Nuclear Waste Management Organization

Integrated Strategy for Radioactive Waste
Initial Plan Development – Characterization and Options

Project Report

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Executive Summary

This study was prepared to support the initial planning of the Integrated Strategy for Radioactive Waste (ISRW), a long-term management strategy for Canada's low- and intermediate-level radioactive waste (L&ILW). The purpose of this study is to evaluate Canada's L&ILW inventory at a summary level to categorize and sort the radioactive waste, and to identify suitable long-term management options for each radioactive waste category. Six (6) potential options for the long-term management of Canada's L&ILW have been identified by the NWMO:

- Engineered Containment Mound
- Concrete Vault
- Shallow Rock Cavern
- Deep Geological Repository
- Deep Borehole
- Rolling Stewardship

For the purposes of this initial plan, a summary level of detail was gathered about the current and projected future inventories from the current Canadian waste owners. This report identifies existing and future Canadian L&ILW that have no current long-term management plans and presents an integrated assessment for the long-term management of this waste (totalling approximately 294,000 m^3 of LLW and 51,000 m^3 of ILW, presented in Figure ES-1).

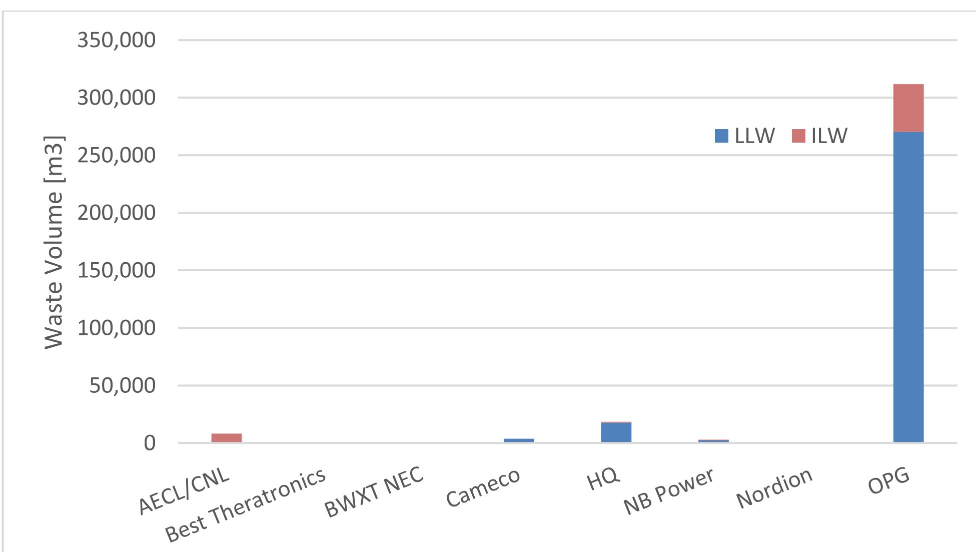


Figure ES-1: Canadian L&ILW with no current long-term management plans (current and anticipated).

Recommended long-term management options were identified for each waste type and are presented in Figure ES-2. Bulk low-level waste (LLW) includes low concentrations of radioactivity and was therefore deemed most suitable for the Engineered Containment Mound. For other LLW, variable physical characteristics and concentrations of radioactivity warranted a conservative approach to recommend the Concrete Vault and Shallow Rock Cavern options. Intermediate-level waste (ILW) has a relatively high concentration of long-lived radionuclides compared to LLW, which requires disposal deep underground. As a result, the Deep Geological Repository was recommended as per international best practice.

Additional alternative options were presented, including Deep Borehole disposal for small dimension ILW, subject to further assessment as discussed in this report. Rolling Stewardship is identified as conceptually feasible, but after considering technical, financial, and human risk factors, is considered impractical. The report body will go into further detail on technical and financial challenges (repackaging and long-term active management), and human factors (consistency of intergenerational management). The capability of a repository to accept a particular type of waste will depend on the waste acceptance criteria of the repository, which is driven by the safety assessment for the specific repository.

Overall, the evaluation presented in this report provides observations and recommendations for further investigation on the Integrated Strategy for Radioactive Waste. Given the summary level of detail gathered for this initial plan, there is an opportunity to further engage each waste owner and investigate the characterization of the waste in future studies.

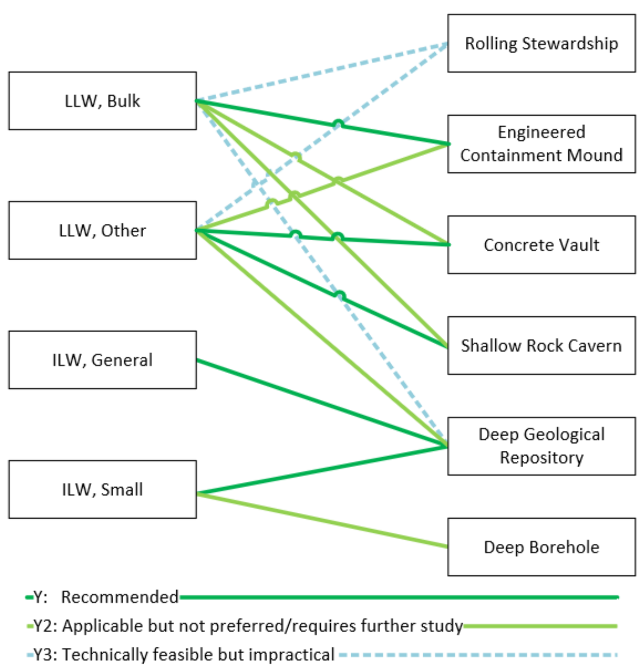


Figure ES-2: Long-term management recommendations for Canadian L&ILW.

Revision History

Rev #	Description of Change	Date Revised
0	Issued for Use	19-Aug-2021

Table of Contents

List of Appendices

List of Figures

List of Tables

Nomenclature

Abbreviation	Definition
Activity	A measure of the radioactivity in Becquerels.
AECL	Atomic Energy of Canada Limited
APM	Adaptive Phased Management – Canada's long-term management plan for used nuclear fuel.
BNGS	Bruce Nuclear Generating Station
Bulk Material	Material that is granular in nature, such as soil, demolished concrete or construction/demolition waste.
CANDU	Canada Deuterium Uranium – A Canadian heavy water reactor that is currently the only type of power reactor operating in Canada.
Calandria	Internal Vessel of CANDU reactor holding the heavy water moderator at atmospheric pressure and low temperature
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
DGR	Deep Geological Repository
Disposal	The placement of radioactive waste without the intention of retrieval.
DNGS	Darlington Nuclear Generating Station
DWMF	Darlington Waste Management Facility
ECM	Engineered Containment Mound
HLW	High-Level Waste, including used fuel, as defined in [1]
ILW	Intermediate-Level Radioactive Waste, as defined in [2]
LLW	Low-Level Radioactive Waste, as defined in [2]
Long-term Management	The long-term management of radioactive nuclear waste by means of storage or disposal.
L&ILW	Low- and Intermediate-Level Waste, as defined in [2]
MWe	Megawatt of electricity
NPD	Nuclear Power Demonstration reactor
NSDF	Near Surface Disposal Facility
NWMO	Nuclear Waste Management Organization
OPG	Ontario Power Generation
PNGS	Pickering Nuclear Generating Station
PWMF	Pickering Waste Management Facility
SMR	Small Modular Reactor
Waste	In the context of this report, *waste* is assumed to be a radioactive waste unless specified otherwise (e.g., *non-nuclear waste*).
WR1	Whiteshell Reactor 1
Waste Owner	The radioactive *waste owner* is the organization currently responsible for the radioactive waste.
WWMF	Western Waste Management Facility, owned and operated by OPG located at the Bruce Nuclear Generating Station site.

1. Introduction and Scope

1.1 Introduction

The Nuclear Waste Management Organization (NWMO) was tasked by Canada's Minister of Natural Resources to share its extensive engagement expertise and lead the development of a strategy for the safe, long-term management of all of Canada's low- and intermediate-level radioactive waste (L&ILW). While L&ILW is safely managed today on an interim basis at the nuclear waste owners' facility, a long-term, integrated strategy for Canada's L&ILW needs to be developed.

To support this strategy, Hatch has been retained to analyze Canada's L&ILW and identify suitable long-term management options for the waste. Based on international benchmarking, the NWMO has identified six (6) potential options for the long-term management of Canada's L&ILW, which are presented in further detail on the Integrated Strategy for Radioactive Waste (ISRW) website[1]. The six potential long-term management options for L&ILW are:

- Engineered Containment Mound
- Concrete Vault
- Shallow Rock Cavern
- Deep Geological Repository
- Deep Borehole
- Rolling Stewardship

This report discusses the volume and radiological, physical, and chemical characteristics of L&ILW reported by waste owners in Canada and their fit with the six potential long-term management options.

1.2 Scope

The scope of this project is to support the development of an integrated and strategic plan for the long-term management of Canada's L&ILW via the preparation of a report that will address the following:

1. Analyze the current and future volumes of L&ILW inventory provided by the nuclear waste owners/producers.
2. Identify the main pertinent radiological and chemical characteristics of the nuclear waste for long-term management (e.g., waste type, form, volume, main radioactive isotopes, subsidiary hazard, etcetera).
3. Propose appropriate "groups" for different nuclear waste to be bundled into for long-term management purposes.

[1] Website URL: https://radwasteplanning.ca/content/learn-more

4. From the list of six potential long-term management options described for L&ILW:
   i. Identify suitable options for each nuclear waste group.
   ii. Provide a rationale for excluding any options.

The scope of this study excludes the following radioactive waste streams:

1. High-Level Waste (HLW) (e.g., used fuel), which is instead covered under Canada's Adaptive Phased Management (APM) plan.
2. L&ILW from international waste owners.
3. Uranium mining and milling waste.
4. L&ILW volumes generated from potential future nuclear installations in Canada. However, anticipated waste from the considered new nuclear projects is discussed qualitatively in this report.
5. L&ILW that currently has a long-term management plan. For example, the LLW proposed for Canadian Nuclear Laboratories (CNL) Near Surface Disposal Facility (NSDF) and AECL's planned in-situ disposal of ILW.

2. Data and Methodology

2.1 Methodology

The waste inventory data was collected and organized according to the following characteristics, as available:

- Waste owner,
- Current location,
- Waste description,
- Radioactive Classification (i.e., LLW or ILW),
- State (i.e., solid or liquid),
- Current inventory volume,
- Lifecycle inventory volume,
- Packaging/physical configuration,
- Radiological characteristics,
- Non-nuclear characteristics,
- Current waste disposal plans, if any.

Once the full L&ILW inventory was organized, the characteristics from the list above were applied to group the waste inventory into categories of similar nature for the purpose of long-term management. In general, the waste was grouped based on radiological classification (i.e., LLW and ILW) and physical configuration (i.e., bulk material, packages, containers, etcetera). Additionally, wastes that have current long-term management plans were removed from the ISRW inventory.

The radioactive waste groups were assessed against each long-term management option based on technical feasibility and practicality. Each waste group was assigned one of four levels of applicability:

Y	The approach is applicable and recommended for the allocated waste group.
Y2	The approach may be applicable to the allocated waste group but is either not preferred or requires further study.
Y3	The approach is conceptually feasible but, after considering technical, financial, and/or human risk factors, is considered impractical.
N	The approach is not suitable for the allocated waste group.

The recommended waste group assignments to each long-term management option will be used to further develop the plan for the ISRW. It was identified that all LLW might be disposed of at a near-surface facility (i.e., Engineered Containment Mound, Concrete Vault, or Shallow Rock Cavern), whereas all ILW must be disposed of in a DGR or a Deep Borehole. If necessary, LLW can be disposed of in a deep underground facility, but ILW cannot be disposed of at a near surface facility. Rolling stewardship might be an option for L&ILW.

2.2 Assumptions and Simplifications

The study made the following assumptions in preparing each waste owner's radioactive waste inventory for analysis:

1. All liquid waste is assumed to be solidified (via incineration, vitrification, grouting, solidification agent, etcetera, as required).
2. Unless quantified by the waste owner, additional decontamination and volume reduction practices were not assumed in this study.
3. Projected operational waste is assumed to be packaged in the same physical configuration as an existing operational waste of the same source. For example, OPG's low level non-processible waste is currently stored in steel containers, so any future production of low level non-processible waste is assumed to be confined in steel containers as well.
4. It is assumed that all long-term management options can accept nuclear waste with non-nuclear hazardous properties because non-nuclear hazardous waste facilities employ engineered containment measures similar to those present in near-surface nuclear waste

disposal facilities, including water-proofing, leachate control, and monitoring. Additional design considerations may be required to address all non-nuclear hazards at the detailed design stage.

5. Waste owner inventory volumes have been rounded, given the level of uncertainty present at this time. This is considered a reasonable simplification, given the level of detail required for this study.

3. Waste Inventory Inputs

Data is reported in this section for each waste owner by waste types, lifecycle waste volumes, and other notable characteristics. For the purpose of this study, a summary level of detail was provided by each waste owner. As such, the level of detail available is different between waste owners. For instance, some owners reported only their current waste inventory while others reported their lifecycle waste volumes (i.e., including their projections of future waste generation). The study made adjustments such that lifecycle waste volumes were estimated and used in the analysis for all waste owners.

This section discusses the quality of the available information, any gaps in the available information, and assumptions used to cover missing information, as required.

The integrated waste inventory is presented in Section 4.1, and the detailed waste inventory data are tabulated in Appendix A.

3.1 AECL/CNL

3.1.1 Waste Sources and Data Reporting

AECL/CNL's waste inventory was reported as the volume of waste at each AECL/CNL location. AECL/CNL currently stores legacy Canadian radioactive waste from research reactors and legacy power reactors. Additionally, Chalk River Laboratories, operated by CNL, is an active nuclear research facility and stores a variety of waste arising from research activities. At this time, all LLW that belongs to AECL/CNL, as well as ILW from WR1 and NPD, has a planned disposal facility undergoing regulatory review and is therefore not considered part of the ISRW plan.

3.1.2 Waste Types and Volumes

The waste inventory that is considered as part of the ISRW plan, comprising ILW from Douglas Point, Gentilly-1, Chalk River Laboratories, and Whiteshell Laboratories, totals approximately 8,200 m^3. As this waste is predominantly from nuclear research activities, this waste is heterogeneous and not standard compared to the majority of Canada's waste which is generated in CANDU power plants. AECL/CNL has identified the potential inclusion of the following non-nuclear hazardous components: bitumen, mercury, oils, solvents, and organic coolants, but further information on non-nuclear hazardous components is not available at this time.

3.1.3 Data Preparation for Analysis

Based on the accuracy of data provided by AECL/CNL, the following adjustments were made to the data:

- The AECL/CNL data provided the volume of waste at each location, as well as an estimate that 91% of waste is solid and 9% is liquid. For the purpose of this study, it is assumed that liquids are conditioned to a solid state prior to disposal, so the liquid waste was adjusted to a solid-state per Assumption 1.
- AECL/CNL identified that the waste is heterogeneous and may contain non-nuclear hazardous components. Further elaboration was not provided, so all AECL/CNL waste was conservatively assumed to contain organic material and heavy metals.
- The assumption that all CNL waste contains organic material and heavy metals is likely overly conservative. This may affect the safety assessment for long-term management of AECL/CNL waste, so further investigation is recommended as this study progresses.
- AECL/CNL's waste packaging is not specified; however, since AECL/CNL's current strategy is to process all of their ILW to a passively safe state and contain the waste in modern, above-ground storage, it was assumed that AECL/CNL's waste would be contained in packages.

3.1.4 Technical Considerations

Given that AECL/CNL waste considered in the ISRW study is ILW, the waste inventory will contain long-lived radionuclides and will require containment for several hundred to several thousand years. As such, the ILW will need to be disposed of in a deep underground facility to meet adequate containment needs for long-lived waste.

3.2 Cameco

3.2.1 Waste Sources and Data Reporting

Cameco's waste inventory was reported as volumes from Cameco's Fuel Services Division, coming from industrial processes at the Blind River Refinery, Port Hope Conversions Facility, and from Cameco Fuel Manufacturing.

3.2.2 Waste Types and Volumes

Cameco's waste inventory is LLW contaminated with either depleted, enriched, or natural uranium, typically at low concentrations. The volume of Cameco's waste with no existing long-term management plans is less than 2,000 m^3. The type of waste present is not provided at this time, with the exception of 200 m^3 of depleted uranium scrap.

3.2.3 Data Preparation for Analysis

Based on the accuracy of data provided by Cameco, the following adjustments were made to the data:

- The Cameco data indicates that the waste from each location is predominantly solid but contains some liquid. For the purpose of this study, it is assumed that liquids are conditioned to a solid state prior to disposal, so the liquid waste was adjusted to a solid state per Assumption 1.

- Cameco did not specify the type of waste with the exception of 200 m^3 of depleted uranium scrap. Given the operation of the facilities, Cameco's waste was assumed to be manufacturing waste placed into LLW containers.
- The type of waste and waste packaging for Cameco's LLW inventory is not known and requires further investigation. However, since this waste is a relatively low volume of LLW, it is expected to have minimal impact in the context of this study.

3.2.4 Technical Considerations

Cameco's inventory is containerized LLW and is, therefore, suitable for long-term management at either near-surface or deep underground facilities.

3.3 Hydro Quebec

3.3.1 Waste Sources and Data Reporting

Hydro Quebec's reported data includes volumes of waste arising from operations and decommissioning of the Gentilly-2 reactor[2].

The waste volume produced from Gentilly-2 decommissioning was available for each system being decommissioned as well as the general characteristics of LLW and ILW. The best data available on waste volumes was provided in the Hydro Quebec document, H08-1770-001, Gentilly-2 Nuclear Generating Station Decommissioning Cost Study [3]. This data provided the system the waste will come from, rather than the waste type itself, so the waste type was assumed based on the system.

3.3.2 Waste Types and Volumes

Hydro Quebec's lifecycle waste inventory is produced from the past operations and planned decommissioning of the Gentilly-2 reactor. Hydro Quebec's operational waste is currently stored on-site and will be removed for disposal as part of dismantling and decontamination activities.

Hydro Quebec has indicated that their operational waste currently in storage at the Gentilly-2 Waste Management Facility is similar to typical CANDU nuclear plant operational waste, including ILW (e.g., purification filters and spent ion exchange resins) and LLW (e.g., compactable material, barrels of activated carbon, molecular sieves, desiccants, pieces of metal and other waste matrices, etcetera).

Hydro Quebec's current decommissioning plan includes a safe storage period of approximately 45 years between decommissioning and dismantling [4]. This safe storage period will substantially reduce the radioactivity of most L&ILW on site. ILW from decommissioning will include reactor internal components and the Calandria itself. LLW from

[2] As noted in Section 3.1, Gentilly-1 radioactive waste is included as part of AECL/CNL's waste inventory, not Hydro Quebec's.

decommissioning will primarily include piping, large objects (e.g., steam generators, pressurizers, etcetera), concrete and metallic construction waste, contaminated insulation, and secondary waste generated during decommissioning activities (personal protective equipment, contaminated tools, etcetera). With the exception of ILW, most metallic waste from decommissioning is expected to be surface contaminated. Hydro Quebec has identified that the components of the Gentilly-2 reactor may include non-nuclear hazardous material properties such as lead and mercury.

In total, Hydro Quebec's lifecycle waste inventory will include 18,000 m^3 of LLW and 1,000 m^3 of ILW.

3.3.3 Data Preparation for Analysis

Based on the accuracy of data provided by Hydro Quebec, the following adjustments were made to the data:

- The Hydro Quebec data indicates that the waste contains some liquid in drums but does not specify the volume of the waste. For the purpose of this study, it is assumed that liquids are conditioned to a solid state prior to disposal, so the liquid waste was adjusted to a solid state per Assumption 1.
- Gentilly-2 has not yet been dismantled, so the waste arising from decommissioning has not yet been packaged. Where reasonable, waste arising from decommissioning was assumed to be placed in LLW steel containers and ILW packages. This assumption will need to be confirmed with the waste generator at a later phase.
- As indicated in Section 3.3.1, the best waste volume data was organized based on the system being decommissioned rather than waste type. Since the waste was organized by the system, the waste type was defined based on the most common type of waste anticipated from each system. For example, the waste produced from dismantling a piping system was assumed to be an entirely metallic waste. This methodology underrepresents secondary wastes arising from decommissioning, such as personal protective equipment, contaminated tools, etcetera. However, given the level of detail in this study, this assumption is considered acceptable at this time.

3.3.4 Technical Considerations

Hydro Quebec's LLW includes a significant volume of metallic, containerized waste that is suitable for near-surface disposal or deep disposal. Bulk LLW that is generated from contaminated soils and concrete will be suitable for near-surface disposal, but the large volumes of low-contaminated waste may not be practical for deep disposal.

Hydro Quebec's ILW will contain long-lived radionuclides and will require containment for several hundred to several thousand years. As such, the ILW will need to be disposed of in a deep underground facility to meet adequate containment needs for long-lived waste.

Most of the ILW from operations is spent resin, which is dimensionally small and may be suitable for repackaging and disposal in a Deep Borehole.

3.4 New Brunswick Power (NB Power)

3.4.1 Waste Sources and Data Reporting

NB Power's waste inventory is produced by the operations, refurbishment, and planned decommissioning of the Point Lepreau Nuclear Generating Station. The inputs provide a detailed list of the current waste inventory volumes, as well as general projections of the waste growth and lifecycle waste inventory volumes.

3.4.2 Waste Types and Volumes

The waste arising from NB Power's operations is similar to typical CANDU operational waste, including spent purification filters, spent ion exchange resins, irradiated core components, and miscellaneous LLW (e.g., contaminated plant components, personal protective equipment, machine shop waste, contaminated tools, wire and cables, etcetera), and is stored at Point Lepreau Waste Management Facility. NB Power currently plans to reduce the volume of spent ion exchange resins with a reduction factor of 10:1 and reduce the volume of most other waste with a reduction factor of 80:1 via incineration. It is conservatively assumed that volume reduction products are returned to NB Power and are therefore included in this study. The waste arising from operations of NB Power's Point Lepreau Nuclear Generating Station is projected to be 186 m^3 of LLW and 80 m^3 of ILW.

Additionally, the waste arising from NB Power's refurbishment is similar to typical waste arising from CANDU refurbishments, including irradiated core components, primarily fuel channels. LLW from NB Power’s refurbishment is stored at Point Lepreau Waste Management Facility and includes piping, large objects (e.g., steam generators, pressurizers, etcetera), metallic construction waste, contaminated insulation, and secondary waste generated during refurbishment activities (personal protective equipment, contaminated tools, etcetera). The waste arising from NB Power's refurbishment is 684 m^3 of LLW and 130 m^3 of ILW.

Finally, the waste that will be produced by the decommissioning of Point Lepreau Nuclear Generating Station will be similar to typical waste produced from CANDU decommissioning. ILW from decommissioning will include reactor internal components and the Calandria itself. LLW from decommissioning will primarily include piping, large objects (e.g., steam generators, pressurizers, etcetera), concrete and metallic construction waste, contaminated insulation, and secondary waste generated during decommissioning activities (personal protective equipment, contaminated tools, etcetera). The waste arising from NB Power's decommissioning is estimated to be approximately 1,400 m^3 of LLW and 570 m^3 of ILW.

3.4.3 Data Preparation for Analysis

Based on the accuracy of data provided by NB Power, the following adjustments were made to the data:

- NB Power classifies waste using radioactive dose rates as Type 1, Type 2, and Type 3 rather than LLW and ILW. To align this dataset with the Canadian definition of LLW and ILW [2], the NB Power activity concentrations were compared to OPG's activity concentrations for LLW and ILW. Based on the comparison to OPG data, Type 1 waste was classified as LLW, and Type 2 and Type 3 waste were classified as ILW.

- The inputs provide a detailed list of the current waste inventory, as well as general projections of the waste growth and lifecycle waste inventory. Thus, the current waste inventory was scaled based on general waste projections to estimate the lifecycle waste volumes.
- It is noted that NB Power's anticipated waste volumes from decommissioning are significantly lower than other CANDU waste owners (Ontario Power Generation and Hydro Quebec). At this time, it is presumed that NB Power is planning a significant volume reduction campaign resulting in low waste volumes. Further investigation is recommended.

3.4.4 Technical Considerations

NB Power's LLW includes a significant volume of metallic, containerized, and drummed waste that is suitable for near-surface disposal or deep disposal. Bulk LLW that is generated from contaminated soils and concrete during decommissioning will be suitable for near-surface disposal, but the large volumes of low-contaminated waste may not be practical for deep disposal.

NB Power's ILW will contain long-lived radionuclides and will require containment for several hundred to several thousand years. As such, the ILW will need to be disposed of in a deep underground facility to meet adequate containment needs for long-lived waste.

3.5 Ontario Power Generation (OPG)

3.5.1 Waste Sources and Data Reporting

OPG's waste inventory is produced from the operations, refurbishment, and planned decommissioning of the Pickering Nuclear Generating Station (PNGS), Darlington Nuclear Generating Station (DNGS), and Bruce Nuclear Generating Station (BNGS)[3] [5]. The inputs provide a detailed breakdown of current and lifecycle operational waste for all stations, as well as waste from the refurbishment of DNGS and BNGS. This dataset includes predicted radionuclide inventories, non-nuclear composition, and the presence of non-nuclear hazardous components, which will be key inputs when establishing the repository safety case.

3.5.2 Waste Types and Volumes

OPG's operational L&ILW is stored at the Western Waste Management Facility (WWMF). Operational ILW includes typical CANDU nuclear plant operational waste such as spent purification filters, spent ion exchange resins, and irradiated core components. Operational LLW includes miscellaneous LLW (e.g., contaminated plant components, personal protective equipment, machine shop waste, contaminated tools, wire, and cables, etcetera). OPG

[3] OPG does not operate BNGS, but is responsible or is assumed to be eventually responsible for all radioactive waste produced by the station.

incinerates all combustible LLW, so the operational LLW inventory also includes ash collected from the WWMF incinerator.

ILW from OPG's refurbishment of DNGS is currently stored at the Darlington Waste Management Facility (DWMF) in transportation-ready packages. ILW from the refurbishment of BNGS is currently stored at WWMF and has been processed similarly to DNGS refurbishment waste. ILW from the refurbishment of PNGS is available from the Seventh Canadian National Report [6], and is stored in Dry Storage Modules. ILW from the Pickering Refurbishment will need to be transferred into transportation-ready packages prior to disposal. ILW from refurbishment includes irradiated core components, primarily fuel channels. LLW from refurbishment is stored at WWMF and includes piping, large objects (e.g., steam generators, pressurizers, etcetera), metallic construction waste, contaminated insulation, and secondary waste generated during refurbishment activities (personal protective equipment, contaminated tools, etcetera).

General data is also available for the remaining OPG inventory: waste arising from decommissioning was retrieved from the PNGS, DNGS, and BNGS Decommissioning Plans, [7] [8] [9]. Although the preliminary decommissioning plans do not provide detailed information on waste beyond LLW and ILW volumes, data available from the Gentilly-2 decommissioning plan (see Section 3.3) provided a basis to anticipate incoming waste types. This includes ILW, including reactor internal components and the Calandria itself as well as LLW, including piping, large objects (e.g., steam generators, pressurizers, etcetera), concrete and metallic construction waste, contaminated insulation, and secondary waste generated during decommissioning activities (personal protective equipment, contaminated tools, etcetera).

OPG’s L&ILW inventory also includes the following miscellaneous waste:

- Cobalt waste (spent cobalt bundles & processing scrap from cobalt adjuster rod handling).
- Tritiated heavy water from decommissioned reactors.
- Tritium waste from the Tritium Removal Facility and tritium wastes from the sale of tritium.
- Decommissioning wastes from Kinectrics and Health Physics labs.
- Contaminated reactor maintenance and retube tooling.
- Contaminated empty used fuel containers, L&ILW storage containers, and transportation packages.

OPG's lifecycle waste inventory comprises approximately 270,000 m^3 LLW and 40,000 m^3 ILW.

3.5.3 *Data Preparation for Analysis*

Based on the accuracy of data provided by OPG, the following adjustments were made to the data:

- Current and projected lifecycle waste was available. However, projected waste is presented in limited detail. For example, all non-processible waste was reported as a single volume. To estimate waste volumes from individual waste types, waste volumes were scaled proportionally to current waste volumes. This is considered a suitable adjustment for this stage of the study.
- Waste projected from decommissioning was presented with volumes of LLW and ILW, which has substantially less granularity than waste from operations and refurbishment. As a result, values from the Hydro Quebec study were used as the basis for the OPG reactors. This is considered a reasonable assumption because both are CANDU reactors, so the waste streams will generally align.
- A substantial portion of OPG's waste inventory comprises large objects that are contaminated and will need to be disposed of as LLW/ILW (10-20% of OPG's waste inventory by volume). Typically, large objects such as steam generators, heat exchangers, etcetera are candidates of volume reduction such as cutting/segmentation. However, with the exception of steam generators, for which the waste owner provided a volume-reduced inventory, volume reduction is not accounted for in this study. This provides an opportunity to reduce OPG's inventory substantially, and further investigation on OPG's volume reduction plan is recommended.

3.5.4 *Technical Considerations*

OPG's LLW includes a significant volume of metallic, containerized waste that is suitable for near-surface disposal or deep disposal. Bulk LLW that is generated from contaminated soils and concrete will be suitable for near-surface disposal, but the large volumes of low-contaminated waste may not be practical for deep disposal. OPG's LLW inventory also includes a significant volume of large objects, for which a segmentation or volume reduction may be necessary depending on the disposal method. For example, deep disposal will likely require some segmentation or volume reduction of large objects.

OPG's ILW will contain long-lived radionuclides and will require containment for several hundred to several thousand years. As such, the ILW will need to be disposed of in a deep underground facility to meet adequate containment needs for long-lived waste. Additionally, most of the ILW from operations is spent resin, which is dimensionally small and may be suitable for repackaging and disposal in a Deep Borehole.

3.6 Anticipated New Nuclear Generators

There are a number of Small Modular Reactors (SMR), under consideration for development for power utilities across Ontario, Saskatchewan, Alberta, Manitoba, and New Brunswick. These utilities have expressed interest in various designs and currently have SMR development plans under consideration. For example, OPG is currently assessing three potential SMR technologies for construction at the Darlington Nuclear Generating Station. OPG plans to select a single preferred SMR technology by the end of 2021 and build the demonstration plant by 2028. Similarly, New Brunswick Power is actively working with private sector partners to develop and deploy other Advanced Reactor Concepts in New Brunswick.

As a result of the interest in SMRs from utilities across Canada, a number of SMR vendors have entered into the pre-licensing Vendor Design Review (VDR) process with the Canadian Nuclear Safety Commission (CNSC). The CNSC is currently conducting pre-licensing VDR review for about a dozen SMR vendor designs (refer to the CNSC website for a complete list of SMR designs currently under review[4]). These SMR technologies employ next-generation nuclear technology, and the expected L&ILW and quantity will depend on the selected SMR concept. Nevertheless, the majority of L&ILW will be somewhat similar to present CANDU waste, and the six identified long-term management options would be suitable for the anticipated waste types. However, given that the designs of these SMRs are currently under development, formal waste quantities and detailed characteristics are not available at this time. As a result, anticipated SMR waste types are discussed in this section but not quantified for this study.

For the purposes of this study, it is assumed that the majority of the reactor vessel, primary heat transport systems and surrounding reactor building concrete will become activated and/or contaminated with radioactive elements and will need to be disposed of as LLW or ILW. Similarly, it is assumed that operational radioactive waste would be similar to present-day reactors (e.g., personal protective equipment, contaminated tools, etcetera). However, since the SMRs are planned to be operated with improved processes and passive designs, fewer moving parts will require less maintenance. Thus, it is possible that the operational waste quantities will be significantly reduced compared to existing reactors. L&ILW streams may also be introduced from the advanced nuclear systems (e.g., molten salt cooling), which may not be specifically captured in this report, but the six long-term management options are considered to be suitable for the type of waste expected. It is recommended that SMR waste is investigated further as this study progresses and the particular SMR vendor designs are selected for further design and deployment.

3.7 Other Waste Sources

The *Seventh Canadian National Report* was prepared by the CNSC in 2020 for the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* to, in part, account for Canada's current inventory of L&ILW, as well as meet other Canadian obligations to the Joint Convention [6]. The *Seventh Canadian National Report* was used to gather data on smaller waste inventories from owners that were not contacted directly for this study. These waste owners with small waste inventories are Best Theratronics, BWXT Fuel Manufacturing, and Nordion. The inventory of Best Theratronics and Nordion, each have a small volume of ILW comprising disused cobalt-60 and cesium-137

[4] Website URL: https://nuclearsafety.gc.ca/eng/reactors/power-plants/pre-licensing-vendor-design-review/index.cfm

sealed sources, Best Theratronics also has a small volume of LLW from depleted uranium shielding components. BWXT Fuel Manufacturing has a small volume of solid, drummed LLW from fuel processing. The L&ILW is reported as current volumes and activities of LLW and ILW as of the end of 2019. Since the waste volumes are minimal, lifecycle waste was assumed to equal current waste.

Additionally, waste from Cameco's Port Hope Conversions Facility decommissioning is included in this report. In total, this waste comprises 1,740 m^3 LLW and 7 m^3 ILW. The majority of this waste comes from the Cameco Port Hope Conversions Facility decommissioning.

3.8 Excluded Waste

L&ILW that has existing long-term management plans that are either under regulatory approval or in operation are not considered for the ISRW study. Since nearly 90% of the total L&ILW in Canada currently has long-term management plans, the total waste volume that is included as part of the ISRW study is reduced from 3,350,000 m^3 to 345,000 m^3. The L&ILW with existing long-term management plans is predominantly contaminated soils and other bulk material, and is planned for disposal at various near-surface facilities. For example, the Near Surface Disposal Facility proposed by Chalk River Laboratories is intended to dispose of 763,000 m^3 of LLW and the Port Hope Long-Term Waste Management Facility is intended to dispose of 1,270,000 m^3 of LLW, both using Engineered Containment Mounds.

The reduced ISRW inventory consists of approximately 294,000 m^3 of LLW and 51,000 m^3 of ILW. For reference, Figure 3-1 shows the full Canadian L&ILW inventory, and Figure 3-2 shows the L&ILW covered by this study (note the difference in scale). Bulk material LLW has been separated from other LLW to show that the majority of excluded waste consists of contaminated soils and other bulk material.

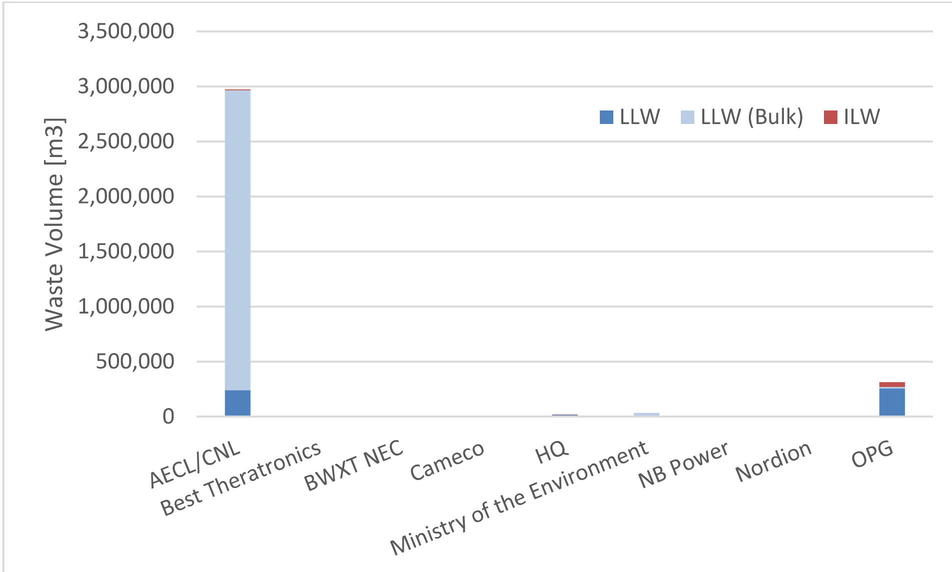


Figure 3-1: All Canadian L&ILW (current and anticipated)

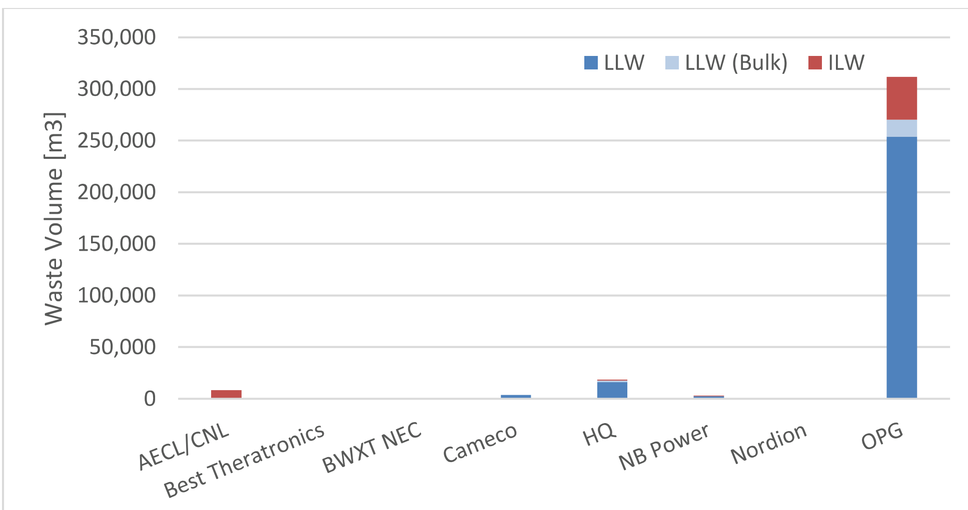


Figure 3-2: Canadian L&ILW with no current long-term management plans (current and anticipated).

4. Evaluation Summary

4.1 Radioactive Waste Groupings

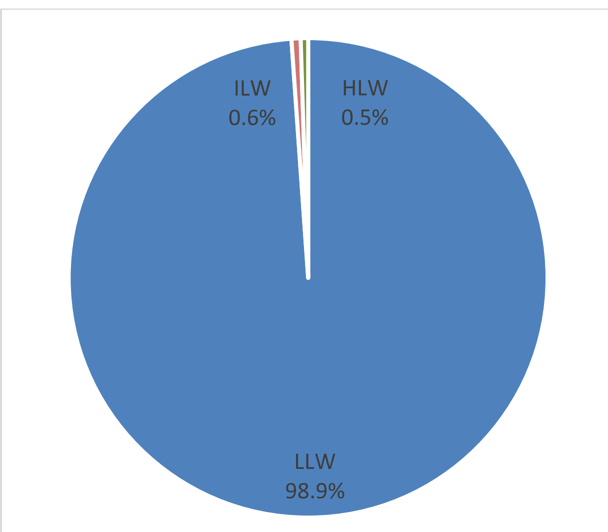
The Canadian waste inventory was organized into categories to support the assignment of long-term waste management options based on the following characteristics:

- Radioactive classification,
- Physical configuration/packaging characteristics,
- Non-nuclear hazardous characteristics.

4.1.1 Radioactive Classification

The radioactive waste was classified using CNSC definitions of low-level radioactive waste and intermediate-level radioactive waste[5] [2]. In general, LLW requires isolation and containment for periods of up to a few hundred years and is suitable for disposal in near-surface facilities, and ILW requires a higher level of containment and isolation for periods ranging from hundreds to thousands of years. Due to its long-lived radionuclides, ILW generally requires a higher level of containment and isolation than can be provided in near-surface repositories.

The study found that 15% of the ISRW waste inventory is ILW, and 85% is LLW. A chart of L&ILW as percentages of the total waste volume are presented in Figure 4-1 (Right). For reference, the current total radioactive inventory in Canada is presented in Figure 4-1 (Left).



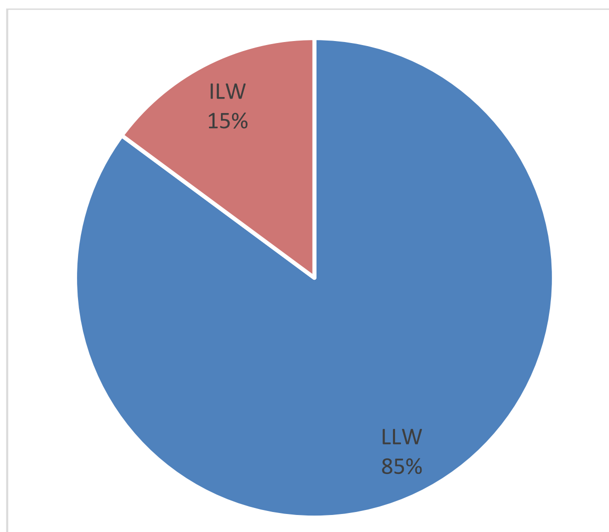


**Figure 4-1: (Left) Total Canadian Radioactive Waste Inventory as of 2019 [6].
(Right) Lifecycle L&ILW with No Current Long-Term Management Plans Organized by Radioactive Classification.**

[5] The waste owners have minor inconsistencies in how LLW and ILW are defined that are not accounted for in this study. This is not expected to have a significant impact on the study at this time.

4.1.2 Packaging/Physical Configuration

In addition to radioactive classification, the ISRW radioactive waste inventory was organized based on the existing physical configuration of the waste. The size and shape of each waste package is an important consideration to determine if the package can physically fit in a specific long-term management facility. The packaging/physical configuration of the L&ILW was organized into the following categories and are presented graphically in Figure 4-2 and Figure 4-3:

- Container – a solid waste container of variable dimensions depending on the model, typically rectangular or cylindrical. Typically, containerized waste is suitable for handling and transportation for LLW.
- Package – a solid waste package of variable dimensions depending on the model, typically rectangular or cylindrical. Typically, packaged waste is suitable for handling and transportation of ILW.
- Bulk Material – Contaminated material that is granular in nature, typically soil, demolished concrete, or other construction demolition waste. This waste form typically comprises large volumes of waste with low concentrations of radioactivity.
- Drum – Waste (typically LLW) stored in standard sealed drums that are easy to handle/transport but require additional shielding for handling if used for ILW.
- Large Object – irregular – Various irregular large objects such as steam generators, pressurizers, heat exchangers, pumps, transportation packages, etcetera. These objects are often suitable for segmentation and/or substantial volume reduction, given the large interior void space and potentially uncontaminated exterior surfaces.
- Unpackaged – A category assigned to waste produced by decommissioning that has not yet been packaged (i.e., from a facility that has yet to be dismantled). Once dismantled, it is assumed that this waste will be packaged in transportation and/or disposal-ready containers.

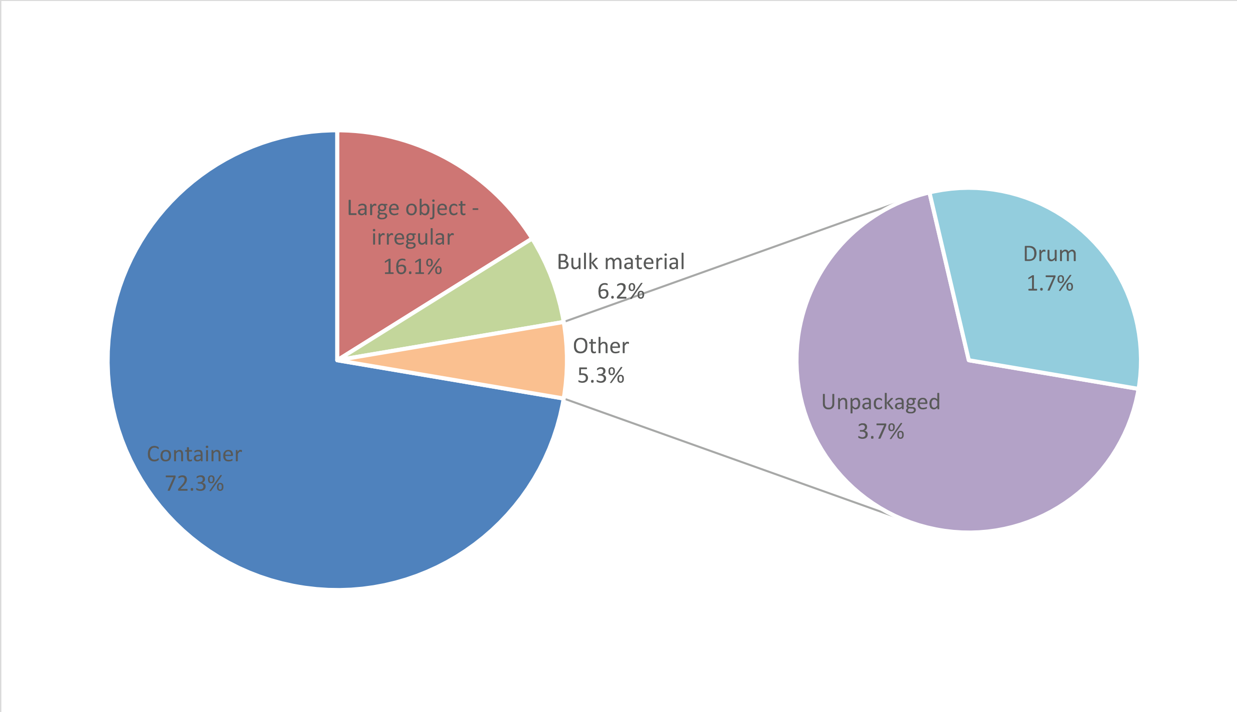


Figure 4-2: Percentage of LLW volume by physical configuration.

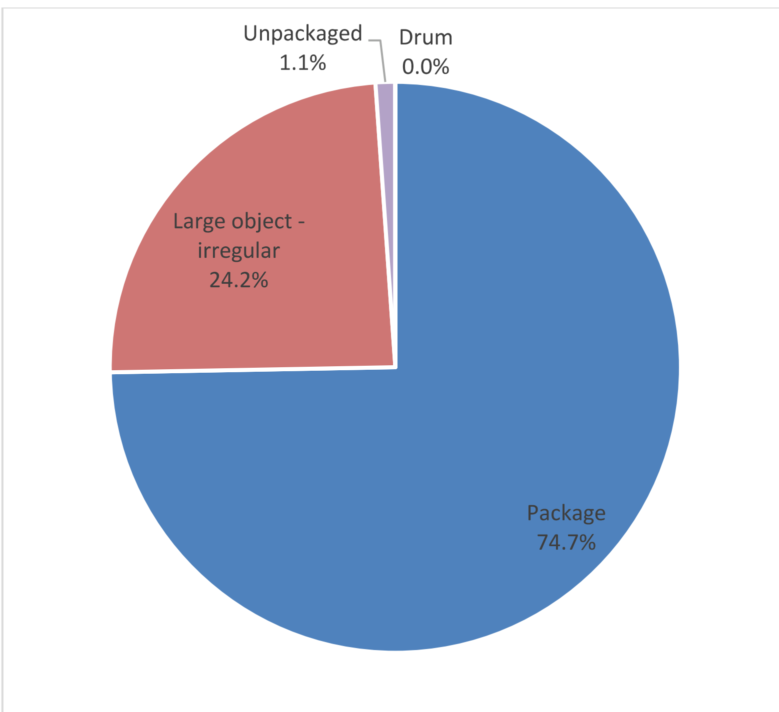


Figure 4-3: Percentage of ILW volume by physical configuration.

4.1.3 Non-Nuclear Hazardous Characteristics

The non-nuclear hazardous characteristics were considered in the long-term waste management options analysis. The level of detail available for non-nuclear hazardous characteristics of the waste inventory varied greatly depending on the waste owner. However, a number of notable non-nuclear hazardous characteristics were identified, in particular heavy metals (depleted uranium, lead, cadmium and mercury) and organics (plastics, rubbers, resins, bitumen, and various toxic organic compounds). Heavy metals require consideration because heavy metal toxicity will outlive the radioactivity of nuclear waste, most notably for LLW. Organics require consideration because of potential flammability and, in some cases, toxicity.

The disposal of non-nuclear hazardous waste is well established in Canada and is regulated at the provincial level. In the case of this study, it is assumed that all considered disposal options can accept nuclear waste with non-nuclear hazardous properties because non-nuclear hazardous waste facilities employ engineered containment measures similar to those present in near-surface nuclear waste disposal facilities, including waterproofing, leachate control, and long-term monitoring. Ultimately, this will depend on the safety assessment of a nuclear waste disposal site, which will determine if the site can accept nuclear waste with non-nuclear hazardous properties.

Therefore, non-nuclear hazardous characteristics are not expected to be a factor in facility type selection at this stage of the project. However, they will influence the safety assessment and waste acceptance criteria of the facility as they are developed in the future. Additional design considerations may be required to address other non-nuclear hazards at the detailed design stage. It is therefore recommended that non-nuclear hazardous characteristics are examined further as this project proceeds.

4.1.4 General Waste Groupings

The following four waste groupings are developed based on waste's radioactive classification and packaging/physical configuration:

1. LLW, Bulk Material – includes contaminated soil, concrete, and construction materials.
2. LLW, Other – Includes containerized/drummed waste, metallic components, and large objects. Potential volume reduction will be possible for some, but not all, waste in this category.
3. ILW, General – Includes packaged/drummed waste, bulky metallic components, large objects. That is all waste that is too large to fit in a Deep Borehole. Volume reduction will be possible for some, but not all, waste in this category.
4. ILW, Small - Includes small, malleable objects such as spent IX resins and solidified liquids, allowing for potential Deep Borehole disposal. Existing ILW in this category will likely require repackaging for Deep Borehole disposal.

4.1.4.1 Physical Configuration Exception for the Deep Borehole

International studies are examining the use of boreholes for the disposal of ILW (and HLW). A borehole with a diameter of approximately 40 cm limits the physical dimensions of waste that can be disposed of in a borehole. This limitation is based on current oil and gas industry equipment being adapted for this application. The technology is constrained to boreholes of 40 cm diameter or smaller, with limited opportunity for larger diameters. The placement of ILW and/or HLW waste also needs to account for borehole casings and packaging. These uniquely small dimensions of the Deep Borehole disposal option mean that the existing packaging for waste will be too large for disposal. As such, the Deep Borehole option assumes waste will be repackaged prior to disposal. In this case, the existing packaging is not relevant, but the waste must be small enough to repackage into a borehole compatible package (i.e., with a diameter less than 40 cm).

Waste that was identified to meet this criterion includes spent resin and solidified liquids. In total, this waste category is entirely packaged waste and comprises 18% of the total ILW inventory.

4.2 Long-Term Management Options

The long-term management options assessed in this study are described below, as presented in further detail on the ISRW) website[6]. All options employ multiple safety functions and engineered barriers to providing isolation and containment of the radioactive waste.

1. Shallow Rock Cavern – Long-term management of radioactive waste via underground cavern disposal at a depth of approximately 50-100 m, suitable for LLW. In Canada, only LLW is suitable for the Shallow Rock Cavern because LLW can be disposed of in a near-surface facility, whereas ILW cannot. The containment capability and lifespan of this facility will depend on, in part, the site's specific rock quality and fracture network.

2. Deep Borehole – Long-term management of radioactive waste via deep underground disposal in a series of boreholes at a depth of approximately 500-1000 m. International studies have examined the use of boreholes using existing technology with a diameter of approximately 40 cm, limiting the physical dimensions of waste that can be disposed of in the borehole, with limited opportunity for larger diameter boreholes. Given this limitation, this long-term management method is best suited for small dimension ILW. Also, this method is most applicable to countries with low volume inventories of ILW and HLW, i.e., no nuclear reactors. These boreholes can typically be drilled at or near the current storage locations as deep bedrock is typically suitable and available in many locations.

3. Deep Geological Repository (DGR) – Long-term management of radioactive waste via deep underground disposal in an underground facility accessed by shafts or ramps. The DGR is the internationally accepted best practice for the long-term management of ILW

[6] Website URL: https://radwasteplanning.ca/content/learn-more

as it provides multiple barriers of containment for long-lived waste over thousands of years.

4. Engineered Containment Mound (ECM) – Long-term management of radioactive waste via a surface-level, landfill-type design with advanced containment measures, as well as leachate monitoring, control, and treatment. Given that the ECM has a containment lifespan of several hundred years, this facility is suitable for the disposal of LLW, but is unsuitable for the disposal of ILW.
5. Concrete Vault – Long-term management of radioactive waste via a surface-level or below-grade disposal facility encased in Concrete Vaults suitable for the disposal of LLW. Given that the Concrete Vault has a containment lifespan of several hundred years, this facility is unsuitable for the long-term management of ILW.
6. Rolling Stewardship – Continuous active monitoring and management of waste by future generations without any immediate disposal plans. This strategy assumes that future technology will resolve the long-term management of nuclear waste. Rolling stewardship is conceptually feasible for LLW; however, after considering technical, financial, and human risk factors, is considered impractical. The need to re-handle, re-package and re-construct storage buildings over several hundred years or more is expected to present significant technical and financial challenges. Additionally, the participation of future generations is required to provide consistent, intergenerational management of the waste, and this cannot be guaranteed at this time. Rolling Stewardship is not in line with international best practices for LLW/ILW disposal.

4.2.1 Recommended Long-Term Waste Management Plan

Table 4-1 presents a matrix of the applicability of each repository type to each of the waste groupings. Additionally, the recommended long-term management options are represented in a diagram shown in Figure 4-4. Reasoning for each selected combination is included in the table. Three levels of applicability have been applied:

Y	The repository type is applicable and recommended for the allocated waste group.
Y2	The repository type may be applicable to the allocated waste group but is not preferred or requires further study.
Y3	The repository type is conceptually feasible but, after considering technical, financial, and/or human risk factors, is considered impractical.
N	The repository type is not suitable for the allocated waste group.

Table 4-1: Recommended Long-Term Waste Management Options by Waste Type.

	LLW Bulk material Contaminated soil, concrete, and construction materials.	**LLW Other** Containerized/drummed waste, metallic components, large objects.	**ILW General** Packaged/drummed waste, bulky metallic components, large objects.	**ILW Small** Small, malleable objects such as spent IX resins (re-packaged) and incinerated spent resin ash.
Engineered Containment Mound	**Y** Most suitable for large volumes of bulk LLW.	**Y2** Subject to the ECM safety case and, if necessary, further characterization.	**N** Repository type not suitable for ILW.	**N** Repository type not suitable for ILW.
Concrete Vault	**Y2** High volume of waste will add significant expenses for minimal containment benefit.	**Y** Internationally accepted practice for LLW disposal.	**N** Repository type not suitable for ILW.	**N** Repository type not suitable for ILW.
Shallow Rock Cavern	**Y2** High volume of waste will add significant expenses for minimal containment benefit.	**Y** Internationally accepted practice for LLW disposal. Large objects may require segmentation or volume reduction.	**N** Repository type not suitable for ILW as defined in Canada (see Section 5.2).	**N** Repository type not suitable for ILW as defined in Canada (see Section 5.2).
Deep Geological Repository	**Y3** Excessive containment option for high volume of waste.	**Y2** Overly conservative in terms of containment for LLW, but pursued originally by OPG in the L&ILW DGR. Large objects may require segmentation or volume reduction.	**Y** Internationally recognized best practice for ILW disposal. Large objects may require volume reduction.	**Y** Internationally recognized best practice for ILW disposal.
Deep Borehole	**N** Excessive containment option for high volume of waste.	**N** Excessive containment option for high volume of waste.	**N** Excessive processing will be required for bulky objects.	**Y2** Dimensionally suitable for disposal, but additional processing/repackaging may be required.
Rolling Stewardship	**Y3** Technically feasible, but impractical considering the extended period of active management and monitoring of several hundred years.	**Y3** Technically feasible, but impractical considering the extended period of active management and monitoring of several hundred years.	**N** Not considered practical for several hundred to several thousand years of storage and monitoring.	**N** Not considered practical for several hundred to several thousand years of storage and monitoring.

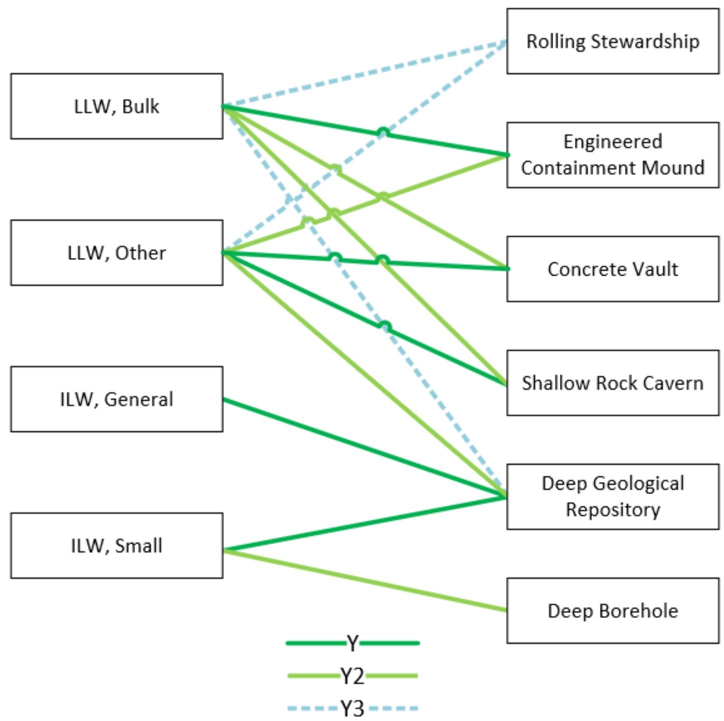


Figure 4-4: Repository Groupings Diagram.

The results of Table 4-1 were sorted using the inventory waste volumes and are presented in Figure 4-5. Figure 4-5 shows the percentage of the total waste inventory that may be suitable for each long-term management option. Furthermore, the waste classification (i.e., LLW or ILW) is identified, as well as the level of applicability applied (i.e., Y, Y2, Y3). For example, the Deep Geological Repository is considered a suitable option for 100% of the total waste inventory if ILW and LLW are included, whereas the Concrete Vault is considered a suitable option for 85% of the total waste inventory (LLW only).

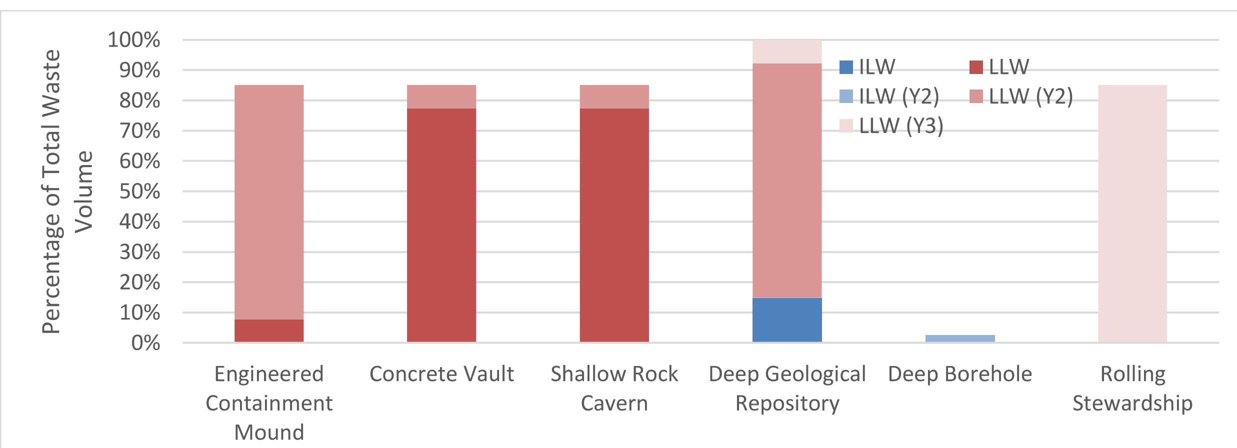


Figure 4-5: Waste Inventory Volumes Suitable for Each Long-Term Management Option.

5. Observations and Recommendations

5.1 Observations

The purpose of this project was to identify groups in Canada's L&ILW inventory and assign these groups to potential long-term management options. In general, the waste was grouped based on radioactivity classification (i.e., LLW and ILW) and physical configuration (i.e., bulk material, containers, etcetera). It was identified that all LLW might be disposed of at a near-surface facility (i.e., Engineered Containment Mound, Concrete Vault, or Shallow Rock Cavern), whereas all ILW must be disposed of in a DGR or a Deep Borehole. Typically, LLW can be disposed of in a higher level of containment (i.e., deep underground), but ILW cannot move to a lower level of containment (i.e., near the surface). This is demonstrated by the Deep Geological Repository in Figure 4-5, which is technically feasible for the full L&ILW inventory. This fact presents a key consideration for the ISRW: to consolidate long-term management facilities to fewest number of types or to consider multiple long-term management facilities.

The Engineered Containment Mound (ECM) was determined to be the most suitable option for bulk LLW such as soils and demolished concrete, given the low concentrations of radionuclides and the large volume of waste. Additional LLW may be suitable for the ECM, depending on the safety case of the disposal facility.

The Concrete Vault and Shallow Rock Cavern were considered the most suitable option for non-bulk LLW, given the increased containment and structural integrity offered (concrete barrier or rock mass) compared to the ECM. These long-term management options may also be suitable for bulk LLW, but the containment and isolation offered by these options are considered excessive for bulk material. It should be noted that there is international experience with the long-term management of short-lived ILW in Shallow Rock Caverns, and this is discussed further in Section 5.2.

The DGR is internationally recognized as the preferred approach to ILW long-term management and was therefore considered the most suitable option for all ILW. Additionally, the co-disposal of non-bulk LLW was considered as an alternative.

Deep Boreholes are considered an alternative long-term management option for small dimensional ILW such as incinerated waste and spent ion exchange resins. Deep Boreholes are best applied to a decentralized disposal approach (i.e., with multiple borehole locations across Canada) in order to reduce the need for radioactive waste transportation. Further investigation on the applicability of this option is required as the technology develops.

Rolling Stewardship is a potential near-term waste management solution but is not a practical solution for any LLW or ILW in the long-term. Rolling Stewardship may be feasible for certain types of low-level waste that decays quickly to allow its free release or conventional disposal of waste in several decades, but not for wastes that will remain radioactive for several hundred years or longer. Detailed characterization data would allow the half-life of the waste inventory to be assessed and potentially identify any shorter-lived LLW as Rolling

Stewardship candidates. However, Rolling Stewardship is not in line with international best practices for the long-term management of radioactive waste. Additional cost considerations include the potential need to repackage waste as waste containers degrade for centuries, as well as the potential need for new, specialized long-term facilities.

Overall, the results presented in Table 4-1 provide a direction for further investigation on the Integrated Strategy for Radioactive Waste. In addition to technical feasibility, as examined in this study, the consideration of cost efficiency, siting geology, safety/environmental/licensing must be considered when selecting the best long-term management option. For instance, although Rolling Stewardship is conceptually feasible by monitoring LLW for several hundred years, it may involve a need for repackaging and/or construction of new storage facilities. This, along with the cost of active monitoring, will likely be significantly greater than other more suitable long-term management options.

5.2 Recommendations and Next Steps

5.2.1 Waste Characterization

For the purposes of this study, the NWMO collected a summary level of detail about the current and projected inventories from the waste owners. There were inconsistencies in reporting formats between owners regarding the metadata collected and managed, the application of volume reduction strategies and the development of long-term management plans. As the ISRW progresses and the waste owners are engaged further, there will be opportunities to better categorize each waste form, particularly for waste volumes, radionuclide inventories, and non-nuclear characterization.

What is required for future engineering evaluations would be a compilation of all raw data, including detailed waste characterization from each owner. Then, systematic gap analysis and investigation to bring the level of information to a consistent level of detail. Once this is complete, there would be a solid base of data to support a quantified evaluation of long-term management options.

Typical information required would include, but not be limited to:

- Radiological isotopes, concentrations, and overall activities
- Non-nuclear hazardous waste elements/compounds and concentration
- Packaging details

In terms of radionuclide characterization, a detailed radionuclide inventory, concentrations and overall activity will allow the waste hazards and half-life to be better understood, enabling the pursuit of less conservative long-term management approaches (i.e., disposal in an ECM rather than a Shallow Rock Cavern). Additionally, considerations will be necessary for fissile material content, if present, to ensure its safe long-term management.

As discussed in Section 4.1.3, non-nuclear characterization and hazards were assumed to not limit the long-term management options of the waste. However, this assumption requires verification subject to the waste acceptance criteria of the repository, as well as the characterization of the waste. The detailed review of international, national, and local regulations for storage and disposal of hazardous waste would help to identify any gaps in long-term management plans for waste with non-radiological hazardous properties.

5.2.2 Processing Considerations

This study did not consider options for additional waste processing, including volume reduction, beyond those planned and quantified by the waste owner. Waste processing methods vary based on the physical properties of the waste but can include:

- Mechanical volume reduction: cutting, segmentation, compaction
- Incineration
- Metal melting
- Decontamination
- Bulk decontamination (e.g., hydrometallurgy for contaminated concrete)
- Solidification of liquids (including dewatering, vitrification, grouting, etcetera)

Subject to future study, the Integrated Strategy for Radioactive Waste may benefit from a holistic approach to waste processing. Furthermore, an integrated approach may open avenues of waste processing resulting from economies of scale for waste processing options that have not yet been accessible for smaller waste owners.

5.2.3 Repository Considerations

Some additional items were identified in this study regarding repository types and considerations that are discussed in this section:

- If the surrounding containment system (e.g., ECM or Concrete Vault) can't provide sufficient structural integrity to shield packages from external forces, the grouting of waste containers may be required to fill the void space of partially full containers to ensure structural integrity. In addition to radiological concerns with reopening closed containers, these containers are typically only built to accommodate vertical loading from container stacking and not extensive static or dynamic loads such as that present from the surrounding soil in an ECM or grout/gravel fill in a Concrete Vault. There is no clear international precedent on this matter, so further investigation will be required.
- The Shallow Rock Cavern has been recommended as unsuitable for the disposal of ILW. However, the Olkiluoto and Loviisa nuclear power plants in Finland, as well as the SFR repository in Sweden, disposes of short-lived L&ILW in Shallow Rock Caverns [10]. In Canada, there is no classification for short-lived ILW, so further investigation will be required. The capability for a Shallow Rock Cavern to safely manage ILW would depend on the specific repository's waste acceptance criteria, driven by its safety assessment.

- Rolling stewardship has been determined impractical for the long-term management of any Canadian L&ILW given the long-term management and monitoring period of several hundred years. However, Rolling Stewardship may become a more attractive option if the waste is short-lived and decays to a level of radioactivity low enough to allow for material free release or conventional landfill disposal over several decades. The provided level of detail in the waste inventory does not allow making such a separation of a short-lived LLW stream at this time. It should also be noted that Rolling Stewardship may still involve a need for repackaging and/or construction of new storage facilities.
- Most concrete included in the bulk material category will be contaminated via tritium permeation, which is a relatively short-lived beta emitter (12.3-year half-life). However, reactor vault concrete, given its proximity to the reactor core, will also include carbon-14 and other radioactive metal produced by neutron activation. Carbon 14 is a long-lived beta emitter (5,700-year half-life). Depending on the concentration of carbon 14 and the safety case of the repository, additional steps may be required to meet the waste acceptance criteria, such as bulk decontamination.

6. References

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Appendix A
Consolidated Waste Owner Data

Owner	Current Location	Waste Description	Classification	State	Current Volume	Lifecycle Volume	Unit	Packaging/ Physical Configuration	Physical Configuration Category	Radiological Characteristics	Non-nuclear characteristics	Non-Nuclear Category	Current Waste Disposal Plans	Engineered Containment Mound	Concrete Vault	Shallow Rock Cavern	Deep Geological Repository	Deep Borehole	Rolling Stewardship	Additional Notes
AECL/CNL	Douglas Point	Various wastes	LLW	Solid	92	731	m3	Various Packaging Configurations	Various Packaging Configurations			Unknown Non-Nuclear Characteristics	CNL NSDF	Y	Y	Y	Y2	N	Y3	Includes contaminated soil and LLW components.
AECL/CNL	Gentilly 1	Various wastes	LLW	Solid	161	908	m3	Various Packaging Configurations	Various Packaging Configurations			Unknown Non-Nuclear Characteristics	CNL NSDF	Y	Y	Y	Y2	N	Y3	Includes contaminated soil, dry low-level contaminated equipment and material.
AECL/CNL	Chalk River	Contaminated soils	LLW	Solid	138,131	621,509	m3	Bulk material	Bulk material			Organic Materials Present	CNL NSDF	Y	Y2	Y2	Y3	N	Y3	Currently planned for disposal by 2100.
AECL/CNL	Chalk River	Various wastes	LLW	Solid	20,761	93,412	m3	Tile holes, bunkers and legacy tanks.	Large object - irregular			Unknown Non-Nuclear Characteristics	CNL NSDF	Y	Y	Y	Y2	N	Y3	Currently planned for disposal by 2100.
AECL/CNL	Chalk River	Contaminated soils	LLW	Solid	22,316	17,089	m3	Bulk material	Bulk material			Organic Materials Present	In Situ at CNL	Y	Y2	Y2	Y3	N	Y3	Currently planned for disposal by 2100.
AECL/CNL	Chalk River	Various wastes	LLW	Solid	128,512	98,411	m3	Tile holes, bunkers and legacy tanks.	Large object - irregular			Unknown Non-Nuclear Characteristics	In Situ at CNL	Y2	Y	Y	Y2	N	Y3	Currently planned for disposal by 2100.
AECL/CNL	Whiteshell	Various wastes	LLW	Solid	14,719	28,464	m3	Above ground concrete bunkers	Unpackaged			Unknown Non-Nuclear Characteristics	CNL NSDF	Y	Y	Y	Y2	N	Y3	
AECL/CNL	Whiteshell	Various wastes	LLW	Solid	-	14,621	m3	Above ground concrete bunkers	Unpackaged			Unknown Non-Nuclear Characteristics	In Situ at CNL	Y2	Y	Y	Y2	N	Y3	Currently planned for disposal by 2030.
AECL/CNL	Port Hope	Contaminated soils	LLW	Solid	17,879	720,000	m3	Bulk material	Bulk material			Organic Materials Present	Port Hope LTWMF	Y	Y2	Y2	Y3	N	Y3	720,000m3 by 2030
AECL/CNL	Port Hope	Contaminated soils	LLW	Solid	-	10,000	m3	Bulk material	Bulk material			Organic Materials Present	CNL NSDF	Y	Y2	Y2	Y3	N	Y4	10,000 m3 by 2100.
AECL/CNL	Welcome	Contaminated soils	LLW	Solid	550,000	550,000	m3	Bulk material	Bulk material			Organic Materials Present	Port Hope LTWMF	Y	Y2	Y2	Y3	N	Y3	Currently planned for disposal by 2022.
AECL/CNL	Port Granby	Contaminated soils	LLW	Solid	765,622	800,000	m3	Bulk material	Bulk material			Organic Materials Present	Port Granby LTWMF	Y	Y2	Y2	Y3	N	Y3	Currently planned for disposal by 2022.
AECL/CNL	Port Granby	Contaminated soils	LLW	Solid	-	2,800	m3	Bulk material	Bulk material			Organic Materials Present	CNL NSDF	Y	Y2	Y2	Y3	N	Y3	
AECL/CNL	Greater Toronto Area	Radium-Contaminated Soils and Building Components.	LLW	Solid	4,900	4,900	m3	Bulk Material	Bulk Material			Organic Materials Present	CNL NSDF	Y	Y2	Y2	Y3	N	Y3	4,900 m3 by 2030
AECL/CNL	Douglas Point	Various wastes	ILW	Solid	5	241	m3	Various Packaging Configurations	Package	H-3, Cs-137, Pu-241, Sr-90, Co-60	May include bitumen, mercury, oils, solvents, and organic collants	Organic Materials Present - Heavy Metals Present	-	N	N	N	Y	Y2	N	Includes reactor components, HTS and moderator piping, drums of contaminated steel and IX resin.
AECL/CNL	Gentilly 1	Various wastes	ILW	Solid	-	292	m3	Various Packaging Configurations	Package	H-3, Cs-137, Pu-241, Sr-90, Co-60	May include bitumen, mercury, oils, solvents, and organic collants	Organic Materials Present - Heavy Metals Present	-	N	N	N	Y	Y2	N	Includes reactor components, HTS and moderator piping, and IX resin.
AECL/CNL	Chalk River	Various wastes	ILW	Solid	299	5,735	m3	Tile holes, bunkers, legacy tanks, SMAGS	Package	H-3, Cs-137, Pu-241, Sr-90, Co-60	May include bitumen, mercury, oils, solvents, and organic collants	Organic Materials Present - Heavy Metals Present	-	N	N	N	Y	N	N	
AECL/CNL	Whiteshell	Various wastes	ILW	Solid	910	1,201	m3	In-ground concrete bunkers and storage tanks.	Package	H-3, Cs-137, Pu-241, Sr-90, Co-60	May include bitumen, mercury, oils, solvents, and organic collants	Organic Materials Present - Heavy Metals Present	-	N	N	N	Y	N	N	
AECL/CNL	Douglas Point	Various wastes	ILW	Solid	1	23	m3	Various Packaging Configurations	Package	Sr-90, Cs-137, H-3, Pu-239, Pu-240	May include bitumen, mercury, oils, solvents, and organic collants	Organic Materials Present - Heavy Metals Present	-	N	N	N	Y	Y2	N	Liquid waste - assumed to be solidified.
AECL/CNL	Gentilly 1	Various wastes	ILW	Solid	-	28	m3	Various Packaging Configurations	Package	Sr-90, Cs-137, H-3, Pu-239, Pu-240	May include bitumen, mercury, oils, solvents, and organic collants	Organic Materials Present - Heavy Metals Present	-	N	N	N	Y	Y2	N	Liquid waste - assumed to be solidified.
AECL/CNL	Chalk River	Various wastes	ILW	Solid	33	542	m3	Liquid storage - to be solidified	Package	Sr-90, Cs-137, H-3, Pu-239, Pu-240	May include bitumen, mercury, oils, solvents, and organic collants	Organic Materials Present - Heavy Metals Present	-	N	N	N	Y	Y2	N	Liquid waste - assumed to be solidified.
AECL/CNL	Whiteshell	Various wastes	ILW	Solid	101	114	m3	In-ground concrete bunkers and storage tanks.	Package	Sr-90, Cs-137, H-3, Pu-239, Pu-240	May include bitumen, mercury, oils, solvents, and organic collants	Organic Materials Present - Heavy Metals Present	-	N	N	N	Y	N	N	Liquid waste - assumed to be solidified.
Cameco	Blind River Refinery	Refinery wastes	LLW	Solid	4,400	1,000	m3	Manufacturing Wastes	Container	Natural Uranium Contamination (U-235, U-238)	Includes solidified acidic liquid	Inorganic Material - Heavy Metals Present	-	Y2	Y	Y	Y2	N	Y3	Active waste management plan sent to a permitted US commercial landfill, reducing the inventory from 4,400m3 to <1000m3. Assumed liquid (acidic) is solidified. Packaging Assumed.
Cameco	Port Hope Conversions Facility	Fuel Conversion wastes	LLW	Solid	4,000	500	m3	Manufacturing Wastes	Container	Natural, depleted, and enriched uranium contamination (U-235, U-238).	Includes 200m3 uranium scrap	Inorganic Material - Heavy Metals Present	-	Y2	Y	Y	Y2	N	Y3	Most of the waste will go to the CNL LTWMF or a permitted US commercial landfill. 200m3 of the remaining waste is depleted uranium scrap. Assumed liquid (acidic) is solidified. Packaging Assumed.
Cameco	Fuel Manufacturing Wastes	Fuel manufacturing wastes	LLW	Solid	4,000	500	m3	Manufacturing Wastes	Container	Natural, depleted, and enriched uranium contamination (U-235, U-238).		Inorganic Material - Heavy Metals Present	-	Y2	Y	Y	Y2	N	Y3	Most of the waste will go to a permitted US commercial landfill. Assumed liquid (acidic) is solidified. Packaging Assumed.
Best Theratronics	Best Theratronics Manufacturing Facility, Kanata	Disused cobalt-60 sealed sources	LLW	Solid	1	1	m3	Dry Container	Container	Co-60	Storage of disused sealed sources and depleted uranium shielding	Inorganic Material - Heavy Metals Present	-	Y2	Y	Y	Y2	N	Y3	Some waste is currently in pool storage - assume this waste is moved to dry containers prior to disposal
Best Theratronics	Best Theratronics Manufacturing Facility, Kanata	Disused cesium-137 sealed sources	LLW	Solid	1	1	m3	Dry Container	Container	Cs-137	Storage of disused sealed sources and depleted uranium shielding	Inorganic Material - Heavy Metals Present	-	Y2	Y	Y	Y2	N	Y3	Some waste is currently in pool storage - assume this waste is moved to dry containers prior to disposal
Best Theratronics	Best Theratronics Manufacturing Facility, Kanata	Disused cobalt-60 sealed sources	ILW	Solid	1	1	m3	Dry Container	Package	Co-60	Storage of disused sealed sources and depleted uranium shielding	Inorganic Material - Heavy Metals Present	-	N	N	N	Y	N	N	Activity of 71 TBq. Some waste is currently in pool storage - assume this waste is moved to dry containers prior to disposal
Best Theratronics	Best Theratronics Manufacturing Facility, Kanata	Disused cesium-137 sealed sources	ILW	Solid	1	1	m3	Dry Container	Package	Cs-137	Storage of disused sealed sources and depleted uranium shielding	Inorganic Material - Heavy Metals Present	-	N	N	N	Y	N	N	
BWXT NEC	BWXT Fuel Manufacturing, Peterborough	Processing Waste	LLW	Solid	2	2	m3	205 L-drums, waste boxes	Drum		Unknown	Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	Activity of <1 TBq, Lifecycle volume assumed based on limited information.
BWXT NEC	BWXT Fuel Manufacturing, Toronto	Processing Waste	LLW	Solid	33	33	m3	205 L-drums, skids	Drum		Unknown	Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	Activity of <1 TBq, Lifecycle volume assumed based on limited information.
Nordion	Nordion Manufacturing Facility, Kanata	Disused cobalt-60 sealed sources	ILW	Solid	5	5	m3	Pool storage or dry containers	Package		Storage of disused sealed sources	Inorganic Material	In Situ	N	N	N	Y	N	N	Activity of 4126 TBq, Lifecycle volume assumed based on limited information.
AECL/CNL	Nuclear Power Demonstration	Decommissioned reactor waste	LLW	Solid	2,289	2,289	m3	Reactor building	Unpackaged		Decommissioned reactor waste	Unknown Non-Nuclear Characteristics	In Situ at CNL	Y	Y2	Y2	Y3	N	Y3	Lifecycle volume assumed based on limited information.
AECL/CNL	Nuclear Power Demonstration	Decommissioned reactor waste	ILW	Solid	389	389	m3	Reactor building	Unpackaged		Decommissioned reactor waste	Unknown Non-Nuclear Characteristics	In Situ at CNL	N	N	N	Y	N	N	Includes liquid (assumed to be solidified), Lifecycle volume assumed based on limited information.
OPG	PNGS	Pickering A Refurb Reactor Wastes	ILW	Solid	1,012	1,012	m3	Dry storage modules. Assumed to require repackaging per 2014 Inventory Report.	Package		Interim storage of historic intermediate-level reactor refurbishment waste from Pickering A (Units 1 to 4).	Inorganic Material	-	N	N	N	Y	N	N	Activity of 2374 TBq. Lifecycle volume assumed based on limited information.
Cameco	Port Hope Conversion Facility	Decommissioning waste	LLW	Solid	1,700	1,700	m3	Drums or other appropriate industrial packaging	Drum		Decommissioning waste	Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	Lifecycle volume assumed based on limited information.
MoE	Deloro Mine Site	Contaminated soils and historical tailings	LLW	Solid	34,500	34,500	m3	In situ (fenced-in area)	Bulk Material		Contaminated soils and historical tailings	Organic Materials Present	Deloro Waste Disposa	Y	Y2	Y2	Y3	N	Y3	Activity of 2 TBq, Lifecycle volume assumed based on limited information.
HQ	Gentilly-2	Disposal of Dry Active Waste - Secondary Waste	LLW	Solid	-	143	m3	Unknown	Container			Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Waste produced initial scaffolding	LLW	Solid	-	80	m3	Bin	Container			Organic Materials Present	-	Y2	Y	Y	Y2	N	Y3	Assumed to be miscellaneous PPE and decontamination consumables
HQ	Gentilly-2	Irradiated Fuel Storage Frames	LLW	Solid	-	235	m3	Segmented during D&D	Unpackaged			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Legacy Waste	LLW	Solid	-	19	m3	Unknown	Unpackaged			Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	Unknown configuration
HQ	Gentilly-2	PHT Piping	LLW	Solid	-	6	m3	Segmented during D&D	Container	Co-60		Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	PHT System Pumps & Motors	LLW	Solid	-	186	m3	Solid equipment, seal-welded and binned	Large Object - Irregular		Assumed to include trace amounts of motor oil/lubricants.	Organic Materials Present	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Dump Tank	LLW	Solid	-	5	m3	Segmented during D&D	Large Object - Irregular			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Steam Generators	LLW	Solid	-	1,202	m3	May be segmented depending on disposal site, otherwise will be seal-welded.	Large Object - Irregular	Co-60		Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Pressurizer	LLW	Solid	-	68	m3	Segmented during D&D	Large Object - Irregular			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Calandria and Internals	LLW	Solid	-	248	m3	Segmented during D&D	Large Object - Irregular	Fuel Channels: Nb-95, Zr-95, Fe-55, Nb-94, Co-60 Calandria Shell: Fe-55, Co-60, Ni-63, Nb-94		Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	

Owner	Current Location	Waste Description	Classification	State	Current Volume	Lifecycle Volume	Unit	Packaging/ Physical Configuration	Physical Configuration Category	Radiological Characteristics	Non-nuclear characteristics	Non-Nuclear Category	Current Waste Disposal Plans	Engineered Containment Mound	Concrete Vault	Shallow Rock Cavern	Deep Geological Repository	Deep Borehole	Rolling Stewardship	Additional Notes
HQ	Gentilly-2	Calandria and Internals	ILW	Solid	-	567	m3	Segmented during D&D	Large Object - Irregular	Fuel Channels: Nb-95, Zr-95, Fe-55, NB-94, Co-60 Calandria Shell: Fe-55, Co-60, Ni-63, Nb-94		Inorganic Material	-	N	N	N	Y	N	N	Assume this includes control rods, emergency shutdown systems, flux detectors, and other reactivity control mechanisms.
HQ	Gentilly-2	Large Component Segmentation	LLW	Solid	-	5	m3	Segmented during D&D	Large Object - Irregular	Co-60		Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	PHT Feeder Piping, Headers & Supports	LLW	Solid	-	338	m3	Segmented during D&D, pipes are seal-welded.	Container	Co-60	Includes insulation	Organic Materials Present	-	Y2	Y	Y	Y2	N	Y3	Assume this includes feeder cabinet insulation (unknown) and header insulation (Marinite insulation (calcium silicate with some organic fibers)).
HQ	Gentilly-2	Vault Concrete	LLW	Solid	-	1,464	m3	Bulk Material	Bulk Material	Tritium permeation likely		Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	~2050 tonnes of concrete
HQ	Gentilly-2	Vault Steel Liner	LLW	Solid	-	10	m3	Segmented during D&D	Container			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	~39 tonnes of steel
HQ	Gentilly-2	Boiler Waste Blowdown Waste	LLW	Solid	-	6	m3	Metallic waste	Container			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Coolant Storage & Recovery Waste	LLW	Solid	-	13	m3	Metallic waste	Container			Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	D2O processing and clean-up	LLW	Solid	-	537	m3	Metallic waste	Container	Tritium contamination		Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Electrical System Disposal	LLW	Solid	-	204	m3	Contaminated equipment and cables, junction boxes, I&C components.	Unpackaged			Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Emergency Core Cooling	LLW	Solid	-	112	m3	Metallic waste	Container			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Fuel Machine	LLW	Solid	-	40	m3	Contaminated equipment	Unpackaged			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Gland Seal Circuit	LLW	Solid	-	3	m3	Metallic waste	Container			Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Removal of miscellaneous liquid and gas support systems.	LLW	Solid	-	300	m3	Metallic waste	Container			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	Including spent fuel pool cooling & purification system, Instrument air system, liquid handling system, liquid poison system, dousing system, liquid zone control, main cover gas, main steam system, H2 and H2O2 System, service air system, breathing air system, annulus gas system, shutdown cooling.
HQ	Gentilly-2	Recirculated Service Water System	LLW	Solid	-	304	m3	Metallic waste	Container			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Moderator sampling and control systems	LLW	Solid	-	77	m3	Metallic waste	Container			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Purification Circuit	LLW	Solid	-	70	m3	Metallic waste	Container			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Radioactive Drains	LLW	Solid	-	65	m3	Contaminated equipment	Unpackaged			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Resin Handling System	LLW	Solid	-	6	m3	Metallic waste	Container		Assumed to include traces of organic resins.	Organic Materials Present	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	RX Building Ventilation System	LLW	Solid	-	187	m3	Metallic waste	Container			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Shielding Cooling Circuit	LLW	Solid	-	118	m3	Metallic waste	Container			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Spend Fuel Pool Cooling & Purification	LLW	Solid	-	66	m3	Metallic waste	Container			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Reactor Building	LLW	Solid	-	234	m3	Contaminated metals and concrete	Bulk Material			Inorganic Material	-	Y	Y2	Y2	Y3	N	Y3	Assumed
HQ	Gentilly-2	Tour D2O	LLW	Solid	-	8	m3	Solidified decontamination products	Unpackaged			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	Assumed
HQ	Gentilly-2	Service Building	LLW	Solid	-	6,778	m3	Contaminated construction waste	Container			Inorganic Material	-	Y	Y2	Y2	Y3	N	Y3	Assumed
HQ	Gentilly-2	ASDR	LLW	Solid	-	3,250	m3	Contaminated construction waste	Container			Inorganic Material	-	Y	Y2	Y2	Y3	N	Y3	Assumed
HQ	Gentilly-2	ICDRS	LLW	Solid	-	81	m3	Solidified decontamination products	Unpackaged			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	Assumed
HQ	Gentilly-2	Chemical Building	LLW	Solid	-	1	m3	Solidified decontamination products	Unpackaged			Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	Assumed
HQ	Gentilly-2	Circulating Water Tunnels	LLW	Solid	-	165	m3	Metallic waste	Container			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	Assumed
HQ	Gentilly-2	Process decommissioning water waste	LLW	Solid	-	5	m3	Incinerated liquid from various decommissioning processes	Unpackaged			Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Decommissioning equipment disposition	LLW	Solid	-	102	m3	Unknown	Unpackaged			Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Disposal of DAW	LLW	Solid	253	253	m3	Unknown	Unpackaged			Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Disposal of ASDR Waste	LLW	Solid	159	159	m3	On-site waste storage	Container			Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Disposal of ASDR Waste	ILW	Solid	73	73	m3	On-site waste storage	Package			Organic Materials Present	-	N	N	N	Y	Y2	N	Filters, IX resins (currently stored in tanks), sandblast residues.
HQ	Gentilly-2	Disposal of IGDRS Waste	LLW	Solid	473	473	m3	On-site waste storage	Container			Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	
HQ	Gentilly-2	Disposal of IGDRS Waste	ILW	Solid	338	338	m3	On-site waste storage	Package			Organic Materials Present	-	N	N	N	Y	Y2	N	Filters, IX resins (currently stored in tanks), sandblast residues.
NB Power	Point Lepreau	Compactable waste	LLW	Solid	338	4	m3	Vault Storage	Container	<2 mSv/h, 0.33 GBq/m3, (Zr/Nb-95 (60%), Co-60 (20%), Sb-124/Sb-125 (5%), Other (15%))	Unknown	Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	From Phase I (2019)
NB Power	Point Lepreau	Compactable waste (currently in vaults)	LLW	Solid	199	2	m3	Vault Storage	Container	<2 mSv/h, 0.28 GBq/m3, (Zr/Nb-95 (60%), Co-60 (20%), Sb-124/Sb-125 (5%), Other (15%))	Unknown	Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	From Phase III (refurbishment waste)
NB Power	Point Lepreau	Non-compactable waste	LLW	Solid	177	177	m3	Vault Storage	Container	<2 mSv/h, 0.12 GBq/m3, (Zr/Nb-95 (60%), Co-60 (20%), Sb-124/Sb-125 (5%), Other (15%))	Unknown	Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	From Phase I (2019)
NB Power	Point Lepreau	Non-compactable waste (currently in vaults? TBC)	LLW	Solid	681	681	m3	Vault Storage	Container	<2 mSv/h, 260 GBq/m3, (Zr/Nb-95 (60%), Co-60 (20%), Sb-124/Sb-125 (5%), Other (15%))	Unknown	Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	From Phase III (refurbishment waste)
NB Power	Point Lepreau	Purification Filters	LLW	Solid	29	0	m3	Vault Storage (Filter storage structure)	Container	<2 mSv/h, 1.81 GBq/m3 (Zr/Nb-95 (95%), Co-60 (1%), Other short-lived (4%))	Unknown	Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	From Phase I (2019)
NB Power	Point Lepreau	Drummed Waste	LLW	Solid	286	4	m3	Drum	Drum	<2 mSv/h, 0.59 GBq/m3, (Zr/Nb-95 (60%), Co-60 (20%), Sb-124/Sb-125 (5%), Other (15%))	Unknown	Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	From Phase I (2019)
NB Power	Point Lepreau	Miscellaneous	LLW	Solid	3	1	m3	20L Container	Container	<2 mSv/h, 0.13 GBq/m3, (Zr/Nb-95 (60%), Co-60 (20%), Sb-124/Sb-125 (5%), Other (15%))	Various (a 20L Container containing a Sr-Y-90 Calibration Source, Concrete, Active Lathe Cuttings, Carbon-14 Waste, Rubber Matting, Lead Sheet.)	Organic Materials Present	-	Y2	Y	Y	Y2	N	Y3	From Phase I, Includes a Sr-Y-90 Calibration source, concrete, active lathe cuttings, C-14 waste, rubber matting, lead sheet.
NB Power	Point Lepreau	Decommissioning Waste	LLW	Solid	-	1,434	m3	No current packaging	Unpackaged	Unknown	Unknown	Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	This will be a mix of long-lived and short-lived waste.
NB Power	Point Lepreau	Compactable waste	ILW	Solid	0	0	m3	Boxed waste	Package	2-125 mSv/h, 44.4 GBq/m3, (Zr/Nb-95 (60%), Co-60 (20%), Sb-124/Sb-125 (5%), Other (15%))	Unknown	Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	From Phase I (2022)
NB Power	Point Lepreau	Non-compactable waste	ILW	Solid	9	15	m3	Boxed waste	Package	2-125 mSv/h, 13.7 GBq/m3, (Zr/Nb-95 (60%), Co-60 (20%), Sb-124/Sb-125 (5%), Other (15%))	Unknown	Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	From Phase I (2022)
NB Power	Point Lepreau	Non-compactable waste (Refurbishment waste)	ILW	Solid	131	131	m3	Retube Canisters	Package	2-125 mSv/h, 3787 GBq/m3, (Zr/Nb-95 (60%), Co-60 (20%), Sb-124/Sb-125 (5%), Other (15%))	Unknown	Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	From Phase III (refurbishment waste)
NB Power	Point Lepreau	Purification Filters	ILW	Solid	11	18	m3	Vault Storage (Filter storage structure)	Package	2-125 mSv/h, 256 GBq/m3, (Zr/Nb-95 (95%), Co-60 (1%), Other short-lived (4%))	Unknown	Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	From Phase I (2022)
NB Power	Point Lepreau	Drummed Waste	ILW	Solid	2	3	m3	Drum	Drum	2-125 mSv/h, 245 GBq/m3, (Zr/Nb-95 (60%), Co-60 (20%), Sb-124/Sb-125 (5%), Other (15%))	Unknown	Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	From Phase I (2022)
NB Power	Point Lepreau	Spent IX Resin	ILW	Solid	227	37	m3	Quadricell storage	Package	Activity not yet assessed (Sb-124/125 (21%), Zr/Nb-95 (18%), Co-60 (16%), Cs-134/137 (14%), Sn-113 (12%), Mn-54 (9%)	Assume organic resin	Organic Materials Present	-	N	N	N	Y	Y2	N	From Phase I (2022), Assume liquid is solidified.

Owner	Current Location	Waste Description	Classification	State	Current Volume	Lifecycle Volume	Unit	Packaging/ Physical Configuration	Physical Configuration Category	Radiological Characteristics	Non-nuclear characteristics	Non-Nuclear Category	Current Waste Disposal Plans	Engineered Containment Mound	Concrete Vault	Shallow Rock Cavern	Deep Geological Repository	Deep Borehole	Rolling Stewardship	Additional Notes
NB Power	Point Lepreau	Compactable waste	ILW	Solid	0	0	m3	Vault Storage	Package	>125 mSv/h, 652 GBq/m3, (Zr/Nb-95 (60%), Co-60 (20%), Sb-124/Sb-125 (5%), Other (15%))	Unknown	Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	From Phase I (2022)
NB Power	Point Lepreau	Purification Filters	ILW	Solid	2	3	m3	Vault Storage (Filter storage structure)	Package	Unknown, >125 mSv/h, 4565 GBq/m3, (Zr/Nb-95 (95%), Co-60 (1%), Other short-lived (4%))	Unknown	Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	From Phase I (2022)
NB Power	Point Lepreau	Drummed Waste	ILW	Solid	0	0	m3	Drum	Drum	Unknown, >125 mSv/h, 820,000 GBq/m3	Unknown	Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	From Phase I, Specifically drummed horizontal flux detector material, placed in 1992.
NB Power	Point Lepreau	Decommissioning Waste	ILW	Solid	-	567	m3	No current packaging	Unpackaged	Unknown	Unknown	Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	Projected, From Phase I (2022-2100), unspecified waste. This will be a mix of long-lived and short-lived waste.
OPG	WWMF	Bottom Ash	LLW	Solid	1,885	2,618	m3 (waste only)	DGR-ready Ash Bin - not grouted	Container	3.0e8 Bq/m3; Fe-55, Ni-63, Co-60, Cs-137+Ba-137m, Sr-90/Y-90	Ash	Organic Materials Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	In DGR-ready packaging. Heterogeneous ash and clinker from waste incineration. Contains traces of Cl-Benzenes, Cl-Phenols, Diozins and Furans, PAH, PCB, Chromium VI.
OPG	WWMF	Baghouse Ash	LLW	Solid	452	628	m3 (waste only)	DGR-ready Ash Bin - not grouted	Container	7.1e7 Bq/m3; Cs-137+Ba-137m (57%), H-3 (35%), others (<1%)	Fine Ash	Organic Materials Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	In DGR-ready packaging. Fine homogeneous ash from waste incinerations. Contains traces of Cl-Benzenes, Cl-Phenols, Diozins and Furans, PAH, PCB, Chromium VI.
OPG	WWMF	Compact Bales	LLW	Solid	2,268	4,531	m3 (waste only)	Steel bin	Container	1.1e10 Bq/m3; H-3 (99+%), Cs-137+Ba137m (0.2%), C-14 (0.05%), others (<1%)	Includes organic materials (cellulose, rubber, plastics)	Organic Materials Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	17,248m3 as of 2019, includes compacted drums, rubber waste, process/machine shop waste, PPE, etc. (Cellulosic materials 27%, Plastic 32%, rubber 10%, steel 26$%, glass 5%). Contains 60,000 kg of Nitrate Ions
OPG	WWMF	Box Compacted	LLW	Solid	13,769	27,506	m3 (waste only)	Steel bin	Container	4.5e10 Bq/m3; H-3 (99+%), others (<1%)	Includes organic materials (cellulose, rubber, plastics)	Organic Materials Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	
OPG	WWMF	Non-processible	LLW	Solid	65,312	21,573	m3 (waste only)	Various LLW Bins	Container	1.7e9 Bq/m3; H-3 (76%), Cs-137+Ba-137m (24%), others (<1%)	Includes organic materials (cellulose, rubber, plastics, bitumen, other)	Organic Materials Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	In DGR-ready packaging. Includes heavy guage metal, concrete and cement, metal components, wire and cables, tools, etc. Some will be processed via the 2020 NW System Plan, however this is not specified. Between non-processible and non-pro drums: Includes 450,000kg asbestos and 35000 kg nitrate ions. Metal 36%, absorbent 18%, cellulosic materials 18%, plastic 6% rubber 1%, glass 4%, concrete 4%, bituman 1%, other (inorganic) 12%.
OPG	WWMF	Non-processible, drummed	LLW	Solid	9,572	3,162	m3 (waste only)	55gal drum (6/rack) / LLW Drum Container	Drum	9.3e10 Bq/m3; H-3 (99+%), others (<1%)	Includes organic materials (cellulose, rubber, plastics, other)	Organic Materials Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	In DGR-ready packaging. Between non-processible and non-pro drums: Includes 450,000kg asbestos and 35000 kg nitrate ions. Metal 36%, absorbent 18%, cellulosic materials 18%, plastic 6% rubber 1%, glass 4%, cnocrete 4%, bituman 1%, other (inorganic) 12%.
OPG	WWMF	Other non-processible	LLW	Solid	1,861	205	m3 (waste only)	Various	Large object - irregular	1.4e9 Bq/m3; H-3 (71%), Cs-137+Ba-137m (27%), others (<1%)	Includes organic resins	Organic Materials Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	1,861m3 (1,871m3 packaged) Includes HXs, ETHs, Tile Hole Liners, minimal volume reduction expected.
OPG	WWMF	ETH	LLW	Solid		205	m3 (waste only)	Encapsulated in cement in steel pipe (1.5m OD).	Large object - irregular			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	175m3, 1.5m OD x 4.6m OL, assume long-lived radionuclides are present
OPG	WWMF	Tile Hole Liner	LLW	Solid		205	m3 (waste only)		Large object - irregular			Inorganic Material	-	Y2	Y	Y	Y2	N	Y3	77m3, 0.61 OD x 3.4 OL Contains filder vessels, IX columns, core component liners, filter elements, and bagged waste.
OPG	WWMF	Feeder Pipes	LLW	Solid	2,095	692	m3 (waste only)		Container	1.4e10 Bq/m3; Fe-55 (41%), Co-60 (17%), Pu-241 (16%), Sr-90+Y-90 (11%), H-3 (7%), Am-241 (1.6%), others (<1%)		Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	2,095m3 (2,682m3 packaged), carbon steel.
OPG	WWMF	LL/ALW Resin	LLW	Solid	1,216	402	m3 (waste only)	Various Low-Level Resin Boxes/tanks (steel or steel/plastic)	Container	1.2e10 Bq/m3; H-3 (92%), C-14 (4%), Fe-55 (2%), others (<1%)	Includs organic resins - some packaging includes plastic.	Organic Materials Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	1,216m3 (2,481m3 packaged), from light water auxiliary systems and active liquid waste systems. Assume liquid is solidified.
OPG	WWMF	ALW Sludge	LLW	Solid	1,588	525	m3 (waste only)	AWL Sludge Box	Container	2.8e9 Bq/m3; H-3 (99+%), others (<1%)	Clay (flocculant), polymers, pH adjusting agents	Organic Materials Present	-	Y2	Y	Y	Y2	N	Y3	1,588m3 (6,775m3 packaged), solidified waste product collected from ALW treatment. Blend of clay (flocculant), polymers, pH adjusting agents. Assume liquid is solidified.
OPG	WWMF	Other wastes	LLW	Solid	10,880	13,696	m3 (waste only)	Various	Container			Unknown Non-Nuclear Characteristics	OPG NSDF	Y2	Y	Y	Y2	N	Y3	Everything that is not the above eg. processible liquid, empty drums, etc., 10,880m3 as of 2019. Assume liquid waste is solidified, assume long-lived radionuclides are present.
OPG	WWMF	Moderator Resin	ILW	Solid	1,623	2,119	m3 (waste only)	Resin Liner	Package	2.8e12 Bq/m3; C-14 (94%), H-3 (3%), others (<1%)	Nitrate Ions	Organic Materials Present	-	N	N	N	Y	Y2	N	Needs disposal packaging, from moderator purification systems. Contains traces of nitrate ions. Assume liquid is solidified.
OPG	WWMF	PHT Resin	ILW	Solid	1,119	1,461	m3 (waste only)	Resin Liner	Package	2.1e11 Bq/m3; C-14 (42%), Cs-137+Ba-137m (33%), H-3 (21%), others (<1%)	Nitrate Ions	Organic Materials Present	-	N	N	N	Y	Y2	N	Needs disposal packaging, from PHT purificaation systems. Contains traces of nitrate ions. Assume liquid is solidified.
OPG	WWMF	Misc Resin	ILW	Solid	1,520	1,984	m3 (waste only)	Resin Liner	Package	3.1e11 Bq/m3; C-14 (51%), H-3 (40%), Cs-137+Ba-137m (5%), Co-60 (1.5%), others (<1%)	Nitrate Ions	Organic Materials Present	-	N	N	N	Y	Y2	N	Needs disposal packaging, From station auxiliary systems. Contains traces of nitrate ions. Assume liquid is solidified.
OPG	WWMF	CANDECON Resin	ILW	Solid	1,557	2,032	m3 (waste only)	Resin Liner	Package	1.7e11 Bq/m3; H-3 (30%), Fe-55 (27%), Sr-90+Y-90 (25%), C-14 (13%), others (<1%)	Nitrate Ions, EDTA	Organic Materials Present	-	N	N	N	Y	Y2	N	Needs disposal packaging, from chemical decontamination process for heat transport systems. Contains 34,000kg EDTA and traces of nitrate ions. Assume liquid is solidified.
OPG	WWMF	IX Columns	ILW	Solid	275	545	m3 (waste only)	ILW Shield	Package	1.7e11 Bq/m3; C-14 (54%), Cs-137+Ba-137m (28%), H-3 (15%), others (<1%)		Organic Materials Present	-	N	N	N	Y	N	N	IX Columns from the Pickering PHT purification system
OPG	WWMF	Shield Plugs	ILW	Solid	-	441	m3 (waste only)	Shield Plug Container	Package			Inorganic Material	-	N	N	N	Y	N	N	Assume long-lived radionuclides are present
OPG	WWMF	Filters and Filter Elements	ILW	Solid	978	1,908	m3 (waste only)	ILW Shield	Package	7.4e11 Bq/m3; H-3 (66%), C-14 (21%), Fe-55 (6%), Co-60 (2%), others (<1%)	Various filter elements including organic material (e.g. resin and epoxy-impregnated filters)	Organic Materials Present	-	N	N	N	Y	N	N	Filters and Filter Elements from various systems
OPG	WWMF	Core Components	ILW	Solid	27	54	m3 (waste only)	ILW Shield	Package	3.5e12 Bq/m3; Ni-63 (40%), Fe-55 (24%), Sb-125 (22%), Co-60 (8.7%), C-14 (2.2%)		Inorganic Material	-	N	N	N	Y	N	N	Core Components including flux detectors and liquid zone control rods. 0.17-5.85kg inconel-600 or SS 304L.
OPG	WWMF	Miscellaneous	ILW	Solid	-	2,732	m3 (waste only)	Various	Package			Unknown Non-Nuclear Characteristics	OPG NSDF	N	N	N	Y	N	N	Trench Waste, Stern Flasks, assumed to have long-lived radionuclides.
OPG	WWMF	In Ground Heat Exchangers	ILW	Solid	1,544	1,172	m3 (waste only)	Not Packaged	Large object - irregular			Inorganic Material	OPG NSDF	N	N	N	Y	N	N	ICHX
OPG	DNGS	Pressure Tubes	ILW	Solid	442	438	m3 (waste only)	DGR-ready packaging.	Package	5.0e13 Bq/m3; Co-60 (28%), Fe-55 (26%), Ni-63 (21%), Nb-96 (19%), H-3 (3%), C-14 (2%), others (<1%)		Inorganic Material	-	N	N	N	Y	N	N	In DGR-ready packaging.
OPG	DNGS	Garter springs	ILW	Solid		438	m3 (waste only)	Packaged with Pressure Tubes	Package			Inorganic Material	-	N	N	N	Y	N	N	In DGR-ready packaging.
OPG	DNGS	Girdle wires	ILW	Solid		438	m3 (waste only)	Packaged with Pressure Tubes	Package			Inorganic Material	-	N	N	N	Y	N	N	In DGR-ready packaging.
OPG	DNGS	Calandria Tubes	ILW	Solid	143	425	m3 (waste only)	DGR-ready packaging.	Package	5.1e13 Bq/m3; Sb-125 (46%), Fe-55 (25%), Co-60 (13%), Ni-63 (10%), H-3 (4%), others <1%)		Inorganic Material	-	N	N	N	Y	N	N	In DGR-ready packaging.
OPG	DNGS	End Fittings	ILW	Solid	1,608	4,782	m3 (waste only)	DGR-ready packaging.	Package	9.1e12 Bq/m3; Fe-55 (86%), Co-60 (13%), others (<1%)		Inorganic Material	-	N	N	N	Y	N	N	In DGR-ready packaging. Includes shield plugs.
OPG	DNGS	Calandria Tube Inserts	ILW	Solid	35	104	m3 (waste only)	DGR-ready packaging.	Package	4.3e14 Bq/m3; Fe-55 (91%), Co-60 (8%), others (<1%)		Inorganic Material	-	N	N	N	Y	N	N	In DGR-ready packaging.
OPG	WWMF	Steam generators	LLW	Solid	5,987	1,554	m3 (waste only)	Large Object - Not Packaged	Large object - irregular	3.6e10 Bq/m3; Fe-55 (36%), Pu-241 (20%), Co-60 (17%), H-3 (9%), Sr-90+Y-90 (7%), Ni-63 (3%), Am-241 (1.7%), others <1%)		Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	~128 medium steam generators (100 tonnes ea.) plus 16 large stream generators (340 tonnes ea.) that have been volume reduced per 2020 NW System Plan
OPG	WWMF	Steam Drums	LLW	Solid	-	984	m3 (waste only)	Large Object - Not Packaged	Large object - irregular			Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	Exposed to secondary water only (low level surface contamination only).
OPG	WWMF	Pre-heaters (Primary side)	LLW	Solid	-	1,344	m3 (waste only)	Large Object - Not Packaged	Large object - irregular	H-3		Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	45 tonnes each. Exposed to primary D2O on tube side - may have tritium permeation leaving to minor surface contamination.
OPG	WWMF	PHT Pressurizers	LLW	Solid	-	444	m3 (waste only)	Large Object - Not Packaged	Large object - irregular	H-3		Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	83 tonnes each, with internal surface contamination (exposed to primary D2O)
OPG	WWMF	PHT Bleed condensers	LLW	Solid	-	220	m3 (waste only)	Large Object - Not Packaged	Large object - irregular	H-3		Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	21 tonnes each, exposed to primary D2O on tube side, leading to minor surface contamination outside tubes and inside shell.

Owner	Current Location	Waste Description	Classification	State	Current Volume	Lifecycle Volume	Unit	Packaging/ Physical Configuration	Physical Configuration Category	Radiological Characteristics	Non-nuclear characteristics	Non-Nuclear Category	Current Waste Disposal Plans	Engineered Containment Mound	Concrete Vault	Shallow Rock Cavern	Deep Geological Repository	Deep Borehole	Rolling Stewardship	Additional Notes
OPG	WWMF	Other Large HX's	LLW	Solid	-	16,330	m3 (waste only)	Large Object - Not Packaged	Large object - irregular	H-3		Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	Up to 53 tonnes each, some minor surface contamination outside tubes and inside shell.
OPG	WWMF	Small PHT Pumps	LLW	Solid	-	973	m3 (waste only)	Large Object - Not Packaged	Large object - irregular	H-3		Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	20 tonnes each, exposed to D2O, motors may have tritium permeation.
OPG	WWMF	Large PHT Pumps	LLW	Solid	-	3,120	m3 (waste only)	Large Object - Not Packaged	Large object - irregular	H-3		Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	48 pumps (18 tonne) and motors (62 tonne), include surface contamination, motors may have tritium permeation
OPG	WWMF	Moderator Dump Tanks	LLW	Solid	-	1,152	m3 (waste only)	Large Object - Not Packaged	Large object - irregular	H-3		Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	25 tonnes each. Surface contamination and tritium permeation - top portion may be neutron irradiated.
OPG	WWMF	Other Large Tanks	LLW	Solid	-	-		Large Object - Not Packaged	Large object - irregular	H-3		Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	Unspecified quantity. Surface contamination and tritium permeation
OPG	WWMF	Encapsulated RWOS 1 Tileholes	ILW	Solid	-	184	m3 (waste only)	Large Object - Concrete/Steel monolith	Large object - irregular	IX resins, filters and other ILW (e.g. H-3, C-14, Co-60, Cs-137, Fe55, Sb-125)	Waste includes organic resin	Organic Materials Present	-	N	N	N	Y	N	N	23 tonnes each, waste is not removed from the package.
OPG	WWMF	Concrete Integrated Cask	LLW	Solid	-	38	m3 (waste only)	Large Object - Concrete/steel packaging	Large object - irregular			Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	65 tonnes each. Interior and exterior contamination, including alpha contamination.
OPG	WWMF	DSMs	ILW	Solid	-	2,340	m3 (waste only)	Large Object - Concrete/steel packaging	Large object - irregular	C-14		Inorganic Material	-	N	N	N	Y	N	N	175 tonnes. Interior surface contamination including loose C-14 contamination. Waste is assumed to be removed.
OPG	WWMF	Old Radwaste Incinerator	LLW	Solid	-	-		Large Object - Not Packaged	Large object - irregular			Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	Unspecified quantity. Surface contamination (inside/outside), including alpha contamination. Composed of steel shells and silica-based refractory materials,
OPG	WWMF	Gloveboxes	LLW	Solid	-	-		Large Object - Not Packaged	Large object - irregular			Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	Interior surface contamination. Consists of stainless frame with large glass or polymer windows.
OPG	WWMF	Modified Super-Tiger Overpack	LLW	Solid	-	30	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular			Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	4.5 tonnes each. Transportation package, surface contamination
OPG	WWMF	NOD F1 Fuel Cask	LLW	Solid	-	2	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular			Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	14 tonnes. Transportation package, surface contamination
OPG	WWMF	NUPAC Cask	LLW	Solid	-	11	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular		Includes lead shielding	Inorganic Material - Heavy Metals Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	25 tonnes each. Transportation package, surface contamination
OPG	WWMF	NAC Cask	LLW	Solid	-	2	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular		Includes DU shielding	Inorganic Material - Heavy Metals Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	21 tonnes. Transportation package, surface contamination
OPG	WWMF	IXAPAC	LLW	Solid	-	7	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular		Includes lead shielding	Inorganic Material - Heavy Metals Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	16 tonnes. Transportation package, surface contamination
OPG	WWMF	IFC Irradiated Fuel Cask	LLW	Solid	-	5	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular			Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	30 tonnes. Transportation package, surface contamination
OPG	WWMF	TDO Package	LLW	Solid	-	293	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular			Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	16 tonnes each. Transportation package, surface contamination plus H-3 permeation in foam insulation
OPG	WWMF	Trillium Transportation Package	LLW	Solid	-	105	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular		Includes lead shielding	Inorganic Material - Heavy Metals Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	33 tonnes each. Transportation package, surface contamination
OPG	WWMF	RFTP Package	LLW	Solid	-	110	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular			Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	17 tonnes each. Transportation package, surface contamination plus H-3 permeation in foam insulation
OPG	WWMF	Roadrunner Package	LLW	Solid	-	6	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular		Includes DU shielding	Inorganic Material - Heavy Metals Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	23 tonnes each. Transportation package, surface contamination plus interior DU shielding (toxic+radioactive).
OPG	WWMF	ISO LLW Packages	LLW	Solid	-	1,370	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular			Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	4.1-7.6 tonnes each. Transportation package, surface contamination
OPG	WWMF	ISO Container for CIGAR	LLW	Solid	-	152	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular			Inorganic Material	OPG NSDF	Y2	Y	Y	Y2	N	Y3	4.1 tonnes each. Transportation package, surface contamination
OPG	WWMF	Pickering On-Site Fuel Transfer Flask	LLW	Solid	-	15	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular		Includes DU shielding	Inorganic Material - Heavy Metals Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	Transportation package, surface contamination. Volume assumed based on typical transportation package sizes.
OPG	WWMF	Misc Casks and Flasks	LLW	Solid	-	190	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular		Includes lead shielding	Inorganic Material - Heavy Metals Present	OPG NSDF	Y2	Y	Y	Y2	N	Y3	Transportation package, surface contamination. Volume assumed based on typical transportation package sizes.
OPG	WWMF	Misc Casks and Flasks	ILW	Solid	-	190	m3 (waste only)	Large Object - Intrinsic transportation-ready package.	Large object - irregular		Includes lead shielding	Inorganic Material - Heavy Metals Present	-	N	N	N	Y	N	N	Transportation package, surface contamination. Volume assumed based on typical transportation package sizes.
OPG	PNGS	Decommissioning Waste	LLW	Solid	-	3,103	m3	Various	Unpackaged	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	Waste is decontaminated and volume reduced where possible. Liquid has been dewatered/solidified. Volume assumed based on Hydro Quebec LLW proportion (66% concrete, 33% other)
OPG	PNGS	Decommissioning Waste	LLW	Solid	-	6,206	m3	Bulk Material	Bulk Material	H-3 contamination plus other surface contamination (Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)). Vault concrete likely also includes C-14 through neutron activation.		Organic Materials Present	-	Y	Y2	Y2	Y3	N	Y3	Contaminated concrete - volume assumed based on Hydro Quebec LLW proportion (10% bulk, 90% other).
OPG	PNGS	Decommissioning Waste	LLW	Solid	-	46,546	m3	Bin	Container	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	Waste is decontaminated and volume reduced where possible. Liquid has been dewatered/solidified.
OPG	PNGS	Decommissioning Waste	LLW	Solid	-	6,206	m3	Large object - irregular	Large object - irregular	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	Waste is decontaminated and volume reduced where possible. Liquid has been dewatered/solidified.
OPG	PNGS	Decommissioning Waste	ILW	Solid	-	3,539	m3	Large object - irregular	Large object - irregular	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	Waste is decontaminated and volume reduced where possible. Liquid has been dewatered/solidified.
OPG	PNGS	Decommissioning Waste	ILW	Solid	-	2,563	m3	Bin	Package	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	Waste is decontaminated and volume reduced where possible. Liquid has been dewatered/solidified.
OPG	DNGS	Decommissioning Waste	LLW	Solid	-	4,704	m3	Large object - irregular	Large object - irregular	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	Waste is decontaminated and volume reduced where possible. Liquid has been dewatered/solidified.
OPG	DNGS	Decommissioning Waste	LLW	Solid	-	35,282	m3	Bin	Container	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	Waste is decontaminated and volume reduced where possible. Liquid has been dewatered/solidified.
OPG	DNGS	Decommissioning Waste	LLW	Solid	-	4,704	m3	Bulk Material	Bulk Material	H-3 contamination plus other surface contamination (Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)). Vault concrete likely also includes C-14 through neutron activation.		Organic Materials Present	-	Y	Y2	Y2	Y3	N	Y3	
OPG	DNGS	Decommissioning Waste	LLW	Solid	-	2,352	m3	Various	Unpackaged	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	
OPG	DNGS	Decommissioning Waste	ILW	Solid	-	2,057	m3	Bin	Package	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	
OPG	DNGS	Decommissioning Waste	ILW	Solid	-	1,490	m3	Large object - irregular	Large object - irregular	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	
OPG	BNGS	Decommissioning Waste	LLW	Solid	-	5,674	m3	Large object - irregular	Large object - irregular	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	
OPG	BNGS	Decommissioning Waste	LLW	Solid	-	42,556	m3	Bin	Container	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	
OPG	BNGS	Decommissioning Waste	LLW	Solid	-	5,674	m3	Bulk Material	Bulk Material	H-3 contamination plus other surface contamination (Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)). Vault concrete likely also includes C-14 through neutron activation.		Organic Materials Present	-	Y	Y2	Y2	Y3	N	Y3	

Owner	Current Location	Waste Description	Classification	State	Current Volume	Lifecycle Volume	Unit	Packaging/ Physical Configuration	Physical Configuration Category	Radiological Characteristics	Non-nuclear characteristics	Non-Nuclear Category	Current Waste Disposal Plans	Engineered Containment Mound	Concrete Vault	Shallow Rock Cavern	Deep Geological Repository	Deep Borehole	Rolling Stewardship	Additional Notes
OPG	BNGS	Decommissioning Waste	LLW	Solid	-	2,837	m3	Various	Unpackaged	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	Y2	Y	Y	Y2	N	Y3	
OPG	BNGS	Decommissioning Waste	ILW	Solid	-	4,059	m3	Bin	Package	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	
OPG	BNGS	Decommissioning Waste	ILW	Solid	-	2,940	m3	Large object - irregular	Large object - irregular	Ni-63 (89.6%), Co-60 (7.6%), Nb-94 (1.2%), Ni-59 (0.66%), Fe-55 (0.58%), C-14 (0.22%), Zr-93 (0.06%)		Unknown Non-Nuclear Characteristics	-	N	N	N	Y	N	N	