Plan

CANADIAN NUCLEAR LABORATORIES INTEGRATED WASTE STRATEGY

COMPANY WIDE

CW-508600-PLA-002

Revision 1

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2019 March
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1. **INTRODUCTION**

1.1 **Purpose**

The Integrated Waste Strategy (IWS) is a guiding document which describes the strategic approach to waste management for Canadian Nuclear Laboratories (CNL). The purpose is to support integrated management of waste across CNL, and ensure alignment with the goals and requirements of CNL’s primary business missions.

The IWS aims to answer three important questions:

1. Where are we today? Describes the current management of waste.
2. Where do we want to get to and when? Describes our strategic vision for waste.
3. What actions are needed to get there? Identifies the enabling facilities and capability required to complete the strategy.

The IWS is a living document and is updated as processes and management changes are implemented, and waste routes are optimized.

1.2 **Scope**

The IWS applies to all CNL managed waste for the entire waste management lifecycle (Figure 2-1). Liquid and air effluent waste discharges are out of scope for this document and are addressed by CNL’s Environmental Protection Program.

Materials which are not currently considered as waste (e.g., some spent (used) fuel, tritiated heavy water) are out of the scope of the IWS. Although not considered as waste, reuse and management of this material may result in secondary wastes due to processing, or if identified disposition pathways become exhausted or unavailable. This material is discussed in Section 3.6.

The Key IWS activities stated in Section 4 are executed through an associated IWS Action Plan which details short, medium and long term activities. Full details of the actions required to meet the key activities are not addressed in this document.

1.3 **Background**

CNL and Atomic Energy of Canada Limited (AECL) have been instrumental in the development of Canada’s nuclear industry. For more than 70 years, nuclear technology has evolved to meet the needs of the world for clean, reliable energy; sustainable economic growth; and public health, safety and security. Today, CNL operates multiple sites across Canada, and manages AECL’s waste liabilities. CNL also manages small amounts of radioactive wastes received from Canadian generators including hospitals and universities, consistent with existing commercial arrangements. A description of CNL managed sites is provided in Section 1.4.

CNL’s 10 Year Plan sets out priorities and plans across all of CNL’s missions: science and technology, capital, and decommissioning and waste management [1]. Based on the plan, CNL
will implement safe, cost-effective environmental remediation (ER) and waste management strategies.

A program of decommissioning of sites and facilities is planned, which includes:

- Revitalisation of the Chalk River Laboratories (CRL) site with a program of accelerated decommissioning of redundant buildings to enable this.
- In-situ decommissioning and disposal where applicable (e.g., as proposed for Nuclear Power Demonstration (NPD) and Whiteshell Reactor -1 (WL WR-1)).
- Retrieval, processing and packaging of legacy waste.
- Construction of the proposed Near Surface Disposal Facility (NSDF), located at CRL, for disposal of CNL managed Low Level Waste (LLW).
- Transfer of CNL managed Intermediate Level Waste (ILW) from other sites to CRL for storage until final disposal is available.
- Transfer of CNL managed High Level Waste (HLW) from other sites to CRL for storage until final disposal is available.
- Management of land remediation. This includes ongoing monitoring of contaminated sites and remediation of existing contaminated sites.

### 1.4 CNL Managed Sites

CNL manages a number of locations across Canada (Figure 1-1). This section provides a brief description of each CNL operated site requiring management of waste as at 2018 October.
1.4.1 Chalk River Laboratories (CRL)

CRL is located near the Town of Chalk River, Ontario, 190 km northwest of Canada's national capital, Ottawa. The CRL site comprises approximately 4000 hectares along the Ottawa River and contains several licence-listed nuclear facilities that support innovation in safety, security, health, environmental and clean energy technologies. The long term plan for CRL is revitalization of the site to create a modern National Nuclear Laboratory campus. To enable this, a program of accelerated decommissioning of redundant facilities is underway, and in 2018 March the National Research Universal (NRU) reactor began the transition from an operating facility to being maintained in a safe shutdown state. New near term priority projects planned include an Advanced Nuclear Material Research Centre (ANMRC), Business Hub, support facility and logistics/ warehouse facility as well as the proposed NSDF.
1.4.2 Nuclear Power Demonstration (NPD)

The Nuclear Power Demonstration (NPD) site is located on the Ottawa River near the town of Rolphton, Ontario, approximately 25 km from CRL. The NPD reactor operated as a training facility from 1962 until 1987. NPD is presently in the Storage with Surveillance (SwS) phase of decommissioning under a Waste Facility Decommissioning Licence issued by the Canadian Nuclear Safety Commission (CNSC).

1.4.3 Douglas Point (DP)

The Douglas Point (DP) site is located at the Bruce site, on the shores of Lake Huron near the town of Kincardine, Ontario. The DP site housed Canada’s first full scale nuclear power plant, operational from 1968 to 1984. DP is presently in the SwS phase of decommissioning under a Waste Facility Decommissioning Licence issued by the CNSC. The current plan is near-term decommissioning of the site with the exception of the reactor building and used fuel canister area, which will continue in ongoing SwS.

1.4.4 Gentilly-1 (G-1)

The Gentilly-1 (G-1) site is located at Bécancour, Québec, and is situated within the boundaries of the G-2 site, which is owned by Hydro Quebec. G-1 ceased operations in 1979 and is presently in the SwS phase of decommissioning under a Waste Facility Decommissioning License issued by the CNSC. The current plan is near-term decommissioning of the site with the exception of the reactor building which will continue in ongoing SwS.

1.4.5 Whiteshell Laboratories (WL)

Whiteshell Laboratories (WL) are located 100 km northeast of Winnipeg, Manitoba and operated from 1961 to 2002. The WL site covers an area of about 4,375 hectares with the main part of the site located on the east bank of the Winnipeg River. WL carried out nuclear research and development activities for higher temperature versions of the Canada Deuterium Uranium (CANDU) reactor. The site includes WR-1 Organic Cooled Reactor that operated from 1965 until 1985. WL also has a range of nuclear facilities and hot cells that provided support for these programs.

1.4.6 Historic Waste Program Management Office (HWP MO)

The Historic Waste Program Management Office (HWP MO) is located at Port Hope, Ontario. Historic LLW is waste that was managed in the past in a manner that is currently no longer acceptable, but for which the current owner cannot reasonably be held responsible and for which the government of Canada has accepted long term responsibility. Through the HWP MO, CNL implements federal programs and projects related to the safe management of historic LLW across Canada, on behalf of AECL. The HWP MO includes the projects under the Port Hope Area Initiative (PHAI) and the National Programs for historic LLW.
1.4.6.1 Port Hope Area Initiative (PHAI)

The PHAI represents the Government of Canada’s commitment to respond to the community-recommended solutions for the cleanup and local, long-term, safe management of historic LLW in the municipalities of Port Hope and Clarington and is currently one of the largest environmental restoration projects being undertaken in Canada.

The Port Hope project involves the cleanup of approximately 1.2 million m$^3$ of historic LLW from various sites in Port Hope. The LLW will be emplaced in the Port Hope Long Term Waste Management Facility, an engineered above ground mound where the waste will be safely contained, and the long-term monitoring and maintenance of the new facility. The mound will be capped and closed and the existing site restored.

The Port Granby project, in the Municipality of Clarington, will relocate approximately 450,000 m$^3$ of historic LLW and marginally contaminated soils, located at an existing waste management facility on the shoreline of Lake Ontario, to the Port Granby Long Term Waste Management Facility, an engineered above ground mound built about a kilometre north of the current site. The facility will be capped and closed and the existing site restored.

1.4.6.2 National Programs

The National Programs manages historic LLW, on behalf of the federal government, stored at numerous waste sites located throughout Canada. The National Programs has successfully completed projects in Ontario, British Columbia, Alberta and the Northwest Territories. At many of these sites, materials have been placed in interim storage pending the development and implementation of a long-term management approach. At other sites, the waste is in long-term storage. Larger volumes of contaminated soil can be potentially managed at or near the source. Ongoing site monitoring, inspection and maintenance are conducted at all storage and in-situ sites by the National Programs.

1.5 Key Changes

From the previous IWS Revision (revision 0), the baseline waste strategy and associated waste flows have been updated to reflect the following major changes:

- Adjustment of the proposed NSDF project scope to exclude ILW. The formal decision was provided to CNSC in November 2017, and the proposed NSDF will dispose of LLW that meets the facility Waste Acceptance Criteria (WAC).

- Materials which are not currently considered as waste have been removed from discussion as waste. This includes irradiated fuel which is suitable for repatriation, unirradiated fuel and tritiated heavy water. However, if these materials cannot be managed as anticipated, there is still the possibility of waste arisings. Section 3.6 has been added to discuss these materials separately.
• The structure of the IWS document has been updated to focus on the strategy and less on the methodology used to prepare the IWS. The aim is to provide a clearer picture of the development and progress of waste management at CNL.

• Mixed waste (radioactive waste with a hazardous component) has been incorporated into the ILW and LLW classifications.

### 1.6 Significant Developments and Achievements

Table 1-1 highlights progress regarding waste management at CNL since the last revision of this document. It summarizes what has been achieved to complete the identified actions and provides next steps where further action is required.

#### Table 1-1
IWS Action Progress and Next Steps

<table>
<thead>
<tr>
<th>IWS Action</th>
<th>Progress Since Revision 0</th>
<th>Next steps</th>
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<tbody>
<tr>
<td>Identify and prioritize waste characterization gaps.</td>
<td>Characterization gap analysis prepared and recommendations identified.</td>
<td>Continue to implement recommendations</td>
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<tr>
<td>Develop technical and programmatic improvements to address gaps with a focus on Facilities Decommissioning (FD) and Environmental Remediation (ER) across CNL</td>
<td>Characterization program created Waste certification process developed to ensure that waste requirements are met.</td>
<td>Continue to implement characterization program improvements. Implement Waste certification process.</td>
</tr>
<tr>
<td>Produce long term strategies to enable reliable processes to be put in place to align with best practice.</td>
<td>Strategy for CNL liquid waste developed Site Waste Management Plan for Vegetation produced</td>
<td>Develop ILW strategy</td>
</tr>
<tr>
<td>Ongoing inventory and forecast refinement as assumptions and risks identified are mitigated.</td>
<td>Inventory and forecast update initiated.</td>
<td>Complete initial inventory integration and move to ongoing maintenance to update regularly.</td>
</tr>
<tr>
<td>Identify suitable Waste Data Tracking System platform to provide data support and integrate across CNL.</td>
<td>Waste Data tracking system platform identified and is currently being a implemented at CRL</td>
<td>Roll out across CNL</td>
</tr>
<tr>
<td>Review processing technology requirements (based upon previous studies), identify areas requiring further assessment and develop standard waste treatment approaches for specific waste streams and waste types.</td>
<td>Processing technology requirements review completed. Design of the WL ILW retrieval, characterization, conditioning, and packaging system completed. Identified LLW processed via commercial operators</td>
<td>Complete development of Technical baseline, and implement to ensure alignment of research and development to waste strategy requirements.</td>
</tr>
<tr>
<td>Carry out option studies as required.</td>
<td>Option studies completed for: - LLW bulk packages - Future CNL liquid waste capability</td>
<td>Identify and complete option studies for waste requiring additional processing to meet proposed NSDF WAC</td>
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<th>IWS Action</th>
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<th>Next steps</th>
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<tr>
<td>Review and implement interim storage and waste package options to support missions.</td>
<td>Additional storage capability at CRL, for NSDF destined waste developed and implemented Options reviewed for LLW reusable packages for bulk items Process documented for the management of clean spoils</td>
<td>Increase spoils management capability</td>
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<tr>
<td>Review and implement storage requirements at CRL taking into consideration the needs of off-site producers</td>
<td>Storage capacity gaps identified and plans initiated to mitigate. Expansion for storage of WL used fuel at CRL completed.</td>
<td>Continue to manage storage capacity and ensure early identification of gaps to ensure timely mitigation measures can be put in place</td>
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<tr>
<td>Proposed NSDF Project.</td>
<td>Regulatory approvals process for NSDF initiated and licensing documents submitted to CNSC</td>
<td>Complete approvals process</td>
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<tr>
<td>Identify right size solution for management of waste destined for a yet to be determined ILW disposal facility.</td>
<td>Ongoing</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Continue to cooperate and coordinate with Nuclear Waste Management Organization (NWMO) regarding all CNL managed fuel.</td>
<td>Options assessed to increase use of waste minimization hierarchy to extend the clean landfill lifetime completed</td>
<td>Ongoing through IWS meetings</td>
</tr>
<tr>
<td>Prioritize projects requiring option studies, which have been identified and agreed upon with internal stakeholders and subject matter experts.</td>
<td>A series of initiatives to divert waste from the CRL landfill using local available municipal landfills have been successfully implemented.</td>
<td>Develop technical baseline to assist in identifying areas to optimize</td>
</tr>
<tr>
<td>Continue to identify and assess projects until complete.</td>
<td>Discussed at Environmental Stewardship Council and NSDF public information sessions. Included in CNL new employee training. Included on cnl.ca webpage</td>
<td>Ongoing</td>
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<tr>
<td>Roll out strategy to ensure the appropriate parties are engaged and aware of the IWS.</td>
<td>Regular meetings held with internal stakeholders</td>
<td>Ongoing</td>
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<td>Ensure that all wastes continue to be captured in the IWS, and progress on identified gaps is ongoing.</td>
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Areas of progress which were not specifically detailed in the IWS action plan as they have their own projects associated and do not need to be monitored, managed or incorporated into the IWS Action Plan, but contribute to progress of the waste strategy include:

- The NPD project is currently going through the Environmental Assessment (EA) process under the Canadian Environmental Assessment Act (CEAA).
- The Whiteshell WR-1 project is currently going through the EA process under the CEAA.
• Waste placement into the Port Hope long term waste management facility began in November 2017. As of October 2018, approximately 215,000 m$^3$ of historic LLW has been placed into the facility from waste transfer and environmental remediation work.

• Waste placement into the Port Granby long-term waste management facility began in November 2016. As of October 2018, approximately 410,000 m$^3$ of historic LLW has been placed into the facility from waste transfer and environmental remediation work.

• As part of the national programs, a contract was fully executed with Secure Energy Service, Inc. for the future disposal of the uranium ore impacted soils resulting from past handling identified along the Northern Transportation Route.
2. WASTE MANAGEMENT AT CNL

2.1 Classification of Waste

The classification of waste are described in Table 2-1 and are adopted from CNL’s Waste Management (WM) Program definitions.

Table 2-1
Classification of Waste

<table>
<thead>
<tr>
<th>Non-Radioactive Waste</th>
<th>Clean Waste</th>
<th>Non-hazardous material that is declared to be non-radioactive by its history, location and use; or non-hazardous material that has been determined to meet regulatory requirements for unconditional clearance by means of suitable radiological monitoring.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radioactive Waste</td>
<td>Hazardous waste</td>
<td>Solid, liquid or gaseous waste material, other than a radioactive material, that may pose a potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed, and as specified in applicable regulations.</td>
</tr>
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</table>

Radioactive Waste Any material (liquid, gaseous or solid) that contains radioactive “nuclear substances”, as defined in Section 2 of the Nuclear Safety and Control Act [2] and which the Waste Generator has declared to be waste.

The waste classification system is generally organized according to the degree of containment and isolation required to ensure safety in the short and long term. It also considers the hazard potential of the different types of radioactive waste. The three main categories are:

**High Level Waste (HLW)** - Used (i.e., irradiated) nuclear fuel that has been declared as radioactive waste and/or is waste that generates significant heat (typically more than 2 kW/m³) via radioactive decay.

**Intermediate Level Waste (ILW)** - Waste which exhibits levels of penetrating radiation sufficient to require shielding but needs little or no provision for heat dissipation during its handling and transportation. ILW generally contains long-lived radionuclides in concentrations that require isolation and containment for periods greater than several hundred years (i.e., more than 300 to 500 years).

**Low Level Waste (LLW)** - Waste with radionuclide content above established clearance levels and exemption quantities, but that generally has limited amounts of long-lived activity. LLW requires isolation and containment for periods of up to a few hundred years. LLW does not require significant shielding during handling and transportation.

2.2 Radioactive Waste Framework

In accordance with Canada’s Radioactive Waste Policy Framework [3] the waste producers and owners of radioactive waste are responsible for the funding, organization, management and operation of disposal and other facilities required for their wastes.
AECL is a federal Crown corporation responsible for managing Canada’s radioactive waste liabilities and enabling nuclear science and technology which is delivered through a contractual arrangement with Canadian National Energy Alliance (CNEA) for the management and operation of CNL. Natural Resources Canada (NRCan) is the lead federal government department responsible for developing and implementing uranium, nuclear energy and radioactive waste management policies in Canada.

In accordance with the Nuclear Safety and Control Act, section 9, [2] the CNSC is mandated to regulate the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information in order to:

- Prevent unreasonable risk, to the environment and to the health and safety of persons, associated with that development, production, possession or use,
- Prevent unreasonable risk to national security associated with that development, production, possession or use, and
- Achieve conformity with measures of control and international obligations to which Canada has agreed; and
- To disseminate objective scientific, technical and regulatory information to the public concerning the activities of the Commission and the effects, on the environment and on the health and safety of persons, of the development, production, possession and use.

2.3 Waste Management Goals and Activities

CNL’s strategic objectives include the requirement to safely and cost effectively accelerate Environmental Remediation Management (ERM) efforts, thereby facilitating the Science and Technology (S&T) Mission and reducing Canada’s liability. ERM strategic priorities include:

- Constructing and operating the proposed NSDF at CRL.
- Consolidating ILW and HLW for storage at CRL until disposal is available.
- Aligning facilities decommissioning (FD) and environmental remediation (ER) to international best practice.
- Remediating Waste Management Areas (WMAs) and other affected areas.
- Repatriation of low and high enriched used fuel and target materials from molybdenum-99 production to the US.
- Improving integration of ERM with CNL’s enduring S&T mission through the newly established strategic Initiative.
2.4 Waste Management Lifecycle

The IWS considers current and planned future waste management requirements including activities associated with operational, Research & Development (R&D), post operational clean out, FD, ER, legacy and historic wastes, and waste received from small generators across Canada. This requires a long term view and consideration of the full waste management lifecycle (Figure 2-1) has been adopted to enable integration and planning across all activities and sites.

**Figure 2-1 Waste Management Lifecycle and Examples of Performed Activities**

The Waste management lifecycle is an iterative process and although effort is made to avoid
unnecessary repetition of stages, it is recognized that the process can require more than one cycle to get to final disposal.

2.5 Waste Hierarchy

The waste hierarchy (Figure 2-2) can be defined as: “a framework for waste management decision making to enable an effective balance of priorities, with a focus on waste prevention” [4].

At CNL, the waste hierarchy provides a key input to decisions regarding the management of all waste. Prevention and reduction is the preferred approach but, where waste is generated, reuse and recycle are preferred to disposal. The application of the waste hierarchy requires a balance of priorities including protection of health, safety, security and the environment, value for money, affordability and technical maturity.

![Figure 2-2 The Waste Hierarchy](image)

2.6 Waste Management Policy and Principles

CNL’s IWS has been developed in accordance with government policies, regulatory requirements, and company environment and health and safety policies with regard to waste management, and will support the ongoing missions. The IWS is currently managed under CNL’s WM Program.

CNL’s WM Program provides details on the framework through which the WM Program is governed. The CNL WM Program defines the overall high-level process for managing waste, following the WM lifecycle, and identifies the WM lifecycle process steps to correctly plan, assess, characterize, segregate, package, transport, process, store, and/or dispose of waste. This ensures that all waste generated or received at CNL-operated sites not only meets WM requirements, but is managed in a safe and environmentally responsible manner. To ensure a
consistent application of waste management across all operations and activities at CNL sites, the IWS is integrated with other CNL strategies, plans and implementation processes (Figure 2-3) which ensures alignment and integration across the organization, particularly where wastes are to be transferred between sites for consolidation, storage and disposal.
Figure 2-3  IWS Interaction with other CNL Strategies and Plans
3. **CNL’S WASTE STRATEGY**

3.1 **Baseline Strategy Overview**

To realize CNL’s objectives of revitalizing the CRL campus by renewing its capabilities, there is a focus on accelerated decommissioning. This is being enabled by reducing radioactive and non-radioactive waste and decommissioning liabilities across CNL sites; investing in facilities and infrastructure; and modernizing systems and work practices. In the near term, these activities are significantly increasing the rate at which wastes arise and highlighting the need for new waste management capabilities to be implemented.

Through ER projects, prudent management and cleanup of legacy contaminated and affected sites will progressively reduce the Government of Canada’s risk and liability. CNL will use comprehensive site characterization to understand radioactive and hazardous material contamination levels, environmental transport, conceptual site models and key site specific parameters to support risk assessments. The characterization results will be used to determine which areas require remedial actions or no further action.

Table 3-1 provides a brief description of the baseline waste strategy for each classification of waste. Further detail is provided in Sections 3.3 and 3.4.

<table>
<thead>
<tr>
<th>Waste Classification</th>
<th>Baseline Waste Strategy</th>
</tr>
</thead>
</table>
| **Clean Waste**      | • Identify re-use and recycle opportunities.  
                       • Manage waste through local municipal landfills and processing facilities. |
| **Hazardous Waste**  | • Manage as per Hazardous Waste Regulations. |
| **Low Level Waste**  | • Consolidate LLW at CRL in interim storage until the proposed NSDF becomes available.  
                       • Manage suitable LLW in-situ where the safety case can be demonstrated and approval is obtained from the CNSC.  
                       • Process LLW, where required, to address hazardous constituents and ensure waste is disposal ready.  
                       • Align decommissioning strategy to waste storage and disposal availability.  
                       • Defer large scale ER to align with proposed NSDF availability.  
                       • Manage Historic LLW at the Port Hope and Port Granby Long Term Waste Management Facilities, and at local sites across Canada. |
### Waste Classification

<table>
<thead>
<tr>
<th>Waste Classification</th>
<th>Baseline Waste Strategy</th>
</tr>
</thead>
</table>
| **Intermediate Level Waste (ILW)** | • Segregate ILW using waste hierarchy to optimize storage and disposal requirements.  
• Process ILW, where required, to address hazardous constituents and ensure waste is disposal ready.  
• Consolidate packages at CRL in engineered storage until a geological disposal facility becomes available.  
• Manage suitable ILW in-situ where the safety case can be demonstrated and approval is obtained from the CNSC (e.g. NPD and WR-1). |
| **High Level Waste (HLW)** | • Consolidate used fuel identified as waste at CRL and place it in safe, secure and suitable storage until the NWMO Adaptive Phased Management (APM) used fuel deep geological repository (DGR) becomes available. |

### 3.2 Waste Inventory and Forecast Information Overview

The baseline waste volume forecast until the year 2100 (the assumed end date of operations at CRL for planning purposes) is provided in the *Inventory of Radioactive Waste in Canada 2016* [5]. The waste inventory is collated from a number of sources including historical data for some of the legacy wastes as well as characterization data for more recent arisings. Waste volumes are reported as raw (i.e., unpackaged) volumes, unless stated otherwise.

As strategies and plans evolve, the waste forecast will be updated accordingly. These forecasts are used to identify gaps and areas of concern regarding waste storage and plan the logistics of waste receipt, processing and disposition.

### 3.3 Non-Radioactive Waste

#### 3.3.1 Clean Waste

- Identify reuse and recycle opportunities.  
- Manage waste through local municipal landfills and processing facilities.

Clean waste includes conventional trash, metal, construction, demolition and decommissioning material, ground material and vegetation.
3.3.2 Hazardous Waste

- Manage as per Hazardous Waste Regulations.

Hazardous waste at CNL includes chemicals, oils, lead, mercury and asbestos. Hazardous waste is managed in accordance with applicable hazardous waste regulations and transferred off-site for processing and disposal at commercial facilities. Hazardous waste management at CNL is working towards integrating with other CNL strategies, plans and implementation processes which ensures alignment and integration across the organization.

3.4 Radioactive Waste

3.4.1 Low Level Waste

- Consolidate LLW at CRL in interim storage until the proposed NSDF becomes available.
- Manage suitable LLW in-situ where the safety case can be demonstrated and approval is obtained from the CNSC.
- Process LLW, where required, to address hazardous constituents and ensure waste is disposal ready.
- Align decommissioning strategy to waste storage and disposal availability.
- Defer large scale ER to align with proposed NSDF availability.
- Manage Historic LLW at the Port Hope and Port Granby Long Term Waste Management Facilities, and at local sites across Canada.

Solid LLW is generated from operational, decommissioning and ER activities and produces the greatest volume of radioactive waste to be managed. Waste streams include personal protective equipment & clothing, metal, rubble, concrete, wood, equipment, soil and vegetation.

The baseline strategy for solid LLW at CRL, WL (excluding WR-1), DP and G-1 is to segregate where practical, process as required and place in storage until the proposed NSDF becomes available. In the near term a sort/ segregation facility at CRL is planned to manage some of the legacy LLW to produce disposal ready packages. Waste management challenges include identifying and implementing solutions for managing specific wastes and in particular legacy LLW, including mixed waste. Examples include moderators such as graphite, organic reactor coolant, mercury and lead and asbestos. Degradation of waste and packages creates an additional challenge due to mixing of material and contamination with soil and sand, creating additional processing needs prior to disposal at the proposed NSDF. Large scale ER at CRL will be deferred until the proposed NSDF is available to mitigate the need for additional storage capability.
A decision on the NSDF EA, confirming that the proposed activities will not cause significant adverse environmental impacts is required before the CNSC can make a licensing decision for the NSDF. A draft Environmental Impact Statement (EIS) was submitted and a period of public comment held, which is now closed and CNL is addressing those comments received. The final EIS, with associated public hearing will be scheduled.

Historic LLW, managed by the Port Hope Area Initiative project, is waste which has been contaminated with residue ore from the former radium and uranium refining activities of Eldorado nuclear. This waste will be remediated and placed in the Port Hope Long Term Waste Management Facility and material at the current Port Granby site will be excavated and transferred to the Port Granby Long Term Waste Management Facility. Both facilities are above ground engineered storage mounds. Waste placement at Port Hope and Port Granby will continue until all 1.7 million m³ of waste has been recovered and emplaced. Historic LLW, managed by the national Program will be managed locally to the area of remediation, or transferred to CRL for storage and disposal.

Liquid LLW is retrieved and processed (immobilized) so that the waste can be managed as solid LLW. The liquid LLW at CRL can be evaporated at the Waste Treatment Centre (WTC), then bituminized. Future liquid processing capability will be required when the WTC shuts down.

LLW located within NPD and WL WR-1 will be managed in-situ at their respective licensed sites, and the regulatory process to gain approval for these has been initiated. The draft NPD EIS was submitted and a period of public comment was held. This closed in February 2018. The draft WR-1 EIS was submitted and a period of public comment was held. This closed December 2017. CNL is addressing those comments received. The final EIS for each, with associated public hearing will be scheduled.

### 3.4.2 Intermediate Level Waste

- Segregate ILW using waste hierarchy to optimize storage and disposal requirements.
- Process ILW, where required, to address hazardous constituents and ensure waste is disposal ready.
- Consolidate packages at CRL in engineered storage until a geological disposal facility becomes available.
- Manage suitable ILW in-situ where the safety case can be demonstrated and approval is obtained from the CNSC (e.g., NPD and WR-1).

Solid ILW is generated from reactor parts and components associated with reactor operations, isotope production processes, facilities decommissioning and ER. Liquid ILW is also produced by a variety of processes and laboratory operations.

The long term strategy for ILW is characterisation, processing (where required) and engineered storage until a geological repository is available. As with LLW, waste management challenges
exist, in particular with processing legacy ILW including mixed ILW, which include hazardous constituents. Examples include consideration of ion exchange resins, sludges and isotope production wastes which will not meet disposal criteria. Processing capability will be required to produce disposal ready packages.

Prior to the availability of engineered storage at CRL, ILW will continue to be stored in current various storage structures, including below grade tile holes and stand pipes, concrete bunkers, and the Shielded Modular Above Ground Storage (SMAGS) facilities. Where required, waste will be transitioned into engineered storage in acceptable packages to mitigate aging structures.

To enable decommissioning of the WL site, the associated storage structures will be emptied and the ILW transferred to CRL for subsequent storage. Waste processing and packages for ILW is being assessed and developed to ensure that the waste is in a suitable form for storage and ready for disposal, once any facility becomes available.

At CRL, liquid waste processing is generally undertaken at the WTC where liquid is evaporated and bituminized in drums to produce a stable product. The recent shutdown of NRU will result in a reduction of waste water production. Work is underway to assess the options for the longer-term to ensure future ILW liquid processing capability is sized appropriately and produces a waste form that will meet geological disposal criteria.

As discussed in the significant developments Section 1.6, ILW located within NPD and WR-1 will be managed in-situ at their respective licensed sites, and the regulatory process to gain approval for these has been initiated.

CNL continues to progress development of an ILW disposal solution through industry best practice, including opportunities for a collaborative solution within Canada.

3.4.3 High Level Waste Strategy

- Consolidate used fuel identified as waste at CRL and place it in safe, secure and suitable storage until the NWMO APM used fuel DGR becomes available.

CNL does not generate large volumes of HLW (used nuclear fuel which has been identified as waste), however CNL does have a wide range of HLW currently in dry storage at CRL, WL, DP and G-1. This HLW consists of CANDU type fuel and research reactor fuels.

The HLW strategy is identify co-located dry storage options at CRL, awaiting disposal at the proposed NWMO APM used fuel DGR. Processing of some of the HLW will be required to meet the DGR WAC. The complexity of processing required will be based upon the parent fuel.

The program of work being undertaken by NWMO to develop a national repository for permanent disposal used fuel has been approved by the federal government. The national solution is currently in the siting process and is anticipated to be operational c. 2045 [6]. For planning purposes, the used fuel DGR is currently assumed to be available c.2055 for CNL managed material. However, due to uncertainty around the assumed date, strategic decisions
regarding processing and storage of fuel need to be managed effectively to ensure sufficient flexibility. CNL continues to work with NWMO to ensure all CNL managed fuel will be compliant with the proposed used fuel DGR requirements.

### 3.5 Waste Flow Overview

Figure 3-1 provides a visual high level summary of the CNL waste strategy. Current and future known wastes streams have been identified and the life cycle of the waste, from generation to final disposition is illustrated in the waste flow diagrams. The aim is to optimize the route to disposition waste. However, for legacy waste, duplication of stages may be required to ensure waste meets disposal requirements.
**SUMMARY OF WASTE STREAM FLOWS**

**Classification**
- High-Level Waste (HLW) Used Fuel
- Intermediate Level Waste (ILW)
- Low-Level Waste (LLW)
- Mixed Waste
- Client Waste

**Processing**
- Segregate & Process (as required)

**Storage**
- Dry Storage, Transload, Contain, Used Pipe
- Engineered Storage
- Hypothesized Interim Storage Facility
- Consolidation Sites
- Historical LLW National Program

**Disposal**
- Near-Surface Disposal Facility (NSDF)
- Low-Level Waste Disposal Facility
- Off-Site Processing and/or Disposal
- In-Site

**LEGEND**
- Capability needs to be developed to satisfy requirements
- Further work is required to implement
- Baseline Strategy

Figure 3-1 Summary of CNL Waste Flow
3.6 Non-Waste Material

This section discusses radioactive material that is not currently considered as waste within the IWS, but requires suitable management to ensure that the material does not become waste. This includes consideration of future processing requirements of the material, which may generate secondary waste.

3.6.1 Irradiated Fuel

Irradiated (used) fuel currently stored at CRL that is eligible for repatriation will be returned to the US. This is being completed under a commitment made in 2010 by the government of Canada as part of the Global Threat Reduction Initiative to work cooperatively to repatriate low and high enriched used fuel and target materials, and will eliminate proliferation risks.

3.6.2 Unirradiated Fuel

Unirradiated fuel includes enriched, natural and depleted uranium, plutonium and mixed fuels. A program of work is underway to identify opportunities for use of the unirradiated material. The unirradiated fuel will continue to be safely stored at CNL facilities until opportunities for use are realised.

3.6.3 Tritiated Heavy Water

Tritiated heavy water is currently stored at CNL facilities within CRL and at the heavy water storage facility at La Prade, located at Bécancour, Québec. To enable resale opportunities for the heavy water, upgrading processes will be required to remove tritium, and work is underway to fully determine the requirements. Secondary waste may be produced as the result of processing.
4. KEY IWS ACTIVITIES

Although there have been significant achievements to CNL’s waste strategy as detailed in Section 1.6, there are still gaps in the management of waste that need to be addressed. This section expands upon some of next steps identified in Table 1-1 and identifies the activities, both ongoing and moving forward, that are required to ensure gaps are addressed within the identified timescales.

IWS gaps identified, agreed and prioritized with input from CNL subject matter experts, range from programmatic gaps, which affect all areas of waste management, to specific waste classification or waste type technical issues. Many are highlighted in the waste flow diagram in Figure 3-1 as yellow or red boxes, depending on their current status. However, factors which affect all areas, e.g., characterization and opportunities for optimization, may not be fully visible on the diagrams.

The gaps primarily focus on radioactive waste management; logistics of managing large volumes of accelerated decommissioning waste; and strategic consideration of the full waste lifecycle. Major IWS activities to address gaps include:

- **Continuing to update and refine waste inventory and forecasting.** This includes identifying and implementing methods for improved consolidated data capture. Current inventory data is spread across several groups and in an impractical form. CNL is working to gather and consolidate inventory data to effectively inform the IWS, waste forecasting, CNL user groups and internal stakeholders. Further granularity is also required to enhance waste forecasting certainty and build a capable inventory foundation for future uses.

- **Continuing to develop characterization program and technical improvements.** There is insufficient characterization within the waste routes, for newly generated wastes and to legacy wastes. These gaps have been highlighted and are being addressed in a phased manner. Characterization of the waste will refine and improve inventory data.

- **Continuing to Identify and improve transport capabilities across CNL.** CRL is working to develop these capabilities while managing the need for an integrated transportation strategy, which spans across all CNL sites.

- **Identifying planning and technical gaps across the ERM program.** CNL will further detail waste strategies and ensure critical gaps in the IWS are identified and linked to key ERM activities which are dependent on the capabilities to be put in place. A technical baseline, currently being developed, will identify the processes and technologies that are required to deliver the ERM mission. The baseline will manage closure of technical gaps, using sufficient and appropriate R&D, in a coordinated and prioritized manner, ensuring the approach to completing the ERM mission is technically justified and underpinned.

- **Identifying and implementing processing requirements for LLW requiring additional processing to enable it to meet the proposed NSDF WAC.** At CRL, a sort/ segregation facility has been identified and defined to process legacy LLW at CRL to enable it to be ready
for disposal. Work is underway to put this capability in place. The facility will be able to process ILW to the extent the ILW can be handled safely. The sort/ segregation facility is expected to be operational in 2020/21 to process waste from the SMAGS facility and other stores of legacy waste.

- **Ensuring sufficient LLW storage capability is maintained at CRL prior to proposed NSDF availability.** This will enable accelerated decommissioning to continue, and provide capacity for consolidation of LLW from other CNL sites until the proposed NSDF is operational. Current waste projections show that storage space at CRL for LLW will reach capacity around 2023/24.

- **Defining and implementing an ILW strategy which focuses on producing waste which is ready for disposal.** This will include production of WAC against which processing requirements can be determined and implemented to ensure disposal ready packages are produced. Current waste projections show that storage space at CRL for ILW will reach capacity around 2022/23. Therefore, suitable and sufficient storage capability will be defined and implemented as required to meet CNL needs. However, there are complications in determining what will be required to produce disposal ready ILW as final disposal options still need to be evaluated. Therefore, some processing may need to be delayed to avoid the need for double handling of waste. This decision still needs to be made and justification is required to determine the best way forward.

- **Identifying and implementing liquid waste processing capability at CRL to meet future CNL needs.** In 2018, a Best Available Technique study was completed that recognises the need for a new capability to replace CRL’s WTC. Further activities are required to progress this and provide a full programme of planning. It is assumed this new facility would be required around 2023/24 to align with the construction of the new ANMRC facility.

- **Expanding HLW dry storage capability at CRL in a phased manner.** This will ensure that sufficient capability is available in the required timeline to enable the consolidation of HLW at CRL.

- **Implementing a program of work to ensure HLW meets the NWMO used fuel DGR WAC.** Although it is not planned to transfer the waste until the used fuel DGR becomes available to CNL c. 2055, waste which requires processing to meet the DGR WAC will be processed, made ready for disposal and placed in suitable engineered storage at CRL. The processing and storage requirements for HLW have not yet been fully defined and planning work is underway to ensure that all HLW can be managed through the NWMO APM plan. The processing of used fuel to ensure it meets disposal requirements will involve the resolution of complex technical issues which need to be fully justified to underpin the path forward.
5. REVIEW PERIOD

The IWS will be reviewed and updated annually or as necessary. Progress on the associated action plan activities is reviewed bi-monthly and updated to reflect any changes and completion of underpinning evidence, such as option studies, as required.
6. **GLOSSARY**

For general terminology, this document relies primarily on word meanings as found in CNL’s current *Glossary of Controlled Terms and Acronyms* [7]. Although waste management specific definitions are detailed within CNL WM Program definitions, it is recognised that the IWS may be used to inform a national approach to waste strategy in the future. Therefore the references provided have, as far as possible, been obtained from the national Canadian Standards Association *CSA standard N 292.0* [8] and the International Atomic Energy Agency (IAEA) *Radioactive Waste Management glossary* [9].

**Characterization**: Determination of the physical, chemical, biological, and/or radiological waste characteristics for use in the assessment of health, safety, and environmental hazards.

**Cradle to Grave approach**: An approach in which all the stages in the lifetime of a facility, activity or product are taken into consideration.

**Conditioning**: Operations that produce a waste package suitable for handling, transport, storage, and/or disposal.

Note: Conditioning may include the conversion of the radioactive waste to a solid waste form, enclosure of the radioactive waste in containers, and, if necessary, providing an overpack.

**Disposal**: Placement of radioactive waste in an appropriate facility without the intention of retrieval.

**Disposal Ready**: Waste characterized and packaged in a passively safe state, such that it is contained sufficiently to protect people and the environment and will meet the acceptance requirements of the relevant disposal facilities without the need for further processing.

**Disposition**: Consignment of, or arrangements for the consignment of, radioactive waste for some specified (interim or final) destination.

Note: For example, for the purpose of processing, disposal, or storage.

**Facility**: Assembly of structures, systems, components, and/or associated land where radioactive materials are produced, processed, managed, used, handled, stored, or disposed of on such a scale that consideration of safety is required.

**Handling**: The physical manipulation and movement of waste material.

**Highly Enriched Uranium**: Uranium containing 20% or more of the isotope U-235, uranium-233, or combined uranium-233 and uranium-235.

**In-situ**: ‘In the original place’ [Oxford English Dictionary]

**Mixed Waste**: Radioactive waste that would also be classified as hazardous waste on the basis of its non-radiological characteristics.

**Operational waste**: Waste associated with normal operation of a facility.
Package: The product of conditioning that includes the waste form and any container(s) and internal barriers (e.g., absorbing materials and liners), prepared in accordance with the requirements for handling, transport, storage and/or disposal.

Pre-Treatment: Any or all of the operations prior to waste treatment, such as collection, segregation, chemical adjustment and decontamination.

Radioactive Waste: Any material (liquid, gaseous or solid) that contains radioactive “nuclear substances”, as defined in Section 2 of the Nuclear Safety and Control Act and which the Waste Generator has declared to be waste.

Radioactive Waste Management: All steps in the management of radioactive waste

Stakeholder: Interested party; concerned party.

Storage: The short or long-term management of waste in a facility that provides for containment with the possibility for retrieval where institutional controls and maintenance are required.

Transport: Handling activities and means associated with the movement of radioactive waste.

Treatment: Operations intended to benefit safety and/or economy by changing the characteristics of the waste. Three basic treatment objectives are: Volume reduction; Removal of radionuclides from the waste; Change of composition.

Waste: Residual material, generated as a result of a process, operation or activity that has no further use in that process, operation or activity and is declared for reuse, recycling or disposal.

Waste acceptance criteria: Quantitative or qualitative criteria, specified by the regulatory body or by the operator of a waste management facility, that are to be used to determine the acceptability of the radioactive waste for inclusion in a short-term or long-term waste management facility.

Waste processing: Any operation that changes the characteristics of waste, including pretreatment, treatment and conditioning.

Waste stream: A series of wastes resulting from a particular source and with consistent characteristics.
7. ACRONYMS & ABBREVIATIONS

AECL  Atomic Energy of Canada Limited
ANMRC  Advanced Nuclear Material Research Centre
APM  Adaptive Phased Management
CANDU  Canada Deuterium Uranium
CEAA  Canadian Environmental Assessment Act
CNEA  Canadian National Energy Alliance
CNL  Canadian Nuclear Laboratories Ltd.
CNSC  Canadian Nuclear Safety Commission
CPDP  Comprehensive Preliminary Decommissioning Plan
CRL  Chalk River Laboratories
CSA  Canadian Standards Association
DGR  Deep Geological Repository
DP  Douglas Point
EA  Environmental Assessment
EIS  Environmental Impact Statement
ER  Environmental Remediation
ERM  Environmental Remediation Management
FD  Facilities Decommissioning
G-1  Gentilly-1
HLW  High Level Waste
HWP  Historic Waste Program
HWP MO  Historic Waste Program Management Office
IAEA  International Atomic Energy Agency
ILW  Intermediate Level Waste
IWS  Integrated Waste Strategy
LLW  Low Level Waste
MAGS  Modular Above Ground Storage
NPD  Nuclear Power Demonstration
NRCan  Natural Resources Canada
NRU  National Research Universal
NSDF  Near Surface Disposal Facility
NWMO  Nuclear Waste Management Organization
PHAI  Port Hope Area Initiative
R&D   Research and Development
SMAGS Shielded Modular Above Ground Storage
S&T   Science and technology
SwS   Storage with Surveillance
WAC   Waste Acceptance Criteria
WL    Whiteshell Laboratories
WM    Waste Management
WMA   Waste Management Area
WR-1  Whiteshell Reactor -1
WTC   Waste Treatment Centre
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9. REFERENCES


