



Plan

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Title:
Pickering Nuclear Site Preliminary Decommissioning Plan

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**Pickering Nuclear Site Preliminary
Decommissioning Plan**

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Revision Summary

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R003	January 2022	<ul style="list-style-type: none"> Revised to update information for CNSC quinquennial review. Entire document: Revised to reflect OPG's current planning assumptions, strategy for decommissioning the PNGS, CNSC staff recommendation regarding timeline for DDP submission, feedback from OPG's Preparation for Safe Storage Group and TLG's Decommissioning Cost Study for PNGS. Entire document: Consistent terminology used throughout for Storage with Surveillance and remove reference to OPG's L&ILW DGR. Revised to be in compliance with CSA N294:19. Section 1.0 – Revised introduction to current planned shutdown dates of PNGS A and B and included scope of a site PDP to address the interfaces with the Pickering Waste Management Facility, also located on the Pickering Nuclear Site. Section 1.1 – Updated regulatory submissions required for transition to decommissioning and for the application for a decommissioning licence. Sections 1.2.1 and 1.2.2 – Updated licensing documents consistent with the latest PNGS Licence and LCH. Section 1.2.3 – Replaced Canadian Environmental Assessment Act (CEAA) 2012 with the Impact Assessment Act (IAA). Section 1.2.4 – Updated to the most current list of International Atomic Energy Agency Guides/Standards, consistent with CSA N294:19 references. Section 1.3 – New Section to describe the applicable OPG programs relevant to decommissioning. Section 1.5 – Updated planning assumptions for shutdown and decommissioning. Updated Figure 2-3 – Site Layout. Sections 2.2.1, 2.2.8 – Revised to incorporate changes from the latest PNGS A and B Safety Reports, PWMF Safety Reports as well as most up-to-date construction on-site. Section 2.2.8, including Section 2.2.8.1 – Included interfaces between PNGS and PWMF. Added Figure 2-11 – Location of PWMF within the Pickering Nuclear Site. Added Section 2.2.8.2 – New Section on Electrical Transmission Facilities. Section 2.3 (including: 2.3.1, 2.3.2.3, 2.3.2.4, 2.3.3.1, 2.3.3.2, 2.3.4, Figure 2-13) – Updated references and information related to the description of the surrounding environment and current assumptions on land use. Section 2.3.2.3 – Added updates per the most recent Environmental Risk Assessment for Pickering Nuclear. Section 2.3.2.4 – Updated seismic data. Section 2.3.3.3 – Updated Lake Ontario water level to latest Fisheries and Oceans Canada, water levels bulletin. Section 2.3.4 – Updated current use of land adjacent to PNGS. Section 2.3.5, including Table 2-1 – Population statistics updated.

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		<ul style="list-style-type: none"> • Section 2.3.6 – Updated text and revised title to ‘Indigenous Communities’. • Sections 2.3.7 – Updated to reflect latest community engagement and emergency drills conducted by OPG in the community surrounding PNGS. • Added Section 2.3.7.1 on Indigenous Relations. • Section 2.4 – Clarified status of PNGS A Units 2 and 3. • Section 3.0 – Included scope that the PNGS PDP is considered as the site PDP. • Table 3-1 – Updated per list of buildings considered in cost estimations for PNGS. • Section 3.3 and Figure 3-1 – Updated per CSA N294:19. • Section 3.4.1 – Added alternate decommissioning strategies investigated by OPG and provided updates on the phased decommissioning strategy. Updated the list of major activation radionuclides and fission products based on latest decommissioning OPEX. • Section 3.4.2 – Revised to be consistent with CSA N294:19. • Section 3.4.3.1 – Updated with OPG’s decommissioning experience and CNL’s progress with its decommissioning and site remediation projects. • Section 3.4.3.2 – Updated to latest statistics on International Decommissioning Strategies and Experience. • Section 3.5 – Changed timeline for conducting scoping and characterization surveys. Provided updates on OPG’s program to minimize spills at PNGS. • Section 3.6 – Provided an update on OPG’s studies for repurposing Pickering. • Section 3.7 – Updated to reflect the elements of risk and uncertainty associated with decommissioning PNGS. • Section 4.0 and Figures 4-1, 4-2 – Modified for consistency with PNGS Costing Report. Added interfaces with the PWMF. Added a new Figure 4-3 to address Pickering decommissioning interferences. • Section 4.1, including subsections 4.1.1 to 4.1.4 – Revised per feedback from OPG’s Safe Storage Project Group, updated the SWS Planning / Stabilization Activities and the regulatory submissions. • Section 4.1.4.1 – Added Table 4-1 on PNGS A and B planned defueling schedule. • Section 4.1.4.2 – Added Figure 4-4 on PNGS Defueling and Dewatering Timeline. • Added a new subsection 4.1.4.7 to describe other activities during Stabilization. • Section 4.2, including subsections 4.2.1 to 4.2.5 – Updated to reflect activities carried out during SWS, to align with OPG’s planning assumptions and meet new clauses of CSA N294:19. • Section 4.2.4 – Provided additional details on the structure of the DDP that will be prepared prior to Dismantling and Demolition. Added the purpose of the Decommissioning Safety Assessment. • Section 4.3, including subsections 4.3.1, 4.3.2, 4.3.4, 4.3.5, 4.3.7 to 4.3.9 – Updated to OPG’s planning assumptions, minor wording changes and to meet new clauses of CSA N294:19. • Section 4.3.1 – Removed “pressurizer” in bullet (g) since PNGS has a bleed and feed system instead. • Section 4.4 – New text to describe OPG’s strategy for waste management and characterization.
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		<ul style="list-style-type: none"> • Section 4.4.1.3 – Provided updates on OPG’s disposal options for L&ILW. • Table 4-2 – Updated estimated volumes of L&ILW generated during decommissioning. • Section 4.4.1.2 – Updated assumptions for management of high-level waste. • Section 4.4.1.3 – Updated assumptions for management of low- and intermediate-level waste. • Section 4.4.2.1 and Table A-1 – Included OPG’s assessments for controlling designated substances at PNGS. Updated the inventory of hazardous materials at PNGS. • Section 5.1 – Updated to TLG 2022 cost estimates. • Section 6.1 – Added elements of risk associated with decommissioning activities and how these will be managed. • Section 6.3 – Updated text on staffing for each phase of PNGS decommissioning. • Section 6.4 – Revised per OPG’s staffing plan for SWS. • Section 7.0 – Revised from an environmental assessment (EA) to an impact assessment (IA). • Section 7.1.1 – Updated text on air quality. • Sections 7.1.2, 7.1.4 and 7.1.5 – Updated per Predictive Effects Assessment for PNGS SWS and latest Environmental Risk Assessment. • Sections 7.1.4 and 7.1.5 – Revised per the latest updates on wildlife and aquatic life on and around the Pickering Nuclear Site, respectively. • Section 7.2.2 – Revised text to include the potential impacts of demolition noise during decommissioning and the mitigation strategies. • Section 7.3.2 – Revised to reflect changes from CEAA 2012 to IAA. • Sections 7.3.4, 7.3.5, 7.3.6, 7.3.7 and Table 7-1 – Revised to current decommissioning planning assumptions and PNGS Costing Report. • Table 8-1 – Revised list of hazards, description / comments, as required. • Section 8.2 – Updated text to include qualified use of personnel throughout the decommissioning phases. • Section 9.1 – Revised to include compliance with licensing conditions in relation to security during decommissioning. • Section 10 – Added reference to OPG’s Nuclear Management System. • Section 11 – Updated information regarding record keeping. • Section 12 – Updated the Public Involvement Program. • Section 13.0 – Revised to reflect changes from CEAA 2012 to IAA. • Updated Section 14 – References. • Appendix A – Updated PNGS hazardous Substances List. • Appendix B – Updated with revised decommissioning cost estimate and PNGS Costing Report. • Previous Appendix C and Table C-1 on estimated workforce during the course of decommissioning of PNSG – Deleted so as not to duplicate information in the PNGS Costing Report.
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	<ul style="list-style-type: none">• Appendix C – Updated compliance matrix against CSA N294:19.• Appendix D – Replaced the 2016 IAEA Operational Safety Review Team (OSART) with a summary of some of the PNGS' systems End State Determination Reports (note that OSART's recommendations have been incorporated in the PDP (see e.g., Section 4.1.4 pertaining to the organizational structure during decommissioning)).
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Acronyms

AIFB	– Auxiliary Irradiated Fuel Bay
ALARA	– As Low as Reasonably Achievable
APM	– Adaptive Phased Management
CANDU	– Canada Deuterium Uranium
CCNS	– Centre for Canadian Nuclear Sustainability
CEAA	– Canadian Environmental Assessment Act
CN	– Canadian National
CNL	– Canadian Nuclear Laboratories
CNSC	– Canadian Nuclear Safety Commission
CSA	– Canadian Standards Association
DDP	– Detailed Decommissioning Plan
DGR	– Deep Geologic Repository
DOC	– Decommissioning Operations Contractor
DP	– Douglas Point
DRL	– Derived Release Limit
DSC	– Dry Storage Container
DSM	– Dry Storage Modules
EA	– Environmental Assessment
ECO	– End-of-commercial operation
ESDR	– End State Determination Report
FAD	– Filtered air discharge
FRF	– Fire Resistant Fluid
G-1	– Gently-1
HF	– Human Factors
HFEPP	– Human Factors Engineering Program Plan
HPECI	– High Pressure Emergency Coolant Injection
HSA	– Historical Site Assessment
HVAC	– Heating, ventilation and air-conditioning
HWP	– Heavy Water Plant
IA	– Impact Assessment
IAC	– Indigenous Advisory Council
IAA	– Impact Assessment Act
IAEA	– International Atomic Energy Agency
IFB	– Irradiated Fuel Bay
IGLD	– International Great Lakes Datum
ILW	– Intermediate Level Waste
IX	– Ion Exchange
KI	– Potassium Iodide
L&ILW	– Low and Intermediate Level Waste
LCH	– Licence Condition Handbook
LLW	– Low Level Waste
MAPLE	– Multipurpose Applied Physics Lattice Experiment
MARSSIM	– Multi-Agency Radiation Survey and Site Investigation Manual
MCR	– Main Control Room
MECP	– Ministry of the Environment, Conservation and Parks

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MSC	– Modular Shielded Container
NBP	– New Brunswick Power
NGS	– Nuclear Generating Station
NPD	– Nuclear Power Demonstration
NPP	– Nuclear Power Plant
NRCan	– Natural Resources Canada
NRU	– National Research Universal
NRX	– National Research Experimental
NSCA	– Nuclear Safety and Control Act
NWMO	– Nuclear Waste Management Organization
OH&S	– Occupational Health and Safety
ONFA	– Ontario Nuclear Funds Agreement
OPG	– Ontario Power Generation
OSART	– Operational Safety Review Team
PAPR	– Powered Air Purifying Respirator
PCBs	– Polychlorinated Biphenyls
PDP	– Preliminary Decommissioning Plan
PHT	– Primary Heat Transport
PIOTS	– Pickering Incoming Outgoing Tritiated D ₂ O Transfer System
PNGS	– Pickering Nuclear Generating Station
PPE	– Personal Protective Equipment
PTR	– Pool Test Reactor
PWMF	– Pickering Waste Management Facility
QA	– Quality Assurance
RBSW	– Reactor Building Service Water
RSSI	– Radiation Survey and Site Investigation
SAP	– Stabilization Activity Plan
SB	– Storage Building
SCA	– Safety and Control Area
SCR	– Station Condition Record
SEIA	– Socio-Economic Impact Assessment
SON	– Saugeen Ojibway Nation
SOP	– Sustainable Operations Plan
SSCs	– Structures, Systems and Components
SSP	– Storage and Surveillance Plan
SSS	– Safe Storage State
SSTF	– Spent Solvent Treatment Facility
SWS	– Storage with Surveillance
TLG	– TLG Services, LLC.
UFDS	– Used Fuel Dry Storage
UFDSF	– Used Fuel Dry Storage Facility
UPP	– Upgrading Plant at Pickering (Heavy Water)
VLLDS	– Very Low Level Drain State
VSDS	– Visual Survey Data System
WBS	– Work Breakdown Structure
WR-1	– Whiteshell Reactor
WWMF	– Western Waste Management Facility
ZEEP	– Zero Energy Experimental Pile

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Abstract

This Preliminary Decommissioning Plan (PDP) describes the activities that will be required to decommission Pickering Nuclear Generating Stations (PNGS) A and B and restore the site for other Ontario Power Generation uses. It is also referred to as the site PDP as it addresses the interfaces of the PNGS with other facilities located on the Pickering Nuclear Site. This PDP demonstrates that decommissioning is feasible with existing technology and it provides the schedule as well as the basis for estimating the cost of decommissioning.

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1.0 INTRODUCTION

Pickering Nuclear Generating Stations A and B (PNGS A and PNGS B respectively or PNGS collectively) are owned and operated by Ontario Power Generation (OPG). Each of PNGS A and PNGS B is a four-unit Canada Deuterium Uranium (CANDU) Nuclear Generating Station (NGS). PNGS is located in the Municipality of Pickering, Ontario and is approximately 32 km east of Toronto.

For the purposes of this plan, it is assumed that PNGS A and PNGS B will be shut down in 2024 and 2025 respectively, and a deferred decommissioning strategy is planned. However, flexibility is built into the process to cater to the final decision OPG may make with respect to shutdown dates.

This Preliminary Decommissioning Plan (PDP) is the proposed plan for decommissioning the PNGS and since it also addresses the interfaces of the PNGS with the Pickering Waste Management Facility (PWMF), which is also located on the Pickering Nuclear Site, it is referred to as the site PDP. Details of the PWMF decommissioning are provided in the PWMF PDP [R-1].

This PDP is prepared in accordance with the Canadian Nuclear Safety Commission (CNSC) Regulatory Guide G-219¹ [R-2] and Canadian Standards Association (CSA) Standard N294 [R-4]. The purpose of this PDP is to define the areas to be decommissioned and the sequence of the principal decommissioning work for the PNGS. This PDP also demonstrates that decommissioning is feasible with existing technology and it provides a basis for estimating the cost of decommissioning.

The PDP (and the associated cost estimate) will be revised, at minimum, every five years, unless specified otherwise by the CNSC.

1.1 Phased Approach to Decommissioning Planning

Planning for the eventual decommissioning of PNGS is an ongoing process and the planning assumptions will evolve over time. This document describes the preliminary plan as it exists at the time of writing and it supersedes all previous versions of the PDP for PNGS. This plan will continue to be revised periodically throughout the life of PNGS to incorporate:

- Operational experience;
- Industry best practices;
- Technological advances;
- Changes to site conditions;
- Changes to proposed planning assumptions;
- Changes to proposed decommissioning objectives and/or strategy;
- Changes in ownership or management structure;
- Modification of the facility;
- Updated cost and funding information;
- Changes in regulatory requirements;

¹ REGDOC-2.11.2, Decommissioning, was published January 2021 and supersedes G-219. OPG has communicated the timing for a gap analysis and implementation plan to REGDOC-2.11.2 in [R-3].

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- Changes in recordkeeping requirements; and
- Benchmarking reviews.

The transition to decommissioning of the PNGS will be managed through the following regulatory submissions:

- A Sustainable Operations Plan (SOP) – The SOP describes OPG’s approach for shutting down the remaining operating units at PNGS. Further details on the SOP are provided in Section 4.1.3.
- A Stabilization Activity Plan (SAP) – The SAP outlines OPG’s plan for managing the arrangements and activities that will be conducted in support of the transition of the PNGS from its final shutdown state to its Safe Storage State (SSS) [R-5]. Further details on the SAP are provided in Section 4.1.3.
- A Detailed Decommissioning Plan (DDP) – The DDP will be prepared and submitted to the CNSC with the application for a decommissioning licence approximately two to five years prior to the Storage with Surveillance (SWS) period. The DDP² will cover the decommissioning activities for the entire period of the decommissioning. Towards the end of SWS, the DDP will be revised to describe OPG’s detailed plan for managing the arrangements and activities that will be conducted in support of Dismantling & Demolition. The methods and technologies available for use at the time of decommissioning will be reviewed and where appropriate, they will be adopted and described in the revised DDP. Further details on the DDP are provided in Sections 4.1.3 and 4.2.4.

1.2 Applicable Legislation, Standards and Regulatory Guidance

All decommissioning activities will be performed in accordance with the most relevant legislation, regulations, codes and standards.

The following subsections identify some of the current legislation applicable to OPG’s decommissioning activities.

1.2.1 Canadian Nuclear Safety Commission

The CNSC was established under the Nuclear Safety and Control Act (NSCA) as Canada’s independent nuclear regulator. The NSCA, 1997 and its regulations placed a requirement on operators of nuclear facilities to make adequate provisions for their safe operation and decommissioning. With reference to decommissioning and waste management, the following regulations under the Act have relevance to the decommissioning of a nuclear facility:

- Class 1 Nuclear Facilities Regulations (SOR/2000-204);
- General Nuclear Safety and Control Regulations (SOR/2000-202); and

² Note that the DDP that will be produced and submitted to the CNSC prior to SWS will include details of the Storage and Surveillance Plan (SSP) or the latter will be submitted as a separate document.

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- Nuclear Substances and Radiation Devices Regulations (SOR/2000-207).

The CNSC identifies the regulatory basis for decommissioning, as defined in the following key references:

- ‘Decommissioning Planning for Licensed Activities’, Regulatory Guide G-219, June 2000 [R-2]¹;
- ‘Financial Guarantees for the Decommissioning of Licensed Activities’, Regulatory Guide G-206, June 2000 [R-6]³;
- ‘Public Information and Disclosure’, REGDOC-3.2.1, May 2018 [R-7]; and
- ‘Indigenous Engagement’, REGDOC-3.2.2, version 1.1, August 2019 [R-8].

The guidance indicates the production of a PDP by the licensee as soon as possible in the life-cycle of the licensed activity. Additionally, the CNSC requires the development and updating of decommissioning plans throughout the facility life cycle to:

- Identify the impacts of decommissioning and demonstrate that the planned decommissioning activities will remediate all significant impacts and hazards to persons and the environment.
- Ensure compliance with all applicable requirements and criteria.
- Ensure that the financial responsibility for decommissioning is maintained by the licensee and that appropriate mechanisms are put in place to identify the costs of decommissioning together with provisions and maintenance of adequate funding to carry out decommissioning operations.

1.2.2 Canadian Standards Association

In addition to the publications produced by the CNSC, the CSA has produced guidance on the decommissioning of facilities as follows:

- ‘Decommissioning of facilities containing nuclear substances’, CSA N294;
- ‘Management of low- and intermediate-level radioactive waste’, CSA N292.3; and
- ‘Interim dry storage of irradiated fuel’, CSA N292.2.

Other CSA standards that are relevant to decommissioning are:

- ‘Management system requirements for nuclear facilities’, CSA N286;

³ REGDOC-3.3.1, Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities was published in January 2021 and supersedes G-206. OPG has communicated the timing for a gap analysis and implementation plan to REGDOC-3.3.1 in [R-3].

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- CSA N288 series on environmental management for nuclear facilities – in particular:
 - ‘Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills’, CSA N288.4;
 - ‘Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills’, CSA N288.5;
 - ‘Environmental risk assessments at class I nuclear facilities and uranium mines and mills’, CSA N288.6;
- ‘General principles for the management of radioactive waste and irradiated fuel’, CSA N292.0; and
- ‘Fire protection for nuclear power plants’, CSA N293.

1.2.3 Other Applicable Legislation and Regulatory Guidance

Other key legislation and regulatory guides include:

- Environmental Protection Act;
 - Regulation 347: General – Waste Management
- Ontario Water Resources Act;
- Occupational Health and Safety (OH&S) Act;
- Fisheries Act;
- National Pollutants Release Regulations; and
- Impact Assessment Act (IAA), if applicable⁴.

1.2.4 International Atomic Energy Agency Guides/Standards

OPG will also consider the recommendations and guidance from the International Atomic Energy Agency (IAEA) relevant to decommissioning. Some of these include, but are not limited to the following:

- Leadership and Management for Safety, General Safety Requirements, No. GSR Part 2, IAEA, 2016;
- Safety Assessment for Facilities and Activities, General Safety Requirements, No. GSR Part 4 (Rev. 1), IAEA, 2016;
- Predisposal Management of Radioactive Waste, General Safety Requirements, No. GSR Part 5, IAEA, 2009;

⁴ The Canadian Environmental Assessment Act (CEAA) 2012 [R-9] has been superseded by the IAA [R-10].

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- Decommissioning of Facilities, General Safety Requirements, No. GSR Part 6, IAEA, 2014;
- Disposal of Radioactive Waste, Specific Safety Requirements, No. SSR-5, IAEA, 2011;
- Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities, Specific Safety Guide, No. SSG-47, IAEA 2018;
- Release of Sites from Regulatory Control on Termination of Practices, Safety Guide, No. WS-G-5.1, IAEA, 2006;
- Safety Assessment for the Decommissioning of Facilities Using Radioactive Material, Safety Guide, No. WS-G-5.2, IAEA, 2008;
- Storage of Radioactive Waste, Safety Guide, No. WS-G-6.1, IAEA, 2006;
- Safe Enclosure of Nuclear Facilities During Deferred Dismantling, Safety Report Series, No. 26, 2002;
- Safety Considerations in the Transition from Operation to Decommissioning of Nuclear Facilities, Safety Report Series, No. 36, 2004;
- Standard Format and Content for Safety Related Decommissioning Documents, Safety Report Series, No. 45, IAEA, 2005;
- Decommissioning Strategies for Facilities Using Radioactive Material, Safety Reports Series, No. 50, IAEA, 2007;
- Management of Project Risks in Decommissioning, Safety Report Series, No. 97, 2019;
- Monitoring Programmes for Unrestricted Release Related to Decommissioning of Nuclear Facilities, Technical Reports Series, No. 334, IAEA, 1992;
- Application of Remotely Operated Handling Equipment in the Decommissioning of Nuclear Facilities, Technical Reports Series, No. 348, IAEA, 1993;
- Radiological Characterization of Shut Down Nuclear Reactors for Decommissioning Purposes, Technical Reports Series, No. 389, IAEA, 1998;
- State of the Art Technology for Decontamination and Dismantling of Nuclear Facilities, Technical Report Series, No. 395, IAEA, 1999;
- Organization and Management for Decommissioning of Large Nuclear Facilities, Technical Report Series, No. 399, IAEA, 2000;

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- Methods for the Minimization of Radioactive Waste from Decontamination and Decommissioning of Nuclear Facilities, Technical Report Series, No. 401, IAEA, 2001;
- Record Keeping for the Decommissioning of Nuclear Facilities: Guidelines and Experience, Technical Reports Series, No. 411, IAEA, 2002;
- Transition from Operation to Decommissioning of Nuclear Installations, Technical Report Series, No. 420, IAEA, 2004;
- Decommissioning of Underground Structures, Systems and Components, Technical Reports Series No. 439, IAEA, 2006;
- Dismantling of Contaminated Stacks at Nuclear Facilities, Technical Reports Series No. 440, IAEA, 2005;
- Management of Problematic Waste and Material Generated During the Decommissioning of Nuclear Facilities, Technical Reports Series No. 441, IAEA, 2006;
- Redevelopment of Nuclear Facilities after Decommissioning, Technical Report Series, No. 444, IAEA, 2006;
- Selection and Use of Performance Indicators in Decommissioning, Nuclear Energy Series, No. NW-T-2.1, IAEA, 2011;
- Policies and Strategies for Radioactive Waste Management, Nuclear Energy Series, No. NW-G-1.1, IAEA, 2009; and
- Policies and Strategies for the Decommissioning of Nuclear and Radiological Facilities, Nuclear Energy Series, No. NW-G-2.1, IAEA. 2011.
- Selection of Decommissioning Strategies: Issues and Factors, IAEA-TECDOC-1478, IAEA, 2005;
- New Methods and Techniques for Decontamination in Maintenance or Decommissioning Operations, IAEA-TECDOC-1022, IAEA, 1998;
- Safe and Effective Nuclear Power Plant Life Cycle Management Towards Decommissioning, IAEA-TECDOC-1305, IAEA, 2002;
- On-site Disposal as a Decommissioning Strategy, IAEA-TECDOC-1124, IAEA, 1999;
- Approaches relating to decommissioning of nuclear facilities, PDRP-2, IAEA, 1998; and
- Managing the Unexpected in Decommissioning, No. NW-T-2.8, IAEA, 2016.

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1.3 Applicable Programs

OPG's Nuclear Management System [R-11] provides a framework that establishes the processes and programs required to ensure OPG achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture.

OPG is responsible for planning, executing and funding all the phases of decommissioning of all of OPG's owned nuclear facilities. Decommissioning work will be conducted in accordance with the management system requirements and in compliance with OPG's Decommissioning Program [R-12], which ensures that when retiring a licensed nuclear facility permanently from service and rendering it to a predetermined end-state condition, actions are taken in the interest of health, safety, environment, security, quality and economics. The Decommissioning Program is further implemented through two standards to address the requirements and processes for decommissioning planning [R-13] and conduct of decommissioning [R-14]. The Decommissioning Program describes the interface with the Nuclear Management System as well as other Interfacing Governance such as the Nuclear Waste Management program, Integrated Aging Management.

1.4 Regulatory Compliance with Applicable Standards

This document outlines the preliminary decommissioning planning work that has been completed. In accordance with the requirements described in CNSC Regulatory Guide G-219 [R-2] and CSA Standard N294:19 [R-4] it includes or references:

- A description of the facilities to be decommissioned;
- A description of the decommissioning strategy that will be employed;
- An outline of the work that will be required to complete the decommissioning;
- A discussion of the decommissioning cost estimate and financial guarantee;
- A proposed schedule for the decommissioning work;
- An estimated inventory of the radioactive wastes that will be generated during decommissioning;
- A preliminary assessment of the potential environmental and socio-economic impact of decommissioning; and
- A preliminary assessment of the radiological and conventional safety issues involved in decommissioning.

Appendix C refers to the specific requirements of CSA N294:19 and identifies the respective sections of the PDP that cover these requirements. With regards to compliance with CNSC Guide G-219 [R-2], this is inferred through the demonstration of compliance with CSA N294:19 [R-4]. The correspondence between the requirements set out in CSA Standard N294:19 [R-4] and this plan is shown in Appendix C, Table C-1, Table C-2 and Table C-3.

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1.5 Planning Assumptions

The assumed station shutdown dates and decommissioning timelines (i.e., Storage With Surveillance, Dismantling & Demolition, and Site Restoration) are in accordance with the latest information available. Planning for decommissioning of the PNGS is based on the following fundamental assumptions:

1. For financial planning purposes, it has been assumed that the individual reactor units at the PNGS will be shut down based on business planning considerations in the following sequence [R-15]:
 - At PNGS A, end of operating life/shut down dates:
 - Unit 1 September 2024;
 - Unit 2 1997; (in SWS since 2005);
 - Unit 3 1997; (in SWS since 2005); and
 - Unit 4 December 2024.
 - At PNGS B, end of life dates:
 - Unit 5 December 2025;
 - Unit 6 December 2025;
 - Unit 7 December 2025; and
 - Unit 8 December 2025.
 - Note: All dates are nominal.
2. For planning purposes, it is assumed that decommissioning (planning for Dismantling & Demolition) will commence in the following sequence [R-15]:
 - For PNGS A:
 - Unit 1 in January 2050
 - Unit 2 in January 2051
 - Unit 3 in January 2052
 - Unit 4 in January 2053
 - And for PNGS B:
 - Unit 5 in January 2054
 - Unit 6 in January 2055
 - Unit 7 in January 2056
 - Unit 8 in January 2057
 - Note: All dates are nominal. Any modifications associated with shutdown dates may impact these dates.
3. Dismantling of the units will be staggered over a nominal 10 year period after SWS.

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4. The systems and components that are part of PNGS A Unit 0 will be dismantled in conjunction with Unit 4 in 2054 and the portions of Unit 0 that are common to both PNGS A and B will be dismantled together with the last Unit of PNGS B, i.e., with Unit 8 in 2058.
5. OPG will retain ownership of the site throughout the course of the decommissioning and subsequent restoration for other industrial use (commonly known as 'brown field' status).
6. OPG will be responsible for all work conducted during the shutdown of the units, the Preparation for Safe Storage or Stabilization period and the SWS stages of the decommissioning although some specialized services may be provided by contractors working under the oversight of OPG staff.
7. A Decommissioning Operations Contractor (DOC)⁵, a company or consortium selected on the basis of experience, safety record, overall approach and cost, will perform all work during the Dismantling & Demolition, and Site Restoration stages. OPG will provide the necessary oversight.
8. Electric heating will be available while PNGS is in SWS (for areas used during SWS), during preparation for Dismantling & Demolition, during Dismantling & Demolition, and up to the end of large component removal (calandria and steam generators).
9. Used Fuel Dry Storage Facilities (UFDSFs) will be dismantled concurrent with their corresponding station. Used fuel will be removed from the site to a licensed long term-storage facility before start of dismantling activities. Please refer to Section 4.4.1.2 for more details regarding management of high-level waste.
10. Low- and Intermediate-Level Waste (L&ILW) arising from decommissioning activities will be disposed of in long-term disposal facilities, as described in Section 4.4.1.3. Non-radioactive hazardous waste will be disposed of at approved disposal facilities.
11. Decontamination and dismantling activities will be coordinated at all eight Pickering units (Pickering A and B) to optimize the project schedule and maintain continuity in the overall process.
12. 'Clearance Levels' based on guidance provided in CSA Standard N292.5 [R-16] will be developed prior to decommissioning (Dismantling & Demolition). These criteria will standardize the approach for segregation of the decommissioning wastes into those requiring long-term management and those that can be recycled, left on site or disposed of in conventional waste facilities.
13. For the purpose of the financial guarantee, no salvage credit is assigned to equipment and components removed during decommissioning; these are considered waste for

⁵ Decommissioning Operations Contractor (DOC) used in the TLG Cost Estimate [R-16] is equivalent to "Decommissioning Contractor(s)" terminology used throughout the PDP document.

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costing purposes. However, consistent with the principles of the waste management hierarchy, recycling of clean materials will be pursued.

14. Above-ground structures will be surveyed for contamination, decontaminated if required and demolished.
15. Underground metal and concrete piping will be excavated for survey and removed, if necessary. Uncontaminated materials beyond one meter will be left in place, while contaminated materials that exceed the site release criteria will be removed and disposed of appropriately.
16. Sub-surface structures will be surveyed for contamination, decontaminated if required and, consistent with international practices, dismantled to a nominal depth of one meter below grade, backfilled with concrete rubble and/or soil and graded over. If contamination is present beyond one meter depth, OPG will be responsible to remediate until the respective screening levels are met. Additionally, the one meter depth allows for the placement of both gravel for drainage and topsoil for erosion control through the establishment of vegetation and provides significant attenuation of any residual gamma radionuclides that may remain within the site release limits. At-grade foundation slabs exceeding one meter in thickness will be abandoned in place and covered with a one meter thick layer of backfill.
17. The site will be graded and made available for other OPG uses after completion of decommissioning as a 'brownfield'⁶.

⁶ As per nuclear industry practice, a brownfield is defined as a former industrial land that has the potential to be developed for new industrial uses.

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2.0 DESCRIPTION OF THE PICKERING NUCLEAR GENERATING STATIONS A AND B AND SURROUNDING AREA

2.1 Location of the Pickering Nuclear Site

The Pickering Nuclear Site is located on the north shore of Lake Ontario at Moore Point in the City of Pickering Regional Municipality of Durham, Province of Ontario. The site is 32 km (20 miles) east-north-east of downtown Toronto and 21 km (13 miles) south-west of the City of Oshawa at a latitude of 43°49' N and longitude of 79°04' W. The location of the Pickering Nuclear Site is shown in Figure 2-1.

The Pickering Nuclear Site occupies a land area of 240 ha (600 acres) in lots 17 to 22 inclusive in the Broken Front Concession. The total frontage of the site along the shoreline of Lake Ontario is approximately 2,260 m (7,400 ft.). The transmission egress right-of-way which leads north from the site boundary is 155 m (500 ft) in width and occupies part of lots 19 and 20 in the Broken Front Concession. Two licensed nuclear facilities are currently operating on the site. There is a one-site licence for both power reactor stations (PNGS A and PNGS B) and the second licensed facility is the PWF, as shown in Figure 2-11.

Seventeen small parcels of land, which have not been acquired by OPG, lie within the 914 m (3000 ft) exclusion radius from the exterior Reactor Buildings walls of the eight generating units. The Duffin's Creek Water Pollution Control Plant and the retired Frenchman's Bay Water Pollution Control Plant are located on the two largest properties in the exclusion zone.

The site is well serviced by road and rail. Two major roadways, Highway 401 and Highway 2, as well as the main Canadian National (CN) rail line run in an east-west direction within 3.5 km (2 miles) of the site. Access from the site to the highways is provided by Brock Road, a four-lane north-south artery. A spur line from the CN to the site was built in the initial stages of site development; it is no longer in place but could be re-instated if necessary. A dock was constructed on the west side of PNGS A to facilitate unloading of the major reactor components. The two major watercourses closest to the site are Duffin Creek, 2.2 km (1.5 miles) to the east and the Rouge River, 4 km (2.5 miles) to the west [R-17].

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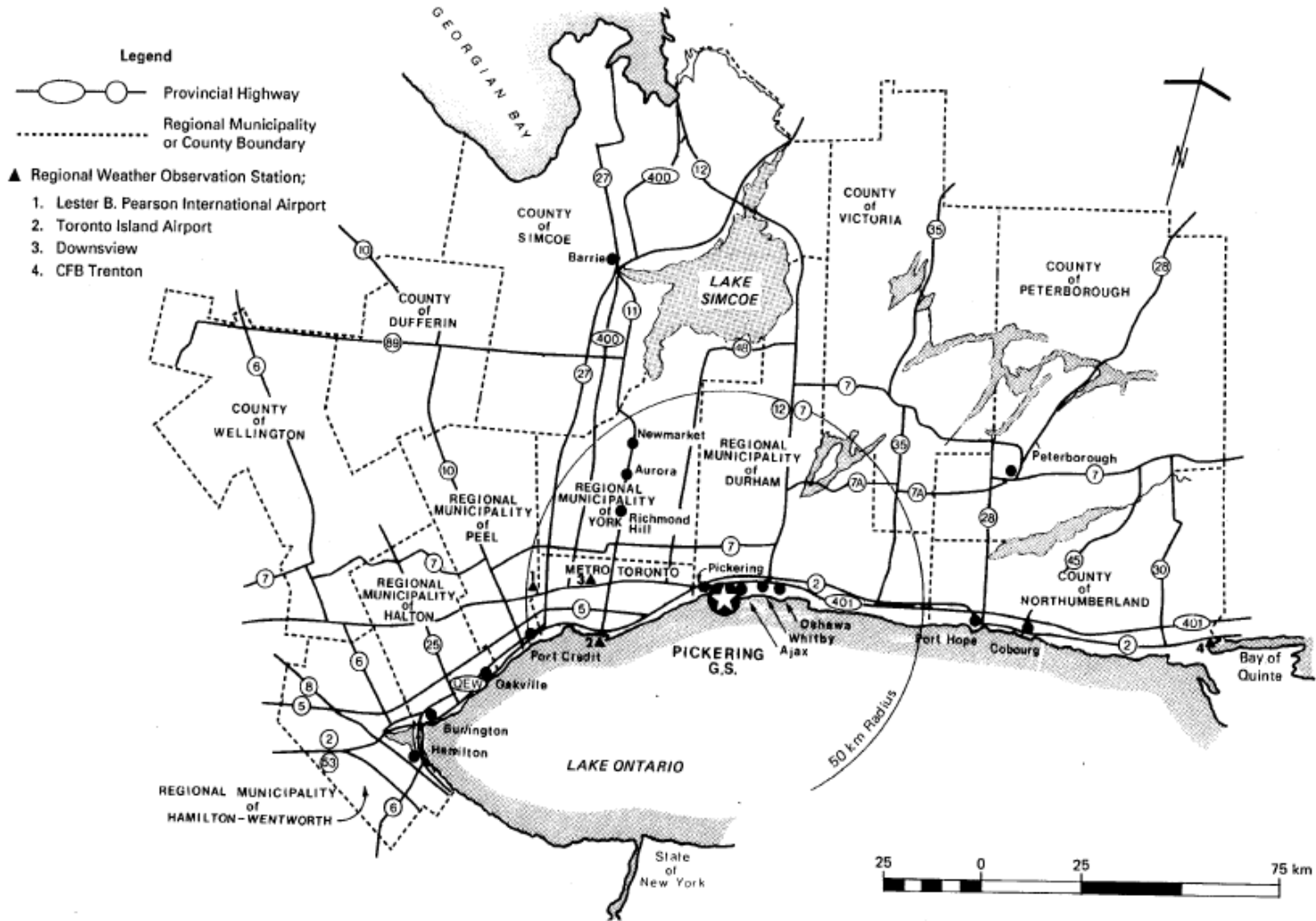


Figure 2-1: Map Showing Location of the Pickering Nuclear Site

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2.2 Description of Pickering Nuclear Generating Stations A and B

2.2.1 Overview

The two generating stations (PNGS A and PNGS B) and the PWMF are located on the property described in Section 2.1. PNGS A and PNGS B are located in an area protected by the operating island security fence called the protected area. In terms of layout, PNGS A and PNGS B are similar. The two stations are connected and share certain common services, as shown in Figure 2-2.

Figure 2-3 and Figure 2-4 shows the site plan and a layout of PNGS B. Buildings inside the boundary are included in the decommissioning plans for the two stations. Although the PWMF on the Pickering Nuclear Site is excluded from this boundary, the interdependencies with the PNGS are included as part of the scope of the site PDP (see Section 3.1).

The generating stations are described in detail in their respective Safety Reports [R-17], [R-18] and [R-19]. Each station consists of:

- Four (4) Reactor Buildings;
- Reactor Auxiliary Bay for each station;
- Main Control Rooms (MCRs);
- Irradiated Fuel Bays (IFBs);
- Powerhouse (including the Turbine Hall and Turbine Auxiliary Bay) for each station;
- Annex Building (connected to the Reactor Auxiliary Bay and the Powerhouse);
- Screen house; and
- Standby Generators and their Oil Tanks.

There are additional structures on site that support the station, including:

- Administration Building;
- Service Wing and Service Wing Extension (between PNGS A and PNGS B and connected to both);
- Heavy Water Upgrading Plant at Pickering (UPP);
- High Pressure Emergency Coolant Injection (HPECI) Pumphouse and HPECI Water Storage Tank, PNGS B;
- Pressure Relief Duct that runs the full length of PNGS A and B;
- Vacuum Building with its associated pressure relief duct;

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- Auxiliary Irradiated Fuel Bay (AIFB), located southwest of Unit 4, PNGS A;
- Water Treatment Building, PNGS A (old), PNGS B complex (new);
- Tempering Water Pumphouse, PNGS B;
- Emergency Water Pumphouse and Power Supply Building, PNGS B; and
- East Security Complex.

Two switchyards, one for each station, are located outside the protected area. A variety of workshops, office buildings and warehouses and Auxiliary Power System are also located outside the protected area. PWMF Phase I (including the Processing Building, Storage Buildings (SBs) 1 and 2 and a storage area for Dry Storage Modules (DSMs)) is located at the southeast corner of PNGS B, just off the lake shoreline. PWMF Phase II consists of SBs 3 and 4, which are currently both in service. Two additional SBs 5 and 6 are also planned for construction. PWMF Phase II is located on the PNGS site in the East complex, but within its own protected area approximately 500 m north-east of Phase I.

2.2.2 Reactor Building

The Reactor Building houses the reactor and associated equipment. It is also part of the containment system, which prevents the escape of radioactivity, and provides radiation shielding between active areas and staff outside the building. It is a cylindrical, reinforced-concrete structure, 42 m (140 ft.) in diameter and 36 m (117 ft.) high with elliptical domed roof. The pressure relief panel separates the Reactor Building from the Pressure Relief Duct.

The interior of the Reactor Building is subdivided by a massive concrete structure of walls and floors, which are independent of the external wall and dome. This structure provides shielded areas that can be safely entered while the reactor is operating and other areas, which may be occupied while the reactor is shut down depending on the nature of the equipment contained in the areas. A system of steel platforms, walkways, ladders and stairs provide access to equipment that cannot be reached directly from the concrete floors. Access to the Reactor Building is by means of airlocks so that the containment integrity is intact at all times. These airlocks are provided in pairs on three elevations.

The Calandria Vault forms an independent box-like structure of concrete and contains the calandria. The two stations have different Calandria vault configurations. The PNGS A vaults are concrete chambers that house both the calandria and the dump tank (see Figure 2-5) while the PNGS B vaults are concrete, steel-lined, water-filled tanks that house the calandria (see Figure 2-6). There are also differences in the calandria design. The PNGS A calandria has 390 fuel channels while the PNGS B calandria has only 380 fuel channels. Differences in the shielding design resulted in the PNGS A calandria having a greater mass than that of PNGS B. The PNGS A design includes a dump tank directly below the calandria for the heavy water moderator, but the PNGS B design does not include this tank (see Figure 2-7 and Figure 2-8). Furthermore, the PNGS A design also includes a helium storage tank on each unit; this is not included on PNGS B (see Figure 2-7 and Figure 2-8).

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Cross walls are located directly north and south of the Calandria Vault. These walls run east to west across the full width of the Reactor Building and extend from the grade floor at elevation 254 ft. to the Boiler Room floor at elevation 317 ft. 6 in. Above the Boiler Room floor there is a structural steel framework that supports a crane, the Steam Generators (also called 'boilers') and the Heat Transport Pumps.

The Steam Generators and Heat Transport Pumps are also part of the Heat Transport System, which is designed to circulate pressurized heavy water through the fuel channels. The configuration of Steam Generators is shown in Figure 2-9. There are 12 boilers and 16 Heat Transport Pumps (four on standby), per unit, at PNGS. The heat transport system also includes the headers and the feeder pipes that run to and from each fuel channel.

The crane is centred on and runs along the north to south centreline of the Reactor Building. A hatch in the northern part of the Boiler Room floor allows the crane to work the full height of the building on the south side.

2.2.3 Reactor Auxiliary Bay

To keep the size of the Reactor Building and the need for entry of personnel to a minimum, reactor auxiliary systems that do not require the containment and shielding provided by the Reactor Building are located in a Reactor Auxiliary Bay that runs the full length of each station. The Auxiliary Bay is a conventional four-storey steel frame building that is fitted around the northern half of the four Reactor Buildings. The Reactor Auxiliary Bays for the two stations are connected between the two stations. The MCR and the IFB for each station are located in the centre of the Reactor Auxiliary Building (between Units 2 and 3 for PNGS A and between Units 6 and 7 for PNGS B).

2.2.4 Other Nuclear Systems & Structures

The Service Wing and Service Wing Extension are located at the centre of the station. They are connected to the east end of PNGS A and the west end of PNGS B. The Service Wing and its extension house laboratories, stores, locker and change room facilities, maintenance shops, fuelling machine dismantling facilities, waste management areas and office space.

The AIFB is located southwest of Unit 4 at the west end of PNGS A. It is connected to the PNGS A IFB in the Reactor Auxiliary Bay by the IFB Hallway.

The Heavy Water UPP is located north-west of PNGS A. It is connected to PNGS A by the overhead UPP duct. The HPECI Pumphouse and HPECI Tower are located south of the Service Wing.

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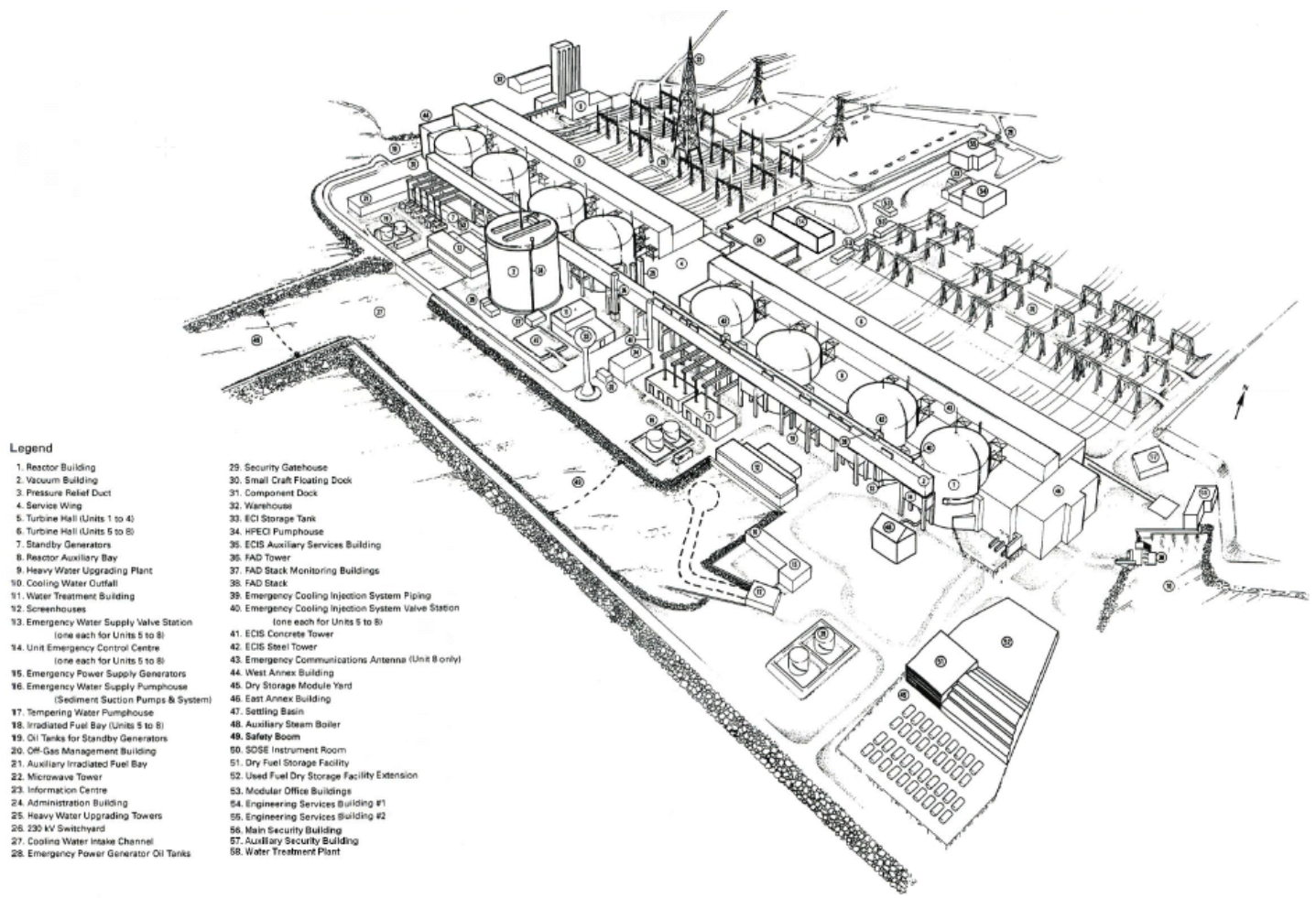
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Legend

- 1. Reactor Building
- 2. Vacuum Building
- 3. Pressure Relief Duct
- 4. Service Wing
- 5. Turbine Hall (Units 1 to 4)
- 6. Turbine Hall (Units 5 to 8)
- 7. Standby Generators
- 8. Reactor Auxiliary Bay
- 9. Heavy Water Upgrading Plant
- 10. Cooling Water Outfall
- 11. Water Treatment Building
- 12. Screenhouses
- 13. Emergency Water Supply Valve Station
(one each for Units 5 to 8)
- 14. Unit Emergency Control Centre
(one each for Units 5 to 8)
- 15. Emergency Power Supply Generators
- 16. Emergency Water Supply Pumphouse
(Sediment Suction Pumps & System)
- 17. Tempering Water Pumphouse
- 18. Irradiated Fuel Bay (Units 5 to 8)
- 19. Oil Tanks for Standby Generators
- 20. Off-Gas Management Building
- 21. Auxiliary Irradiated Fuel Bay
- 22. Microwave Tower
- 23. Information Centre
- 24. Administration Building
- 25. Heavy Water Upgrading Towers
- 26. 230 kV Switchyard
- 27. Cooling Water Intake Channel
- 28. Emergency Power Generator Oil Tanks
- 29. Security Gatehouse
- 30. Small Craft Floating Dock
- 31. Component Dock
- 32. Warehouse
- 33. ECI Storage Tank
- 34. HPECI Pumphouse
- 35. ECIS Auxiliary Services Building
- 36. FAD Tower
- 37. FAD Stack Monitoring Buildings
- 38. FAD Stack
- 39. Emergency Cooling Injection System Piping
- 40. Emergency Cooling Injection System Valve Station
(one each for Units 5 to 8)
- 41. ECIS Concrete Tower
- 42. ECIS Steel Tower
- 43. Emergency Communications Antenna (Unit 8 only)
- 44. West Annex Building
- 45. Dry Storage Module Yard
- 46. East Annex Building
- 47. Settling Basin
- 48. Auxiliary Steam Boiler
- 49. Safety Boom
- 50. SOSE Instrument Room
- 51. Dry Fuel Storage Facility
- 52. Used Fuel Dry Storage Facility Extension
- 53. Modular Office Buildings
- 54. Engineering Services Building #1
- 55. Engineering Services Building #2
- 56. Main Security Building
- 57. Auxiliary Security Building
- 58. Water Treatment Plant

Figure 2-2: Pickering Nuclear Generating Stations

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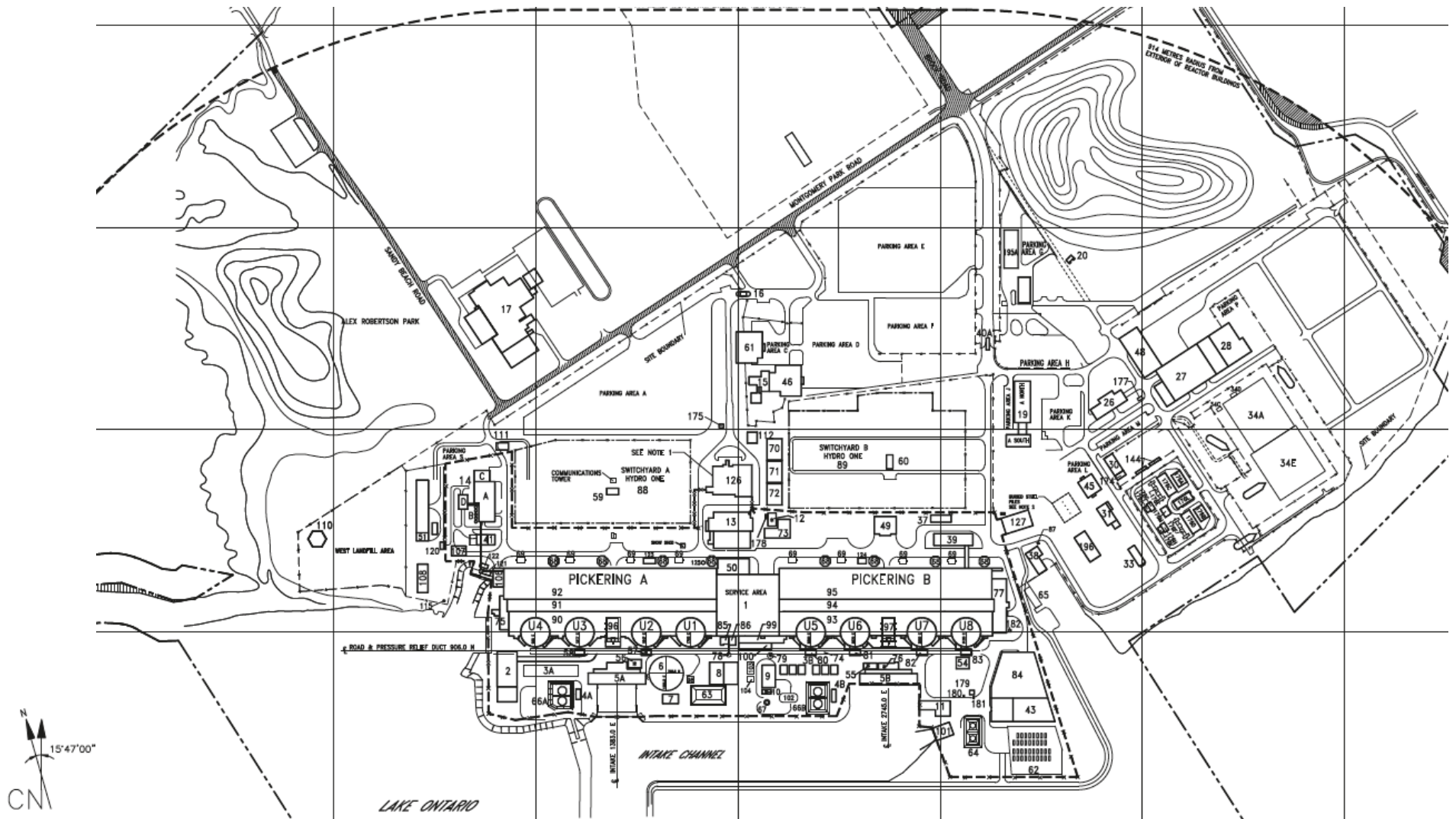


Figure 2-3: Site Layout

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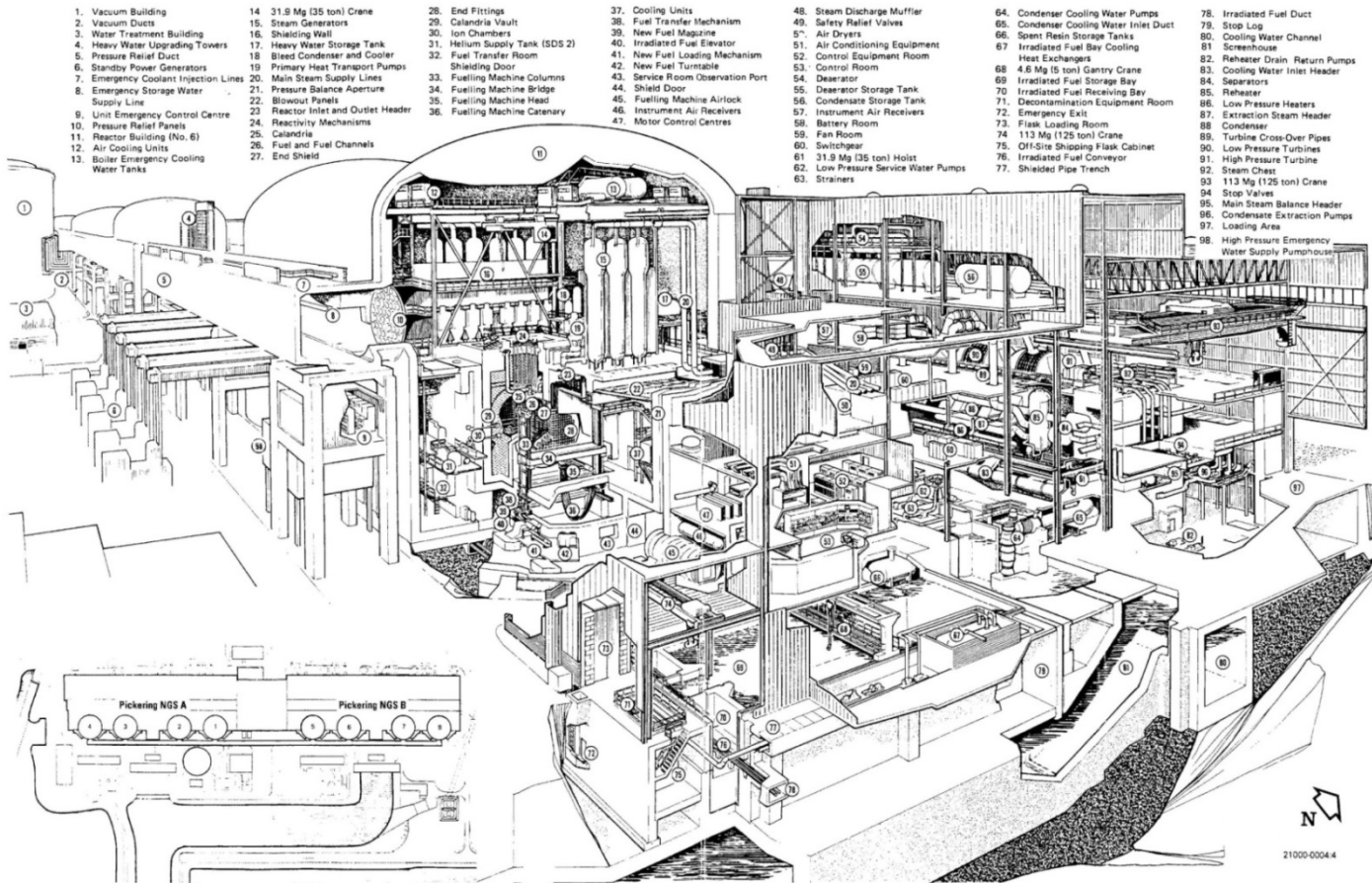


Figure 2-4: Layout of PNGS B

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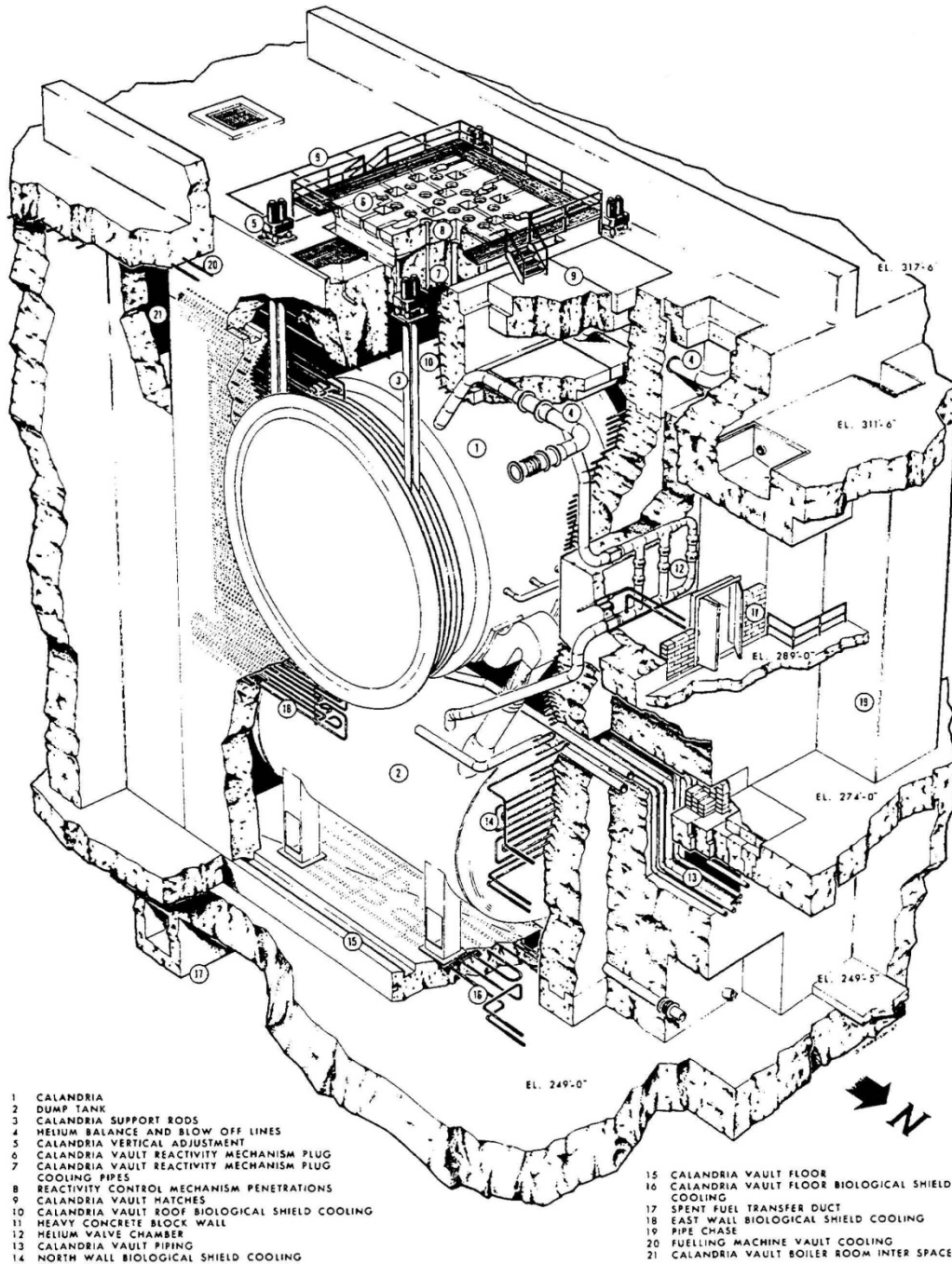
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- 1 CALANDRIA
- 2 DUMP TANK
- 3 CALANDRIA SUPPORT RODS
- 4 HELIUM BALANCE AND BLOW OFF LINES
- 5 CALANDRIA VERTICAL ADJUSTMENT
- 6 CALANDRIA VAULT REACTIVITY MECHANISM PLUG
- 7 CALANDRIA VAULT REACTIVITY MECHANISM PLUG COOLING PIPES
- 8 REACTIVITY CONTROL MECHANISM PENETRATIONS
- 9 CALANDRIA VAULT HATCHES
- 10 CALANDRIA VAULT ROOF BIOLOGICAL SHIELD COOLING
- 11 HEAVY CONCRETE BLOCK WALL
- 12 HELIUM VALVE CHAMBER
- 13 CALANDRIA VAULT PIPING
- 14 NORTH WALL BIOLOGICAL SHIELD COOLING

- 15 CALANDRIA VAULT FLOOR
- 16 CALANDRIA VAULT FLOOR BIOLOGICAL SHIELD COOLING
- 17 SPENT FUEL TRANSFER DUCT
- 18 EAST WALL BIOLOGICAL SHIELD COOLING
- 19 PIPE CHASE
- 20 FUELLING MACHINE VAULT COOLING
- 21 CALANDRIA VAULT BOILER ROOM INTER SPACE

44.21300.5
1990

Figure 2-5: PNGS A Calandria Vault

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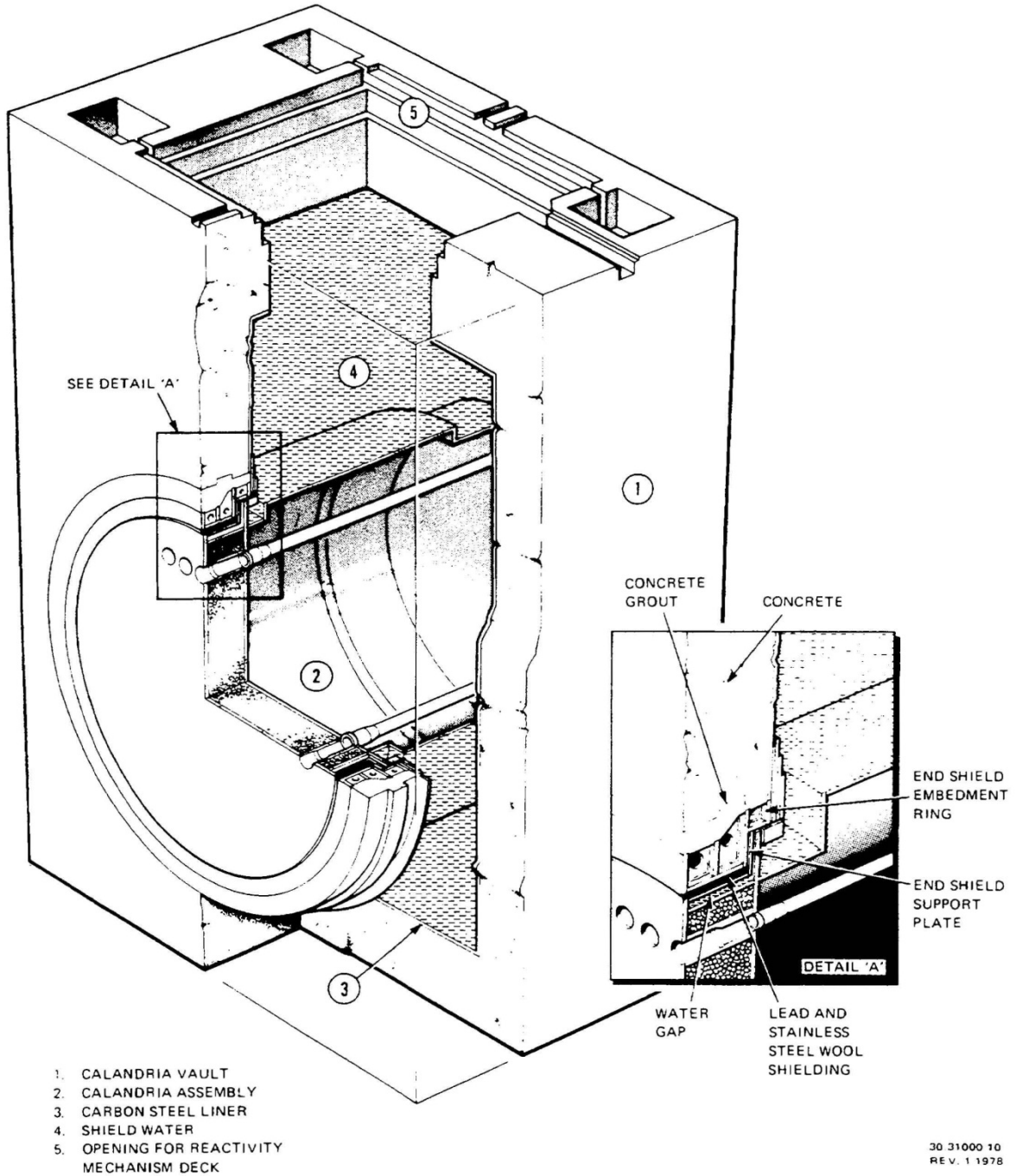
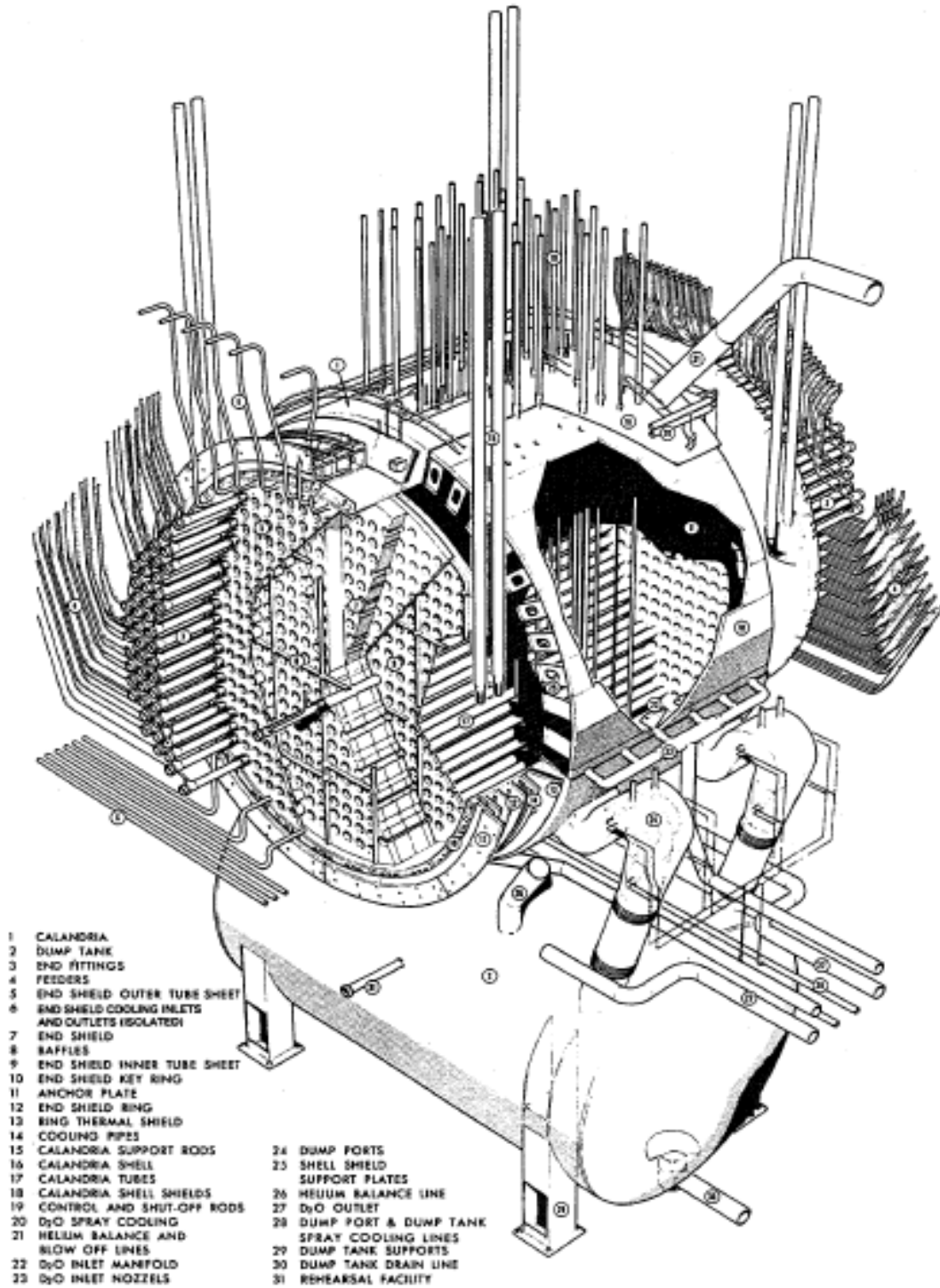


Figure 2-6: PNGS B Calandria Vault

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- 1 CALANDRIA
- 2 DUMP TANK
- 3 END FITTINGS
- 4 FEEDERS
- 5 END SHIELD OUTER TUBE SHEET
- 6 END SHIELD COOLING INLETS AND OUTLETS (ISOLATED)
- 7 END SHIELD
- 8 BAFFLES
- 9 END SHIELD INNER TUBE SHEET
- 10 END SHIELD KEY RING
- 11 ANCHOR PLATE
- 12 END SHIELD RING
- 13 RING THERMAL SHIELD
- 14 COOLING PIPES
- 15 CALANDRIA SUPPORT RODS
- 16 CALANDRIA SHELL
- 17 CALANDRIA TUBES
- 18 CALANDRIA SHELL SHIELDS
- 19 CONTROL AND SHUT-OFF RODS
- 20 D₂O SPRAY COOLING
- 21 HELIUM BALANCE AND BLOW OFF LINES
- 22 D₂O INLET MANFOLD
- 23 D₂O INLET NOZZELS
- 24 DUMP FORTS
- 25 SHELL SHIELD SUPPORT PLATES
- 26 HELIUM BALANCE LINE
- 27 D₂O OUTLET
- 28 DUMP FORT & DUMP TANK SPRAY COOLING LINES
- 29 DUMP TANK SUPPORTS
- 30 DUMP TANK DRAIN LINE
- 31 REHEARSAL FACILITY

Figure 2-7: PNGS A Reactor Assembly

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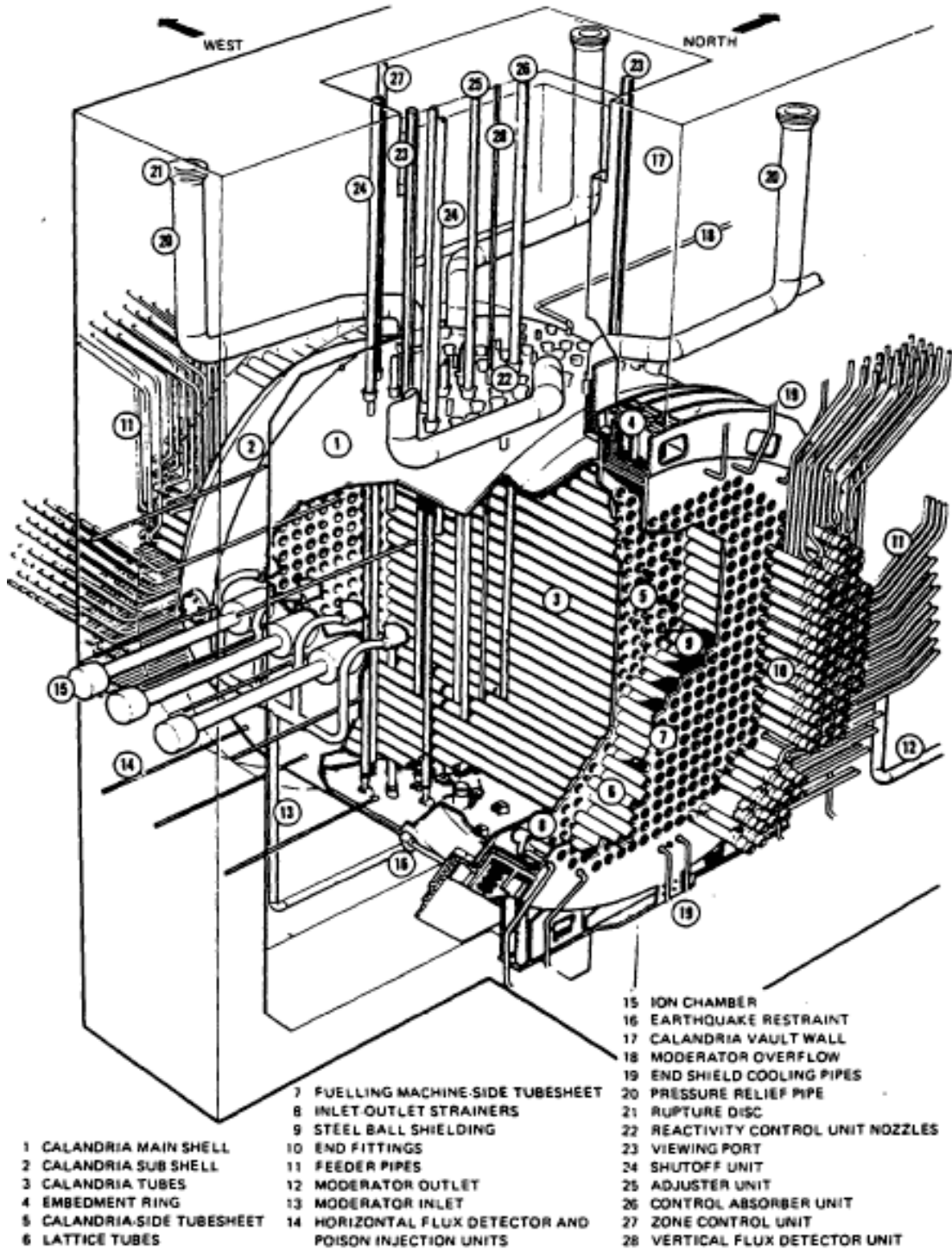


Figure 2-8: PNGS B Reactor Assembly

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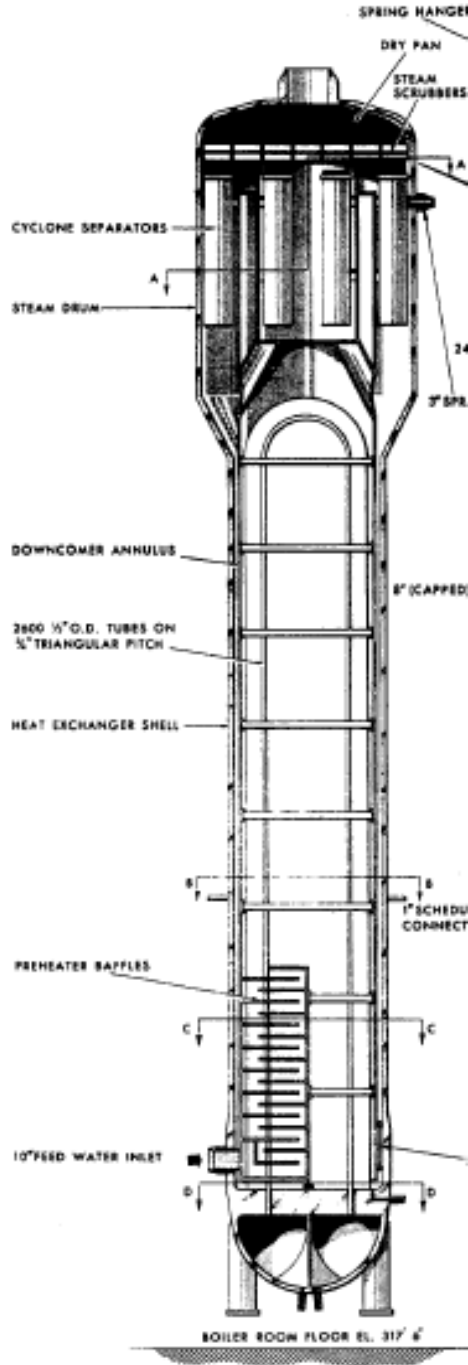


Figure 2-9: Steam Generator

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2.2.5 Containment

Together, the Reactor Buildings, the Pressure Relief Duct, the Vacuum Ducts and the Vacuum Building form the containment boundary of the stations.

The Pressure Relief Duct is an elevated, rectangular, reinforced concrete structure set on concrete supports. It runs the full length of both stations midway between the Vacuum Building and the Reactor Buildings. Twelve cylindrical steel Vacuum Ducts 1.6 m (6 ft.) in diameter link the Pressure Relief Duct to the Vacuum Building.

The Vacuum Building (Figure 2-10) is a reinforced-concrete structure with an internal space frame. The frame supports the roof and the emergency water storage tank. The basement houses the Vacuum Building equipment including the vacuum pumps, electrical and instrumentation equipment and the water recirculation and recovery system. Two hatches are provided in the floor slab and sized for personnel access and equipment passage. Two hatches are located in the roof slab for access to the water tank. A ramp is provided to the basement for personnel and vehicle access. Services to the basement are routed through a tunnel connected to the Reactor Auxiliary Bay.

2.2.6 Powerhouse

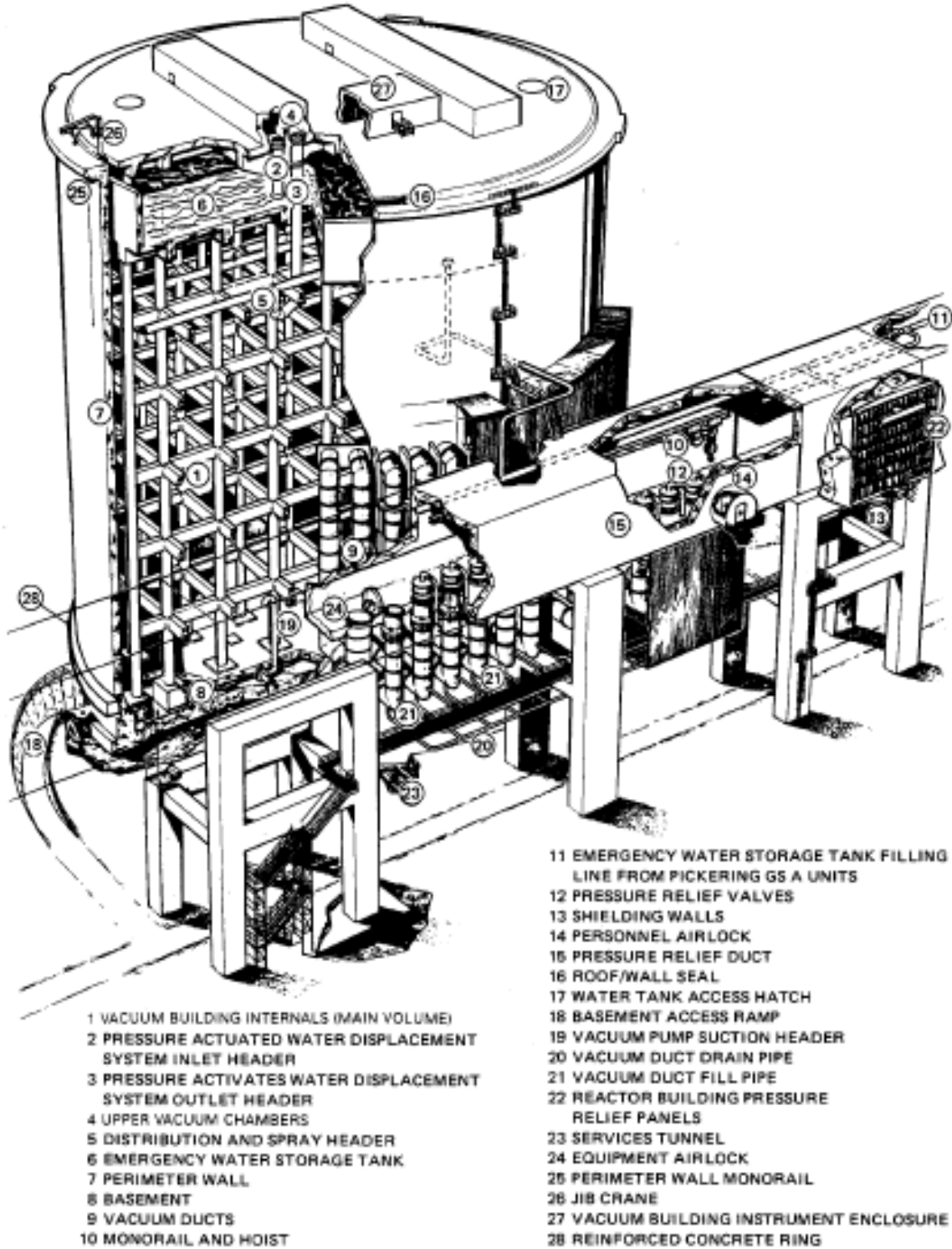
The Powerhouse is a conventional steel structure, supported on concrete spread footings. It consists of a Turbine Hall and a Turbine Auxiliary Bay. The turbine generators are arranged in a line down the Turbine Hall that runs the length of each station. A loading bay is centrally located on the main axis of each Turbine Hall. The Turbine Auxiliary Bay houses the condenser circulating water and process water pumps, switch gear, deaerators and other auxiliary equipment.

2.2.7 Other Non-Nuclear Systems & Structures

The Administration Building is located north of the Service Wing and Service Wing Extension. It is connected to an upper floor of the Service Wing by a pedestrian bridge.

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- 1 VACUUM BUILDING INTERNALS (MAIN VOLUME)
- 2 PRESSURE ACTUATED WATER DISPLACEMENT SYSTEM INLET HEADER
- 3 PRESSURE ACTIVATES WATER DISPLACEMENT SYSTEM OUTLET HEADER
- 4 UPPER VACUUM CHAMBERS
- 5 DISTRIBUTION AND SPRAY HEADER
- 6 EMERGENCY WATER STORAGE TANK
- 7 PERIMETER WALL
- 8 BASEMENT
- 9 VACUUM DUCTS
- 10 MONORAIL AND HOIST

- 11 EMERGENCY WATER STORAGE TANK FILLING LINE FROM PICKERING GS A UNITS
- 12 PRESSURE RELIEF VALVES
- 13 SHIELDING WALLS
- 14 PERSONNEL AIRLOCK
- 15 PRESSURE RELIEF DUCT
- 16 ROOF/WALL SEAL
- 17 WATER TANK ACCESS HATCH
- 18 BASEMENT ACCESS RAMP
- 19 VACUUM PUMP SUCTION HEADER
- 20 VACUUM DUCT DRAIN PIPE
- 21 VACUUM DUCT FILL PIPE
- 22 REACTOR BUILDING PRESSURE RELIEF PANELS
- 23 SERVICES TUNNEL
- 24 EQUIPMENT AIRLOCK
- 25 PERIMETER WALL MONORAIL
- 26 JIB CRANE
- 27 VACUUM BUILDING INSTRUMENT ENCLOSURE
- 28 REINFORCED CONCRETE RING

Figure 2-10: Pickering Vacuum Building

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The East Security Complex is located east of PNGS B and north-east of PWWF.

The Screenhouses, Pumphouses and a number of other small buildings, including the Standby Generator Buildings and Above Ground Storage Tanks, are all located south of the stations within the operating island protected area.

2.2.8 Other Nuclear Facilities on the Pickering Site

2.2.8.1 Pickering Waste Management Facility

The PWWF is located on the East side of the Pickering Nuclear Site (near Unit 8), as shown in Figure 2-11. As mentioned in Section 2.1, the PWWF is licensed independently of the PNGS. The purpose of the PWWF is:

- To provide safe interim storage of the used fuel from PNGS reactors in Dry Storage Containers (DSCs) until all the used fuel is transported to a long-term used fuel disposal facility (i.e., Adaptive Phased Management (APM)).
- To provide safe storage of the retube reactor components for PNGS A in DSMs until they are transported to a disposal facility for Intermediate Level Waste (ILW).

The PWWF is composed of two sites:

- PWWF Phase I (see Figure 2-12) is located within the PNGS protected area, south-east of Unit 8 and adjacent to the east side of the PNGS security fence (see Figure 2-3). The PWWF Phase I site consists of the following sub-facilities: Used Fuel Dry Storage (UFDS) for interim storage of Pickering used fuel in DSCs; and Retube Components Storage for interim storage of PNGS A irradiated reactor components in DSMs.
- PWWF Phase II is located approximately 500 m north-east of the PWWF Phase I site in the East Complex, within a distinct “protected area”. The PWWF Phase II site contains a security kiosk, DSC SBs 3 and 4 and the site for additional DSC SBs.

Used fuel from the PNGS IFBs is loaded into DSCs and then transported to dry storage at the PWWF. The fuel removal strategy is a key component of the decommissioning strategy.

There are currently multiple interfacing systems and services between the PWWF and PNGS to ensure safe operations of these facilities. The interfacing systems include:

- Electrical Power:
 - Class IV Main Power Supply, which is required for the general building loads, and is provided from Unit 5 (Powerhouse);
 - Class II Power, which is used for the emergency lighting, fire protection control panel, alarm and annunciation equipment, and security monitoring equipment, and this is provided from Unit 5 (Powerhouse);

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- Class I Power, which is required for switch gear protection and control circuits, and is provided from Unit 5 (switchgear);
- Fire protection water is supplied from PNGS B fire water;
- Instrument air is supplied from Unit 5 (Reactor Building) Instrument Air System;
- Domestic (service) water is supplied from the underground domestic water piping north of PNGS-B/Unit 8;
- Active Drainage originating from floor drains and directed to two underground stainless steel lined sumps within the facility is pumped to two holding tanks. After routine monitoring, the tank contents are periodically transferred through a connection to the Unit 8, Reactor Building and ultimately to the active waste treatment system at the station in Unit 5; and
- Sewage, which is collected in a sump is subsequently pumped from the PWMF to the PNGS B yard Manhole #5 in the North East corner of the powerhouse. This in turn flows into the main yard sewage pumping station (where it is monitored and discharged to municipal sewage systems).

There are other systems at the PWMF such as Ventilation, Heating and Air Conditioning and Service Air, which do not require external supply. As none of the systems used by SB #3 are sourced from the station, there will be no impact on PWMF operation as PNGS undergoes Stabilization and SWS. SB #4 connects internally to systems of SB #3 and does not require additional supplies nor will it be impacted during the PNGS Stabilization and SWS period.

The current interfacing services between PNGS and PWMF include the following:

- Environmental Monitoring;
- Radiation Protection;
- Security; and
- Emergency Response.

Although the life cycle plans of PNGS and the PWMF are separate from each other, the impact that the decommissioning of PNGS may have on PWMF is included in this PDP (See Sections 4.0). The PWMF is described in more detail in the PWMF PDP [R-1].

The impact of PNGS shutdown and decommissioning on the PWMF is further described in Section 4.0.

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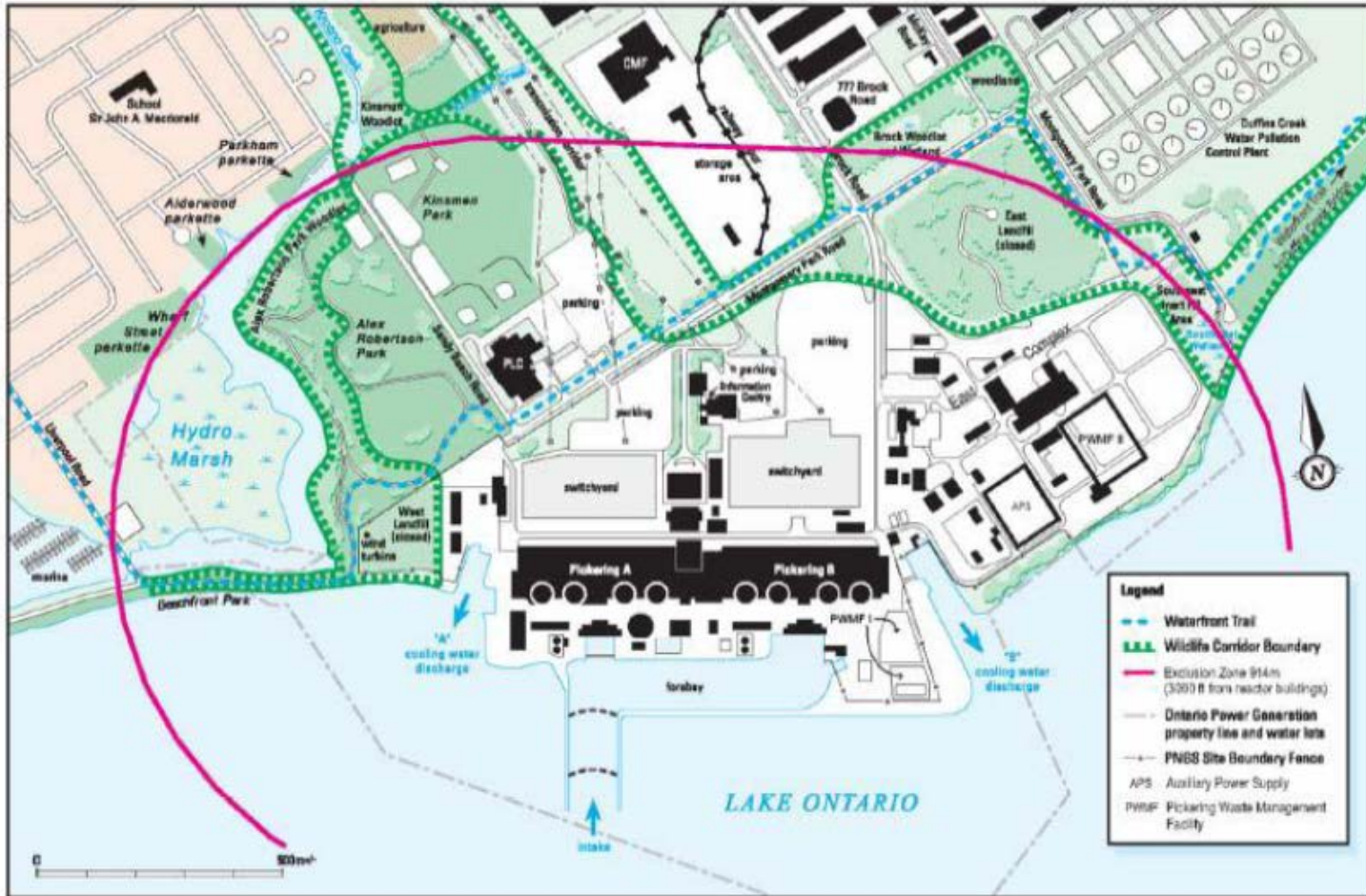


Figure 2-11: Location of PWMF within the Pickering Nuclear Site

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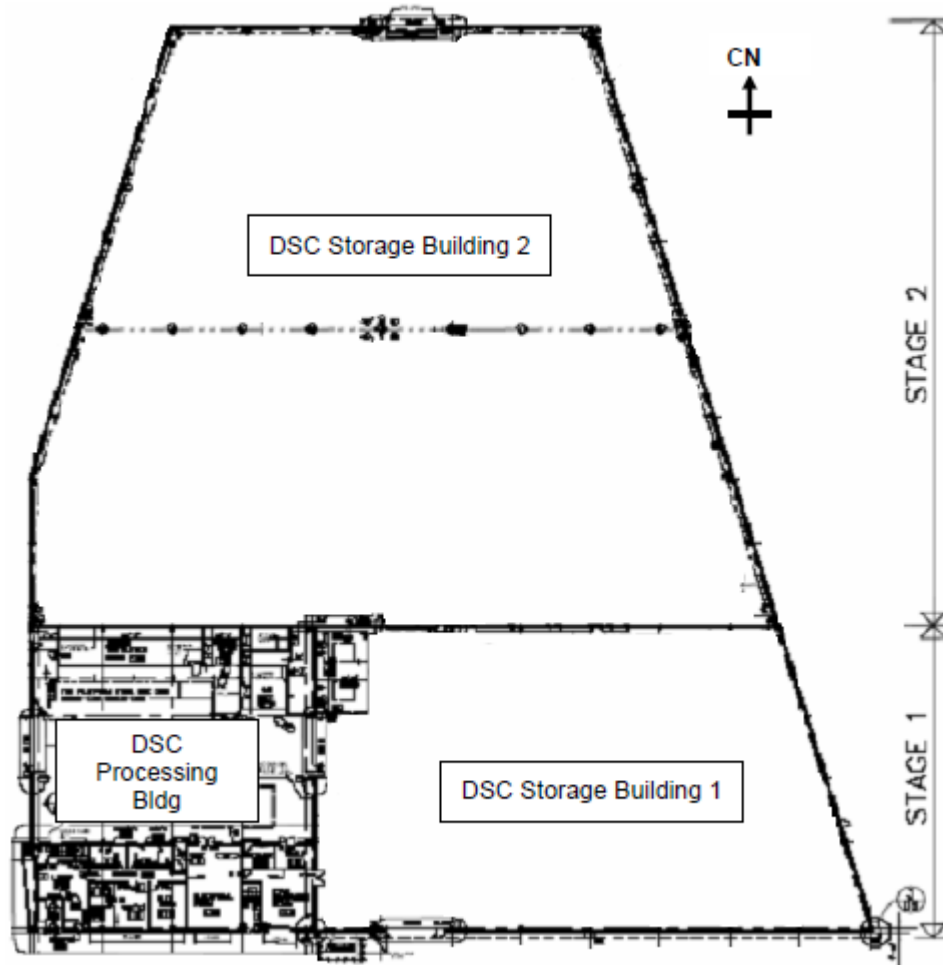


Figure 2-12: Pickering Used Fuel Dry Storage Facility – Phase I Layout

2.2.8.2 Electrical Transmission

Each unit generator has one main output transformer which steps up the voltage from the generator to the level required to deliver it to the bulk electrical power system via the switchyard. The switchyard and transmission lines are owned and maintained by Hydro One Inc. In addition to the main output transformer, each unit also has two step-down transformers housed in the same building. The station service transformer allows electricity to be drawn directly from the grid and the generating service transformer allows generated power to be directed back to the station to meet internal needs [R-20].

During the Stabilization phase the main output transformers and generating system transformers associated with each unit will be taken out of service and placed into a safe state following the shutdown of the reactor units. Select station service transformers and switchyard equipment may remain in operation to supply power to the facility. Any transformers no longer required would be placed in a safe storage state.

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During SWS, the output transformers and the transmission yard will be de-energized and disconnected from PNGS, with the exception of service transformer(s) needed to supply power to the Pickering Nuclear Site. Unused transformers will be drained of oil in accordance with accepted practices and placed in a safe storage state [R-21]. The electrical switchyard will remain after decommissioning of PNGS, in support of the utility's electrical transmission and distribution system [R-15].

2.3 Description of the Surrounding Environment

2.3.1 Natural Environment

The environment in the immediate vicinity of the Pickering Nuclear Site is heavily urbanized and the surrounding areas are dominated by light manufacturing enterprises, repair shops, warehouses and laboratories. The southern portion of the Pickering Nuclear Site is dedicated to power generation while most of the northern portion is vegetated. The vegetated lands are occupied by public parkland, athletic fields and a transmission corridor [R-20].

One swamp thicket area and five marsh areas were identified within and in the vicinity of the Pickering Nuclear Site [R-20]. The eastern end of the site is dominated by an artificial hill covering the abandoned East Landfill. A second abandoned waste landfill is located on the western end of the site. These landfills were closed in 1997 and 1999 and have become a habitat for wildlife.

The area within and surrounding the Pickering Nuclear Site is host to a variety of natural vegetation. The dominant vegetation cover is related to agricultural use, including cash crops and pasture land. Other natural vegetation features are associated with valley lowlands associated with rivers and creeks, and the Lake Ontario shoreline environment. Dominant tree species in the natural forest areas in the vicinity of the Pickering Nuclear Site include: beech, sugar maple, basswood, red maple, white oak and bur oak. Four terrestrial community types were identified in the vicinity of Pickering Nuclear, including deciduous, coniferous, and mixed forest areas, and an open beach/bar [R-20].

A number of small wetlands (wet meadows and shallow marshes) can be found throughout the site, with a larger wetland occupying the north-west corner of the Pickering Nuclear Site boundary. More details about the vegetation are provided in Section 7.1.3.

Most undeveloped areas on the site are covered by grasses or scrub bush. Numerous species of ducks, geese and swans have been observed during waterfowl surveys around Pickering Nuclear Site. Woodland habitat within the Pickering Nuclear Site is used for nesting foraging and roosting by resident and migratory bird species. Small mammals will also use these sites for shelter, foraging and reproduction [R-20]. More details about the wildlife are provided in Section 7.1.4.

2.3.2 Geophysical Environment

2.3.2.1 Soils

The surface deposits beneath the Pickering Nuclear Site are comprised of two layers of dense, clayey glacial till overlying bedrock. The Upper Till is nearly continuous across the site

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except where it was removed during construction. It consists of impervious clay tills with interglacial strata of very dense layered silts, sands and gravel containing water and some accumulations of flammable gas (probably methane) under very low pressure. The Lower Till consists of firm to stiff clayey silt till with random lenses and layers of soft, wet clay and sand.

2.3.2.2 Bedrock

The Pickering Nuclear Site is underlain by Ordovician age sedimentary rocks composed of nearly flat-lying shales and limestones that dip gently (1%) southward, characteristic of the north shore of Lake Ontario. The bedrock surface is encountered at depths of approximately 10 m to 20 m below the surface with localized areas of low bedrock topography. The surface of the bedrock sequence slopes southward from elevations of 68 m above sea level at the north of the site to elevations of approximately 47 m above sea level approximately 1.5 km offshore in Lake Ontario. The projected local dip of the bedrock is southeastward at a generally uniform grade of 1%. The bedrock surface directly beneath the Pickering Nuclear Site, in the vicinity of the units is relatively level, varying between elevations of approximately 58 m to 62 m, with a gentle southward dip of approximately 0.1% to 0.2%.

There is no evidence in the borings and excavations carried out to date of any structural weakness in the rock at the site. No mining activity or withdrawal of fluids under the site has occurred that may affect the foundations of the plant structures. There is no evidence of surface faulting at the site. No evidence of fault offset or discontinuity was found in the investigation borings. There are no zones in the load bearing soil or bedrock that are considered to be unstable [R-17] and [R-18].

2.3.2.3 Groundwater

Regional groundwater flow patterns are largely determined by topography. With high topography to the north at the Oak Ridges Moraine and low topography at Lake Ontario, the regional groundwater flow direction is towards Lake Ontario. Groundwater flow is also directed to the local surface water drainage basins, which also flow to the south and discharge to Lake Ontario.

Groundwater flow in the area local to PNGS generally follows the regional trend, with groundwater generally flowing to the south, with discharge to Lake Ontario. Shallow groundwater flow is directed from the high elevation at the East Landfill radially outward to the south, southwest, and west. The westerly flow component is directed to the Hydro Marsh. The remainder of the shallow groundwater will flow to the south or southwest and discharge into Lake Ontario.

Groundwater flow patterns on the Pickering site are influenced by the significant network of buried structures and utilities present beneath the surface. These include building foundations/slabs, foundation drains, water intake and discharge ducts, soldier pile walls and utility pipelines. Depending on the depth and characteristics of these structures, they impact local groundwater flow patterns by introducing either preferential pathways for groundwater flow (in the case of permeable fill materials), or groundwater barriers (in the case of impermeable structures or fill). Higher rates of groundwater flow are also associated with backfill beneath the building structures, such as the Reactor buildings, Auxiliary Reactor Buildings, and the backfill of the condenser cooling water intake and discharge ducts.

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The most significant or influential subsurface features on site are the foundation drainage systems which collect groundwater seepage from below the powerhouse. These foundation drains represent the lowest hydraulic points in the groundwater flow system and as a result act as a sink for groundwater flow, inducing groundwater flow toward these systems under hydraulic gradients, which would otherwise follow the local flow pattern southerly toward the lake.

The intermediate groundwater flow system is similar to the shallow system. Local influences affecting intermediate groundwater flow include the Turbine Auxiliary Bay drains and Vacuum Building Ramp Sump which create artificial hydraulic sinks similar to those observed in the shallow groundwater system, limiting groundwater flow towards the lake south of the Reactor buildings [R-20].

Due to a limited number of wells located within the deep overburden and bedrock, the deeper groundwater flow systems are less well defined, but generally the flow is towards Lake Ontario with some influence of the Turbine Auxiliary Bay foundation drains [R-20].

Localized areas of elevated tritium concentrations are present in the groundwater located within the protected area of the Pickering site. The sources of these historical releases were identified by previous assessments and subsequently eliminated through procedural and/or operational changes, with steps taken to mitigate the risk of future releases.

Previous Environmental Assessments (EAs) [R-22] indicate that tritium concentrations are not migrating off-site and that no effects result from the tritium in groundwater on biota are likely. The latest groundwater data collected from many of the key areas at PNGS indicate that tritium concentrations have remained constant or decreased. Municipal drinking water samples collected from downstream Water Supply Plants, as part of the annual OPG PNGS Environmental Monitoring Program, were well below the Ontario Drinking Water Quality Standard for tritium of 7,000 Bq/L [R-23]. There were also no indications of adverse off-site impacts from PNGS groundwater. This was also confirmed from the results of the most recent Environmental Risk Assessment for Pickering Nuclear [R-20], which highlights that due to the direction of groundwater flow at the site, there is no exposure pathway between offsite terrestrial biota and groundwater exposed to activities due to the operation of PNGS. Although there is potential for site groundwater to migrate to surface water (Lake Ontario), groundwater flux from the site into Lake Ontario is likely to be small based on the estimated groundwater velocity and influence of site infrastructure; therefore, any Contaminants of Potential Concern in groundwater that reach the lake are subject to considerable dilution before they can migrate with surface water to a point of water intake for human consumption. The nearest water intake at Ajax is approximately 7 km east of the Pickering Nuclear Site and is not at any risk due to constituents in groundwater on the site.

The groundwater monitoring program will continue to track, monitor, and report on the groundwater quality on site.

2.3.2.4 Seismicity

The western Lake Ontario region lies within the tectonically stable interior of the North American continent, which is characterized by low rates of seismicity. Two seismic events with a magnitude of greater than 4 have been recorded within 100 km of the station from

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1900-1991; one centered southeast of St. Catharines in 1954 had a magnitude of 4.1 and the other centered near Hamilton in 1958 had a magnitude of 4.3.

From 1992-2017, 655 events were detected, out of which 9 events had a magnitude greater than 4.0 M and 120 events had a magnitude greater than 2.6. Within an approximated 100 km radius of the Pickering NGS, 72 events were recorded and of these, the highest event magnitude was 3.8 [R-17]. From August 2017 to February 2021 inclusive, there has been an additional 12 seismic events (two of which are man-made seismic events) reported in Ontario of a magnitude greater to or equal to 3.0. The magnitude of these earthquakes range between 3.0 and 4.1, and two of these earthquakes were within a 100-km radius of PNGS [R-24].

2.3.3 Aquatic Environment

The total frontage along the shoreline of Lake Ontario is approximately 2,260 m [R-17]. The shoreline immediately adjacent to the site has been altered by the construction of the common Cooling Water Intake Channel and two Cooling Water Outfall Channels, one on each side of the Pickering Nuclear Site. No natural shoreline remains; all structures are man-made.

2.3.3.1 Drainage

There are no rivers or streams on the Pickering Nuclear Site, but a number of major cold-water streams enter Lake Ontario within 50 km of the site. The two major ones closest to the site are Duffin’s Creek (2.2 km to the east) and the Rouge River (4 km to the west) [R-17], [R-18], [R-19]. The Hydro Marsh and the Frenchman’s Bay Marsh, which is a provincially significant wetland and designated as an Environmentally Sensitive Area by the Toronto and Region Conservation Authority [R-20], are located west of the Pickering Nuclear Site and the Duffin’s Creek Wetland is located east of the site. Drainage in the PNGS site is a mix of ephemeral swales, ditches, culverts and storm sewers. Stormwater runoff from the PNGS site is collected by the stormwater drainage system and directed through drainage pathways south to Lake Ontario [R-20]. Surface drainage from the PNGS site is enabled by 19 separate storm water drainage basins, or catchments [R-25].

2.3.3.2 Fish

More than 90 fish species are known to inhabit Lake Ontario, of which 60 species have been found in impingement, gillnetting and electrofishing studies at the PNGS site and are considered to represent the fish community in its vicinity. The American Eel was identified as a species at risk in the Environmental Risk Assessment [R-20]. As there are no surface water features suitable as fish habitat within the site, the only aquatic habitat and biota are located within Lake Ontario. However, almost all of these species make use of the nearshore waters of the lake for one or more of spawning, rearing, feeding, migration and over-wintering. The major spawning areas near the Pickering Nuclear Site include the Rouge River, Frenchman’s Bay and Duffin Creek [R-17]. The PNGS B discharge channel is used by smallmouth bass as a spawning area [R-25].

Commercial fishing is not a significant industry in the area and its importance is declining. Within a 100 km radius of the Pickering Nuclear Site, there are two Ministry of Natural Resources hatcheries [R-17], [R-18].

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2.3.3.3 Lake Water Levels

Based on measurements of the monthly average water levels of Lake Ontario (i.e., the average levels of the whole lake) from 1918 to 2011, the annual maximum monthly average water levels range from a low of 73.74 m relative to the International Great Lakes Datum (IGLD) (1934) to a high of 75.76 m relative to the IGLD (1952). Lake Ontario water levels have been regulated since the completion of the St. Lawrence Power Project in 1958. The mean Lake Ontario water level from 2004 to 2019 has been 74.63 m (December) – 75.79 m (June) above mean sea level [R-26].

With near-shore water depths of 2 to 2.5 m, the maximum wave run-ups will be approximately 2 m on a riprap shore. As the crest of the protection walls at PNGS exceeds 77.5 m IGLD for much of their length, the probability of flooding due to wave run-up and overtopping is considered low. Periodic wetting during extreme events due to wave spray and splash will occur; however, it is considered unlikely that waves breaking directly over top of the foreshore works will occur. It is also reasonable to assume that the surface drainage system will have adequate capacity to deal with any spray that may occur [R-25].

2.3.4 Current Use of the Adjacent Land

As mentioned in Section 2.1, PNGS is located in the Regional Municipality of Durham, which is one of the largest municipalities in Canada and is also among the fastest growing. The Pickering Nuclear Site is close to residential, industrial, agricultural, technological, recreational, municipal service and transportation lands.

Agriculture has historically been an important component of the local and regional economies, environment and social fabric, and represents the most significant land use throughout most of the northern portions of the City of Pickering and Durham Region. Notwithstanding this agricultural heritage, both the City and the Region have developed an industrial platform with major industries in energy, automotive manufacturing, plastics/packaging, pharmaceuticals, aerospace/defense, chemicals/ rubber and environmental technologies [R-25].

Existing residential as well as other land uses in the vicinity of the site are illustrated in Figure 2-13. This figure is taken from the Regional Municipality of Durham official plan and is used to demonstrate existing land use designations [R-27]. The area bounded by Highway 401 on the north, Duffin Creek on the east, the Pickering Nuclear Site on the south and Sandy Beach Road on the west has been designated for industrial development. The southern boundary of the Pickering Nuclear Site property extends as a water lot into Lake Ontario. The lake is used locally for sport fishing, as well as recreational swimming and boating. The lands and ravines associated with Frenchman's Bay, immediately west of the Pickering site boundary fence, also provide the greatest concentration of recreational amenities in the City of Pickering. In addition, recreational and natural areas are located immediately to the east and north-west of the site, while the residential areas of Bay Ridges and Fairport are located further to the north-west (north of the Alex Robertson Community Park and Frenchman's Bay) [R-17], [R-18].

Lake Ontario provides water supply to the adjacent municipalities, the nearest water supply plant being in Ajax, 4 km to the east. The Duffin Creek Water Pollution Control Plant is located on lands immediately east of the Pickering property. The remaining portions of the Brock Industrial neighbourhood contain a variety of employment uses and vacant land [R-25].

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There is a 914 m radius exclusion zone around the PNGS reactors. Beyond this limit, land uses include recreational, institutional, industrial, commercial and park facilities. In general, land use adjacent to the Pickering Nuclear Site is consistent with industrial and residential development throughout the City.

The Pickering Nuclear Site has been developed since its inception in the early 1960s. The Pickering property is designated as a utility in the Region of Durham Official Plan. The property is zoned Industrial Zone M2. The entire property is fenced and access to the site is restricted and controlled by OPG. Within the PNGS boundaries, existing land uses consist of buildings, structures, switchyards (belonging to Hydro One Inc.) and transportation access required to operate and support the stations' functions. A small site located between the closed Brock Road right-of-way and the Pickering NGS B thermal discharge bay is zoned Public Service Zone M3 [R-25].

The Waterfront Trail, an active recreational path paralleling Lake Ontario across the City of Pickering, with connections to municipalities to the east and west, runs adjacent to the Pickering NGS site boundary fence along Montgomery Park Road, on lands leased to the municipality by OPG [R-25].

The Bay Ridges, West Shore and Rosebank neighbourhoods west of Pickering NGS contain predominately residential and compatible ancillary uses (e.g., schools), with some employment and commercial uses generally along Bayly Street and Liverpool Road [R-25].

After Pickering end-of-commercial operation (ECO), it is recognized that the OPG-owned lands on and adjacent to the PNGS and the PWMF may be subject to changes in use. This may be either as part of OPG's activities to prepare the PNGS for the SWS Stage or as part of OPG's Repurposing Pickering initiative (see Section 3.6).

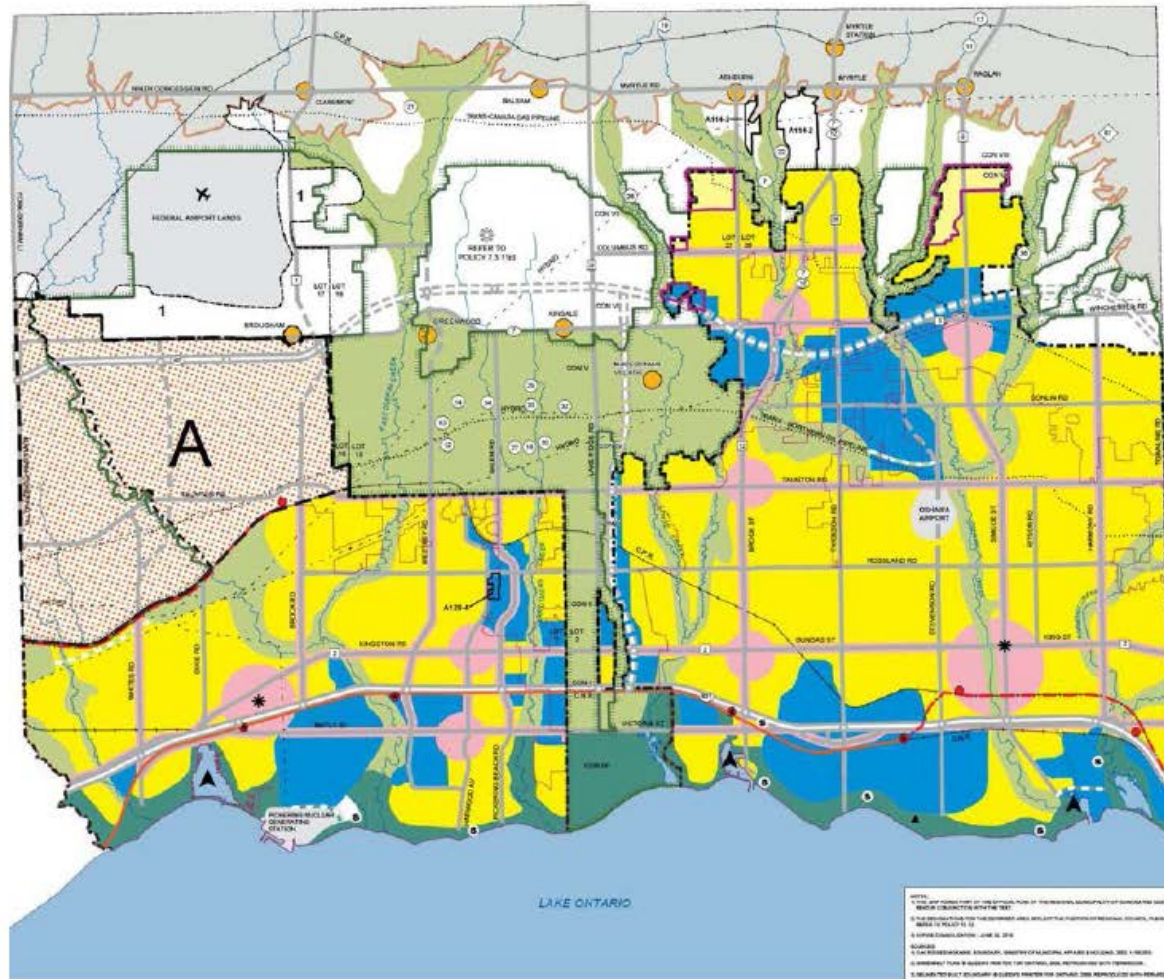
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OFFICIAL PLAN OF THE REGIONAL MUNICIPALITY OF DURHAM

SCHEDULE 'A' - MAP 'A4' REGIONAL STRUCTURE

LEGEND

URBAN SYSTEM

- URBAN AREA BOUNDARY
- URBAN GROWTH CENTRE
- EMPLOYMENT AREAS
- AREAS DEVELOPABLE ON FULL-TIME MUNICIPAL SERVICES
- AREAS DEVELOPABLE ON PRIVATE WELLS & MUNICIPAL SEWER SYSTEMS
- MUNICIPAL SERVICE
- BUILT BOUNDARY
- REGIONAL CENTRE
- REGIONAL CORRIDOR
- EMPLOYMENT AREAS
- AREAS DEVELOPABLE ON MUNICIPAL WATER SYSTEMS & PRIVATE WASTE DISPOSAL SYSTEMS
- AREAS DEVELOPABLE ON PRIVATE WELLS & PRIVATE WASTE DISPOSAL SYSTEMS

RURAL SYSTEM

- PRIME AGRICULTURAL AREAS
- RURAL SETTLEMENTS:
 - HAMLET
 - RURAL EMPLOYMENT AREA (SEE TABLE C1 FOR DESCRIPTION)
 - REGIONAL NODE (SEE SECTION 9C FOR DESCRIPTION)
 - AGGREGATE RESOURCE EXTRACTION AREA (SEE TABLE C1 FOR DESCRIPTION)
 - COUNTRY RESIDENTIAL SUBDIVISION (SEE TABLE C2 FOR DESCRIPTION)
 - SHORELINE RESIDENTIAL

GREENLANDS SYSTEM

- MAJOR OPEN SPACE AREAS
- WATERFRONT AREAS
- ONE RIDGED MORaine BOUNDARY
- TOURIST ACTIVITY/RECREATIONAL NODE
- OPEN SPACE LINKAGE
- ONE RIDGED MORaine AREAS
- ONE RIDGED MORaine AREAS
- ONE RIDGED MORaine BOUNDARY
- WATERFRONT PLACE
- WATERFRONT LINKS

TRANSPORTATION SYSTEM

SEE SCHEDULE C FOR DESIGNATIONS

THE FOLLOWING IS SHOWN SELECTIVELY, FOR CASE OF INTERPRETATION OF OTHER DESIGNATIONS ONLY

EXISTING:	ARTERIAL ROAD	FUTURE:	ARTERIAL ROAD
	FREEWAY		FREEWAY
	INTERCHANGE		INTERCHANGE
	GO RAIL		GO RAIL
	GO STATION		GO STATION

SPECIAL AREAS

- SPECIAL STUDY AREA
- DESIGNED BY MINISTER OF MUNICIPAL AFFAIRS
- SPECIFIC POLICY AREA
- APPEALED TO OMB
- LANDS APPEALED TO OMB, REFER TO POLICY 14.13.7

NOTES:

1. THE CITY OF PICKERING IS THE DESIGNATED PART OF THE REGIONAL MUNICIPALITY OF DURHAM THAT SHALL BE MAJOR JURISDICTION WITHIN THE CITY.
2. THE CITY OF PICKERING IS THE DESIGNATED PART OF THE REGIONAL MUNICIPALITY OF DURHAM THAT SHALL BE MAJOR JURISDICTION WITHIN THE CITY.
3. THE CITY OF PICKERING IS THE DESIGNATED PART OF THE REGIONAL MUNICIPALITY OF DURHAM THAT SHALL BE MAJOR JURISDICTION WITHIN THE CITY.

LEGEND:

- 1. THE CITY OF PICKERING IS THE DESIGNATED PART OF THE REGIONAL MUNICIPALITY OF DURHAM THAT SHALL BE MAJOR JURISDICTION WITHIN THE CITY.
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- 3. THE CITY OF PICKERING IS THE DESIGNATED PART OF THE REGIONAL MUNICIPALITY OF DURHAM THAT SHALL BE MAJOR JURISDICTION WITHIN THE CITY.

Figure 2-13: Land use in the Vicinity of PNGS

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2.3.5 Local Communities

The local and regional areas have experienced strong population and economic growth over the last decade. Detailed population data of the City and the nearby municipalities in 2016 are shown in Table 2-1 [R-25], [R-28].

Table 2-1: Population of Nearby Municipalities

Municipality	Population (2016)
City of Pickering	91,771
Town of Ajax	119,677
Town of Whitby	128,377
City of Oshawa	159,458
Town of Clarington	92,103
Township of Scugog	21,617
Township of Uxbridge	21,176
Greater Toronto Area	5,928,040
Town of Markham	328,966
Town of Richmond Hill	195,022
Town of Newmarket	84,224
Town of Vaughan	306,233
Town of Aurora	55,445
Township of King	24,512
Town of Whitechurch - Stouffville	32,634

The economy in the region of the Pickering Nuclear Site is founded on a diverse manufacturing base. As such, there is a large and mobile labour force, which supports a wide range of industrial, commercial, technological and institutional businesses. The economic base, in turn, is supported by good infrastructure, skilled labour and a solid range of available community amenities and housing. PNGS is a major employer within the region.

2.3.6 Indigenous Communities

There are seven indigenous communities located within 155 km of the Pickering NGS property. First Nations in particular have a relationship with the lands along the north shore of Lake Ontario (from Toronto east to the Bay of Quinte) and north to Lake Simcoe and Rice Lake as a result of their occupation and traditional use of these lands prior to European settlement.

These indigenous communities are listed here, along with their approximate location:

- **Alderville First Nation:** 20 km southeast of Peterborough on south side of Rice Lake.
- **Curve Lake First Nation:** 15 km north of Peterborough on Buckhorn Lake.

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- **Hiawatha First Nation:** 15 km southeast of Peterborough on north side of Rice Lake.
- **Mississaugas of Scugog Island First Nation:** 35 km north of Oshawa on Scugog Island in Lake Scugog.
- **Chippewas of Georgina Island First Nation:** 10 km north of Sutton West on the southern end of Lake Simcoe.
- **Mohawks of the Bay of Quinte:** 35 km east of Belleville.
- **Métis Nation of Ontario, Region 8:** Three community councils, which take in an area between Durham and Guelph.

Although there are no historic Métis settlements in the immediate vicinity of the PNGS property, there are Métis persons residing within the area. These people are represented by the Oshawa and Durham Region Métis council. Overall, Durham has a fast-growing, diverse Indigenous population from across the country [R-25].

2.3.7 Community Relationships

OPG believes in open and transparent communication with the public in a timely manner, in accordance with CNSC REGDOC-3.2.1 [R-7]. As such, OPG regularly and proactively provides information to the public on operations and projects.

OPG’s Corporate Relations manages communications and relationships between the nuclear facilities and the host communities by fostering healthy, open relationships and sustainable partnerships with community stakeholders, including government, media, business leaders, educational institutions, interest groups, and community organizations [R-29]. OPG ensures transparent disclosure of its operations and potential impacts, both positive and negative that may occur as a result of OPG’s operations.

OPG regularly provides milestones and regular waste management updates to key stakeholders. Presentations are regularly made at the Pickering Community Advisory Committee and Durham Nuclear Health Committee. In addition, presentations and informal meetings are held with local elected officials and community leaders a number of times each year to provide updates on performance and other activities taking place both at the station and waste facilities.

In addition to maintaining the Pickering and Darlington Public Information Centres, OPG has a robust online presence and is active in local communities. To provide local residents with information on operations, projects and future endeavors, including Pickering decommissioning, OPG produces a number of communications materials, including Neighbours Newsletter. The OPG corporate website, www.opg.com, provides online access to information, including informational brochures, quarterly performance reports, annual Environmental Monitoring Program reports, educational videos and more. OPG also shares information and responds to inquiries through Twitter, Facebook, LinkedIn and other social media platforms. For operational status

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changes, OPG follows a protocol to notify key community stakeholders in a timely manner by maintaining a duty on-call position 24 hours a day, seven days a week.

The Indigenous Relations Policy, OPG-POL-0027 [R-30], describes OPG's commitment to work with Indigenous communities and peoples, proximate to OPG's present and future operations, and to develop positive and mutually beneficial relationships that will create social and economic benefits through partnership and collaboration. This policy governs OPG's engagement with Indigenous peoples with respect to End of Commercial Operations (ECO) and beyond planning for PNGS.

The Nuclear Public Information and Disclosure Standard, N-STD-AS-0013 [R-31], identifies Indigenous communities and peoples as one of the target audiences, among others, for regular and targeted communication through the Public Information protocol.

The purpose is to work with Indigenous communities and peoples to convey ECO and related plans and activities, elicit feedback and foster opportunities through partnership and collaboration. Indigenous communities proximate to PNGS include Williams Treaties First Nations (specifically Scugog Island, Curve Lake, Hiawatha, and Alderville), Mohawks of the Bay of Quinte and Métis Nation of Ontario Region 8.

OPG is respectful of the fact that PNGS is sited within the traditional and treaty territory of the Williams Treaties First Nations. OPG engages with these identified Indigenous communities on a regular basis to discuss plans such as ECO as well as station operations, environmental reporting, employment/procurement opportunities and other subjects.

OPG's Centre for Canadian Nuclear Sustainability (CCNS) is focused on community and stakeholder communications and relationships specifically related to decommissioning. The CCNS communication program is integrated into OPG's existing public information program and focuses on research and development, innovation and collaboration in decommissioning. It holds meaningful interaction with CCNS partners, committees, Indigenous communities and the broader community through a variety of channels including social media, Neighbours Newsletter, community presentations and events, and collaboration with the Pickering Community Advisory Council. The CCNS also has its own website, www.theccns.com, which provides online access to the general public about CCNS projects and opportunities to engage with the CCNS team.

The CCNS has also launched an Indigenous Advisory Council (IAC) that provides advice and insight to CCNS on how Indigenous communities, organizations and businesses can bring Indigenous values and content into the Centre's mandate. The IAC is comprised of Indigenous individuals and representatives of specific Indigenous organizations within Durham Region and the surrounding area.

Public opinion polling in Durham Region for Pickering station and the PWF waste operations following the Fukushima event showed an increase in the level of support for OPG and nuclear power. This speaks to the strength of the relationships and trust OPG has built up with the community and community leaders. Quantitative and

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qualitative research in Durham two months after the events in Japan point to higher-than-ever perceptions of OPG's station and used fuel operations and nuclear power in Ontario [R-32].

In 2017, OPG conducted a three-day emergency drill at the Pickering Nuclear Site to test the inter-operability of emergency response plans and demonstrate how the participating agencies coordinate the response to a simulated nuclear emergency. OPG also conducts multiple nuclear emergency drills each year at both PNGS and DNGS to test on-site plans and demonstrate proficiency of responders. OPG staff meet with citizens and community groups regularly as part of OPG's social licence, including Community Advisory Council, Durham Nuclear Health Committee, Durham Public-Private Symposium and other venues. Under CNSC's mandate, Potassium Iodide (KI) pills were pre-distributed by OPG to all homes and businesses within a 10 km zone surrounding PNGS and DNGS in 2015, and pills remain available through the preparetobesafe.ca website for qualifying homes and businesses within 50 km of the PNGS and DNGS sites.

2.3.7.1 Indigenous Relations

OPG has a board-level Indigenous Relations Policy [R-30] and active community relations program that focuses on:

- Community relations and outreach;
- Capacity building support with communities;
- Employment/business contracting opportunities; and
- OPG staff education.

Building positive, community-minded relationships with Indigenous communities is important to OPG with respect to current operations and the planning of new projects. OPG recognizes close consultation with community members and leaders is an essential part of the process. OPG continues to engage in active dialogue with Indigenous people on a number of issues and operational decisions related to the nuclear operations. Discussions and information sharing are undertaken to build long-term mutually beneficial working relationships with Indigenous communities near the nuclear host communities and along the radioactive transportation routes.

Nuclear Waste operations is an important issue for Indigenous people. OPG has ongoing discussions and information sharing with Williams Treaty First Nations (Alderville First Nation, Chippewas of Georgina Island First Nation, Curve Lake First Nation, Hiawatha First Nation, and Mississaugas of Scugog Island First Nation) and more detailed discussions with Alderville First Nations, Métis Nation of Ontario and Oshawa and Durham Region Métis Councils. During the recent Pickering licence hearing OPG engaged the Métis Nation of Ontario – Toronto/Durham Councils with an information sharing session, community exchange and tours to discuss station and waste operations. This engagement will continue [R-25].

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2.4 History and Current Status

Construction of PNGS A started in 1966. The first unit (Unit 1) entered commercial service on July 29, 1971 followed by Unit 2 on December 30, 1971, Unit 3 on June 1, 1972 and Unit 4 on June 17, 1973 [R-17].

All four PNGS A units were successfully re-tubed during the Large Scale Fuel Channel Replacement Program conducted between 1984 and 1992. During the course of the re-tubing, it was discovered that some reactor systems had become contaminated with carbon-14 produced from nitrogen-14 in the annulus gas. Some contaminated components were removed from the reactor and transferred to DSMs. These modules are now stored in the PWWF in the south-east corner of the Pickering Nuclear Site.

In 1997, Units 1-4 were shut down and subsequently laid-up. Units 1 and 4 were refurbished and restarted/return to commercial operation in November 2005 and September 2003 respectively. Units 2 and 3 of PNGS A were not refurbished and never restarted since 1997. Both Units 2 and 3 have been defueled and the D₂O in both the moderator and the HTS has been completely drained [R-17]. OPG has placed the two units in SWS and has no plans to restart Units 2 and 3 in the future.

Construction of PNGS B started in 1974. The first unit (Unit 5) entered commercial service on May 10, 1983 followed by Unit 6 on February 1, 1984, Unit 7 on January 1, 1985 and Unit 8 on February 28, 1986. All four PNGS B units have remained in service since the beginning of commercial operations except for maintenance outages [R-18].

3.0 PRELIMINARY DECOMMISSIONING PLAN

3.1 Scope of the Decommissioning Plan

This plan describes the decommissioning of the PNGS. This includes but is not limited to the following:

- The Reactor Buildings;
- The Reactor Auxiliary Bays;
- The Pressure Relief Ducts and the Vacuum Ducts;
- The Vacuum Building;
- The Service Wing and Service Wing Extension Buildings;
- The Irradiated Fuel Storage Bays and the AIFB;
- The Powerhouses including the Turbine Halls and the Turbine Auxiliary Bays;
- The Heavy Water UPP;

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- The East and West Annex Buildings;
- The Administration Building; and
- All other small buildings, aboveground storage tanks, underground storage tanks and structures located inside the protected area.

A full list of buildings that has been considered when developing the cost estimates for decommissioning (as detailed in Section 5.0) is provided in Table 3-1. Refer to Figure 2-3 for the location of buildings. This plan is considered as the Site⁷ PDP as it takes into account the interfaces of the PWMF with the PNGS, as described in Sections 2.2.8. The impact of decommissioning the PNGS may have on the PWMF is further described in Section 4.0, while the details for decommissioning of the PWMF or any buildings associated with the operation of that facility are provided in the PWMF PDP [R-1].

This plan will be revised as appropriate to incorporate any future changes in the scope of the decommissioning.

⁷ Per CSA N294:19 [R-4], a site is defined as: “the immediate area containing the nuclear facility including the exclusion zone (if any) and under the control of the operating organization”.

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Table 3-1: List of Buildings Considered in Cost Estimations for PNGS

Location	Building Name
U1 - U4	
U5 - U8	
1	Service Area / Wing
2	Aux Irradiated Fuel Building
3A/B	Standby Generator Building
4A/B	Standby Generator Oil Pumphouse
5A/B	Screenhouse
6	Vacuum Building
7	Off Gas System Building
8	Water Treatment Building
9	HPECIS Pumphouse
10	HPECIS Auxiliary Services Building
11	Emergency Water & Power System Building
13	Administrative Building
14A-D	Heavy Water / UPP Area
41	Transport & Work Equipment Garage
49	Oil / Chemical Storage Building
50	Service Wing Extension
55	Gas Bottle Storage Enclosure 'B'
57	SDSE Instrument Room 1-2
58	SDSE Instrument Room 3-4
63	Settling Basin
64	Emergency Water & Power Oil Tanks
65	Pickering B Dish Channel Dock
66A&B	Standby Generator Oil Tanks
67	Emergency Coolant Injection Tower

Location	Building Name
68	Demineralized Water Tanks
69	Transformer Buildings
74	Pressure Relief Duct
75	West Annex
77	East Annex
78	Filtered air discharge (FAD) Tower
79	ECI Shield Tower
80-83	Emergency Control Center U5-8
85-86	D ₂ O Upgrading Towers A/B
90-92	Reactor Auxiliary Bay A, Turbine Auxiliary Bay A, Turbine Hall A
93-95	Reactor Auxiliary Bay B, Turbine Auxiliary Bay B, Turbine Hall B
96-97	IFB A & B
98	FAD Building
99	Service Wing Addition
100	Solid Waste Handling Facility
101	Tempering Water Pumphouse
126	Main Security Building
127	Auxiliary Security Building
12	Quality Assurance (QA) Vault
37	Electrical / Pipe Shop
54	Standby Boiler Building
56	Gas Bottle Storage Facility 'A'
73	Training Trailer
109	Operator Training Fac.
179	Reactor Building Service Water (RBSW) Environmental Building

3.2 Objective of the Decommissioning Program

The objective of the decommissioning program is to permanently retire PNGS from service in a manner that will ensure that the health, safety and security of workers, the public and the environment are protected. During the course of decommissioning, radioactive and other hazardous materials will be removed and the site will be restored to meet the radiological release criteria approved by the CNSC. Upon completion of the decommissioning program, the site will be in a condition that will support an application to the CNSC for release from regulatory control. OPG will retain ownership of the site and it will then be available for other OPG uses.

3.3 Decommissioning Phases

According to CSA N294:19 [R-4], decommissioning proceeds according to four distinct phases (see Figure 3-1):

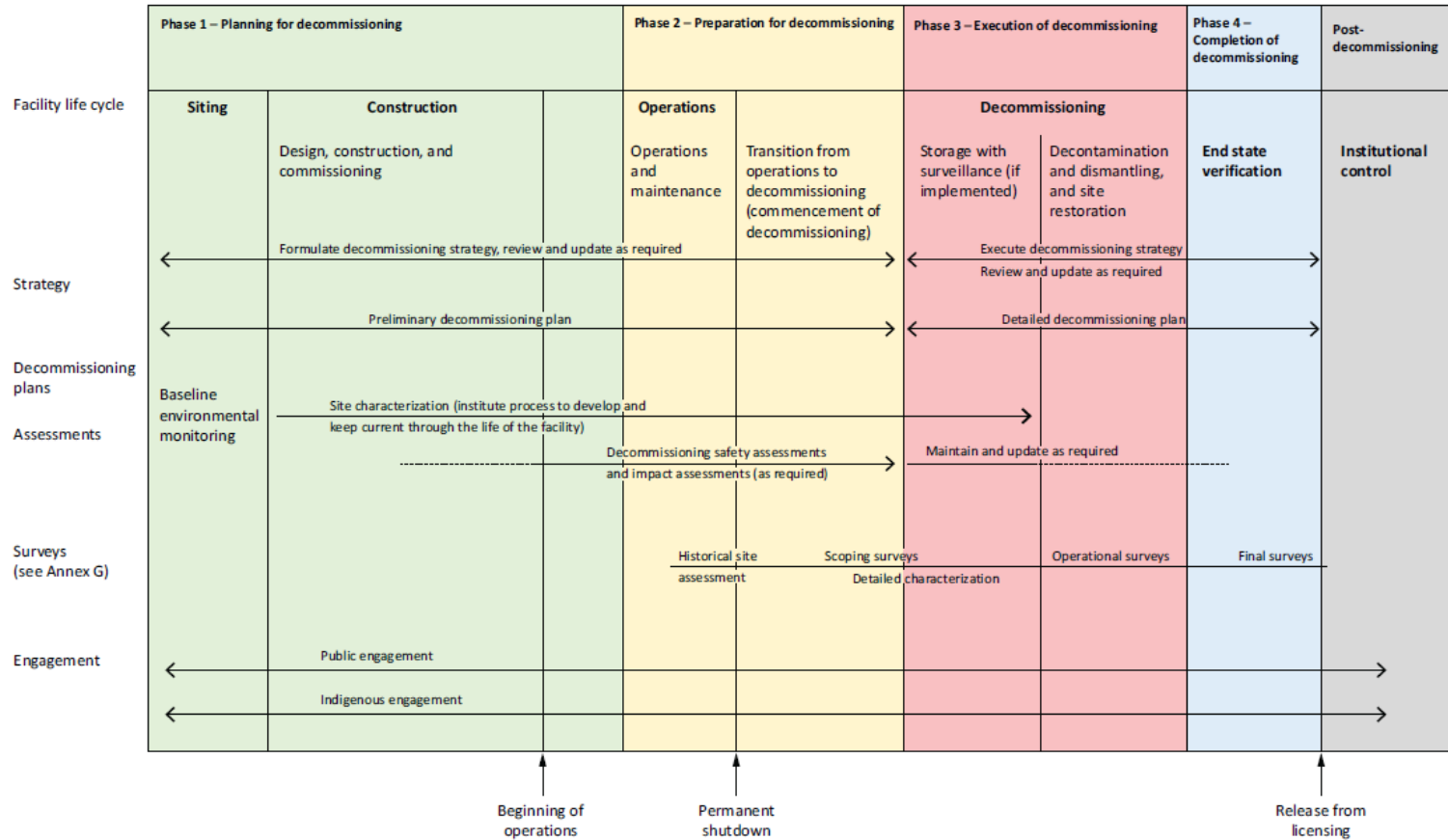
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- (a) **Phase 1, Planning for Decommissioning:** This is carried out throughout the operating life of PNGS and results in the preparation of a decommissioning strategy (Section 3.4) and a PDP (i.e., this document).
- (b) **Phase 2, Preparation for Decommissioning:** Pickering has entered into this phase in February 2010 when OPG announced its decision not to refurbish the nuclear facility. OPG is planning to cease operations of PNGS A and B in 2024 and 2025, respectively. After the units in PNGS are permanently shut down, OPG will defuel and dewater the reactors and make all the necessary modifications to the Structures, Systems and Components (SSCs) to prepare for the subsequent SWS; this phase will end when the units enter into SWS. The PDP will be further developed into a DDP to include details of the activities that would be conducted in the next phase of decommissioning.
- (c) **Phase 3, Execution of Decommissioning:** During this phase, a decommissioning licence will have been received from the CNSC and the DDP that was prepared in Phase 2 will be implemented. The PNGS will have been placed in SWS and will be monitored and maintained as deemed necessary while the radiation levels in the reactor systems decay. For planning purposes, it is assumed that the dismantling of the station will begin after a nominal 30 years of SWS. The activities under this phase also include the execution of the physical works (i.e., decontamination, Dismantling & Demolition of the facility) and site restoration.
- (d) **Phase 4, Completion of Decommissioning:** When Dismantling & Demolition and site restoration activities are completed, final surveys and an end state verification of the site will take place and release from regulatory control will be requested from the CNSC.

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Time interval shown denotes the applicability of the plans and not the time when they are developed

Legend:

- identifies when the activity may be performed
- identifies when an optional activity may be performed if required

Figure 3-1: Phases of Decommissioning [R-4]

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3.4 Decommissioning Strategy

3.4.1 Decommissioning Strategy Adopted by Ontario Power Generation

OPG has chosen a decommissioning strategy that is considered to minimize both the occupational radiation dose to staff and the potential exposure of the public and the environment. It is known as the 'Deferred Decommissioning' strategy.

The main feature that distinguishes the decommissioning of a nuclear station from that of any other large industrial plant is the radiological hazard. At shutdown, major activation radionuclides such as H-3, Fe-55, Fe-59, Ni-63, Ni-59, Nb-95, Zr-93, Zr/Nb-95 and Co-60 will be present in the systems and equipment subject to neutron flux, but also carried to other portions of the systems not subjected to the flux (such as throughout the heat transport and moderator system). Contamination fission products will also be present in the reactor cooling systems from defect fuel and tramp uranium: radioiodines, xenons, Sr-90, Tc-99, Ru-106 and Cs-137 typically. Historically fuel failure rates have been low, however some actinides may be present in the Primary Heat Transport (PHT) from defect fuel particulate and tramp fuel. Whereas the activation radionuclides in the fixed structure of the reactors may be estimated by calculation, the contamination nuclides will need to be measured via sampling and in-situ measurements to complete the inventory.

Co-60, Zr/Nb-95 and Sb-124 are the principal gamma emitters associated with reactor surfaces. Co-60 is usually the dominant contributor to radiation levels during operation and into shutdown. Co-60 is found in activated steel structures (reactor core) and as a corrosion product in nuclear process systems. Co-60 is a strong gamma radiation emitter with a relatively short half-life of 5.3 years and remains the dominant radiological hazard for several decades after shutdown. After about 30 years of decay, the level of Co-60 activity would be reduced by a factor of approximately 60 and its contribution to the radiation fields would also be reduced.

Dismantling the radioactive parts of the stations are considered to be the most challenging and labour and cost intensive activities involved in decommissioning. Hence, reducing the amount of radiation exposure to workers, public and the environment was one of the most important factors considered when OPG was developing the strategy for decommissioning.

Three decommissioning options were considered, consistent with CSA N294:19 [R-4]:

- (a) **Prompt Decommissioning**, where the reactors and station would be decontaminated and dismantled, and the site restored promptly after shutdown.
- (b) **Deferred Decommissioning**, where the reactors and stations would be safely stored for several decades after shutdown to allow radiation levels to decay prior to Dismantling & Demolition and Site Restoration.

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- (c) **In-situ Decommissioning**, where the facility would be placed in a safe and secure condition, in which some or all of the radioactive contaminants will remain in-place, resulting in a waste disposal site.

CSA N294:19 also allows a combination of the above strategies. A combination of options (a) and (b) will result in a phased decommissioning strategy, where decommissioning proceeds according to a sequence of dismantling activities and periods of SWS, according to the prevailing conditions, e.g., resource availability, safety, environmental and stakeholder conditions.

Deferred decommissioning strategy was selected on the basis of decommissioning planning studies that OPG started in the 1980s. This strategy was chosen based on the following considerations and benefits:

- Minimizes dose/radiation exposure to workers consistent with the As Low As Reasonably Achievable (ALARA) principle. This in turn reduces cost of dismantling activities due to substantially lower radiation levels. Reducing the amount of radiation exposure to workers, public and the environment was one of the most important factors considered when OPG was developing the strategy for decommissioning.
- Gives time to implement long-term disposal strategies for used fuel and L&ILW.
- Allows continued growth of the decommissioning fund to help moderate price of power as a result of future expenditures vs. expenditures in the present.
- Lower classification of radioactive waste is achieved through natural radiation decay and the ALARA goal is met. This additionally lowers waste management costs associated with handling, packaging, shielding, transporting and disposing of waste.
- Efficiencies as a result of technological development in the area of decommissioning and nuclear waste management, and benefit from industry decommissioning experience.

Studies performed by OPG showed that the 'Prompt Decommissioning' option would incur higher costs and result in higher occupational dose. The studies also showed that dismantling costs and occupational dose would fall over time, thus favouring the other two options: 'Deferred Decommissioning' and 'In-situ decommissioning'. However, the current post decommissioning plans for the Pickering Nuclear Site are for OPG's re-use, therefore In-situ decommissioning strategy was not considered further. The following subtle strategy modifications to the Prompt Decommissioning option (a) and Deferred Decommissioning option (b) were also evaluated but was not pursued further [R-33]:

- Immediate Dismantling of the Units, Deferred Dismantling of the wet bays after used fuel is transferred; and

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- Deferred Dismantling where dismantling of the unit starts immediately after the removal of all used fuel from the station.

When the three options (a) – (c) described above were compared, it was concluded that Deferred Decommissioning, entailing a SWS period was currently the most suitable option for decommissioning OPG's NGSSs. The duration of the SWS period was determined by balancing the reduced decommissioning cost and occupational dose achieved by allowing the residual activity to decay, against the increased social and economic costs of a longer storage period. OPG has determined that a SWS period of nominally 30 years offers a reasonable time to defer dismantling and the available funding assumes a Deferred Decommissioning strategy for PNGS [R-34]. This decision will be reassessed periodically in light of experience, cost, changing technology and the possible requirement of the site for other purposes.

3.4.2 Stages in Deferred Decommissioning Strategy for PNGS

Applying the 'Deferred Decommissioning' strategy, the PNGS will pass through four distinct stages:

- Preparation for Safe Storage or Stabilization period (also referred to as Phase 2: Preparation for Decommissioning in Section 3.3(b));
- Storage with Surveillance (Part of Phase 3: Execution of Decommissioning, see Section 3.3(c));
- Dismantling & Demolition and Site Restoration (Part of Phase 3: Execution of Decommissioning, see Section 3.3(c)); and
- End State Verification (Part of Phase 4: Completion of Decommissioning, see Section 3.3(d)).

3.4.2.1 Stage 1 – Preparation for Safe Storage

During the Preparation for Safe Storage, OPG will plan and execute the safe transition of the PNGS from its current (electricity generating) state, to a predetermined SSS. This will take place in two sub-stages:

- Planning for SWS – occurs before shutdown. Details of the project planning activities are given in Section 4.1.2.
- Stabilization – execution of activities detailed in the planning phase. Details of the project Stabilization activities are given in Section 4.1.4.

The planning for SWS will consist of activities to ensure that the physical and operational condition of the facility will meet all regulatory and operational requirements while minimizing the operational footprint of the facility to be maintained over the nominal 30-year SWS period. In preparation for scheduled shutdown of PNGS, the design basis and safety analysis appropriate for the transition from

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operations to decommissioning will also be reviewed and modified to reflect plant conditions and the safety concerns consistent with permanent cessation of operations.

Stabilization activities will start following shutdown of PNGS. The reactors will be defueled, and each unit will be dewatered, thereby reducing the radioactivity in the reactor by approximately 99 percent. Following defueling, used fuel transfer operations from the IFBs will resume. All unnecessary SSCs will be placed into an inactive safe state, where they will be removed from the design basis, de-energized, drained of gas or fluids and isolated from operational systems. SSCs supporting continued operations will be reclassified and reconfigured, as required, to meet the operational needs of the SWS period. At the end of the Stabilization, the facility will remain intact with the structures in a safe condition.

3.4.2.2 Stage 2 – Storage with Surveillance

Storage with Surveillance (also referred to as Safe Storage) allows time for the decay of the short-lived fission and activation products that remain in plant components. The specifics of SWS will be outlined in the SSP (refer to Sections 1.1 and 4.1.3). During this period used fuel transfer operations from the IFBs will continue until all the used fuel has been transferred to PVMF. As such there will be two distinct phases of SWS: SSS (pools) when the used fuel are still in the IFBs and SSS (dry) when the IFBs have been emptied of all used fuel.

3.4.2.3 Stage 3 – Dismantling & Demolition

Following SWS, Dismantling & Demolition are scheduled to occur over a nominal 10-year period for each PNGS unit. The first reactor will be dismantled, followed in sequence by the others. Radioactive and other hazardous materials will be removed from the site and transferred to approved disposal facilities.

3.4.2.4 Stage 4 – Site Restoration

During the fourth stage, surveys will be conducted to verify the site meets the release criteria agreed with the CNSC before the remaining buildings and structures are demolished. The site will be restored to a condition suitable for other OPG uses. At the conclusion of this work, OPG will apply to the CNSC for release from regulatory control.

3.4.3 Domestic and International Decommissioning Strategies and Experience

3.4.3.1 Domestic Decommissioning Strategies and Experience

Decommissioning strategies adopted in Canada for nuclear facilities are summarized below.

OPG has successful decommissioning experience at both the Bruce Heavy Water Plant (HWP) and the Spent Solvent Treatment Facility (SSTF), which are both located on the Bruce Nuclear site.

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The Bruce HWP was in continuous operation from April 1973 until March 1998 for the purpose of producing reactor-grade heavy water [R-35]. After it was no longer in operation, the Bruce HWP decommissioning project was carried out in accordance with a DDP, remediation and an EA and follow-up program. Demolition began in October 2004 and was completed in 2006. The buildings were demolished using standard demolition techniques. The debris was removed from the site for recycling or disposal. Bioremediation of oil-contaminated soil in the effluent lagoons was required and began in 2006. About 25% of the soil was bioremediated to below the end-state criteria and was used as clean backfill in the immediate area. Any soil that did not meet the end state criteria was disposed of off-site at a licensed facility. The radiological end state was that no nuclear substances would remain within the HWP facility boundaries and the remaining structures, equipment and grounds were free of significant radiological contamination. In order to demonstrate that this end state criterion was met, a final radiological survey was performed in 2012 using the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) methodology [R-36]. This survey found no radioactive contamination on the HWP site [R-37], [R-38] and a licence to abandon the facility was granted by the CNSC in 2014 [R-39].

From May to December 2018, OPG completed decontamination of all radiologically contaminated piping in the SSTF. As decontamination progressed, each room or section was systematically surveyed and sampled for radiation in accordance with the MARSSIM methodology [R-36]. A Site Survey and Characterization report was prepared and approved by OPG in March 2019. This report concluded that radioactivity levels in the SSTF were below the site unconditional release criteria. The CNSC also concluded that OPG satisfactorily demonstrated that the SSTF was free of any contamination above the regulatory limits [R-40], [R-41] and [R-42]. This resulted in CNSC acceptance of OPG's request to remove the SSTF from licensing control [R-43]. In November 2019, demolition of the above ground structure was completed. Most of the underground infrastructure was removed in February 2020, with the exception of some Bruce Power water lines that remained. Final site grading and remediation was completed in June 2020.

Gentilly-2 Nuclear Power Plant (NPP), owned by Hydro-Québec, was shut down in 2012 and is currently in the SSS for approximately 40 years. Some of the main activities that have taken place from Gentilly-2 shutdown to reactor Stabilization and transition to SWS were [R-44]:

- Placing Gentilly-2 in guaranteed shutdown state;
- Removal of the fuel from the reactor;
- Transfer of resins and tank repairs;
- Emptying and transfer of heavy water;
- Preparations, modifications, removal of systems;
- Construction of infrastructure required for dry storage; and

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- Transfer of fuel from the pool to dry storage (yearly summer campaign on site).

Hydro-Québec was granted (in June 2016) a 10-year power reactor decommissioning licence from the CNSC to continue activities related to the preparation for the decommissioning of Gentilly-2. Under this decommissioning licence, the activities, include but are not limited to the following [R-44]:

- Construction of infrastructure required for dry storage; and
- Continuation of the transfer of fuel from the pool to dry storage (yearly summer campaign on site).

The Point Lepreau NGS, owned by New Brunswick Power (NBP) Corporation, has been operating since it was last refurbished in 2012. Currently, NBP has opted for the deferred decommissioning strategy.

Canadian Nuclear Laboratories (CNL) currently maintains several reactors in SWS including three prototype reactors (Nuclear Power Demonstration (NPD), Douglas Point (DP) and Gentilly-1 (G-1)) and several research reactors (Whiteshell Reactor (WR-1), National Research Experimental (NRX), Multipurpose Applied Physics Lattice Experiment (MAPLE)-1 and MAPLE-2). An eighth reactor, National Research Universal (NRU), is in a permanent shutdown state after ceasing operations in 2018. CNL originally proposed a deferred decommissioning strategy for all of these but changed to In-situ decommissioning for NPD and WR-1. This strategy has been adopted for small reactors in several countries but has generally not been used for a large power reactor. The In-situ decommissioning strategy is usually limited to a small number of facilities in a given country, particularly to remote sites, in order to prevent the proliferation of waste disposal sites [R-45]. In 2019, the CNSC amended CNL's Waste Facility Decommissioning Licence into three separate licences for NPD, DP and G-1. Under these new licences, CNL can proceed with the different decommissioning strategies and timelines for each site [R-46]. CNL is currently planning to proceed with final active decommissioning of nuclear facilities as well as continuing with its planned removal of remaining non-nuclear area facilities at the DP site [R-47], [R-48]. Both the Zero Energy Experimental Pile (ZEEP) reactor and the Pool Test Reactor (PTR) have been completely decommissioned. In addition to the reactors, CNL has been actively decommissioning legacy research and isotope production facilities and other support facilities across its sites.

Within the last 5 years, CNL has accelerated its decommissioning timelines to reduce legacy liabilities and support the larger revitalization effort of its Chalk River campus. CNL applies a graded approach to its decommissioning activities that considers the unique radiological and non-radiological characteristics of facilities. In addition, CNL is considering multiple decommissioning strategies (prompt, deferred, and in-situ) for its portfolio of reactors and research facilities. Below is an update of the decommissioning plans for CNL's eight main reactors:

- At the NPD and WR-1, CNL continues to plan for in-situ disposal of the reactor and remaining systems.

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- At DP and G-1, CNL is advancing the decommissioning of non-reactor components and hazard reduction while planning for the dismantlement of the Calandrias.
- At Chalk River (NRX, NRU, MAPLE-1, and MAPLE-2), decommissioning strategies are being explored to support the revitalization of the site. Where feasible, a prompt decommissioning strategy is preferred to support construction of new Science and Technology research facilities.

OPG has an active decommissioning planning program and maintains links with other utilities on the topic of decommissioning to gain experience on other decommissioning projects.

3.4.3.2 International Decommissioning Strategies and Experience

Decommissioning strategies adopted by the operators of other nuclear facilities around the world vary from Prompt Decommissioning (as referred to as immediate dismantling) to a variety of different Deferred Decommissioning approaches. The choice between Prompt and Deferred Decommissioning is influenced by many factors, as described in several publications prepared by the IAEA [R-49], [R-50] and [R-51].

In summary, some of the reasons to choose Prompt Decommissioning may include:

- Regulatory requirements;
- Government subsidies;
- Costs for maintaining a site in SWS;
- Retention of staff and related expertise;
- Availability of waste disposal facilities;
- Public acceptability;
- Desire for re-use of the sites; and
- Risks related to future uncertainty.

Reasons to choose Deferred Decommissioning may include:

- Reduction in radiation levels during a deferral period that will likely reduce dose to decommissioning workers and the associated cost savings with decreased complexity of the decommissioning due to the likely use of less complex robotic and remote dismantling technologies;
- Unavailability of waste disposal facilities;

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- Unavailability of immediate funding and allows time for growth of the decommissioning fund;
- Continued operation of other reactors on site;
- Continued growth of the decommissioning fund to help moderate price of power as a result of future expenditures versus expenditures in the present; and
- Potential for making use of newly developed technologies and taking advantage of additional operating experience.

A review of international practices in decommissioning [R-52] has indicated that Belgium, Germany, Italy, Spain, France and Switzerland are planning for Prompt Decommissioning, whereas Canada, Netherlands and the United Kingdom are planning for Deferred Decommissioning. Japan, Sweden, Finland and the United States are using both strategies for their reactors with strategy selection dependent upon the site-specific constraints. On average, SWS periods range from a low of 10 years (Japan) to a high of 85 years (United Kingdom) with most nations falling into a 25 to 40 year timeframe.

In the United States, the choice of decommissioning strategy is made by the station owner. Many utilities with multiple units on site choose to delay decommissioning until the final unit has ceased operation. Decommissioning may not occur until 25 to 30 years after the first unit has been shut down. This practice is similar to the OPG strategy. Owners with only one unit tend to start decommissioning within a few years after the end of operation.

Internationally, several small and some full-size power reactors have been successfully decommissioned and the sites made available for other uses. As of December 2019, 186 power reactors worldwide have been permanently shut down. Of these, 7 power reactors had been fully decommissioned, and their licences terminated. Decommissioning strategies for these 7 power reactors were as follows: 3 Deferred Decommissioning, 2 Prompt Decommissioning, 1 In-situ decommissioning and 1 adopted a different decommissioning strategy. Of the remaining 179 power reactors, 63 opted for Deferred Decommissioning, 54 opted for Prompt Decommissioning, 2 opted for In-situ decommissioning, 23 opted for 'Other decommissioning strategy' and 37 had not commenced decommissioning and/or did not have a specified decommissioning strategy [R-53].

These industry experiences indicate that the strategy adopted for the decommissioning of PNGS is technologically feasible and can be completed in a manner that protects the health, safety and security of workers, the public and the environment, consistent with current international practice.

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3.5 Predicted Characteristics of the Pickering Nuclear Generating Stations at Shutdown

As each station is shut down, it will be transitioned from operations to Stabilization (Preparation for Safe Storage), then SWS (Safe Storage), followed by Dismantling & Demolition and subsequent Site Restoration. The actual station condition will be characterized, as required, prior to each stage. However, certain conditions such as the radiological, chemical and physical conditions of the station can already be predicted with sufficient accuracy for preliminary decommissioning planning purposes. A general description of the radiological, chemical and the physical conditions of the stations at the time of shutdown is outlined below and more details can be found in Section 8.0 and in Appendix A.

The radiological condition of the station will depend on both the design and the operating history of the reactor units. Generally, the main sources of radiation at shutdown will be the used fuel resident in the reactors and stored in the IFBs, the activated and contaminated sections of the reactor internals and the components of the PHT and moderator systems. Other sources of radiation can be found in the heavy water used in the PHT coolant and moderator, in fission products in the IFBs, in the ion exchange resin and columns used in purification of the PHT and moderator system fluids and in the fuelling machines.

During operations, routine radiation dose rate and contamination surveys of the accessible, normally frequented areas of the facility are performed at regular intervals. Any loose contamination discovered outside of contamination control areas is removed or the area is re-designated as a contamination control area. In addition, non-routine radiation dose rate and contamination surveys (for exposure control) are carried out whenever abnormal or changed radiological conditions are known or suspected to exist [R-54].

In preparation for the decommissioning of PNGS, a Historical Site Assessment (HSA) has been developed. The HSA used historical information to provide initial area and facility classifications, which would be used in the development of a site characterization plan and for guiding remediation efforts. The HSA described the site physical configuration, identified the radioactive material, designated substances and hazardous constituents that constitute site contamination. In addition, the HSA assessed the potential migration of contaminants, identified contaminated media, identified impacted and non-impacted areas, and classified the impacted areas in accordance with a standard process. The HSA evaluated all structures and areas in the licensed portion of the site. However, since most of the contaminated structures and systems would be removed during the Dismantling & Demolition stage, the HSA focused more heavily on SSCs that would likely remain at the time of final status surveys and on open land areas.

The HSA has also been conducted as a precursor for further site characterization activities in a Radiation Survey and Site Investigation (RSSI) process and will be maintained up to the Dismantling & Demolition stage of decommissioning as per the MARSSIM [R-36].

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As mentioned in Section 4.1.4.4, post-operational/scoping surveys will be performed when the station is shut down. Characterization surveys will also be performed during the Preparation for Safe Storage or during the SWS period, prior to the start of the Dismantling & Demolition stage. The acquired site characterization field data will permit an appropriate assessment of the radiological and conventional hazards that can affect workers, the public and the environment.

The RSSI will use a graded approach for performing a site investigation and has begun by preparing an HSA, and includes various surveys and sampling to assess site radiological conditions. The RSSI will conclude with a final survey (See Section 4.3.7), which is designed to show that residual radioactivity at the site meets regulatory approval, and which ultimately leads to final licence termination after decommissioning is completed.

The results of the radiation dose rate and contamination surveys, together with other information on the radiological hazards and conditions in the facility, are recorded in OPG's electronic database known as the Visual Survey Data System (VSDS). The information in this database will be available for use during the Preparation for Safe Storage, SWS and final preparation of the DDP. Other information on hazards that are discovered are also recorded in this database. A 'Station Condition Record' (SCR) is used to document, evaluate and correct an adverse condition related to personnel performance, procedure, or programs and an adverse condition causing or identified as a result of an event. The SCRs are recorded in an electronic database that will also be available during the preparation for decommissioning.

Pickering NGS also has extensive programs to minimize spills to the environment and to manage those that occur effectively. Spills that may cause an adverse effect are categorized as Category A (major); Category B (moderate) and Category C (minor) and are reported to the Ontario Ministry of the Environment, Conservation and Parks (MECP). From 2013 to 2017, there were no Category A or Category B spills at Pickering. There were 12 Category C spills through that period, involving substances like ethylene glycol, different types of oils, and sewage. The number of these spills has been decreasing due to improved environmental awareness and stricter spill control practices [R-55].

Most of the hazardous materials stored on the site (flammable, cryogenic gases, oxidizers, corrosives, etc.) will be consumed during routine station operations. Some of the remaining materials will be consumed during the shutdown period. Others, such as the fuel oil for the standby generators, can be removed for use at other sites when the systems have been permanently removed from service.

Until the final shutdown of PNGS, OPG will continue to maintain and operate the station SSCs in a manner that will minimize the deterioration of these assets. It is anticipated that these SSCs will be in good working condition at the time of shutdown. Individual component condition assessments will be conducted prior to station shutdown.

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3.6 Repurposing Pickering

OPG is currently undertaking studies to explore future uses of the Pickering site. The intention is to create a long term vision for the site that benefits both the City of Pickering and Province of Ontario and aligns with OPG's strategic objectives.

The company conducted extensive public and stakeholder consultations in 2015 as outlined in the Repurposing Pickering Preliminary Assessment Report. Based on this feedback and additional analysis of opportunities and constraints, it is envisioned that the site will support a combination of generation, industrial and commercial applications post decommissioning.

OPG will carefully assess the range of opportunities to ensure that they work in synergy with the continuing presence of nuclear facilities on site.

3.7 Uncertainty and Degree of Conservatism

There are several elements of risk and uncertainty associated with decommissioning PNGS. Some of the main ones include, but are not limited to the following:

- Planning assumptions;
- Physical, radiological and non-radiological state of the facility;
- Regulatory framework;
- Technical strategy/approach for decommissioning;
- Waste disposition; and
- Stakeholder concerns.

Any risks associated with the planning assumptions supporting this PDP and the associated cost estimates have been identified, documented and are being tracked by OPG. The cost estimate is also based on a well-established methodology and takes into account a risk contingency to address problems that are likely to occur beyond the project scope (i.e., unknown unknowns), as described in Appendix B. To further address uncertainties, relevant OPEX from other sites being decommissioned, industry best practices and the cost estimator's judgement were used for preliminary decommissioning planning.

As mentioned in Section 3.5, characterization surveys will be completed and will be used as input in the development of the DDP. This thorough site characterization based on the MARSSIM approach will reduce the uncertainties associated with execution of decommissioning by addressing the following [R-56]:

- Understanding of the conditions of facility – radiometric, chemo-toxic, biological, physical and structural;
- Defining the amount, location and composition of contaminants (radiological and non-radiological) and the associated physical parameters; and
- Categorizing the SSCs and site areas (including ground water) in contaminated, potentially contaminated and non-contaminated areas as a basis for zoning or implementation of a graded approach for clearance.

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The safety assessment, which will be prepared in conjunction with the DDP (see Section 4.2.4), will take into account all identifiable uncertainties and address them as the decommissioning activities progress. The safety assessment should be conservative though not normally unduly unless this allows the safety assessment to be simplified and gives overall benefit to the decommissioning project. Typical sources of uncertainty as identified in IAEA Safety Guide WS-G-5.2 [R-57] include:

- Source and magnitude of radiological hazards (e.g., inventory characteristics and source terms – location, dimensions, spatial distribution, constituents and quantities);
- Scenarios that could lead to these hazards such as the frequency of occurrence, exposure pathways, assumptions required in support of the calculations of frequencies and consequences, during both normal and accidental conditions;
- Predicted consequences – such as the dose rate and occupational doses; and
- The mathematical models used in the calculation of the effective doses or risks following normal and accident scenarios.

In addition, generic data may be primarily used in the preparation of the preliminary safety assessment. There is also an uncertainty issue arising from the state of the facility during and after the SWS period, in particular the extent to which aging may have compromised the building structures or engineered safety measures, which may affect the safety margins [R-58].

The safety assessment will be reviewed, revised or updated, as required, when additional information becomes available as compared to the earlier phases of the decommissioning project. It is also expected that the uncertainty with regard to radioactive inventory and the condition of the facility may be reduced as decommissioning progresses.

Further details on the uncertainty associated with decommissioning safety assessment are given in [R-57].

In terms of any uncertainty related to the regulatory framework, OPG maintains a good communication protocol with the CNSC and ensures that the PDP meets the regulatory requirements in its licence and Licence Condition Handbook (LCH), as described in Section 1.4 and Appendix C.

This PDP demonstrates that decommissioning is feasible with existing technology. OPG will use OPEX from refurbishment projects to further reduce the uncertainty associated with execution of the decommissioning tasks.

Up until January 2020, the L&ILW Deep Geologic Repository (DGR) has been the long-term disposal strategy for OPG's L&ILW decommissioning waste. The facility was planned to be expanded in 2045 to accommodate the L&ILW generated from

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decommissioning activities. The L&ILW DGR was planned to be in-service for the purpose of receipt of decommissioning waste in 2050. On January 31, 2020, the Saugeen Ojibway Nation (SON) members voted not to support the L&ILW DGR project. Since then, OPG is not proceeding with the DGR at the Bruce site without SON support. Therefore, OPG is working on alternative long-term disposal strategy for L&ILW decommissioning waste as described in 4.4.1.3.

To manage uncertainty related to stakeholder perception for PNGS decommissioning, OPG has extensive public and stakeholder engagement activities, as described in Section 3.6 and 12.0.

To further reduce the uncertainty associated with the decommissioning project, clear endpoints will be defined to accurately determine intermediate progress and develop reliable forecasts to complete remaining activities. This will be set up in the form of optimal selection and use of performance indicators in alignment with best practices recommended by the IAEA [R-59].

It is also expected that the level of uncertainty of knowledge relevant to decommissioning will decrease with maturity of the decommissioning planning [R-56], i.e., as this plan evolves from a PDP to a DDP.

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4.0 DESCRIPTION OF PLANNED DECOMMISSIONING ACTIVITIES

This section describes the major activities that will be performed during the course of the planned decommissioning work at PNGS A & B with respect to each of the four stages described in Section 3.4.2.

The Preparation for Safe Storage stage will begin before shutdown. It is anticipated that three years will be required to complete execution of Stabilization for PNGS A and B once they have been shut down. OPG will prepare and submit a DDP² or a separate SSP to the CNSC approximately two to five years prior to the SWS period as part of OPG's application for a decommissioning licence.

All timing should be considered approximate and used for planning purposes.

PNGS A

The anticipated major project milestones for decommissioning PNGS A are shown in Figure 4-1 [R-15]. More detailed schedules of decommissioning activities will be submitted to the CNSC as part of the DDP.

1. Note: In Figure 4-1⁸, Stage 1 'Preparation for Safe Storage' refers to:
 - Planning for SWS – which occurs before shutdown.
 - Execution of Stabilization – which occurs after shutdown until the units enter SWS.
2. Planning for dismantling will be done during the SWS stage before dismantling starts.
3. Stage 3 in Figure 4-1 combines both Stage 3 (Dismantling & Demolition) and Stage 4 (Site Restoration), as described in Section 3.4.2.

⁸ In both Figure 4-1 and Figure 4-2, Safe Storage is referred to as SWS, which is the terminology that has been used in this document.

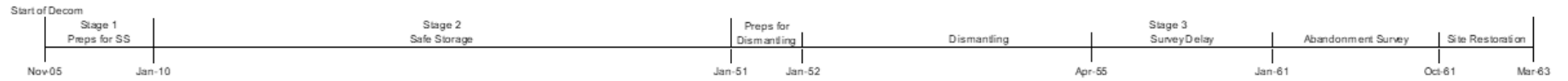
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Pickering A Unit 1



Pickering A Unit 2



Pickering A Unit 3



Pickering A Unit 4



Pickering A Unit 0



Figure 4-1: Planned Project Milestones Related to the Decommissioning of PNGS A

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For planning purposes, the shutdown date for PNGS A Units 1 and 4 is assumed to be 2024.

The SWS stage will begin upon the completion of the preparation work. The duration of the SWS period will be long enough to bring the total time from shutdown to the beginning of the Dismantling & Demolition, Disposal and Site Restoration period to nominally 28 years for Unit 1 and 30 years for Units 4, except Units 2 and 3, which will have been shut down for approximately 50 years.

OPG will prepare and submit an updated DDP for PNGS to the CNSC approximately two to five years, prior to the commencement of Dismantling & Demolition, for acceptance. This revised DDP will include a description of the planned Dismantling & Demolition, and Site Restoration activities, a corresponding schedule and an estimate of the expected costs. It will also address outstanding environmental impacts associated with the proposed decommissioning scenario – see Section 13.0.

The preparation for Dismantling & Demolition is expected to begin in 2050 for Unit 1 and the execution of Dismantling & Demolition work itself is expected to begin in 2051. Work on the other units will begin at intervals of approximately one year. OPG will consider operational experience gained from dismantling the first unit and apply to the other units.

As shown in Figure 4-1, the final survey for Pickering A Units 0, 1 to 4 will be initiated in 2061, corresponding to when the last unit at PNGS B (Unit 8) has been dismantled.

Site restoration of PNGS A will take place from 2061-2063, and is expected to be complete by the year 2063.

PNGS B

The anticipated major project milestones for decommissioning the PNGS B are shown in Figure 4-2⁸ [R-15]. More detailed schedules of decommissioning activities will be submitted to the CNSC as part of the DDP.

Planning for dismantling will be done during the SWS stage before dismantling starts.

Note: Stage 3 in Figure 4-2 combines both Stage 3 (Dismantling & Demolition) and Stage 4 (Site Restoration), as described in Section 3.4.2.

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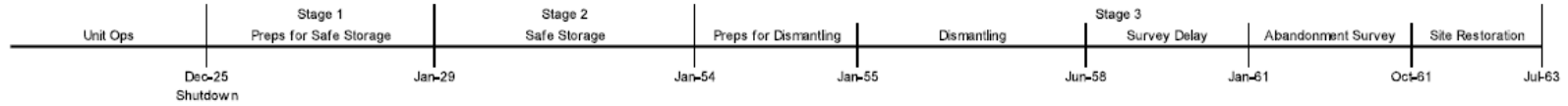
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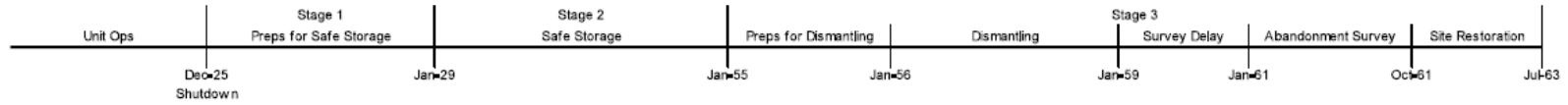
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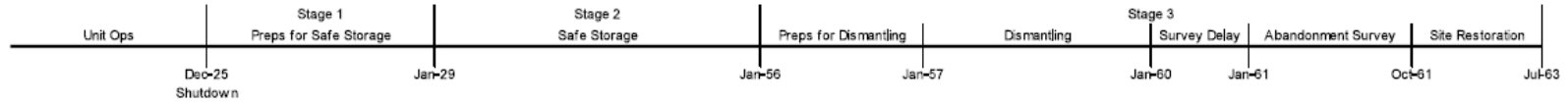
Pickering B Unit 5



Pickering B Unit 6



Pickering B Unit 7



Pickering B Unit 8



Pickering B Unit 0



Figure 4-2: Planned Project Milestones Related to the Decommissioning of PNGS B

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For planning purposes, the shutdown dates for Unit 5 through 8 are assumed to be December 2025.

The SWS stage will begin upon the completion of the preparatory work. The duration of the SWS period will be long enough to bring the total time from shutdown to the beginning of the Dismantling & Demolition period to nominally 30 years for each unit.

It is anticipated that the detailed plans describing the work that will be performed in the Dismantling & Demolition, and Site Restoration period will be submitted in a revised DDP prior to the start of dismantling for CNSC acceptance. The preparation for Dismantling & Demolition, and Site Restoration is expected to begin in 2054 for Unit 5 and the execution of Dismantling & Demolition work itself is expected to begin in 2055. Work on the other units will begin at intervals of approximately one year. OPG will consider operational experience gained from dismantling the first unit and apply to the other units.

As shown in Figure 4-2, the final survey of PNGS will be initiated in 2061 when Unit 8 (the last unit at PNGS) has been dismantled.

Site restoration of PNGS B will take place from 2061-2063, and decommissioning is expected to be complete in 2063.

PWMF

The PWMF will remain in operation after shutdown of the PNGS reactors and is expected to continue receiving, processing, and storing DSCs during Stabilization and SWS, until all the fuel has been removed from the IFBs. The interfacing systems with the PWMF as described in Section 2.2.8 are expected to be impacted as follows during Stabilization and SWS:

- For Electrical Power, since Unit 8 will no longer provide service a new power source (main power and an uninterruptible power supply) will be required for different classes of power provided to the facility.
- The Fire Protection system will remain in service to the facility during both periods.
- The instrument air system will remain fully active throughout Stabilization. As it will not be active during SWS, an alternative system will be needed.
- The domestic (Service) Water will remain fully active during Stabilization. During SWS, it will supply areas as needed and the supply to the Used Fuel Dry Storage Facility will remain open.
- The Active Drainage will remain fully active during Stabilization and SWS to support the PWMF.

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- The sewage drains system will remain fully operational during Stabilization. The domestic sewer system will remain active only in and downstream of areas that are heated and staffed – the PWMF will be operational and as such will still be supported by the sewage drains system.

The interfacing services between PNGS and the PWMF as described in Section 2.2.8 are not expected to be impacted during the Stabilization and SWS periods.

The impact of the shutdown of PNGS on the interfacing systems and services with PWMF will be further assessed in the SSP or the DDP (see Section 1.1). Overall, these systems and services will either be maintained or reconfigured to allow PWMF to continue operating safely after PNGS has been shutdown.

Figure 4-3 shows the overall decommissioning timeline of the stations and the PWMF. Since both the stations and the waste facility will be dismantled concurrently, it is not anticipated that there will be any interferences.

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4.1 Preparation for Safe Storage

4.1.1 Preparation for Safe Storage Project Scope

The Preparation for Safe Storage Project will plan and execute the safe transition of the PNGS from its current (electricity generating) state, to its predetermined SSS. The SSS refers to the physical, operational and administrative state in which the PNGS will be maintained for the nominal 30-year SWS period until dismantling activities commence.

The Preparation for Safe Storage Project goals and objectives include, but are not limited to [R-5]:

- Defuel and removal of heavy water from systems;
- Continue to safely and securely store nuclear substances, such as irradiated fuel and heavy water on site;
- Maintain the facility in a safe and stable condition while creating no new hazards;
- Reduce the footprint of the station in preparation for the next phase of decommissioning; and
- Protect workers, the public and the environment from residual radioactive sources and hazardous materials remaining on site and maintain exposures to ALARA.

4.1.2 SWS Planning Activities

Work to define the SSS has commenced and will continue in the coming years in order to confirm the physical and operational condition of the facility which will meet all regulatory and operational requirements, while minimizing the operational footprint of the facility to be maintained over the nominal 30-year SWS period.

The following Safe Storage Project planning activities have been completed:

- The strategies as well as timeline and resource estimates for major Stabilization activities, such as defueling, dewatering, system end-stating or reconfiguration, and for SWS have been developed.
- A system by system review of the plant through end state determination reports to determine which modifications are required to transition the plant to a SSS was conducted (see Section 4.1.4.3).
- A Predictive Effects Assessment to proactively assess the potential environmental impacts resulting from proposed SWS activities or physical/operational changes to the station was completed [R-21]. The results

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of the assessment have identified environmental monitoring studies and/or mitigation measures required to manage the predicted effects. There are plans for reviews and potential revision to the Predictive Effects Assessment in the near future.

Project planning activities which are currently underway include:

- Confirming the regulatory and system drivers that will determine the operational demands during the SWS period.
- Reviewing and revising programs that are in place during operations to ensure that requirements for the remaining stages of decommissioning are met. Examples include, but are not limited to, environmental monitoring, radiation protection, emergency response, and fire protection. The plans and protocols, developed during the detailed planning stage, for monitoring the following would be submitted to the CNSC for acceptance and implemented during the SWS period:
 - work hazards during decommissioning;
 - personnel dosimetry;
 - environmental emissions and effluents; and
 - materials, sites and structures to be cleared from regulatory control.
- Completing engineering designs to meet SWS requirements, such as the alternative means for supplying and distributing adequate heating and ventilation, electrical supplies or service water to the station in the SSS.
- Developing a safety assessment framework to manage the nuclear and reactor safety aspects of Stabilization activities.
- Engaging stakeholders, including the public, in SWS planning activities.

In support of the Preparation for Safe Storage Project, a safety assessment will also be completed, including controls and approvals, to facilitate the shutdown and Stabilization of the station. The objectives for the safety assessment will [R-5]:

- a) Demonstrate that applicable regulatory requirements are met throughout Stabilization.
- b) Demonstrate through systematic hazard analyses that the risks posed by hazards due to both Stabilization activities and for accident conditions are understood and managed.
- c) Identify necessary mitigating measures, limit controls and conditions to meet safety criteria throughout Stabilization.
- d) Quantify the hazard reduction to be achieved through Stabilization activities.

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4.1.3 Regulatory Submissions

As noted in Section 1.1, the SAP and SOP will be prepared and submitted to the CNSC prior to entering into the SWS period, per the agreed upon protocol for managing the ECO as outlined in the LCH for the PNGS [R-60]. In addition, a DDP² will be prepared and submitted to the CNSC with the application for a decommissioning licence.

The SOP describes the arrangements and activities that ensure safe and reliable operation of PNGS to the ECO. The SOP covers the period starting 5 years prior to the final shutdown of the first of the six operating units and ending with the final shutdown of the last operating unit. The SOP provides confidence that as PNGS approaches ECO:

- Nuclear safety is assured such that plant personnel, the public and the environment are protected;
- Systems, structures and components at the plant continue to be fit for service until its end of service life;
- Staff are qualified and competent to operate the plant, including sufficient staffing numbers;
- Impacts of plant operation to the public, workers, and the environment will continue to be of low risk and adequately mitigated, while continuing to provide the various societal and environmental benefits of plant operation;
- Transparency and appropriate public and indigenous engagements and consultations will continue;
- End of Commercial Operation is structured to align with OPG's Nuclear Management System governance framework; and
- Planning is integrated to ensure consistency in the transition from commercial operation to the next phases.

The SAP [R-5] describes at a high level, the plan for managing arrangements and activities that will be conducted in support of the shutdown and Stabilization of PNGS across all 14 Safety and Control Areas (SCAs) of the licence. The purpose of the SAP is to ensure the safe transition of the facility from its guaranteed shutdown state to its SSS [R-5]. The SAP is intended to be a living document, evolving with time and increasing in scope and definition with future submissions as planning progresses.

The DDP² will outline OPG's plan for the continued safe operation and management of the facility over the SWS period, covering all applicable SCAs of the licence and include information on the physical, operational and administrative state of the facility in the SWS period. This DDP will be prepared to meet the applicable requirements of

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CSA N294:19 [R-4] and it will be organized to address the various stages of the decommissioning (Section 3.4.2). During the upcoming stages of decommissioning (i.e., 3.4.2(a) and (b)), the DDP will address the following in detail:

- SSS (Pools), i.e., when the fuel is still in the IFBs; and
- SSS (dry), i.e., when the fuel has been transferred to dry storage.

Future stages of decommissioning (i.e., 3.4.2(c) and (d)) will also be addressed conceptually. The DDP will later be revised to provide additional details in preparation for, and execution of, Dismantling and Demolition and Site Restoration (see Section 4.2.4).

4.1.4 Stabilization

The transition, or Stabilization of the station, will commence immediately following the ECO and be complete once the physical, operational and administrative transition to the SSS is confirmed.

The Stabilization activities that will be undertaken as part of the Safe Storage Project will be carried out under the existing Power Reactor Operating Licence and can be performed with currently available technology. It is estimated that the transition of the station will take approximately 3 years to complete following the shutdown of the last unit.

OPG has a process for organizational change such as that documented in OPG-PROC-0166, Organization Design Change [R-61] and that will be followed to ensure capable and competent staff will remain at Pickering through the Preparation for Safe Storage, SWS, and the Dismantling phase. The change management plan, and the resulting organizational strategy, will encompass Nuclear and centre-led business units and divisions that directly support Pickering operations and confirm accountabilities are clearly defined as the organization transitions from operations to the decommissioning phases. The plan will utilize benchmarking to capture best practices from industry to be utilized within OPG.

The Stabilization of the station will include physical changes to the plant, resulting from end-stating activities, as well as personnel and programmatic changes to how the plant is organized and managed.

Some of the key Stabilization activities are outlined in the subsections below. At the end of Stabilization, an interim end state report including the End State Declaration reports for Stabilization (see Section 4.1.4.3) will be produced and submitted to the CNSC to document the work that was executed. Any repurposing activities inside the protected area implemented after shutdown will not negatively impact decommissioning activities.

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4.1.4.1 Defueling

The first step to reducing hazards and placing each unit into its SSS will be reactor defueling. Defueling will be completed by plant personnel as efficiently as possible to achieve a guaranteed defueled state using conventional defueling practices (utilizing existing fuelling machines). All fuel removed from the units will be transferred to their respective IFBs for storage and monitoring. Thereafter, the fuel handling systems that are no longer required will be end stated.

The defueling schedule currently planned for PNGS Units A and B is shown in Table 4-1.

Table 4-1: PNGS A and B Planned Defueling Schedule

PNGS Unit	Unit Shutdown / Breaker Open	Target Start Date	Target Finish Date
Unit 1	September 30, 2024	October 10, 2024	March 27, 2025
Unit 4	December 31, 2024	January 10, 2025	June 19, 2025
Unit 5	January 1, 2026	July 1, 2026	December 10, 2026
Unit 6	January 1, 2026	January 12, 2026	June 19, 2026
Unit 7	January 1, 2026	July 1, 2026	December 10, 2026
Unit 8	January 1, 2026	January 12, 2026	June 19, 2026

4.1.4.2 Dewatering

Following the completion of defueling activities, each unit will be dewatered of heavy water. The moderator system will be drained, followed by a light water flush of the moderator heat exchangers and air drying of the calandria to reduce residual contamination. The heat transport system will be drained to Very Low Level Drain State (VLLDS) and then bulk vacuum dried.

The D₂O dewatering strategy shown in Figure 4-4 [R-62], is based on the shutdown dates and defueling schedule shown in Table 4-1.

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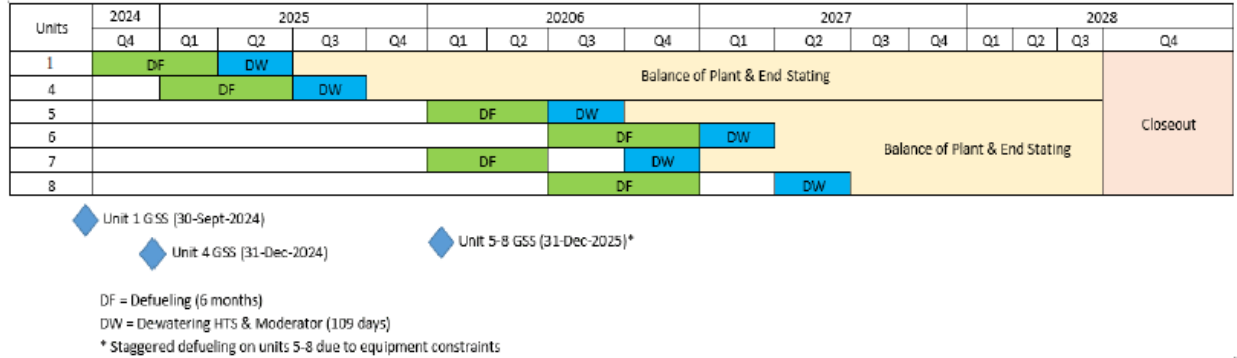


Figure 4-4: PNGS Defueling & Dewatering Timeline

The target completion date for the overall dewatering campaign is mid of 2027. Based on Gentilly-2 OPEX, dewatering all units by mid 2027 is a credible goal [R-62].

A detailed dewatering time study depicting various dewatering sequence options has been developed to optimize and identify potential bottlenecks and/or opportunities in order to streamline the dewatering process [R-63]. Several OPEX reports have been prepared for dewatering the PHT and the moderator systems [R-64], [R-65], [R-66].

Approximately 3700 Mg to 4000 Mg of D₂O is expected to require storage once PNGS shuts down.

Heavy water removed from the reactor systems will be initially stored on site in suitable long-term storage tanks and may then be transferred to a suitable storage facility.

There has been a significant amount of work done to date to determine the best options for Pickering D₂O storage [R-67], [R-68], [R-69]. It is currently planned that some of the heavy water released from PNGS will be stored on site in the following:

- Storage and Inventory tanks;
- Helium Storage tanks;
- Upgrading Plant (UPP) storage tanks; and
- Pickering Incoming Outgoing Tritiated D₂O Transfer System (PIOTS) tanks.

Approximately 1500 Mg of heavy water released from PNGS will be transferred to the planned DNGS Heavy Water Management Building West Annex.

Heavy water removed from PNGS units upon shut down will not be detritiated prior to being placed in interim storage. After interim storage, the heavy water removed from PNGS will be transferred to long-term management.

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4.1.4.3 End State of Stabilization Activities

As Stabilization activities progress, all contaminated and non-contaminated systems that are no longer required to support the operation of the station will be placed into an inactive safe state. That is, they will be de-energized, drained of gas or fluids and isolated from operational systems. Contaminated systems will be decontaminated as required for future maintenance and inspection.

Systems that will remain necessary to support continued operation in the SSS will be constructed, modified or left as is, as required to meet the SWS operational demands. A high-level overview of the anticipated system demands in the SWS phase is outlined in Section 4.2.

The operational requirements for each individual system (or groups of related systems) have been identified and are documented in the Safe Storage End State Determination Reports (ESDRs). In the case of active (or partially active) systems, ESDRs describe the role of each system in meeting the SWS design basis. Alternatively, for inactive systems, ESDRs provide justification as to why the system is no longer required to operate in the SSS. Collectively, ESDRs outline, in detail, the physical and operational footprint of the facility in the SSS. The ESDRs also define the periodic monitoring requirements for these systems.

Appendix D provides a sample of the ESDRs for some of the PNGS' systems. These ESDRs will be further revised once detailed design is completed. The plant systems determined not necessary to support decommissioning operations will be de-energized and drained of fluids, principally water. This activity will also include sluicing resins and flushing tanks. The purpose of this activity is to eliminate mobile sources of contamination or means of transporting contamination, eliminate damage caused by freezing or leaking water-filled systems, and to reduce industrial safety hazards (electric shock). The balance of Plant systems will be reconfigured to support removal of redundant equipment from service.

Final end state declaration(s) for Stabilization will be prepared to complete the documentation to describe the as-left Safe Storage configuration. The station end state will be declared when all the systems at PNGS achieve the conditions prescribed in the End State Declaration reports for Stabilization [R-70].

4.1.4.4 Radiation Surveys and Decontamination

Detailed post-operational/scoping surveys will be conducted after PNGS is shut down and that will be used as input for preparation of the DDP. Radiation surveys will also continue to be performed throughout the Stabilization period to facilitate dose control and the requirements of the Radiation Protection Program [R-54]. Loose and/or fixed contamination will be removed, as required, from areas of the plant which would be accessed by personnel. Contaminated equipment located in accessible areas may be removed for decontamination or disposal, if appropriate.

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Any radiation devices not required during SWS will be removed for use at another licensed facility or packaged and shipped for disposal at an approved facility.

After reactor shutdown and as part of the Preparation for Safe Storage, the PHT system will not be chemically decontaminated.

The secondary side demineralized water will be sampled to confirm that the non-radiological contaminants in the water are within the Derived Release Limits (DRLs) and discharged (as appropriate) through the inactive drainage, using similar procedures adopted during outages.

4.1.4.5 Hazardous Material

In general, transient hazardous wastes will be removed as a result of Stabilization activities. Stabilization activities will include:

- Draining lubricants, coolants and other chemicals from inactive station systems, including above and below ground storage tanks and/or sumps.
- Removing from the site hazardous chemicals or compressed chemical gases that are no longer required.

Pre-approved pathways for hazardous material removal or disposal will be utilized for all Stabilization activities.

4.1.4.6 Site Characterization

OPG will perform a limited site characterization of the plant and the licensed site during the Preparation for Safe Storage to investigate the amount (if any) of contamination present on the PNGS site and to identify the decontamination necessary to reduce occupational exposure for facility maintenance during the SWS period. Characterization of the radioactive contamination remaining in the station will be performed based on the results of the radiation and contamination surveys (see Section 4.1.4.4) and the existing historic information (see Section 3.5). The results of these surveys will be recorded and eventually be used when preparing the work plans for the DDP (Section 4.2.4) that will be submitted for approval to the CNSC prior to Dismantling & Demolition.

4.1.4.7 Other Activities during Stabilization

Upgrades will be done to the existing standby boiler to improve reliability. The standby boiler will be used to augment station heating needs while permanent electric heaters are installed to provide heat to areas for short term use during the Preparation for Safe Storage. New local electric heaters will be installed and existing steam heater coils will be replaced with electric coils for long term heating. Provision will also be made for electric heaters for short term use during the Preparation for Safe Storage. Ventilation modifications will be made to ensure uniform building heating.

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By the end of Stabilization, sufficient building heating and ventilation will be provided to all required areas of the station.

Contaminated filter elements and resin beds not required for processing wastes from decontamination activities will be disposed of.

Lighting and alarm systems whose continued use is required will be prepared. Consistent with any code requirements portions of fire protection, electric power, and heating, ventilation and air-conditioning (HVAC) systems, whose continued use is not required, will be de-energized and/or secured.

Physical barriers will be erected and/or all access to radioactive or contaminated areas will be secured, except as required for controlled access, i.e., inspection and maintenance. Warning signs will be posted as appropriate.

Security and surveillance monitoring equipment will be installed.

4.2 Storage with Surveillance

The facility will be maintained in a safe and secure state over the SWS period to allow for the decay of residual activation and fission products that remain in the station's systems prior to commencing Dismantling & Demolition activities. For planning purposes, it is assumed that the SWS period will last for nominally 30 years from shutdown for each unit with the exception of Units 2 and 3, which were permanently shut down in 1997 and subsequently placed into a SSS in 2010, where they will remain in SWS for approximately 40 additional years prior to decommissioning.

In order to reduce the operational footprint of the station for the SWS period, SSCs no longer required to support regulatory or system requirements will be placed into an inactive safe state, that is, they will be removed from the design basis, de-energized, drained of gas or fluids and isolated from operational systems. SSCs that remain necessary to support continued operations (i.e., in active safe state) to meet operational demands will be modified or reconfigured, as required, during Stabilization. Based on the planning efforts to date, systems required to satisfy operational and regulatory requirements in the SWS period include [R-5]:

- IFBs (including sufficient cooling, purification, monitoring equipment, Emergency Mitigating Equipment⁹ and the means to continue to transfer spent fuel to dry fuel storage containers);
- The PWMF, including the ability to continue to receive, package, process and store DSCs containing spent fuel (Note: The PWMF is included here for completeness, however it is not included in the scope of the PNGS PDP – See Section 2.2.8);

⁹ Emergency Mitigating Equipment or other equivalent equipment will be available to provide fuel cooling in the bays in case of Beyond Design Basis Events.

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- Select heavy water storage tanks located at various locations across the facility, potentially including the D₂O UPP storage and feed tanks, helium storage tanks, PIOTS tanks, Supply and Inventory tanks and additional tanks, as required for storing the tritiated heavy water (see Section 4.1.4.2);
- IFB operations support (e.g., spent resin storage and handling systems);
- Environmental monitoring equipment for intermittent (or continuous) monitoring of selected atmospheric and liquid emission streams;
- Active and inactive drainage systems, including the means to collect, store, treat and discharge liquid waste streams;
- Heating and ventilation systems to maintain minimum temperatures in all in-service (or partially in-service) areas of the facility, as required;
- Radiation monitoring equipment;
- Select fire protection equipment;
- Security systems;
- Auxiliary systems that will be required to support the above noted operational systems including, but not limited to, power (including back-up power) supplies, air supplies, service water, domestic water and demineralized water supplies;
- L&ILW management systems, including the means to collect, store, package, and ship L&ILW generated on site; and
- An (alternative) central monitoring and control station.

Essential facilities will have necessary heating and lighting during the SWS period.

Activities during SWS will include security, preventive and corrective maintenance on security systems, area lighting, general building maintenance, fire protection, heating and ventilation of buildings, routine radiological inspections of contaminated structures, maintenance of structural integrity, and a site environmental and radiation monitoring program.

Equipment maintenance, inspection activities, and routine service are performed by resident maintenance personnel. This work force will maintain the structures in a safe condition, provide adequate lighting, heating, and ventilation, and perform periodic preventive maintenance on essential site equipment.

Administratively, programs that will continue to support station operations, organized by Safety and Control Areas, will include:

- Management System;

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- Human performance management, including training;
- Operating performance;
- Safety Analysis;
- Physical Design;
- Fitness for Service (including aging management and preventative maintenance programs);
- Radiation protection;
- Conventional health and safety programs;
- Environmental protection and environmental monitoring;
- Emergency management and fire protection;
- Waste management;
- Security;
- Safeguards and non-proliferation; and
- Packaging and transport.

Other matters of regulatory interest such as that stipulated in CNSC REG-DOC-1.1.3 [R-71] will continue to be addressed during the SWS:

- Reporting that meets the requirements of CNSC REGDOC-3.1.1 [R-72];
- Public and Indigenous engagement that meets the requirements of CNSC REGDOC-3.2.1 [R-7] and CNSC REGDOC-3.2.2 [R-8], respectively; and
- Financial guarantee that meets the requirements of CNSC REGDOC-3.3.1 [R-73] (which supersedes G-206 the CNSC Regulatory Guide [R-6]).

In all cases, the programs and procedures will be adapted to meet regulatory requirements, while remaining commensurate with the complexity and risks of the SWS operations and any revisions to these programs and procedures will require acceptance by the CNSC, where applicable.

Activities involved in removing intermediate level operational waste generated prior to the stations entering SWS will also continue into the SWS period. Contaminated waste generated from periodic surveys, inspections and maintenance activities at PNGS during SWS will be processed at Western Waste Management Facility (WWMF)

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until it is shut down. OPG will also maintain the IFBs and associated systems while the fuel remains in the bays, up until the fuel is transferred to dry storage.

During the SWS phase, access to contaminated areas will be secured to provide controlled access for inspection and maintenance. OPG will perform continuous monitoring and surveillance of the facility to ensure that worker and public safety is maintained and to ensure that potential adverse releases of radioactive material to the environment are controlled and prevented.

The SSP (see Section 4.1.3) will be implemented during the SWS period to ensure that:

- The station remains safe.
- Any release of materials to the environment is controlled.
- Inadvertent entry of unauthorized persons in the facility is prevented.
- Any biological hazards, that may result from any animals, plants, fungi or their detritus in the building or from the growth of moulds on exposed surfaces that may appear over time, are mitigated.

The radiological monitoring and survey plans approved by the CNSC (see Section 4.1.2) will also be implemented during the SWS.

An effluent monitoring program, consistent with CSA N288.5 [R-74], will be carried out during the SWS period to ensure any radiological and non-radiological emissions to the environment are controlled and monitored. Appropriate emergency procedures will be established and initiated for releases that could exceed prescribed limits. An environmental monitoring program, consistent with CSA N288.4 [R-75], will be maintained and will constitute an abbreviated version of the program in effect during normal plant operations. A small plant staff will be maintained during this period to support the maintenance, inspection, and monitoring/surveillance programs.

Routine radiological monitoring of contaminated structures and systems will also be performed. Procedures for responding to unanticipated changes in the radiological environment of the site and potential releases to the environment will be prepared and implemented, if required.

Security during SWS is limited to access control and is expected to be minimal. Security during the SWS period will be maintained primarily to prevent unauthorized entry due to the presence of spent fuel on the site. Once all the spent fuel is in DSCs, there will be a case for reducing the security presence on site. Security will be provided by the security fence, sensors, alarms, surveillance equipment, etc., which will be maintained in good condition for the duration of this period. Fire and radiation alarms are also to be monitored and maintained. A small plant staff will be available during this period to support the maintenance, inspection and surveillance programs.

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4.2.1 Used Fuel Transfer Operations

The used fuel transfer operations will continue during Preparation for Safe Storage and extend into the SWS period.

Fuel will be transferred to dry fuel storage at the end of the cooling period and stored in DSCs at the PVMF, which will remain in operation during SSS (dry). Consequently, the IFBs will remain in operation through the first part of the SWS period until all the used fuel has been transferred to the PVMF. The defected fuel is planned to be removed last from the fuel bays.

In order to comply with CNSC and IAEA requirements, safeguard arrangements will be maintained until all of the used fuel has been removed from the IFBs.

A used fuel long-term disposal facility (i.e., APM) will be available no earlier than 2043. Since PNGS will be shut down prior to the in-service date of this long-term disposal facility, used fuel will be emptied from their wet bays into DSCs and transferred to interim storage at the PVMF.

Once all waste has been removed from the IFBs, the following will be carried out:

- Conduct surveys to confirm that no fuel particles remain in the IFBs if fuel particles are found, the water will be treated to remove such particles;
- Collect samples of the IFB water and analyze it to confirm that it meets the radiological and chemical clearance levels that have been established;
- Drain the IFBs and dispose of the water in accordance with the applicable regulatory requirements;
- Remove ion exchange resins for disposal;
- Survey and decontaminate the surfaces of the IFBs;
- Mitigate any remaining hazards to workers through the erection of barriers and posting of warning signs;
- Perform a site characterization survey of the empty fuel bays and surrounding areas to confirm safe state;
- Secure the IFBs for the remainder of the storage period; and
- Shut down and remove the safeguard monitoring equipment.

By the end of the SWS period, all used fuel is assumed to have been removed from the site to the used fuel disposal facility. Once used fuel is removed from the DSCs, the DSCs will be decontaminated (to the extent possible ensuring regulatory clearance levels are met) and free released or disposed of as radioactive waste.

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4.2.2 Planning for Dismantling & Demolition and Site Restoration

Towards the end of the SWS period, OPG will make detailed preparations for the dismantling of the remaining systems, structures, and the disposal of the waste. The DDP will be revised and submitted to the CNSC for acceptance (see also Section 4.2.4). The end-state objectives for decommissioning will be developed to the guidance in CSA N294 Annex F [R-4]. A plan will be developed for the orderly progression from SWS to Dismantling & Demolition operations, including staff augmentation and any required plant system re-activation. Detailed work plans will be prepared to ensure that they remain appropriate in light of any improved knowledge of the condition of the site and the hazards that might be encountered during the course of the dismantling. The organization required to manage the intended dismantling activities will be assembled from available plant staff at Pickering, other OPG stations, and from outside resources such as Decommissioning Contractor(s), as required. The activities performed by the contractor(s) will include, but not be limited to, updating procedures for the characterization surveys, dismantling work, waste packaging, disposal, Site Restoration and final surveys. The Dismantling & Demolition operations will be designed to accomplish the required tasks while maintaining all doses ALARA. The procedures will also address the continued protection of the health, safety, security of workers, the public and the environment.

During this stage of the work, OPG staff and/or Decommissioning Contractor(s) will:

- Develop a detailed schedule of activities – sequential planning of activities to minimize conflicts with simultaneous tasks;
- Review the results of the site characterization (Section 4.1.4.6) and address any gaps or deficiencies in the information required to plan the decontamination, Dismantling & Demolition and disposal;
- Prepare the work packages for decontamination, Dismantling & Demolition, and disposal activities;
- Prepare the detailed work procedures for the decontamination of SSCs and procure decontamination equipment, which may include high-pressure sprays, chemical mixing tanks, decontamination solvent injection and treatment components, grit-blasting and abrasive jets devices, components for the scarification and spalling of concrete surfaces, chemical applicators, etc.;
- Prepare the detailed work procedures and sequences for the removal of systems and components;
- Perform a safety assessment to evaluate the processes for decontamination and dismantling the station, including waste handling, conditioning and on-site processing;
- Evaluate the options for the disposal of the calandria and its internals;

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- Evaluate the options for the removal, handling and disposal of other large radioactive components such as steam generators, etc.;
- A graded approach will be taken in reviewing and revising station drawings, consistent with the need to maintain configuration control of the facility;
- Design, procure and test the tooling and equipment (including remotely operated equipment) that will be used during the dismantling work;
- Procure Dismantling & Demolition equipment:
 - Heavy equipment, which may include lifting gear (cranes, hoists and rigging), material transfer equipment (forklifts and trucks), and demolition equipment (demolition hammers, cutting torches, saws);
 - Small tools, which may include hand and power tools such as drills, circular and band saws, slings, small cutters and power hack saws, etc.; and
 - Pipe cutting equipment, which may include plasma arc torches, track cutters, milling machines, band saws, etc.
- Procure or design and fabricate shielding and contamination control envelopes in support of removal and transportation activities;
- Develop the procedures for occupational dose control, contamination control, industrial safety, environmental protection, fire protection and emergency response;
- Develop/revise the emission monitoring program;
- Develop/revise the waste management program so that it covers the following processes, as applicable:
 - Characterization;
 - Classification;
 - Minimization;
 - Segregation;
 - Clearance;
 - Handling;
 - Volume reduction;
 - Treatment;

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- Packaging;
- Storage;
- Transportation; and
- Final disposition.
- Develop a waste management plan, which typically includes but is not limited to:
 - Develop a plan for both the short term and, where possible, the long term, for managing all decommissioning waste;
 - Develop the procedures for processing radioactive waste such as resins, filter media, metallic and non-metallic waste generated during the dismantling work;
 - Determine the transport and disposal container requirements for radioactive materials and hazardous wastes including the requirements for shielding and stabilization of the waste;
 - Procure and test the transportation and disposal containers for radioactive materials and hazardous waste;
 - Prepare the detailed procedures for the packaging, removal and disposal of radioactive materials, hazardous waste and construction debris; and
 - Assess/investigate decontamination methods such as chemical cleaning, electro polishing, mechanical abrasion or melting. These decontamination methods may be used to decontaminate scrap metal if the reduction in the volume of the scrap is sufficient to justify further processing. Depending on the efficiencies achieved, metals will be considered as either radioactive waste for controlled disposal, lightly contaminated (or activated) for consideration for re-use within the controlled nuclear environment or metals that are decontaminated to levels below the clearance levels will be released for recycling in the open market.
- Prepare plans for final surveys;
- Prepare plans for site remediation; and
- Obtain any additional licences, permits or approvals that may be required and complete any other regulatory processes that may be applicable.

An Impact Assessment (IA) and safety assessment for the intended Dismantling & Demolition processes will also be performed as required by prevailing regulations prior

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to Dismantling & Demolition. Refer to Section 4.2.4 and 13.0 for additional details on the safety assessment and IA, respectively.

Acceptable site radiological release criteria and clearance levels for decommissioning waste will be developed prior to Dismantling & Demolition. The guidance provided in CSA N292.5 [R-16] will be followed for the application of exemption quantity and clearance level criteria for the release of materials containing, or potentially containing, radioactive nuclear substances, and the activities necessary to demonstrate compliance with these criteria [R-16].

Based on the identified requirements and needs for Dismantling & Demolition appropriate subcontractors will be identified and selected to support the various phases and project deliverables.

4.2.3 Building and Site Preparation

Building and site preparation work will include activities to prepare the site for subsequent Dismantling & Demolition work. The preparation work will be performed towards the end of the SWS period.

In preparation for dismantling, the following activities will be initiated:

- Prepare any required site support and storage facilities including a Central Waste Processing Area that will be used to process and package waste;
- Complete a comprehensive site characterization survey to determine extent of site contamination (see also Section 4.1.4.6);
- Use survey data to develop packaging and transportation requirements and procedures;
- Determine transport and disposal container requirements for activated materials and/or hazardous materials, including shielding and stabilization. Fabricate or procure such containers;
- Procure required transportation packages from suppliers;
- Reactivate, refurbish and/or procure essential plant services necessary for dismantling;
- Develop procedures for occupational exposure control, control and release of liquid and gaseous effluent, processing of radioactive wastes including resins, filter media, metallic and non-metallic components generated in dismantling, site security and emergency programs and industrial safety;
- Clean all plant areas of loose contamination and process all liquid and solid wastes; and

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- Conduct radiation surveys of work areas, major components (including the calandria and internals), sampling of internal piping contamination levels and primary shield cores.

4.2.4 Detailed Decommissioning Plan

As mentioned in Section 1.1, a DDP will be prepared and submitted approximately two to five years for CNSC acceptance prior to the SWS period. Towards the end of the SWS period, the DDP will be revised to describe OPG's detailed plan for managing the arrangements and activities that will be conducted in support of Dismantling & Demolition and Site Restoration phase. The DDP will be prepared to meet the requirements of CSA N294:19 [R-4]. It will include a corresponding schedule and an estimate of expected costs to complete the dismantling. It would also address any un-reviewed environmental impacts associated with the proposed decommissioning scenario.

The DDP will establish the criteria (clearance levels) that will be used to determine if the material is suitable for uncontrolled release from the site. The DDP will also establish the clearance levels and end-state criteria that will be used to determine if the site itself is suitable for release from further regulatory control.

The original DDP that was prepared prior to SWS (See Section 4.1.3) will be revised to include a detailed description of the decontamination, dismantling and demolition work that will be performed, broken down into a multi-volume document by Decommissioning Planning Envelopes which will be integrated with an overall plan to ensure the work is done efficiently with safety being the top priority. The Decommissioning Planning Envelopes may include:

- Reactor Building and Calandria Vault;
- Vacuum Building and Pressure Relief Ducts;
- Reactor Auxiliary Bays;
- Turbine Halls and Turbine Auxiliary Buildings;
- Service Wing and Service Wing Extension Buildings;
- Heavy Water UPP;
- Pumphouse and Water Treatment System; and
- Standby Generator buildings, fuel storage tanks and other small buildings (machine shops, garages, etc.) located inside the fenced area.

Additional details of the site restoration work will also be included in the DDP.

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However, a decision may be taken to dismantle some of the conventional plants in the above list during the SWS period to reduce the 'footprint' of the site and in the interest of maintaining a safe shutdown state.

A detailed safety assessment of the work to be performed during Dismantling & Demolition as well as Site Restoration will also be prepared and submitted along with the DDP or included in the DDP. The decommissioning safety assessment will address potential radiological hazards to workers, the public, and the environment, from both routine decommissioning activities and credible accidents during decommissioning. The decommissioning safety assessment will also identify the mitigating methods to address the risks associated with these hazards and any residual risks to the public once decommissioning is complete [R-4].

4.2.5 End State of SWS Stage

By the end of the SWS period, all used fuel, including all defected fuel and all waste in the IFBs, is planned to have been removed from the station. Radioactive decay will have substantially reduced the residual contamination levels throughout the station and reduced the dose rates surrounding the calandria and calandria internals. Station systems (except for those in use during the SWS period) will remain in a drained, de-energized and secure state. The station will remain intact with the structures and systems maintained in a safe condition. An interim end state report indicating the current status of the facility will be prepared at the end of the SWS period for submission to the regulatory body.

4.3 Dismantling & Demolition and Site Restoration Stages

Dismantling work would begin after the detailed planning has been completed and the necessary permits and approvals have been obtained. The work in this phase can be divided into a series of conceptual steps:

- Prepare the buildings and site;
- Decontaminate and dismantle systems;
- Decontaminate and dismantle structures;
- Dismantle non-nuclear systems;
- Demolish buildings;
- Manage and dispose the waste; and
- Restore the site.

Work in the different steps may occur in parallel. Remedial action support surveys for radioactive and other hazardous materials will be performed throughout the dismantling work, up to the final survey.

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4.3.1 Dismantle Nuclear Systems

Dismantling activities are anticipated to involve the following:

- (a) Construct temporary facilities, modify existing storage facilities, erect and place scaffolding in and around components to be dismantled to support the dismantling and decontamination activities. These may include a cutting station (for boilers and other large components), additional change rooms and contaminated laundry facilities for increased work force, establishment of laydown areas to facilitate equipment removal, upgrading roads to facilitate hauling and transportation and modifications to the reactor building to facilitate access of large/heavy equipment.
- (b) Remove the irradiated fuel stacking frames from the fuel wet storage bay. Frames will be disassembled, decontaminated with high-pressure water (to the extent possible) and packaged for off-site disposal.
- (c) Design and fabricate shielding and contamination control envelopes to support removal and transportation activities. Specify and/or procure special tooling and remotely operated equipment. Modify containment to support segmentation activities and prepare rigging for segmentation and extraction of heavy components, such as the steam generators.
- (d) Conduct decontamination of components and piping systems, as required, to control (minimize) worker exposure. Remove, package and dispose of all piping and components that are no longer essential to support dismantling operations. It is anticipated that radioactive corrosion products on inner surfaces of piping and components will not have decayed to levels that will permit unrestricted use or allow conventional removal. These systems and components are surveyed as they are removed and disposed of in accordance with the radiological clearance levels that have been developed (see Section 4.2.2).
- (e) Dispose radioactive Polychlorinated Biphenyls (PCBs) waste remaining at the Pickering site (see Section 4.4.2.1).
- (f) Remove asbestos from PNGS (see Section 4.4.2.1).
- (g) Remove the steam generators and feed and bleed system [R-17] for shipment and controlled disposal. A potential method for removal (and the one used as the basis in this PDP for cost estimating) is the one-piece vertical extraction of the steam generators through the reactor building dome. Sections of the shield walls and floor grating in the compartment will have to be removed to allow for the vertical lift of the generators through the roof openings. Once removed, all nozzles will be welded shut and the interior volume will be filled with low-density cellular concrete for stabilization of the internal contamination. The steam generators will then be segmented at the site in order to meet the waste disposal site acceptance criteria prior to disposal since they are considered large objects which could exceed the waste disposal facility size/weight guidelines. The exterior surfaces will be decontaminated, as required, and openings will be seal-welded (inspection

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hatches and other penetrations). The segmented sections can then serve as their own disposal containers, provided that all penetrations are properly sealed and the internal contaminants are stabilized.

- (h) Remove the moderator heat exchangers and bleed cooler intact and prepare for transport and disposal to serve as their own container in a manner similar to the steam generators. All nozzles and other openings will be welded closed for containment of the internal contamination. Segmentation and packaging for these components will be completed similar to the work done on the steam generators.
- (i) At each calandria face, remove the fuelling machine bridge structure and insulated feeder cabinet which encloses the PHT headers and feeder tubes.
- (j) Remove the PHT and moderator primary and auxiliary piping and pumps. Any fuel cladding failure that has occurred or may occur during the operation of the plant is assumed to have released fission products at sufficiently low levels that the build-up of quantities of long-lived isotopes (e.g., Cs-137, Sr-90, or transuranics) has been prevented from reaching levels exceeding those that permit the major PHT and moderator system components to be shipped as Surface Contaminated Object or Low Specific Activity waste and to be emplaced within the requirements of the long-term disposal facilities for respective Low-Level Waste (LLW) and ILW (See Section 4.4.1.3).
- (k) Package the piping in transportation packages; the pumps are sealed with steel plates so as to serve as their own containers. Segment those components that are considered large object waste that exceed the waste disposal facility size guidelines. Ship piping and pumps for disposal.
- (l) Install calandria segmentation system in reactor vault and test.
- (m) Segment the calandria vault and internal components by remote in-place segmentation. A depth of 46 cm of the internal calandria vault walls are expected to be activated and be classified as decommissioning LLW, and will be packaged in B-25 waste containers. The ILW will be packaged in Modular Shielded Containers (MSCs). Major activities as part of this work will include the following:
 - Install temporary shielding as necessary.
 - Remove all horizontal and vertical control elements and their associated drive mechanisms.
 - Remove all reactivity housing mechanisms (vertical and horizontal).
 - Cut annulus bellows and cut the pressure tubes, remove end fittings and pressure tubes from calandria; cut into lengths to fit MSCs for disposal.
 - Remove calandria tubes from calandria structure; cut into lengths to fit MSCs for disposal.

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- Remove the shielding slabs (Pickering A) and end shield balls (Pickering B) and fit into MSCs for disposal.
 - Transport all waste in suitable containers to the transportation staging area.
 - Segment the balance of the calandria structure.
- (n) Remove the balance of the systems and equipment from the reactor vault. These components will be segmented prior to disposal.
- (o) Remove systems and associated components as they become non-essential to the vessel removal operation, related decommissioning activities, or worker health and safety (e.g., waste collection and processing systems, electrical and ventilation systems, etc.).
- (p) Remove activated concrete biological shield and accessible contaminated concrete. Remove those portions of the associated enclosures necessary for access and component extraction.
- (q) Remove contaminated equipment and material from the Ancillary Services Building, East Service Area, Fueling Duct, Off-Gas System Room, Pressure Relief Duct, Fuel Transfer Duct, and the Spent Resin Storage area. Remediate contaminated surfaces until radiation surveys indicate that the structure can be released for unrestricted access.
- (r) Decontaminate tooling used for dismantling, disassemble and prepare for use at another unit at PNGS, as applicable. Solid and liquid radioactive waste generated from this activity is either routed for treatment or removed to a centralized processing area for conditioning.
- (s) Remove all remaining L&ILW along with any remaining hazardous materials. Material removed in the decontamination and dismantling of the nuclear units will be routed to an on-site central processing area. Material that meets clearance criteria will be released for unrestricted disposition, e.g., as scrap, recycle or general disposal. Contaminated material will be characterized and packaged for controlled disposal at the long-term disposal facilities for respective LLW and ILW (See Section 4.4.1.3).
- (t) Remove remaining components, equipment and plant services in support of the area release survey(s).
- (u) Conduct final radiation surveys to ensure that all radioactive materials in excess of permissible residual levels have been remediated.

All dismantling work performed on contaminated nuclear systems will be conducted in a manner that will minimize the spread of contamination and in accordance with OPG's Radiation Protection Program [R-54]. Appropriate contamination control techniques, including the use of portal monitoring systems at controlled egress points, temporary

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enclosures, local ventilation, Personal Protective Equipment (PPE) and contamination monitoring will be used when the work is performed.

4.3.2 Dismantle Contaminated Structures

Contamination will be removed from the surfaces of structures wherever possible in order to reduce waste volumes. Any contaminated paint, coatings, steel or other materials will be removed from the walls and floor. Removal can include surface scarification or physical dismantling depending upon the depth of contamination/activation. If required, removal of surface structures will be pursued to sub-surface contaminants that have migrated to inaccessible locations over the operating life of the facility. Contaminated concrete will be removed by scarifying (needle de-scaling, scabbling or hammering), concrete shaving or by drilling and spalling. The contaminated debris will be collected and packaged for disposal as radioactive waste. Concrete waste will be packaged in steel containers, at an average waste density of approximately 1,400 kg/m³.

Contamination may be removed from surfaces with chemical cleansers or by mechanically removing material from the surface (by planing, scarifying or drilling and spalling).

Large structures will be removed and segmented into smaller pieces at the station using commercially available equipment, e.g., diamond wire sawing, or other alternative technologies available at the time.

Metals will be decontaminated in place (if practical) or removed by dismantling or cutting. The scrap metal will be sent to the Central Waste Processing Area for further processing. Metallic waste will be packaged in steel containers, at an average waste density of approximately 1,000 kg/m³.

Contaminated metal may be packaged for disposal as radioactive waste. However, chemical cleaning, electro polishing, mechanical abrasion or melting might be used to decontaminate scrap metal if the reduction in the volume of the scrap is sufficient to justify further processing. Depending on the efficiencies achieved, metals will be considered as one of the following three:

- Metals that are decontaminated to levels below the clearance levels will be released for recycling in the open market;
- Lightly contaminated (or activated) for consideration for re-use within the controlled nuclear environment; and
- Radioactive wastes for controlled disposal.

Structures designated as “internally clean” but located within potentially contaminated areas are treated as though they are contaminated and disposed of as LLW.

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All decommissioning work performed on contaminated structures will be conducted in a manner that will minimize the spread of the contamination. Appropriate contamination control techniques will be used when the work is performed. This may include the use of temporary enclosures, local ventilation, PPE and contamination monitoring.

This work will continue until surveys confirm that contamination levels have been reduced to below the clearance level established in the DDP, after which the structures will be treated as non-contaminated (see Section 4.3.4 below). It is assumed that demolition would be delayed until after all radioactive materials in excess of release levels have been removed.

4.3.3 Dismantle Non-Nuclear Systems

The non-nuclear systems will be dismantled using conventional demolition techniques, surveyed for radioactivity and other contamination and prepared for disposal. Components and equipment located outside the Radiological Controlled Area will be removed. Material deemed to be free from contamination (i.e., below the established clearance level) may be released for recycling or disposal. Dismantling activities are likely to include, but may not be limited to, the following:

- Remove secondary circuit steam cycle components (assumed to be within the clearance for free release);
- Cap-off the condenser cooling water inlet and outlet ducts and remove the condensers;
- Remove the turbines, generators and ancillary equipment;
- Remove the condenser cooling water pumps and associated piping;
- Remove the de-aerator; and
- Remove the feed water heaters, piping and other equipment.

The following are anticipated to be dismantled in conjunction with the last unit on site:

- Water Treatment Plant;
- The remaining Standby Generators and Emergency Power Generators;
- Above-ground storage tanks (after draining, purging, and decontaminating); and
- Remaining offices, workshops, laboratories and storerooms.

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4.3.4 Demolition

Once contaminated systems, structures and non-nuclear systems have been dismantled and final surveys (see Section 4.3.7) have confirmed that the remaining structures are below radioactive and hazardous materials release limit, demolition activities may begin.

Efficient removal of the contaminated materials and verification that residual radionuclide concentrations are below regulatory limits will result in substantial damage to many of the structures. Blasting, coring, drilling, scarification (surface removal), and the other decontamination activities will substantially damage power block structures including the reactor, service and ancillary service buildings. Verifying that subsurface radionuclide concentrations meet site release requirements may require removal of grade slabs and lower floors, potentially weakening footings and structural supports. This removal activity will be necessary for those facilities and plant areas where historical records, when available, indicate the potential for radionuclides having been present in the soil, where system failures have been recorded, or where it is required to confirm that subsurface process and drain lines were not breached over the operating life of the station.

Any remaining structures (including buildings that were not contaminated and temporary structures) will be demolished by general demolition crews by drilling and controlled blasting or by other conventional demolition techniques. The waste blocks will be sized so that they can be handled and moved by the available technologies. All foundation and exterior walls will be removed to the nominal one meter removal depth below grade whenever possible. At-grade foundation slabs exceeding one meter in thickness will be abandoned in place and covered with a one meter thick layer of backfill. Concrete rubble and other clean materials may be used to fill the voids left by the demolition, including the entire Turbine Building basement.

Underground metal and concrete piping will be excavated and removed for survey. Any piping that exceeds the site release criteria will be removed and disposed of appropriately. Clean metal piping will be considered scrap or will be recycled. Clean concrete piping will be used as backfill. Crushed concrete from demolition of the onsite facilities that is below the clearance level can also be used to backfill voids below grade. Clean piping, subterranean tunnels, chases, etc., will be abandoned in place unless deemed a hazard from collapse and subsidence. Circulating water intake and discharge tunnels will be exposed and the roof of the tunnels collapsed, with the exception of the portion that runs under the station IFB. This portion will be abandoned in place and backfilled from each end of the tunnel segment. Shallow portions of the concrete circulating water closed-loop piping will be exposed and the roof of the piping will be collapsed. Deeper portions of the piping will be capped and abandoned in place. OPG will investigate the requirements for capping the underground piping and utility lines while maintaining consistency with provincial and/or national regulations at the time of dismantling/demolition.

Asphalt will be removed from the immediate perimeter. Culvert and headwalls will be left to control drainage and minimize erosion. Road and parking areas with asphalt or

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concrete surfacing will be broken up and the rubble used for backfilling on site if needed.

Once demolition is complete, an interim end state report will be prepared for submission to the regulatory body.

4.3.5 Waste Processing

All material removed during the decontamination and dismantling of the nuclear units will be routed to a Central Waste Processing Area, which will characterize and prepare the material for release or shipment to an appropriate waste disposal, storage or recycling facility. The estimated maximum size of the packaged decommissioning waste, including any required shielding, is 2.65 m x 5.2 m x 14 m and the estimated weight criterion is 35 Mg (as required by transportation regulations [R-76]). Radioactive, hazardous and conventional wastes will be managed as described in Section 4.4.

4.3.6 Restore the Site

Depending on the nature of the future activities that will be carried out on the site, restoration work may include:

- Removing or remediating any remaining contaminated soil to meet the regulations for clearing the site as 'brownfield'⁶ [industrial];
- Breaking up road and parking areas covered with asphalt or concrete surfacing and using the rubble for backfilling, if needed;
- Cleaning the site to remove any remaining inactive waste and debris;
- Covering the filled excavations with gravel (for drainage) and topsoil;
- Abandoning water drain holes at the bottom of all subgrade structures;
- Removing the rock breakwater structure extending out into Lake Ontario from the forebay in front of the intake screenhouses and relocating the excavated material along the existing shoreline in front of the station. The forebay will be filled in with the available breakwater material;
- Restoring the lake front property (including the water inlets and outlets and outfall deposits) to inhibit erosion and potential detrimental impacts on fish, fowl or other wildlife;
- Exposing shallow portions of the concrete circulating water closed-loop piping and collapsing the roof of the piping. Deeper portions of the piping will be capped and abandoned in place;

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- Grading the area to prevent ponding and inhibit the re-floating of subsurface material; and
- Establishing a covering of vegetation to prevent soil erosion.

As mentioned in Section 4.0, the existing electrical switchyard will remain after decommissioning in support of the utility's electrical transmission and distribution system [R-15].

Soil and structural surfaces that are within authorized limits may remain at site following Dismantling & Demolition activities. The Pickering site will be shown to meet the final clearance levels in support of release from further regulatory control.

4.3.7 Surveys

A series of surveys for radioactive and other hazardous materials will be performed throughout the course of the Dismantling & Demolition work. MARSSIM-like survey, surveys such as those based on Annex G of CSA N294:19 and any other surveys based on guidelines available at the time decommissioning will be performed [R-4], [R-36], [R-77]. Several different types of surveys should be performed at different stages of the decommissioning:

- A scoping survey – to determine facility status;
- A characterization survey – to evaluate remediation options and perform risk assessments;
- Operational surveys during the various decommissioning phases, pre- and post- Storage With Surveillance, and remedial action support surveys during Dismantling & Demolition operations – to control the spread of contamination, assess wastes for category and determine levels of site remediation achieved;
- A final survey (also referred to as the abandonment survey, as shown in Figure 4-1 and Figure 4-2) during Site Restoration – to provide evidence that a declared end state has been achieved; and
- A verification survey by an independent party, may be requested by the regulator – to provide compliance monitoring and to ensure that agreed site remediation levels have been achieved, that will then be used as the basis for removal from regulatory control.

According to international experience, scoping and characterization surveys (also referred to as post-operational surveys) should be performed as early as possible, prior to the start of decommissioning. Scoping surveys will be performed in order to identify contaminants, identify impacted and non-impacted areas and provide an estimate of the variability of the contamination (Annex G, [R-4]). Characterization surveys will be performed to provide a complete description of the nature, extent and variability of the contamination in each area of the site/facility (Annex G, [R-4]). Both

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of the above-mentioned surveys will assist with the planning of the decontamination work.

Operational surveys and remedial action support surveys will be performed throughout the dismantling and decontamination process in order to guide and monitor the decontamination work. They are also used to help control the exposure of decontamination workers to radiation and hazardous materials. Operational surveys are typically based on simple measurements such as contact radiation dose rates or direct contamination checks. More extensive surveys may be required in order to measure subsurface contamination. This may require the removal of grade slabs and lower floors, particularly where historical records indicate that process failures have occurred or where it is necessary to confirm that subsurface vessels or pipes have not leaked.

The final survey will be performed to verify that the facility has been remediated to such an extent that all remaining buildings, components and the site itself now have residual activity levels that are below the established end state criteria. A Final Survey Plan will be developed before any of the final survey work begins. The survey plan will describe the survey work that will be performed, the schedule for that work, the methods that will be used to collect and analyze the data and the structure of the final report that will be produced. The Plan will also set out the performance criteria for the measurements and analyses that will be performed and the acceptance criteria for data from other sources, such as previous survey work, that will be incorporated into the Final Survey. The End State Criteria set out in the Detailed Decommissioning Plan will be reviewed to confirm that they remain appropriate and they will be revised if necessary.

Although the final survey is described as though it were a single activity performed at a well-defined stage of the decommissioning process, this will probably not be the case. The final surveys will likely be performed in stages and at different times in different units or different work areas within a unit. In order to ensure that the surveys are thorough, they will be performed when the remaining structures and materials are still accessible. However, the surveys will be performed as expeditiously as possible after the completion of the decontamination work since the remaining structures may be unstable and could present a hazard to the decommissioning staff working in or around these structures. Any residual contaminants identified in the survey will have been remediated. Administrative and/or physical controls will be in place to isolate the surveyed areas and prevent recontamination. Demolition work (see Section 4.3.4) may proceed once the final surveys have confirmed that the residual contamination levels in a work area or unit are below the established clearance levels and the results of these surveys have been accepted by the CNSC and other regulatory agencies.

The final stage of the survey will be performed after all demolition work is complete to ensure that no residual contamination remains on the site. Periods of deferral (called 'Survey Delays') may be incorporated into the decommissioning schedule (see Figure 4-1 and Figure 4-2) to ensure that all decommissioning work has been completed before this final stage of the survey work begins.

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A report on the Final Release Survey will be prepared upon completion of all survey work. The report will present a description of the methods used to collect and analyze the data. The results of the analyses that were performed and the results of the analysis of the data will include the following [R-4]:

- The criteria used to define the end-state;
- The methods and procedures used to ensure that the criteria were met; and
- The measurement data, including appropriate statistical analysis and systematic approaches.

Data from other surveys performed at earlier stages of the decommissioning process, such as the characterization survey and the remedial action surveys, may be incorporated in the final survey if they meet the acceptance criteria that were set out in the Final Survey Plan. The results of the analyses will be compared to the End State Criteria and the conclusions drawn from that comparison will be included in the report.

Regulatory agencies may wish to perform additional surveys or a verification survey by an independent survey organization may be requested by the regulator to assess any residual activity on site and this will form the basis for the release of the site from further regulatory control. This possibility will be provided for in the DDP.

All of the surveys will be performed according to approved procedures that will be based on the recognized standards and guidelines applicable at the time [R-4], [R-36], [R-77]. The procedures will describe:

- The sampling strategies and methods that will be employed during the survey;
- The instruments and laboratory methods that will be used;
- The statistical techniques that will be used to analyze and interpret the data;
- The documentation that will be prepared and retained; and
- The Quality Assurance (QA) and quality control program that will be in place.

4.3.8 Final End State

By the end of the Dismantling & Demolition and Site Restoration stages, the site will be free of industrial and radiological hazards. All of the station SSCs will have been dismantled and all non-essential buildings and site facilities will have been demolished to a depth of one meter below grade. The switchyard will remain for continued use.

All radioactive contamination in excess of the established clearance levels for a 'brownfield'⁶ [industrial] site and all other hazardous materials will have been removed from the site. It is expected that the clearance level used for the clean up of the site will not require institutional controls after the release from regulatory control.

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Subsurface structures will have been drained and de-energized. These subsurface structures will also have been surveyed for contamination, decontaminated, if required, and dismantled to a nominal depth of one meter below grade (consistent with international practices), backfilled with clean concrete rubble and/or soil and graded over. The remaining site will have been backfilled to prevent future subsidence and restored to a state suitable for other OPG uses. By the end of this stage, the end-state objectives defined in the DDP will be verified to have been achieved and the site will meet the criteria to release from regulatory control.

4.3.9 Release from Regulatory Control

Upon completion of decommissioning, the Pickering Nuclear Site will be in a condition that will support its removal from regulatory control. A final end state report on the decommissioning program will be prepared. The final report will describe the decommissioning work that has been performed and the outcome of that work, the results of the final surveys that were performed and the interpretation of those results (i.e., whether the results meet the end-state objectives defined in the DDP). Any other information required by the applicable regulations will also be included in the report. The final report will be submitted to the CNSC as part of the request for a release from regulatory control. Institution controls are not expected to be required.

4.4 Waste Management

Waste management is governed by OPG's Management of Waste and Other Environmentally Regulated Materials standard [R-78], which includes the instruction that all waste generators follow the concept of reduce, reuse and recycle in the waste management activities. All radioactive waste generated during decommissioning will be characterized as per CSA N292 series of Standards, consistent with OPG's Nuclear Waste Management program [R-79]. Transportation of decommissioning waste will be carried out per OPG's Radioactive Materials Transportation program [R-80], which includes the Radioactive Shipments procedure [R-81] that addresses consultation with the waste receiver per the transportation regulations. Non-radioactive waste packaging and transportation will be carried out according to OPG's Management of Waste and Other Environmentally Regulated Materials standard [R-82].

4.4.1 Radioactive Waste Management

4.4.1.1 Radioactive Waste Inventory

The radioactive material inventory of a reactor at the time of shutdown will depend on both the design and the operating history of the unit. The inventory will decrease over time due to the removal of activity by any decontamination work and the natural decay of the radioactive material. Estimates of the activity that will remain at PNGS A and PNGS B at the end of the SWS period are shown in Table 4-2. These estimates are based on the assumption that the units have been in service for 40 years after which the radioactivity will be allowed to decay for 30 years [R-83]. However, it is important to note that the current estimates of radioactivity may need to be updated post targeted site characterization activities at the PNGS site.

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Table 4-2: Summary of Radionuclide Inventory at PNGS A and PNGS B

(After 40-years in-service and 30-years storage)

Radionuclide	Residual Activity			Half-life (years)	Percentage (% total)
	Type	PNGS A (Bq)	PNGS B (Bq)		
C-14	β	4.7×10^{13}	4.9×10^{13}	5,730	0.22
Fe-55	γ	1.2×10^{14}	1.2×10^{14}	2.73	0.58
Ni-59	γ	1.0×10^{14}	1.0×10^{14}	76,000	0.66
Co-60	β - γ	1.5×10^{15}	1.6×10^{15}	5.27	7.6
Ni-63	β	1.5×10^{16}	1.5×10^{16}	100	89.6
Zr-93	β - γ	1.3×10^{13}	1.4×10^{13}	1,530,000	0.06
Nb-94	β - γ	2.9×10^{14}	2.9×10^{14}	20,300	1.2
TOTAL		1.7×10^{16}	1.7×10^{16}		

All four PNGS A units were retubed during the 1980s and then laid-up for a prolonged period starting in 1997. Units 2 and 3 will have operated for 25 years and the period of decay will be longer than 30 years.

The residual radionuclide inventories will be recalculated during the preparation of the DDP.

Estimates of the volume of L&ILW that will be generated during the decommissioning of PNGS have been prepared and are shown in Table 4-3 [R-15]. This table also summarizes the refurbishment waste (i.e., ILW) contained within the DSMs at the PWMF, which will be handled (i.e., packaged, transported and disposed) together with PNGS decommissioning waste. Note that although the DSM waste is not costed as part of the decommissioning, during the decommissioning of PNGS, the DSMs are planned to be emptied by transferring them to the PNGS ILW central waste processing area where the retube components will be removed from the DSMs and packaged accordingly.

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Table 4-3: Estimated Volumes of L&ILW Generated During the Decommissioning of the PNGS A and B and Waste from DSM

PNGS A and B Units	Low-level Radioactive Waste (m³)	Intermediate-Level Radioactive Waste (m³)
Unit 1	5,828	1,312
Unit 2	5,247	1,311
Unit 3	5,247	1,311
Unit 4	5,816	1,312
Unit 5	5,088	757
Unit 6	5,084	757
Unit 7	5,084	757
Unit 8	5,087	757
Unit 0 (common services)	16,779	126
TOTAL*	59,260	8,400

* May not add due to rounding

The radioactive wastes generated during the decommissioning will consist mainly of those wastes generated during dismantling. Wastes generated during Preparation for Safe Storage are likely to include:

- Filters and ion exchange resins;
- Wastes from decontamination activities; and
- Routine radioactive waste from the Preparation for Safe Storage period.

The radioactive waste generated during the Dismantling & Demolition and Site Restoration Phase will consist of process components and structural materials contaminated with residual activity. The principal sources generated during dismantling are:

- Component parts of the reactor assembly;
- Calandria and shield tank (PNGS B) and Dump Tank (PNGS A);
- PHT System pumps and other smaller pumps;
- Steam Generators;
- Piping and valves;
- Heat exchangers;
- Fuelling machines; and

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- Other components of active systems.

Demolition will generate large amounts of concrete wastes.

Single unit inventory of plant system equipment and components of PNGS A and B was taken as base inventory for all units. Modifications performed to one or two units are likely to be performed on the other units.

Material quantities for plant structures (i.e., concrete, steel, etc.) may vary from unit to unit due to the differences in the arrangement and location of exterior walls.

4.4.1.2 Management of High-Level Waste

During the operating life of the station, used fuel from the reactors is initially stored in the IFBs for cooling. Used fuel that has been stored in the IFBs for the required minimum cooling period is then loaded into DSCs and transported to the PWMF.

When the station is shut down, all the used fuel (resident in the six reactor units) will be transferred to the IFBs for an initial cooling period. All the support programs for fuel (including monitoring, security, safeguards and criticality safety) will be maintained while fuel is on the PNGS site. Fuel in the IFB-A will be moved to the AIFB after four years. It is anticipated that all the used fuel remaining in the IFBs will be transferred to dry storage. The transfers will continue for 10 to 15 years after station shutdown. Once all of the used fuel has been removed, the IFBs will be decontaminated and secured for the remainder of the SWS period. It is not anticipated that any activity will remain in the IFBs after the decontamination is complete. Although the decommissioning of the IFBs is addressed by this PDP, the used fuel transfer activities from the IFBs (post 2028) or operations of the PWMF are not part of PNGS decommissioning scope. Although the life cycle plans of the PNGS and the PWMF are separate from each other, interdependencies were considered (see Section 2.2.8 and Figure 4-3), while decommissioning planning for the PWMF has been documented in a separate PDP [R-1].

The Government of Canada passed the Nuclear Fuel Waste Act in 2002. The legislation required nuclear energy corporations to establish the Nuclear Waste Management Organization (NWMO) to study the options available and to recommend a long-term management approach for used fuel.

The NWMO has issued a study report "Choosing a Way Forward - The Future of Canada's Used Nuclear Fuel", in 2005 [R-84]. This report was intended to assist the Federal Government in defining the approach for the long-term management of Canada's nuclear fuel waste. On June 14, 2007, the Government of Canada selected APM as the best plan for Canada for safeguarding the public and the environment over the very long time in which used nuclear fuel must be managed [R-85]. APM involves the containment and isolation of used nuclear fuel in a Deep Geological Repository in a suitable rock formation. At the time of shutdown of the PNGS, the used fuel remaining in the IFBs will be transferred to dry storage in the PWMF until the used fuel long-term disposal facility is available in 2043. By the end of the SWS period and

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before dismantling begins, all used fuel is assumed to have been removed from the site to the used fuel disposal facility (i.e., APM).

4.4.1.3 Management of Low- and Intermediate-Level Waste

Radioactive wastes will be treated (e.g., by volume reduction where foreseeable) and packaged on site by the Decommissioning Contractor(s) in order to reduce worker exposure, to meet the regulatory requirements for waste transport and disposal. Liquid waste will be generated from decontamination activities, cutting operations in the PHT system, selective decontamination of laundry, personnel showers, etc.

All processing and packaging of decommissioning waste will also be performed on site by the Decommissioning Contractor(s) and not by OPG. The following waste treatments are assumed for planning purposes:

- Decontamination using aggressive cleaning solutions, and/or using decontamination equipment described in Section 4.2.2;
- Dewatering of waste slurries either by removing the activity from the liquid (using filters and resins) or by evaporating the liquid from the waste;
- Waste processing units, which are usually self-contained and portable, are delivered on skids, from which hook-ups are made to the plant's waste collection tanks;
- Waste immobilization by solidifying concentrated liquid wastes; and
- Volume reducing low-density materials by compaction and packaging.

The waste treatment processes will be reassessed in more detail during the preparation of the DDP.

The decommissioning of the PNGS will produce a relatively large number of components such as pumps, vessels, motors, concrete, structural steel, construction debris, etc., which will need to be packaged for disposal as LLW. Large components will be segmented and packaged as such (e.g., steam generators as described in Section 4.3.1). Other large components (e.g., calandria) will be processed and packaged in suitable containers. Other smaller components and equipment will be cut to fit and be placed in standard waste containers. Contaminated concrete (e.g., surface contaminated concrete from the IFBs) will be broken up, loaded into disposal containers and shipped to a licensed long-term LLW facility. The remaining concrete that meets the clearance criteria will be crushed and graded, and used on-site as backfill.

Wastes will be packaged for transport and disposal according to the requirements of the applicable federal and provincial regulations. It is assumed that the waste produced in the decommissioning of the nuclear units will be moved by truck or multi-wheeled transporter to the waste disposal facility. The necessary packages will be

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identified, designed, tested and procured prior to the decommissioning project. The required licences, approvals and certifications will also be obtained before the packages are put into service.

Although OPG owns and operates the WWMF on the Bruce Power site for interim storage of radioactive waste generated during the operating phase of OPG-owned NGSs, there are no plans to store or dispose decommissioning waste from any of OPG's nuclear facilities at the WWMF. Any loose contamination removed by Operations prior to stations entering into SWS will continue to be sent to the WWMF and waste from PNGS during SWS will be processed at the WWMF until it is shut down.

OPG had planned to dispose of L&ILW from its owned generating stations in a DGR at the Bruce Nuclear Site. Early in 2020, the L&ILW DGR Project was cancelled. OPG is exploring options and remains committed to the permanent and safe disposal of its operational waste as well as future decommissioning waste.

OPG is also participating in Natural Resources Canada (NRCan)'s work in public engagement on the existing Radioactive Waste Policy to ensure OPG is meeting international best practices. The NWMO was asked to lead a dialogue to develop an integrated strategy for Canada's radioactive waste through close collaboration among waste owners and producers (including OPG), indigenous people and other interested Canadians. Any progress in regard to the Policy and Integrated Strategy will be taken into consideration in OPG's decommissioning waste disposal strategy.

Note: For financial planning purposes, the L&ILW generated during decommissioning is assumed to be transferred to long-term disposal facilities for respective LLW and ILW [R-15].

4.4.2 Hazardous Waste Management

4.4.2.1 Hazardous Waste Inventory During Operation

Designated Substances are defined in the Regulations made pursuant to the Ontario OH&S Act. An assessment of the Designated Substances used at the PNGS A and PNGS B has been completed as required in 2021 [R-86]. The results of the assessments indicate that seven designated substances have been found in the stations.

- (a) Asbestos – OPG has a program in place to control all hazardous materials including asbestos-containing materials [R-87]. The asbestos management is implemented through Health and Safety Management of Asbestos-Containing Material OPG-PROC-0124 [R-88] and Asbestos Work Procedure OPG-GUID-08963-0003 [R-89]. In addition, with the assistance from industry experts, Pickering station maintains an asbestos database which is updated on an on-going basis. Asbestos is likely present in SSCs such as gaskets, thermal insulation, magnesia block and parging cement. There is also an ongoing effort

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to inspect and repair the asbestos insulation used in the stations. Damaged insulation is removed if it cannot be repaired.

- (b) Lead – Lead blocks, plate and blankets are used for radiation shielding around both stations. Lead can also be found in product categorised as follows: Lead Sheets, Lead wool, Hilti cartridges, Lead shot, Solders alloy, Lead wire, Lead batteries, Abrasive shot (copper slag with minor lead contamination) and lab standards. A large inventory of unused lead block and plate previously stored on the site has been removed. The melting and pouring of lead for shielding is no longer carried out at the PNGS. Some contamination may remain on surfaces from previous lead melting operations.

Lead paints are no longer used at either station. However, a survey of Units 1 and 5 indicates that lead-based paints were used in both stations, but they were more common at PNGS A than PNGS B. A more complete survey will be required before beginning decontamination work.

A Designated Substance Assessment for lead was conducted at PNGS in compliance with Ontario Regulation, O. Reg. 490/09, Designated Substances. This was done to determine the presence of lead-containing products at PNGS, whether workers were likely be exposed to lead during their job functions, and whether or not their health was likely to be affected by this exposure [R-90].

- (c) Mercury – Mercury was not used as a construction material. However, it is used in thermometers, manometers, hygrometers, mercury-wetted relays, magnetol and mercoid switches, vacuum pump temperature switches, transformer deluge systems, sealed batteries and various types of lamps (fluorescent, mercury vapour, metal halide, etc.). Free mercury is not stored or used at either station.

Other designated substances such as benzene and isocyanates are occasionally used during projects, but they are not routinely stored at either station. Although silica is used in some of the structural products such as cement, concrete, and grouting products, it is not typically used during operations. Silica containing materials are not used as decontamination (sandblasting) agents within the protected area of the stations; however, they may be used in workshops outside of the protected area. Lastly, very low concentration of arsenic is present in SSCs such as batteries. Additional information on these Designated Substances are documented [R-86].

Most of the hazardous materials stored on the site (flammable, oxidizers, corrosives, etc.) will be consumed during routine plant operations. It is anticipated that the inventories will be reduced as the units are successively shut down so that only small quantities will remain after the last unit is shut down. Some of the remaining materials (e.g., welding gases) will be consumed during the Preparation for Safe Storage period. Others, such as the fuel oil for the standby generators, can be removed for use at other sites. Hazardous wastes (i.e., asbestos, PCBs, etc.) which cannot be reasonably removed during station/facility operations will be included as part of Dismantling & Demolition activities.

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PCBs waste management will be handled as follows:

- Non-radioactive PCBs: On March 22, 2021, 271 lighting ballasts were removed from PNGS Site. Currently there is no PCB material at the storage sites [R-91]. Any remaining non-radioactive PCBs waste generated will be disposed of in accordance with Federal PCB Regulations.
- Radioactive PCBs: Waste containing radioactive PCBs¹⁰ will be stored at the Pickering site in accordance with PCB storage requirement until a disposal pathway approved by the Environment and Climate Change Canada becomes available.

A number of other materials used during routine station operations are potentially harmful to workers or the environment. The inventories of these materials will be reduced as the plant approaches shutdown so only small quantities should remain at the start of the decommissioning. The hazardous materials include:

- (a) Compressed gases including oxygen, helium, carbon dioxide, hydrogen and sulphur hexafluoride. Compressed gas cylinders are stored on-site;
- (b) Flammable liquids including fuel oils and organic solvents used as decontamination agents:
 - Fuel oil is stored in outdoor tanks with secondary containment;
 - Lubricating oil and seal oil are stored in three tanks on the north side of the turbine hall;
 - Insulating oil, used for cooling transformers, is brought in by trucks;
 - Diesel, used in diesel fire pumps, is stored in tanks on-site;
 - Hydraulic oil, used in the fuelling machines, is stored in tanks on-site;
 - Six large above-ground oil storage tanks are located between the station and the lake shore (two south of Unit 4, two south of Unit 5 and two south of Unit 8);
 - Two waste oil storage tanks, one for PNGS A and one for PNGS B, are located inside the Powerhouses;
 - Industrial-sized containers (e.g., 200 L drums) of oils and organic solvents are stored in the Oil and Chemical Storage Building located north of the Main Transformer for Unit 7; and

¹⁰ Radioactive PCBs waste contains low levels of radioactivity but above the Nuclear Substances and Radiation Devices clearance levels [R-92].

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- Small volumes of other flammable liquids are stored in special storage cabinets located in laboratories and workshops around the stations.
- (c) Corrosives:
- Morpholine and hydrazine are used to prevent corrosion of piping and equipment; morpholine is added to the Steam Generator and condensate feedwater to control the pH while hydrazine is added to the emergency coolant injection system, Steam Generator feedwater, condensate feedwater, recirculating cooling water system and shield cooling water to remove dissolved oxygen and to control the pH;
 - Lithium hydroxide is used to control the pH and is added to the Heat Transport system, end shield cooling system and recirculating cooling water system;
 - Sodium hypochlorite is used in the zebra mussel control program; it is currently stored in tanks in the chlorination house; and
 - Sodium metabisulphite is used for dechlorination; it is added to inactive drainage and Reactor building service water.
- (d) Toxic substances:
- Boric acid and gadolinium nitrate, used for reactivity control in the moderator system, are stored mixed with D₂O in the liquid poison tanks;
 - Ion exchange (IX) resin: Neutral mixed bed resin, used for pH control and removal of impurities in the Moderator system, IFB, auxiliary fuel bay, liquid zone control stator cooling water, is stored in purification IX columns;
 - IX resin: Lithiated mixed bed resin, used for pH control and removal of impurities in the HT system, end shield cooling system and recirculating cooling water system, is stored in purification IX columns;
 - IX resin: Deoxygenating resin, used for oxygen removal in the stator cooling water system, is stored in IX columns;
 - IX resin cation, used for removal of cations in the moderator, is stored in purification IX columns;
 - Ethylene glycol, used as chillers in various systems, is stored in small tanks in the powerhouse; and
 - Reolube Turbofluid (fire resistant fluid), used as hydraulic fluid for turbine governor valves in turbine governor, is stored in tanks in the powerhouse.
- (e) Ozone depleting substances are used in chillers and air conditioners (there are no halon fire suppression systems on the Pickering Nuclear Site) but these were

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replaced by less detrimental refrigerants. R11 and R12 are no longer used at PNGS; R22 is still used in some small air conditioners. The purchase and sale hydrochlorofluorocarbons is required to be phased out by 2020 (with the exception of Freon 123 (R-123)). R-123 will be phased out in January 2030; and

- (f) Pesticides and herbicides are applied by licensed contractors when required to control weeds, insects, rodents and other pests but they are not routinely stored on the site.

Small quantities of other chemicals are used in the laboratories and workshops located around the facility. Appendix A shows the types, quantities and locations of hazardous materials at PNGS [R-86].

4.4.2.2 Hazardous Waste Inventory During Decommissioning

Hazardous wastes removed during the Preparation for Safe Storage period will include oils, lubricants and refrigerants. Many of these wastes can be recycled. Other hazardous wastes likely to be generated during the SWS period are the decontamination agents used during the decontamination of the IFBs and associated equipment. The volume of hazardous waste generated during this phase of the project is expected to be minimal.

Hazardous wastes generated during the Dismantling & Demolition and Site Restoration period of the decommissioning will likely be limited to hazardous materials originally used as building materials. Volumes of these wastes are likely to be small since very few hazardous materials were used in the construction of the plant. Dry active waste such as combustibles (paper, cloth, wood, filter cartridges) could also be generated in the removal of plant systems.

Hazardous materials that might be used during the decommissioning, such as welding gases, petroleum products (e.g., gasoline and diesel fuel) and organic solvents, are anticipated to be similar to materials used during station operations and maintenance.

4.4.2.3 Management of Hazardous Waste

The PNGS are already registered with the MECP¹¹ as a generator of hazardous wastes. The waste generator registrations will be reviewed prior to beginning the decommissioning project to ensure that all of the wastes that will be generated are registered.

Appropriate disposal facilities for hazardous wastes will be identified prior to the beginning of the decommissioning project. Hazardous wastes will be packaged for transport and disposal according to the requirements of the applicable provincial regulations. All hazardous wastes, including non-radioactive hazardous wastes, will be transferred to an appropriate, licensed waste management facility for storage or disposal at approved disposal facilities. Waste manifests will be prepared and

¹¹ In 2022, the MECP is poised to hand over oversight over the Provincial hazardous waste program to Resource Productivity and Recovery Authority.

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submitted as required by provincial regulations. Mixed waste (i.e., radioactive waste mixed with clean waste that is also hazardous) will be transferred to an appropriate long-term disposal facility.

4.4.3 Other Wastes

The bulk of the non-hazardous waste materials generated during the decommissioning will be produced during the Dismantling & Demolition and Site Restoration period of the decommissioning, although some is likely to be produced during the Preparation for Safe Storage period. Non-hazardous wastes that meet the established clearance levels will be re-used or recycled wherever possible or disposed of at approved disposal facilities.

If the volume or value of the contaminated scrap metal generated during the decommissioning is sufficient to justify further processing, chemical cleaning, electro polishing, mechanical abrasion or melting might be used to decontaminate scrap metal. Any metals that are decontaminated to levels below the clearance levels established in the DDP will be released for recycling or disposal.

Clean concrete rubble may be used on site for fill. Other non-contaminated materials will be released for disposal according to the applicable regulations.

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5.0 DECOMMISSIONING COST ESTIMATE AND FINANCIAL GUARANTEE

This section deals with the costs associated with decommissioning PNGS and the provision of a financial guarantee for the accumulated liability.

5.1 Cost Estimates

The decommissioning cost estimate update was prepared by TLG Services LLC (TLG), on behalf of OPG.

The cost associated with decommissioning PNGS is estimated at \$6.765 billion (2022 Dollars) for this financial guarantee period (2023-2027) and covers the activities as detailed in Section 3.1 of [R-15]. The aforementioned decommissioning cost is accurate as of the time of PDP approval. As OPG is currently in the process of finalizing its 2022 Ontario Nuclear Funds Agreement (ONFA) Reference Plan, this decommissioning cost may change pending further reviews by the Province.

A summary of the cost estimate for decommissioning PNGS can be found in Appendix B. The cost estimate will be updated when changes to PNGS planning assumptions occur. These changes may include the addition of or removal of facilities, systems and equipment or other changes to planning assumptions such as shutdown dates.

The costs associated with the management of used fuel including interim storage, transportation and disposal from the PNGS are not included in this estimate. Plans and cost estimates for these activities are described in separate documents.

OPG will continue to provide an annual status report to the CNSC staff detailing amounts accumulated in the applicable segregated funds for decommissioning and management of used fuel. The report will also identify any material changes in decommissioning plans or cost estimates, which may affect the financial liability incurred.

Only facilities and land within the licensed/ protected area are covered by the decommissioning segregated funds.

5.2 Financial Guarantee

For the 2023 - 2027 Financial Guarantee liabilities calculations, the TLG cost estimates will be adjusted to incorporate costs from the Financial Guarantee year onwards and will include oversight costs specific to the OPG decommissioning program. The OPG Financial Guarantee liabilities calculations process allows for managing/evaluating changes that may be required if the shutdown dates are affected.

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6.0 HUMAN AND ORGANIZATIONAL FACTORS

The term 'Human Factors' (HF) refers to those factors that influence human performance as it relates to the safety of a nuclear facility or activity over all phases, including design, construction, commissioning, operation, maintenance and decommissioning. The term 'HF engineering' refers to the application of knowledge about human capabilities and limitations to facility, system and equipment design. HF engineering ensures that the design of the equipment, human tasks and work environment are compatible with the sensory, perceptual, cognitive and physical attributes of the personnel who operate, maintain and support the facilities, systems and equipment. The goal in any phase of station life, including decommissioning is to achieve productive, error-free and safe system performance.

Unique Human and Organizational Factors issues can occur during decommissioning and that do not exist during the design, construction or operational phases of an NPP. The Human and Organizational Factors issues that may arise during the decommissioning of the PNGS can be split into the following three categories [R-93]:

(a) Work Environment, which may include:

- Activities that may be hazardous to personnel and the environment;
- Material that may be in less than optimal condition at the facility; and
- Incomplete documentation and records from operation that can create uncertainty among decommissioning staff.

(b) Work Planning, which may include:

- Activities unique to decommissioning that can impose burdens on development and maintenance of staff skills and technical knowledge;
- The long timeframe of decommissioning that can pose difficulties to organizational continuity, culture, staffing and knowledge;
- Complications in decommissioning planning due to the potential for the need to replace obsolescent systems and work practices; and
- Unique issues with human performance resulting from new tasks.

(c) Work Execution, which may include:

- Adaptations to the decommissioning work plans due to unexpected findings ('discovery work');
- Impacts of a declining staffing resource as the decommissioning program proceeds; and

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- Complications with control over monitoring remote and automated operations as well as overseeing less knowledgeable contract staff.

OPG will establish, prior to decommissioning, a Human Factors Engineering Program Plan (HFEP) for the decommissioning of the PNGS according to the recommendations of CNSC REGDOC-2.5.1, General Design Considerations: Human Factors [R-94] and REGDOC-2.2.1 'Human Factors' [R-95]. The details of the Plan will be included in the DDP. The following items should be included in the HFEP:

- Human-machine interface system;
- Human-machine allocation of function;
- Human reliability;
- Job design;
- Operating experience review;
- Physical working environment;
- Activities with potentially hazardous human interactions;
- Procedures development;
- Shift-work systems;
- Staffing; and
- Validation & verification.

Decommissioning work will also comply with requirements of the HF in design and any other guidelines available at the time of decommissioning. HF in design applies to nuclear safety, protection of the environment, health and safety of persons, security, productivity, and economics [R-96].

6.1 Transition to Decommissioning

The period of transition from operations to decommissioning poses different Human and Organizational Factors challenges to OPG than during the operational phase because of the complex process and the long time frame required to complete decommissioning. There are many HF issues that are unique to decommissioning that are not encountered during the commissioning or operational phases. Human and Organizational Factors issues that arise during the transition to decommissioning may include [R-97]:

- Loss of personnel expertise during the transition from operations to decommissioning;

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- Immediate reduction in the number of employees working at the station;
- Reliance on contractors during decommissioning instead of knowledgeable and experienced station staff;
- Decommissioning activities, such as Preparation for Safe Storage, will occur while other units on site continue to operate;
- The maintenance of safety culture of the station during the transition from operations into decommissioning;
- The change of mission from operations to decommissioning;
- The change in management and organizational structure;
- The morale of station personnel, both as the station nears scheduled shutdown and after shutdown; and
- The impact of delaying the Dismantling & Demolition of the decommissioned station and the duration of the SWS period, e.g., reduction in staff numbers.

The Human and Organizational Factors issues listed above will have a major impact on the course of the decommissioning project. OPG will ensure that Human and Organizational Factors issues are considered throughout the planning and execution of the project. Special attention will be given to staffing and training in order to minimize potential problems resulting from the loss of experienced personnel over time. Furthermore, a plan to manage staff reductions during the period following shutdown will be implemented.

As mentioned in Section 3.7, the risks associated with the decommissioning activities will be managed as per OPG's risk management process to ensure these risks are identified, analyzed, documented and appropriate measures are put in place to mitigate these risks.

6.2 Administration

OPG will retain responsibility for the station throughout the course of the Preparation for Safe Storage period for the project. OPG staff will perform the work in this phase although contractors may be retained to provide specialized services under the supervision of OPG staff. The Safe Storage Project organization has been established within OPG to plan and execute all necessary Stabilization phase activities required to place the Pickering Station into SWS.

OPG will also retain responsibility for the station throughout the course of the SWS period of the project and OPG staff will perform the work required during this phase of the project, such as equipment maintenance, inspection activities, and routine service.

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It is anticipated that for the Dismantling & Demolition stage, the organization required to oversee the decommissioning program will be assembled from available OPG station staff and outside resources as needed. Decommissioning Contractor(s) will be retained to perform the Dismantling & Demolition and Site Restoration work. OPG will provide the necessary oversight during this time period. The Decommissioning Contractor(s) will be a company or consortium selected on the basis of factors such as decommissioning experience, safety record, overall approach and cost. OPG will remain the owner and licensee of the PNGS throughout the course of the decommissioning, but the Decommissioning Contractor(s) will be given charge and control of the site during the Dismantling & Demolition and Site Restoration. Other contractors may also be given charge and control of designated portions of the site during the earlier phases of the decommissioning. During these periods, the contractor will become the 'Constructor' for the decommissioning work as defined by the Construction Safety Regulations made pursuant to the OH&S Act. The Decommissioning Contractor(s) and sub-contractors will be required to comply with OPG procedures related to Nuclear Energy Workers and other federal and provincial regulations.

6.3 Staffing

The staffing numbers for each phase of decommissioning can be found in [R-15] and have been estimated based on activities in each phase, schedule, work difficulty factors, industry experience, etc.

The numbers should be considered preliminary (i.e., for cost estimating purposes only). Business plan staffing numbers have not yet been established and will be determined at a later date.

6.4 Training

OPG will ensure that all workers are qualified to perform the work assigned to them. They will be provided with training on the hazards associated with their work and the procedures that may be used to protect against those hazards. All workers will be provided with the training through OPG's training program [R-98]. This will include training in:

- Radiation protection;
- Construction safety;
- Workplace Hazardous Materials Information System;
- Emergency procedures; and
- Any other topics that may be deemed appropriate at the time.

Long term fleet staffing plans, which include clearly defined training requirements, are being developed to cover a 10-year rolling window and these plans will be refreshed

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yearly. The staffing plans, and associated training requirements, will ensure training can be delivered within the specified timeframe to ensure capability is maintained, and that sufficient resources are available for safe and reliable operation.

Details of the training program for SWS will be provided in the DDP (or a separate SSP).

Detailed descriptions of the required training for Dismantling and Demolition will be included in the DDP that is expected to be available prior to the entering this phase.

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7.0 POTENTIAL ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS

An IA is not required for the transition period. In consultation with the CNSC and to comply with all applicable laws and regulations, OPG will determine the requirements for performing an IA, if required prior to Dismantling & Demolition. Section 13.0 provides further information on the IA process. This section is only intended to highlight some of the major effects on the natural and socio-economic environment that might occur over the course of the decommissioning work. This listing is not intended to be exhaustive.

7.1 Natural Environment

7.1.1 Air Quality

The decontamination and dismantling of nuclear systems could release airborne radioactivity. The impact of these releases will be minimized through the use of temporary containment structures and local filtered ventilation.

The heavy construction equipment and the vehicles used for transport of waste and other materials will release particulates (dust) and exhaust gases into the atmosphere. These vehicles may also result in traffic and noise pollution. The nature and extent of these releases will depend on the type of equipment in use at the time of the decommissioning. Dusts, fumes and other emissions from cutting or blasting operations, particularly during the dismantling operations, may have some impact on air quality.

Traffic resulting from the movement of heavy vehicles to and from the Pickering Nuclear Site during decommissioning may have an impact on the surrounding community but the additional impact on the environment should not be significant. Shipment of radioactive waste and used fuel from the site is governed by the Radioactive Materials Transportation program [R-80] and will be subject to strict application of the following transportation regulations [R-76], [R-99] and [R-100].

As described in Section 7.2.2, there may be noise pollution resulting from use of heavy equipment but this should be limited to a small number of distinct events during the Dismantling & Demolition work.

7.1.2 Surface Waters, Groundwater and Soil Quality

Some increase in turbidity of the water along the lakeshore may result from filling and sealing the stations' water inlets and outlets as well as from runoff during the Dismantling & Demolition and Site Restoration work.

The wetlands on the Pickering Nuclear Site are well removed from both PNGS A and PNGS B. Runoff from the decommissioning work can be controlled by standard construction techniques.

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Two conventional waste landfill sites (the East Landfill and the West Landfill) are located outside the operating island security fence of the stations. These landfills were closed in 1997 and 1999. Landfill monitoring will be required for 25-years after closure to ensure that these sites do not adversely affect the groundwater on or off the site.

Investigations, which began in the late nineties, have identified localized contamination of the groundwater on the Pickering Nuclear Site by tritium and fuel oil. There is no indication that any of the contamination has migrated beyond the immediate vicinity of the stations. PNGS has a comprehensive tritium Groundwater Monitoring Program that monitors the quality of groundwater in and around the PNGS site and can detect changed conditions that affect groundwater quality. Monitoring has shown that there are no new sources of tritium contamination and the concentration in the already affected groundwater is decreasing due, in part, to removal by the foundation till drains.

At the time of decommissioning, there are two foreseeable sources of sub-surface radioactivity at PNGS, due to [R-101]:

- Known tritium-contaminated groundwater.

After the PNGS A and B units are shut down and all the sources of tritium leakage have been terminated, significant decreases in overall groundwater tritium concentrations can be expected to occur over the course of the 30-year SWS period (see Section 3.4.1) due to dispersion and radioactive decay over time. As such, tritium concentrations will naturally decrease to levels that would meet the release criteria for the site. As such, it is plausible that remediation of the tritiated groundwater will not be required.

- Potentially contaminated soil that has become contaminated with activation and fission products.

The longer half-life radionuclides that are typically found during decommissioning are Co-60, Cs-137 and Sr-90. This contamination is likely to be found in soil relatively close (within a few meters) to the underside of the structure or components from which the leakage occurred.

Remediation would likely entail excavation of the affected soil, with off-site disposal of the soil as radioactive waste. A preliminary estimate has been made, which indicates that there is an estimated volume of 6,730 m³ of contaminated soil that would require excavation and disposal at the Pickering A station. This quantity represents the volume of soil packaged for disposal.

Annual reports on the monitoring and remedial work are being submitted to the CNSC [R-102].

The potential impact of a spill of tritium in Lake Ontario from the PNGS has also been evaluated. Mitigating actions/reduction plans will be put in place in cooperation with Central Lake Ontario Conservation Authority in the event of a tritium spill to avoid

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taking raw water containing elevated tritium levels into the municipal drinking water treatment plants [R-103].

A predictive effects assessment for Pickering Nuclear SWS was conducted to assess the potential interactions with the environment resulting from transition from its current operational condition to its safe storage state and from SWS activities. The findings of this report concluded that all emissions containing contaminants of potential concern would be discharged at acceptable levels and that current conditions were considered bounding. The overall emissions from the site and the effects on the environment during these future phases are expected to be reduced overall; therefore, the need for monitoring and mitigations and emission controls will be commensurately reduced. No interactions were identified that are predicted to pose an unacceptable risk to humans or the environment during the Stabilization and SWS activities proposed. Therefore, no new mitigation is required based on the conclusions of the Predictive Effects Assessment [R-21]. The findings of this report [R-21] will be updated when the next Environmental Risk Assessment revision is available.

During both the Stabilization and Storage with Surveillance Phases, OPG's environmental programs will be maintained, and updated as needed, to ensure continual protection of human health and the environment.

Decommissioning is also a potential source of soil and groundwater contamination, through spills of heavy water, oils and chemicals. The impact of possible releases will be minimized through the reduction of inventories immediately following the end of operations or during Preparation for Safe Storage and through the use of good practices as well as appropriate mitigating actions. More details regarding mitigating actions, such as runoff control measures, will be provided in the DDP.

7.1.3 Vegetation

As mentioned in Section 2.3.3.1, the Hydro Marsh and the Frenchman's Bay Marsh are located west of the Pickering Nuclear Site. Both Hydro Marsh and Frenchman's Bay Marsh provide habitat for migrating waterfowl and are both designated provincially significant wetlands.

Two butternut trees (designated as a nationally endangered species and protected under Ontario's Endangered Species Act) are present along the north edge of the Mixed Forest lot north of Kinsmen Park, which is located within PNGS exclusion zone. There are also three other plant species at risk have been recorded at the Pickering Nuclear Site, but which have not been observed since 2000 [R-20].

The latest annual species at risk monitoring reports such as that documented in [R-104] will be reviewed for reference and guidance to ensure compliance prior to decommissioning. However, it is not anticipated that the work performed during Preparation for Safe Storage period would have any impact on the vegetation in the immediate vicinity of the site beyond that caused by normal station operations.

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The reduced level of activity on the site during the SWS period might permit increased growth of the vegetation on the site. However, it is anticipated that the growth of vegetation inside the security fence would be controlled to prevent the areas from becoming naturalized habitat prior to dismantling.

The Dismantling & Demolition and Site Restoration work may temporarily affect whatever vegetation is growing in the immediate vicinity of the work sites. The dust produced by the work may also impact some of the vegetation near the site.

7.1.4 Wildlife

The warm water of the condenser cooling water outlets and the booms across the forebay have created feeding grounds and resting places for a variety of other waterbirds including ducks, geese and gulls. These areas remain ice-free throughout the winter and offer shelter from Lake Ontario during inclement weather [R-20]. Shutting down the stations will change the habitat of these birds. There are also some avian species that have been identified on the Pickering Nuclear Site that have the potential to be listed under the Endangered Species Act [R-105] in the future. The taller buildings and their auxiliary structures provide opportunity for raptors, such as Peregrine Falcon, and other species to scan for food sources and provides roosting opportunities for other species such as doves and sparrows. The PNGS site is also visited by birds during the spring and fall migration and a number of species have also been identified as breeding on-site, particularly in association with the Hydro Marsh and adjacent Frenchman's Bay Marsh. Few reptile or amphibian species have been recorded on the PNGS property. The Black-crowned Night Heron, which is classified as a vulnerable species in the province, is commonly observed roosting on cables across the PNGS Units 5-8 discharge channel. Three reptile species, eleven bird species and one insect species at risk with a provincial ranking of threatened or special concern were also recorded at the Pickering Nuclear Site [R-20]. If decommissioning activities impact the habitats of these species, such as removing buildings or removing grassed areas for lay-down areas, the Endangered Species Act states certain requirements are to be met and which may include providing mitigation and off-sets plans to protect these species.

In addition, the warm water conditions likely create a productive environment for fish that serves as a food source for water fowl species. Removing the warm water source will change the water environment which may impact fish and waterfowl species.

Some parts of the site that are not routinely used (such as the East Landfill and West Landfill and the marsh areas at the east and west ends of the site) have naturalized and thus become a habitat for wildlife. A variety of species of mammals, birds, reptiles and amphibians have been observed in these areas.

The latest annual species at risk monitoring reports such as that documented in [R-104] will be reviewed for reference and guidance to ensure compliance prior to decommissioning. However, it is not anticipated that the work performed during Preparation for Safe Storage period would have any impact on local animal populations beyond that caused by the operating stations.

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The local animal populations may increase during the SWS period since there will be less activity on the site. Any clearing and grubbing of vegetation on the site during the SWS period will be planned so as not to impact the annual breeding bird season.

The increased level of activity during the Dismantling & Demolition and Site Restoration period, along with the noise and dust has potential to affect species inhabiting the Pickering Nuclear Site. Increased vehicular traffic during some phases of the decommissioning may have a potential to impact wildlife.

7.1.5 Aquatic Life

The operation of the stations has created an artificial habitat for some fish species, due to warm water released from the condenser cooling water outlets. As mentioned in Section 2.3.3.2, the American Eel was identified as a species at risk in the Environmental Risk Assessment [R-20]. Additional species at risk potentially impinged at PNGS are documented in [R-106]. The Environmental Risk Assessment [R-20] concluded that this species was likely not at risk from any contaminants of potential concern arising from PNGS operations. By shutting down the stations and removing the thermal plume, changes to the local aquatic environment will likely occur and will potentially impact this habitat. This may also have an impact on sport fishing in the area.

A number of fish, amphibians and other forms of aquatic life have been observed in the marsh areas to the east and west of the site. It is not anticipated that the work performed during Preparation for Safe Storage period would have any impact on local aquatic populations beyond that caused by the operating stations. The local aquatic populations may increase during the SWS period since there will be relatively little activity on the site. The Predictive Effects Assessment for Pickering Nuclear Safe Storage further concluded that the American Eel is not at risk during the SWS Phase [R-21].

Changes in runoff from the site during Dismantling & Demolition and Site Restoration period may impact some species found on the site and this will require discussion and consultation with the Department of Fisheries and Oceans. It should be possible to control these impacts by controlling run-off from the work areas. Some increase in turbidity of the water along the lakeshore may result from filling and sealing the stations' water inlets and outlets as well as from runoff during the Dismantling & Demolition and Site Restoration work. This may have a temporary impact on some aquatic life forms.

If part of the decommissioning plans requires in-filling of the intake channels and forebay, then mitigation and off-set commitments may be required under the Fisheries Act [R-107].

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7.2 Land Use and Noise

7.2.1 Land Use

The site itself is anticipated to be utilized for other OPG uses, although it is recognized that this is subject to change – in particular in light of OPG’s Repurposing Pickering initiative (see Section 3.6).

Decommissioning itself is anticipated to have minimal impact on the use of the surrounding lands.

7.2.2 Noise

Several station systems are known to be noise sources. These include the station stacks, the standby generators and the paging system. Shutdown of the station will reduce and eventually eliminate these noise sources.

Heavy construction equipment and blasting may be used during the dismantling and demolition work towards the end of the decommissioning project. This work may produce localized elevated noise levels during the Dismantling & Demolition work. Site workers and wildlife may be temporarily impacted by the increased noise. The potential impacts of demolition noise will be assessed prior to Dismantling & Demolition and appropriate mitigation strategies will be put in place, such as not using certain demolition methods.

7.3 Human and Socio-Economic Environment

7.3.1 Purpose

The Regulatory Guide G-219 specifies that a PDP should include the “identification of any features of the surrounding... social environment that could be significantly affected by the decommissioning process” [R-2]. This section will focus on the potential for socio-economic impacts at the local community and regional level associated with the decommissioning of the stations.

This section does not attempt to assess or evaluate what impacts may actually result at the time when decommissioning actually occurs. The impacts resulting from the decommissioning process will be assessed in an IA, if required to comply with all applicable laws and regulations prior to Dismantling & Demolition, and their significance will be determined at that time.

7.3.2 Scope

If an IA is required per the IAA [R-10] which came in force in 2019, the scope of the socio-economic assessment considerations would include the other planned activities occurring in the same time period, such as decommissioning of PWSMF, which when taken together with the planned decommissioning of the PNGS may have the potential for cumulative impact on the local communities. For more details on the IA, refer to Section 13.0.

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Aspects to be considered include:

- Direct economic impacts – employment (local/non-local), skill groups required, labour supply, etc.;
- Indirect economic impacts – employee expenditure, suppliers, labour markets, etc.;
- Demographics – changes in population size and characteristics (long and short term);
- Housing; and
- Other local services – police, health, social, education, etc.

7.3.3 Definitions

Socio-economic impacts are defined as changes in people’s well-being and/or changes in significant aspects of their communities as a result of a development or project.

Socio-Economic Impact Assessment (SEIA) is a process designed to identify and evaluate the potential social, cultural and economic effects of a proposed project, policy, program or plan on people, organizations, institutions, communities and social systems. The purpose of SEIA is to recommend impact management measures that would improve a project by reducing negative community effects and enhancing community benefit.

Impact management involves the coordinated application of measures designed to mitigate, enhance, compensate, plan for contingencies, monitor and to ensure continuing liaison. Measures could also include formal impact agreements.

SEIA and impact management improve projects by identifying and managing the costs and benefits and by facilitating decision-making. A SEIA would be undertaken as part of the EA of decommissioning, if required.

7.3.4 Temporal Considerations

Shutting down the stations and the four phases associated with decommissioning, (i.e., Planning, Preparation, Execution and Completion Phases) will each have discrete activities that will result in effects on local communities. As a part of the planning activities, the local communities will be engaged throughout the process. This results in a number of socio-economic effects taking place. This has already begun for PNGS A and will continue until the end of decommissioning, i.e., in 2063. For planning purposes, it is assumed that these effects will commence in 2022 for PNGS A and 2025 for PNGS B and extend until decommissioning is complete for the site in 2063 (see Table 7-1) [R-15]. However, as noted in Section 1.0, if the station shutdown

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dates are different from the assumed dates, socio-economic conditions, including work/issues, would remain largely unchanged.

Table 7-1: Planning Schedules Affecting Socio-Economic Conditions for the Decommissioning of the Pickering Nuclear Site

Event	PNGS A Dates	Total Time Required	PNGS B Dates	Total Time Required	PWMF Dates	Total Time Required
Preparation for Safe Storage including shutdown <small>Notes 1&2</small>	2022 – 2028	8-years	2025 – 2028	3-years	–	–
SWS <small>Notes 1&2</small>	2029 – 2049	20-years	2029 – 2053	24-years	–	–
Preparation for & activities associated with Dismantling & Demolition and Site Restoration and release from regulatory control <small>Notes 1&2</small>	2050 – 2063	13-years	2054 – 2063	9-years	2058 – 2063	5-years
Total Duration at Site	2022 – 2063	41-years	2025 – 2065	36-years	2058 – 2063	5-years

Note 1: These dates are for the first units decommissioned (Unit 1 at PNGS A and Unit 5 at PNGS B).

Note 2: All dates are nominal.

The scheduled phases of decommissioning are almost continuous and overlapping, extending for a total period of nominally 40 years, for PNGS A and PNGS B from shutdown to end of decommissioning. Actual activities associated with these planned phases will be intermittent; however, it is important to understand the overall flow of activities, as these will be the major source of potential socio-economic impacts.

7.3.5 Preparation for Decommissioning/Shutdown/Preparation for Safe Storage

The most significant source of community effect will be changes in the size of the workforce when the stations are shut down. Prior to shutdown, there would be nominally 2000 workers at the PNGS station. In total, about four and three years will be needed to complete the transition activities from operations to SWS for PNGS A and B, respectively. After each station is shut down, most of the established workforce will no longer be required. The reduction of staff would probably be staggered, as the units are shut down. See Section 6.3 for further details on the staffing needs during this decommissioning phase. Some displaced workers and their families may not move away from the community and may or may not find employment locally. Other workers and their families may move away from the community. The loss of jobs, income and population will affect the local communities in a variety of ways, including effects on the housing market, services, consumer spending and social aspects.

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Local traffic patterns would change, as the numbers of staff are reduced at the stations. Any nuisance effects associated with worker traffic would change.

L&ILW generated by the decommissioning in the Preparation for Safe Storage period will be transported by truck to long-term disposal facilities for respective LLW and ILW as described in 4.4.1.3.

The closure of the PNGS will change the pattern of local expenditures and tax payments. Local and regional purchases of goods and services associated with the operation of the stations would cease. There may be some spending associated with the shutdown activities. It is possible that indirect economic effects would occur. Under current assessment legislation, tax monies will continue to be paid on buildings and structures until the structures are removed. For planning purposes, it is assumed that the amount will vary as the work progresses through each phase of the decommissioning.

7.3.6 Storage With Surveillance

The SWS period will last for nominally 30 years for each station. Over that period, a small workforce will be required, which may represent opportunities for local employment and consumer spending. Towards the end of the SWS period and during preparation for Dismantling & Demolition, the staff complement will increase at PNGS A and B to accommodate the planning activities and mobilizing for Dismantling & Demolition and Site Restoration. See Section 6.3 for further details on the staffing needs during this decommissioning phase.

7.3.7 Dismantling & Demolition and Site Restoration

When Dismantling & Demolition begins, the workforce will increase at PNGS A and PNGS B. See Section 6.3 for further details on the staffing needs during this decommissioning phase. The Dismantling & Demolition and Site Restoration activities at each station will extend over approximately 10 years. Consequently, some of these workers may move into the community. There may be local spending associated with the Dismantling & Demolition activities. It is possible that local contractors and suppliers will benefit. These changes will affect the local and regional community.

Other activities associated with Dismantling & Demolition will also be a source of effects. Most of the waste generated by the Dismantling & Demolition will not be radioactive. Of this waste, the concrete-based materials are anticipated to be used for filling at the site. The availability, proximity and cost of the disposal and any impacts related to haulage may potentially affect community services and infrastructure. Similar to L&ILW produced during Preparation for Safe Storage (Section 7.3.5), L&ILW generated during this stage of Decommissioning will be transported by truck to long-term disposal facilities for respective LLW and ILW as described in 4.4.1.3. The volume of these wastes would be substantial (~ 70,000 m³ – per Table 4-3), so it is currently expected that the number of truck trips would be considerable, probably more than the present transportation trips for operational waste from Pickering to the WWMF on the Bruce Nuclear site.

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At the conclusion of the Dismantling & Demolition period for both stations, the site will be restored for other OPG use(s). During Site Restoration, the workforce will decrease significantly at the Pickering Nuclear Site. The site will remain under the control of OPG and the input of a broad cross-section of stakeholders will be sought for the future use of the site, as described in Section 3.6. Under current assessment legislation, tax monies will continue to be paid on buildings and structures until the structures are removed. It is assumed that the tax amount paid will vary as the work progresses through each phase of decommissioning. The amount of taxes paid after the Dismantling & Demolition of all buildings will depend on the new land uses.

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8.0 POTENTIAL HAZARDS AND HEALTH & SAFETY

8.1 Hazard Assessment

A thorough assessment of the radiological, chemical and construction safety hazards that might be encountered in the course of the decommissioning project will be performed during the preparation for decommissioning. A preliminary assessment of some of the hazards likely to be encountered during the course of the decommissioning of the PNGS is summarized in Table 8-1. This preliminary hazard assessment is not exhaustive. Other potential hazards may be identified during the course of decommissioning planning and these will be addressed as appropriate.

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Table 8-1: Preliminary Hazard Assessment for the Decommissioning of PNGS

Hazard	Most Likely Source(s) of Hazard	Description/Comments
Radiation Hazard	Preparation for Safe Storage <ul style="list-style-type: none"> Handling used fuel, tritiated heavy water, filters and resins. Performing decontamination work (including the chemical decontamination). Working in gamma radiation fields produced by fission and activation products in station systems and components. 	
	Storage With Surveillance <ul style="list-style-type: none"> Storage of used fuel in the facility. Radiation fields will exist in other parts of the facility throughout SWS. 	Used fuel will continue to be stored in the facility for an initial cooling period after shutdown and the work required to transfer this fuel to dry storage will continue. At the beginning of this phase, the radiation fields will primarily be due to short-lived activation products such as tritium and cobalt-60 and these fields will decay significantly over the course of the SWS period.
	Dismantling & Demolition and Site Restoration Internal and external radiological hazards include: <ul style="list-style-type: none"> Radiation fields produced by the fission and activation products that remain in station systems and components. Hot spots from radioactive particles. Radiation fields produced by the radionuclides in the waste. Loose surface contamination (including alpha emitting radioisotopes) on tools, equipment and systems that are opened during the work. Airborne contamination generated during the decontamination work or the packaging of the waste. 	All of the radiological hazards will be removed by the end of the decontamination and disposal work during Dismantling & Demolition and Site Restoration period.
Chemical Hazard	Preparation for Safe Storage <ul style="list-style-type: none"> Draining and cleaning of water treatment facility tanks, etc. Handling the cleaning agents used during decontamination work. Transporting bulk/waste chemicals. 	
	Storage With Surveillance <ul style="list-style-type: none"> No unusual chemical hazards are expected during this phase. 	Chemical storage during SWS and decommissioning will include appropriate

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Hazard	Most Likely Source(s) of Hazard	Description/Comments
	Dismantling & Demolition and Site Restoration <ul style="list-style-type: none"> Handling the cleaning agents used during decontamination work. Transporting bulk/waste chemicals. Concrete dust generated during the dismantling work. 	storage requirements including separation of chemicals where required to avoid potential chemical hazards/explosions in case of spills or common mode event (earthquake).
Industrial and Construction Hazards	Preparation for Safe Storage <ul style="list-style-type: none"> Similar hazards to those encountered in an operating station during a shutdown (such as during a scheduled outage). Airborne hazards necessitating the use of breathing air or Powered Air Purifying Respirator (PAPR). 	
	Storage With Surveillance <ul style="list-style-type: none"> Similar hazards to those encountered in an operating station during a shutdown. Airborne hazards necessitating the use of breathing air or PAPR. 	
	Dismantling & Demolition and Site Restoration <ul style="list-style-type: none"> Airborne hazards necessitating the use of breathing air or PAPR. The operation of heavy construction equipment in close proximity to workers. Fires caused by cutting torches and grinders. The collapse of equipment or structures during dismantling. The use of blasting and other techniques to demolish concrete structures. Falls, lifting heavy objects, falling objects, use of hand tools and the other hazards routinely encountered during construction work. Working at heights inside the station. Hazards from decontamination activities (mechanical/chemical). Hazards from concealed or hidden services. 	
Biological Hazards	Biological organisms and materials that might be found on the site during the decommissioning could also produce hazards that include: <ul style="list-style-type: none"> Stings and bites from insects, rodents, birds or other animals that might live or nest inside accessible buildings. Toxins and antigens produced by moulds and other fungi that might grow on surfaces (particularly those made of biological materials). Infections or adverse reactions resulting from exposure to organisms living in decaying biological material (such as carcasses and droppings) or their by-products. 	

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Hazard	Most Likely Source(s) of Hazard	Description/Comments
Motor Vehicle Accidents	<ul style="list-style-type: none"> Highway travel/shipments. Vehicle/pedestrian collisions. Vehicle/wildlife collisions. 	
Inclement Weather	<ul style="list-style-type: none"> Temperature extremes (hot/cold). Lightning. High winds. 	Workers at the above grade structures face the greatest risk of lightning strike.
Work around Open Water	<ul style="list-style-type: none"> Work around the forebay. 	
Work at Heights	<ul style="list-style-type: none"> Work on the meteorological tower, stacks, and other tall structures. 	
Fire/Explosion	<ul style="list-style-type: none"> Hot work (e.g., cutting torches, etc.). Storage of flammable liquids. 	
Flying/Falling	<ul style="list-style-type: none"> Objects falling from heights. 	Pipes, walkways and other equipment will fall to the ground after it is cut.
	<ul style="list-style-type: none"> Objects falling off buildings/structures as they are demolished. 	Objects could fly off buildings and structures as they are being demolished.
Sharp/Heavy Objects	<ul style="list-style-type: none"> Heavy objects. 	Objects will be cut to the size required by recyclers, etc. Most objects will be too heavy to lift by hand.
	<ul style="list-style-type: none"> Sharp objects. 	Metal objects that are cut or torn may have sharp corners/edges.
Confined Spaces	<ul style="list-style-type: none"> Work in confined spaces. 	Little work will be performed in confined spaces.
Power/Hand Tools	<ul style="list-style-type: none"> Working with power tools and hand tools. 	
Heavy Equipment	<ul style="list-style-type: none"> Working around heavy equipment. 	
Excavations	<ul style="list-style-type: none"> Work in or near below grade structures. 	There are open, below-grade concrete structures on the site.
	<ul style="list-style-type: none"> Work in or near excavation in soil. 	
Demolitions	<ul style="list-style-type: none"> Working near buildings and structures under demolition. 	
Noise	<ul style="list-style-type: none"> All conventional industrial processes. 	PPE will be used.
Work around Live Services	<ul style="list-style-type: none"> Work near live aboveground services. 	Due to the tight footprints of the stations, the logistics for safe work areas, laydown areas and access for heavy lifts, etc. need to be planned,
	<ul style="list-style-type: none"> Work near live underground services. 	Live electrical and water lines are buried below the site.

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8.1.1 Occupational Dose Estimate

A preliminary assessment of the occupational dose for the decommissioning of PNGS A was conducted in 1986 [R-108].

According to this analysis, the total estimated dose for the decommissioning of PNGS A is 5.34 person-Sieverts (534 person-rem). This estimate was based on 40-years of continuous operation of the PNGS A units followed by 30-years of decay. As Units 2 and 3 are permanently shut down, those units will have operated for less than 40 years and the period of decay will be longer than 30 years. Consequently, this dose estimate is likely conservative for PNGS A, but is considered adequate for preliminary planning purposes and can serve as a guide/OPEX for future studies. The design and operating history of the PNGS B units is different from that of the PNGS A units and the occupational dose for the decommissioning of PNGS B may also be different. However, for preliminary planning purposes, it is assumed that the occupational dose estimate for PNGS A will also be applicable to PNGS B. This plan is based on the assumption that the PNGS B units will not be refurbished. An Occupational Dose Estimate for the decommissioning of the PNGS will be prepared prior to Dismantling & Demolition. The Occupational Dose Estimate will be prepared by:

- Reviewing the work breakdown to identify those decommissioning tasks that will result in an occupational exposure to workers;
- Determining the location of the work that will be performed and the number of person-hours required to complete each task;
- Using survey results or numerical models to estimate the radiation dose rates that will be encountered in each location during the performance of each task; and
- Calculating the anticipated occupational dose that will result from the performance of each task.

8.1.2 Hazards to Workers

Primary hazards to workers throughout the decommissioning will be from conventional (non-radiological) hazards, particularly through the Dismantling & Demolition and Site Restoration period. Radiological hazards will be significantly reduced by removal of contamination and/or sealing of contamination in the Preparation for Safe Storage and through the SWS period with the removal of the used fuel from the IFBs. Further details on the hazards that are likely to exist during decommissioning are provided in Table 8-1.

8.1.3 Hazards to the Public

It is currently assumed that throughout the decommissioning project, radiological hazards to the public are most likely to result from accidents during the off-site transport of radioactive wastes. The bulk of the off-site transport is expected to occur

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during the Dismantling & Demolition period. Since this activity is scheduled to occur nominally 30 years after the final station shutdown, OPG will perform an in depth analysis closer to the end of the SWS stage. This will allow OPG to take advantage of the technological advances and industry experience, further minimizing any radiological risks to the public.

8.2 Radiological Safety

All decommissioning activities will be carried out in accordance with the ALARA principle and the Radiation Protection Program of OPG [R-54]. The procedures set out in the Radiation Protection Program with respect to dose control, contamination control and so forth will continue to be followed until they are suspended or modified in consultation with the CNSC. Some of the actions that will be taken to help ensure the radiological safety of workers during the different phases are described in Sections 8.2.1 through 8.2.3. Where required, Radiation Work Plans and detailed procedures will be prepared before work begins.

Throughout the decommissioning phases, qualified staffs will be used to perform the work assigned to them using approved procedures to mitigate/eliminate hazards and any potential releases.

8.2.1 Preparation for Safe Storage Stage

OPG station staff will perform the defueling, dewatering activities with contractors performing decontamination activities during Preparation for Safe Storage. The decontamination work that will be performed at this time should further reduce the radiation dose rates in the station. When these activities are complete, the portions of the station that still contain radioactivity will be sealed off and all systems and services essential to caretaking will be kept in service.

Routine radiation surveys to help ensure public, environmental and personnel safety will be performed throughout this phase of the decommissioning. Environmental monitoring will be continued in order to confirm that radioactive emissions to the environment are kept ALARA. Surveys of work area contamination and radiation levels will also be routinely conducted and documented. The results of surveys performed at the end of this period will be used to more accurately predict the radiation levels that are likely to exist during later stages of the work.

8.2.2 Storage With Surveillance Stage

Spent fuel transfers from the IFBs to the PWMF will continue during the SWS period for 10 to 15 years after station shutdown. OPG staff will perform this work.

Radiation fields will exist in parts of the facility throughout the SWS period. At the beginning of the period, the fields will primarily be due to short-lived activation products such as tritium and cobalt-60 and these fields will decay over the course of the SWS period. During this stage of the decommissioning, surveillance, inspection and maintenance of the buildings and site will be carried out in order to ensure that the

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nuclear building structures and system envelopes retain their integrity. Hence, routine radiation surveys to help ensure public, environmental and personnel safety will be performed throughout this phase of the decommissioning. Consequently, employee exposure to the remaining fields and the resulting dose will be limited.

Environmental monitoring of the site and surrounding area will be maintained in order to confirm that radioactive releases are being controlled. Periodic gamma dose rate surveys will be carried out and documented to more accurately predict the radiation fields that will exist during Dismantling & Demolition and Site Restoration.

8.2.3 Dismantling & Demolition and Site Restoration Stage

In order to minimize radiation doses during the Dismantling & Demolition process:

- Radiation surveys will be performed and dose estimates will be prepared before work begins;
- Work plans that make allowance for the difficulty of the work to be performed will be prepared (the cost and duration estimates will make allowance for the difficulty of the work by adjusting for respiratory protection, protective clothing, work breaks and radiation protection/ALARA);
- Workers will be qualified in radiation protection and trained to perform the work. The level of training will be commensurate with the work being performed;
- The most active part of the station, the reactor calandria and associated systems will be dismantled using remotely-controlled cutters and manipulators. The operators will remain in a shielded control room and the resulting wastes will be packaged by remotely controlled manipulators;
- Where possible, components will be removed in one piece without dismantling;
- Because of the potential for airborne activity, temporary containment envelopes will be erected and many dismantling operations will be carried out by workers using approved PPE and respiratory protection;
- Contamination control procedures will be strictly observed; and
- Regular contamination and dose rate surveys will be performed and documented.

Procedures will be implemented to ensure that all persons, packages or flasks leaving the site satisfy the radioactive material transport or clearance levels. Environmental monitoring of the site and the surrounding area will be maintained throughout dismantling and waste transport operations. On completion of these operations, the final surveys will be performed to confirm that all prescribed substances have been removed to the extent specified in the DDP.

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8.3 Chemical and Demolition Safety

OPG will ensure that all decommissioning work is conducted in accordance with the requirements of the applicable federal and provincial OH&S regulations. OPG currently has a comprehensive OH&S program that meets the requirements of the OH&S Act of Ontario [R-109]. This program recognizes:

- The right of employees to know of the hazards associated with their work;
- The right of employees to participate in decisions related to health and safety; and
- The right of employees to refuse to perform work that is considered to be unsafe.

As described in Section 6.2, Decommissioning Contractor(s) will perform the decommissioning work during the Dismantling & Demolition and Site Restoration period. The contractor(s) will be given charge and control of the work area (or designated parts of the work area) as the 'Constructor'. The Decommissioning Contractor(s) will be responsible for:

- Registering the Construction Project with the Ontario Ministry of Labour as required by the Construction Safety Regulations made pursuant to the OH&S Act; and
- Providing the personnel, equipment, procedures and training required for the protection of workers, the public and environment.

OPG will provide oversight of the Decommissioning Contractor(s) to ensure that the work is performed in accordance with the requirements of the decommissioning licence, OPG policies, and the contract.

8.4 Emergency Response Planning

During the preparation of the DDP, OPG will prepare an assessment of the potential hazards to workers, the public and the environment. During Stabilization, while there is still fuel in the reactors, it is anticipated that the real or potential emergency situations that might occur will be similar to those that might occur in an operating station during a shutdown. It is also anticipated that the emergency response plans and resources required to deal with these situations would be similar to those required in an operating station during a shutdown and, on this basis, it will be necessary to maintain the operational emergency response capability until the reactors are defueled and dewatered. For example, provision of Emergency Mitigating Equipment or equivalent will still be retained for back up fuel cooling in the bays to respond to emergencies (such as Total Loss of On-Site Power). Subsequently, the response may be reduced to address spent fuel stored in IFBs. For example, distribution of KI pills to residents in the vicinity of the Pickering site (See Section 2.3.7) will no longer be required.

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As the project progresses, the potential emergency situations will come to resemble more closely those that might occur during the course of a major construction project.

At all stages of the project, OPG will ensure that:

- The required emergency response plans and procedures are in place;
- The plans are reviewed and exercised regularly;
- An adequate number of personnel are available to respond to any emergency situation that may occur;
- The emergency response personnel receive the training required to respond appropriately to any emergency situation that may occur; and
- The necessary equipment and supplies are available for use by emergency response personnel.

OPG will coordinate its response to a real or potential emergency situation with the appropriate federal, provincial, regional and municipal agencies.

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9.0 SECURITY AND SAFEGUARDS

9.1 Security

During decommissioning, OPG will continue to comply with the CNSC regulations on the physical security of nuclear facilities. OPG will be responsible for the security of the site throughout the course of the decommissioning project.

OPG will ensure the security of the site and the Decommissioning Contractor(s) and sub-contractors will be required to comply with licensing conditions and OPG procedures regarding the physical security. During most of the decommissioning of PNGS, the PWSF will still be operational. Even though they are two different facilities that are currently under separate licences, the same security staff will be responsible for both facilities.

9.2 Safeguards

In accordance with an agreement between the Government of Canada and the IAEA, nuclear safeguards are implemented at OPG's NGSs. These international safeguards apply to used fuel management.

The existing safeguards arrangements for used fuel will continue until modified or terminated by agreement with the CNSC.

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10.0 QUALITY ASSURANCE

OPG has QA programs for its operations, which is detailed in the Nuclear Management System [R-11] and that meet the requirements of national (i.e., CSA N286) and international standards. A QA program for the decommissioning work will be prepared and revised at the time of the DDP and will meet the requirements of the QA program of OPG.

The Decommissioning Contractor(s) and all sub-contractors will be required to have a QA Plan that meets the standards established by OPG's QA Plan. OPG may perform audits to ensure that they perform their work in accordance with the requirements of their QA Plan.

11.0 RECORDS

The IAEA Technical Report [R-110] states that operational records should be retained in order to meet the needs of future decommissioning. It is recognized that there is a potential for information about the PNGS to be lost as work transitions through the stages of decommissioning, and staff numbers decrease. It is therefore necessary that measures are taken to preserve and improve the existing records database and capture all potentially relevant information. Records filing and retention are governed by OPG's Information Management program [R-111], which identifies records relevant to decommissioning are permanent records. Decommissioning-related documentation will also be managed and maintained in accordance with CSA N294:19 [R-4]. The IAEA documents on record keeping (e.g., Technical Reports Series No. 411 [R-110]) will also be consulted to provide additional guidance. These records will contain historical information that may be required in the future in order to update this PDP, prepare the DDP and ultimately facilitate successful decommissioning. They will include, but are not limited to:

- (a) The DDPs and Storage with Surveillance Plans;
- (b) Interim end-state reports;
- (c) Design of facilities and buildings included in the decommissioning plan;
- (d) Licences and permits required for the decommissioning work;
- (e) Details of the operating history of the reactors;
- (f) Details of the initial design and configuration of station systems and the maintenance and modifications made to that configuration over the course of the station's operating lifetime including records of:
 - Updated drawings and photographs taken from inspections, modifications, and repairs to SSCs;

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- Details of materials used;
 - Special repair or maintenance activities and techniques; and
 - Details of the design, material composition and the history and location of all temporary modifications and devices.
- (g) Records of routine and extraordinary radiation dose rate and contamination surveys that are performed throughout the station (these records are stored in an electronic database called the VSIDS);
- (h) Records of worker and contractor doses received during the course of the station's operating lifetime;
- (i) Descriptions of the nature and location of any hazardous materials in the station and the disposition of any hazardous materials that have been removed;
- (j) Reports and other documents that describe the criteria used to define radioactive and hazardous materials and to distinguish contaminated from uncontaminated materials;
- a. the criteria used to define the final contamination status of the facility;
 - b. the principles and models used in deriving the criteria in Items a) and b);
 - c. the residual radionuclide inventory after decontamination;
 - d. the amounts of radioactive and hazardous materials removed and the disposition method;
 - e. waste management and transfer records;
 - f. the equipment and materials removed from the facility for recycling or use elsewhere, their treatment prior to removal from the site, and the disposition method;
 - g. the survey methods and the types of instruments used;
- (k) the equipment, nuclear and non-nuclear materials, and structures remaining at the end of decommissioning;
- (l) Details of any spills or releases of radioactive materials or environmentally hazardous substances that may have occurred over the course of the station's operating lifetime;
- (m) Records of any unplanned events or unusual occurrences;
- (n) Site characterization and environmental review or Impact Assessment; and
- (o) Public and Indigenous engagement/communications records.

Records pertinent to the shutdown of the station will also be maintained. The progressive shutdown of the operational units is very similar to the commissioning of a station. Record keeping during shutdown will be similar to record keeping during commissioning. Records from Stabilization such as the system end-stating activities,

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scoping and characterization surveys, etc. (see Section 4.1.4) will be well documented and be properly archived so that they can be readily available at the time of Preparation for Dismantling and Demolition. OPG will document the progress of decommissioning in a traceable manner.

Furthermore, during the course of the decommissioning, OPG will retain records of:

- The plans and procedures used in decommissioning;
- The progress achieved in meeting the schedule for the decommissioning;
- The implementation and results of the decommissioning, including the residual radionuclide inventory after decontamination;
- The results and interpretations of environmental monitoring programs;
- The manner in which and the location where any nuclear or hazardous waste is managed, stored, disposed of or transferred (i.e., waste management and transfer records);
- The name and quantity of any radioactive nuclear substances, hazardous substances and radiation that remain at the nuclear facility after completion of the decommissioning;
- The amount of radionuclides discharged via airborne and liquid pathways;
- Occupational dose records, i.e., records of worker and contractor doses received during the decommissioning phases;
- The status of each worker's qualifications, re-qualification and training, including the results of all tests and examinations completed in accordance with the licence;
- Any deviations from plans and procedures;
- The quality assurance records;
- The final radiological and hazardous materials surveys;
- Final end-state reports; and
- The land remediation undertaken, including the results of verification analyses as compared to criteria used or derived for soil and water quality (defined in the DDP), and the disposition of any affected media.

At the completion of decommissioning, all appropriate records will be retained for the purpose of:

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- Confirmation of completion of decommissioning activities;
- Recording the disposition of wastes, materials and premises; and
- Responding to possible liability claims.

Decommissioning records will be kept in the storage medium in standard use at the time of the decommissioning. All records will be assembled and maintained in accordance with the document and record management process and governance. Because of the long time frame anticipated for the decommissioning, records will be periodically checked to ensure their preservation and protection from loss, deterioration and destruction.

12.0 PUBLIC AND STAKEHOLDER ENGAGEMENT PROGRAM

A public and stakeholder engagement program along with an Indigenous relations program will support the development of the DDP, an IA (if one is required – see also Section 13.0) and to support consultation for future uses of the site (see also Section 3.6). The program will include both information and consultation opportunities. It will be designed to involve a broad cross-section of stakeholders employing a variety of methods that will meet the needs of the participants and the objectives of the business.

The program will identify issues and concerns; ensure opportunities for involvement; ensure all input was considered in decommissioning planning and/or in the environmental risk assessment, and include the documentation of the process and results. The program will also support the development of an integrated community impact management plan.

The public and stakeholder engagement programs will comply with the applicable requirements of REGDOC-3.2.1, Public Information and Disclosure [R-7] and REGDOC-3.2.2, Indigenous Engagement [R-8].

13.0 IMPACT ASSESSMENT

The IAA came into force in 2019 and is the legal basis for the federal EA process in Canada, now known as IA [R-10]. In consultation with the CNSC and to comply with all applicable laws and regulations, OPG will determine the requirements for performing an IA, if required, prior to Dismantling & Demolition to ensure that adequate provisions for the protection of the environment and the health and safety of persons are made during decommissioning. Some of the effects on the natural and socio-economic environment that might occur over the course of the decommissioning work are described in Section 7.0.

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- [R-108]** Jayawardene, N. D., 'Pickering NGS A Decommissioning Cost Study', Report 86301, Ontario Hydro, November 1986.
- [R-109]** Government of Ontario, 'Occupational Health and Safety Act, R.S.O 1990', Consolidated: July 2020.
- [R-110]** IAEA, 'Record keeping for the Decommissioning of Nuclear Facilities: Guidelines and Experience', Technical report Series No. 411, 2002.
- [R-111]** OPG, 'Information Management', OPG-PROG-0001.

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Appendix A: Types, Quantities and Locations of Hazardous Materials Stored at PNGS

Table A-1: PNGS Hazardous Substances List [R-86]

Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Boric acid	Moderator system	Reactivity control	Mixed with D ₂ O in the liquid poison tanks	Removed by IX resin in the moderator purification system	~54 pcs of 500g bottles of Boric Oxide	Pickering 014: ~1700L Pickering 058: ~850L	Solid, made into solution for addition.	Toxic, irritant.
Gadolinium Nitrate	Moderator system	Reactivity control	Mixed with D ₂ O in the liquid poison tanks	Removed by IX resin in the moderator purification system	~36 pcs of 5kg bags	Pickering 058: LISS: ~19,000 L Moderator: ~1700 L	Solid, made into solution for addition.	Toxic, severe irritant.
Helium gas	Cover gas for moderator; Liquid zone control;	Cover gas to prevent air ingress	Gas cylinders	Periodically purged to reactor building exhaust for chemistry control	~80 cylinders 291ft ³ per cylinder	Moderator Cover Gas: P014 and P058 combined ~6000ft ³ LZC: P014 and P058 combined: ~7000ft ³	Compressed Gas	Compressed gas, simple asphyxiant, lighter than air.
Oxygen gas	Moderator cover gas; annulus gas	Added to recombine with D ₂ gas; to maintain pressure	Gas cylinders	Consumed; emitted to reactor building exhaust	~2 cylinders 335ft ³ per cylinder	Moderator Cover Gas P058: ~2600ft ³ P014: none	Compressed Gas	Strong oxidizer - increases flammability of flammable or combustible

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Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
		integrity				Annulus Gas P014 and P058 combined ~1000ft ³		material.
Hydrogen gas	Heat transport system; main generators	Remove O ₂ from the heat transport system; cooling for the generators	Mobile trailer and gas cylinders	Consumed in the heat transport system and vented to reactor building exhaust; periodically vented to atmosphere from the main generators	~2 cylinders @ 196ft ³ ; 5 cylinders @ 2.77m ³	HTS:P014 and P058 combined: ~6500ft ³ Main Generator: P014 and P058 combined: ~115,000ft ³ In a Mobile trailer hooked up directly to the system.	Compressed Gas	Flammable Compressed Gas, lighter than air.
Hydrazine (35% solution)	Emergency coolant injection system; steam generator feedwater; condensate feedwater; recirculating cooling water system; end shield cooling water	Removal of O ₂ and pH control	Oil and Chemical Storage Building – Totes and drums – Totes in chemical addition station in turbine hall	Consumed but residual may be discharged to lake or atmosphere. A breakdown product in feedwater is ammonia.	Pickering 014 uses drums. ~ 12 drums @ 208.65kg per drums as hydrazine hydrate Pickering 058 uses totes. ~1800 L (2x 900L totes) as hydrazine hydrate	Pickering 014: typically 1 drum (205 L) connected to the system. Pickering 058: ~1800 L This is in totes connected to the system.	Liquid	Corrosive base, Toxic

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Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Lithium hydroxide	Heat transport system; end shield cooling system; recirculating cooling water system	pH control	Station – chemical addition systems	Consumed (used when pH must be rapidly corrected; usually the pH is controlled by lithiated IX columns)	~14 pcs of 0.5kg bags	P014 and P058 combined: HTS: ~ 240g (in solution) (0.24kg) RCW: ~2.7kg (in solution)	Solid, made into solution for addition.	Corrosive base
IX resin: Neutral Mixed Bed Resin	Moderator system; irradiated fuel bay; auxiliary fuel bay; liquid zone control Stator Cooling Water	pH control and removal of impurities	Purification IX columns	Temporary storage – spent resin tank	~45 pcs of 1ft ³ package 2pcs of 35ft ³ package	P014 and P058 combined: Moderator: ~55ft ³ IFB: ~ 240ft ³ AIFB ~ 200ft ³ LZC ~ 4ft ³ SCW ~ 14ft ³	Solid	Toxic, irritant
IX resin: Lithiated mixed bed resin	Heat transport system; end shield cooling system; recirculating cooling water system	pH control and removal of impurities	Purification IX columns	Temporary storage – spent resin tank	~243 pcs of 0.5ft ³ bags	All P014 and P058 combined: HTS ~30ft ³ RCW ~4ft ³ ESC ~23ft ³	Solid	Toxic, irritant
IX resin: Deoxygenating Resin	Stator cooling water system	Removal of O2	IX column	Industrial waste disposal	~4 pcs of 1ft ³ packages	All P014 and P058 combined:	Solid	Toxic, irritant

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Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
						~14ft ³		
IX resin Cation	Moderator (PB only)	Removal of cations	Purification IX columns	Industrial waste disposal	~50 pcs of 1ft3 packages (28.32 l/bag)	Moderator (P058 only) ~1ft3	Solid	Toxic, irritant
Carbon dioxide gas	Annulus gas system; generator	Annulus gas system – carrier gas; generator – purging gas	Outdoor tank (gas cylinder)	Annulus gas system – to reactor building exhaust; generator – vented to atmosphere	~33 pcs of 12 pack cylinders (K size container)	Annulus Gas: P014 and P058 combined: ~120ft3	Compressed Gas	Mildly toxic, asphyxiant in high concentrations, heavier than air.
Morpholine The liquid is 45%; The drum is 50%	Steam generator feedwater; condensate feedwater	pH control and corrosion control	Totes in Oil and Chemical Storage Building and chemical addition station in turbine hall	Partly consumed; atmospheric discharge; and steam generator blowdown	Pickering 014 uses drums ~45 drums @ 441lb/drum of 50% solution. Pickering 058 uses totes ~ 1800L of 45% solution	Pickering 014: typically, 1 drum (205 L) connected to the system. Pickering 058: ~ 1800L. This is in totes connected directly to the system.	Liquid	Combustible liquid, toxic, corrosive base.
Sodium Hypochlorite 7%	Low pressure service water	Zebra mussel control	Four tanks in chlorination house	Consumed and residual to Lake Ontario	Pickering 014: ~52,000L Pickering 058: ~54,000L	Tanks connected to the system directly	Liquid	Corrosive acid, oxidizer - increases flammability of flammable or combustible material.
Sodium Metabisulphite 38%	Inactive drainage; reactor building	Dechlorination	Outdoor tanks with secondary	Consumed	Pickering 014: ~	Tanks connected to the system	Liquid	Corrosive acid, toxic.

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Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Reolube Turbofluid 46XC (Fire Resistant Fluid (FRF))	Turbine governor	Hydraulic fluid for turbine governor valves	Tanks in powerhouse	Reused or drummed for disposal	Pickering 014 and 058 combined: ~3400L	Tanks directly connected to the system	Liquid	Mildly toxic
Diesel (Fire pumps)	Diesel Fire Pumps	Operating Pumps	Tanks	Consumed resulting in waste gases CO2, NOx, SOx, etc.	Pickering 014: ~ 7200 L	Directly connected to the system	Liquid	Combustible Liquid, toxic
Gas, Mixed, 3% Nitrogen, 1.5% Oxygen	QC gas – Chemical Lab use as per chemical assessment	Quality control	gas cylinder	Vented to atmosphere	K and A size bottles	Chem Lab use	Gas	Compressed gas
GAS, Freon R134A Refrigerant	Used as a refrigerant	Maintenance - HVAC	gas cylinder	In the system	100 lb cylinder	In the station chillers on Units 0, 1,2,3,4.	Gas	Compressed gas
GAS, Argon, refrigerated liquid	Used in chem. Lab instrumentation. Also used by BTU as a cover gas for their metal analyzer	Ultra high purity ICP grade	gas cylinder	Return to empty gas bottle storage area and/or vendor as per HIS/SDS	230 litre cylinders	Chem lab use for instrumentation	Gas	Compressed Gas
Sodium hydroxide	stator cooling water system	Alkalization	NaOH tank on 254' in the Turbine Bay	There is a plan to use this material in 2018	Not available	Dilute 2%	Liquid	Corrosive
Xylene	various	Solvent, thinner	Flammable cabinet	Industrial waste disposal	4IX23	Used as required	Liquid	Flammable
Refrigerant	HVAC	Refrigerant	HVAC System	Re-used in the system	45.4 KG DRUM	Contained within equipment	Gas	Toxic
Desiccant	CID: 193074 Compressed Air	Adsorbents	General Storage Area/	Disposed as conventional	25 kg containers (140	Connected to the system as child	Solid	Not WHMIS controlled

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Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
	Circuit HP & LP Instrument Air CID: 328987 Boiler Vapour Recovery (72210) Reactor Vault Vapour Recovery (72230) Mod Room Vapor Recover (72220)	Adsorbent material used as moisture remover in system driers.	Bulk Storage as per HIS/SDS 570 Requires compress gas storage as per HIS/SDS 1440	waste or active waste if active as per HIS/SDS 570 Dispose as conventional waste or active waste if active – take to appropriate chem. Waste drop off area as per HIS/SDS 1440	kg and 150 kg steel drums for molecular sieve)	CAT ID 193074 to Parent CAT ID 188684 (Inlet Filter). connected to the system	Beads or Pellets	Toxic
Scintillant	For on line tritium monitors	Monitors	Corrosive cabinet	Industrial waste disposal	5LX110 bottle	Used as required	Liquid	Corrosive
Solvent, Degreaser	Varies	Cleaning compound, for parts washer	Flammable storage cabinet	Industrial waste disposal	45 GAL DRUM	Used as required	Liquid	Flammable
Xiameter PMX- 561 Transformer Fluid	Filling stator cavity with di- electric oil as part of overhaul	Pump motor lubricant	General Storage	Industrial waste disposal	20Kg/Pail	As required	Liquid	Non-toxic during normal use
Teresstic B8	Lube oil for auxiliary equipment like Gear box, Compressors, Bearings- CAT ID 1007634 (replacement of Teresso 68 Cat Id 323192 for PNGS)	Auxiliary equipment	General Storage	Industrial waste disposal	>1200 L	> 4 hours/shift, permanent	Liquid	Non-toxic during normal use.
Atlas Roto Inject	Garage (CAT ID	Compressor	General	Industrial waste	Not available	< 1 hour/shift,	Liquid	Non-toxic during

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Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Compressor Fluid	323170)	Fluid	Storage	disposal		permanent		normal use.
Super Fast Glue Flex 20-G	Nuclear Waste Transportation (CAT ID 1007788)	Adhesive	General Storage	Industrial waste disposal	Not available	< 1 hour/shift, permanent	Liquid	Toxic
Silicon Spray	Lubrication of Door Seals during loading and unloading of the package (CAT ID 1007789)	Lubricating door seals	Flammable storage cabinet	Industrial waste disposal	500ml	< 1 hour/shift	Aerosol containing a liquefied gas	Flammable
Kent Acrysol	Nuclear Waste Transportation (CAT ID 1007822)	Paint preparation and auto body solvent	Flammable storage cabinet	Industrial waste disposal	Not available	1-4 hours/shift	Liquid	Flammable
Electron-22	Flushing oil	Testing equipment	General Storage Cabinet	Industrial waste disposal	Possibly 2 L/month	> 4 hours/shift, permanent	Liquid	Toxic
Birkosit Dichtungskitt	Sealant (CAD ID 1012768)	Turbine components (use to prevent Steam Leak)	Regular Storage	Industrial waste disposal	1 Kg Tin	Used as required	Viscous at 20 °C	Could be irritant
Potassium nitrate	Chem lab (CAT ID 1014997)	Station laboratory	Oxidizer storage cabinet	As per Chem Lab procedure	500 grams	As per lab procedure	Solid	Oxidizer
Scale Break MP (Citric acid- based)	ESW Heat Exchangers (CAT ID 1015061)	Clean and Flush ESW Heat Exchanger coils	Corrosive acid storage cabinet		Not available	1-4 hours/shift, when needed	Liquid	Corrosive
Lubricating oil and seal oil	Turbine lubricating oil system; generator seal oil system	Lubrication and sealing	Three tanks on the north side of the turbine hall	Reused or removed by contractor	~570 drums @ 205L each	P014 and P058 combined: ~375,000L	Liquid	Non-toxic during normal use.

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Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Teresso #46								
Dow 738	Applied on generator hoses during re-assembly	Lubricant	General Storage Cabinet	Industrial waste disposal	2 tubes	Stator Chemical Cleaning	Paste	Low toxicity
Hellerine	Applied on generator hoses during re-assembly	Lubricant	Flammable storage cabinet	Industrial waste disposal	2 bottles	Stator Chemical Cleaning	Liquid	Low toxicity, flammable
Loctite 243	Applied on generator bolts (CAT ID 848625)	Threadlocker	General Storage Cabinet	Industrial waste disposal	As per procedure	Stator Chemical Cleaning	Liquid	Irritant
RTV11 Part A	Injected in the generator boots	Silicone Injection	Corrosive Storage Cabinet	Industrial waste disposal	2 boot kits	Stator Chemical Cleaning	Liquid	Corrosive
RTV11 Part B	Injected in the generator boots	Silicone Injection	General Storage Cabinet	Industrial waste disposal		Stator Chemical Cleaning	Liquid	Irritant
Molykote	MOLYKOTE® 4 Electrical Insulating Compound	Electrical Insulator/Grease	General Storage Cabinet	Industrial waste disposal	As per procedure	Stator Chemical Cleaning	White translucent grease	Low toxicity
Snoop	Sprayed on the generator hose fittings to detect leak	Leak detection	General Storage Cabinet	Industrial waste disposal	~ dozen of 500 ml bottles.	Stator Chemical Cleaning	Liquid	Low toxicity
BioCorr	Sprayed on the generator rotor, machine ring coupling	Rust prevention	General Storage Cabinet	Industrial waste disposal	As per procedure	Stator Chemical Cleaning	Emulsion	Low toxicity
Glyptal	Painted in the Stator Bore (CAT ID 732194).	Varnish	Compressed gas	As per procedure	As per procedure	Stator Chemical Cleaning		Medium toxicity, flammable

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Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Certainty Plus	Various (No CAT Id), SDS# 7475	Disinfectant wipe	Regular Storage	Waste disposal	As per procedure	Used as required	Solid	Non-toxic during normal use.
Hand sanitizer - Formulation 3	Various (No CAT Id), SDS# 7433	Disinfectant	Flammable storage cabinet	Industrial waste disposal	As per procedure	Used as required	Liquid	Flammable
Neutral disinfectant cleaner	Laundry- radiation protection comfo respirator routine service. CAT ID: 683051	Liquid bleach	Corrosive cabinet blue	Industrial waste disposal	As per daily requirements	As required per wash	Liquid	Corrosive

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Appendix B: Executive Summary “Decommissioning Cost Study for the Pickering Nuclear Generating Stations” [R-15]

This study, prepared for OPG by TLG, estimates the decommissioning costs of the PNGS at \$6.765 billion (2022 CAD). The major contributors to the overall decommissioning cost are labour and radioactive waste management. The cost is based on several key assumptions, regarding regulatory requirements, estimating methodology, allowance requirements, low and intermediate-level radioactive waste, disposal site availability for radioactive waste management and site restoration requirements. A complete discussion of the assumptions used in this estimate is presented in Section 3.5 of [R-15].

NOTE: for the 2023 - 2027 Financial Guarantee liabilities calculations, the TLG cost estimates will be adjusted to incorporate costs from the Financial Guarantee year onwards and include oversight costs specific to the OPG decommissioning program.

The estimate considers the early shutdown of Units 2 and 3 and includes a SWS period prior to the initiation of dismantling operations. Units 2 and 3 are currently in a safe storage condition. Unit 2 and 3 costs incurred prior to 2020 are not included in this estimate. Decontamination and dismantling activities are coordinated at all eight Pickering units to optimize the project schedule and maintain continuity in the overall process.

Regulations

Guidance on nuclear station decommissioning in Canada is found in Regulatory Guide G-219, ‘Decommissioning Planning for Licensed Activities’ [R-2], promulgated by the CNSC. This document provides guidance regarding the preparation of decommissioning plans for activities licensed by the CNSC.

The CNSC summarized the statement on decommissioning in G-219 as follows: ‘The CNSC requires that an acceptable preliminary decommissioning plan be filed as early as possible in the life cycle of a licensed activity. The main roles of the preliminary decommissioning planning process and plan are to:...2) document a preferred decommissioning strategy which, in light of current knowledge, represents a technically feasible, safe and environmentally acceptable approach; and 3) provide a structured and dynamic outline for establishing and maintaining an acceptable financial guarantee program and preparing a detailed decommissioning plan.’

This statement is similar in philosophy to the United States Nuclear Regulatory Commission’s position on decommissioning: that adequate funds be collected over the operating life of a nuclear facility, such that, at the end of its useful life, the facility may be removed from service safely, without endangering the health and welfare of the public. The basic intent of this requirement is the same for both Canada and the United States: that the estimates for performing this future work be reviewed and updated periodically to capture economic trends, technical advances in the performance of any field-related activities that would affect final decontamination and dismantling of a facility, and changes in facility configuration or conditions.

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This study addresses all activities necessary to comply with the applicable CNSC requirements, and includes those decommissioning activities and work stages defined by the CSA's 'Decommissioning of facilities Containing Nuclear Substances'. The cost estimate for PNGS addresses the cost of the following activities [R-4]:

- (a) preparation for final shutdown;
- (b) site characterization, site surveys;
- (c) facility shutdown activities;
- (d) additional activities for safe enclosure;
- (e) decontamination and dismantling activities;
- (f) processing, storage and disposal of all waste including used fuel;
- (g) project management, engineering, and site support;
- (h) site clean-up, landscaping, and restoration;
- (i) long-term management of radioactive waste and used fuel;
- (j) long-term monitoring and maintenance of the site and institutional control;
- (k) licensing costs; and
- (l) miscellaneous expenditures.

Methodology

The methodology used to develop the decommissioning cost estimates for OPG follows the basic approach originally presented in the cost estimating guidelines¹² developed by the Atomic Industrial Forum (now Nuclear Energy Institute). This reference describes a unit cost factor method for estimating decommissioning activity costs. The unit cost factors used in this study reflect site-specific costs and the latest available information about worker productivity in decommissioning. The experience gained in the Shippingport Station Decommissioning Project, completed in 1989, as well as from TLG's involvement in the decommissioning planning and engineering for the Vermont Yankee, Chrystal River, Gentilly-2, Shoreham, Yankee Rowe, Trojan, Rancho Seco, Pathfinder and Cintichem reactor facilities, is reflected within this estimate.

An activity duration critical path is used to determine the total decommissioning program schedule required for calculating the carrying costs, which include program management, administration, field engineering, equipment rental, QA and security. This systematic approach for assembling

¹² T.S. LaGuardia et al., 'Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates,' AIF/NESP-036, May 1986.

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decommissioning estimates has ensured a high degree of confidence in the reliability of the resulting costs, in line with CSA N294:19 requirements [R-4].

Allowance

Consistent with accepted cost estimating practice, allowances are applied to the decontamination and dismantling costs developed as ‘specific provision for unforeseeable elements of cost within the defined project scope, particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur.’¹³ The cost elements in the estimate are based on ideal conditions; therefore, the types of unforeseeable events that are almost certain to occur in decommissioning, based on industry experience, are addressed through a percentage allowance applied on a line-item basis. This allowance factor is a nearly universal element in all large-scale construction and demolition projects. It should be noted that allowance, as used in this estimate, does not account for price escalation and inflation in the cost of decommissioning over the remaining operating life of the station and subsequent storage period.

The use and role of allowances within decommissioning estimates is not a safety factor issue. Safety factors provide additional security and address situations that may never occur. Allowance funds, by contrast, are expected to be fully expended throughout the program. Inclusion of allowance is necessary to provide assurance that sufficient funding will be available to accomplish the intended tasks.

Low- and Intermediate-Level Radioactive Waste Disposal

The contaminated and activated material generated in the decontamination and dismantling of a commercial nuclear reactor is classified as low- and/or intermediate-level radioactive waste (LLW and ILW). OPG has developed both ‘fixed’ and ‘schedule-sensitive variable unit’ disposal charges for both classifications of waste based on disposing of these products at OPG’s proposed LLW and ILW waste disposal facility. Refer to Section 3.4.5 of the PNGS Decommissioning Costing Study [R-15] for a description of the applicable Pickering waste management disposal rates. Note: disposal fees include transportation to the waste facility, the applicable tariffs, fees and mileage-related expenses.

High-Level Radioactive Waste

The disposition of high-level radioactive waste is limited to the used fuel generated from operations. This study includes the direct cost of removing fuel from the calandria to the fuel bays as a decommissioning expense after permanent cessation of operations. Other used fuel management costs are not considered and are accounted for separately by OPG.

Site Restoration

Site Restoration, which includes the demolition of ‘clean’ structures, will occur promptly after radioactive material has been removed from the station (site meets radiological release criteria).

¹³ Project and Cost Engineers’ Handbook, Second Edition, American Association of Cost Engineers, Marcel Dekker, Inc., New York, New York, p. 239.

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Consequently, this study assumes that site structures within the restricted access area are removed to a nominal depth of one meter below the local grade level wherever possible. Foundation grade slabs greater than one meter in thickness will be abandoned in place and covered over with a layer of backfill. The site is then graded and stabilized.

Summary

This study provides an estimate for decommissioning the PNGS under current requirements and is based on present-day costs and available technology. Tables are provided at the end of this section that summarizes the decommissioning costs by category and the costs organized by Work Breakdown Structure (WBS) element. The categories as used in the summary table include:

- Decontamination – The cost of decontaminating systems and structures.
- Removal – The cost of removing systems and structures.
- Packaging – The cost of packaging contaminated material for disposal.
- LLW and ILW Transportation and Disposal – The cost of transporting and disposing of contaminated material.
- Project Management – The cost associated with managing and supporting the decommissioning work activities.
- LLW and ILW disposal facilities – Incremental decommissioning-related costs associated with the capital expenditures and decommissioning (allocated among NGSs).
- Management of Heavy Water – The costs associated with the long-term management of heavy water after station shutdown (allocated among NGSs).
- Other – Those costs not directly associated with the cost categories described above, including – defueling, de-watering, IA (if required – see Section 13.0), energy, taxes, fees, insurance, overheads, etc.
- Allowance – The cost allocated to project allowance. This cost is applied to each WBS element and varies by element.
- Risk Contingency – The costs associated with decommissioning circumstances not included within specific WBS elements of the estimate. The risk contingency is included to address problems that are likely to occur beyond the project scope (i.e., unknown unknowns).

This information is extracted from the detailed work breakdown structure for each reactor unit and common systems/structures provided in Appendix C of the cost estimate. The schedule and sequence of decommissioning activities are identified in Section 4 of the cost estimate [R-15]. A detailed breakdown of the major cost contributors to the decommissioning cost estimate is reported in Section 6 of the cost estimate [R-15].

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This cost analysis is designed to provide OPG with sufficient information to assess its financial obligations, as they pertain to the eventual decommissioning of PNGS. It is a cost estimate prepared in advance of the detailed engineering preparations required to carry out the decommissioning and is based upon current industry experience.

Table B-1: Summary of Decommissioning Cost Estimate for PNGS

Work Category	Costs Estimate 2022\$ CAD ² (thousands) [R-15]
Decontamination	60,065
Removal	715,261
Packaging	303,097
LLW and ILW Transportation and Disposal	305,607
Project Management (Utility & DOC) ⁵	1,444,976
LLW & ILW Waste Disposal Facilities	261,598
Management of Heavy water	117,869
Other ¹	2,112,287
Sub-Total Direct Cost	5,320,760
Allowance ³	1,001,240
Sub-Total Direct Cost with Allowance	6,322,000
Risk Contingency ⁴	442,540
Total	6,764,540

Note:

- (1) Other includes: Engineering and preparations, insurance, taxes, energy, facility maintenance, defueling, dewatering costs, etc.
- (2) Columns may not add due to rounding.
- (3) Allowance as a Percent of Direct Costs.
- (4) Risk Contingency as a Percent of Direct Costs with Allowance.

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Appendix C: Compliance Matrix with CSA N294:19

Table C-1: Compliance Matrix between CSA N294:19 and this Plan

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
4.1	The owner of a nuclear facility shall be responsible for planning, executing, and funding all phases of decommissioning.	1.3 5.2
4.2	Decommissioning activities shall be planned and executed in accordance with relevant regulations and standards and in keeping with relevant guides. Responsibilities for decommissioning, preparing documents, and recordkeeping shall be clearly established throughout the life cycle of a facility. Responsibility for the funding of the decommissioning shall be identified and financial guarantee shall be established to ensure adequate funding for decommissioning	1.2, 1.4 1.3, 6.1, 6.2 11.0 1.3, 5.2
4.3	The owner shall consider the requirements of CSA N286 when executing decommissioning works, including the following: <ul style="list-style-type: none"> (a) protecting the health and safety of workers and the public; (b) protecting the environment; (c) complying with requirements of the AHJ; (d) keeping radiation exposures as low as reasonably achievable (ALARA); (e) managing all radioactive and hazardous materials generated by the decommissioning; (f) security; and (g) safeguards 	10.0 8.0, 8.1.2, 8.1.3, 8.2 7.0, 8.2.1 - 8.2.3, 8.3, 8.4 & 13.0 1.4 8.2 4.3.5, 4.4 9.1 9.2
4.4	Programs shall be developed and implemented to support decommissioning.	4.1.2, 4.1.4, 4.2, 4.2.3 This pertains to the execution phase.
5.1.1.3	A financial guarantee for decommissioning shall be established to ensure that adequate funding is available at the time of decommissioning. The financial guarantee for decommissioning shall be maintained throughout the life cycle of the facility.	1.3 5.2
5.1.6	The final end-state shall be considered reached when the end-state objectives as set in the DDP are verified to have been achieved (Annex F describes how to establish the end-state objectives).	4.3.8

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Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
5.1.7	The party accountable for decommissioning shall identify the applicable institutional control requirements following decommissioning as well as the available administrative processes in the jurisdiction in which they are located.	This will be done as part of preparing the DDP (see Section 4.2.4) 4.3.8, 4.3.9

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Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
5.2.5	<p>Decommissioning records shall include, as applicable,</p> <ul style="list-style-type: none"> a) the DDP(s); b) public and Indigenous engagement/communication records (as per CNSC REGDOC-3.2.2); c) if required by the AHJ, an impact assessment or environmental review in accordance with applicable legislation; d) licences and permits required for the decommissioning work; e) the plans and procedures used in decommissioning; f) reports and other documents that describe <ul style="list-style-type: none"> i) the criteria used to define radioactive and hazardous materials and to distinguish contaminated from uncontaminated materials; ii) the criteria used to define the final contamination status of the facility; iii) the principles and models used in deriving the criteria in Items i) and ii); iv) the residual radionuclide inventory after decontamination; v) the amounts of radioactive and hazardous materials removed and the disposition method; vi) waste management and transfer records; vii) the equipment and materials removed from the facility for recycling or use elsewhere, their treatment prior to removal from the site, and the disposition method; viii) the survey methods and the types of instruments used; ix) the equipment, nuclear and non-nuclear materials, and structures remaining at the end of decommissioning; and x) land remediation undertaken, results of verification analyses as compared to criteria used or derived for soil and water quality, and the disposition of affected media; g) reports, other documents, and photographs describing findings from inspections, modifications, and repairs to SSCs; h) reports and other documents that describe unplanned or unusual occurrences; i) results and interpretations of environmental monitoring programs; j) occupational dose records; k) deviations from plans and procedures; l) quality assurance records; m) storage-with-surveillance plans; n) facility inspection, maintenance, and equipment records; o) the final radiological and hazardous materials surveys; and p) interim and final end-state reports. 	<p style="text-align: center;">11.0</p> <p>This pertains to records following the completion of decommissioning.</p>

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Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
5.4.2	The facility shall be characterized. See Annex G for guidance.	3.5 4.1.4.6, 4.3.7
5.4.3	All radioactive waste generated shall be characterized as per the CSA N292 series of Standards.	4.4
5.5.1	A strategy shall be developed for the management of all radioactive, hazardous, and conventional waste that will be generated throughout the course of the decommissioning.	4.4
5.6	A hazard assessment commensurate with the tasks to be performed shall be completed prior to decommissioning.	8.1
5.8.1	A quality assurance program shall be implemented.	10.0
6.1.1	The owner shall demonstrate that, under the strategy selected, the facility will be maintained in a safe configuration at all times.	1.3 3.4.1
6.1.2.2	In such cases where the end-state for in-situ decommissioning results in a waste disposal site, an applicant shall satisfy all regulatory requirements for a radioactive waste disposal facility and demonstrate safety via a safety case and post-closure safety assessment of a disposal facility.	N/A
6.2.1	For sites with more than one facility, a site decommissioning plan shall be developed to ensure that interdependencies are taken into account.	2.2.8.1 3.1 4.0
6.2.3	<p>Cost estimates shall include all decommissioning activities from operations, during shutdown to the final release from regulatory control.</p> <p>The cost estimate for decommissioning shall address the cost of the following principal activities, if applicable:</p> <ul style="list-style-type: none"> a) preparation for final shutdown; b) site characterization, site surveys; c) facility shutdown activities; d) additional activities for safe enclosure; e) decontamination and dismantling activities; f) processing, storage and disposal of all waste including used fuel; g) project management, engineering, and site support; h) site clean-up, landscaping, and restoration; i) long-term management of radioactive waste and used fuel; j) long-term monitoring and maintenance of the site and institutional control; k) licensing costs; and l) miscellaneous expenditures. 	5.1 Appendix B

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Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
7.1.1	Preparation for decommissioning shall include a) an assessment of the records from the previous life cycle stages and the state of the facility (e.g., baseline configuration) at the time of shutdown; b) an impact assessment or environmental review in accordance with applicable legislation, if required; c) a safety assessment for decommissioning; d) ensuring that there is a sufficient number of qualified staff to ensure safe operation during the approach to shutdown; e) further development of the PDP into the DDP; f) placing a facility in a permanent shutdown state; and g) any additional requirements specified by the AHJ.	3.5, 4.1 11.0 13.0 3.7, 4.1.2, 4.2.4, 8.1 4.1.3, 6.4 1.1, 3.3 4.1(4.1.1 - 4.1.4) 1.2.1, 4.1
7.1.2	The owner shall ensure that processes, systems, and personnel are in place to maintain the facility in a safe state during the transition to decommissioning.	4.1, 8.2.1
7.4.1.1	To ensure a smooth transition from operation to decommissioning, the facility shall be prepared to complete stabilization activities as soon as practical after the permanent shutdown date.	4.1.4
7.4.3	During the transition period between shutdown and decommissioning, monitoring and maintenance activities shall be conducted to ensure the health and safety of persons and the protection of the environment.	4.1.1, 4.1.2 and 4.1.4
7.5.1	An assessment of the state of the facility shall be performed to provide baseline information for condition of the building and SSC, and evaluation of the hazards to be controlled during decommissioning. A thorough survey shall be performed and supplemented by a review of existing records, as applicable.	3.7, 4.1.2, 4.1.4.3, 4.3.7, 8.1 3.5, 4.1.4.4, 4.1.4.6, 4.3.7, 8.2.1, 11.0
7.5.2.1	The following hazards shall be investigated and assessed: a) radiological hazards; b) biologically, chemically, and physically hazardous materials; c) hazards from concealed or hidden services; and d) structural hazards.	8.0, Table 8-1
7.5.2.2	Historical information shall be preserved that is relevant to the eventual decommissioning of the facility.	11.0
7.6.1	A DDP shall be developed for nuclear facilities, in accordance with Annex C and regulatory requirements, and submitted to the AHJ for acceptance.	1.1, 4.1.3, 4.2.4 These requirements pertain to the preparation for the Dismantling & Demolition phase. Relevant for the DDP not the PDP
7.6.2.1	The DDP shall meet the content provisions of Annex C.	4.1.3, 4.2.4

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Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
7.6.3	<p>If deferred decommissioning is the preferred decommissioning strategy, in addition to a DDP, a SWS plan shall be developed.</p> <p>If a SWS plan is standalone, it shall be submitted to the AHJ.</p>	1.1, 4.1.3
7.6.4	<p>A safety assessment shall be performed to identify potential hazards to workers, the public, and the environment, from both routine decommissioning activities and credible accidents during decommissioning.</p> <p>The assessment shall describe the relative importance of the potential hazards and identify the methods for mitigating the risks associated with such hazards.</p> <p>If fissile material is involved, a criticality safety assessment and the planned actions involving fissile material shall be included.</p> <p>The assessment shall also address the residual risks to the public, if any, after decommissioning is completed.</p> <p>In-situ decommissioning may result in a waste disposal site. In such a case, an applicant shall satisfy all regulatory requirements for a radioactive waste disposal facility and demonstrate safety via a safety case and post-closure safety assessment of a disposal facility.</p>	<p>3.7, 4.2.4, 4.4.1.2, 8.0 Table 8-1</p> <p>N/A</p>
7.6.5.1	<p>The strategy for managing all wastes from decommissioning shall include a management plan covering both the short term and, where possible, the long term.</p>	<p>These requirements pertain to the preparation for the Dismantling & Demolition phase.</p> <p>Relevant for the DDP not the PDP 4.2.2, 4.2.4</p>

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Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
7.6.5.2	<p>The waste management program shall cover the following processes, as applicable:</p> <ul style="list-style-type: none"> a) characterization; b) classification; c) minimization; d) segregation; e) clearance; f) handling; g) volume reduction; h) treatment; i) packaging; j) storage; k) transportation; and l) final disposition. <p>Transportation requirements and the waste receiver's acceptance criteria shall be reviewed to ensure that the waste is appropriate for shipment and acceptable to the waste receiver.</p>	<p>These requirements pertain to the preparation for the Dismantling & Demolition phase.</p> <p>Relevant for the DDP not the PDP</p> <p style="text-align: center;">4.2.2 4.2.4 4.4</p>
8.1.2	The work to be performed during the decommissioning shall be described in a DDP.	1.1, 4.1.3, 4.2.4
8.1.3	The physical work to be carried out shall be defined in terms of work packages and work procedures to the level of detail required for safe, effective, and efficient decommissioning.	<p>These requirements pertain to the execution phase and are, as such, not applicable for this PDP.</p> <p style="text-align: center;">4.2.2</p>
8.1.7.1	<p>Where decontamination is being used as part of decommissioning, the following shall be identified:</p> <ul style="list-style-type: none"> a) the areas, locations, and equipment to be decontaminated; b) the objectives of the decontamination (e.g., decontamination of equipment for salvage and reuse, decontamination of metals for recycling, decontamination of building foundations that are to remain in place, decontamination for clearance of materials to be disposed of as non-radioactive); c) the decontamination methods to be employed; and d) the residual level of radioactivity that is to be achieved. 	4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.3.7
8.1.8.1	<p>A demolition plan shall be prepared.</p> <p>The equipment and structures to be dismantled or demolished shall be identified.</p> <p>The equipment and structures that are to remain at the completion of decommissioning shall also be identified.</p> <p>Procedures for dismantling and demolition shall take into account the associated hazards.</p>	4.2.4 4.3.1 - 4.3.4

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Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
8.1.8.2	<p>The following factors shall be considered when selecting dismantling/demolition methods:</p> <ul style="list-style-type: none"> a) availability of professional competence associated with the operations of the chosen equipment; b) the equipment should be simple to operate, decontaminate, and maintain; c) remaining structural elements shall be kept in a physically stable state; d) measures to prevent unintentional releases to the environment; e) planned discharges to the environment shall be controlled as per licence conditions and previous commitments; f) when underwater dismantling and cutting is used, provisions shall be made to process the water to promote and assist in effluent treatment; g) the effect of dismantling tasks on adjacent systems and structures and on other work in progress shall be evaluated; h) waste containers, handling systems, and routes shall be defined before the start of dismantling work; and i) federal, provincial/territorial and/or municipal requirements. 	<p>These requirements are relevant for detailed decommissioning planning and execution, as such, not applicable for this PDP 4.2.2, 4.2.4</p>
8.1.9.1	<p>Surveys during decommissioning shall be performed to comply with</p> <ul style="list-style-type: none"> a) worker occupational safety and radiation protection limits; b) environmental monitoring criteria; and c) processes to release materials and equipment from the site. 	4.3.7
8.1.9.2	<p>At the completion of a decontamination or dismantling work package, a survey shall be performed, if required, to demonstrate that the planned end-state has been achieved.</p> <p>The results of the survey shall be documented in a report that includes</p> <ul style="list-style-type: none"> a) the criteria used to define the end-state; b) the methods and procedures used to ensure that the criteria were met; and c) the measurement data, including appropriate statistical analysis and systematic approaches. 	4.3.7, 4.3.9
8.2	<p>Where decommissioning of the facility is to take place in discrete stages, an interim end-state report shall be prepared when each planned interim end-state is achieved.</p>	4.1.4, 4.2.5, 4.3.4

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Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
8.3	A plan for surveillance, monitoring, physical protection, and maintenance of the facility during such periods shall be developed and implemented to a) maintain the facility in a safe state; b) control the release of materials to the environment; c) prevent access by unauthorized persons; and d) mitigate infestations of vermin and other organisms.	4.1, 4.2, 4.3
8.4	Lands associated with a facility or a standalone site that might have been impacted by previous nuclear activities shall be remediated to the degree required to meet the end-state criteria.	4.3.6, 4.3.8
8.5	At the completion of this phase, final surveys of residual radioactive and hazardous materials shall be performed and documented to demonstrate that the final end-state for remaining equipment, structures, and the site has been achieved in accordance with the criteria specified in the DDP. The results of the final survey shall be documented in a report that includes a) the criteria used to define the end-state; b) the methods and procedures used to ensure that the criteria were met; and c) the measurement data, including appropriate statistical analysis and systematic approaches.	4.3.7
9.1	Following the completion of decommissioning, a final end-state report shall be prepared and retained. Where a decommissioning program involves completing a number of separately approved decommissioning projects, interim end-state reports shall be submitted for each project.	4.1.4, 4.2.5, 4.3.4, 4.3.9

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Table C-2: Compliance Matrix between CSA N294:19 Annex A and this Plan

Section in CSA N294:19 Annex A	Requirement in CSA N294:19	Section in This PDP
A.2 (a)	A PDP may include the following: a description of the location of the facility, including (i) a map of the facility and its specifications; (ii) geographic information; (iii) details regarding the surrounding environment; (iv) land uses; and (v) illustrations and maps of the facility in relation to the municipality;	Figure 2-1, Figure 2-2, 2.1 2.3 2.1, 2.3.4 7.2 Figure 2-1, Figure 2-13
A.2 (b)	purpose and description of the facility, including (i) primary components and systems; (ii) building type and construction, including location of any hazardous building materials (e.g., asbestos, PCBs); (iii) building services (e.g., power, heating, ventilation, sewer, water, fire protection); (iv) laboratories and other hazardous handling areas; (v) type, quantity, and form of radioactive and hazardous materials stored, produced, or used during operation; and (vi) design features used to reduce the spread of contamination and facilitate decontamination and dismantling;	2.2 Figure 2-2, Figure 2-4 2.2 4.4.2.1, Table A-1 2.2.4 2.2 Table A-1 Appendix A, 2.2.5
A.2 (c)	post-operational conditions, including i) a summary of the shutdown process, including planned removal of stored inventories of hazardous or radioactive materials; ii) the predicted nature and extent of contamination remaining in the primary systems and components (in list or table format with reference to applicable illustrations); iii) the predicted nature and extent of contamination on floors, walls, work surfaces, ventilation systems, etc.; iv) the identification of any separate planning envelopes; and v) an overview of the principal hazardous conditions anticipated to exist;	4.1.4, 4.1.4.5 3.5, Table 4-2, Appendix A., 3.5, 4.1.4.6 3.4.2, 4.2.4 8.0
A.2 (d)	the decommissioning strategy, including i) the final end-state objective; ii) rationale for 1) the decommissioning strategy selected; 2) interim end-states; 3) periods of SWS; and 4) in-situ decommissioning concepts; iii) the requirements for long-term institutional controls; and iv) the assessment of alternative strategies (or a rationale for why alternatives do not exist or do not warrant consideration);	3.2 3.4 3.2, 4.3.8 3.4.1 N/A: No long-term institutional controls will be established. 3.4.1, 3.4.3

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Section in CSA N294:19 Annex A	Requirement in CSA N294:19	Section in This PDP
A.2 (e)	a plan of the decommissioning work, including i) a work breakdown structure; ii) a summary of the main steps for decontamination/disassembly/removal of each of the systems (preferably grouped into work packages); iii) for each work package, identification of those types of activities that could pose a significant hazard to workers, the public, or the environment; iv) the role of existing operational standard procedures for radiation protection, hazardous materials handling, industrial safety, and environmental protection in managing hazards; v) specific activities for which additional protection/mitigation procedures will be required at the detailed planning stage; vi) a summary of the final dismantlement of the structures; and vii) a conceptual schedule showing the approximate year of facility shutdown and the approximate sequencing and duration of the decommissioning work packages and, where relevant, storage periods;	Appendix B 4.0, 4.3.1 - 4.3.3, Table 8-1, 8.2, 8.3 4.1, 8.2, 8.3 4.2.2, 4.2.4 4.3.8, 4.3.9 4.0 Figure 4-1, Figure 4-2
A.2 (f)	radiological monitoring and survey commitments, including i) a program for conducting periodic contamination surveys and the recording of contamination events during facility operation; ii) a commitment to conduct detailed post-operation surveys in support of DDP development; and iii) a commitment to develop plans and protocols acceptable to the AHJ at the detailed planning stage for monitoring 1) work hazards during decommissioning; 2) personnel dosimetry; 3) environmental emissions and effluents; and 4) materials, sites, and structures to be cleared from regulatory control;	4.2.3, 4.3.7 4.1.4.4, 4.1.4.6, 4.3.7 4.1.1, 4.2, 8.0, 8.1.1, 8.2.1 - 8.2.3, 8.2 4.3.5, 4.3.6
A.2 (g)	a waste management strategy specifying (i) the approximate quantities and characteristics of radioactive and chemically hazardous wastes expected to arise from the decommissioning (tied to specific work packages, if possible); (ii) the anticipated final disposition of radioactive and chemically hazardous materials; and (iii) a commitment to segregate as much material as possible for reuse and recycling;	4.4, 4.4.1, 4.4.2, Table 4-3 1.5, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.4.3 4.3
A.2 (h)	a commitment to prepare a DDP for regulatory approval prior to dismantling and demolition;	4.2.4
A.2 (i)	a commitment to periodically review and update the PDP until a DDP is prepared, in accordance with Clause 6.2.2;	1.1
A.2 (j)	the physical state of the facility at i) the end of operations; and ii) the start of decommissioning;	3.5 4.0, 4.1
A.2 (k)	the records required for decommissioning, including a description of the facility operational records that will be maintained to periodically update the PDP and prepare the DDP(s); and	11.0

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Section in CSA N294:19 Annex A	Requirement in CSA N294:19	Section in This PDP
A.2 (l)	a public consultation plan, including a public information program and avenues for public participation.	12.0
A.2 (m)	an indigenous engagement plan as per the requirements and guidance of CNSC REGDOC-3.2.2; and	12.0
A.2 (n)	the cost and a financial guarantee, specifying i) an estimate of the total present-value cost of the decommissioning; ii) a reasonable basis for how cost estimates were derived; and iii) a description of how the required funds will be provided;	5.1, 5.2 Appendix B

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Table C-3: Compliance Matrix between CSA N294:19 Annex I and this Plan

Item	CSA N294:19 Annex I	Section in this Plan
I.2.2	When the decision is made to permanently shut down and physically decommission the reactor, a planned process shall be followed to render the reactor to a predetermined final end state condition, release the reactor from licence control, and implement any required institutional controls.	1.1, 4.0
I.3.2	The management accountable for each life-cycle phase shall (a) consider the impact of their activities on the eventual decommissioning; (b) ensure that the reactor conforms to the design basis; and (c) preserve documents and records relevant to decommissioning.	4.0 11.0
I.4.3.1	The level of planning detail builds up through the life cycle. During operation a stand-alone plan is required. Management shall perform the necessary planning, based on the results from assessments, the design and the safety analysis, to establish the objectives, the strategies and the cost estimates for the decommissioning of the reactor.	3.2 3.4 3.4.2.1, 5.0 Appendix B
I.4.3.2	In addition to Clause 6.2.1, the plan shall include a) a description of the site, including all of the facilities on the site and adjacent to the site; b) a description of the reactor and its auxiliary facilities; c) a description of the common and interdependent SSCs and work; d) identification of i) the planning assumptions; ii) proposed end-state criteria; iii) uncertainty and degree of conservatism; and iv) the planned decommissioning strategy; e) an outline of the proposed scope of work and schedule to complete the decommissioning. This includes a description of the proposed start date, end date, and milestones. There should be a broadly scoped and generally described work breakdown structure that will require further detailed planning as described in Clause I.4.4; and f) identification of the expected inventory of waste and surplus items that will result from decommissioning and their final disposition.	2.1, 2.2, 2.2.8 2.2.2, 2.2.3 2.2.4, 2.2.5, 2.2.6, 2.2.7 1.5 4.3.8 3.7 3.4 4.0 4.4.1.1, 4.4.2, 4.4.3
I.5.1.1.2	The reactor shall be safely shut down and its SSCs shall be placed in a safe state in preparation for decommissioning.	4.1, 4.2
I.5.1.1.2	During final shutdown, the following actions shall be performed: (a) Implementing the defueling, dewatering and waste management plan; (b) Establishing operating controls for the SSCs that will remain in operation during the remaining stages of decommissioning (e.g., the used fuel system); (c) Placing each SSC in a pre-defined interim end-state.	4.1(4.1.1 - 4.1.4)

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Item	CSA N294:19 Annex I	Section in this Plan
I.5.1.1.4	Additionally, programs in place during operations shall be reviewed, revised, and/or eliminated to ensure that requirements for the remaining stages of decommissioning are covered. Such examples include, but are not limited to, environmental monitoring, emergency response, and fire protection.	4.1.2 4.2
I.5.1.2.1	SWS (sometimes referred to as "safe storage") shall include the period when the reactor is under surveillance while the radioactivity decays and/or until the prerequisites for dismantling and demolition are achieved.	4.2
I.5.1.2.2	During this stage, the following actions shall be performed: a) conducting planned surveys; b) removing the nuclear fuel from the spent fuel bay to dry storage; c) placing the spent fuel bay and auxiliaries in a pre-defined end-state for future decommissioning; and d) ongoing removal of radioactive waste.	4.2 4.2.1 4.2.2
I.5.2	During this stage, the reactor shall be subjected to the planned decontamination, dismantling and demolition, and any resulting materials will either be a) decontaminated to meet release criteria; or b) disposed of into a waste facility.	4.3, 4.3.4 4.3.1 4.3.2 4.3.3 4.3.5, 4.4.1.1, 4.4.1.2, 4.4.1.3
I.5.3	Site restoration shall include a) disposing of hazardous substances; b) restoring the topography (for example, by restoring the landscape); c) restoring vegetation; d) removing the licence and making the site available for other use; and e) preparing the final end-state report in accordance with Clause 9.1 and Annex E.	4.4.2.3 4.3.6 4.3.8

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Appendix D: A Sample of Some PNGS System End State Determination Reports

OPG ESDR Document No.	Document Title	ESDR Category	System End State at Safe Storage Declaration	Summary of When the Building/Systems Will Be End- Stated
P-ESR-09013-00001	EME - Emergency Mitigating Equipment	Common Conventional Support	Active	A portion of the system will be active during the SWS phase until the irradiated fuel is removed from the bays.
P-ESR-20000-00001	Buildings And Lighting	Common Conventional Support	Active	Following station shutdown, defueling and dewatering the number of active SSCs and the requirements for buildings services (e.g., electricity, lighting, heating and ventilation, fire detection and protection, etc.) will be reduced. The buildings and electrical services will be end-stated following the end-stating of the SSCs located therein.
P-ESR-54100-00001	Class III Electrical System	Common Conventional Support	Active	Class III Electrical System will be needed to supply power to Class III, Class II and Class I active loads during the SWS phase.
P-ESR-54200-00001	Pickering B - Class II Power System	Common Conventional Support	Active	The Class II can be end-stated after the station is defueled, dewatered and all the systems on all units are end-stated.
P-ESR-54300-00001	Emergency Power Supply (EPS) Distribution System	Common Conventional Support	Inactive - Abandoned	The EPS system will be shutdown following defueling of all six reactors.
P-ESR-54600-00001	Standby Generators	Common Conventional Support	Inactive - Abandoned	The Standby Generators (54600) system can be end-stated after an equivalent backup supply source for the SWS phase has been commissioned.
P-ESR-54800-00001	Emergency Power Supply Generators	Common Conventional Support	Inactive - Abandoned	The EPS system will be shutdown following defueling of all six reactors.
P-ESR-54900-00001	Auxiliary Power System	Common Conventional Support	Inactive - Abandoned	The Auxiliary Power System can be end-stated once all reactor units have been shut down and HTS is cooled.

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OPG ESDR Document No.	Document Title	ESDR Category	System End State at Safe Storage Declaration	Summary of When the Building/Systems Will Be End- Stated
P-ESR-55100-00001	Class I Power System U5-8	Common Conventional Support	Active	Individual loads which are not required during SWS will be disconnected once the relevant system is shut-down and end-stated.
P-ESR-55100-00002	Pickering A - Class I And Class II	Common Conventional Support	Active	Class I and Class II can be end-stated after the station is defueled, dewatered and all systems on all units are end-stated.
P-ESR-67140-00001	Pickering A - Fire Detection And Alarm System	Common and Unitized Conventional Support	Active	This system should stay in-service during the SWS phase including during the station's dismantling phase.
P-ESR-67140-00002	Pickering B - Fire Detection And Alarm System	Common and Unitized Conventional Support	Active - Partially	This system should stay in-service during the SWS phase, including during the station's dismantling phase.
P-ESR-67876-00001	Stack Monitoring	Unitized Nuclear Support	Active	Individual stack monitors can be end-stated when the Environmental Department determines that monitoring is no longer required. This is done through the use of a Maximum Probable Emission Rate Assessment.
P-ESR-71100-00001	Pickering 018 - Common Water System	Common Conventional Support	Active	Common water provides the source of water for the nuclear and non-nuclear SWS loads and will remain available (i.e., active) for the stabilization and SWS phases.
P-ESR-71300-00001	Service Water System	Unitized Nuclear Support	Active	After all used fuel and radioactive materials have been removed from the bays into the dry storage, the IFBs and AIFB systems can be made inactive for the remainder of the SWS phase.
P-ESR-71320-00001	Recirculated Cooling Water (RCW) System	Unitized Conventional Support	Inactive - Abandoned	The RCW can be end-stated following defueling for units 5 to 8 and dewatering for units 1 and 4.
P-ESR-71400-00001	Fire Water Supply Configuration	Common Conventional Support	Active	This system should stay in-service during the SWS Phase including during the station's dismantling.

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OPG ESDR Document No.	Document Title	ESDR Category	System End State at Safe Storage Declaration	Summary of When the Building/Systems Will Be End- Stated
P-ESR-71500-00001	Domestic Water And Sewer	Common Conventional Support	Active	This system should stay in-service during the SWS Phase including during the station's dismantling.
P-ESR-71620-00001	Demineralized Water System	Common Conventional Support	Active	Once the stabilization period is completed, the demineralized water system will remain active for multiple active systems during the SWS Phase.
P-ESR-71710-00001	Inactive Drainage System	Common Conventional Support	Active	The majority of the sub-systems and components of the subject system remain operational during the SWS Phase.
P-ESR-71720-00001	Pickering A And B Active Drainage	Common Nuclear Support	Active	The system should be re-evaluated at such a time (A- and B-IFBs fully drained) to determine which components are still required to operate for the remainder of the SWS phase.
P-ESR-71750-00001	Liquid Effluent Monitoring And Sampling System for PNGS	Common Conventional Support	Active - Partially	End stating activities cannot commence until regulatory requirements for monitoring and sampling change as part of the SWS Phase.
P-ESR-73000-00002	Reactor building and Reactor Auxiliary Bay Heating And Ventilation	Unitized Nuclear Support	Active	Multiple subsystems will need to remain active into SWS (>2035).
P-ESR-75140-00001	Pickering 018 - Breathing Air System	Common Conventional Support	Active	Breathing Air delivers clean air to 'contaminated' areas and will remain available (i.e., active) for the stabilization period.
P-ESR-76100-00001	Cranes And Hoists	Common Conventional Support	Active	Cranes and Hoists will not be end stated (i.e., will remain Safe Storage Project "Active") through to decommissioning.
P-ESR-78700-00001	Radiation Protection Equipment	Common/Unitized Nuclear Support	Active	The Radiation Protection Equipment will be required throughout the SWS Phase for contamination control and monitoring purposes.
P-ESR-79000-00001	Radioactive Waste Management	Common Nuclear Support	Active	The system can be end-stated when all spent resin from the spent resin tanks are removed.
P-ESR-79200-00001	Radioactive Liquid Waste Management System	Common Nuclear Support	Active	This system will remain operational during the stabilization phase as well as during the SWS Phase.