-salvageable and non-hazardous materials and equipment from underground operations in the underground mine upon approval from the regulatory authorities. All hazardous materials and fluids need to be removed from equipment left underground.



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- Transport hazardous materials to a southern location for recycling or disposal.

#### **2.3.5.4 Northern Limitations and Considerations**

The following items should be considered when developing closure and reclamation plans for mine buildings and equipment at northern mine sites:

- Caution should be taken in permafrost zones where buried material can migrate to the surface years later due to frost heave processes.
- Maintaining permafrost under buildings and roads may be important to ensure physical stability of the infrastructure during operation (heat, from buildings and processing plant, may be enough to affect the underlying ground conditions).
- The physical and chemical degradation of materials left on northern sites will be slow due to cold temperatures.
- Closure and reclamation activities at remote northern sites are hampered by restrictive and perhaps seasonal factors such as transportation (ice roads, water access), climate, and hours of daylight; logistics, such as scheduling of closure and reclamation activities and disposal options, should consider these limitations.
- Local residents and communities may identify buildings they wish to maintain for historical significance or emergency or community uses (ownership liability will need to be considered).

#### **2.3.5.5 Post-Closure Monitoring**

Post-closure monitoring with respect to the reclamation of mine buildings and equipment may include, but is not limited to, the following:

- Maintain all buildings and equipment left on site to ensure safety of humans and wildlife.
- Inspect remnant foundation covers to ensure settlement of backfill has not exposed remnant foundation materials such as concrete or interrupted surficial drainage patterns.
- Inspect former excavation areas to monitor if permafrost degradation has interrupted surficial drainage patterns.
- Inspect disposal areas periodically to establish if buried materials are migrating to the surface as a result of frost-heaving.

### **2.3.6 Mine Infrastructure**

Infrastructure may include on-site roads, airstrips, electrical power supply systems, bridges, culverts, railways, ports, barge landings, borrow pits, quarries, fuel transfer areas, and ore-handling facilities within the mine site.

#### **2.3.6.1 Closure Objectives**

Objectives for the closure and reclamation of mine infrastructure may include the following:

- Remediate contaminated portions of infrastructure (e.g., metals or hydrocarbon-contaminated sections of mine site roads) so they do not pose an unacceptable environmental risk.





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- Re-establish natural drainage patterns and scarification of granular structures to encourage vegetation colonization.
- Restore natural drainage patterns where surface infrastructure has been removed.
- Minimize access to remaining mine infrastructure for the safety of humans and wildlife.
- Monitor the entire mine site, including any remaining infrastructure, to meet future use targets.
- Ensure physical and geotechnical stability of remaining mine infrastructure.

#### **2.3.6.2 Closure and Reclamation Planning Considerations in Mine Design**

The following items need to be considered during the mine design stage of the project to minimize post-closure reclamation efforts with respect to mine infrastructure<sup>17</sup>:

- Construct airstrips as part of site access roads to minimize the project footprint.
- Select locations that will have minimal impact on wildlife habitat and therefore require minimal reclamation efforts.
- Minimize interruptions of natural drainages.
- Construct earth fills related to infrastructure, such as road fills out of geochemically inert materials.
- Evaluate terrain sensitivity along route alignments, potential environmental impacts and construction mitigation requirements.
- Avoid or minimize bridge crossings.
- Where possible, use gentle slopes in road verges to facilitate wildlife passage during operation and after closure.
- Where possible, share valuable infrastructure amongst proponents or interested parties when feasible, as it is beneficial to all and may reduce the amount of land disturbed.
- Minimize the use of granular resources, which are a valuable resource in the North.

#### **2.3.6.3 Closure Options**

Closure options for progressive and post-closure reclamation for mine infrastructure are combined as they are applicable to both. They may include, but are not limited to, the following:

- Reclaim infrastructure, such as roads, as soon as they are no longer required by mining operations, as long as they are not required for future reclamation or monitoring purposes.
- Remove structures including bridges, culverts, pipes, buried wires/cables, and power lines; fill ditches in if no longer required and evaluate the area for potential contaminants.
- Reclaim contaminated infrastructure areas such as portions of road fills contaminated by hydrocarbons or metals.
- Reclaim areas to the original topography and drainage or to a new topography or drainage compatible with future use targets.
- Scarify abandoned road/runway surfaces to promote revegetation of native species.
- Leave roads, airstrips, or railways intact if identified as an objective based on stakeholder input (ownership liability will need to be considered).
- Remove wildlife controls when no longer required.
- Flatten berms and slopes at the side of roads to facilitate wildlife passage.

<sup>17</sup> Refer to AANDC's *Northern Land Use Guidelines: Pits and Quarries* and *Northern Land Use Guidelines: Access Roads and Trails* for additional considerations.



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- Remove roads and scarify remaining surface to promote revegetation.
- Stabilize borrow pits.
- Ensure no acid rock drainage/metal leaching concerns from rockfill from various quarries used at the mine site.

#### **2.3.6.4 Northern Limitations and Considerations**

The following items should be considered when developing closure and reclamation plans for mine infrastructure at northern mine sites:

- The scheduling for dismantling infrastructure components should be carefully considered in the context of the need for their use during the reclamation and monitoring period.
- Mine sites and related infrastructure in the North may result in opening up the area by providing access to other land users (e.g., tourists, hunters, prospectors).
- Maintaining permafrost under roads and pads may be important to ensure physical stability of the infrastructure.
- Permafrost may aggrade into thick road fills over the life of the operation, making removal during reclamation difficult.
- Local residents and communities may also identify a desire to maintain certain infrastructure for emergency or community purposes (ownership liability will need to be considered).
- Power cables may be frozen into the ground making their removal difficult.
- Icing of drainage measures (i.e., culverts, ditches, etc.) may lead to drainage blockages with consequent adverse impacts on other selected closure activities.

#### **2.3.6.5 Post-Closure Monitoring**

Post-closure monitoring with respect to reclamation of mine infrastructure may include, but is not limited to, the following:

- Maintain access to infrastructure required to support on-going reclamation and post-closure monitoring.
- Monitor wildlife/fish use of area to ensure selected closure activities are successful.
- Monitor other land users access and activity in the area.
- Monitor success in terms of slope stability of cuts, erosion protection in drainage areas, and revegetation impacts.
- Monitor sediment loading downstream of access road breaches.
- Check stream-crossing remediation and any degradation associated with decommissioned roads, such as erosion or ponding of water.

#### **2.3.7 Transportation Routes**

Transportation routes may include any all-weather or winter roads, barging routes and staging areas, and railways or pipelines used to transport ore, fuel, hazardous materials, or equipment to or from a mine site. They differ from other infrastructure in that they are generally not located on the mine site. The route may be between the mine site and a local port site or community and may extend great distances (i.e., 100s of kilometres).



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### **2.3.7.1 Closure Objectives**

Objectives for the closure and reclamation of transportation routes may include the following:

- Remediate contaminated portions of transportation routes (e.g., metals or hydrocarbon-contaminated sections of mine site roads) so they do not pose an unacceptable environmental risk.
- Minimize impacts to the environment, fish, and wildlife from localized areas of contamination that may be present along a route.
- To the extent possible, restore pre-disturbance surface conditions including drainage patterns and self-sustaining vegetation growth.
- Limit adverse impacts to permafrost along the route.
- Render the route impassable to the public after closure (unless it is permitted for use by others) to ensure it does not pose a safety hazard to humans and wildlife.

### **2.3.7.2 Closure and Reclamation Planning Considerations in Mine Design**

The following items need to be considered during the mine design stage of the project to minimize post-closure reclamation efforts with respect to transportation routes<sup>18</sup>:

- Geotechnical and permafrost characterization assessments should be conducted along the route to provide proper design inputs to associated infrastructure.
- Collect baseline environmental conditions to identify areas of environmental sensitivity along the route that may need to be avoided.
- Provide emergency containment measures along the route, such as properly designed dump ponds to handle emergency releases should they be required.
- Conduct archaeological assessments along the route that incorporate Traditional Knowledge to avoid disturbing significant cultural sites.
- Conduct wildlife assessments along the route that incorporate Traditional Knowledge to avoid disturbing wildlife sensitive areas such as migration routes or dens/habitat.
- If earth-fills are required to be constructed, use geochemically inert, erosion-resistant materials (avoid the use of fine-grained materials that can impact surface water quality if eroded).
- Avoid, where possible, construction of infrastructure through and over thaw-unstable ground.
- Be aware that any minor disturbance (i.e., cuts, vegetation removal) may thaw unstable ground and can lead to severe progressive instability.
- Avoid, where possible, routes that require thick fills and/or high road cuts inconsistent with surrounding surface conditions.
- Consider the use of expanded foam insulation to reduce quantity of insulation fill over thaw-unstable ground.
- Minimize the number of water-course crossings.
- Consider the need for drainage measures and waterway crossings that may ice up and lead to blockages.
- Conduct a geohazards assessment along the route and avoid geohazards where possible.
- Conduct a geochemical assessment of the route to identify problematic areas which may be

<sup>18</sup> Refer to AANDC's *Northern Land Use Guidelines: Access Roads and Trails* for additional considerations.



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susceptible to acid rock drainage/metal leaching issues if disturbed.

- Avoid cuts in potentially acid generating materials such as mineralized rock outcrops.
- Conduct a detailed surface water hydrological assessment along the route to properly design all water-course and drainage crossings.
- Consider how the routes may be closed to restrict access during initial planning.
- Choose staging areas by considering both logistical and environmental concerns e.g., avoid environmentally-sensitive areas.
- If below the treeline, use pre-existing routes as much as possible to minimize the need for clearing of trees and brush.
- Discuss access needs and issues with adjacent land users to minimize overall disturbance and to create efficiency.

### **2.3.7.3 Closure Options**

Progressive reclamation options for transportation routes may include, but are not limited to the following:

- Conduct regular debris collection campaigns along routes.
- Record and report all spills and ensure appropriate reclamation and clean up is undertaken.
- Ensure all vehicles travelling the route carry equipment/supplies to mitigate spills potentially associated with their usage.
- In the case of hauling ore via truck or rail car, cover transport vehicle to limit air borne migration of contaminants.
- Monitor size of equipment and loads used on transportation routes to ensure they meet design criteria for safety and minimize compaction on seasonal roads.
- Monitor drainage conditions along the route during operation to identify areas requiring breaching during closure.
- Monitor impacts to water-courses and drainages due to presence of infrastructure to aid in identifying closure requirements.
- Monitor routes, especially seasonal winter roads, for permafrost degradation.
- Monitor geohazards along the route on an ongoing basis to mitigate long-term adverse impacts.
- Monitor cuts for indications of acid rock drainage/metal leaching that may need to be addressed in closure.

Post-closure reclamation options for transportation routes may include, but are not limited to, the following:

- Local communities should be engaged to determine if some transportation routes may remain intact (transfer of liability would be required).
- Identify/assess areas of contamination along the route and reclaim these areas.
- If infrastructure is to be removed, restore drainage conditions along the route and deactivate roads such that revegetation to natural surroundings and impact to migrating wildlife is limited.
- Decommission any associated infrastructure such as emergency shelters or power cables located along the route.
- Mitigate any acid rock drainage/metal leaching issues identified along the route that are associated with the construction or operation of the route.



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- Remove all culverts and bridges.
- Remove all berms constructed along the sides of roads.
- Remove pipelines and rails, being careful to control any remnant contaminants inside pipelines, and dispose at a designated and properly designed facility.
- Restore drainage to minimize erosion and potential for sediment-loading to adjacent water bodies.

#### **2.3.7.4 Northern Limitations and Considerations**

The following items should be considered when developing closure and reclamation plans for transportation routes originating at northern mine sites:

- Transportation infrastructure is very limited in the North and may benefit many, including multiple proponents and the public.
- Minimize the use of natural granular resources in the development of transportation routes due to its scarcity throughout the North.
- Permafrost may aggrade into thick road fills making removal/breaching difficult and time consuming.
- Northern ecosystems can be very sensitive to environmental change.
- Permafrost/ice-rich ground can pose difficulties to the construction and operation of linear infrastructure, thus detailed understanding, investigations, and characterization efforts are required.
- Maintenance of routes on thaw-unstable ground may require additional resources during operation.
- Any ponding of water or new drainage routes/ditches in permafrost terrain will likely result in significant erosion and/or thaw settlement.
- Transportation during harsh winter conditions in the North can be difficult on equipment and can lead to breakdown and spills that can be difficult to deal with under the harsh winter conditions. As such, emergency mitigation measures need to be practical enough to be effectively implemented.
- Pipes, cables, rails, and ties may freeze into permafrost and may be difficult and time consuming to remove.
- Climate change impacts must be incorporated into design, especially in thaw-unstable permafrost areas.
- Impacts of transportation corridors on wildlife, particularly long, permanent corridors may impact wildlife migration routes, breeding areas, or other habitat or may provide undesirable access by the public to these areas and increased hunting pressure or ground disturbance by ATVs and/or snowmobiles. Accessing Traditional Knowledge and consideration of these potential impacts is very important in planning, operation, and post-closure.

#### **2.3.7.5 Post-Closure Monitoring**

Post-closure monitoring with respect to the reclamation of transportation routes may include, but is not limited to, the following:

- Monitor stability of breaches to ensure that any instabilities are not negatively impacting downstream water quality to an unacceptable level.
- Monitor water quality (surface water and ground water) downstream of remediated areas of contamination.



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- Visually inspect route for indications of permafrost degradation, acid rock drainage/metal leaching, and any associated impacts on adjacent water quality.
- Monitor the ground thermal regime to assess if permafrost aggradation or degradation is occurring and the potential impacts of these geothermal changes.
- Monitor wildlife movements and habitat use of areas that may have been impacted to determine the effectiveness of reclamation.

### **2.3.8 Landfills and Other Waste Disposal Areas**

Landfills and other waste disposal areas may include industrial and domestic waste, sewage, chemicals, contaminated soils, and water treatment sludge. A landfill is an engineered waste management facility where waste is disposed by placing it on or in land in a manner that minimizes adverse human health and environmental effects. Other waste disposal areas may include land farms, waste management facilities, abandoned quarries, borrow pits, underground mine workings, waste rock piles, and tailings containment areas. Disposal includes the relocation, containment, treatment, or processing of unwanted materials.

#### **2.3.8.1 Closure Objectives**

Objectives for the closure and reclamation of landfills and other waste disposal areas may include the following:

- Prevent inadvertent access to landfill debris by humans and wildlife.
- Ensure waste disposal areas do not become a source of contamination to the environment.
- Control erosion and effects to the ground thermal regime (e.g., use vegetation to aid in re-establishment of original geothermal conditions) to ensure physical stability.
- Restore, to the extent possible, surface areas occupied by landfills and other waste disposal areas to pre-disturbance conditions or to a condition compatible with the future use targets.
- Minimize the risk for the occurrence of acid rock drainage/metal leaching and leachate (e.g., from landfills).
- Re-establish the pre-mining ground cover (as necessary), which may involve encouraging self-sustaining native vegetation growth and the establishment of supporting media (soil, rock, sediment).

#### **2.3.8.2 Closure and Reclamation Planning Considerations in Mine Design**

The following items need to be considered during the mine design stage of the project to minimize post-closure reclamation efforts with respect to landfills and other waste disposal areas:

- Minimize the use of hazardous chemicals during mining operations.
- Use recyclable, re-usable, or degradable building materials or chemicals during mining operations.
- Plan activities to limit the amount of waste generated throughout the life of the mine.
- Take inventory of chemicals used during mining operations.
- Ensure that only the appropriate waste is placed within an on-site landfill.
- Locate waste management facilities away from waterways to minimize environmental impacts that could result from leachate generation/migration.





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- Select location and design that will have minimal impact on wildlife habitat and therefore require minimal reclamation effort.
- Divert runoff around waste disposal area with ditches or berms to minimize migration of contaminants.
- Do not excavate or cut ice-rich soils to construct a landfill.
- Assess suitability of using abandoned quarries, borrow pits, underground mine workings, waste rock piles, and tailings containment areas for inert waste disposal to minimize footprint.
- Provide Global Positioning System coordinates for the four corners of the landfill location.
- If gas production could occur over time, proper venting through the landfill cover should be incorporated into the design.
- As landfill material degrades, there is potential for heat production which could affect the ground thermal regime and permafrost potential in the cover design.
- Landfill capacity and location (clay foundation, distance from water bodies, topography).

### **2.3.8.3 Closure Options**

Closure options for progressive and post-closure reclamation for landfills and other waste disposal areas are combined as they are applicable to both. They may include, but are not limited to, the following:

- Maintain an inventory of materials disposed of in the operating landfill.
- Implement a recycling program during mine operations to reduce landfill volumes.
- Burn domestic waste and special waste (i.e., waste oil) in an approved incinerator during mine operations<sup>19</sup>.
- Sample water treatment sludge periodically to determine the chemical characteristics, sludge stability, and leachability under the proposed long-term storage conditions.
- Some relatively clean soil may be used progressively to cover landfills if the entire landfill is designed to be ultimately encapsulated in permafrost.
- Remove hazardous waste to an approved on-site waste management facility prior to shipping for off-site disposal.
- Upon approval by regulatory authorities, dispose of wastes in quarries, borrow pits, and underground mine workings.
- Cover landfills with an appropriately designed cover system to limit infiltration to acceptable levels. The surface of the landfill cover should be comprised of erosion resistant materials, and the surface landform should be sustainable in the long-term.
- Contour/blend to match the natural topography or a new desired topography and revegetate with native species to meet the future use targets.
- Consider surface application of a medium to facilitate revegetation.
- Remove sludges from water treatment facilities and consolidate within tailings or waste rock deposits, or alternatively transport sludges to the underground mine workings prior to reclamation of these areas.
- Cover sludges in settling ponds within water treatment facilities in place with a cover system - provided they are not located within a natural surface water drainage path.

<sup>19</sup> Refer to Environment Canada's 2010 *Technical Document for Batch Waste Incineration* for more information.



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#### **2.3.8.4 Northern Limitations and Considerations**

The following items should be considered when developing closure and reclamation plans for landfills and other waste disposal areas at northern mine sites:

- Many northern sites do not have large, local sources of low permeability soils, such as clays, to use as a liner or as cover materials to limit infiltration.
- Landfill sites may be underlain by permafrost and permafrost may aggrade into the landfill debris overtime.
- Landfills may not be permitted in materials that experience significant frost heave.
- In areas of continuous permafrost, waste materials may be encapsulated in permafrost
- Careful consideration should be given to the effects of climate change on the long-term stability of cover system designs dependent on permafrost for encapsulation.
- In areas of discontinuous permafrost, conventional landfill designs using an impervious liner may be more appropriate than utilizing frozen ground conditions to encapsulate the waste.
- Freezing of systems designed to collect leachate may compromise the operation of the landfill.

#### **2.3.8.5 Post-Closure Monitoring**

Post-closure monitoring with respect to reclamation of landfills and other waste disposal areas may include, but is not limited to, the following:

- Test water quality and quantity to measure the success of the selected closure activities for landfills and waste disposal areas.
- Identify any unpredicted sources of potential contamination.
- Monitor the ground thermal regime (by means of thermistors) and cover system performance to determine if permafrost has aggraded into the landfill and if the seasonal active zone remains within the cover.
- Inspect surface of landfill cover systems for cracking or slumping of the cover and for underlying waste materials migrating to surface.
- Monitor wildlife use to ensure the selected closure activities have been effective in preventing wildlife access to these areas.

### **2.3.9 Water Management Systems**

The components of a water management system may include structures such as embankments, spillways, diversion channels, ditches and culverts, pipelines, and storage tanks associated with fresh water supply, in addition to the collection, treatment, and discharge of non-compliant water.

#### **2.3.9.1 Closure Objectives**

Objectives for the closure and reclamation of water management systems may include the following:

- Dismantle and remove/dispose of as much of the system as possible.
- Restore, to the extent possible, natural drainage patterns.
- Stabilize and protect from erosion and failure for the long-term.



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- Use natural water courses (e.g., adjacent rivers or streams) for post-closure drainage where practical.
- Maintain stable release of water discharge to the environment at designated discharge points (e.g., spillway outlets, outlets of tailings containment areas). Achieve approved water quality limits, and in the case of existing mines, implement long-term treatment only if necessary.
- Ensure that no long-term active care is required.
- Re-establish the pre-mining ground cover (as necessary), which may involve encouraging self-sustaining native vegetation growth and the establishment of supporting media (soil, rock, sediment).
- Ensure physical and geotechnical stability for the safety of humans and wildlife.

### **2.3.9.2 Closure and Reclamation Planning Considerations in Mine Design**

The following items need to be considered during the mine design stage of the project to minimize post-closure reclamation efforts with respect to water management systems:

- Minimize reliance on surface water diversion structures in the long-term.
- Plans should be designed to be robust to address development plans of other mine components and be compatible with future use targets.
- For any water management structures that may be required during closure, design parameters should be selected to reflect the need to maintain stability in the long term, not just during operations (selecting design flood values for closure scenarios as opposed to operational scenarios).
- Design water management systems such that migration of potential contaminants is minimized.
- Construct pilot channels to assess how ice builds up in water passage channels.
- Select location and design that will have minimal impact on wildlife and aquatic habitat and therefore require minimal reclamation effort.

### **2.3.9.3 Closure Options**

Progressive reclamation options for water management systems may include, but are not limited to, the following:

- Document performance of water management structures such as spillways and diversion channels under a variety of operating conditions.
- Embankments, dams and culverts not required for long-term use should be breached and levelled/re-contoured once they are no longer needed.

Post-closure reclamation options for water management systems may include, but are not limited to, the following:

- Treat non-compliant water in storage and subsequently release once discharge criteria are achieved.
- Embankments, dams, and culverts not required for long-term use should be breached and levelled/re-contoured.
- The pre-disturbance drainage network should be restored, to the extent possible.
- Use passive treatment systems as the preferred method for treating contaminated waters following closure if it can be demonstrated to be effective during operations.



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- A contingency plan for active treatment should be prepared and ready to implement in the event that passive treatment does not achieve water quality compliance.
- Locate permanent spillways in competent rock.
- Drain, dismantle, and remove tanks and pipelines from the site or fill and cover them with appropriate materials if they are approved to remain.
- Ensure any remnant embankments or other water management structures have appropriate erosion control measures in place to maintain stability throughout closure.

#### **2.3.9.4 Northern Limitations and Considerations**

The following items should be considered when developing closure and reclamation plans for water management systems at northern mine sites:

- Remote northern mine sites often have limited climate data available from which to conduct hydrological design assessments needed for water management structures.
- Collection of site-specific climate data should begin as early as possible during the project.
- Hydrological design for water management structures required during closure should incorporate considerations for climate change impacts and not solely rely on the existing hydrological record.
- Designs should account for snowfall and snowdrifts that may accumulate in topographic lows.
- Permafrost is a significant regulator of runoff patterns, particularly during snowmelt, and designs should account for this impact.
- The flow capacity of the water passages may be affected by ice build up and debris in the channels.
- Management of water under ice and snow conditions may need to be incorporated; this is particularly difficult during spring melt when flows can be large, ice and snow may obstruct flows, and visibility and access to those flows may be limited.
- Passive treatment systems are more difficult to implement due to long periods of snow or ice cover.
- Water in the North is considered relatively pristine and aquatic organisms may be particularly sensitive to water quantity and quality changes.

#### **2.3.9.5 Post-Closure Monitoring**

Post-closure monitoring with respect to water management systems may include, but is not limited to, the following:

- Periodic inspections to assess the performance of the remaining water management structures.
- Climatic conditions at site should continue to be monitored to compare to design assumptions (e.g. regarding storm events) and performance of selected closure activities.
- Monitor the performance of erosion protection on embankment structures, such as rip rap or vegetation, and the physical stability of water management systems including permafrost integrity where applicable.
- Monitor water quality, quantity, and flows to ensure system is working as predicted.
- Conduct ongoing inspection and maintenance of passive or active water treatment facilities associated with non-compliant mine site water or runoff discharges.
- Sample surface and groundwater if site-specific conditions dictate.
- Monitor the smell and taste of water and fish (guidance from local communities and Elders should be sought).
- Monitor wildlife/fish use of area to ensure the selected closure activities are successful.



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## Appendix A – References and Additional Guidance Documents

General references are listed below under the following sub-headings: guiding concepts for mine site reclamation, communication and public engagement, general northern considerations, and technical considerations by topic for mine site closure and reclamation. Additionally, relevant legislation and websites are provided.

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### **Tailings and Dams**

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## **Relevant Legislation**

Closure and reclamation of advanced mineral exploration and mine sites in the NWT is subject to a number of statutes. The primary Acts and Regulations applicable in the NWT at the time of publishing these guidelines are listed. It is incumbent upon the proponent to ensure compliance with all pertinent legislation including conditions set out in updated versions of existing policies, regulations, and guidelines.



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## FEDERAL

*Canadian Environmental Assessment Act and Regulations*

*Canadian Environmental Protection Act and Regulations*

*Fisheries Act and Regulations*

*Arctic Waters Pollution Prevention Act and Regulations*

*Northwest Territories Waters Act and Regulations*

*Mackenzie Valley Resource Management Act and Regulations*

*Territorial Lands Act and Regulations*

*Transportation of Dangerous Goods Act and Regulations*

## TERRITORIAL – NWT

*Commissioner's Lands Act and Regulations*

*Environmental Protection Act and Regulations*

*Environmental Rights Act and Regulations*

*Mine Health and Safety Act and Regulations*



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## Appendix B – Definitions and Acronyms

To ensure a common understanding of important closure and reclamation planning terminology, the following definitions and acronyms are integral to the understanding of the concept of closure and reclamation and are provided here to ensure consistent interpretation of these guidelines:

### Definitions

**Active layer:** the layer of ground above the permafrost which thaws and freezes annually.

**Baseline:** a surveyed condition and reference used for future surveys.

**Boards:** land and water boards of the Mackenzie Valley, as mandated by the *Mackenzie Valley Resource Management Act* including the Mackenzie Valley Land and Water Board, Gwich'in Land and Water Board, Sahtu Land and Water Board, and Wek'èezhìi Land and Water Board.

**Care and maintenance:** describes the status of a mine when it undergoes a temporary closure.

**Closure goal:** is the guiding statement that provides the vision and purpose of reclamation. The closure goal is met when the proponent has satisfied all closure objectives. By its nature, the closure goal is a broad, high-level statement and cannot be directly measured. The closure goal is: "To return the mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities".

**Closure principles:** these guide the selection of closure objectives. The four core closure principles are 1) physical stability, 2) chemical stability, 3) no long-term active care requirements, and 4) future use (including aesthetics and values).

**Closure objectives:** describe what the selected closure activities are aiming to achieve. Closure objectives must be guided by the closure principles. Closure objectives are typically specific to project components, and must be measurable and achievable and allow for the development of closure criteria.

**Closure options:** are proposed for the closure objective. A set of alternatives should be evaluated for each mine component. A selected closure activity will be chosen from the list of closure options for each project component for approval by the Board.

**Closure criteria:** These become standards that measure the performance of selected closure activities in successfully meeting closure objectives. Closure criteria may have a temporal component (e.g., testing will be done for 2, 5, 10 years). Closure criteria can be site-specific or adopted from territorial/federal standards and can be narrative statements or numerical values.

**Contaminant:** any physical, chemical, biological or radiological substance in the air, soil, or water that has an adverse effect. Any chemical substance with a concentration that exceeds background levels or which is not naturally occurring in the environment.



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**Cover system:** range from simple covers over non-hazardous waste in landfills to cover systems over waste rock piles to complex, engineered cover systems over acid-generating tailings. They serve to prevent release of substances that could damage the receiving environment by providing physical stability.

**Effluent:** treated or untreated liquid waste material that is discharged into the environment from a structure such as a settling pond or a treatment plant.

**Inukshuk:** a stone representation of a person, used as a milestone or directional marker by the Inuit of Canada.

**Leachate:** water or other liquid that has washed (leached) from a solid material, such as a layer of soil or water; leachate may contain contaminants.

**Long-term active care:** A post-closure mine site is in long-term active care when sustained monitoring of active facilities is required (e.g., for more than 25 years). This should be avoided whenever possible.

**Passive long-term care:** A post-closure mine site is in passive long-term care when occasional monitoring, coupled with infrequent maintenance or repairs, takes place following reclamation. Many mine sites require ongoing passive care, which can be an acceptable practice.

**Passive treatment:** treatment technologies that can function with little or no maintenance over long periods of time (e.g., use of wetlands).

**Project:** Any activity that requires a water licence or land use permit.

**Progressive reclamation:** selected closure activities that can be taken at advanced mineral exploration and mine sites before permanent closure to take advantage of cost and operating efficiencies by using the resources available from an operation to reduce the overall reclamation costs incurred. It enhances environmental protection and shortens the timeframe for achieving the closure objectives.

**Reclamation:** the process of returning a disturbed site to its natural state or one for other productive uses that prevents or minimizes any adverse effects on the environment or threats to human health and safety.

**Reclamation research:** is conducted to resolve uncertainties and answer questions pertaining to environmental risks; reclamation research plans are designed to provide data and information which will reduce uncertainties for closure options, selected closure activities, and/or closure criteria.

**Remediation:** the removal, reduction, or neutralization of substances, wastes, or hazardous material from a site in order to prevent or minimize any adverse effects on the environment and public safety now or in the future.





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**Risk assessment:** reviewing risk analysis and options for a given site, component, or condition. Risk assessments consider factors such as risk acceptability, public perception of risk, socio-economic impacts, benefits, and technical feasibility. It forms the basis for risk management.

**Selected closure activities:** is chosen from the closure options for each mine or advanced mineral exploration component and outlines specific actions and measures to be undertaken.

**Security deposit:** funds held by the Crown that can be used in the case of abandonment of an undertaking to reclaim the site or carry out any ongoing measures that may remain to be taken after the abandonment of the undertaking.

**Stakeholders:** includes industry, federal government departments and agencies, the territorial government, Aboriginal governments and organizations, communities, landowners, and other interested parties

**Tailings:** material rejected from a mill after the recoverable valuable minerals have been extracted.

**Traditional Knowledge:** A cumulative, collective body of knowledge, experience, and values built up by a group of people through generations of living in close contact with nature. It builds upon the historic experiences of a people and adapts to social, economic, environmental, spiritual, and political change.

**Waste rock:** all unprocessed rock materials that are produced as a result of mining operations.

**Acronyms:**

AANDC:	Aboriginal Affairs and Northern Development Canada (formerly known as INAC)
ARD/ML:	Acid rock drainage/metal leaching
CRP:	Closure and Reclamation Plan
GLWB:	Gwich'in Land and Water Board
INAC:	Indian and Northern Affairs Canada (former name of AANDC)
MVLWB:	Mackenzie Valley Land and Water Board
MVRMA:	<i>Mackenzie Valley Resource Management Act</i>
SLWB:	Sahtu Land and Water Board
WLWB:	Wek'èezhìi Land and Water Board