



Waste Management **Waste Management, Volume II: Management of Uranium Mine Waste Rock and Mill Tailings**

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**Waste Management, Volume II:
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Preface

Regulatory document REGDOC-2.11.1, *Waste Management, Volume II: Management of Uranium Mine Waste Rock and Mill Tailings*, sets out the requirements of the Canadian Nuclear Safety Commission (CNSC) for the sound management of mine waste rock and mill tailings during site preparation, construction, operation and decommissioning of new uranium mine or mill projects and/or of new waste management facilities at existing uranium mines and mills in Canada to ensure the protection of the environment and the health and safety of people.

This regulatory document also provides guidance to applicants regarding the CNSC's expectations for new mining projects throughout Canada on the management of waste rock and tailings generated by uranium mining and milling operations. CNSC staff use this document when making regulatory decisions regarding the management of mine waste.

Applicants for new uranium mine and/or mill projects, or new projects at existing mine and mill sites, are required to submit a licence application to the CNSC. A licensing decision is supported by an environmental assessment of alternative means to manage mineralized waste rock or tailings, and provides the rationale for the preferred waste management method. The licence application includes the results of the environmental assessment and provides a description of the management method for safe long-term storage of mineralized waste rock and mill tailings. The CNSC staff reviews the information contained in the environmental assessment and in the application, and makes recommendations to the Commission Tribunal on the acceptability of the proposed management method.

This document replaces RD/GD-370, *Management of Uranium Mine Waste Rock and Mill Tailings*, published in March 2012, and P-290, *Managing Radioactive Waste*, published in July 2004. This regulatory document should be applied in conjunction with REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures*, version 1.1.

In this document, “shall” is used to express a requirement; i.e., a provision that a licensee or licence applicant is obliged to satisfy in order to comply with this regulatory document. “Should” is used to express guidance, or that which is advised. “May” is used to express an option or that which is permissible within the limits of this regulatory document. “Can” is used to express possibility or capability.

Note: In 2013, the CNSC adopted a revised regulatory framework structure with a new system for naming and numbering regulatory documents. This document has been published as part of the CNSC's initiative to bring regulatory documents that were published before the current framework was adopted into the new system. The requirements and guidance in this document have not changed.

Table of Contents

1.	Introduction.....	1
1.1	Purpose.....	1
1.2	Scope.....	1
1.3	Relevant regulations	1
1.4	National and international standards.....	2
2.	Requirements for Managing Mine Waste.....	3
3.	Guidance on Managing Mine Waste	3
3.1	Guidance on selecting a mine waste management alternative	3
3.2	Assessment of alternatives.....	4
3.3	Monitoring	4
4.	Performance Measurement.....	5
	Appendix A: Principles for Managing Radioactive Waste	6
A.1	Purpose.....	6
A.2	Scope.....	6
A.3	Definition	6
A.4	Background.....	6
A.5	Policy statement.....	7
	Glossary	8
	References.....	11

Management of Uranium Mine Waste Rock and Mill Tailings

1. Introduction

1.1 Purpose

This regulatory document sets out the requirements of the Canadian Nuclear Safety Commission (CNSC) for the sound management of mine waste rock and mill tailings during site preparation, construction, operation and decommissioning of new uranium mine or mill projects and/or of new waste management projects at existing uranium mines and mills in Canada, to ensure the protection of the environment and the health and safety of people.

1.2 Scope

Applicants for new uranium mine and/or mill projects, or new waste management projects at existing mine and mill sites, are required to submit a licence application to the CNSC. A licensing decision is supported by an environmental assessment of alternative means to manage mineralized waste rock or tailings, and provides the rationale for the preferred waste management method. The licence application includes the results of the environmental assessment and provides a description of the management method for safe long-term storage of mineralized waste rock and mill tailings. The CNSC staff reviews the information contained in the environmental assessment and in the application, and makes recommendations to the Commission Tribunal on the acceptability of the proposed management method.

In addition to setting out the requirements, this regulatory document provides guidance to applicants regarding the CNSC's expectations for new mining projects throughout Canada on the management of mineralized waste rock and tailings generated by uranium mining and milling operations. CNSC staff use this regulatory document when making regulatory decisions regarding the management of mine waste.

Note that prospecting for uranium or surface exploration activities are not licensed by the CNSC.

1.3 Relevant regulations

The following provisions of the *Nuclear Safety and Control Act* (NSCA) and regulations made under the NSCA are relevant to this regulatory document:

- paragraph 3(a) of the NSCA states “The purpose of this Act is to provide for (a) the limitation, to a reasonable level and in a manner that is consistent with Canada's international obligations, of the risks to national security, the health and safety of persons and the environment that are associated with the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information;”
- paragraph 24(4)(b) of the NSCA states “No licence may be issued, renewed, amended or replaced — and no authorization to transfer one given — unless, in the opinion of the Commission, the applicant [...] (b) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.”

- paragraph 3(1)(j) of the *General Nuclear Safety and Control Regulations* states “An application for a licence shall contain the following information: [...] (j) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste;”
- paragraph 3(1.1)(b) of the *General Nuclear Safety and Control Regulations* states “The Commission or a designated officer authorized under paragraph 37(2)(c) of the Act, may require any other information that is necessary to enable the Commission or the designated officer to determine whether the applicant [...] (b) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.”
- paragraph 5(1)(h) of the *Uranium Mines and Mills Regulations* (UMMR) states “An application for a licence to prepare a site for and construct a uranium mine shall contain the following information in addition to the information required by section 3 and subsection 4(2): [...] (h) the anticipated quantities and grade of ore and waste rock that will be removed, their proposed storage location, and the proposed method, program and schedule, for their removal and disposal;”

REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures*, version 1.1 [1], and appendix A, Principles for managing radioactive waste, also apply to the management of mineralized waste rock and mill tailings.

The following federal legislation is also relevant to the control of mine waste and mill tailings:

- *Canadian Environmental Protection Act, 1999* (CEPA 1999) [2], particularly paragraphs 2(1)(a), (a.1), (b) and (i), and paragraphs 2(1.1)(a), (b) and (c)
- *Canadian Environmental Assessment Act, 2012* (CEAA) [3], particularly paragraphs 15(1)(a) and (c), and 19(1)(a)
- *Fisheries Act* (FA) [4], particularly subsections 36(3), 36(6), 38(5), and paragraphs 34(a) to (d) and 36(4)(a) and (b)
- *Metal and Diamond Mining Effluent Regulations* (MMER) [5], particularly subsections 5(1) and 27.1(1)

In order for a natural water body frequented by fish to be designated as a tailings impoundment area, it must be added to Schedule 2 of the MMER, which requires an amendment to the MMER. This regulatory amendment triggers a federal environmental assessment according to the CEAA. The environmental assessment must undertake an analysis of alternatives for the disposal of the mine waste, based on environmental, technical, economic and socio-economic criteria.

1.4 National and international standards

This regulatory document is consistent with the philosophy of modern national and international guides and standards for the management of mine waste. In particular, this regulatory document is based in part on the following national and international publications:

- *Guidelines for the Assessment of Alternatives for Mine Waste Disposal*, Environment and Climate Change Canada (ECCC) [6]
- *Environmental Code of Practice for Metal Mines*, ECCC [7]

- *Management of Radioactive Waste from the Mining and Milling of Ores, Safety Guide WS-G-1.2*, International Atomic Energy Agency (IAEA) [8]
- *Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities*, European Commission [9]
- *Best Practice in Environmental Management of Uranium Mining, Nuclear Energy Series No. NF-T-1.2*, IAEA [10]

2. Requirements for Managing Mine Waste

The use of natural water bodies frequented by fish shall be avoided to the extent practicable for the long-term management of mineralized waste rock and tailings.

Licensees shall manage mineralized waste rock and tailings:

- to maximize the use of:
 - mine workings, such as open pits and underground developments
 - natural and/or engineered barriers between the waste materials and the environment
 - controls designed to minimize releases to the environment
- with due consideration of the characteristics of the mineralized waste rock or tailings, and best management practices
- to ensure the long-term protection of Canada's terrestrial and aquatic environment, as well as the protection of current and future generations

Overburden and clean rock shall be used as construction material, and/or as a resource, and/or managed on surface through effective rock segregation programs, to the extent practicable and in a manner that is consistent with the concept of waste minimization.

The design of mineralized waste rock and tailings management systems shall minimize the reliance on active institutional controls post decommissioning.

3. Guidance on Managing Mine Waste

This section clarifies the CNSC's expectations on selecting a mine waste management alternative and on avoiding, to the extent practicable, the use of natural water bodies frequented by fish for the long-term management of mine waste.

3.1 Guidance on selecting a mine waste management alternative

In general, the use of water bodies frequented by fish for the management of mine waste that contains a deleterious substance requires:

- authorization by the Governor in Council by way of a regulatory amendment to list the water body on Schedule 2 of the MMER
- approval of a habitat compensation plan by Fisheries and Oceans Canada (DFO)
- a licence from the CNSC

Environment and Climate Change Canada provides guidance [6] on the assessment of alternatives for mine waste disposal in water bodies frequented by fish. This guidance should be used for all metal mining operations, including uranium mining, when the proponent's preferred option included the use of natural water bodies frequented by fish.

Applicants should select the most suitable mine waste disposal alternative from an environmental, technical, economic and socio-economic perspective, and obtain input and strive to achieve consensus on the decision from a broad stakeholder group. In order to do so, CNSC staff recommends applicants conduct an appropriate assessment of all mine waste disposal alternatives to transparently demonstrate how the preferred option was selected. This analysis may be conducted pursuant to ECCC 2011 [6] or a similar means that is commensurate with the risk to the environment and level of public concern.

3.2 Assessment of alternatives

An assessment of alternatives objectively and rigorously considers all available options for mine waste disposal. The assessment considers predicted quality and quantity of releases to the environment, and the predicted effects on the environment. The assessment of alternatives should also consider the full cost of each option throughout the project lifecycle and its associated benefits.

The major steps of the assessment include:

- development of a list of all possible candidate mine waste disposal options, with the input from stakeholders and without prior judgments
- screening of options to reduce the number and to provide assurance that any of the remaining options could prove to be the preferred option
- characterization of the remaining alternatives to ensure proper consideration of every aspect and nuance and the comparison of alternatives in a clear and concise format, to ensure complete transparency of the decision process
- identification of evaluation criteria that are linked to an effect and that easily differentiate the alternatives
- inclusion of quantitative value judgment in the decision process by scoring and weighting all evaluation criteria under the environmental, technical, economic and socio-economic characteristics of each alternative
- an assessment of the sensitivity of the decision-making process

The results of this assessment of alternatives are documented and submitted to CNSC staff as part of an environmental assessment. The results are verified through the subsequent licence application. The submission should provide a clear and concise summary of the findings of each step, using comparative tables and clear descriptive text. Detailed supporting information related to cost estimate breakdowns, geochemical assessment and contaminant transport modeling should also be included. The CNSC, as the responsible authority, consults with other federal and provincial agencies (i.e., ECCC, DFO, Natural Resources Canada, and provincial jurisdictions) to ensure that all regulatory requirements are satisfied by the final waste management plan.

3.3 Monitoring

The applicant should also conduct follow-up monitoring and develop an ongoing characterization plan to ensure the chosen mine waste management method(s) are undertaken and verified throughout the lifecycle of the project. For example, clean waste rock and overburden should be sorted and stored separate from the mineralized waste rock and tailings. Commitments to establish this type of quality control and verification should be made initially, and further detailed in subsequent phases of the project – during siting, construction and operation.

4. Performance Measurement

Adaptive management is essential to the sound management of mine waste management projects [11]. Adaptive management is a planned and systematic process for continuously improving environmental management practices by learning from their outcomes. It may not always result in changes to the mine waste management system already in place, but may help improve the design of future waste management projects, by ensuring that best management practices improve as science evolves with time. In an adaptive management process, environmental managers monitor the effects of the selected management action, and adjust the action based on the monitoring results [11].

Monitoring programs should be designed to effectively evaluate the performance of the waste management approach against predicted or required outcomes; this will help to ensure that long-term objectives can be met. Actual field-scale data resulting from the performance monitoring program should be used to refine and calibrate models used in the design of mine waste management facilities.

Performance indicators should be used to reflect how well elements of the mine waste management plan are performing against predictions made in the environmental assessment and updated throughout the lifecycle of the mine waste management facility. Examples of performance indicators include:

- fluxes of contaminants from the waste facility compared to anticipated quality
- percolation through a cover or liner system compared to estimated values
- concentrations of contaminants in specific environmental media (for example, groundwater and surface water quality as compared to anticipated quality)
- sublethal or acute toxicity testing for relevant species of fish, benthic invertebrates and algae
- biological indicators, such as benthic community indexes, fish usage (i.e., contaminant levels in fish tissue) and fish health indicators

If performance indicators vary significantly from the predictions, then the management plan may need to be modified to achieve the desired performance [11]. Performance indicators should be presented by the licensee and used to determine what will be monitored, how long the monitoring will be conducted, and when contingency measures and adaptive management should be initiated.

Appendix A: Principles for Managing Radioactive Waste

A.1 Purpose

These principles are intended to promote:

- the implementation of measures to manage radioactive waste so as to
 - protect the health and safety of persons and the environment
 - provide for the maintenance of national security
 - achieve conformity with measures of control and international obligations to which Canada has agreed
- consistent national and international standards and practices for the management and control of radioactive waste

A.2 Scope

These principles describe the philosophy that underlies the CNSC's approach to regulating the management of radioactive waste and the principles that are taken into account when making a regulatory decision concerning radioactive waste management. These principles are relevant to all waste management phases, practices and considerations, including the generation, handling, processing, controlled release, storage, disposal and abandonment of radioactive waste.

These principles also express the CNSC's commitment to consulting and cooperating with provincial, national and international agencies on matters concerning harmonization of the regulation of radioactive waste management in Canada.

A.3 Definition

The term "radioactive waste" means any material (liquid, gaseous or solid) that contains a radioactive "nuclear substance," as defined in section 2 of the *Nuclear Safety and Control Act* (NSCA) and which the owner has declared to be waste. In addition to containing nuclear substances, radioactive waste may also contain non-radioactive "hazardous substances," as defined in section 1 of the *General Nuclear Safety and Control Regulations*.

A.4 Background

The CNSC regulates the use of nuclear energy and materials to protect the health and safety of persons, the environment and national security and to respect Canada's international commitments on the peaceful use of nuclear energy. Under section 26 of the NSCA, subject to exemptions authorized by the regulations, no person may possess, transfer, import, export, use, abandon, mine, produce, refine, convert, enrich, process, reprocess, package, transport, manage, store or dispose of a nuclear substance, except in accordance with a licence issued by the CNSC.

Since all radioactive waste contains nuclear substances, radioactive waste is subject to the NSCA and its regulations. Stated explicitly, all of the exclusions, prohibitions, requirements, exemptions and limitations imposed by the NSCA, the *General Nuclear Safety and Control Regulations*, the *Radiation Protection Regulations*, the *Class I Nuclear Facilities Regulations*, the *Class II Nuclear Facilities and Prescribed Equipment Regulations*, the *Uranium Mines and Mills Regulations*, the *Nuclear Substances and Radiation Devices Regulations*, the *Packaging and Transport of Nuclear Substances Regulations*, the *Nuclear Security Regulations*, and the *Nuclear Non-Proliferation Import and Export Control Regulations* apply to radioactive waste.

Licensed activities produce many types of radioactive waste, such as uranium mill tailings, medical isotope waste, spent nuclear fuel, and cleaning material contaminated with low levels of nuclear substances; each presenting its own level of hazard. Since all nuclear substances associated with licensed activities will eventually become waste, the safe long-term management of that waste is taken into consideration during the review process for any licensed activity.

A.5 Policy statement

When making regulatory decisions concerning the management of radioactive waste, it is the policy of the CNSC to consider the extent to which the owners of the waste have addressed the following principles:

- a) The generation of radioactive waste is minimized to the extent practicable by the implementation of design measures, operating procedures and decommissioning practices;
- b) The management of radioactive waste is commensurate with its radiological, chemical and biological hazard to the health and safety of persons and the environment and to national security;
- c) The assessment of future impacts of radioactive waste on the health and safety of persons and the environment encompasses the period of time when the maximum impact is predicted to occur;
- d) The predicted impacts on the health and safety of persons and the environment from the management of radioactive waste are no greater than the impacts that are permissible in Canada at the time of the regulatory decision;
- e) The measures needed to prevent unreasonable risk to present and to future generations from the hazards of radioactive waste are developed, funded and implemented as soon as reasonably practicable; and
- f) The trans-border effects on the health and safety of persons and the environment that could result from the management of radioactive waste in Canada are not greater than the effects experienced in Canada.

It is also CNSC policy to consult and cooperate with provincial, national and international agencies to:

- g) promote harmonized regulation and consistent national and international standards for the management of radioactive waste; and
- h) achieve conformity with the measures of control and international obligations to which Canada has agreed concerning radioactive waste.

Glossary

adaptive management

A planned and systematic process for continuously improving environmental management practices by learning from their outcomes.

assessment

The process, and the result, of systematically evaluating the hazards associated with sources and practices, and associated protection and safety measures, aimed at quantifying performance measures for comparison with criteria. Assessment should be distinguished from analysis. Assessment is aimed at providing information that forms the basis of a decision about whether something is satisfactory or not. Various kinds of analysis may be used as tools in doing this. Hence, an assessment may include a number of analyses.

best practice

An industry-accepted design, process or procedure that consistently produces superior results.

clean waste rock

Rock which does not have the potential to release hazardous and/or nuclear substances that could have a significant adverse effect on human health or be deleterious to the environment. Clean rock may still require management for other reasons, such as to control erosion to prevent siltation of local surface water bodies.

control

Environmental management procedures or engineering techniques that reduce the release of hazardous and nuclear substances to the environment.

deleterious substance

As defined in the *Fisheries Act* [4]:

1. Any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water
2. Any water that contains a substance in such quantity or concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would, if added to any other water, degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water

frequented by fish

See “water frequented by fish”.

institutional controls

The control of residual risks at a site after it has been decommissioned. Institutional controls can include active measures (requiring activities on the site such as water treatment, monitoring, surveillance and maintenance) and passive measures (that do not require activities on the site, such as land use restrictions, markers, etc.).

licensing basis

A set of requirements and documents for a regulated facility or activity comprising:

- the regulatory requirements set out in the applicable laws and regulations
- the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence
- the safety and control measures described in the licence application and the documents needed to support that licence application

long term

In mineralized waste rock and tailings disposal, any period of time after active institutional controls can be expected to cease.

mineralized waste rock

Rock which has the potential to release hazardous and/or nuclear substances that could have a significant adverse effect on human health or be deleterious to the environment. Mineralized waste rock may be further segregated based on radiological content, contaminants of concern (e.g., nickel, arsenic), and acid generating potential. Mineralized waste rock is often referred as to special waste rock.

mine waste

Includes tailings and mineralized waste rock but does not include overburden and clean rock.

nuclear substance

As defined in the NSCA, means:

- deuterium, thorium, uranium or an element with an atomic number greater than 92
- a derivative or compound of deuterium, thorium, uranium or of an element with an atomic number greater than 92
- a radioactive nuclide
- a substance that is prescribed as being capable of releasing nuclear energy or as being required for the production or use of nuclear energy
- a radioactive by-product of the development, production or use of nuclear energy
- a radioactive substance or radioactive thing that was used for the development or production, or in connection with the use, of nuclear energy

overburden

Generally means the material overlying the ore deposit, including rock as well as soil and other unconsolidated (loose) materials. For this document, the term overburden is restricted to soil and other unconsolidated materials, including glacial deposits, sand and sediment. Overburden may still require management for other reasons, such as soil contamination or to control erosion to prevent siltation of local surface water bodies.

pollution prevention

The use of processes, practices, materials, products, substances or energy that avoid or minimize the creation of pollutants and waste and reduce the overall risk to the environment or human health.

project lifecycle

Includes all ongoing activities during the main licence granted by the CNSC: preparing the site, constructing, operating, and decommissioning of a mine project.

tailings

The waste material and water mixture that is left over after the mill removes the valuable rocks. The rock material in tailings is usually the size of sand grains or smaller.

waste rock

Rock which does not contain any minerals in sufficient concentration to be considered ore, but which must be removed in the mining process to provide access to the ore. Waste rock includes both mineralized and clean waste rock.

water frequented by fish

As defined in the *Fisheries Act* [4], means Canadian fisheries waters.

References

1. Canadian Nuclear Safety Commission (CNSC), REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures*, Version 1.1, Ottawa, Canada, 2017
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6. Environment and Climate Change Canada (ECCC), [*Guidelines For The Assessment Of Alternatives For Mine Waste Disposal*](#), Ottawa, Canada, 2011
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11. Mine Environment Neutral Drainage (MEND) Program, *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials*, MEND Report 1.20.1, Natural Resources Canada, CANMET Mining and Mineral Sciences Laboratories, editor: William A. Price, Smithers, British Columbia, Canada, 2009

CNSC Regulatory Document Series

Facilities and activities within the nuclear sector in Canada are regulated by the Canadian Nuclear Safety Commission (CNSC). In addition to the *Nuclear Safety and Control Act* and associated regulations, these facilities and activities may also be required to comply with other regulatory instruments such as regulatory documents or standards.

Effective April 2013, the CNSC's catalogue of existing and planned regulatory documents has been organized under three key categories and twenty-five series, as set out below. Regulatory documents produced by the CNSC fall under one of the following series:

1.0 Regulated facilities and activities

Series	1.1	Reactor facilities
	1.2	Class IB facilities
	1.3	Uranium mines and mills
	1.4	Class II facilities
	1.5	Certification of prescribed equipment
	1.6	Nuclear substances and radiation devices

2.0 Safety and control areas

Series	2.1	Management system
	2.2	Human performance management
	2.3	Operating performance
	2.4	Safety analysis
	2.5	Physical design
	2.6	Fitness for service
	2.7	Radiation protection
	2.8	Conventional health and safety
	2.9	Environmental protection
	2.10	Emergency management and fire protection
	2.11	Waste management
	2.12	Security
	2.13	Safeguards and non-proliferation
	2.14	Packaging and transport

3.0 Other regulatory areas

Series	3.1	Reporting requirements
	3.2	Public and Aboriginal engagement
	3.3	Financial guarantees
	3.4	Commission proceedings
	3.5	CNSC processes and practices
	3.6	Glossary of CNSC terminology

Note: The regulatory document series may be adjusted periodically by the CNSC. Each regulatory document series listed above may contain multiple regulatory documents. For the latest list of regulatory documents, visit the [CNSC's website](http://www.cnscc.gc.ca).