Guidelines for Northern Mine Decommissioning and Reclamation

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1.0 INTRODUCTION

Planning and management for mine closure is an integral part of overall project development and operations. Mining operations usually progress through the following phases during their development: exploration; feasibility; environmental assessment; construction and operation; and finally decommissioning. Likewise a decommissioning and reclamation plan will evolve over time from the initial conceptual plan that is submitted as part of the environmental assessment of the project to the final plan that is implemented at the closure of the project. Once the decommissioning and reclamation activities are complete and the objectives have been met, the operator may transfer the site back to provincial custodial responsibility.

These guidelines are intended to provide the proponent with an overview of the various factors to be considered during the development of a decommissioning and reclamation plan for a mining site. The first section will provide an overview of the legal requirements for developing and implementing a decommissioning and reclamation plan. The subsequent sections provide a review of some basic planning principles to be considered when designing a decommissioning and reclamation plan (Section 2); a review of the general closure criteria for the various components of a mining site (Section 3); and finally a brief discussion on the role of public consultation in developing, implementing and finally completing a decommissioning and reclamation plan (Section 4).

1.1 Provincial Legislation

There are a number of provincial acts and regulations that a proponent should be aware of when developing and implementing a decommissioning and reclamation plan for a mining development (project). The following sections provide an overview of these acts and regulations.

1.1.1 Environmental Assessment Act

In Saskatchewan, planning for decommissioning and reclamation of a mining site begins during a project's assessment phase. Under Section 9 of The Environmental Assessment Act a proponent is required to conduct an Environmental Impact Assessment (EIA) of their development and to prepare and submit an Environmental Impact Statement (EIS).

As part of the assessment of mining and mill proposals the proponents are required to submit a conceptual decommissioning and reclamation plan. The *Project Specific Guidelines for the Preparation of an Environmental Impact Assessment*, issued by the Ministry of Environment – Environmental Assessment Branch, contains guidance on the preparation of the conceptual decommissioning and reclamation plan.

After the completion of the Environmental Assessment (EA) process, the minister will decide if the development may or may not proceed. As part of the EA approval, the minister may impose any terms and conditions that are considered to be necessary or advisable. If a development is approved under the EA process, it then proceeds to the regulatory phase in which the proponent applies for the necessary permits and/or approvals to construct and/or operate the various facilities that are associated with a mining operation.

1.1.2 Environmental Management and Protection Act, (2002)

The Environmental Management and Protection Act, 2002 (EMPA 2002) is the primary provincial legislation that applies to mining operations. A number of regulations under EMPA 2002 may be applied in the implementation of a decommissioning and reclamation plan.

1.1.2.1 Mineral Industry Environmental Protection Regulations, 1996

The Mineral Industry Environmental Protection Regulations, 1996 (MIEPR 1996) require proponents to apply for approval to construct and operate pollutant control facilities at the mining site. Before receiving

an approval to operate pollutant control facilities a proponent must have an approved decommissioning and reclamation plan in place along with an assurance fund that will ensure the completion of the above plan.

The information that is required in an application for approval of a decommissioning and reclamation plan and the various forms for establishing an assurance fund are described respectively in sections 14 and 15 of MIEPR 1996. The application must include the following information:

- a time frame for decommissioning and reclaiming the mine site;
- a description of the proposed methods and procedures of, and time frames for, monitoring the mining site for physical and chemical stability and for detecting spills or the release of pollutants during and after decommissioning and reclamation;
- an estimate of the cost required to carry out the decommissioning and reclamation plan and the cost of monitoring the mining site after the decommissioning and reclamation;
- a proposal for an assurance fund that complies with section 15, to ensure completion of the decommissioning and reclamation plan;
- a proposal for the management and administration of the assurance fund; and
- a proposal respecting the release of all or portions of the assurance fund during the decommissioning and reclamation of the mining site.

As described in Section 15 of the MIEPR 1996, an assurance fund for a decommissioning and reclamation plan may take a variety of forms. Examples of the form of the assurance fund include: cash; irrevocable letters of credit; and term deposits.

As stated in Section 18 of MIEPR 1996, proponents are required to give sixty days notice in writing prior to the initiation of an approved plan to permanently close pollutant control facilities, mines or mills.

If a sufficient period of transition phase monitoring demonstrates that the site has achieved an appropriate level of environmental and physical stability in accordance with the decommissioning and reclamation plan, the operator may make a written application for a Release from Decommissioning and Reclamation. Section 22 of MIEPR 1996 outlines the application procedures for a proponent to follow for obtaining their release from any further obligations that are set out in the decommissioning and reclamation plan.

Based in part on this section of the regulations, the application for Release from Decommissioning and Reclamation should contain, at a minimum:

- a summary of the decommissioning and reclamation activities that have been completed by the operator;
- a description of the performance of the site during the transition (decommissioning and post decommissioning) monitoring phase;
- predictions that are based on the documented performance of the site during the post decommissioning phase monitoring, of any potential ongoing expenditures the province may be expected to accrue in order to adequately maintain and monitor the site if it assumes custodial responsibility for the property;
- a list and assessment of remaining environmental liabilities; and,
- an estimate of the potential costs to the province to address such liabilities should it assume custodial responsibility.

Upon receiving the application, the Ministry of Environment will initiate a detailed review of the application. That review will include opportunities for public input on any conditions that may be applied before the Release from Decommissioning and Reclamation is issued and the type of institutional controls that will be applied to the site.

Only after these steps are completed to the satisfaction of the Minister of Environment will a Release from Decommissioning and Reclamation be issued to the operator and the custodial responsibility for the property is transferred from the operator to the provincial institutional control management framework.

1.1.2.2 The Hazardous Substances and Waste Dangerous Goods Regulations

Section 17 of The Hazardous Substances and Waste Dangerous Goods Regulations (HSWDGR) requires that anyone proposing to remove, abandon, dispose, or permanently close any storage facility for hazardous substances and waste dangerous goods must apply to the minister for approval to decommission and reclaim any storage facilities used for the storage of hazardous substances or waste dangerous goods.

The request for approval should be submitted at least 30 days prior to the work being undertaken. The information to be provided with the request should include the following:

- a description of how the decommissioning will take place;
- how any remaining equipment, hazardous substances, or contaminated materials will be disposed;
- a proposal describing how the site will be decontaminated and reclaimed as well as how the area will be monitored to determine the adequacy of the decommissioning and reclamation plan.

Prior to submitting an application, the proponent is required to undertake a site assessment to determine the degree of contamination and the risks to the environment and to the health and safety of the public.

1.1.2.3 Other EMPA 2002 Regulations

During decommissioning, some activities may require approvals from other branches of the Saskatchewan Ministry of Environment. In particular any work in or near water (i.e. removal of stream crossings) may require an Aquatic Habitat Protection Permit under Section 36 of EMPA 2002.

These permits will describe the conditions under which the work may be undertaken. The following are examples of the types of conditions that may be included in these permits: the timing of when any work in the water may be conducted; the need for sediment and erosion control measures; and measures to limit the deposition of deleterious substances.

1.1.3 The Occupational Health and Safety Act 1993, (The Mines Regulations 2003)

The Mines Regulations, 2003 (Mine Regs 2003) which are issued pursuant to The Occupational Health and Safety Act 1993, include a number of sections that relate to the closing of mines. Section 406 of the Mines Regs 2003 states that before a mine or any part of a mine is closed, abandoned or otherwise rendered inaccessible, the employer, contractor or owner must ensure that all plans required pursuant to Subsection 7(2) are updated. Copies of the plans are to be certified as correct by the employer, contractor or owner and forwarded to the chief mines inspector. Subsection 7(2), describes the information that the owner or operator of the mine must provide the Chief Mines Inspector of Saskatchewan Advanced Education, Employment, and Labour prior to initiating final closure activities. The information to be provided includes the following:

- a surface plan showing the boundaries of the property and all lakes, streams, roads, railways, electric transmission lines, main pipelines, buildings, shafts, adits, surface workings, diamond drill holes, boreholes, dumps, and tailings management areas;
- a plan of each underground level, showing all workings, shafts, drifts, crosscuts, diamond drill holes, dams, and bulkheads;
- a plan respecting vertical mine sections at suitable intervals showing all shafts (raises and winzes), drifts, crosscuts, stopes and workings in relation to the surface, including the location of the top of bedrock, the surface of overburden, the position of any unconsolidated deposit, and the position of any known watercourse or body of water, with each section shown on a separate drawing; and,
- a ventilation plan showing the direction and quantity of the main air currents, locations of permanent fans, ventilation doors, stoppings, and connections with adjacent mines.

This information will also be included in the application for Release from Decommissioning and Reclamation discussed previously in Section 1.1.2.

The conditions for the closure of underground mines and open pits are described respectively in Sections 407 and 408 of the Mine Regs 2003. Section 409 describes a number of requirements pertaining to the final closure of any plants that are associated with mines that are being closed.

1.1.4 Reclaimed Industrial Sites Act and The Reclaimed Industrial Sites Regulations

An operator or site holder that plans to return the site into provincial custody after having completed the decommissioning and reclamation and has met the closure objectives and requirements to receive a Release must apply for the transfer of custody into the province's institutional control program. The program is legislated by The Reclaimed Industrial Sites Act and The Reclaimed Industrial Sites Regulations.

The operator may find it beneficial to review the entry requirements of that program in the design and implementation of the decommissioning and reclamation plan.

1.2 Federal Legislative Requirements

Some decommissioning activities, in particular those requiring work in or around water (i.e. removal of stream crossings), may require review by various federal authorities such as Fisheries and Oceans Canada (DFO) and/or by the Navigable Waters Protection Program (NWPP) with Transport Canada. If a formal approval is required for these activities, the federal authority may require an Environmental Assessment of the proposal pursuant to Section 5.1(d) of the *Canadian Environmental Assessment Act* (CEAA).

For mines that have been subject to the *Metal Mining Effluent Regulations* (MMER), the proponent will be required under Section 32 of the MMER to apply to Environment Canada for recognition of closed mine status. After a period of three years where the mine has maintained a rate of production at less than 10% of the designed rate of capacity the mine will be granted status as a closed mine.[1] It should be noted that upon attaining the status of a closed mine, that the mine is still subject to Section 36(3) of the *Fisheries Act* for the occurrence of any deposition of a deleterious substance.

The decommissioning of uranium mining sites will require review and approval from the Canadian Nuclear Safety Commission (CNSC). The detailed decommissioning plan is filed with the CNSC for appropriate licensing action under the federal *Nuclear Safety and Control Act* prior to beginning decommissioning activities. Presently, under the CEAA, the CNSC will be required to undertake an environmental assessment of the plan prior to providing a license to decommission the mine site.

2.0 BASIC PLANNING PRINCIPLES OF DECOMMISSIONING AND RECLAMATION PLANS

In the following sections, a number of basic planning principles for developing and implementing decommissioning and reclamation plans are presented. These planning principles will aid the proponent in attaining their primary decommissioning and reclamation objective of restoring the mining site to a condition that is similar to the conditions that existed prior to disturbance by mining operations.

2.1 Conceptual Plan

In Saskatchewan, as part of the environmental assessment of a mining development, the proponent will be required to present a conceptual plan for the decommissioning and reclamation of the project site. The conceptual plan should identify the following:

- the predicted impacts of the project on the surrounding ecosystems;
- a description of how the impacts will be mitigated and what the residual impacts will be;

[1] As per the amendments in 2006 to the MMER.

- a general overview on how the site will be decommissioned (i.e. buildings removed; pits filled in, etc.); and
- the final decommissioning objective, which will in part be based on the residual impacts of the project.

2.2 Operational Decommissioning Plan

As stated previously, mining companies are required pursuant to Section 12 of the MIEPR 1996 to develop decommissioning and reclamation plans that also include the provision of a financial security or assurance. The operational decommissioning plan is developed on a "decommission tomorrow by a third party scenario" that provides the technical details for decommissioning the mining project. Based on the technical details, the financial costs for undertaking the operational plan are calculated. At a minimum, the plan is reviewed at least every five years or sooner when there are significant changes to the mining project such as expansion of the operation or when the minister believes the financial assurance is under funded.

The operational plan should include the following:
- proposed end use of the decommissioned site (if available the proponent should consider any land use plans for the area when formulating the end use objectives);
- the predicted timelines for reclamation of the site;
- a discussion of alternative procedures that may be used for decommissioning the various site facilities (i.e., camp and office buildings, pit mine(s), underground mines and waste rock stockpiles, etc.);
- identification of the preferred procedures for decommissioning the site facilities;
- the time frame and sequence of decommissioning activities;
- environmental mitigation and reclamation measures e.g., contouring of waste rock piles, covering of wastes and re-vegetation;
- post-decommissioning contaminant loadings and residual impacts to the local drainage system and to groundwater;
- monitoring program during the decommissioning and transition (post-decommissioning) phases;
- proposed contingency measures if initial plans are not successful; and
- an estimate of the cost to undertake the decommissioning and reclamation plan and the cost of monitoring the site after decommissioning and reclamation has been completed.

The following are some planning principles that should be utilized when developing the operational plan for decommissioning and reclaiming a mining operation.

2.2.1 Design for Decommissioning

During the design of the various mining facilities at a project site, consideration should be given as to how the facilities will be decommissioned. This may reduce the amount of work required and the costs for decommissioning a facility when it has completed its period of service.

Some of the factors to be considered when designing a facility for decommissioning will include the elimination or at least the minimization of any future impacts from the facility, the long term stability of the facility, any concerns in relation to the long term liability for the facility and its aesthetics (i.e. how well does the decommissioned and reclaimed facility fit in with the surrounding landscape). Preference should be given to systems that allow for passive management in the post decommissioning phases.

2.2.2 Progressive Decommissioning and Reclamation

The majority of the decommissioning and reclamation activities at a mine site usually occur after the completion of the operating phase of the project when the recovery of minerals is no longer economically viable. However, the mine should be developed and operated with a focus on progressive decommissioning and reclamation. For example, the re-vegetation of disturbed areas that will no longer be used will reduce erosion concerns and aid in site water management. Therefore, whenever possible,

areas that have reached the end of their productive life should be decommissioned and reclaimed during operations. Progressive decommissioning allows for adaptive management in that various decommissioning strategies may be implemented and evaluated for their effectiveness in achieving the decommissioning and reclamation objectives. This also decreases the amount of work that will have to be done during the decommissioning phase. Areas within the surface lease that are no longer required and have not been disturbed by the mining operation could be considered for release from the custody of the mine operator.

In Saskatchewan, it is a regulatory requirement that the decommissioning and reclamation plan be reviewed every five years. This review can help the mine operator to implement progressive decommissioning over the operating lifetime of the project. The review should summarize any progressive decommissioning that has been completed and any that may be proposed for the future. Depending on the amount of decommissioning and reclamation work that has been undertaken during a five year period and the amount of development that has occurred, the assurance fund could decrease or increase after the review of the plan has been completed.

As part of the progressive decommissioning process, on-going, relevant research on strategic mine closure issues is an important part of decommissioning, reclamation and final closure as it contributes to site specific, regional, and industry knowledge. Research and modeling also provides the information required to make informed decisions in relation to mine closure design outcomes by assisting in the development of achievable completion criteria.

2.2.3 Ecological Risk Assessment

An ecological risk assessment (ERA) is a tool that can be used in the development of the operational plan. An ERA may be undertaken to evaluate the risks associated with the residual impacts of a project after the completion of the decommissioning and reclamation plan. An ERA will help identify potential sources, pathways, and receptors within the impacted ecosystems. The general sources, pathways and receptors that are used in an ERA are described below.

Sources include:
- mining operations (i.e. underground and open pit mines);
- waste rock storage areas;
- tailings areas; and
- effluent release points from treatment facilities.

Pathways:
- air;
- groundwater;
- surface water;
- sediments and soil; and
- food chain.

Receptors
- water quality;
- aquatic biota (i.e., benthic community, fish);
- fur bearing animals;
- ungulates (moose, caribou, etc.);
- vegetation (i.e., berries); and
- humans.

An ERA evaluates the risk that a source may impact a site. Risk can be described as the probability that a receptor will be negatively impacted by its exposure to a source through a pathway. The Canadian Council of Ministers of the Environment (CCME) has prepared a number of documents on undertaking ecological risk assessments (CCME 1996, CCME 1997).

2.3 Monitoring

Monitoring of the local environment around a mining operation has three phases (assessment, operational, and transition). During the assessment phase, monitoring provides information on the baseline conditions of the ecosystems that will be potentially impacted by the project. The ecological baseline should describe the natural variability of baseline or undisturbed conditions that occur in the local ecosystems. This would include estimates on the fluctuations in population levels, the range of streamflow conditions, etc. During the assessment phase, care should be taken in establishing reference sites that will also be used during the operational phase of the monitoring program. Reference sites should be representative of the ecological conditions in the local area and of the areas that will be impacted by the mining operations. This will aid in comparisons between the impacted and reference sites during the operational monitoring phase. The reference sites also provide a benchmark for assessing the success of reaching the decommissioning and reclamation objectives. The reference sites will also provide information on any long-term regional trends, which are unrelated to the mining operation that may be having an impact on the local environment.

Operational monitoring confirms or refutes the accuracy of the predictions on the impacts of the project that were made during the environmental assessment. If impacts that were not predicted are observed and are due to the project, then changes to the mitigations that are being used can be made and the decommissioning and reclamation plan can be revised. Monitoring of reference sites will determine if the impacts that are observed are the result of the mining operation or if they are a response to some regional stress that is unrelated to the mining operation. The final stage of the operational monitoring phase at the end of operations will describe conditions prior to the beginning of the decommissioning and reclamation phase.

The transition phase of monitoring will begin with the start of the approved decommissioning and reclamation activities. The objective of this phase of the monitoring program will be to determine the recovery of the impacted areas in response to the implementation of the decommissioning and reclamation plan and the impacts as a result of the shutdown of operations.

As the agreed to post closure land use may take years or even decades to achieve, a set of specific performance indicators should be developed to measure progress in meeting the decommissioning and reclamation criteria. Correctly chosen, the monitoring of these environmental indicators will show whether the ecological processes that will lead to successful rehabilitation are trending in the right direction. This action will also identify and enable early intervention where trends are not positive.

During the transition phase monitoring period, the operator is required to:

- continue monitoring and maintaining the site, as per the requirements in the decommissioning and reclamation plan, at their own expense; and
- maintain an assurance fund of sufficient value to cover the cost of the remaining obligations outlined in the decommissioning and reclamation plan and any monitoring and maintenance requirements for the balance of the transitional period as well as a negotiated contingency for any unexpected occurrences.

3.0 FINAL MINE CLOSURE OBJECTIVES AND CRITERIA

The general objective for all mine decommissioning and reclamation plans should be to leave all areas that were disturbed during operations safe for traditional land uses and in an ecological condition that is consistent with the surrounding physical and biological environment. Wherever possible, decommissioning and reclamation activities should also endeavor to leave all areas of the site in a state that requires minimal or no maintenance.

Based on the predicted impacts of a project that are determined during the EIA and the results of the operational monitoring, the site specific closure criteria should be developed in consultation with stakeholders. This will ensure that there is a broad agreement on both the post closure land use

objectives and on the basis for measuring the achievement of those objectives (i.e. the decommissioning criteria).

Decommissioning criteria should be flexible enough to adapt to changing circumstances without compromising the agreed to end objective. There should be an agreed process for the periodic review and modification of completion criteria in light of improved knowledge or changed circumstances.

3.1 General Site Objectives

In general, the areas disturbed by the mining operations should be reclaimed to an ecological (i.e., physical and biological) condition that will be similar to what was observed in the area prior to disturbance. If information is not available in regards to site conditions prior to disturbance the surrounding undisturbed sites will often be an indicator of what the site conditions were like prior to disturbance. Reclaimed areas should be similar to undisturbed areas in the following ways:

- soil infiltration rates and groundwater movement (pathways and rates) are similar to nearby undisturbed areas. Note that for areas that may be sources of contaminants to groundwater, the soil infiltration rates may be purposefully reduced.
- groundwater chemistry parameters are within the natural range of variation that is found within undisturbed areas. It is recognized that this may not be applicable to the groundwater that is down gradient of mined out pits that have been used for the disposal of tailings and special waste.
- soils should be similar in organic content, layers (horizons), and particle size to what is observed in undisturbed areas.
- vegetation communities should have similar species at densities that are comparable to the natural range of variation in similar local ecosystems.
- if the disturbed site has been restored then it would be expected that local animals will immigrate into and use the reclaimed areas.
- waste rock piles should be shaped as much as possible to blend in with the local topography.
- lake shorelines and riverbanks should be reclaimed to their pre-disturbed condition.
- surface water quality should be within the natural range of variation for the area.

At some mine sites as predicted in the EIA, there may be areas that cannot be fully reclaimed to their original ecological condition. Examples of such sites would include tailings areas, special waste rock piles, and open pits. These sites could be potential sources for contaminants that could migrate from impacted areas within the project sites to ecosystems outside of the project area. This potential should be minimized through site specific mitigation measures that ideally should not require any long term maintenance. Exceedance of predicted impacts may prevent the approval of the Release from Decommissioning and Reclamation.

3.2 Reclamation Objectives for Mine Infrastructure

Mining operations involve the construction of a variety of physical works that result in physical changes to the environment. Each of the physical works on the project site will be required to be decommissioned and reclaimed to a standard that will ensure their long term stability (i.e. resistance to erosion, re-establishment of drainage). Closure methods for physical mine works must be approved subject to the Mines Regulations 2003 and closure objectives subject to MIEPR.

The following sections review the environmental and safety concerns associated with the various physical works that may be constructed at mining operations. This is followed by suggestions on how these concerns may be mitigated in order to attain the proposed decommissioning and reclamation objectives for each respective physical work.

3.2.1 Open Pits

The primary environmental and safety concerns that relate to open pit mines include:

- the release of contaminants from the walls and floor of the pits and how this may affect both groundwater and surface water quality;
- the stability of the pit walls;
- the types of materials that may be placed in them after mining is completed and how these materials may affect ground and surface water quality; and
- the possibility of people and/or wildlife accidentally falling into the pit and not being able to get out.

The primary options available to the mine operator to mitigate the above concerns are backfilling of the pit and/or allowing the pit to flood. The types of material available for backfilling open pits may include: clean waste rock, special waste rock, tailings, and/or demolition materials. A combination of the above materials may be used to backfill the pit. The volume and characteristics of the materials that are deposited in the open pit must be recorded. One of the primary considerations when selecting the type of material for placement in the pit should be how the material may affect groundwater quality and ultimately surface water quality. Consideration will also have to be given as to how the deposited material may settle over time. This may require that the material backfilled in the pit must be mounded to allow for settling. Completion of backfilling should include the placement of a layer of material that will allow for the development of vegetation.

If the pits are not backfilled they should be allowed to fill with water to a level that coincides with the local water table. If oxidation of the pit walls is a concern and the groundwater inflows are likely to be slow, pumping of surface water should be considered to speed up flooding. However, the volume of water that is being pumped into the pit should not have an impact on streamflows or water levels of the source waterbody. The quality of the surface water within flooded pits should be similar to what is found in local waterbodies. Water quality in deeper zones within flooded pits may be of poorer quality if these zones become isolated through the formation of a chemocline. Stability of chemoclines in flooded pits must be established before release from decommissioning and reclamation requirements will be considered.

Some open pit mines may extend into local waterbodies. This usually will require the construction of dykes to aid in the isolation of pits from waterbodies. One option to be considered when decommissioning and reclaiming these types of pits is the feasibility of re-connecting the pits to the waterbodies. This would entail at least a partial removal of any dykes. In this situation the bottom substrate and slope should be similar to what was present prior to the initial excavation.

3.2.2 Mine Openings and Workings

The primary concerns with mine openings and other associated structures are similar to those of open pits. These are impacts on the quality of surface and ground water and safety. One additional concern is the potential for slumping of materials after backfilling has been completed.

Adits, raises, shafts, or other openings to the surface should be backfilled entirely or at least down to an offset when one is present. It is preferable that this be done with clean waste rock but some special waste may be used if it can be shown that this will have negligible effects on ground water quality. The waste rock should be at least flush with the entrance to prevent any entry or for larger openings an engineered bulkhead may be required to be placed at openings. Careful consideration of the long-term risks posed by the accumulation of water behind waste rock barriers must be given. The backfilling of materials within openings as described above may cause water to accumulate in the underground workings to the extent that pressure and/or erosion may eventually dislodge the material used to fill the adits and re-open the holes. This type of work may be done during the operating phase as part of progressive decommissioning.

Underground workings (i.e., drifts and tunnels) should also be backfilled as much as possible during operations as part of progressive decommissioning. This will help reduce the amount of waste rock that remains on the surface and will also help provide stability to the underground workings.

Crown pillars, if they exist on a mine property, must be assessed for long-term stability in order to select the most appropriate closure measures to ensure lasting safety and compatibility with the post closure land use of the property. The assessment should ideally be done during the operational phase of the mine. Whenever possible, unrestricted surface use of the area above the crown pillar should be the ultimate objective in the final closure plan.

3.2.3 Waste Rock Piles

Waste rock materials are typically classified as either clean waste rock or special waste rock. Clean waste rock consists of rock that does not contain sufficient quantities of any minerals that could be mobilized and potentially cause an adverse impact if released into the environment. Clean waste rock may still be a source of fine sediments. Special waste rock in contrast may be potentially acid generating and/or contain minerals such as arsenic, nickel, selenium, molybdenum, or others in amounts that when mobilized from the parent material could cause an adverse impact to the receiving environment.

The main issues with waste rock include the following:

- release of contaminants from the waste rock through a number of pathways to the environment;
- erosion from waste rock and subsequent sedimentation in waterbodies or on the adjacent landscape;
- stability of the waste rock piles;
- aesthetics; and
- changes to the local topography.

These issues may be addressed through careful planning in the selection of locations for the placement of waste rock, design of waste rock piles, and progressive decommissioning. Surface waste rock piles can also be reduced through the placement of waste into underground workings, backfilling of pits, and the use of clean waste rock as construction materials for roads, dams, and berms.

Waste rock piles should be located in areas that are away from waterbodies, and that also provide sufficient room for the final configuration of the waste rock pile during decommissioning and reclamation. In addition the location should not interfere with wildlife routes.

Design Criteria

The final configuration of waste rock piles should ensure that they are stable, allow for the re-vegetation of the pile, and if feasible blend into the local landscape. Consideration of the final shape of the waste rock pile, undertaken during the design and placement phase, will significantly reduce the effort and cost required to achieve the desired final slope configuration during decommissioning and reclamation.

The primary objectives in the design of waste rock piles should include the following:

- provision for a surface layer that will allow a suitable plant community to develop;
- the quality of water running off waste rock piles should meet Saskatchewan Surface Water Quality Objectives;
- weathering of near surface material should be limited to maintain the physical and chemical stability of this material; and
- net infiltration of precipitation should be reduced to attenuate the peak concentrations of contaminants in natural watercourses to levels that can be assimilated without an adverse impact to the aquatic ecosystem.

The effective management of acid generating waste rock is to limit the formation of acids at the source by inhibiting the oxidation of the sulphides within the rock. This may be done through the immersion of the waste rock in water or by preventing or reducing the migration of acid drainage to the environment. The latter mitigations relies on the prevention of water contact with the acid drainage through such activities as diversion of surface waters, interception of groundwater, and/or the prevention of infiltration by the use of caps or covers. Price (2005) provides a general guide on the information requirements for addressing

concerns with acid generating waste rock and also discusses a number of mitigation measures to limit the generation of acid rock drainage.

3.2.4 Dams, Dykes and Other Containment Structures

The stability of any dams and/or other containment structures that will be remaining in place after decommissioning and reclamation activities are completed should be assessed. The stability assessment should consider but not be limited to the following factors:

- evaluation of the design life of the structures;
- the types of materials that were used in construction;
- the extent that the stability of structures will be altered by weathering, frost action, and/or forest fires;
- the slopes of the structures; and
- the impact of maximum runoff events.

The Canadian Dam Association has produced a guideline document for assessing the safety of dams entitled Dam Safety Guidelines: Approved as Principles, October 2005. This document is available on their website (http://www.cda.ca).

If the analysis indicates that changes are required to the configuration (i.e. slopes) of structures then these should be undertaken to ensure long-term stability. The final configuration should ensure that structures can be maintained with little or no maintenance. The minimum design criteria that would be considered acceptable would be a 1:100 year standard.

3.2.5 Tailings Management Facilities

Tailings are the materials that remain after the mineral of interest has been extracted during the processing of the ore. As ore processing often involves crushing and/or grinding of the ore, the resulting tailings will consist of materials that are small in particle size. Tailings may contain a number of contaminants of concern that originate from the geochemical matrix of the ore or from introduction during the ore milling process. Tailings are usually transferred as a slurry from the mill to the tailings management facility (TMF). This can result in the tailings at least initially having a high water content.

The potential for a TMF to serve as a source of contaminants must be minimized. This objective should be incorporated as one of the primary considerations in the design of a TMF. The primary pathways would be through mobilization into either surface and/or groundwater. A secondary pathway is through the mobilization of dust particles if the tailings surface is left exposed and allowed to dry. Mitigations to address these concerns should be incorporated and implemented during the design and operational phases of the TMF and continued into decommissioning and reclamation.

Measures to be used to control the transport of contaminants to surface and ground water would include diversion of surface and groundwater around or away from the tailings mass. The actual mechanism for achieving this would be implemented on a site specific basis and would essentially entail developing preferential pathways for water to go around or away from the tailings mass rather than through the tailings. Examples would include the placement of coarse granular material around the tailings in an in-pit facility or the placement of a sloped cover over the tailings for an above ground facility. The movement of water around the tailings mass can also be enhanced through ensuring the tailings are deposited in such a manner that they are well consolidated. Therefore, consideration must be given to how the tailings are deposited into the TMF. Of particular concern is the formation of ice lenses during the winter deposition of tailings. This will limit the consolidation of the tailings and also reduce the total volume of tailings that can be deposited in the TMF Consideration should also be given to include mitigations to limit the solubility of contaminants in the pore water that is within the tailings mass. This will reduce the concentration of contaminants that are transported out of the tailings into the surrounding groundwater.

Decommissioning and reclamation measures should be designed to optimize the following:

- consolidation of the tailings;

- control of infiltration into the tailings;
- enhancement of runoff;
- control of erosion; and
- re-vegetation where appropriate with plants that do not have a tendency to uptake contaminants.

Similar to waste rock piles, the decommissioned TMF, should not require any long-term maintenance. In addition, the areas impacted by any contaminants that are released by tailings should be minimized. The size of the impacted area will be site specific.

3.2.6 Camp Infrastructure

Camp infrastructure includes residences, offices, water and sewage treatment systems, landfills, recreational facilities, and other structures that have been constructed to provide support to staff or materials on the project site. Some of these structures will continue to remain in operation during closure until the site is ready for release.

Maximizing the salvage and recycling of appropriate materials during the decommissioning of buildings and other infrastructure will serve to reduce the total amount of material that will have to be effectively disposed during decommissioning and reclamation.

For those materials that cannot be recycled, a strategy should be developed and implemented during building and infrastructure decommissioning that ensures the most appropriate disposal methods are employed and ensures the long-term stability of the disposal area.

Concrete foundations should be broken apart and the pieces disposed of in an appropriate manner. The inclusion of blast tubes within the foundations to aid with the decommissioning would be an example of designing for decommissioning. Where the breakup of the foundations is not practical, holes should be drilled through the foundations and the concrete cracked to facilitate drainage and consideration should be given to burying the foundation with local benign material.

The use of existing landfills should be maximized and the construction of additional landfills should be kept to a minimum within the project site. These facilities should provide containment of any hazardous wastes that may have been deposited. The surface may be raised somewhat to minimize the infiltration of water through the final surface cover. Materials should be segregated and inventoried and the landfill locations must be recorded and monitored with specific information regarding hazardous materials that have been deposited.

3.2.7 Transportation Infrastructure

The transportation infrastructure (i.e. roads, water crossings, and airport facilities) will likely be some of the final site infrastructure that will be decommissioned and reclaimed at a project site. Local stakeholders should be consulted prior to any closure of local roads within the mining operation surface lease. After the removal of bridges and culverts, the reclamation of the stream channels and adjacent riparian zone should be undertaken with the objective of establishing a channel form that is similar to what is observed in undisturbed upstream and downstream sections of the stream. The bed, banks and substrate of the channel and the riparian zones should have similar characteristics (i.e., substrate, channel width and depth, bank slopes) as the undisturbed channel. The approaches to the crossings may have to be pulled back as part of the reclamation of the riparian zones.

The road beds and right of ways should be scarified as part of the road decommissioning activity once the operator is assured that no additional remediation or monitoring is required at a particular property that will require road access. Re-vegetation measures may be required particularly for sections of road that are near streams or lakes. The final reclamation objective for the roads and right-of-ways should be to establish plant communities that are similar to undisturbed areas.

3.2.8 Wells and Piezometers

Wells may be used at mine sites for a variety of reasons such as sources of water for potable water systems or process water for mill facilities and the de-watering of open pits. Piezometers are used for groundwater monitoring programs and their network may be extensive. Both of these structures could lead to mixing of surface and ground water and of groundwater from different layers. Decommissioning of these structures should be undertaken through the placement of grouting material to ensure that there is no vertical movement between surface water and groundwater and between different groundwater layers. This may involve the complete grouting of the drill hole from surface to the bottom. Casings should be removed to just below the ground surface. How far below the surface will depend on the potential for the surface materials to erode and thus expose the casing.

3.3 Re-vegetation

The re-vegetation of the disturbed areas at a project site will be one of the final reclamation steps. One of the most important components of a successful re-vegetation program is to have a suitable substrate for the seed bed. Ideally it is best to use the original topsoil from the disturbed area. In most situations, the topsoil from all areas being cleared should be retained for subsequent reclamation. The topsoil contains the majority of seeds and other plant propagules (such as rhizomes, roots, etc.), soil micro organisms, organic matter, and the more labile (more readily cycled) plant nutrients. Stockpiling of topsoil should be undertaken in the following manner:

- if possible, the stockpiles should be placed in areas that have already been disturbed and the stockpiles should be away from any waterbodies;
- the stockpiles should be revegetated to protect the soil from erosion, discourage weeds, and maintain active populations of beneficial soil microbes; and
- the stockpiles should be located in areas where they will not be disturbed by future activities, as excessive handling will adversely affect soil moisture.

The timing of topsoil stripping can be important for subsequent rehabilitation. Soils should not be stripped or replaced when they are too wet or too dry, as this can lead to compaction, loss of structure, and a loss of variability of seeds and mycorrhizal inoculum (a natural ecosystem component that increases uptake of plant nutrients from the soil).

The surface soils at reclaimed sites may need some preparation prior to re-vegetation. Soil preparation may include the addition of chemical fertilizers, composted sewage sludge and/or mulches. Native plants are likely to require fewer nutrients in comparison to agricultural plants therefore application rates should be examined on test plots before general application. Organic mulches such as wood fibers provide some organic materials for soils and also help to stabilize the soil surface and reduce erosion (Wright 2005).

Sites should be re-vegetated with local, natural seed mixes, shrubs, and trees. A review of species lists for the various plant communities in the project area will provide an indication of the species to use for area re-vegetation. Proponents should check with seed suppliers for the source of their seed stock. While focused on plant communities in the commercial forest area of Saskatchewan, Kosowan and Smith (2004) provide suggestions on what native species to use for re-vegetation based on the characteristics of the sites. Many of the suggested species also occur in northern Saskatchewan.

It will not be necessary to restore disturbed sites to the final climax community but rather to a successional community that will be consistent with local undisturbed vegetation. The species present and their density should be within the range in variation that is observed in local undisturbed plant communities.

Some small disturbed areas that are no greater than 2 ha in surface area may be re-vegetated through natural encroachment of local native vegetation. This is provided that the areas are relatively flat and are not near surface waterbodies so that erosion is not a concern. It is best that this approach is used during

active operations so that if the encroachment of natural vegetation is slow, active re-vegetation may be undertaken.

The placement of shrub species and tree saplings should be conducted in a random pattern. Placement of shrubs and trees in straight lines results in an artificial look for a re-vegetated area. The initial planting densities may be somewhat higher than what is observed in natural undisturbed areas. This will allow for some mortality during the planting of the shrubs and trees.

3.4 Radiation

For uranium mines and mills, an additional concern is the level of gamma radiation that remains after site reclamation. The final radiation levels at reclaimed sites should not be greater than a mean of 1 μSv/hr above the natural range in variability that is observed at reference locations (i.e. background radiation levels) The mean value will be taken from a 100 m by 100 m area (1 ha). Measurements are to be taken from approximately 1 m above the surface. The frequency of readings within the sample grid would in part be determined by the variability in the individual readings. However, the minimum density of readings should be 1 gamma reading per 100 m^2. Reclaimed sites should be matched with reference locations that are similar in terms of soils and plant communities.

4.0 PUBLIC CONSULTATION AND DECOMMISSIONING AND RECLAMATION PLANS

The process of consultation for decommissioning should begin early during the final closure phase. Consultation should not be on a selective basis, but should involve all stakeholders in the project. Other parties, such as conservation organizations and other non-government organizations may have an interest in the project and may be included in the consultation process. To be effective, communication must not only provide information on the predicted impacts of a project and the mine closure proposals and activities but must also include listening to, and considering, public comments, concerns and feedback.

Depending on the type of impacts there may be restrictions on the type of land use for certain areas of the reclaimed site. Consultation will therefore help to avoid building false expectations about the outcomes of decommissioning and final closure.

Stakeholders will include:

- local First Nation and Metis (Environmental Quality Committees, impacted aboriginal communities) - local Aboriginals provide a vital link to communities. Early consultation and planning is essential to minimize disruption to communities and address concerns for the physical rehabilitation of the site.
- leaseholders, neighbours and nearby residents - these groups may be physically affected by the closure and may have particular needs and desires that can be incorporated into rehabilitation planning. These groups may include trappers, commercial fisherman, and outfitters.
- local governments (northern villages and hamlets) - local governments provide a vital link with the community. Early consultation and planning is essential to minimize disruption to community services.
- local and regional business and service providers - the economic effects of mine closure on local and regional business and service providers may be severe and consultation is important to assist them in their own planning for the transition.
- NGOs and Community Groups (Environmental Groups, land use planning groups) - these groups will be the most varied and often represent different points of view from those elements in the community that are physically and/or financially affected by the mine closure.

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GLOSSARY

A number of definitions of terms that relate to decommissioning and reclamation plans are provided in Section 2 of The Mineral Industry Environmental Protection Regulations, 1996. These definitions include:

- **decommission** means to remove or retire permanently from service or take any action to remove or retire all or part of a mining site;

- **decommissioning and reclamation plan** means a plan, including any amendments to a plan, to decommission and reclaim all or part of a mining site;

- **mining site** means: a pollutant control facility, a mine, a mill, and any land, water, or watercourses used or disturbed by the construction or operation of a pollutant control facility, mine or mill;

- **pollutant control facility** means: a facility or area for the collection, containment, storage, transmission, treatment or disposal of any pollutant arising from mining operation or from the development of or the exploration for any mineral, and includes the environmental protection components of: i) a mine or a mill; ii) a tailings management area; iii) an ore storage facility; iv) a waste rock disposal area; v) a mine overburden or spoil disposal area; vi) a waste treatment plant; vii) a fuel storage facility; viii) a chemical storage facility; ix) a waste sump; x) a site drainage control; xi) a groundwater dewatering system; xii) any equipment used for exploration; and xiii) all associated machinery and equipment, including pumps, pipes, conveyors, launders, and ditches used in connection with facilities or areas mentioned in subclauses (i) to (xii).

- **reclaim** means to rehabilitate all or part of the land, water, or watercourses used or disturbed by the construction or operation of a pollutant control facility, mine or mill.