Canada's Nuclear Regulator

# Environmental Protection Review Report:
# **Darlington Waste Management Facility**

**October 2022**

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**Environmental Protection Review Report: Darlington Waste Management Facility**


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## Document availability

This document can be viewed on the CNSC website. To request a copy of the document in English or French, please contact:

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# Revision History

The following table identifies the revision history of this document.

| Revision number | Change | Summary of changes | Date |
|---|---|---|---|
| 000 | Initial release | N/A | October 2022 |
| 001 | | | |
| | | | |

# Executive summary

The Canadian Nuclear Safety Commission (CNSC) conducts environmental protection reviews (EPRs) for all nuclear facilities with potential interactions with the environment, in accordance with its mandate under the *Nuclear Safety and Control Act* to ensure the protection of the environment and the health of persons. An EPR is a science-based environmental technical assessment conducted by CNSC staff. The fulfillment of other aspects of the CNSC's mandate, such as regulating safety and security, are met through other oversight activities.

This EPR report was written by CNSC staff as a stand-alone document, describing the scientific and evidence-based findings from their review of Ontario Power Generation's (OPG's) environmental protection measures. Under its current operating licence (Waste Facility Operating Licence W4-355.01/2023), OPG is licenced to operate the Darlington Waste Management Facility (DWMF), which is located within the Darlington Nuclear (DN) site. The DN site encompasses both the DWMF and the Darlington Nuclear Generating Station (DNGS). The DWMF is located within the traditional territory of the Wendat, Anishinabek Nation, and the territory covered by the Williams Treaties with the Michi Saagiig and Chippewa Nations.

CNSC staff's EPR report focuses on items that are of Indigenous, public, and regulatory interest, such as potential environmental releases from normal operations, as well as on the risk of radiological and hazardous (non-radiological) substances to the receiving environment, valued components, and species at risk.

This EPR report includes CNSC staff's assessment of documents submitted by the licensee from 2016 to 2021 and the results of CNSC staff's compliance and technical assessment activities, including the following:

- the results of OPG's environmental monitoring, as reported in the annual compliance monitoring reports
- OPG's 2020 environmental risk assessment for the DN site
- OPG's 2021 preliminary decommissioning plan for the DWMF
- the results of the CNSC's Independent Environmental Monitoring Program
- the results from other environmental monitoring programs and/or health studies (such as studies completed by other levels of government) in proximity to the DN site
- OPG's licence renewal application for the DWMF

Based on their assessment and evaluation of OPG's documentation and data, CNSC staff have found that the potential risks from radiological and hazardous releases to the atmospheric, terrestrial, aquatic, and human environments from the DWMF are negligible. Furthermore, human health is not impacted by operations at the DWMF and is indistinguishable from health outcomes found in the general public. CNSC staff have also found that OPG continues to implement and maintain effective environmental protection measures to adequately protect the environment and health of persons. CNSC staff will continue to verify, through ongoing licensing and compliance activities, that the environment and health of persons are protected and will continue to be protected over the proposed licensing period.

CNSC staff's findings may inform recommendations to the Commission in future licensing and regulatory decision making, as well as inform CNSC staff's future compliance and verification

activities. CNSC staff's findings do not represent the Commission's conclusions. The Commission's decision-making will be informed by submissions from CNSC staff, the licensee, Indigenous Nations and communities, the public, and through any interventions heard during public hearings on licensing matters.

For more information on the DN site, including the DNGS and the DWMF, visit the CNSC's webpage and OPG's webpage. References used throughout this document are available upon request and requests can be sent to ea-ee@cnsc-ccsn.gc.ca.

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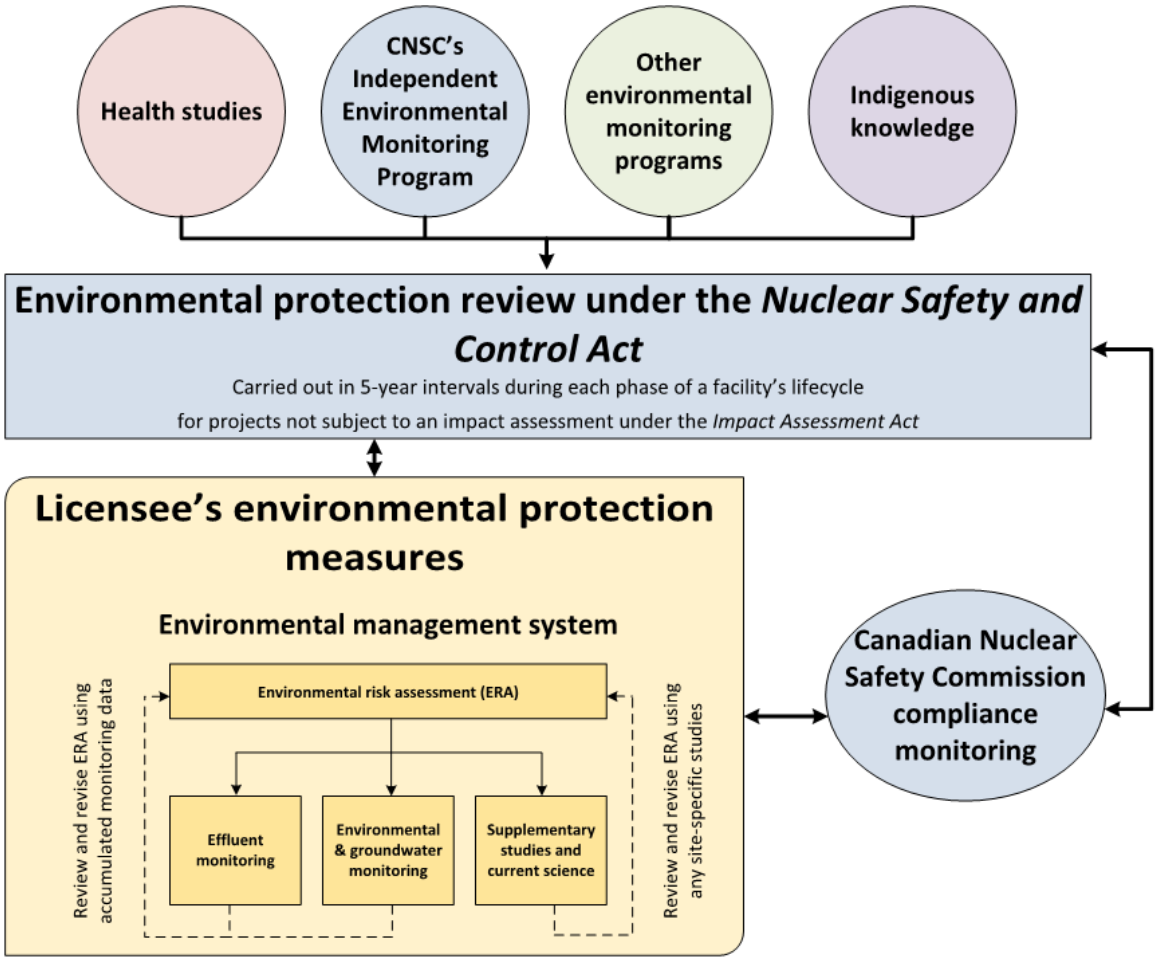
# 1.0 Introduction

## 1.1 Purpose

The Canadian Nuclear Safety Commission (CNSC) conducts environmental protection reviews (EPRs) for all nuclear facilities with potential interactions with the environment, in accordance with its mandate under the *Nuclear Safety and Control Act* (NSCA) [1]. CNSC staff assess the environmental and health effects of nuclear facilities and/or activities during every phase of a facility's lifecycle. As shown in figure 1.1, an EPR is a science-based environmental technical assessment conducted by CNSC staff to support the CNSC's mandate for the protection of the environment and human health, as set out in the NSCA. As per the CNSC's Indigenous Knowledge Policy Framework [2], the CNSC recognizes the importance of considering and including Indigenous knowledge in all aspects of the CNSC's regulatory processes, including EPRs. CNSC staff are committed to working directly with Indigenous Nations and communities and knowledge holders on integrating their knowledge, values, land use information, and perspectives in the CNSC EPR reports, where appropriate and when shared with the licensee and the CNSC. The fulfillment of other aspects of the CNSC's mandate, such as safety and security, is met through other regulatory oversight activities and is outside the scope of this report. Each EPR is typically conducted every 5 years and is informed by outcomes of the licensee's environmental protection (EP) program and documentation submitted by the licensee as per regulatory reporting requirements.

The purpose of this EPR report is to document the outcome of CNSC staff's assessment of Ontario Power Generation's (OPG's) EP measures and CNSC staff's environmental compliance activities for the Darlington Waste Management Facility (DWMF). This review serves to assess whether OPG's environmental protection measures at the DWMF adequately protect the environment and health of persons.

**Figure 1.1: EPR framework**




CNSC staff's findings may inform recommendations to the Commission in future licensing and regulatory decision making, as well as inform CNSC staff's future compliance and verification activities. CNSC staff's findings do not represent the Commission's conclusions, as the Commission is an independent, quasi-judicial administrative tribunal and court of record. The Commission's conclusions and decisions are informed by information submitted by CNSC staff, the licensee, Indigenous Nations and communities, the public, and through any interventions heard during public hearings on licensing matters. The information in this EPR report is also intended to inform Indigenous Nations and communities, members of the public, and interested stakeholders.

EPR reports are prepared in order to thoroughly document CNSC staff's assessment relating to a licensee's EP measures and are posted online for information and transparency. Posting EPR reports online, ahead of the documents drafted during the licensing process, allows interested Indigenous Nations and communities and members of the public additional time to review information related to EP ahead of any licensing hearings or Commission decisions. CNSC staff

may also use EPR reports as reference material when engaging with interested Indigenous Nations and communities, members of the public, and stakeholders.

This EPR report is informed by documentation and information submitted by OPG, compliance and technical assessment activities completed by CNSC staff from 2016 to 2021, as well as the following:

- regulatory oversight activities (section 2.0)
- CNSC staff's review of OPG's 2021 *Preliminary Decommissioning Plan for the Darlington Waste Management Facility* [3] (section 2.2)
- CNSC staff's review of OPG's annual compliance monitoring reports for EP [4] [5] [6] [7] [8] [9]
- CNSC staff's review of OPG's 2020 *Environmental Risk Assessment for the Darlington Nuclear Site* [10] (section 3.2)
- Independent Environmental Monitoring Program (IEMP) results (section 4.0)
- health studies with relevance to the DWMF (section 5.0)
- other environmental monitoring programs in proximity to the DWMF (section 6.0)
- OPG's licence renewal application for the DWMF (currently licensed to operate under WFOL-W4-355.01/2023) [11]

This EPR report focuses on topics related to the environmental performance of the DWMF, including atmospheric (emission) and liquid (effluent) releases to the environment, and the potential transfer of contaminants of potential concern (COPCs) through key environmental pathways and associated potential exposures and/or effects on valued components (VCs), including human and non-human biota. VCs refer to environmental biophysical or human features that may be impacted by a project. The value of a component relates not only to its role in the ecosystem, but also to the value people place on it (for example, it may have scientific, social, cultural, economic, historical, archaeological, or aesthetic importance). The focus of this report is on radiological and hazardous substances associated with activities undertaken at the DWMF, with additional information provided on other topics of Indigenous, public and/or regulatory interest. CNSC staff also present information on relevant regional environmental or health monitoring, including studies conducted by the CNSC (such as the IEMP) or other governmental organizations.

## 1.2 Facility overview

This section of the report provides general information on the facility, including a description of the site location and a basic history of site activities and licensing. This information is intended to provide context for later sections of this report, which discuss completed and ongoing environmental and regulatory oversight activities.

### 1.2.1 Site description

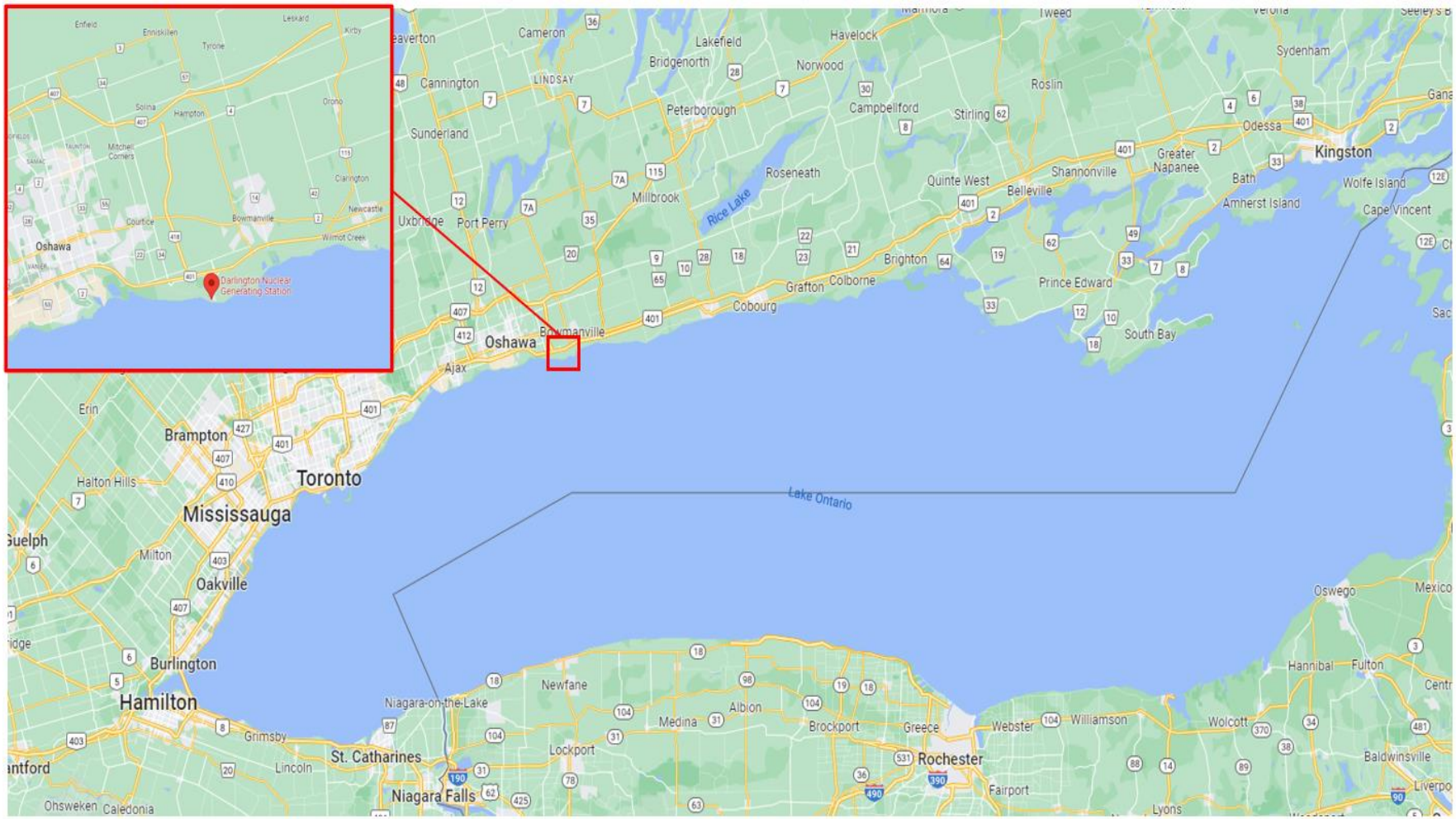
The DWMF is located within the traditional territory of the Wendat, Anishinabek Nation, and the territory covered by the Williams Treaties with the Michi Saagiig and Chippewa Nations. The

DWMF is located in the Darlington Nuclear (DN) site in the Municipality of Clarington, Ontario (formerly the township of Darlington) on the north shore of Lake Ontario. The DN site is located approximately 5 kilometres (km) southwest of the community of Bowmanville, 10 km east-southeast of the City of Oshawa, and 70 km east of Toronto (figure 1.2). The DN site is 485 hectares (ha) in area, with additional water lot areas extending into Lake Ontario to accommodate structures and features associated with the Darlington Nuclear Generating Station (DNGS). The DN site lands are bounded by Highway 401 and Energy Drive West to the north and Lake Ontario to the south. To the west, the DN site is bounded by Solina Road and agricultural land. The St. Marys Cement Bowmanville plant occupies the land east of the DN site.

Owned and operated by OPG, the DN site houses the following nuclear facilities (figure 1.3):

- The DNGS, comprising 4 Canada Deuterium Uranium (CANDU) reactors and associated infrastructure and equipment
- The Tritium Removal Facility (TRF), where tritium is extracted from tritiated heavy water
- The Darlington New Nuclear Project (DNNP) lands
- The DWMF, located in a separate protected area to the east of the DNGS (figure 1.4)

**Figure 1.2: Location of the DN site**




Source: Adapted from Google Maps



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**Figure 1.3: Aerial view of the DN site**


Source: Adapted from OPG **[10]**

**Figure 1.4: Aerial view of the DWMF**

Source: Adapted from Google Maps



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### 1.2.2 Facility operations

The DWMF consists of 2 in-service storage buildings (each designed to house dry storage containers (DSCs)), a DSC processing building, and the Retube Waste Storage Building (RWSB). The DSC processing facility is used to prepare DSCs for storage. The used fuel Storage Buildings #1 and #2 provide interim site storage for the used fuel bundles of the DNGS until a disposal site for used fuel bundles becomes operational. Both DSC Storage Buildings #1 and #2 have the capacity to hold up to 500 DSCs, equivalent to roughly 9 years of operation for the DNGS. The RWSB stores intermediate-level wastes from the Darlington Refurbishment Project. The low-level and intermediate-level radioactive waste that is produced from the DN site is transferred to the Western Waste Management Facility (WWMF) located on the Bruce Nuclear Generating Station site in Tiverton, Ontario. The DWMF's current operating licence (Waste Facility Operating Licence (WFOL) W4-355.01/2023) expires at the end of April 2023.

OPG is requesting to carry over, into the new requested licensing term, the future addition of 2 storage buildings for DSCs (Storage Buildings #3 and #4). OPG is also requesting an increase in storage capacity for the 2 new structures from 1,000 DSCs to 1,200 DSCs, to remove the need for a fifth storage structure. The request for these additional storage structures is expected to have no effect on the findings in this report.

# 2.0 Regulatory oversight

The CNSC regulates nuclear facilities and activities in Canada to protect the environment and the health and safety of persons in a manner that is consistent with applicable legislation and regulations, environmental policies, and Canada's international obligations. The CNSC assesses the effects of nuclear facilities and activities on human health and the environment during every phase of a facility's lifecycle. This section of the EPR report discusses the CNSC's regulatory oversight of OPG's EP measures for the DWMF.

To meet the CNSC's regulatory requirements and according to the licensing basis for the DWMF, OPG is responsible for implementing and maintaining EP measures that identify, control, and (where necessary) monitor releases of radiological and hazardous substances, and the effects on human health and the environment, from the DWMF. These EP measures must comply with, or have implementation plans in place to comply with, the regulatory requirements found in OPG's licence and licence conditions handbook (LCH). The relevant regulatory requirements for OPG's DWMF are outlined in this section of the report.

## 2.1 Environmental protection reviews and assessments

To date, 1 federal environmental assessment (EA) has been carried out specifically for the DWMF. In addition, there have been other EAs and EPRs conducted at the DN site, including for the DNGS. Notably, in 2011, an EA was conducted for the DNGS Refurbishment and Continued Operation Project [12], the purpose of the project being to refurbish the DNGS to allow it to continue to operate until approximately 2055. The principle works and activities within the scope of the proposed project included the construction of the RWSB and other supporting buildings, the transportation of low- and intermediate-level radioactive waste to an off-site management DWMF, and the refurbishment of the CANDU reactors. In 2012, the Commission issued the Record of Proceedings and Decision [13] and concluded that the proposed project was not likely to cause significant adverse effects.

In 2007, an EA was conducted under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) for the proposed DNNP, which encompassed the site preparation and eventual construction and operation of up to four additional nuclear reactors within the DN site. The Federal Minister of Environment referred the EA for the DNNP to a joint review panel for assessment and the panel submitted their EA report in 2011 [14]. In 2012, the Government of Canada accepted the recommendations of the joint review panel [15] and issued the final decision for the proposed DNNP concluding that the project was not likely to cause significant adverse environmental effects [16].

Subsection 2.1.1 provides a description of the EA conducted for the construction of the DWMF under CEAA 1992 [17], predecessor to the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) [18]. In 2019, the *Impact Assessment Act* (IAA) [19] came into force, replacing CEAA 2012. The purpose of any of these assessments is to identify the possible impacts of a proposed project or activity and to determine whether those effects can be adequately mitigated to protect the environment and the health of persons. This EPR report is the first developed specifically for the DWMF.

### 2.1.1 Previous federal EA completed under CEAA 1992 for the DWMF

**Darlington Used Fuel Dry Storage Facility**

In February 2001, OPG submitted a letter of intent to the CNSC to construct and operate the Darlington Used Fuel Dry Storage (DUFDS, which was renamed the DWMF upon construction) at the DN site. The proposed DUFDS project involved the construction of the DUFDS facility (including facilities for the transfer of the DSCs loaded with used fuel from the DNGS), preparation of the DSCs for storage, and placement and monitoring of the DSCs in the storage building. CNSC staff determined that OPG's proposal required a screening-level EA under the appropriate legislation at that time, CEAA 1992, before the CNSC could consider OPG's application under the NSCA [20].

Pursuant to CEAA 1992's *Federal Authorities Regulations* [21], it was determined that the CNSC was the sole responsible authority for the purpose of the assessment. Health Canada, Environment Canada (now Environment and Climate Change Canada), Natural Resources Canada, and the Department of Fisheries and Oceans were identified as federal authorities for the purpose of providing expert assistance to CNSC staff during the assessment. CNSC staff confirmed with the Ontario Ministry of Environment (now the Ministry of the Environment, Conservation and Parks) that there were no provincial EA requirements applicable to OPG's proposal, although the ministry was consulted throughout the EA process.

Pursuant to subsection 17(1) of CEAA 1992, the conduct of the technical support studies, public engagement program, and preparation of an EA study report were delegated to OPG. A draft of the EA study report underwent a technical review by CNSC staff and other relevant federal and provincial government departments. In April 2003, OPG submitted the final EA study report to CNSC staff, who reviewed and accepted it as the basis for the development of the EA screening report [22].

In November 2003, following the Commission's consideration of the EA screening report [23] written by CNSC staff, the Commission issued its Reasons for Decision for the construction and operation of the DUFDS facility [24]. The Commission concluded that, taking into account the appropriate mitigation measures identified in the EA screening report, the project was not likely to cause significant adverse environmental effects.

The EA process identified the need for an EA follow-up program. The EA follow-up program for the DUFDS project [25] included the following activities:

- developing a program to monitor gamma radiation at both the DUFDS facility site boundary and the DN site property boundary
- conducting a walkover survey by qualified biologists to recommend mitigative actions should active bird nests be identified
- developing and executing a soil sampling and analysis program for areas where potentially contaminated soils could be disturbed or redistributed by construction
- developing a program to monitor public attitudes and the effectiveness of mitigation
- including 6 First Nations communities and the Métis Nation of Ontario on the DN community stakeholder list

In 2012, the EA follow-up monitoring program was deemed complete by CNSC staff [26].

## 2.2 Planned end-state

The following section provides high-level information with respect to the end-state of the DWMF following decommissioning activities. This section is informed by OPG's 2021 preliminary decommissioning plan (PDP) for the DWMF [3]. The PDP is important to consider as part of CNSC staff's ongoing oversight for the assessment of environmental and health effects of nuclear facilities and activities during every phase of a facility's lifecycle.

A PDP is developed by the licensee and submitted to the CNSC for review and acceptance as early as possible in the lifecycle of the facility or conduct of the licensed activities. The PDP is progressively updated, where needed, to reflect the appropriate level of detail required for the respective licensed activities. Prior to the commencement of any decommissioning activities and to support an application for a licence to decommission, a detailed decommissioning plan (or DDP) is developed by the licensee and submitted to the CNSC for review and acceptance.

The PDP is developed for planning purposes only, and the associated cost estimate is used to set aside dedicated decommissioning funding in the form of a financial guarantee. The PDP is proposed by the licensee and the Commission will impose a licence condition requiring a certain financial guarantee based on the information within the PDP. The PDP does not authorize decommissioning and does not provide sufficient details for the assessment of environmental impacts during decommissioning. This information is required to be submitted at a later date in support of an application for a licence to decommission.

The PDPs for nuclear facilities are updated at least every 5 years by the licensee and reviewed by CNSC staff. The decommissioning strategy and end-state objectives for the DWMF are documented in the 2021 *Preliminary Decommissioning Plan – Darlington Waste Management Facility* [3], which will be reviewed by CNSC staff to support a recommendation to the Commission in 2022 on the acceptability of OPG's consolidated financial guarantee.

OPG's decommissioning strategy for the DWMF is for prompt dismantling of the facility once regulatory approvals for decommissioning are obtained. This decommissioning strategy is based on the planned removal of used fuel and retube waste to their respective long-term waste disposal facilities prior to the start of decommissioning at the DWMF. Used fuel would be moved to the Adaptive Phased Management facility [27] and retube waste would go to a long-term disposal facility for intermediate-level waste. Both facilities are assumed to become available prior to the start of the DWMF dismantling and demolition activities. OPG expects little to no residual radioactivity to be present at the DWMF once all operational waste is removed and therefore do not currently anticipate the need for any deferment of decommissioning activities. Decommissioning of the DWMF is planned to occur concurrently with the decommissioning of the DNGS and the facility site will be restored to a similar state in nature to that of the DNGS site, making it suitable for other OPG uses. By the end of this phase, the DWMF site would meet the release criteria as agreed with the CNSC for removal of regulatory control for the facility.

## 2.3 Environmental regulatory framework and protection measures

The CNSC has a comprehensive EP regulatory framework which includes both radiological and hazardous substances, physical stressors (such as noise), and the protection of people and the environment. Public dose is considered under the EP framework, as well as from a radiation protection standpoint. The focus of this section of the EPR report is on the EP regulatory

framework and the status of OPG's environmental protection program (EPP) for the DWMF. The results derived from this EPP are detailed in section 3.0 of this report.

The EPP at OPG's DWMF was designed and implemented in accordance with REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures* (2017, namely section 4.6) [28], as well as the CSA Group's environmental protection standards listed below. The EPP for the DWMF includes derived release limits (DRLs) and action levels (ALs). The public dose calculations are conducted at the site level for the whole DN site, which includes the DNGS. OPG is required to update its EPP to meet REGDOC-2.9.1 [28] and the current versions of the associated CSA standards. The implementation status for these items is shown in table 2.1 below.

**Table 2.1: Status of EP measures to implement regulatory documents and standards**

| Regulatory document or standard | Status |
|---|---|
| CNSC REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures*, version 1.1 (2017) section 4.6 [28] | Full implementation scheduled for December 2022 |
| CSA N288.1-14, *Guidelines for Calculating Derived Release Limits for Radioactive Material in Airborne and Liquid Effluents for Normal Operation of Nuclear Facilities* [29] | Implemented (site-wide) |
| CSA N288.4-10, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [30] | Implemented (site-wide) |
| CSA N288.5-11, *Effluent Monitoring Program at Class I Nuclear Facilities and Uranium Mines and Mills* [31] | Implemented (site-wide) |
| CSA N288.6-12, *Environmental Risk Assessment at Class I Nuclear Facilities and Uranium Mines and Mills* [32] | Implemented (site-wide) |
| CSA N288.7-15, *Groundwater Protection Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills* [33] | Full implementation scheduled for December 2022 (site-wide) |
| CSA N288.8-17, *Establishing and Implementing Action Levels to Control Releases to the Environment from Nuclear Facilities* [34] | Implementation plan expected by August 31, 2022 |

CNSC staff confirm that OPG has either implemented its programs according to the relevant EP regulatory documents and standards or has implementation plans in place. OPG has committed to a schedule, such that its programs at the DN site will be designed and implemented according to REGDOC-2.9.1 [28] and CSA N288.7-15, *Groundwater Protection Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills* [33] by December 31, 2022.

OPG is required to regularly report on the results of the EPP for the DWMF. Reporting requirements are specified in REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [35], the *Radiation Protection Regulations* [36] (e.g., for AL or dose limit exceedances), the licensees' approved programs and manuals, and the LCH [37]. OPG submits quarterly operation reports for the DWMF and the

fourth quarter report for each year also serves as an annual compliance report. CNSC staff review these annual compliance reports (ACRs) and annual environmental monitoring program reports for compliance and verification, as well as trending. These annual EMP reports are available on the OPG website, under regulatory reporting [38].

CNSC staff report on the licensee's performance to the Commission for activities conducted at the facility (for example, unplanned spills resulting in potential releases to the environment may be reported to the Commission through an event initial report). Regulatory oversight reports (RORs) are one of the mechanisms for updating Indigenous Nations and communities, the public, and the Commission on the operation and regulatory performance of licensed facilities. RORs are available on the CNSC ROR webpage [39].

### 2.3.1 Environmental protection measures

To meet the CNSC's regulatory requirements under REGDOC-2.9.1 [28], OPG is responsible for implementing and maintaining EP measures that identify, control, and monitor releases of radioactive and hazardous substances from the DWMF, and the effects of these substances on human health and the environment. To fully comply with REGDOC-2.9.1 for the DWMF, OPG will be implementing a groundwater monitoring program that meets all the requirements in CSA N288.7-15, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [33]. EP measures are an important component of the overall requirement of licensees to make adequate provisions for the protection of the environment and the health of persons.

This subsection, and the following ones under section 2.3, summarize OPG's EPP for the DWMF and the status of each specific EP measure relative to the requirements or guidance outlined in the latest regulatory document or CSA Group standard. Section 3.0 of this EPR report summarizes the results of these programs or measures against relevant regulatory limits and environmental quality objectives or guidelines and, where applicable, discusses any interesting trends.

OPG is required to implement an environmental management system that conforms to REGDOC-2.9.1 [28] and to submit an EPP for the DWMF. OPG intends to have fully implemented all the requirements in REGDOC-2.9.1 by December 31, 2022. OPG's EPP includes the following components to meet the requirements and guidance as outlined in REGDOC-2.9.1:

- environmental management system (EMS)
- environmental risk assessment (ERA)
- effluent emissions control and monitoring
- environmental monitoring program (EMP)

### 2.3.2 Environmental management system

An EMS refers to the management of an organization's environmental policies, programs, and procedures in a comprehensive, systematic, planned, and documented manner. It includes the organizational structure, as well as planning and resources to develop, implement, and maintain an EP policy. An EMS requires a facility to continuously improve its EPP; this includes periodic updates to the ERA. The results from the ERA updates determine whether the facility's effluent

monitoring and EMP are effective. The EMS serves as a management tool to integrate all of a licensee's EP measures in a documented, managed, and auditable process, in order to:

- identify and manage non-compliances and corrective actions within the activities, through internal and external inspections and audits
- summarize and report on the performance of these activities both internally (licensee management) and externally (Indigenous Nations and communities, the public, and the Commission)
- train personnel involved in these activities
- ensure the availability of resources (that is, qualified personnel, organizational infrastructure, technology, and financial resources)
- define and delegate roles, responsibilities, and authorities essential to effective management

OPG has established and implemented a corporate site-wide EMS for the DN site, which includes the DWMF, in accordance with REGDOC-2.9.1 [28]. The EMS is registered under the International Organization for Standardization (ISO) 14001 standard (a standard that helps an organization achieve the intended outcomes of its EMS). CNSC staff conduct compliance verifications and desktop reviews to ensure compliance with REGDOC-2.9.1. While the CNSC does not consider ISO 14001 certification as part of the criteria for meeting the requirements of REGDOC-2.9.1, the results of these third-party audits are reviewed by CNSC staff as part of the compliance program. As part of their review of the annual reports on EP, CNSC staff also review the status of OPG's annual goals, targets, and objectives and implementation of the EMS.

The results of these reviews demonstrate that OPG's EMS for the DWMF meets the CNSC requirements as outlined in REGDOC-2.9.1 [28]. The implementation of the EMS ensures that OPG continues to improve environmental performance at the DWMF.

### 2.3.3 Environmental risk assessment

An environmental risk assessment (ERA) of nuclear facilities is a systematic process used by licensees to identify, quantify, and characterize the risk posed by contaminants and physical stressors in the environment on human and other biological receptors, including the magnitude and extent of the potential effects associated with a facility. The ERA serves as the basis for the development of site-specific EP control measures and EMPs. The results of these programs, in turn, inform and refine future revisions of the ERA.

In 2021, OPG submitted the *2020 Environmental Risk Assessment for the Darlington Nuclear Site* [40] in accordance with the requirements set out in CSA N288.6-12 [32], which stipulates that licensees must review and revise their ERA every 5 years. OPG's ERA submission is site-wide and encompasses the entirety of the DN site, including the DWMF. The DN site-wide ERA included an ecological risk assessment (EcoRA) and a human health risk assessment (HHRA) for radiological and hazardous contaminants and physical stressors.

CNSC staff provided comments on the submission [41] and OPG subsequently submitted a revised ERA to the CNSC in February 2021 [10]. CNSC staff reviewed OPG's revised ERA and found it to be compliant with CSA N288.6-12 [32].

OPG's findings from the 2020 revised ERA are summarized in table 2.2 below. CNSC staff reviewed the revised ERA and have found that no new risks have emerged since the previous ERA and that meaningful effects on human health and the environment attributable to DWMF operations are unlikely.

**Table 2.2: Summary of ERA findings for the DWMF [10]**

| Type | Members of the public | Aquatic and terrestrial biota |
|---|---|---|
| **Radiological** | There are negligible releases of radiological COPCs from the facility. No adverse impacts expected on members of the public. | There are negligible releases of radiological COPCs from the facility. No adverse impacts expected on aquatic and terrestrial biota. |
| **Hazardous** | There are negligible releases of hazardous COPCs from the facility. No adverse impacts expected on members of the public. | There are negligible releases of hazardous COPCs from the facility. No adverse impacts expected on aquatic and terrestrial biota. |
| **Physical stressors** | There are no physical stressors associated with operations at the facility. | There are no physical stressors associated with operations at the facility. |

### 2.3.4 Effluent and emissions control and monitoring

Controls on environmental releases are established to provide protection to the environment and to respect the principles of sustainable development and pollution prevention. The effluent and emissions prevention and control measures are established based on industry best practice, the application of optimization (such as in design) and *as low as reasonably achievable* (ALARA) principles, the Canadian Council of Ministers of the Environment (CCME) guidelines, and results of the licensee's ERAs.

The DWMF is located within the DN site and is therefore included under the site-wide DRLs and environmental ALs to control radiological emissions. The DRLs represent the maximum acceptable level of emitted contaminants from the processes and activities at the DN site and are derived from the dose limit for members of the public (that is, 1 millisievert (mSv) per year). Hazardous substances are controlled through limits or thresholds established by different federal and provincial acts and regulations and specified in regulatory documents (including permits and approvals) issued to OPG (see section 2.4 for more information).

Site-specific environmental ALs for the DN site serve as an early warning for any actual or potential loss of control associated with the EPP. OPG must document, report, and investigate exceedances of licence limits and environmental ALs to the CNSC, as well as take appropriate corrective actions where warranted.

The DWMF effluent monitoring program has been reviewed and approved by CNSC staff and is in compliance with REGDOC-2.9.1 [28] and the relevant standards, including CSA N288.5-11,

*Effluent Monitoring Program at Class I Nuclear Facilities and Uranium Mines and Mills* [31]. Based on compliance and technical assessment activities, CNSC staff have found that the effluent monitoring program currently in place for the DWMF continues to protect human health and the environment.

### 2.3.5 Environmental monitoring program

The CNSC requires each licensee to design and implement an EMP that is specific to the monitoring and assessment requirements of the licensed facility and its surrounding environment. The EMP is part of the EPP and is required to:

- measure contaminants in the environmental media surrounding the facility or site
- determine the effects, if any, of the facility or site operations on people and the environment
- serve as a secondary support to emission monitoring programs to demonstrate the effectiveness of emission controls

More specifically, the program must gather the necessary environmental data to calculate public dose and demonstrate compliance with the regulatory public dose limit (that is, 1 mSv per year). The program design must also address the potential environmental interactions identified at the facility or site. It should be noted that the DWMF is included within the site-wide EMP for the whole DN site. While radionuclides are not a significant concern for the DWMF specifically, radionuclides are the major focus at the whole DN site due to the operations and activities at the DNGS. Both hazardous substances and radionuclides are included within monitoring activities associated with liquid discharges and air emissions at the DN site.

Environmental thermoluminescent dosimeters are mounted on the perimeter fence of the DSC processing building and Storage Buildings #1 and #2 (figure 2.1) and around the RWSB (figure 2.2). These dosimeters record ionizing radiation exposure at the closest points of approach to these buildings. OPG changes and analyzes the dosimeters quarterly. All dose rates at the dosimeter locations, from 2016 to 2021, have remained below OPG's target value of 0.5 µGy per hour. OPG's target value has been set to ensure that non-nuclear energy workers working in the vicinity of the DWMF will not receive a radiation exposure that would exceed the regulatory limits for a member of the public and as such, is protective of human health.

**Figure 2.1: Thermoluminescent dosimeter locations around the DSC processing and Storage Buildings #1 and #2 [11]**

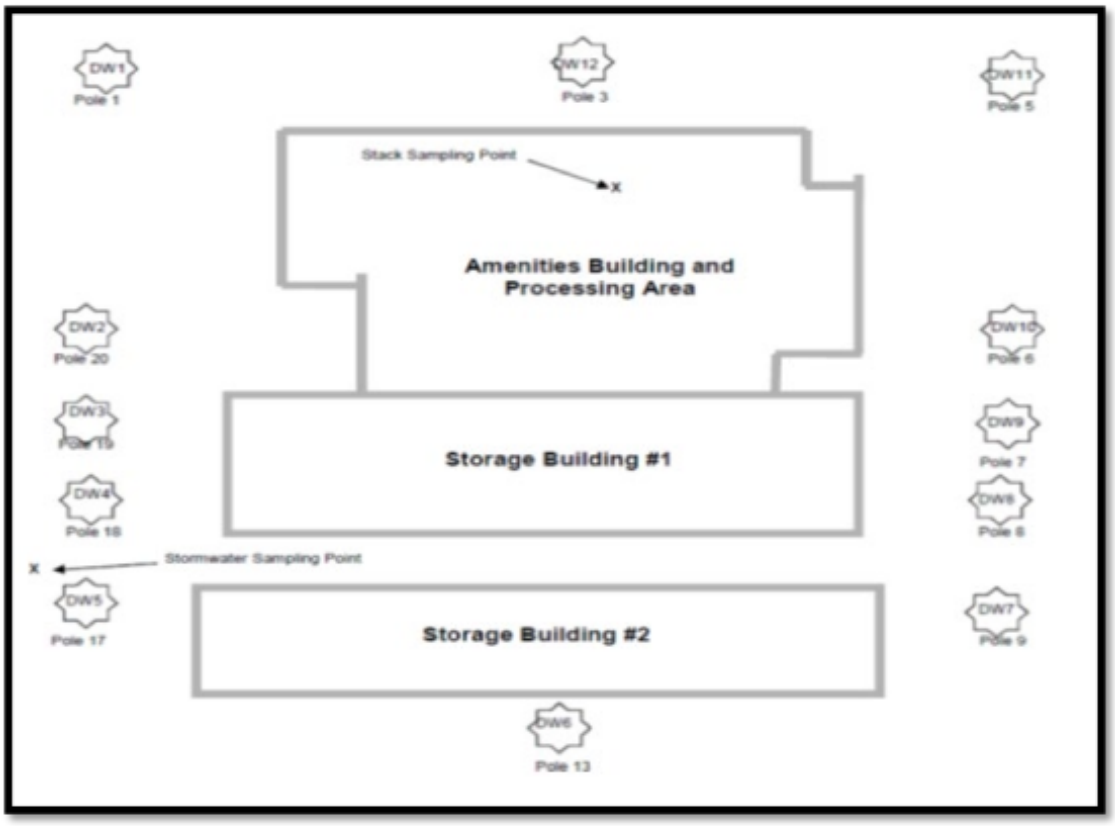
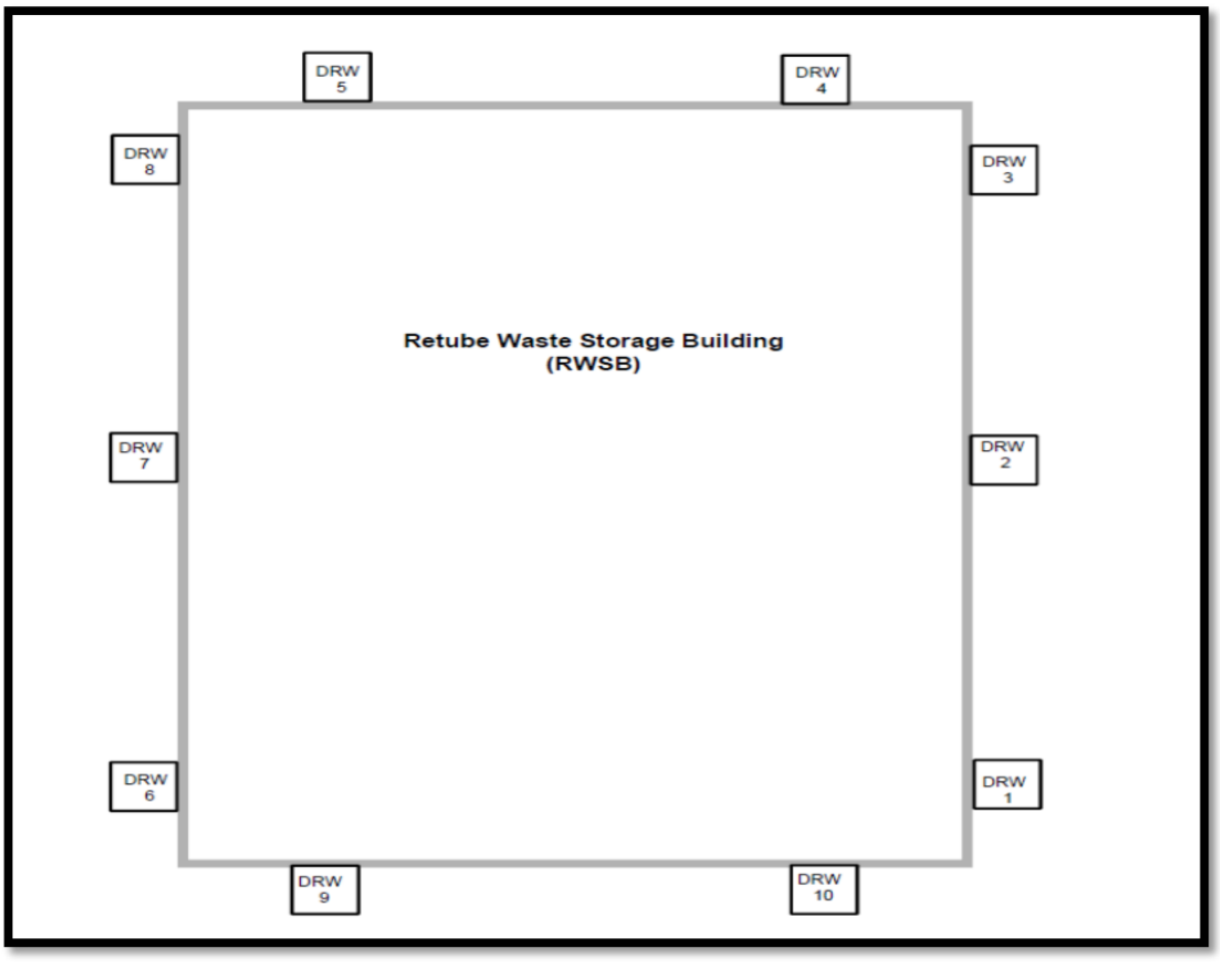


**Figure 2.2: Thermoluminescent dosimeter locations around the RWSB [11]**




OPG is required to update and maintain its EMP, in order to comply with REGDOC-2.9.1 [28] and relevant standards, including CSA N288.4-10, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [30].

Based on compliance activities and technical assessments, CNSC staff have found that OPG's EMP is in compliance with REGDOC-2.9.1 [28] and continues to implement and maintain an effective EMP for the DN site that adequately protects the environment and the health of persons.

# 3.0 Status of the environment

This section provides a summary of the status of the environment around the facility. It starts with a description of the radiological and hazardous releases to the environment (section 3.1), followed by a description of the environment surrounding the facility and an assessment of any potential effects on the different components of the environment as a result of exposure to these contaminants (section 3.2).

It should be noted that CNSC staff regularly review the environmental components through annual reporting requirements and compliance verification activities, as detailed in other areas of this report. This information is reported to the Commission in the sections on EP in licensing Commission member documents and annual RORs. ACRs and environmental monitoring program reports submitted by OPG for the DWMF are made publicly available and can be viewed on the OPG website, under regulatory reporting [38].

## 3.1 Releases to the environment

Radioactive and hazardous substances that have the potential to cause an adverse effect to ecological or human receptors are identified as COPCs. Figure 3.1 below illustrates a conceptual model of the environment around a generic nuclear generating station site (including a generic radioactive waste management facility) to show the relationship between releases (airborne emissions or waterborne effluent) and human and ecological receptors or exposure pathways. The movement of the releases through the environment to the receptors is termed the exposure pathway. This graphic is meant to provide an overall conceptual model of the releases, exposure pathways and receptors for the DN site, and thus, should not be interpreted as an exact depiction of the DN site and its surrounding environment.

The radioactive waste management facility within the model has been outlined in red to highlight the DWMF. Releases from the DWMF are significantly lower than those from the DNGS, and so emissions from the DWMF should be considered as a small fraction of the overall emissions and releases from the DN site. The specific releases and COPCs associated with the DWMF are explained in detail in the following subsections.

**Figure 3.1. Conceptual model of the environment around the DN site**

### 3.1.1 Airborne emissions

OPG controls and monitors airborne emissions from the DWMF to the environment under its EPP. This program is based on CSA N288.5-11, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [31] and includes monitoring of both radiological and hazardous emissions.

Under normal operating conditions, radiological airborne releases are unlikely to occur during transfer and storage of sealed and welded DSCs at the DWMF. However, there is a small potential for airborne emissions at the DWMF resulting from DSC processing operations, such as welding and vacuum drying. The DSC processing building has a dedicated High Efficiency Particulate Air (HEPA) air filtered active ventilation system, and the active ventilation exhaust is monitored for radioactive particulates. A continuous emission sample is passed through a particulate filter that is replaced and analyzed weekly. This emission data is available in OPG's environmental monitoring program reports on the OPG website, under regulatory reporting [38].

**Table 3.1: Annual airborne releases from the DWMF compared with applicable licence release limits (2016 to 2021)** [4] [5] [6] [7] [8] [9]

| Source | Year | Gross beta-gamma (Bq) [(a)] | Licence limits [32] (Bq) |
|---|---|---|---|
| Stack | 2016 | 2849 | $6.70 \times 10^{11}$ |
| | 2017 | 16983 | $6.70 \times 10^{11}$ |
| | 2018 | 12739 | $6.70 \times 10^{11}$ |
| | 2019 | 2812 | $6.06 \times 10^{11}$ |
| | 2020 | 5069 | $6.06 \times 10^{11}$ |
| | 2021 | 2516 | $6.06 \times 10^{11}$ |

(a) Annual values are comprised of weekly sample results. Results below the laboratory MDA are reported (and totalled) as the detection limit value, as opposed to zero, to be conservative.

The potential for airborne hazardous substance releases at the DWMF is negligible. Paint touch-up operations for the DSCs involve a minimal amount of paint quantities and paint aerosols from the paint bays, which are removed through filters before exhausting into the active ventilation system. Welding fumes from DSC seal-welding operations are also exhausted through the HEPA filtered active ventilation system. The emissions from the welding operations are also negligible.

#### 3.1.1.1 Findings

Based on the review of the effluent monitoring results at the DWMF, CNSC staff have found that OPG's air emissions to the environment from the DWMF have remained below CNSC-approved licence limits throughout the reporting period. CNSC staff have also found that OPG's

EPP for the DWMF continues to provide adequate protection of people and the environment from air emissions.

### 3.1.2 Waterborne effluent

There are no liquid operational releases at the DWMF. The DSCs are fully drained and vacuum-dried after loading and are also decontaminated prior to being transferred into storage.

Stormwater and foundation drainage associated with the DSC processing building and the DSC Storage Buildings #1 and #2 were monitored for tritium and gross gamma. This historical sampling was implemented for confirmation purposes. The stormwater and foundation drainage are primarily influenced by air emissions from external facilities (such as tritium washout from the nearby DNGS).

**Table 3.2: Annual stormwater releases from the DWMF compared with applicable administrative limits (2016 to 2021)** [4] [5] [6] [7] [8] [9]

| Source | Year | Tritium (Bq/L) [(a)] | Administrative Limit (Bq/L) | Gross Gamma (Bq/L) [(a)] | Administrative Limit (Bq/L) |
|---|---|---|---|---|---|
| Stormwater | 2016 | 652 | 1850 | 8.55 | 37 |
| | 2017 | 543 | 1850 | 7.92 | 37 |
| | 2018 | 474 | 1850 | 7.41 | 37 |
| | 2019 | 493 | 1850 | 7.47 | 37 |
| | 2020 | 443 | 1850 | 7.60 | 37 |
| | 2021 | 536 | 1850 | 7.48 | 37 |

(a) Annual values are comprised of weekly sample results. Results below the laboratory MDA are reported (and totalled) as the detection limit value, as opposed to zero, to be conservative.

Stormwater and foundation drainage is regulated by the Ministry of Environment, Conservation and Parks (MECP) under the *Environmental Protection Act* [42] and the *Ontario Water Resources Act* [43]. Site stormwater works are under the site Environmental Compliance Approval (ECA) No. 4810-A78QUZ for industrial sewage works. The stormwater works are designed as per the ECA requirement to ensure that stormwater is properly managed to prevent erosion, flooding, and degradation of receiving water bodies. In the case that the stormwater discharge at the facility were to exceed a provincial limit, OPG would be required to report this exceedance to the CNSC as required under REGDOC-3.2.1, *Public Information and Disclosure* [44]. To date, the CNSC has not received any reports of exceedances for stormwater discharge at the DWMF.

#### 3.1.2.1 Findings

CNSC staff have found that OPG's reported stormwater discharge to Lake Ontario from the DWMF remained well below administrative limits for the DN site throughout the reporting period (that is, from 2016 to 2021).

## 3.2 Environmental effects assessment

This section presents an overview of the assessment of predicted effects from licensed activities on the environment and the health of persons. CNSC staff reviewed OPG's assessment of current and predicted effects on the environment and health of persons due to licensed activities included in the ERA (see subsection 2.3.3). OPG's ERA submission is site-wide and encompasses the entirety of the DN site, including the DWMF. The ERA was performed in a stepwise manner as described in CSA N288.6-12, *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills* [32].

To inform this section of the report, CNSC staff reviewed OPG's ERA [10], along with annual reports submitted between 2016 and 2020, inclusively [4] [5] [6] [7] [8].

While CNSC staff conducted a review for all environmental components, only a selection of components is presented in detail in the following subsections. The environmental components were selected based on licensing requirements; some were included because they have historically been of interest to the Commission, Indigenous Nations and communities, and the public.

### 3.2.1 Atmospheric environment

OPG is required to characterize the ambient air quality at the DWMF as part of their assessment of the atmospheric environment. Air quality parameters are monitored for the DWMF and reported to the CNSC on a quarterly basis for review.

#### 3.2.1.1 Ambient air quality

In the 2021 revised ERA [10], OPG predicted and assessed the potential impacts to ambient air quality at the DWMF by using air dispersion modelling for the entire DN site. Contributions to air quality from the DWMF are very low, and the risk to the atmospheric environment from operations at the DWMF is expected to be negligible.

Table 3.2 displays the average measured air KERMA (kinetic energy released in unit mass of material) rates compared against the target rate. The KERMA is a dose measurement of radiation at a specific defined position. The rates were taken at the fence surrounding the DWMF from 2016 to 2019, with an overall average for those years of 0.08 µGy/h. The average air KERMA rates are well below the target rate of 0.5 uGy/h, which is based on a total public dose limit of 1 mSv per year and a maximum exposure of 2000 hours per year (equivalent to approximately 83 days).

**Table 3.3: Average measured air KERMA rates at the DWMF perimeter fence compared with the applicable target rate (2016 to 2019)** [4] [5] [6] [7]

| Year | Average air KERMA rate (µGy/h) |
|---|---|
| Target rate: 0.5 µGy/h [37] | |
| **2016** | 0.082 |
| **2017** | 0.085 |
| **2018** | 0.085 |
| **2019** | 0.085 |

Similarly, results from ventilation stack monitoring for particulates from 2016 to 2019 indicated that dose rates are a minimum of 5 orders of magnitude lower than the action level of $1.21 \times 10^9$ becquerels (Bq). It should be noted, however, that air KERMA is not significant from a public exposure perspective since all potential critical groups are located more than 1 km from the DWMF.

#### 3.2.1.2 Findings

Based on the review of OPG's ERA and the results of OPG's atmospheric monitoring program for the DWMF, CNSC staff have found that radiological airborne emissions are well below regulatory dose limits and hazardous airborne emissions remain significantly below the provincial standard. Therefore, ambient air quality remains at levels protective of human health and the environment.

### 3.2.2 Aquatic environment

An assessment of potential effects on aquatic biota at the DWMF and the surrounding area consists of characterizing the local habitat and species (with consideration of federal and provincial species at risk) and assessing the possibility of their exposure to radiological and hazardous substances, as well as identifying physical stressors that may be disruptive to ecological receptors.

There is no aquatic environmental monitoring specific to the DWMF since there are negligible waterborne releases from the facility, but the DN site has implemented a site-wide comprehensive aquatic monitoring program [45].

Stormwater and foundation drainage from the DWMF were monitored weekly for tritium and gross gamma and results were consistently below the administrative levels of 1850 Bq/litre (L) (for tritium) and 37 Bq/L (for gross gamma). Based on the monitoring data, releases of COPCs from the DWMF to the aquatic environment and negligible and do not pose a risk to the aquatic environment, including aquatic biota and species at risk.

#### 3.2.2.1 Groundwater monitoring

The groundwater monitoring program for the DWMF is integrated into the overall DN site-wide groundwater monitoring program. OPG has committed to being fully in compliance with all the requirements of CSA N288.7-15, *Groundwater Protection Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills* [33] by December 2022. Groundwater monitoring data, including data on water levels and water quality, is collected regularly to verify that groundwater flow and quality are not impacted by operations at the facilities within the DN site. While groundwater is not used for consumption by people at the DN site, results of the groundwater sampling and analysis demonstrate that levels of COPCs are protective of human health and the environment.

#### 3.2.2.2 Surface water

In the developed areas of the DN site, stormwater is collected in ditches and storm drains and then directed into Lake Ontario. There is a stormwater pond associated with the DWMF; however, recent assessments of stormwater and foundation drainage monitoring at the facility identified that routine monitoring is not required per the CSA N288 series of standards. Therefore, OPG discontinued routine stormwater and foundation monitoring at the DWMF in early 2022. Potential impacts to surface water and groundwater at the site will continue to be assessed through the ERAs and groundwater protection programs for the DN site.

#### 3.2.2.3 Findings

Based on the review of OPG's DN site-wide ERA and considering the negligible releases of COPCs from the DWMF, CNSC staff have found that the risk to the aquatic environment is expected to be negligible.

### 3.2.3 Terrestrial environment

There is no terrestrial environment monitoring specific to the DWMF since the DN site has a comprehensive terrestrial monitoring program in place and since releases of COPCs from the DWMF are negligible and do not pose a risk to the terrestrial environment.

The maximum dose rate to any ecological VC residing in proximity (that is, within 5 m) of the DWMF was estimated to be 0.024 milligray (mGy) per day, assuming full capacity of the facility. This is well below the UNSCEAR [46] radiation benchmark of 2.4 mGy per day for terrestrial biota. From 2016 to 2019, the average measured dose rate at the DWMF property boundary was 0.002 mGy per day, while the average measured dose rate at the RWSB perimeter was 0.0014 mGy per day.

#### 3.2.3.1 Terrestrial habitat and species

OPG has implemented an extensive biodiversity program at the DN site, which encompasses the DNGS and the DWMF. The biodiversity program at the DN site was first implemented in 1997 and annual biodiversity monitoring program reports are produced for the site [47] [48] [49]. The purpose of the program is to aid in protecting ecologically significant areas, rebuilding damaged habitats, and recovering at-risk species in Ontario habitats. The DN site has achieved Wildlife Habitat Council conservation certification, which is a program that certifies ecosystem restoration efforts in support of overall biodiversity enhancement and conservation efforts [50].

#### 3.2.3.2 Findings

Based on the review of OPG's ERA and the negligible releases of COPCs from the DWMF, CNSC staff have found that the terrestrial environment remains protected from radiological releases from the facility. In addition, there are negligible hazardous releases and physical stressors caused by the operation of the DWMF.

### 3.2.4 Human environment

An assessment of the human environment at the DN site consists of identifying representative persons located within or in proximity to the site and determining whether they could be exposed to radiological or hazardous COPCs, such as through breathing the air, being on the land, drinking and swimming in surface water, and eating plants, fish, and wildlife from the DWMF area. Representative persons are those individuals who, because of their location and habits, are likely to receive the highest exposures to radiological or hazardous substances from a particular source and, therefore, potentially have their health impacted by these exposures. In general, human receptors may be exposed to contaminants through 4 primary routes: dermal (skin), inhalation, incidental ingestion (soil), and ingestion of food and water.

OPG's 2021 revised ERA [10] included an HHRA to assess the risk to humans from both radioactive and hazardous substances released from activities at the DN site, which includes the DWMF. Potential critical group receptors in the vicinity of the DN site (that is, urban residents in Oshawa/Courtice, Bowmanville, rural residents, and Indigenous peoples) were identified and characterized for exposure to radiological and hazardous substances.

#### 3.2.4.1 Exposure to radiological substances

The *Radiation Protection Regulations* [36] prescribe radiation dose limits to protect workers and the public from exposure to radiation from licensed activities. Doses are either monitored by direct measurement or by estimates of the quantities and concentrations of any nuclear substance released as a result of the licensed activities. The annual effective dose limit for a member of the public is 1 mSv per year.

Dose to the pubic is calcuated for the DN site and reported annually in OPG's annual environmental monitoring program reports. During 2021, the maximum annual dose to the most exposed member of the public was calculated to be 0.6 microsievert (µSv). From 2017 to 2021, the dose to the public from operations at the DN site remained well below the regulatory limit of 1 mSv (1000 uSv) per year. Table 3.4 below displays the annual public doses for the DN site.

**Table 3.4: Estimated annual public doses for the DN site** [51] [52] [53] [45]

| Dose to the public (µSv) | | | | | |
|---|---|---|---|---|---|
| **Public dose limit (µSv)** | **2017** | **2018** | **2019** | **2020** | **2021** |
| **1000** | 0.7 | 0.8 | 0.4 | 0.4 | 0.6 |

#### 3.2.4.2 Exposure to hazardous substances

In OPG's HHRA in the 2021 revised ERA [10] for the DN site (which includes the DWMF), the exposure of representative receptors to hazardous substances was evaluated in accordance with the guidance provided in the CSA N288 standards. As discussed in section 3.1.1, releases of hazardous substances at the DWMF are limited to negligible releases from paint touch-up operations, welding fumes, and cleaning materials. Therefore, operations at the DWMF are not expected to result in exposures of the critical receptors to hazardous substances.

#### 3.2.4.3 Findings

Between 2017 and 2021, the estimated radiological dose to a member of the public around the DN site remained at or below 0.6 µSv per year, with an average around 0.12 µSv per year. Further, these estimated radiological doses to the public have remained well below the annual public dose limit of 1 mSv per year, indicating that radiological releases from the DWMF pose negligible risk to human health and are indistinguishable from health outcomes found in the general public.

With respect to hazardous substances, CNSC staff's review of the HHRA indicated that operations at the DWMF pose a negligible risk to offsite residents (that is, potential risk to human health is indistinguishable from health outcomes found in the general public).

Based on assessments conducted for the DWMF, including the review of OPG's 2021 revised ERA and annual environmental monitoring reports, CNSC staff have found that impacts to the human environment from radiological and hazardous substances released from the DWMF are negligible, and that people living near and working in the facility remain protected.

# 4.0 CNSC Independent Environmental Monitoring Program

The CNSC has implemented its IEMP as an additional verification that Indigenous Nations and communities, the public, and the environment around licensed nuclear facilities are protected. It is separate from, but complementary to, the CNSC's ongoing compliance verification program. The IEMP involves taking samples from public areas around the facilities and analyzing the amount of radiological and hazardous substances in those samples. CNSC staff collect the samples and send them to the CNSC's laboratory in Ottawa for testing and analysis.

## 4.1 IEMP at the DN site

CNSC staff conducted IEMP sampling around the DN site in 2021, 2017, 2015 and 2014. Indigenous Nations and communities were contacted and engaged by CNSC staff ahead of the development of the site-specific sampling plan but did not provide specific sampling media or parameters to be used in the 2021 sampling campaign. However, Curve Lake First Nation had the opportunity to observe the 2021 IEMP sampling campaign for the DN site. The sampling campaign focused on radiological and hazardous contaminants and took into consideration OPG's site-wide EMP and the CNSC's regulatory knowledge of the site.

In 2021, the most recent IEMP sampling campaign, CNSC staff collected the following samples in publicly accessible areas outside the perimeter of the DN site:

- air (3 locations)
- water (4 locations)
- vegetation (5 locations)
- soil and sand (9 locations)
- food (4 locations)

Samples were analyzed by qualified laboratory specialists in the CNSC's laboratory. Using appropriate protocols, CNSC staff measured radionuclides, such as gross alpha, gross beta, and tritium in samples. CNSC staff also measured hazardous substances in the water samples, such as hydrazine, aluminum, zinc, and ammonia. These hazardous substances were included in the IEMP sampling campaign at the DN site following a request by the Commission.

Figure 4.1 provides an overview of the sampling locations for the 2021 IEMP sampling campaign around the DN site. The IEMP results are available on the CNSC IEMP webpage [54].

**Figure 4.1: Overview of the 2021 sampling locations [55]**


## 4.2 Involvement of Indigenous Nations and communities in the IEMP

It is a priority for the CNSC that IEMP sampling reflects Indigenous traditional land use, values, and knowledge, where possible. In 2021, in advance of the IEMP sampling campaign at the DN site, notification emails were sent to the following Indigenous Nations and communities located near the DN site: Curve Lake First Nation, Hiawatha First Nation, Métis Nation of Ontario, Mississauga's of the Credit First Nation, Mohawks of the Bay of Quinte, Beausoleil First Nation, Alderville First Nation, Chippewas of Georgina Island First Nation, Chippewas of Rama First Nation, and Mississauga's of Scugog Island First Nation. CNSC staff invited Indigenous Nations and communities to provide suggestions for species of interest, VCs, and potential sampling locations where traditional practices and activities may take place. CNSC staff did not receive any comments on the 2021 IEMP sampling campaign at the DN site. However, Curve Lake First Nation did observe the 2021 IEMP sampling campaign at the DN site.

### 4.2.1 Sampling with Curve Lake First Nation

Curve Lake First Nation joined CNSC staff for a day to observe the IEMP sampling campaign for the DN site. During sampling, representatives of Curve Lake First Nation observed that the area surrounding the DN site was developed and disturbed. Curve Lake First Nation representatives also observed that there was a mixture of both native and invasive plant species

along the shoreline of Lake Ontario and at other sampling locations, causing difficulty in categorizing plant community types. Having Curve Lake First Nation representatives present to observe the sampling activities helped to promote a better understanding of sampling methods and locations and will help to inform future sampling at the DN site in terms of species of interest, VCs, and potential sampling locations.

CNSC staff are committed to ongoing engagement with interested Indigenous Nations and communities to ensure that IEMP sampling incorporates Indigenous Knowledge in future campaigns, where appropriate.

## 4.3 Summary of results

The levels of radioactive substances (including gross alpha, gross beta, and tritium) and hazardous substances (including iron, aluminum, and zinc) in all samples measured during the 2021 IEMP sampling campaign were below available guidelines and similar to the range of results from the 2017, 2015 and 2014 IEMP sampling campaigns at the DN site. Results for all campaigns are published on the CNSC's IEMP webpage [55].

The CNSC's IEMP results in 2021 are consistent with the results submitted by OPG, supporting the CNSC's assessment that the licensee's EP program is effective. The results add to the body of evidence that people and the environment in the vicinity of the DN site are protected and that there are no anticipated health impacts.

# 5.0 Health studies

The following section draws from the results of regional health studies, national and international reports, and publications to provide further independent verification on whether the health of people living near or working at the DWMF, in southern Ontario, is protected. The Durham Region Health Unit works collaboratively with the office of the Medical Officer of Health and other government and non-government health service providers to directly monitor the health of people living near the DWMF.

To complement the CNSC's regulatory oversight, CNSC staff continuously work toward strengthening relationships with the various health units and offices. CNSC staff also keep abreast of any new publications and data related to the health of populations living near or working at diverse nuclear facilities. Lastly, CNSC staff, at times, conduct health studies on select populations through their research on the effects of low dose (and low dose-rate) exposures. Select community, Canadian, and international publications are discussed below. For additional information on health studies related to nuclear facilities, visit the CNSC's webpage on Health Studies [56].

## 5.1 Population and community health studies and reports

The Municipality of Clarington borders Oshawa, Scugogm, and the county of Northumberland and is located in the southeast of Durham Region. There are 7 health neighbourhoods in Clarington, ranging in population size from 9,200 to 15,200. The neighbourhoods of Darlington and Clarke are rural communities with the remaining 5 neighbourhoods classified as urban (see all 7 community profiles) [57]. Information about this region is also captured by the Durham Regional Health Unit and more broadly by the statistics reported by Cancer Care Ontario.

### 5.1.1 Clarington Neighbourhood Profile

The Clarington neighbourhood profile [58] breaks down demographic information, as well as certain health indicators such as general health, health behaviours (such as smoking and immunization rates, cancer screening), health care, health conditions, and infectious disease rates. The reported statistics were compared to the statistics for Durham Region and were found to be similar overall. Some diseases were more prevalent while others were less prevalent, which is consistent with the natural fluctuation of disease.

Specifically, the Clarington health profile, last published in 2017, indicates that the prevalence of asthma is 20.1 per 100 (similar to Durham Region), the prevalence of diabetes is 9.7 per 100 (ages 20+, similar to Durham Region), the prevalence of lung disease (including chronic obstructive pulmonary disease or COPD) is 11.6 per 100 (ages 35+, at least 20% higher than Durham Region), and the prevalence of cardiovascular disease hospitalizaiton rate is 9.8 per 1,000 (ages 45-64, similar to Durham Region).

### 5.1.2 Durham Region Health Department

The Durham Region Health Department (DRHD) routinely monitors the health status of Durham Region using health indicators and health data from sources such as hospitals and laboratories, among other record-storing facilities and databases.

The DRHD publishes an overview report through the Health Neighbourhood Project [59], which examines information for 50 health neighbourhoods in Durham Region. The report provides a picture of how health varies among communities and includes demographic and health indicators. As expected, due to Durham Region's diverse population, with a mix of urban and rural populations, Durham Region performs better than and poorer than the province of Ontario for specific health indicators. For example, Durham Region has a higher prevalence of diabetes, and lung disease (including COPD) compared to the province of Ontario. On the other hand, Durham Region is performing better than the province of Ontario with higher life expectancy and higher reported screening levels for cancer.

The DRHD has also published community health reports that specifically examined mortality [60] and cancer incidence [61] in Durham Region (last updated in June 2017).

On average, there were 3,500 deaths per year among Durham Region residents between 2008 and 2012. Ischemic heart disease or heart attacks were the leading cause of death in Durham Region and Ontario males and females from 2010 to 2012. Lung cancer was the second leading cause of death among males, and dementia and Alzheimer's disease was the third. These 3 causes accounted for 28% of deaths in Durham Region males. Among females, dementia and Alzheimer's disease was the second leading cause of death and lung cancer was the third. The top 3 causes accounted for 30% of deaths in Durham Region females.

There were 3,500 cancer cases diagnosed in Durham Region residents in 2012, with 84% of these occurring in people aged 50 or older. The most common cancers in males were prostate, lung and colorectal, accounting for half of new cancer cases. In females, breast, lung, and colorectal cancer made up half of new cancer cases. This is similar to Ontario and Canadian rates [62] [63].

### 5.1.3 Cancer Care Ontario

Cancer Care Ontario, through its Ontario Cancer Profiles [64], provides interactive map-based dashboards, which display key public health indicators including cancer incidence, mortality, and risk factors. Major risk factors for cancer development include physical inactivity, obesity, smoking, excessive alcohol consumption, inadequate fruit and vegetable consumption, and binge drinking. Regional statistics are available by public health unit (indicated as PHU under the indicator geographic area of the dashboard) and Local Health Integration Network (LHIN). The DWMF is located in the Central East LHIN and is included in the DRHD.

In 2018, the Central East Region LHIN (and the more specific DRHD) had similar incidence and mortality rates for all cancers combined compared to Ontario (considering males and females separately and together). For both lung cancer incidence and mortality, men (Central East and DRHD) tended to have slightly higher rates compared to Ontario. Alternatively, women had either the same (at the LHIN level) or slightly lower (at the DRHD level) lung cancer incidence and mortality rates than Ontario. From 2015 to 2017, the cancer risk factors differ between the LHIN and the DRHD. The risk factors with the largest disparity with the provincial average for the DRHD are mentioned in the dashboard. Specifically, for the DRHD (considering males and females separately and together), the rates for alcohol consumption, smoking, and binge drinking were slightly higher than the provincial average.

The Cancer Risk Factors Atlas of Ontario [65] outlines geographic distribution patterns of risk factors related to cancer and other chronic diseases in LHINs. From 2000 to 2014 within the

Central East LHIN, alcohol consumption, smoking, and inadequate vegetable and fruit consumption were deemed to be the top 3 priority risk factors. These findings are supported by another report published by Cancer Care Ontario, the Cancer Risk Factors in Ontario report [66].

### 5.1.4 Findings

The review of health reports is an important component for ensuring that the health of people living near nuclear facilities is protected. The population and community health studies and reports indicate that cancer incidence and mortality rates, as well as the prevalence of specific health indicators and risk factors related to cancer, are largely consistent with those of the population of Ontario.

## 5.2 Current scientific understanding of radiation health effects

The current scientific knowledge of the sources, effects, and risks of ionizing radiation is reviewed and published by international experts at the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) [67]. This information comes from many population studies, animal and cell studies, and clinical investigations. These studies build the foundation of knowledge about the relationship between radiation exposure and health effects, such as cancer. This knowledge, in turn, informs the recommendations of the International Commission on Radiological Protection (ICRP) [68], which are focused on the protection of human health.

### 5.2.1 Canadian studies of radiation health effects

No epidemiological studies have been conducted to assess the potential health impacts directly related to the DWMF. However, given that this facility is on-site at the DNGS, studies involving the DNGS can inform populations living near or working at the DWMF. The levels of exposure in local area residents and workers are low, and there is no evidence of adverse health effects as a result of past and present nuclear operations or activities in the region. These findings are consistent with the select robust Canadian and international studies of radiation effects on human health examining similar populations, described below.

**Radiation Exposure and Cancer Incidence (1990 to 2008) Around Nuclear Power Plants in Ontario, Canada (RADICON)**

In 2013, the CNSC conducted a study on radiation exposure and cancer incidence around Ontario nuclear power plants. The RADICON study [69] determined the radiation doses to members of the public living within 25 km of the Pickering, Darlington, and Bruce nuclear power plants and compared cancer cases among these people with the general population of Ontario from 1990 to 2008.

The study mainly found that there was no evidence of childhood leukemia clusters around the 3 Ontario nuclear power plants and no consistent pattern of cancer across the populations in question. Some types of cancer were higher than expected, but in other cases they were lower or no different. Although this study detected variations in all cancers combined and radiosensitive cancers, the pattern was found to be within the natural variation of cancer in Ontario.

**Verifying Canadian Nuclear Energy Worker Radiation Risk: A Reanalysis of Cancer Mortality in Canadian Nuclear Energy Workers (1957-1994)**

In 2011, the CNSC published a study entitled *Verifying Canadian Nuclear Energy Worker Radiation Risk: A Reanalysis of Cancer Mortality in Canadian Nuclear Energy Workers (1957-1994)* [70]. CNSC staff also published this work in the scientific literature [71]. An analysis of 42,228 Canadian nuclear workers (including workers employed by OPG) provided no evidence of increased risk of cancer mortality between 1964 and 1994. Canadian workers had lower all-cause and solid cancer mortality compared to that for the general Canadian population.

### 5.2.2 International studies of radiation health effects

The epidemiological evidence of radiation-related health effects comes from several main research populations. These populations include the life span studies of atomic bomb survivors [72], people involved in the Chernobyl disaster [73] [74], patients treated with radiotherapy for cancer and non-cancer diseases [75], and miners exposed to radon and radon decay products [76] [77].

The largest and most relevant study is the International Nuclear Worker Study (INWORKS), a multinational cohort study that assessed cancer risk from 1943 to 2005 in 308,297 workers from the nuclear industry in France, the United Kingdom, and the United States [78] [79] [80] [81]. This series of studies provides strong evidence of a linear relationship between low dose radiation exposures and cancer. The results were consistent with the current radiation protection framework, whereby the risk is assumed to be proportional to dose.

Two major findings consistent within all these studies are:

1) excess risk of cancer increases as radiation dose increases
2) statistically significant population effects are typically observed at doses above approximately 100 mSv (either acutely or chronically exposed)
3) at doses of 100 mSv (received acutely or chronically), the increased risk of developing cancer is approximately 0.5% above background cancer risk, which in Canada is approximately 50% [82] (resulting in a total risk of 50.5%)

Importantly, the absence of statistically significant data does not indicate the absence of risk. To put these findings into perspective, for nuclear energy workers from the facility, lifetime dose would fall under 100 mSv, given the average dose is less than 1 mSv per year [83]. For comparison, members of the public living near nuclear facilities receive doses less than 0.04 mSv per year, resulting in negligible lifetime doses.

Doses to workers and members of the public from the operation of nuclear facilities are in addition to the average natural background radiation in Canada of 1.8 mSv per year, which varies between 1 and 4 mSv per year.

### 5.2.3 Findings

The existing body of knowledge on various populations is used by CNSC staff to make a determination on the health and safety of workers and persons living near the DWMF, in the absence of population-specific studies with radiation exposure data.

Experts worldwide study radiation health effects to provide objective scientific evidence, which supports the licensees' environmental and radiation protection programs, ensuring that workers and members of the public are protected. The current international understanding is that low doses of radiation are associated with low risks to health, indiscernible from the natural variation of disease. CNSC staff are confident that those living near and working at any nuclear facility in Canada are adequately protected.

## 5.3 Summary of health studies

Reviewing and conducting health studies and reports comprise an important component of ensuring the protection of the people living near or working at nuclear facilities. The population and community health studies and reports indicate that cancer incidence and mortality rates, as well as the prevalence of specific health indicators and risk factors related to cancer, are largely consistent between this population and the population of Ontario.

The current understanding of the risks associated with radiation exposures is supported by the publications by international agencies like UNSCEAR and the ICRP, as well as academics and researchers worldwide. Very low exposures of radiation (like those experienced by Durham Region residents and facility employees) result in very low risks to health, indiscernible from the natural variation of disease.

In conclusion, the health studies and reports presented in this section provide a snapshot of the health of people living near the DWMF. Based on CNSC staff's compliance monitoring of radiation and environmental protection at the facility and available health data, CNSC staff have not observed and do not expect to observe any adverse health outcomes attributable to the operation of the DWMF.

# 6.0 Other environmental monitoring programs

Several monitoring programs are carried out by other levels or bodies of government, and are reviewed by CNSC staff to confirm that the environment and the health of persons around the facility in question are protected. Since the DWMF is located within the DN site, adjacent to the DNGS, these monitoring programs cover all activities and facilities within the DN site. Within these programs, it is not possible to differentiate the releases from the DWMF from the releases from the DNGS. However, releases from the DWMF are significantly lower than those from the DNGS, and so emissions from the DWMF should be considered as a small fraction of the data presented in the following subsections. A summary of the findings of these programs for the DN site is provided below.

## 6.1 National Pollutant Release Inventory

Environment and Climate Change Canada (ECCC) operates the National Pollutant Release Inventory (NPRI) [84], which is Canada's public inventory of pollutant releases, disposals, and transfers, tracking over 320 pollutants from over 7,000 facilities across the country. Reporting facilities include factories that manufacture a variety of goods; mines; oil and gas operations; power plants; and sewage treatment plants. Information that is collected includes:

- releases from facilities to air, water, or land
- disposals at facilities or other locations
- transfers to other locations for treatment and recycling
- facilities' activities, locations, and contacts
- pollution prevention plans and activities [85]

CNSC staff conducted a search of the NPRI database, reviewed the data for the DN site (in other words, the DNGS), and did not notice any trends or unusual results. It is worth noting that radionuclides are not included in the inventory of pollutants in the NPRI database. However, the CNSC receives radionuclide loadings from CNSC licensees through other means, such as annual and quarterly reports. This information has been used in this report, but the complete dataset is available for download on the CNSC's Open Government Portal [86].

## 6.2 Health Canada's Canadian Radiological Monitoring Network and Fixed Point Surveillance Network

Health Canada's Radiation Protection Bureau manages the Canadian Radiological Monitoring Network (CRMN) [87]. The CRMN routinely collects drinking water, precipitation, atmospheric water vapour, air particulate, and external gamma dose for radioactivity analysis at dozens of monitoring locations across Canada.

The CRMN monitoring location closest to the DN site is in Toronto. The results at the Toronto station for 2021 are consistent with data from previous years and are well below the public dose limit of 1 mSv per year.

In addition, Health Canada has complemented the CRMN with the Fixed Point Surveillance (FPS) Network [88]. The FPS network functions as a real-time radiation detection system designed to monitor public dose in Canada from radioactive materials in the air, including atmospheric emissions associated with nuclear facilities and activities both national and

international. Monitoring stations continuously measure gamma radioactivity levels from ground-deposited (groundshine) and airborne contaminants.

Health Canada measures the radiation dose rate as Air KERMA, reported as nanogray per hour (nGy/h) of absorbed dose, and reports it monthly (nGy/month). Air KERMA is also measured for 3 radioactive noble gases associated with nuclear fission, which may escape into the atmosphere during normal operation of nuclear facilities. These 3 noble gases are argon-41, xenon-133 and xenon-135. These measurements are conducted every 15 minutes at 79 sites of its FPS network across the country, including 7 stations operated by Health Canada around the DN site. The monthly data is provided on the Health Canada website [89].

The results around the DN site are similar to the Canadian average for natural background from gamma. These results indicate that total external gamma dose at this station is not significantly influenced by activities at the DN site. Further evidence of this is provided by the extremely low activity levels reported for the noble gases. All the results are significantly below the public dose limit of 1 mSv per year.

# 7.0 FINDINGS

This EPR report has focused on items of current Indigenous, public, and regulatory interest, including airborne and waterborne releases from ongoing operations at the DWMF. CNSC staff have found that the potential risks from physical stressors, as well as from radiological and hazardous releases to the atmospheric, terrestrial, aquatic, and human environments from the DWMF, are negligible.

## 7.1 CNSC staff's follow-up

The following bullet points summarize CNSC staff's expectations regarding the EP measures implemented by OPG for the DWMF. The points below are not expected to change CNSC staff's findings and are included for transparency with Indigenous Nations and communities and the public. It is CNSC staff's expectation that OPG will:

- have fully implemented CSA N288.7-15, *Groundwater Protection Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills* [33] for the DN site and have fully implemented CNSC Regulatory Document REGDOC-2.9.1, *Environmental Principles, Assessments and Protection Measures, version 1.1* (2017) [28] for the DWMF by December 2022; and
- have submitted an implementation plan for CSA N288.8-17, *Establishing and Implementing Action Levels to Control Releases to the Environment from Nuclear Facilities* [34] for the DN site (implementation plan expected by August 31, 2022).

## 7.2 CNSC staff's findings

CNSC staff's findings from this EPR report may inform staff recommendations to the Commission in future licensing and regulatory decision making that pertain to the DWMF. These findings are based on CNSC staff's reviews of documents associated with OPG's DWMF, such as the submitted ERA documentation and the conduct of compliance verification activities, including the review of annual and quarterly reports, onsite inspections, as well as IEMP sampling around the DN site in 2021, 2017, 2015, and 2014. CNSC staff also reviewed the results from various relevant or comparable health studies and other EMPs conducted by other levels of government to substantiate their findings.

Based on their assessment of OPG's documentation, CNSC staff have found that the potential risks from physical stressors, as well as from radiological and hazardous releases to the atmospheric, aquatic, terrestrial, and human environments from the DWMF, are negligible. The potential risks to the environment from these releases or stressors are similar to natural background, and the potential risks to human health are indistinguishable from health outcomes in the general public. Therefore, CNSC staff have found that OPG has and will continue to implement and maintain effective EP measures to adequately protect the environment and the health of persons. CNSC staff will continue to verify and ensure that, through ongoing licensing and compliance activities and reviews, the environment and the health of persons are protected.

# Abbreviations

## Units

| | |
|---|---|
| becquerels | Bq |
| hectare | ha |
| kilometre | km |
| litre | L |
| microsievert | μSv |
| milligray | mGy |
| millisievert | mSv |

## Acronyms

| | |
|---|---|
| ACR | annual compliance report |
| AL | action level |
| ALARA | as low as reasonably achievable |
| CANDU | Canada Deuterium Uranium |
| CCME | Canadian Council of Ministers of the Environment |
| CEAA 1992 | *Canadian Environmental Assessment Act* (1992) |
| CEAA 2012 | *Canadian Environmental Assessment Act, 2012* |
| CNSC | Canadian Nuclear Safety Commission |
| COPC | contaminant of potential concern |
| COPD | chronic obstructive pulmonary disease |
| CRMN | Canadian Radiological Monitoring Network |
| DDP | detailed decommissioning plan |
| DN | Darlington Nuclear |
| DNGS | Darlington Nuclear Generating Station |
| DNNP | Darlington New Nuclear Project |
| DRHD | Durham Region Health Department |
| DSC | dry storage container |
| DRL | derived release limit |
| DUFDS | Darlington Used Fuel Dry Storage |
| DWMF | Darlington Waste Management Facility |
| EA | environmental assessment |
| ECA | Environmental Compliance Approval |

| | |
|---|---|
| EcoRA | ecological risk assessment |
| EMP | environmental monitoring program |
| EMS | environmental management system |
| EP | environmental protection |
| EPP | environmental protection program |
| EPR | environmental protection review |
| ERA | environmental risk assessment |
| FPS | Fixed Point Surveillance |
| HEPA | High Efficiency Particulate Air |
| HHRA | human health risk assessment |
| IAA | *Impact Assessment Act* |
| ICRP | International Commission on Radiological Protection |
| ISO | International Organization for Standardization |
| IEMP | Independent Environmental Monitoring Program |
| KERMA | kinetic energy released in unit mass of material |
| LCH | licence conditions handbook |
| LHIN | Local Health Integration Network |
| MECP | Ministry of Environment, Conservation and Parks |
| NPRI | National Pollutant Release Inventory |
| NSCA | *Nuclear Safety and Control Act* |
| OPG | Ontario Power Generation |
| PHU | public health unit |
| PDP | preliminary decommissioning plan |
| ROR | regulatory oversight report |
| RWSB | retube waste storage building |
| TRF | Tritium Removal Facility |
| UNSCEAR | United Nations Scientific Committee on the Effects of Atomic Radiation |
| VC | valued component |
| WFOL | Waste Facility Operating Licence |
| WWMF | Western Waste Management Facility |

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