Canada's Nuclear Regulator

DRAFT SCREENING REPORT ON:

Environmental Assessment of the Refurbishment and Continued Operation of the Darlington Nuclear Generating Station, Municipality of Clarington, Ontario.

Presented by:

Canadian Nuclear Safety Commission and Fisheries and Oceans Canada

June 2012

CEAR # 11-01-62516

e-DOC: 3917932

Canadian Nuclear Safety Commission / Commission canadienne de sûreté nucléaire

Canada

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EXECUTIVE SUMMARY

The purpose of this Environmental Assessment (EA) Screening Report is to provide the Responsible Authorities (RAs), Canadian Nuclear Safety Commission (CNSC) and Fisheries and Oceans Canada (DFO), with the information necessary to render their decisions under section 20 of the *Canadian Environmental Assessment Act* (CEA Act) regarding the proposal by Ontario Power Generation (OPG) to refurbish the four units at the Darlington Nuclear Generating Station (DNGS), and to operate those units through to the end of their useful lives in 2055 in the Municipality of Clarington, Ontario. The EA Screening Report has been prepared by CNSC staff and DFO following their review and assessment of technical studies submitted by OPG.

This EA Screening Report concludes that the project, taking into account the mitigation measures identified, is not likely to cause significant adverse environmental effects based on a systematic analysis of all the information provided. This EA Screening Report identified the potential interactions between the project activities and the existing environment during all phases of the project, and during relevant malfunctions and accidents. Based on these interactions, the resulting changes that would occur to the components of the environment were described. Mitigation measures were identified that may be applied to each likely adverse effect if appropriate. No residual adverse effects were identified for most biophysical, socio-economic (e.g., Aboriginal interests) and malfunction and accident related components.

Residual effects were identified for impingement and entrainment effects on aquatic biota; however, based on the relatively low magnitude (i.e., no population-level effects) and geographical extent (i.e., limited to the site study area), it was concluded that there were no likely significant adverse environmental effects.

Residual effects were identified for thermal effects on Round Whitefish embryo survival. Based on the low geographical extent (i.e., limited to the site study area) and the prevalence of thermal effects in offshore areas compared to nearshore areas (more optimal spawning depths for Round Whitefish), it was concluded that there were no likely significant adverse environmental effects.

Residual effects were also identified for human health in the event of the unlikely bounding nuclear-related accident scenario assessed in this EA Screening Report. Based on the relatively short duration of this event, low magnitude and subsequent low effects to physical human health, it was concluded that there were no likely significant adverse environmental effects.

An EA follow-up program has been identified for this Project, with specific activities focusing on: surface water (i.e., stormwater quality and liquid effluents); aquatic biota (impingement, entrainment and thermal); malfunctions and accidents (i.e., bounding nuclear accident scenario); and seismically-induced hazards (i.e., liquefaction potential). This follow-up program includes an adaptive management framework that has been outlined to account for impingement, entrainment and thermal effects during the continued operations of the DNGS.

Should the project advance to the regulatory approvals stage, the CNSC licence and compliance process and DFO's authorization process under the *Fisheries Act* will be used to ensure the implementation of the EA follow-up program outlined in this EA Screening Report.

1 PURPOSE OF THE SCREENING REPORT

1.1 Introduction

The purpose of this EA Screening Report is to provide the RAs, CNSC and DFO, with the information necessary to render their decisions under section 20 of the CEA Act regarding the proposal by OPG to refurbish the four units at the DNGS, and to operate those units through to the end of their useful lives in 2055 in the Municipality of Clarington, Ontario (the Project).

This EA Screening Report has been prepared by CNSC staff and DFO on the basis of an Environmental Impact Statement (EIS), technical support documents (TSDs) and other related information submitted by OPG in response to the Scoping Information Document approved by the Commission and issued on October 28, 2011 (CNSC 2011a). The aforementioned OPG documentation can be found on OPG's website regarding the DNGS refurbishment project.

Following the current public consultation, the EA Screening Report will be finalized and submitted to the Commission for consideration and EA decision following a Public Hearing. The EA Screening Report and the Commission's and DFO's decision on the EA Screening Report will fulfill the CNSC and DFO's obligations as RAs under the CEA Act in assessing the environmental effects of the proposed project.

Consistent with section 17 of the CEA Act, specific consultative and technical activities were delegated to the proponent, OPG, in preparation of the EIS which supports the EA Screening Report. These activities were conducted in accordance with the Scoping Information Document.

CNSC staff have posted information on the CNSC website and maintained the Canadian Environmental Assessment Registry (11-01-62516) of all documents relevant to the EA.

1.2 Application of Environmental Assessment Legislation

1.2.1 CNSC Regulatory Framework

The DNGS site is currently licensed as a Class 1 Nuclear Facility under a Power Reactor Operating Licence (PROL 13.15/2013) and the Darlington Waste Management Facility (DWMF) is licensed as a Class 1B Nuclear Facility under a Waste Facility Operating Licence (WFOL-W4-355.02/2012).

In order for OPG to undertake the proposed activities required to refurbish and continue to operate the DNGS, amendments to both the DNGS and DWMF licences pursuant to subsection 24 (2) of the *Nuclear Safety and Control Act* (NSCA) are required.

The amendment of a licence is a power exercised under the authority set out in subsection 24(2) of the NSCA, which is listed as a "trigger" under the *Law List Regulations* of the CEA Act. Therefore, there is a "trigger" pursuant to paragraph 5(1) (d) of the CEA Act.

The proposed refurbishment and continued operation of the DNGS is an undertaking in relation to physical work and, as such, is defined as a “project” pursuant to subsection 2(1) of the CEA Act.

There is both a “project” and a “trigger” for OPG’s proposal, and the *Exclusion List Regulations* do not apply. Therefore, an EA is required to be conducted prior to the CNSC taking any licensing action. As this proposal is not listed on the *Comprehensive Study List Regulations* of the CEA Act, an EA screening is required.

1.2.2 DFO Regulatory Framework

OPG has indicated that it is planning on submitting an application for an authorization under section 32 of the *Fisheries Act* (no person shall destroy fish by any means other than fishing unless authorized by the Minister) for the continued operation of the DNGS. As such, DFO has declared itself to be an RA because the continued operation of the DNGS, specifically the condenser cooling water system, will result in impingement and entrainment of fish and requires an authorization to be compliant with the *Fisheries Act*. Section 32 of the *Fisheries Act* is a “trigger” under the *Law List Regulations* of the CEA Act. Therefore, there is a “trigger” pursuant to paragraph 5(1) (d) of the CEA Act.

The proposed continued operation of the condenser cooling water system is an undertaking in relation to physical work and, as such, is defined as a “project” pursuant to subsection 2(1) of the CEA Act.

There is both a “project” and a “trigger” for OPG’s proposal, and the *Exclusion List Regulations* do not apply. Therefore, an EA is required to be conducted prior to DFO granting any authorizations. As this proposal is not listed on the *Comprehensive Study List Regulations* of the CEA Act, a screening EA is required.

1.3 Federal and Provincial Coordination

Pursuant to the CEA Act *Regulations Respecting the Coordination by Federal Authorities of Environmental Assessment Procedures and Requirements*, the CNSC has consulted with other federal departments to determine whether they are likely to exercise a power, function, or duty under section 5 of the CEA Act and/or whether they possess expert assistance that could be used during the assessment, in accordance with subsection 12(3) of the CEA Act. In addition to DFO declaring itself to be an RA (see section 1.2.2 of this EA Screening Report), Health Canada, Natural Resources Canada and Environment Canada have been identified as Federal Authorities for the purpose of providing expert assistance to CNSC and DFO during the EA. CNSC is also the Federal Environmental Assessment Coordinator for this EA Screening Report.

The CNSC consulted the Ontario Ministry of the Environment (OMOE) to determine whether there were provincial EA requirements under the *Ontario Environmental Assessment Act* and other provincial legislation that are applicable to the proposal. No provincial EA is required; however, CNSC staff has kept the OMOE informed throughout the EA process and sought their participation during the technical review phase of the EA. Similarly, CNSC has kept the Lake Ontario Management Unit of the Ontario Ministry of Natural Resources (OMNR) informed throughout the EA process.

2 OTHER REGULATORY MATTERS

The scope of the EA for this Project is documented in the *Scoping Information Document: Proposal by Ontario Power Generation for the Refurbishment and Continued Operation of the Darlington Nuclear Generating Station in the Municipality of Clarington, Ontario* (Scoping Information Document) approved by the Commission in October 2011.

Other related regulatory initiatives that are ongoing that deal with matters beyond the scope of this EA, are summarized below.

2.1 Integrated Safety Review

In addition to the EA, another element of refurbishment planning is that OPG is conducting an Integrated Safety Review (ISR) of the DNGS in accordance with the CNSC regulatory document RD-360 *Life Extension of Nuclear Power Plants*. In cases where the decision is made to implement life extension and an EA is carried out, the results of the EA (e.g., mitigation, follow-up) and the ISR are incorporated into an Integrated Implementation Plan that describes the program for corrective actions and safety improvement.

2.2 Regulatory Response to the Events at Fukushima

In response to the severe nuclear accident at the Fukushima Daiichi nuclear power plant, a number of key items have been undertaken in a timely and transparent manner:

- CNSC established the CNSC Fukushima Task Force in April 2011 to review licensees' responses to the CNSC order, under subsection 12(2) of the *General Nuclear Safety and Control Regulations*, to re-examine the safety cases of their nuclear power plants.
- The Task Force completed its review and presented its findings and 13 recommendations in the *CNSC Fukushima Task Force Report* (CNSC 2011b), with a subsequent *CNSC Management Response* (CNSC 2011c) which outlined the basis upon which the Task Force recommendations would be implemented in a timely and transparent manner.
- The *CNSC Staff Action Plan on the CNSC Fukushima Task Force Recommendations* (CNSC 2012), presented to the Commission on May 3, 2012, will be implemented through:
    - existing licensing and compliance regulatory oversight programs for items relating to design and operational enhancements

- o the CNSC Harmonized Plan for items relating to regulatory framework improvements

The above steps will allow for the timely and transparent implementation of lessons learned from the events at Fukushima to further enhance the safety of nuclear power plants in Canada.

These actions are being carried out under the authority of the NSCA and its associated *General Nuclear Safety and Control Regulations*. A summary of the actions that OPG has undertaken in response to the events at Fukushima can be found in section 7.10 of OPG's EIS.

3 PROJECT DESCRIPTION

3.1 Purpose of the Project

The "purpose" of the project is defined as what is to be achieved by carrying out the project.

The purpose of the project is to refurbish the DNGS to allow it to continue to operate until approximately 2055, providing a reliable and stable electricity supply for industrial, commercial and residential customers in Ontario. Refurbishment of CANDU reactors is an aspect of their design and accepted as a requirement at some point in their operational service life. The continued operation of DNGS requires that the reactors be refurbished so that they may continue to operate safely and efficiently.

3.2 Project Location and Schedule

The Darlington Nuclear (DN) site is located in the Municipality of Clarington, in the Regional Municipality of Durham; about 70 km east of Toronto on the north shore of Lake Ontario (see figure 3.2-1). The DN site is approximately 485 ha in size and is bounded to the north by the South Service Road of Highway 401 and to the south by Lake Ontario. To the west, the site is bounded by Solina Road and agricultural lands. Immediately to the east of the DN site is the large industrial complex associated with St. Marys Cement limestone quarry and processing plant.

An operating Canadian National (CN) railway track extends east-west across the site. Darlington Provincial Park, a campground and day-use park is located approximately 2 km west of the DN site. The Lake Ontario Waterfront Trail, a multi-use recreation trail extending from Niagara-on-the-Lake to the Quebec border, traverses the DN site north of the CN railway tracks. DNGS is located generally in the southwest quadrant of the DN site, south of the CN railway tracks (see figure 3.2-2).

For EA planning purposes, the refurbishment phase is estimated to start in 2013 and be completed by 2024, with no more than two reactors being in refurbishment outages at any given time. The continued operation phase is estimated to start in 2019 (return to service of first refurbished unit) and continue to 2055. The placement of reactors into end of life shutdown state is estimated to start in 2048 and be completed by 2085.

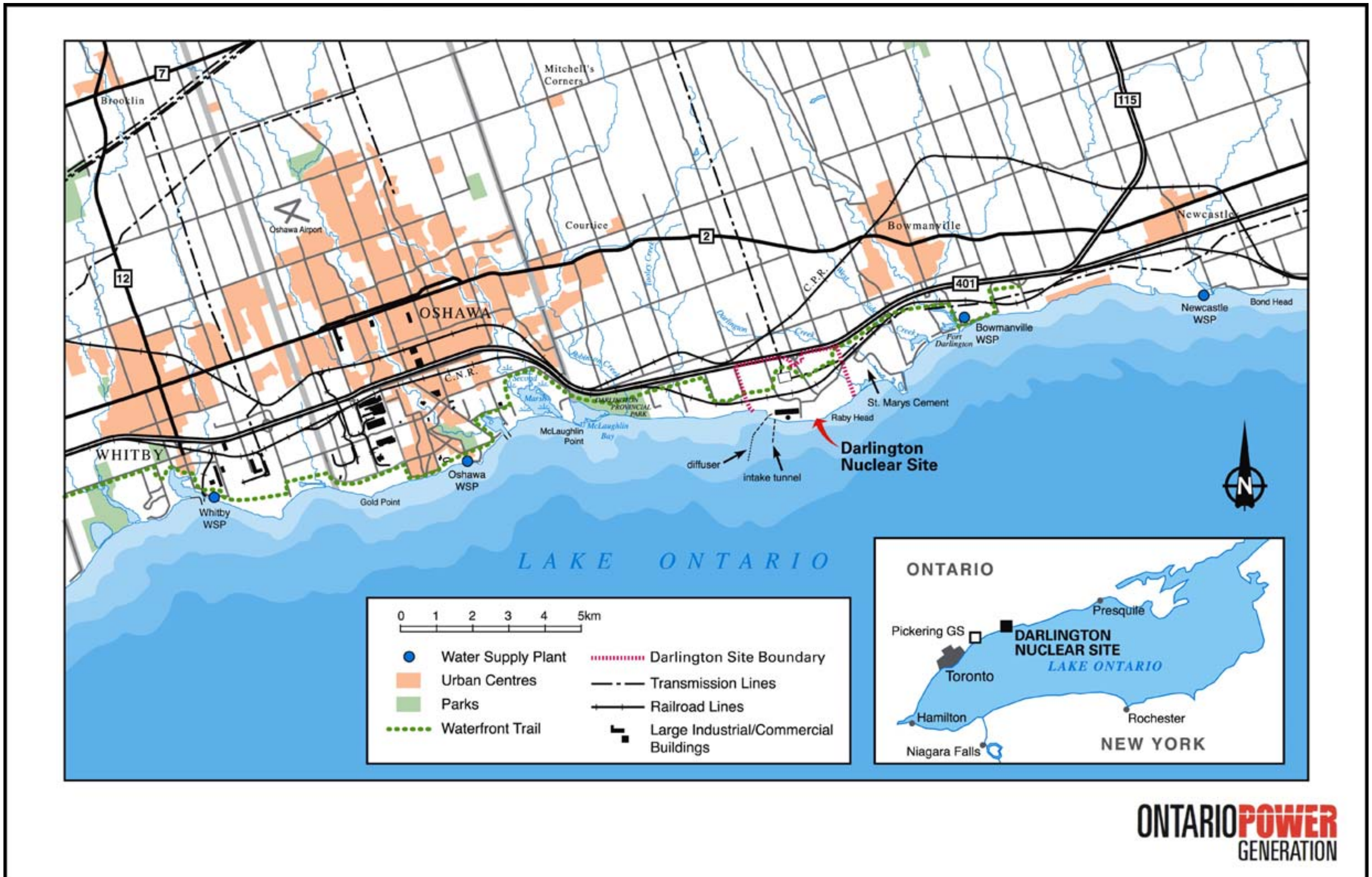


Figure 3.2-1 DN Site Location (source: OPG's EIS)

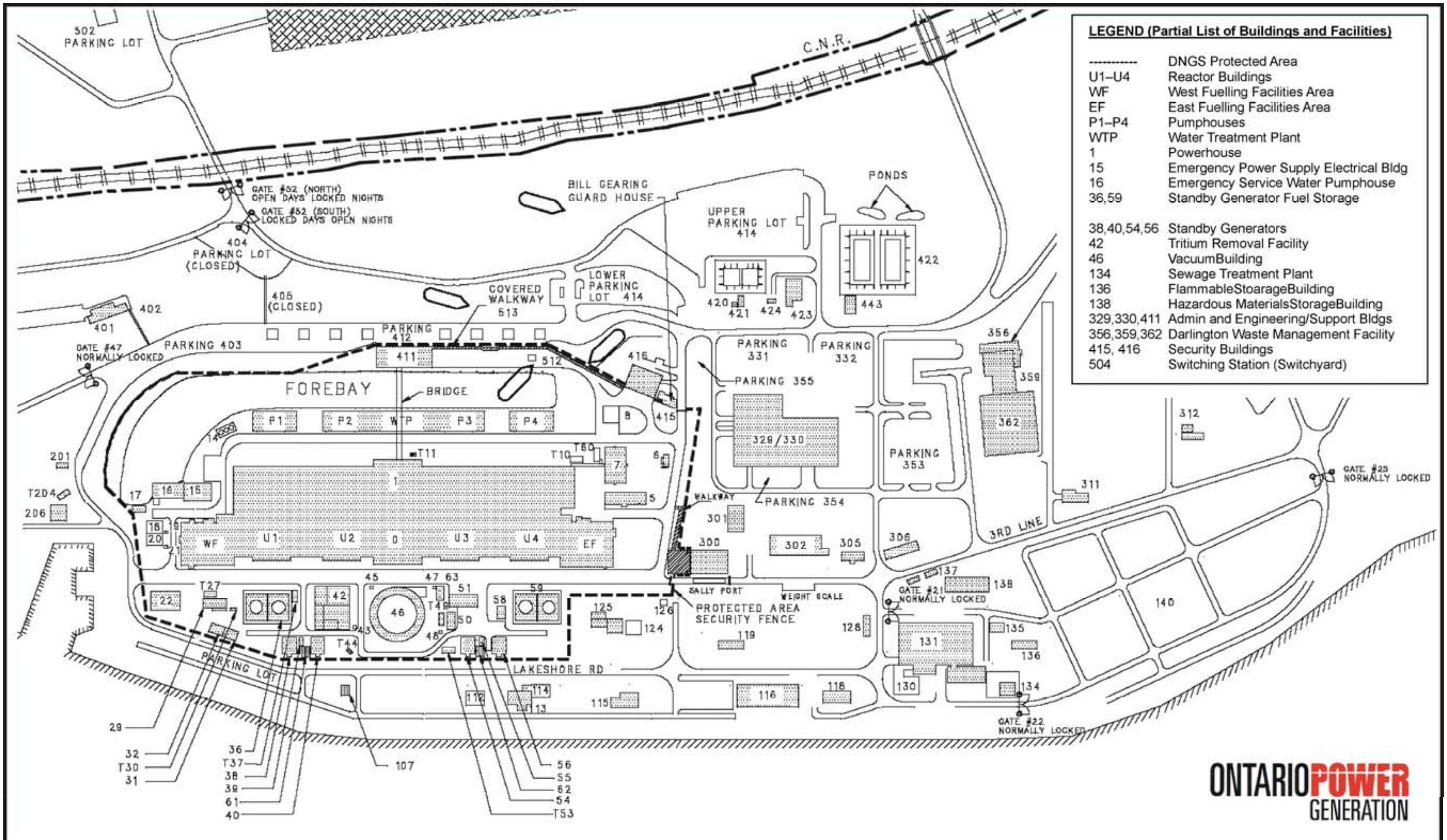


Figure 3.2-2 General Layout – DNGS (source: OPG's EIS)

3.3 Project Works and Activities – Refurbishment Phase

The principal works and activities associated within the scope of the Refurbishment phase are:

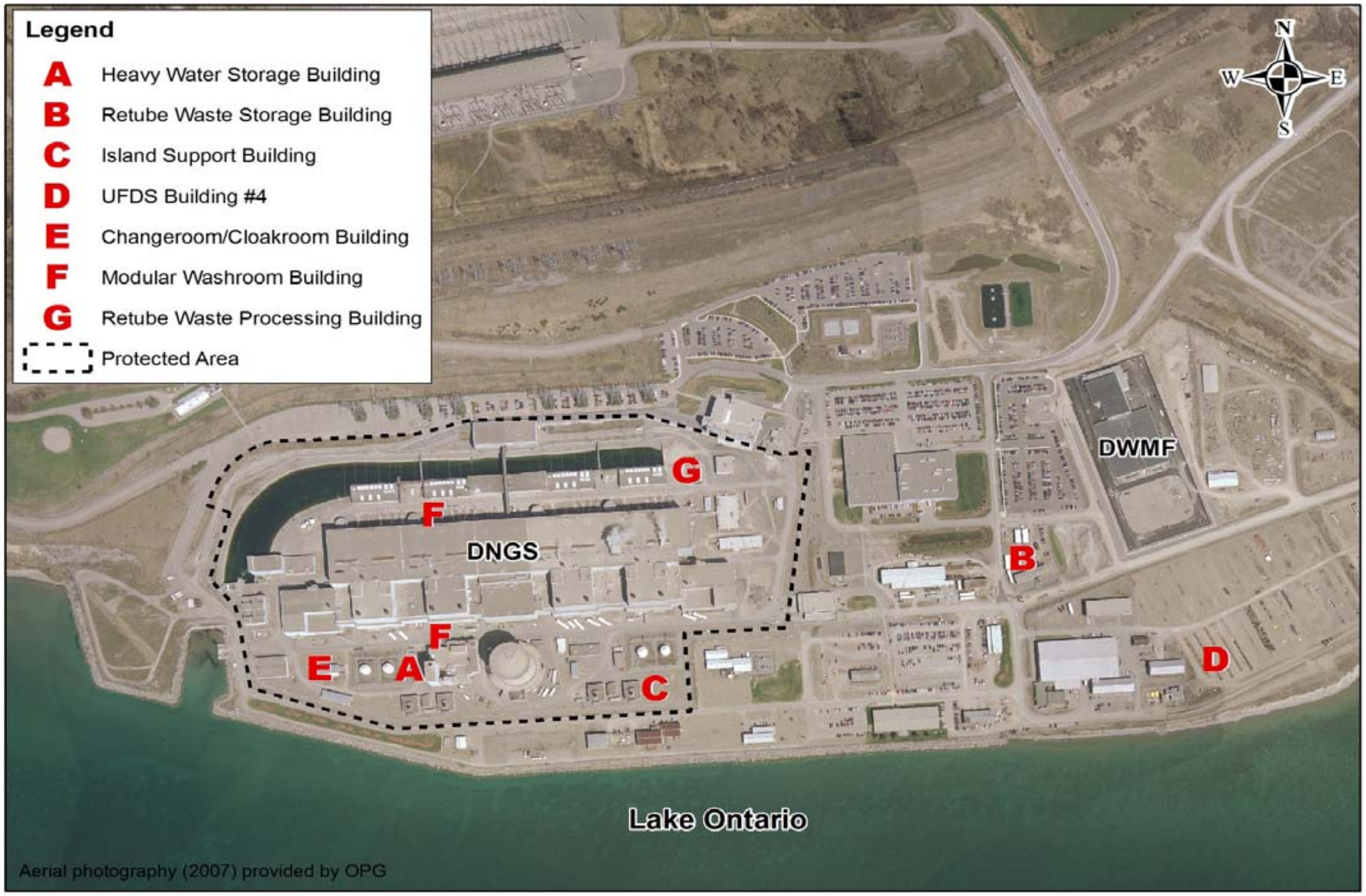
- construction of Retube Waste Storage Building(s) and other support buildings, including preparatory works
- shutdown, defuelling and dewatering of the reactors
- management of heavy water
- removal of reactor components and placement of wastes into storage
- transportation of refurbishment low and intermediate level radioactive wastes to an off-site waste management facility
- management of non-radioactive refurbishment waste
- balance of plant repair, maintenance and upgrades
- refilling, refuelling and restarting the reactors
- transport of workforce and materials

These works and activities are described further in the following sections.

3.3.1 Construction of Retube Waste Storage and Other Support Buildings

The Project will involve construction of support buildings to facilitate refurbishment of the reactors and their ongoing operation. For EA purposes, the six buildings described in table 3.3-1 are representative of this Project work and activity. Precise locations for these buildings will also be the subject of continuing planning and design; however, for purposes of the EA, the approximate (assumed) locations are illustrated on figure 3.3-1.

Preparatory activities for all new building areas will involve surface grading, development of construction laydown areas, and establishment of environmental management controls including stormwater management provisions. Construction of buildings will involve typical civil construction techniques that will result in some amount of dust and noise from the use of heavy equipment, and the generation of conventional construction wastes. For those buildings to be constructed in the Protected Area, it is assumed that any surplus soil which is found to be contaminated will be handled accordingly, including management on-site in an appropriately engineered facility or disposal at an appropriate licensed off-site waste management facility. Groundwater encountered during construction will be managed in compliance with applicable regulations including, where volumes require it, the acquisition of a provincial Permit to Take Water. Where groundwater is pumped from excavations or advanced dewatering systems, it will be monitored prior to discharge in accordance with applicable regulations and following station protocols.



Modified Figure 2.4-1: Generalized Locations of the DNGS Refurbishment Project Support Buildings (February 2012)

Figure 3.3-1 Generalized Locations of DNGS Refurbishment Project Support Buildings (source: OPG 2012)

The Retube Waste Storage Building will be located at separately licensed DWMF. The Heavy Water Storage Building, the Island Support Annex, the Lunchroom/Cloakroom Building, Washroom Modular Buildings, and the Retube Waste Processing Building will all be constructed in the Protected Area under the authority of the Power Reactor Operating Licence (see figure 3.3-1). Further details on the buildings to be constructed are provided in table 3.3-1.

Table 3.3-1 Details on Buildings to be Constructed for Refurbishment

Building	Details
Retube Waste Storage Building (RWSB)	▪ up to 2500 m^2 in size to be constructed at the DWMF to accommodate the retube waste resulting from reactor fuel channel refurbishment ▪ above-grade warehouse style construction with concrete panels over pre-stressed concrete post and beam framing ▪ retube waste will be stored in the RWSB at the DWMF until it is transferred to a long-term waste management facility (i.e., the Deep Geologic Repository) proposed to be built adjacent to the Western Waste Management Facility (WWMF)
Heavy Water Storage Building (HWSB)	▪ 800 m^2 in size to be constructed to provide storage capacity during refurbishment and continued operation, as well as to support ongoing operation of the tritium removal facility ▪ extending approximately 13 m below grade and 20 m above grade, the structure will be steel framed on a concrete foundation ▪ it will accommodate a number of individual storage tanks, most with a capacity of approximately 100 m^3, with a total tank storage capacity of approximately 2,100 m^3
Retube and Feeder Replacement Island Support Annex	▪ provide office, shop and related work spaces and facilities for the additional staff required inside the Protected Area to plan, supervise and execute the refurbishment activities ▪ it will include approximately 300 cubicle office spaces and about 1,200 m^2 of shop space and associated amenities
Lunchroom/ Cloakroom Building	▪ a two storey building of approximately 1500 m^2 ▪ the first floor consists of the lockers and cloakrooms and the lunchroom is on the second floor
Washroom Modular Buildings	▪ the Washroom Modular Buildings will house washroom facilities for men and women, with each module approximately 24 m^2 in size

Building	Details
Retube Waste Processing Building	▪ this building will be approximately 170 m^2 in size ▪ function as a place to remove the retube waste from the flask, volume reduce it by cutting it into smaller pieces and packaging it in Retube Waste Containers

3.3.2 Shutdown, Defuelling and Dewatering of the Reactors

Before the start of refurbishment activities, each reactor to be refurbished will be shut down, defueled, dewatered and placed in an "islanded" state (i.e., isolated from the operating units to a limited extent). Heavy water will be removed from the Moderator System and Primary Heat Transport Systems (PHTS) and their auxiliaries. The systems will be dried and may be rinsed to remove the remaining heavy water. Dewatering the Moderator System and PHTS in one reactor unit will involve the removal of approximately 311 m^3 and 333 m^3 of heavy water, respectively.

On-going reactor vault preparation work during this period will involve such activities as vault decontamination, moving equipment away from the reactor face, removal of reactor face insulation, and installation of shielding cabinets, flasks, lifting equipment and special tooling in the vault.

3.3.3 Management of Heavy Water

The removed heavy water will be collected, detritiated and upgraded as required, and stored on site in a manner similar to current operating practice, including in the HWSB to be constructed. The heavy water will be reused once refurbishment is complete.

3.3.4 Replacement of Reactor Components

Each reactor contains 480 calandria (and pressure) tubes and associated feeders, end fittings, shield plugs and closure plugs. These components will be inspected and replaced as necessary. Modifications to containment structures to facilitate the movement of these components may be required. Following dewatering of each reactor to be refurbished, the fuel channels, calandria tubes and feeder pipes will be removed. The feeder pipes will be removed first.

New fuel channels, calandria tubes and feeder pipes will be installed. The reactor vaults will be returned to operational status through removal of all the temporary services, removal of temporary shielding and tooling, and reinstallation of feeder cabinet and reactor face insulation.

3.3.5 Upgrades to and Maintenance of Other Systems and Components

As part of the Project, OPG is reviewing safety and economic improvement opportunities that may result in modifications. Throughout the nuclear and non-nuclear side of DNGS, there may be opportunities to undertake repairs, maintenance and upgrades of many components while each reactor undergoes a major refurbishment outage.

Any modifications performed will conform to existing OPG governance. This work may generate small quantities of radioactive low level waste (LLW) and non-radioactive waste which will be managed in a manner similar to current practices.

3.3.6 Management of Refurbishment Radioactive Wastes

Retube Waste Handling

Retube radioactive intermediate level waste (ILW) such as the fuel channel assembly waste (e.g., pressure tubes and calandria tubes) will be volume-reduced by cutting and crushing in Retube Waste Processing Building equipped with appropriate ventilation and monitoring equipment. The retube waste materials will be placed into purpose-built retube waste containers (RWCs) and transferred to the RWSB at the DWMF where it will remain in interim storage for approximately 20-25 years until it has decayed to levels appropriate for transportation off-site to the WWMF or a long-term waste management facility. For purposes of this EA, the RWSB(s) will be designed for a total as-stored volume of approximately 3,860 m^3 of retube waste.

For purposes of this EA, at a conceptual design basis, the RWC will comprise a cylindrical, high-density concrete container with inner and outer steel liners. During the storage period at DWMF, the RWC will be stored within a secondary overpack, which will provide additional shielding. The secondary overpack will be a cylindrical, concrete container with an inner steel liner; it may also have an outer steel liner. The RWC design ultimately used for the DNGS retube wastes will consider the unique characteristics of the waste materials (see OPG's dispositions of technical review comments on the EIS: Comment #7 in OPG 2012) and incorporate appropriate features for shielding and handling (including shipment). The container design ultimately selected will be a CNSC certified transportation package and ready for storage at the WWMF or at another appropriately licensed waste management facility.

Miscellaneous L&ILW Handling

The miscellaneous L&ILW (e.g., mop heads, other cleaning materials, clothing, feeder pipes, reactor face insulation, tooling, other equipment used) will be packaged in standard waste containers and transported to the WWMF for processing and/or storage, similar to routine operational L&ILW generated at DNGS. The total volume of miscellaneous L&ILW generated as a result of refurbishment is estimated to be approximately 1,400 m^3 per unit for a total of about 5,600 m^3.

Transportation of Radioactive Wastes

The L&ILW transportation associated with refurbishment waste shipment, approximately two additional shipments per day, would be along routes similar to those currently used. On-going transportation of radioactive materials to the

WWMF is in accordance with all applicable requirements. All wastes requiring off-site transportation would be managed using OPG's existing transportation processes. Any additional transportation packages required for specific wastes would be designed, certified and procured according to OPG's existing processes and applicable CNSC and Transport Canada regulations. Retube ILW will ultimately be transported in a category of packages identified as "Type B" in the *Packaging and Transport of Nuclear Substances Regulations*. A Type B transportation package is designed to survive specific performance tests intended to represent accident conditions during transport. The design, including all supporting safety analyses and tests, of a Type B package must be reviewed and certified by the CNSC.

If the Deep Geologic Repository were to be delayed beyond the EA planning assumptions, the retube waste would be shipped to the WWMF or another licensed off-site facility or there may be a requirement to extend the on-site storage period for the retube wastes.

3.3.7 Management of Non-nuclear Waste

A preliminary estimate of the non-nuclear waste generated during the Refurbishment phase is approximately 15,300 tonnes. Current conventional (i.e., non-radioactive) waste management activities at DNGS are compliant with applicable provincial requirements. Existing programs will be adapted and augmented as necessary to meet the increased waste management requirements of the Project, however, will continue to remain compliant with applicable regulations. As is current practice, the conventional waste stream will be minimized to the extent possible through reuse and recycle programs. The types of chemicals, lubricants or oils currently in use at the DNGS are not likely to change during the refurbishment phase. Any hazardous wastes will be handled in accordance with applicable provincial regulations.

3.3.8 Refuelling and Restarting the Reactors

Following the completion of refurbishment activities for each unit, the Moderator System and PHTS will be refilled with heavy water and the reactor refuelled. It is assumed that new reactor fuel will be brought into the reactor building and manually loaded into the new fuel channels, as is standard practice for initial fuel loading of a new reactor core.

Following refilling and refuelling, reactor systems will be systematically started up, configured for reactor operation, and tested as needed. Once the reactor core reaches equilibrium conditions, several months following restart, routine on-power refuelling will resume.

The refilling, refuelling and restarting activities are expected to generate L&ILW comparable to wastes generated during normal maintenance outages.

3.3.9 Transport of Materials, Workforce and Components

During the peak of the refurbishment project, overall at the DN site, there will be approximately 4,600 individuals, of which 2,700 will be on the Project (2,000 OPG contract and contractor employees plus 700 OPG staff).

3.4 Project Works and Activities – Continued Operations

The principal works and activities associated within the scope of the Continued Operation phase of the Project are described in table 3.4-1 below.

Figure 3.4-1 illustrates a simple unit flow diagram for a single DNGS reactor as reference for the descriptions of several of the reactor systems and components in the following pages.

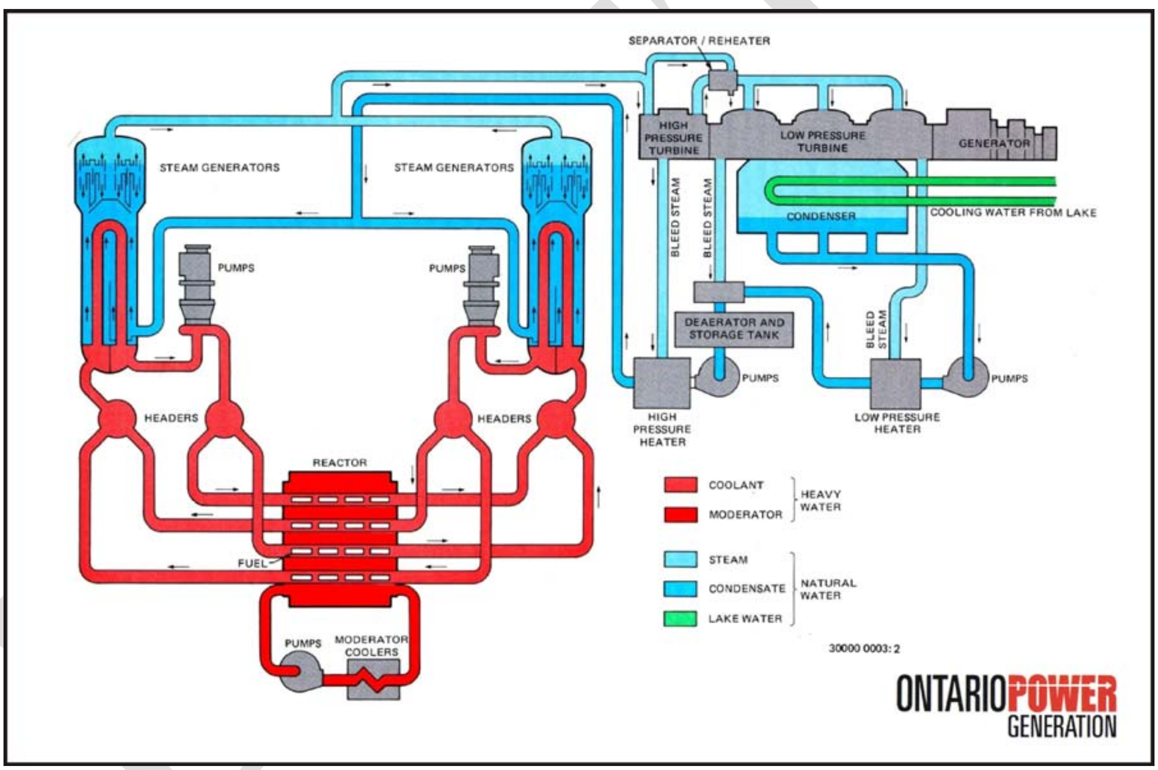


Figure 3.4-1 Simplified Unit Flow Diagram for a DNGS Reactor (source: OPG's EIS)

Table 3.4-1 Principal Works and Activities Associated With the Continued Operation Phase of the Project

Works and Activities	Description
Operation of the Reactor Core	▪ The Reactor Core is the starting point for the generation of electricity and the source of radioactivity through self-sustaining fission chain reactions taking place in which the neutrons generated in the fission reactions go on to cause additional fission reactions at a constant rate within the reactor. ▪ In order to sustain a nuclear chain reaction, the calandria is filled with a "moderator" consisting of heavy water – a liquid that slows down the neutrons released in the fission process so that they can be absorbed more readily by uranium and transuranium atoms causing them to split which releases heat.
Operation of the Primary Heat Transport System (PHTS) and Moderator Systems	▪ The PHTS provides essential cooling of the fuel in the reactor by circulating pressurized heavy water through the Reactor Core (i.e., fuel channels) to remove the produced heat and transfer it to the Steam Generators where it is subsequently transferred to a light water steam cycle that drives the turbine/generator sets. ▪ The Moderator systems include: Moderator Circulation System; Moderator Liquid Poison System; Moderator Auxiliary Systems; and Moderator Purification System. ▪ The Heavy Water (i.e., D_2O) Management System includes the Heavy Water Supply System as well as Collection, Cleanup, and Vapour Recovery Systems.
Operation of Active Ventilation and Active Plant Drainage Systems	▪ The functions of the Active Ventilation System are to remove heat from various buildings and areas, to provide general ventilation and to prevent or minimize cross-contamination between zones by controlling air pressure differential. ▪ Gaseous emissions are monitored and/or treated (e.g., filtered) as appropriate. ▪ The Active Plant Drainage System recovers, segregates and transfers active liquid waste and decontamination solutions generated throughout the station, to collection tanks. All active wastes are segregated based on activity level and chemical content. ▪ Before any liquid waste is discharged from DNGS via the Condenser Cooling Water System, the concentrations of radionuclides in the effluents are confirmed to meet the appropriate discharge criteria.

Works and Activities	Description
	▪ Certain types of non-aqueous radioactive liquids that meet the waste acceptance criteria for the WWMF, are collected, packaged and transported to the WWMF for incineration. ▪ Other types of non-aqueous radioactive liquids are collected and transported to licensed third party facilities for treatment.
Operation of Fuel Handling and Storage Systems	▪ Fuel is delivered to DNGS in protective flame retardant containers and stored in these containers within the Fuelling Facilities Auxiliary Areas (FFAAs) at each end of the station until required. ▪ The DNGS reactors are fuelled on-power using remote-controlled fuelling machines. ▪ The used (irradiated) fuel bundles removed from the reactor are transferred by the receiving fuelling machine along the fuelling duct to an Irradiated Fuel Bay (IFB) located in either of the FFAAs. ▪ Storage modules containing used fuel bundles are held in the IFB storage bay to cool and decay for a period of at least 10 years. ▪ Following the wet storage period, the used fuel is loaded into dry storage containers (DSCs) and transferred to DWMF for continued interim dry storage.
Operation of Special Safety and Safety Related Systems	▪ A multiple barrier approach (based on the "defence-in-depth" concept) is incorporated into the DNGS reactors and their support systems to prevent or control releases of radioactivity to the environment. ▪ Five barriers exist between the radionuclides and the public, including the uranium dioxide fuel matrix, the zirconium alloy fuel cladding, the primary heat transport system boundary, the concrete containment building, and the exclusion zone around the station. ▪ The DNGS reactors have four independent safety systems to prevent or limit radioactive releases in the event of a malfunction or accident: Shutdown System No. 1 and Shutdown System No. 2, which provide emergency safe shutdown capability for the reactors; the Emergency Coolant Injection System; and the Negative Pressure Containment System.
Operation of Secondary Heat Transport System (SHTS) and Turbine-	▪ The function of the SHTS is to transport the steam produced from the light water in the secondary side of the Steam Generators to the turbine set causing the turbine rotor and the attached generator to rotate.

Works and Activities	Description
Generator Systems	▪ After passing through the turbine, the steam is condensed back to liquid form (water) in the Main Condenser and pumped through the Condensate and Feedwater Systems, gradually increasing in temperature as it passes through the various stages of feedwater heating, and finally pumped back into the Steam Generators to begin another cycle. ▪ The Turbine-Generator systems comprise the main power generating equipment of the station and include: turbine-generator sets, condensers, different types of feedwater heaters and auxiliary systems such as the Turbine Lubricating Oil and Gland Seal Systems.
Operation of Station Water Systems	Condenser Cooling Water (CCW) System ▪ The CCW System, referred to as "once-through lake water cooling", draws water from Lake Ontario (maximum design intake flow of approximately155 m^3/s with an average velocity of 0.15 m/s) which is circulated through the unit condensers to cool the steam in the SHTS and returned to Lake Ontario through an open-loop intake and discharge system. ▪ The CCW System intake consists of a 7.5-m diameter tunnel in the lake bottom extending approximately 800 m from the forebay to the intake structure (network of porous and non-porous concrete modules, approximately 5,838 m^2 in area), which is embedded in the lake bottom at a water depth of approximately 10 m (illustrated in Figure 3.4-2). ▪ The CCW discharge extends a total distance of approximately 1,600 m from shore, with the 900-m length diffuser section consisting of a series of 90 diffuser ports rising vertically through the lake bottom from which the water is discharged to promote rapid thermal mixing in the lake at water depths of approximately 10 to 12 m (illustrated in figure 3.4-2). ▪ The DNGS intake and discharge structures are located within a marine shipping prohibited zone (approximately 1,400 m along the Lake Ontario shoreline and 2,000 m into the lake) established according to Transport Canada marine safety standards and within which the operation of ships is prohibited for the safety of both the ships and the underwater structures. Service Water Systems ▪ Service water is required by various operating systems within the plant as follows: Powerhouse Upper Level Service Water System, Low Pressure Service Water System, Recirculated Cooling Water System,

Works and Activities	Description
	Auxiliary Service Water System, Demineralized Water System, and Emergency Service Water System. ▪ At DNGS, service water intake and discharge is combined with the CCW System intake and discharge and drawn as needed through this open loop system with some service water systems utilizing a closed loop system (e.g., those requiring the use of demineralized water). ▪ Demineralized water is produced in the Water Treatment Plant as makeup for the secondary systems of the four generating units.
Operation of Electrical Power Systems	▪ Electrical Power Systems deliver power to and from the grid (i.e., main transformers and switching station), generate emergency power (i.e., standby and emergency power systems) and distribute power throughout the station (i.e., on-site power distribution system).
Operation of Site Services and Utilities	▪ Site services and utilities include domestic water supply and wastewater management, stormwater management, building services (e.g., lighting, heating, ventilation and air conditioning), fire protection, on-site transportation and parking, a number of other auxiliary systems (e.g., compressed air, security), and the supply and storage of chemicals and other materials used for routine operational purposes. ▪ For wastewater management, the collected wastewater is currently pumped or gravity drained to the on-site DNGS Sewage Treatment Plant located centrally at the south end of the DN site. ▪ For stormwater management at the DNGS site, it is comprised of a network of open ditches, culverts, underground conduits (solid-wall or perforated pipe depending on the situation), catch basins, manholes, sumps, infiltration drain pits, stormwater management ponds with control structures, and shoreline outlets to Lake Ontario, all for the collection, transmission, treatment and disposal of site storm water and building roof drains. ▪ Minor modifications to the existing stormwater management system to accommodate the construction of new buildings (e.g., waste storage) will be required. ▪ Various chemicals, gases, lubricants and oils are used at DNGS for routine operational purposes (see table 2.5-2 of OPG's EIS) and managed in accordance with applicable regulatory requirements including the *Liquid Fuels Handling Code* (published by the provincial Technical Standards & Safety Authority) and the provincial *Environmental Protection Act* and its Regulations.

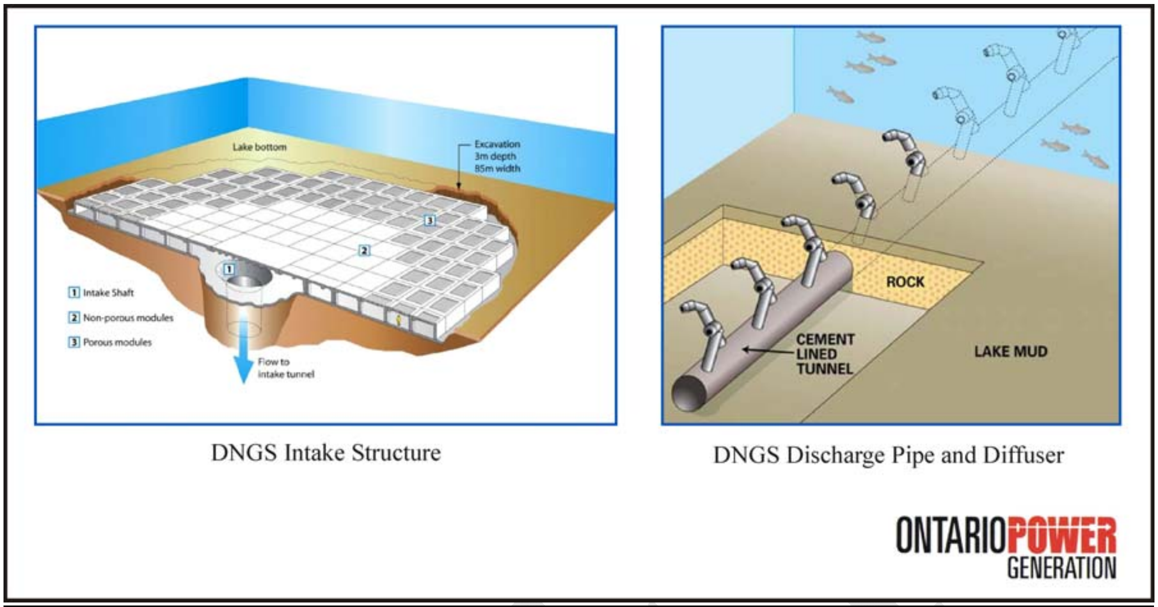
Works and Activities	Description
Operation of the Tritium Removal Facility (TRF)	▪ The TRF processes heavy water used at all of OPG's nuclear stations to reduce the levels of tritium contained within it; heavy water inventories from stations other than DNGS are shipped to the TRF by truck. ▪ Extracted tritium is contained in a stainless steel vessel for storage or transportation and at full capacity the TRF can extract about 7.5×10^{17} Bq/year of tritium.
Construction of Additional Storage Buildings at DWMF (Used Fuel Dry Storage and Steam Generator)	Used Fuel Dry Storage Building[1] ▪ The continued operation of the DNGS will require that 1 additional used fuel dry storage (UFDS) building be constructed at the DWMF complex (in addition to the three used fuel dry storage buildings currently authorized under the DWMF licence), currently estimated to be required in 2031 (see figure 2.1-1 for location). ▪ It will be of a similar design to the current storage building (i.e., single storey, commercial type, concrete structures with concrete slab-on-grade floor, ventilation and drainage) and involve typical civil construction techniques ▪ It will be capable of storing approximately 500 DSCs each containing up to 384 used fuel bundles Steam Generator Storage Building ▪ The EA considers the possible replacement of one or more Steam Generators as an element of normal maintenance during the Continued Operation phase, which would require that the steam generators be placed into a purpose-built storage building (Steam Generator Storage Building) constructed on the DN site or transported off-site to storage at an approved licensed facility. ▪ Should a Steam Generator Storage Building (SGSB) be constructed, it will be an above-ground concrete warehouse-type structure similar in design to the SGSB currently in use at OPG's WWMF, constructed using typical civil construction techniques. ▪ A building such as a SGSB would require a future licence amendment for the DWMF.

Works and Activities	Description
Management of Operational L&ILW	LLW ▪ LLW is defined as waste with contact radiation fields less than 10 mSv/h at 30 cm, and is routine waste that results from day-to-day reactor operations and maintenance, and subsequently categorized as incinerable, compactable, or non-processible. ▪ Annual levels of LLW are forecasted in the short term to range from 607 to 841 m^3 and similar levels are expected in the future. ILW ▪ ILW is defined as waste with contact radiation fields greater than 10 mSv/h at 30 cm and typically consists of spent ion exchange resins, disposable filters and certain non-processible wastes. ▪ Annual levels of ILW are forecasted in the short term to be 20 m^3 and similar levels are expected to be in the future. ▪ A further estimated 960 m^3 of resin waste is expected to be generated from a PHTS chemical clean.
Transportation of L&ILW to Off-site Waste Management Facility	▪ Operational L&ILW will be transported to the WWMF or other appropriately-licensed waste management facility for processing and/or storage using OPG's existing, approved transportation systems and processes in accordance with all applicable requirements, including the *Packaging and Transport of Nuclear Substances Regulations* made under the NSCA and the applicable regulations made under the *Transportation of Dangerous Goods Act*
Management of Conventional Wastes	▪ Management of conventional wastes will be similar to that of the refurbishment phase (see section 3.3.7 of this EA Screening Report).
Maintenance of Major Systems and Components	▪ Throughout the lifetime of a nuclear power plant, some systems and components will require maintenance, replacement or upgrading due to aging, wear and degradation and is managed through OPG's Integrated Aging Management Program. ▪ For maintenance activities requiring temporary unit shutdowns, the unit is placed in a shutdown state and pumps, valves, actuators, motors, and other like components that cannot be accessed while the unit is operational will be maintained or replaced and any design modifications or upgrades, including

Works and Activities	Description
	required safety enhancements, will be made at this time. ▪ In the event that steam generator replacement is needed, the steam generator will be removed intact from the Reactor Building, with any openings capped to prevent the release of loose radioactive contamination, which may necessitate creating an opening in the roof or side of the reactor building to remove the steam generator using heavy lift cranes. ▪ New steam generators would be shipped to the site (possibly by rail or barge) and installed in place by reversing the removal procedure. ▪ Chemical cleaning / decontamination of the PHTS (including cleaning of the primary side of the Steam Generators) is not anticipated but assumed for EA purposes.
Placement of Reactors into End of Life Shutdown State	▪ The final stage in the Continued Operation phase will be the placement of each unit progressively into the end-of-life shutdown state and the maintenance of this condition for approximately 30 years to allow decay of some residual contamination in advance of physical station decommissioning activities. ▪ This activity generally comprises the first two phases of the overall DNGS decommissioning strategy (Phase I – Preparation for Safe Storage; Phase II – Safe Storage and Monitoring) described in section 3.4.1 of this EA Screening Report. <u>Preparation for Safe Storage</u> ▪ The reactors will be defuelled and dewatered and isolated from essential systems associated with the continued operation of other reactors. ▪ Non-fixed external surface contamination will be removed from accessible areas of the station. ▪ Normal station environmental monitoring and surveillance will be maintained as well as radiation and non-radiological contamination surveys of the station and its systems will be performed. <u>Safe Storage and Monitoring</u> ▪ Maintenance staff will perform routine inspections and carry out preventative and corrective maintenance activities.

Works and Activities	Description
	▪ An environmental surveillance program will be carried out to ensure that potential releases to the environment are detected and controlled.
Workforce	▪ The ongoing labour force and supply of equipment and materials required for the continued operation of DNGS will be generally similar to the current workforce of approximately 2,600 individuals.

[1] Though off-site transport of used nuclear fuel is not within the scope of the EA, if the NWMO off-site facility were to be delayed beyond their planning assumptions, OPG's contingency planning for used fuel incorporates the possible requirement for additional storage buildings at the DN site. There is more than adequate space available on the DN site for this purpose.



DNGS Intake Structure

DNGS Discharge Pipe and Diffuser

Figure 3.4-2 CCW System Intake and Discharge Structures (source: OPG's EIS)

3.4.1 Preliminary Decommissioning Plan

The CNSC regulates nuclear activities through a multi-stage licensing process which requires separate applications for site preparation, construction, operating, decommissioning and abandonment licences. A Preliminary Decommissioning Plan (PDP) must be submitted in accordance with the CNSC's Regulatory Guide G-219 *Decommissioning Planning for Licensed Activities* and *CSA Standard N294-09 Decommissioning of Facilities Containing Nuclear Substances.* PDPs have been developed for all of OPG's existing nuclear facilities. The PDPs are developed to document a decommissioning strategy that, in light of current knowledge, represent a technically feasible, safe and environmentally acceptable approach. The PDPs also form the basis of the work packages, which are refined and used to develop procedures to form the detailed decommissioning plan. The detailed plans will ultimately be required for the actual decommissioning of these facilities.

The preferred decommissioning strategy for DNGS is one of deferred dismantling. Deferred dismantling involves storing and monitoring the reactors and station for 30 years after shut down to allow radiation and thermal levels to decay prior to dismantling, demolition and site restoration. The preferred decommissioning strategy of deferred dismantling minimizes both the occupational radiation dose to workers, and the potential exposure of the public and the environment.

The decommissioning strategy of deferred dismantling involves the following three main phases:

- Phase I – Preparation for Safe Storage
- Phase II – Safe Storage and Monitoring

- Phase III – Dismantling, Demolition and Site Restoration

Further information on the PDP can be found in section 2.9 of OPG's EIS.

From a regulatory perspective, decommissioning is not within the scope of this Project. In practical terms, however, the first two phases of the decommissioning plan described in this section (Phase I – Preparation for Safe Storage; and Phase II – Safe Storage and Monitoring) are largely included in the Continued Operation phase of the Project; with only the third phase (Dismantling, Demolition and Site Restoration) not included. More specifically, Phase I and Phase II for the first three units to be shut down would be accommodated through the power reactor operating licence for as long as the last unit was operating. However, it is likely that preparation for safe storage for the last unit would be required to be conducted under a different licence type as would any continuing safe storage and monitoring of the other units. The regulatory framework for these phases will be determined by the CNSC in the future.

3.5 OPG Programs

Comprehensive security, safety and environmental programs based on applicable regulatory requirements, standards and good nuclear industry practices are currently in place at DNGS and will continue to be applied during the Project. For EA purposes, these programs are described further in table 3.5-1.

Table 3.5-1 OPG Programs Applicable to the DNGS Refurbishment and Continued Operation Project

Program	Summary
Security and Safeguards	▪ as Class 1 Nuclear Facilities, DNGS and the DWMF are obligated by regulation to ensure appropriate security systems are in place, meeting the CNSC's security requirements
Safety and Health Management	OPG has in place: ▪ an Occupational Health and Safety Management System who's goal is to ensure employees work safely in a healthy and injury-free workplace by reducing the risks associated with the activities, products, and services of nuclear operations to a value considered As Low As Reasonably Achievable (ALARA) ▪ a corporate Health and Safety Policy establishes the overall objectives of health and safety initiatives, defines the commitments and responsibility of management and staff and advocates the right of employees and contractors to a safe and accident-free workplace ▪ a Conventional Safety Management System Program to ensure workers work safely in a healthy and injury-free workplace by managing risks associated with activities, products and services of OPG's Nuclear operations, including the DWMF

Radiation Protection	OPG has in place:
	▪ a policy on radiation protection that requires the safeguarding of the health and safety of workers, public and the environment from radiological hazards
	▪ a Radiation Protection Program with the following objectives:
	    o controlling occupational and public exposure:
	        ▪ keeping individual doses below regulatory limits
	        ▪ avoiding unplanned exposures
	        ▪ keeping individual risk from lifetime radiation exposure to an acceptable level

Program	Summary
	▪ keeping collective doses ALARA, social and economic factors taken into account o preventing the uncontrolled release of contamination or radioactive materials from the nuclear sites through the movement of personnel and materials o demonstrating the achievement of the above through monitoring
Fire Protection and Emergency Response	OPG has: ▪ an over-arching Nuclear Policy, within which prescribes the protection against fire of its employees and the public ▪ a program that describes the fire protection organization, interfacing organizations, and their fire protection accountabilities
Nuclear Emergency Plan	▪ the Provincial Nuclear Emergency Response Plan (PNERP) (Province of Ontario 2009) provides the off-site basis for emergency planning with the aim of ensuring public safety in the event of an emergency related to a radiological incident ▪ PNERP requires OPG to support emergency planning and response for areas within a 10 km radius of all nuclear plants (i.e. the Primary Zone) and is implemented in OPG through OPG's Consolidated Nuclear Emergency Plan ▪ OPG has in place a plan and procedure that would govern the emergency communications response with the public, media, stakeholders, and employees during a nuclear emergency, if required ▪ the Provincial Emergency Operations Centre is the provincial facility and organization that coordinates overall off-site operations of emergency response and interfaces with municipal emergency operations centres as well as with OPG and the CNSC

Program	Summary

Environmental Programs	OPG has:
	▪ an Environmental Policy that establishes guiding principles for environmental management and environmental performance for OPG Nuclear employees and those working on its behalf, with the key principles being:
	    o pollution prevention
	    o adherence to regulations
	    o continual improvement
	▪ an Environmental Management System to manage environmental aspects in accordance with elements of the ISO 14001 Environmental Management Systems Standard
	▪ a Project-specific Environmental Management Plan (to be developed)
	▪ ongoing environmental monitoring

3.6 Spatial and Temporal Boundaries

3.6.1 Study Areas

The Scoping Information Document requires that the geographic study areas for the EA encompass the areas of the environment that could reasonably be expected to be affected by the Project, or which may be relevant to the assessment of cumulative environmental effects. The three general study areas selected for the EA are described below.

The generic Regional Study Area (RSA) includes the municipalities that are within 20 km of DNGS. This area is generally bounded by Regional Road 23 (Lake Ridge Road) in the west; Regional Roads 5, 20 and 9 in the north; Highway 35/115 and County Road18 (Newtonville Road) in the east; and it extends a distance of 1 km into Lake Ontario to the south.

The generic Local Study Area (LSA) extends approximately 10 km east, west and north of the DN site and 1 km into Lake Ontario. This area includes the DN site and all of the major urbanized communities in the Municipality of Clarington and the easterly urbanized portion of the City of Oshawa. The LSA corresponds generally with the Primary Zone (i.e., within a 10 km radius of DNGS) for emergency planning identified by Emergency Management Ontario.

The generic Site Study Area (SSA) is represented generally as the southwest quadrant (approximately) of the DN site because it is within this area only that the physical activities associated with the DNGS Refurbishment Project will take place. It is bounded in the west by the DN site boundary; the CN railway tracks in the north; in the east by Holt Road (as it would be extended to Lake Ontario); and it extends a distance of 1 km into Lake Ontario to the south. Ancillary activities associated with the Project that may extend beyond this area (e.g., travel routes for workers accessing the Project location) will be considered in terms of the LSA.

The generic study areas were reviewed by OPG and adjusted as appropriate for specific application for each of the individual environmental components and are summarized in table 3.6-1 below.

Table 3.6-1 Study Areas Used for the Environmental Components

Component	Regional Study Area	Local Study Area	Site Study Area
Atmospheric	Generic	Generic	Generic
Surface Water	↑ due to thermal plume interactions extended approximately 5 km offshore	↑ due to thermal plume interactions extended approximately 3 km offshore	↑ due to thermal plume and stormwater considerations extended offshore and to the west

Component	Regional Study Area	Local Study Area	Site Study Area
			includes drainage catchments contributing to DN site stormwater
Aquatic	↑ due to potential cumulative effects extended 35 km to the west and 5 km offshore	↑ due to thermal plume interactions extended approximately 3 km offshore	↑ due potential zone of influence of diffuser extended offshore and to the west
Terrestrial	Generic	Generic	Generic
Geology / Hydrogeology	↑ due to regional groundwater context north to Oak Ridges Moraines and 35 km west and east	↑ to include boundaries of the local area groundwater flow model encompasses watersheds of creeks running through the LSA to Lake Ontario	↑ to include the entire DN site
Radiation / Radioactivity	Generic	Generic	↑ to include the entire DN site which corresponds with current monitoring efforts
Land Use	↑ to include all of the Regional Municipality of Durham, given the application of land use policies	Generic	Generic
Traffic / Transportation	↓ to remove marine modes of transport which are not applicable to this project	↑ to include the key intersections and road links that currently experience measurable traffic associated with DNGS operations	↑ to include the entire DN site
Physical and Cultural Heritage	generic	↓ to exclude the near-shore portions of Lake Ontario	↓ to exclude the near-shore portions of Lake Ontario

Component	Regional Study Area	Local Study Area	Site Study Area
Socio-economic	↑ to include all of the Regional Municipality of Durham given the potential socio-economic effects	↑ to correspond with the Primary Zone for emergency planning identified by Emergency Management Ontario	generic
Aboriginal	generic	generic	generic
Human Health	generic	generic	generic
Non-human Biota Health	generic	generic	generic

3.6.2 Temporal Boundaries

The temporal boundaries for the assessment define the time periods for which project-specific and cumulative effects will be considered. The following dates have been adopted as the temporal framework for the purposes of this assessment:

- Refurbishment phase: 2013 to 2014
- Continued Operations phase, including
  - operating period: 2019 to 2055
  - safe storage period: 2048 to 2085

No more than two reactors will be in refurbishment outages at any given time. As indicated above, the Refurbishment phase and the Continued Operation phase will overlap because some reactors (both pre- and post-refurbishment) will be under normal operation at the same time that others are being refurbished.

4 DESCRIPTION OF EXISTING ENVIRONMENT

The characterization of the existing environment serves as the baseline condition against which incremental changes and likely environmental effects associated with the project are predicted for the study areas. The existing natural environment is presented in terms of the atmospheric environment, surface water resources, aquatic environment, terrestrial environment, and geological/hydrogeological environment, and non-human biota.

A description of the current socio-economic setting is also summarized in this section, providing a description of the transportation, physical and cultural resources, Aboriginal interests, land use socio-economic elements and human health.

Much of the radiological information summarized in the various environmental components in the *Description of the Existing Environment* (section 4 of this

EA Screening Report) for the LSA and RSA are derived from OPG's Radiological Environmental Monitoring Program (REMP) reports. These reports are done on an annual basis and are publically available via OPG's website. The radiological information presented in this EA Screening Report is not meant to repeat everything in the REMP report; rather, it focuses on the key significant pathways and radionuclides. Additional information on the REMP can also be found in OPG's dispositions to technical review comments on the EIS (Comment #70 in OPG 2012).

Valued Ecosystem Components (VECs), as defined by the CEEA Agency, are features that are identified as having scientific, social, cultural, economic, historical, archaeological or aesthetic importance. VECs are considered valuable because they are: legally recognized and afforded special protection by law, policy or regulation; and/or recognized by the scientific or professional community and/or the public as important due to their abundance, scarcity, endangered status, role in the ecosystem or exposure pathway that they represent.

OPG's process of selecting VECs for this EA began with a review of the VECs applied for the New Nuclear – Darlington (NND) Project EA Screening Report because both EAs pertain to generally similar study areas, environmental conditions and similar project-related stressors. A subset of VECs was selected given the nature of the physical works and activities and their interactions with the environment; and that the list of environmental sub-components was not as broad as those used for the NND EA.

Input to OPG's selection of VECs was solicited from the public and other stakeholders. At Stakeholder Workshops held in fall 2010 and spring 2011 and at Community Information Sessions held in June 2011, OPG presented candidate VECs for public discussion and feedback. The final list of VECs ultimately selected for use in the EA Screening Report considered all public and stakeholder feedback and is listed in table 4-1.

Table 4-1 Environmental Components and Selected VECs

Environmental Components	Relevant VECs
Atmospheric Environment	▪ Pathway to Human Health ▪ Pathway to Non-Human Biota Health ▪ Pathway to Terrestrial Environment
Surface Water Environment	▪ Pathway to Human Health ▪ Pathway to Non-Human Biota Health ▪ Pathway to VECs in other environmental components
Aquatic Environment	▪ Lake Ontario Nearshore Habitat ▪ Forage Species (e.g., Round Goby, Alewife, Slimy Sculpin) ▪ Benthivorous Fish (e.g., White Sucker , Round Whitefish) ▪ Predatory Fish (e.g., American Eel, Lake Trout)

Terrestrial Environment	▪ Shrub Bluff Ecosystem (e.g., Grass of Parnassus) ▪ Waterfowl Staging Areas & Winter Habitat (e.g., Bufflehead) ▪ Wildlife Corridor (extent of connectivity across DN site) ▪ Pathway to Human Health ▪ Pathway to Non-Human Biota Health
Geological & Hydrogeological Environment	▪ Pathway to Human Health ▪ Pathway to Non-Human Biota Health ▪ Pathway to VECs in other environmental components
Land Use	▪ Land Use Planning Regime in Local Study Area
Traffic and Transportation	▪ Transportation System Efficiency & Adequacy ▪ Transportation System Safety
Physical & Cultural Heritage Resources	▪ Aboriginal Archaeological Resources (e.g., sub-surface remains, features, artifacts) ▪ Euro-Canadian Archaeological Resources (e.g., structural remains, features, artifacts) ▪ Euro-Canadian Built Heritage Resources (e.g., architecture, structural remains, artifacts) ▪ Euro-Canadian Landscape Resources (e.g., historic settlements, cemeteries)
Socio-Economic Environment	▪ Population and Demographics ▪ Employment ▪ Business Activity ▪ Tourism ▪ Income ▪ Municipal Finance & Administration ▪ Housing and Property Values ▪ Municipal Infrastructure ▪ Health and Safety Facilities & Services ▪ Educational Facilities & Services ▪ Community and Recreational Facilities & Services ▪ Social Services ▪ Use and Enjoyment of Property ▪ Community character ▪ Community cohesion
Aboriginal Interests	▪ Hunting & Fishing for Subsistence ▪ Fishing, Trapping and Traditional Harvesting / Collecting for Sustenance, Recreational and Economic Purposes ▪ Locations and Features of Cultural / Spiritual Importance
Health - Humans	▪ Members of the Public ▪ Workers on the DN site
Health - Non-Human Biota	▪ Terrestrial Vegetation ▪ Insects and Terrestrial Invertebrates (e.g., earthworm) ▪ Birds and Waterfowl (e.g., American Crow, Bank Swallow, Mallard) ▪ Mammals (e.g., Meadow Vole, Raccoon, White-tailed Deer) ▪ Amphibians and Reptiles (e.g., Eastern Garter Snake, Northern Leopard Frog) ▪ Aquatic Benthic Invertebrates ▪ Aquatic Vegetation ▪ Fish (forage & predator species)

4.1 Atmospheric Environment

4.1.1 Air Quality

The description of air quality consists of the physical (climate and meteorology) and chemical characteristics (non-radiological only) of the airshed in the vicinity of the DN site.

Climate and Meteorology

Climatological and meteorological conditions measured include temperature, precipitation, and wind speed and direction. These conditions are important to the Project due to their influence on contaminant transport (dispersion) in the atmosphere. The data reported in OPG's EIS and associated Atmospheric Environment TSD are based on long-term regional data sets in the RSA and Pearson International Airport (1971-2000) and site-specific data (period of 1996-2000) from a meteorological station at the DN site.

Non-radiological Air Quality

The constituents in air at the monitoring stations in the RSA site are not substantially different from the general air quality reported in southern Ontario within the Quebec to Windsor corridor and the Greater Toronto Area. Air quality conditions are dominated by the substances that combine to produce smog or acid rain. These include: carbon monoxide (CO), nitrogen oxides (NO_x – total of nitrogen dioxide, NO_2 and nitrogen oxide, NO), volatile organic compounds (VOCs), sulphur dioxide (SO_2) and particulate matter (suspended particulate matter (SPM), PM_{10} and $PM_{2.5}$).

Air Dispersion Modeling

Air dispersion modeling characterized the current emissions from sources in the SSA including the DNGS, St Marys Cement, and local vehicle traffic. The results were compared to potentially sensitive receptors located beyond, but in proximity to the SSA.

The predicted maximum concentrations of the constituents at the sensitive receptors were compared to the OMOE Ambient Air Quality Criteria (AAQC). Predicted air concentrations of particulate matter were all below applicable AAQC, with the exception of an exceedance of SPM at one receptor located near Highway 401. The concentrations of NO_2, SO_2, CO and acrolein are below the applicable AAQC. Benzene concentrations are below the predicted for 24 hour criteria, but exceeded the annual average concentration criteria at one receptor. The slight increases above the applicable criteria are attributed to the influence of local traffic on Highway 401 and South Service Road.

For emissions of treatment chemicals from the steam generators (acetic acid, ammonia, formic acid, glycolic acid, morpholine and hydrazine), the predicted concentrations in air at the closest sensitive receptors for all modelled parameters are less than 60% of their respective 24 hour criteria, and less than 4% of their respective derived annual criteria.

4.1.2 Noise

The noise environment in the vicinity of DN site is typical of an urban setting and is influenced by several noise sources including DNGS, traffic on Highway 401 and local roads, the CN rail line and the St. Marys Cement plant. Shoreline wind, wave noise from Lake Ontario and other sounds of nature influence the existing noise environment at the site. Overall, with a few exceptions (e.g., in the vicinity of the on-site transformers), the sound levels on the DN site do not include strong tonal components.

The sound environment at the two closest residential receptors (~ 2.5 km to the west and 3.5 km north of the DN site) were measured and additional receptor locations were modeled. The range and distribution of sound levels at these locations indicated that the sound environments are typical of a Class 1 Area, which is defined in the applicable noise limits publication by the OMOE (OMOE 1995) as an acoustical environment typical of a major population centre where the background sound level is dominated by urban hum.

4.1.3 Radiation and Radioactivity

Radiation levels in the atmospheric environment are provided in table 4.1-1 that reflects 2009 monitoring results. For all sources, the 2009 values observed at the different study areas showed similar levels to what has been historically observed.

Table 4.1-1 Summary of Radiation Levels in the Atmospheric Environment for 2009

Source	Study Area	Radiation Level[2]
Tritium (airborne)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	0.2 to 0.3 Bq/m^3 <0.3 to 0.7 Bq/m^3 0.3 to 2.1 Bq/m^3 <0.2 Bq/m^3
Tritium (precipitation)[1]	Regional Study Area Local Study Area Site Study Area Background (provincial location)	7 to 12 Bq/L 10 to 43 Bq/L 23 to 61 Bq/L Not collected
Radioactive Particulate	Regional Study Area Local Study Area Site Study Area Background (provincial location)	14.6 Bq/m^2-month 13.6 to 15.7 Bq/m^2-month 14 to 18.8 Bq/m^2-month 5 to 40 Bq/m^2-month
Carbon-14	Regional Study Area Local Study Area Site Study Area Background (provincial location)	231 to 235 Bq/kg-C 228 to 250 Bq/kg-C 267 to 272 Bq/kg-C 232 to 266 Bq/kg-C

[1] Ontario Drinking Water Standard for Tritium = 7000 Bq/L

[2] Bq = Becquerels; kg-C = kilograms of carbon

In addition, for external gamma dose rate in air, the total dose measured in air for noble gases, I-131 and skyshine (Ir-192) in 2009 at locations in both the LSA and the SSA were all below the corresponding detection limit, which is the same as the results from 2004 to 2008 (i.e., all below corresponding detection limit).

4.2 Surface Water Environment

4.2.1 Lake Circulation

Circulation patterns in the RSA are generally reflective of those at the lake-wide level. The primary meteorological and hydrological influences on Lake Ontario's circulation are the eastward flows from the Niagara River coupled with the discharge to the St. Lawrence River and wind shear. The local wind conditions are the primary determinant in the direction of flow along the north shore and reversals of the nearshore current along the north shore are common following brief patterns of strong winds.

Conditions in the LSA and SSA are primarily a function of nearshore circulation patterns. Flows from the CCW discharge serve to obstruct alongshore lake currents although the effect of the discharge on the currents lessens as current speeds increase.

4.2.2 Drainage and Water Quality

Drainage Patterns

At the DN site, there are 6 stormwater management ponds, 12 sub-catchments located entirely within the SSA and four others are at least partially located within the SSA. The storm runoff generated is conveyed off-site to neighbouring land or directly to Lake Ontario via natural channels/swales and outfalls. There are 16 man-made outfalls discharging to Lake Ontario within the SSA and 11 of these may be submerged or partially submerged outfalls depending on the lake level. The stormwater management catchment areas and general drainage patterns in the SSA (as well as an area east of the DN site between DNGS and the St. Marys Cement plant) are illustrated in figure 4.3-3 in OPG's EIS.

Stormwater Quality

In support of the EA, OPG undertook a study of stormwater discharges to Lake Ontario within and adjacent to the SSA in 2010/2011 to confirm or refine historically defined drainage information.

The stormwater quality results were compared to typical urban runoff quality (OMOE, 2003 and USEPA, 1983), Provincial Water Quality Objectives (PWQOs) and the Durham Region Sewer Use By-law (Regional Municipality of Durham, 2009). Details are provided in OPG's EIS and associated Surface Water Environment TSD. In summary, in 2010/2011, all metal concentrations were below the Durham Region Sewer Use By-Law limits, with the exception of copper, lead, zinc and manganese; however, during one or more monitoring events, samples had concentrations of boron, iron, cadmium, cobalt, copper, hexavalent chromium, lead, molybdenum, vanadium and zinc exceeding the

PWQO guidelines. In addition, all samples collected in 2010/2011 had metals concentrations meeting or below the typical urban stormwater runoff concentrations cited by the OMOE (2003) and USEPA (1983), with the exception of lead and zinc.

Acute lethality tests for Rainbow trout and *Daphnia magna*, which determine the toxicity of liquid effluents and/or stormwater, have been historically conducted at four stormwater outfalls. There were no failures in 2011, one failure in 2001 and four failures in 1996.

Coliforms in storm water discharges from the DN site were not measured prior to 2010. Coliform samples collected in 2010/2011 locations exceeded the USEPA (1983) typical urban stormwater runoff concentrations for fecal coliforms during cold weather; however, all 2010/2011 fecal coliform concentrations were within the range of typical urban stormwater runoff concentrations as cited by the OMOE (2003). The total phosphorous Interim PWQO to avoid nuisance concentrations of algae in lakes during the ice-free period was exceeded; however, concentrations remain well below the values for typical urban runoff water quality.

<u>On-site Water Quality</u>

Water quality has been characterized for various on-site waterbodies including: a portion of Darlington Creek; Coot's Pond; a stormwater management pond located in the operating DNGS area; and a stream (Stream B) located in the southwest corner of the DN site. Exceedances of PWQOs or guidelines were noted in some locations for pH, phosphorous, unionized ammonia, aluminum, boron, cobalt, iron and zirconium. Since 1999, Coot's Pond has been subject to quarterly monitoring under its construction landfill Certificate of Approval (CofA). Additional details can be found in OPG's EIS and the associated Surface Water Environment TSD.

<u>Lake Water Quality</u>

Lake Ontario water quality data was collected in 2007/2008 as part of the NND Project EA baseline characterization and was generally consistent with historical water quality data. Although occasional individual sample exceedances were noted as a result of natural variation or anthropogenic influences, most of the lake water quality in the RSA, LSA and SSA meets the PWQOs and Canadian Council of Ministers for the Environment (CCME) Canadian Environmental Quality Guidelines limits (CCME 2007).

4.2.3 Shoreline Processes

Wave erosion acting on glacial deposits has created shoreline bluffs at the DN site and has deposited the eroded material on the beaches and in the lake. Darlington Creek meets Lake Ontario east of the bluffs.

The processes of sediment erosion, transport, accretion and re-suspension in the vicinity of the DN site are complex and are affected by a number of natural and anthropogenic influences. Sediment transport along the DN site is generally eastward; however, net transport in the longshore direction is not substantial. Sediment deposited at the nearshore lake bottom provides a continuous source of transport material when wave and current conditions are conducive to re-suspension.

A summary of bathymetry and lake substrates as elements of shoreline processes is provided in section 4.3.1 of this EA Screening Report.

Additional shoreline process elements such as water levels, wave characteristics and ice behaviour can be found in section 4.3.5 of the OPG's EIS.

4.2.4 Radiation and Radioactivity

Radiation levels in the surface water are provided in table 4.2-1 that reflects 2009 monitoring results. For some sources, levels were higher than background levels; however, for all sources, the 2009 values observed at the different study areas showed similar levels to what has been historically observed. For tritium in water, the concentrations reported are all below OPG's voluntary commitment level (for nearby water supply plants (WSPs)) of 100 Bq/L and a small fraction of Ontario's Drinking Water Quality Standard for tritium of 7,000 Bq/L. For gross beta, the concentrations are also below OPG's drinking water screening level of 1 Bq/L.

Table 4.2-1 Summary of Radiation Levels in the Surface Water for 2009

Source	Study Area	Radiation Level
Tritium (WSPs)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	5 to 6.2 Bq/L 5 to 6.7 Bq/L Not collected <1.8 to 5.2 Bq/L
Tritium (surface water)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	Not collected 6.2 to 26.2 Bq/L Not collected <1.8 to 5.2 Bq/L
Gross Beta (WSPs)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	0.10 to 0.11 Bq/L 0.11 Bq/L Not collected 0.03 to 0.11 Bq/L
Gross Beta (surface water)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	Not collected 0.14 to 0.19 Bq/L Not collected 0.03 to 0.11 Bq/L

Radiation levels in sediment and sand are provided in table 4.2-2 that reflects 2009 monitoring results. For some sources, levels were higher than background levels; however, for all sources, the 2009 values observed at the different study areas showed similar levels to what has been historically observed.

Table 4.2-2 Summary of Radiation Levels in Sediment and Sand for 2009

Source	Study Area	Radiation Level
Potassium-40 (K-40) (sediment)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	Not collected 319.5 to 408.3 Bq/kg 363.8 to 472.9 Bq/kg 464.6 and 574.0 Bq/kg
Cesium-137 (Cs-137) (sediment)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	Not collected 0.3 to 0.5 Bq/kg 0.5 to 1.3 Bq/kg 0.4 to 1.0 Bq/kg
Carbon-14 (C-14) (sediment)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	Not collected 134 to 153 Bq/kg-C 193 Bq/kg-C 190 Bq/kg-C
K-40 (sand)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	Not collected 314.3 to 330.0 Bq/kg Not collected 353.7 to 366.8 Bq/kg
Cs-137 (sand)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	Not collected 0.2 Bq/kg Not collected 0.5 Bq/kg

4.3 Aquatic Environment

4.3.1 Aquatic Habitat

<u>On-land Water Bodies</u>

The only on-land water bodies within the SSA that may potentially be considered fish habitat are two tributaries to Lake Ontario located in the southwest corner of the SSA (please see figure 4.3-3 in OPG's EIS). The flows in Tributary (Stream) A are supported intermittently by surface drainage from the area west of Bobolink Hill and west of the DN site. Tributary (Stream) B conveys surface flows from a large drainage area on the DN site including Coot's Pond and runoff from the Northwest Landfill and Park Road.

Based on visual assessment and analysis of the habitat assessments, it has been concluded that Tributary A and Tributary B do not support fish as there are several barriers to fish movement that restrict fish access into the tributaries (e.g., ill-defined channel form and minimal water depth in the sections that flow across the beach).

Lake Ontario Nearshore

The area of Lake Ontario directly adjacent to the DN site has gently sloping bathymetry and is exposed to the effects of waves and currents, creating a high-energy environment, which scour away fine sediments and leave behind relatively featureless flat rocky substrates. Extensive stretches of the nearshore in this area are characterized by shallow gravel/cobble beaches. Underwater substrates are comprised of beds of clayey glacial till and further offshore, smaller areas of bedrock outcrop. There are no drop-offs, distinct shoals or other specialized physical habitat features known within this area.

During low current speeds, the DNGS diffuser discharge deflects longshore currents offshore. With higher current speeds (up to 25 cm/s), the currents penetrate the diffuser mixing zone, but are reduced on the lee side of the DNGS diffuser. The longshore currents carry non-motile organisms (e.g., phytoplankton, zooplankton, larvae of certain fish species) along the shoreline.

4.3.2 Thermal Environment

Ambient nearshore temperature conditions are seasonal, but can be quite variable as a result of weather-induced currents, upwellings and downwellings. Temperatures within the SSA and LSA rose to a maximum of over 20º C by July/August, but fluctuations occurred during summer on the range of 10 - 15ºC due to upwelling and downwelling. Temperatures in the range of 0 - 4ºC characterize the November to April period. These conditions were considered to be similar to other north shore locations and representative of the broader RSA.

Within the SSA, the operation of the CCW diffuser influences the water temperature through the production of thermal plumes. The two types of plumes are: a warm plume (exists when the temperature of the water discharged at the bottom of the lake is higher than the ambient surface water temperature); and, a cold plume (exists when the discharge temperature is less than the ambient surface water temperature). From an environmental effects perspective, the focus is on warm plumes given their occurrence during the colder months during sensitive life stages of aquatic biota (e.g., Round Whitefish), and the potential to interact with the bottom.

From a regulatory perspective, under the DNGS CofA (OMOE 2006), the CCW diffuser is designed to limit the surface water temperature rise to a maximum of 2 ºC above ambient lake temperature at the edge of a 1 km^2 Mixing Zone. During normal operation, the water temperature increases across the condensers averaged approximately 12.3ºC (based on data from 1993 to 2010 with all four units operating).

In order to more precisely monitor temperature increases in the vicinity of the diffuser in support of the assessment of effect of thermal discharges on aquatic biota, OPG initiated a thermal and current monitoring program, commencing in January 2011. The following paragraphs summarize the monitoring results from the winter/spring of 2010/2011 (colder than average winter) and 2011/2012 (one of the warmest winters on record) as presented in the series of thermal monitoring reports (Golder 2012a, 2012b, 2012c). In figure 4.3-1 temperatures are overlaid for both winters relative to historical winter data of 1984-1996. Though not depicted on the figure below, it should be noted that a number of warmer winters have occurred in the late 1990s and the 2000s.

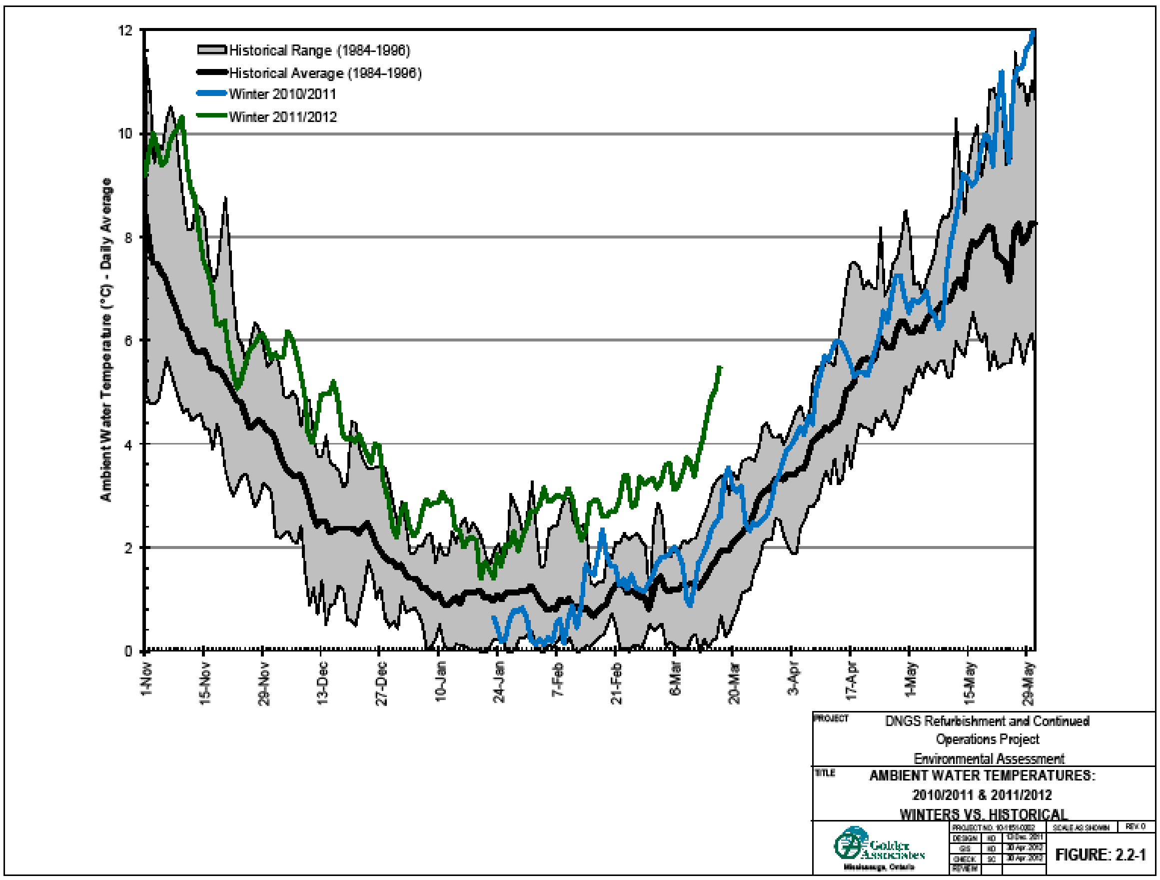


Figure 4.3-1 Ambient Water Temperatures: 2010/2011 and 2011/2012 Winters vs. Historical (source: modified from OPG 2012)

<u>Winter 2010/2011 (starting January 19, 2011)</u>

Ambient temperature was defined using only the average ambient surface temperatures during the winter monitoring period at reference locations.

All diffuser bottom monitoring stations (within and at the edge of the Mixing Zone, and outside of this zone) showed increases of +1 ºC above ambient

(0.1 to 81% of the time); however, increases of +2 ºC and higher dropped dramatically both in the number of stations and frequency of occurrence (Golder 2012b). Eight occurrences of elevated bottom temperatures above ambient (i.e., increases up to +5 ºC) were measured at only one monitoring station (TD35-12 - located at the offshore end of the diffuser near the bottom) and were generally less than 4 hours in duration. These elevated bottom temperatures at this monitoring station may be the results of one, or a combination of, the following factors: ambient currents corresponding to these events (e.g., current reversals, weak alongshore or offshore current components and/or strong onshore current components) that result in decreased advective transport and, therefore, decreased initial mixing and dilution; and density differences between the thermal plume and the ambient water.

Winter 2011/2012 (December 2011 to mid March 2012)

The ambient water temperatures observed during the winter of 2011-2012 were some of the warmest recorded near the DN site.

A brief overview from Golder (2012c) of bottom water temperatures recorded during the winter of 2011-2012 is provided in the paragraphs below.

The hourly average bottom water temperatures and measured ambient water temperatures were generally 5ºC or warmer until mid-December 2011 and generally remained above 4ºC until the last week of December 2011. The measured ambient water temperatures generally decreased to between 1ºC and 2ºC for approximately the last two weeks of January 2012 before beginning to rise again. By mid-March 2012, the hourly average bottom water temperature and measured ambient water temperature had both increased to approximately 5ºC again.

In January 2012 through to mid-March 2012 (before the hourly average bottom water temperatures and measured ambient water temperatures had risen again to approximately 5ºC), occurrences of elevated hourly average bottom water temperatures (i.e., compared to reference monitoring locations) were measured at offshore locations within the Mixing Zone, predominantly at the bottom location at the offshore end of the diffuser (TD35-12). These events occurred primarily in February and March of 2012 and included hourly average bottom water temperatures above 7ºC. Occurrences of hourly average bottom water temperatures above 5ºC (but less than 6ºC) also occurred at two offshore locations between location TD35-12 and the edge of the Mixing Zone (DN17-B and DN18-B). Very few occurrences of hourly average bottom water temperatures above 5ºC occurred at the other offshore locations within the Mixing Zone (locations TD55-B, TD34-B and TD45-B). These events were generally short in duration and were characterized by maximum hourly average temperatures only marginally greater than 5ºC.

There were rare and brief occurrences of hourly average bottom water temperatures above 5ºC during the period of January 2012 through mid-March 2012 at offshore locations beyond the Mixing Zone and these were all well below 6ºC.

There were a few short occurrences of hourly average bottom water temperatures above 5ºC (but well below 6ºC) during the period of January 2012 through mid-March 2012 at a nearshore location within the Mixing Zone approximately 150 m east of the diffuser location (DN10-B) but they were generally short in duration.

All diffuser bottom monitoring stations (within and at the edge of the mixing zone, and outside of this zone) showed increases of +1 ºC above ambient (0.2 to 55% of the time); however, increases of +2 ºC and higher dropped dramatically both in the number of stations and frequency of occurrence (Golder 2012c).

4.3.3 Fish

The Lake Ontario nearshore environment hosts a seasonally dynamic mix of resident and migratory fish species that are parts of both the benthic and pelagic food webs. These species tend to migrate over large foraging ranges and are not resident in SSA, with the exception of White Sucker. The subsequent paragraphs describe the nearshore fish communities.

A list of Lake Ontario fish species observed in the SSA is provided in table 4.3-1.

Table 4.3-1 Lake Ontario Aquatic Fish Species Observed in the Site Study Area

Common Name	Scientific Name	Common Name	Scientific Name
Alewife	*Alosa pseudoharengus*	Longnose Sucker	*Catostomus catostomus*
American Eel	*Anguilla rostrata*	Northern Pike	*Esox lucius*
Brown Bullhead	*Ameiurus nebulosus*	Pumpkinseed	*Lepomis gibbosus*
Brown Trout	*Salmo trutta*	Rainbow Smelt	*Osmerus mordax*
Burbot	*Lota lota*	Rainbow Trout	*Oncorhynchus mykiss*
Common Carp	*Cyprinus carpio*	Rock Bass	*Ambloplites rupestris*
Deepwater Sculpin	*Myoxocephalus thompsonii*	Round Goby	*Neogobius melanostomus*
Emerald Shiner	*Notropis atherinoides*	Round Whitefish	*Prosopium cylindraceum*
Fallfish	*Semotilus corporalis*	Slimy Sculpin	*Cottus cognatus*
Freshwater Drum	*Aplodinotus grunniens*	Smallmouth Bass	*Micropterus dolomieu*
Gizzard Shad	*Dorosoma cepedianum*	Spottail Shiner	*Notropis hudsonius*
Logperch	*Percina caprodes*	Threespine Stickleback	*Gasterosteus aculeatus*
Lake Chub	*Couesius plumbeus*	Walleye	*Sander vitreus*
Lake Trout	*Salvelinus namaycush*	White Sucker	*Catostomus commersonii*
Longnose Dace	*Rhinichthys cataractae*	Yellow Perch	*Perca flavescens*

Bass, bullheads, sunfish and Northern Pike can be found intermittently along shore during the spring, summer and autumn, and retreat to warmwater habitats (e.g., tributaries, coastal marshes and bays) during the winter.

Resident benthic forage fish include Slimy Sculpin and, more recently, the exotic Round Goby which has spread across the lower Great Lakes and is currently abundant in the nearshore of Lake Ontario. OPG had originally indicated in their Aquatic Environment TSD that Spoonhead Sculpin had been identified in various recent data collection efforts; however, it was subsequently determined that these sculpin were mis-identified and in fact the specimens were Slimy Sculpin (OPG 2012).

Planktivorous fishes such as Emerald Shiner and Alewife also occur in the nearshore spawning and foraging on plankton carried by the currents. Historically, Alewife and Emerald Shiner are two of the most abundant fish species along the DN site shore.

The most prevalent benthivorous fish species found year-round at the DN site is White Sucker. Large adult White Sucker forage on benthic invertebrates in the nearshore and ascend tributary streams (i.e., Darlington Creek) in the spring to spawn. Young White Sucker feed and grow in these nursery streams before returning to the lake. Other benthivorous species include the Round Whitefish, Slimy Sculpin and Lake Sturgeon which are discussed further in section 4.3.4 of this EA Screening Report below.

A diverse community of other (e.g., piscivorous) fish species can be found at various times of the year in the nearshore. These include American eel, northern Pike, Walleye, Yellow Perch, White Bass, White Perch, Smallmouth Bass, bullheads and sunfish. The nearshore is also part of the wider range of a number of coldwater predators that currently includes Lake Trout, Atlantic Salmon, Rainbow Trout, Brown Trout, Chinook Salmon and Coho Salmon.

4.3.4 Fish Species of Conservation Concern

Fish species that have been recorded in the vicinity of the DN site that have a federal and/or provincial designation are presented in table 4.3-2.

Table 4.3-2 Fish Species of Conservation Concern

Species	Federal Designation[1]	Provincial Designation[2]
Deepwater Sculpin	Special Concern (SARA)	None
Atlantic Salmon	Extirpated (COSEWIC)	None
Lake Sturgeon	Threatened (COSEWIC)	Threatened (ESA)
American Eel	Threatened (COSEWIC)	Endangered (ESA)

[1] SARA = *Species at Risk Act*; COSEWIC = Committee on the Status of Endangered Wildlife in Canada

[2] ESA = Ontario *Endangered Species Act*

A designation of a species by COSEWIC does not mean it is protected under SARA. Rather, a species that has been designated by COSEWIC may then qualify for legal protection and recovery under SARA. This determination would be made by the Government of Canada.

Deepwater Sculpin, as a species of special concern under SARA, has restricted numbers in deep water and distribution in Lake Ontario, compared to the other Great Lakes. One Deepwater Sculpin larva was identified in a 2011 larval tow study in the SSA. Deepwater Sculpin habitat for larvae is shallow but other life stages are located in deeper water beyond the nearshore zone. Migration of juvenile Deepwater Sculpin may include nearshore areas, but not as primary habitat.

Atlantic Salmon is in low abundance in Lake Ontario but there are restoration efforts underway nearby in nearby tributaries to Lake Ontario (e.g., Duffin's Creek, Cobourg Creek). The reintroduction program, however, remains experimental. To date, one Atlantic salmon has been captured during the 1984-1993 studies associated with the initial start-up of the DNGS, approximately 3 km west of DNGS and outside of the SSA.

Lake Sturgeon is a species of conservation concern that is subject to recovery efforts in Lake Ontario. Catches of 2 large juveniles in experimental gillnets east of the DN site in 1998 suggests general nearshore nursery/foraging habitat may be present within the RSA.

American Eels have been detected infrequently during previous studies (i.e., electrofishing, impingement) and could make use of the nearshore habitat for foraging purposes.

The Round Whitefish, though it does not have an official federal or provincial designation, is a species of conservation/management interest by DFO and the OMNR. As such, the Round Whitefish has been the focus of recent data collection efforts by OPG, including spring and fall fish community studies, spring larval tows and impingement. The following general observations can be derived from the data collected to date:

- forms an abundant component of fall fish sampling efforts, relative to other species captured
- the Round Whitefish population appears to be in a healthy condition based on visual observation
- the high percentage of gravid females captured during the spawning period would indicate that spawning likely takes place in and around the SSA
- aging, length and weight data suggest that Round Whitefish are aging but this may be a broader regional phenomenon
- potential nursery habitat at the DN site as larval Round Whitefish were captured

A Round Whitefish Action Plan (RWAP) is being developed by OPG in conjunction with the OMNR, DFO, Environment Canada and the CNSC to support both its existing and future nuclear power generating stations on Lake Ontario. The RWAP is needed in order to gain a better understanding of the current status of Round Whitefish and the effects that may be contributing to its population decline and to provide a long-term framework for assessment and potential management actions.

To date, the consolidated RWAP objectives are as follows:

- define what is and where is spawning habitat along the north shore of Lake Ontario and then identify what critical spawning habitat is
- determine the status of the population using life history metrics (age at maturity, fecundity condition factor, abundance etc.)
- establish if populations are localized or linked in a meta-population along the north shore of Lake Ontario
- determine the productivity of various spawning substrates
- identify the influence of invasive species on Round Whitefish

OPG anticipates further work to characterize the programs to support the development and implementation of these identified objectives and plans to share/update the regulatory stakeholders.

With respect to Slimy Sculpin, this species has declined over the past 10-15 years. This lakewide phenomenon runs counter to the OMNR Lake Ontario Management Unit's (LOMU) Fish Community Objectives for Lake Ontario and LOMU's proposed Fish Community Objectives (currently on the Ontario Environmental Registry for public comment) in which "restoring" Slimy Sculpin and other benthic fishes is explicitly identified (LOMU 2012).

4.3.5 Benthos

The nearshore environment is dynamic, making it generally unfavourable for aquatic plants and algae. Due to the hard substrates and high energy environment, it supports only a limited density and diversity of benthic invertebrate communities, with chironomids and amphipods being the major benthos components. Since the mid-1990s the Lake Ontario nearshore benthic community and benthic habitat have been altered by the invasion of exotic dreissenid mussels. Nearshore areas were rapidly colonized, first by Zebra Mussels and now, by the closely related Quagga Mussel, which has all but replaced the former. They have altered nutrient flow, food webs and productivity in Lake Ontario, which have resulted in, for example, a proliferation of attached algae, notably Cladophora along the shoreline. Another invasive species, the Bloody Red Shrimp was detected in the vicinity of the DNGS during sampling in 2009.

4.3.6 Radiation and Radioactivity

Radiation levels in the aquatic biota are provided in table 4.3-3 that reflects 2009 monitoring results. For some sources, levels were higher than background levels; however, for all sources, the 2009 values observed at the different study areas showed similar levels to what has been historically observed.

Table 4.3-3 Summary of Radiation Levels in Aquatic Biota for 2009

Source	Study Area	Radiation Level
Tritium (fish)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	Not collected 22.5 to 26 Bq/L 3.5 to 8.9 Bq/L 2.3 to 5.6 Bq/L
C-14 (fish)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	Not collected 224 to 251 Bq/kg-C 220 to 252 Bq/kg-C 225 to 252 Bq/kg-C
Organically bound tritium (OBT) (fish)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	Not collected 37 Bq/L 14 to 19 Bq/L 19 to 22 Bq/L
Cs-137 (fish)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	Not collected Not collected 0.1 to 0.4 Bq/kg <0.1 to 0.5 Bq/kg
K-40 (fish)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	Not collected Not collected 126.0 to 141.5 Bq/kg 112.6 to 145.6 Bq/kg

4.4 Terrestrial Environment

4.4.1 Vegetation

Much of the RSA has been cultivated over the past century and the dominant vegetation cover relates to agricultural use, including row crops and pasture land. Other natural vegetation features are associated with valley lowlands associated with rivers and creeks, and the Lake Ontario shoreline environment.

From a SSA perspective, 18 vegetation community classes have been mapped totalling approximately 50 ha in size (see figure 3.3-1 in OPG's Terrestrial Environment TSD). The most common vegetation communities are the cultural ones, accounting for 86% of the total area. During botanical inventories completed in summer 2010, 194 species of vascular plants were identified in the

SSA with 56 of these being non-native to Ontario. The presence of a number of rare/uncommon species is noteworthy in the wetland areas (marsh, swamp) and beach and bluff areas. The hanging fen community is particularly rare and is a poorly understood species assemblage.

No species listed under SARA or provincially significant plants were recorded from the SSA. The surveys identified 30 locally or regionally rare or uncommon plant species (also referred to as species of conservation concern), which includes records from previous surveys. Fourteen of the recorded species are either locally or regionally rare, 16 are locally or regionally uncommon. The representation of rare species is largely due to the location of the site along the Lake Ontario shoreline and presence of habitat types such as wetlands with seepage zones (i.e., hanging fens) and beaches that support habitat specific rare species.

4.4.2 Wildlife

A number of common amphibian and reptile species occur in the RSA including various frog and turtle species along with the Eastern Garter Snake. More than 350 bird species have been recorded in the RSA with the vast majority of these also occur as migrants; the number of regular breeding species is approximately 140. Approximately 50 mammalian species occur within the RSA.

The wildlife community and species within the LSA are similar to those in the RSA.

In the SSA, 38 and 36 confirmed and probable breeding bird species were detected during surveys conducted in 2007 and 2010; respectively. Five bird species of provincial and/or federal conservation concern have been observed in the SSA (see table 4.4-1): Peregrine Falcon, Chimney Swift, Bobolink, Barn Swallow and Eastern Meadowlark. Of those species, Bobolink, Barn Swallow and Eastern Meadowlark, have been confirmed as breeding in the SSA. It is unlikely that the Peregrine Falcon and Chimney Swift would breed within the SSA; however, a nesting pair of falcons has been reported at St. Marys Cement Plant, with the DN site encompassing part of their feeding territory.

Table 4.4-1 Bird Species of Conservation Concern

Species	Federal Designation[1]	Provincial Designation[2]
Peregrine Falcon	Special Concern (SARA)	Threatened (ESA)
Chimney Swift	Threatened (SARA)	Threatened (ESA)
Bobolink	Threatened (COSEWIC)	Threatened (ESA)
Barn Swallow	Threatened (COSEWIC)	Threatened (ESA)
Eastern Meadowlark	Threatened (COSEWIC)	Threatened (ESA)

[1] SARA = *Species at Risk Act*; COSEWIC = Committee on the Status of Endangered Wildlife in Canada
[2] ESA = Ontario *Endangered Species Act*

Other bird-related features in the SSA include:

- a Bank Swallow colony (101 burrows in 2010) along the bluff face
- waterfowl staging and overwintering areas associated with the DNGS outfall area and the physical structures (e.g., docks) in adjacent areas on Lake Ontario
- fall and spring migrant bird habitat along the Lake Ontario shoreline, largely confined to the southwest portion of the SSA
- winter raptor feeding and roosting areas including roosts of the regionally scarce Long-eared Owls that have been reported at the DN site approximately along the SSA north boundary

4.4.3 Landscape Connectivity

Within the DN site and excluding Lake Ontario, most connectivity for wildlife currently exists north of the CN railway tracks. For some species that are able to avoid collisions with trains, the CN railway right-of-way enhances this connectivity. The immediate environment of Lake Ontario at the beach is an important pathway of connectivity for a variety of terrestrial flora and fauna. In the vicinity of the SSA the connectivity it affords is disrupted by the presence of DNGS and St. Marys Cement operations. Another local pathway likely exists for some amphibian species between Coot's Pond and the seepage zones in the two southwestern valleys.

4.4.4 Radiation and Radioactivity

Radiation levels in the terrestrial environment are provided in table 4.4-2 that reflects 2009 monitoring results. For some sources, levels were higher than background levels; however, for all sources, the 2009 values observed at the different study areas showed similar levels to what has been historically observed.

Table 4.4-2 Summary of Radiation Levels in the Terrestrial Environment for 2009

Source	Study Area	Radiation Level[1]
External Gamma Radiation	Regional Study Area Local Study Area Site Study Area Background (provincial location)	59.2 nGy/h 55.8 to 62.3 nGy/h 54.5 to 58.7 nGy/h 44.2 to 69.4 nGy/h
Cs-137 (soil)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	Not completed 3.9 to 15.9 Bq/kg Not collected 0.5 to 6.3 Bq/kg
K-40 (soil)	Regional Study Area Local Study Area Site Study Area	Not completed 366.6 to 750.4 Bq/kg Not collected

Source	Study Area	Radiation Level[1]
	Background (provincial location)	564.8 to 735.3 Bq/kg
Tritium (vegetation)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	17.9 to 19.0 Bq/L 5.7 to 73.9 Bq/L Not collected 3 to 6.7 Bq/L
C-14 (vegetation)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	220 Bq/kg-C 217 to 352 Bq/kg-C Not collected 222 to 232 Bq/kg-C
Tritium (animal feed)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	14.1 to 16.3 Bq/L 11.5 to 20.2 Bq/L Not collected 3 to 6.7 Bq/L
C-14 (animal feed)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	230 to 250 Bq/kg-C 233 to 255 Bq/kg-C Not collected 222 to 232 Bq/kg
Tritium (milk)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	5.2 to 9.9 Bq/L 3.3 to 9.2 Bq/L Not collected <2.3 to 2.5 Bq/L
C-14 (milk)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	232 to 238 Bq/kg-C 235 to 245 Bq/kg-C Not collected 222 to 231 Bq/kg-C
Tritium (honey)	Regional Study Area Local Study Area Site Study Area Background (provincial location)	11.8 to 49.7 Bq/L Not collected Not collected Not collected
C-14 (honey)	Regional Study Area	241 to 276 Bq/kg C
K-40 (honey)	Regional Study Area	18.1 to 26.8 Bq/kg

[1] nGy/h = nanogray per hour

4.5 Geological/Hydrogeological Environment

4.5.1 Geology and Hydrogeology

On a regional and local level, the bedrock is completely covered by quaternary deposits and bedrock outcrops are found only in local quarries and other man-made excavations.

DNGS was constructed on the shore of Lake Ontario by placing a berm into Lake Ontario, dewatering behind the berm and then backfilling the area with fill materials from other parts of the site or imported from off site. The subsurface materials across the Protected Area are generally described as fill materials. Overburden at the site comprises upper and lower till layers over shale or limestone bedrock.

In general in the RSA, groundwater flows from the Oak Ridges Moraine to the south with discharge to local streams or to Lake Ontario. Within the SSA, the till units with relatively lower hydraulic conductivities will act as aquitards or confining layers which restrict groundwater movement. Groundwater flow in these units is expected to be primarily vertically downward. The interglacial deposits between till units have moderate hydraulic conductivities and act as aquifers and transmit groundwater.

4.5.2 Soil

Soil quality is largely discussed in the context of the Protected Area. The results were compared to the *Ontario Regulation 153 Standards* (2011) and Table 3: Non-Potable Soil Criteria for an industrial / commercial / community property use and medium/fine and coarse soils. Groundwater on the DN site is not considered to be a potable water source and therefore the Table 3 criteria are the appropriate assessment criteria. No parameters were found to exceed the Table 3 criteria. Outside of the Protected Area on the DN site, only beryllium concentrations in soil exceeded table 3 criteria and are representative of natural conditions.

For the Protected Area, the tritium in soil concentrations was in the range of less than the method detection limit of 7 Bq/kg to 318 Bq/kg. The 318 Bq/kg was found from a soil sample near the south-west corner of the Powerhouse. Modeled tritium concentrations contours in soils for the SSA and LSA were provided in OPG's dispositions of technical review comments on the EIS (Appendix G of OPG 2012). Other radionuclides were not detected above the method detection limit with the exception of K-40 which is naturally occurring and in the range of 119 and 402 Bq/kg. Gross beta, gamma-thorium series and gamma uranium concentrations were all considered to be representative of background conditions.

4.5.3 Groundwater

A recent spill of tritium-contaminated water has impacted the investigations and results for the existing conditions inside the Protected Area. On December 21, 2009, an overflow of the Injection Water Storage Tank (IWST) occurred resulting in a release of 210,000 L of combined lake water and IWST water via the yard drainage system to Lake Ontario. The released water contained

44,807,000 Bq/L (1,211 μCi/kg) of tritium and 58.8 mg/kg of hydrazine. The total amount of tritium released as a result of this event was 250 curies, which is less than 1 % of the Derived Release Limit which DNGS is permitted to release by licence. Although this was an event reportable to the CNSC under OPG's licence, CNSC does not consider this to be significant risk to the environment or to public health.

Additional work was completed by OPG to determine the cause of the spill, and the extent and impact of the spill. Groundwater samples collected indicated tritium levels above the 7,000 Bq/L standard for drinking water. OPG has procedures in place to assess and mitigate the identified groundwater contamination. As an element of these procedures, an environmental site assessment is underway to further define the extent of the contamination and will serve as a basis to determine appropriate mitigating actions.

Groundwater Quality

The following summary of groundwater quality in table 4.5-1 is based on samples collected from newly constructed monitoring wells in the Protected Area and the multi-level wells in the Controlled Area immediately surrounding the Protected Area. Comparisons to the *Ontario Regulation 153 Standards* (2011) for groundwater were applied in a manner similar to the soil criteria. Where they exist, comparisons were made to Table 3: Non-Potable Groundwater Criteria for all types of property uses and medium/fine and coarse soils.

Table 4.5-1 Summary of Groundwater Parameters Exceeding Provincial Criteria

Parameter	Exceedances [1]
Base/neutral/acid extractables	▪ Bis(2-ethylhexyl) phthalate: 1 sample in 1 location above non-potable criteria
Petroleum Hydrocarbons and Volatile Organic Compounds (VOCs)	▪ petroleum hydrocarbons above non-potable criteria, attributed to naturally-occurring hydrocarbons in the bedrock ▪ a number of VOCs were also detected at concentrations above the non-potable criteria in the groundwater inside the Protected Area and in box drains ▪ most of the VOCs were associated with naturally-occurring petroleum hydrocarbons in the bedrock, with benzene being predominant
Metals	▪ selenium and sodium were detected in the Box Drain Sump samples in excess of the non-potable criteria ▪ attributed to natural occurrence of these compounds in the bedrock

Anions	▪ chloride was often found in exceedance of non-potable criteria ▪ attributed to natural conditions in the bedrock as well as influences from road salting

[1] Non-potable criteria = Table 3: Non-Potable Groundwater Criteria under *Ontario Regulation 153 Standards* (2011)

Prior to the IWST spill, the tritium concentrations in groundwater were consistent with the expected concentrations that may result from the infiltration of precipitation. Sampled tritium in precipitation ranged from non-detect to a maximum of 1,924 Bq/L with a maximum average of 514 Bq/L. The tritium in groundwater concentrations outside of the IWST spill are the result of atmospheric deposition of tritium from vents and stacks in the Protected Area. Tritium in precipitation generally follows the tritium in air trends over the long term and decreases with increasing distance from the DNGS site (see OPG's dispositions of technical review comments on the EIS: Comment #58 in OPG 2012).

Groundwater Flow

Groundwater flow within the water table in the Protected Area is to the north and northwest towards the Forebay Channel. At a finite scale, the presence of the Powerhouse extending to bedrock as well as the presence of other site structures (e.g., foundations, sumps, utility corridors) leads to more complex groundwater flows and rates within the Protected Area, which is described in further detail in OPG's EIS and associated Geological and Hydrogeological TSD (see figures 4.5-4 to 4.5-7).

4.5.4 Radiation and Radioactivity

Radiation levels in the geological and hydrogeological environments are provided in table 4.5-2 that reflects 2009 monitoring results. For most sources, levels were higher than background levels; however, for all sources, the 2009 values observed at the different study areas showed similar levels to what has been historically observed.

For tritium in water, the concentrations reported are all below OPG's voluntary commitment level (for nearby WSPs) of 100 Bq/L and a small fraction of Ontario's Drinking Water Quality Standard for tritium of 7,000 Bq/L. For gross beta, there is one well location that has a concentration above the drinking water screening level of 1 Bq/L. Historically, the gross beta concentration at this location has been high and subsequent follow-up investigation confirmed the cause of the elevated level to be presence of the naturally occurring K-40.

Table 4.5-2 Summary of Radiation Levels in the Geological and Hydrogeological Environment for 2009

Source	Study Area	Radiation Level
Tritium	Regional Study Area	<2.3 to 5.8 Bq/L
	Local Study Area	<2.3 to 22.5 Bq/L
	Site Study Area	see section 4.5.3
	Background (provincial location)	<1.9 Bq/L
Gross beta	Regional Study Area	0.08 to 0.32 Bq/L
	Local Study Area	0.04 to 1.67 Bq/L
	Site Study Area	Not collected
	Background (provincial location)	0.12 Bq/L

4.6 Land and Resource Use

4.6.1 Land Use Framework

Land use planning in Ontario is predominately carried out within a framework established and implemented by the Province of Ontario (e.g., *Planning Act*, and the Provincial Policy Statement (2005)) and the respective upper-tier (Durham Region), single-tier and lower-tier municipalities which have been delegated planning authority over regional and/or local land use planning matters. In the case of this project, these jurisdictions include Durham Region (e.g., Durham Regional Official Plan and the Growing Durham Study), Municipality of Clarington (e.g., Municipality of Clarington Official Plan) and the City of Oshawa (e.g., City of Oshawa Official Plan). Although the federal government does have jurisdiction on some land use planning matters (e.g., airports), this federal jurisdiction is generally not applicable in the context of an operating nuclear generating station.

4.6.2 Development Activity in the Local Study Area

The Municipality of Clarington and the City of Oshawa have experienced a drop in the levels of development activity in recent years. This can be partly attributed to the recent economic downturn resulting in decreased demand for both residential and non-residential developments. For the most part, new greenfield community development in the Municipality of Clarington is occurring within the designated urban areas within Bowmanville, but outside the Downtown area. For Oshawa, greenfield community development areas are located in the northern and eastern areas of the City.

4.6.3 Existing Land Uses

The DN site is surrounded by rural and industrial land uses. Highway 401 runs east to west directly north of the DN site, beyond which are rural residential and agricultural uses. To the east is the St. Marys Cement plant beyond which is a residential neighbourhood. Agricultural uses, automotive uses and the

Courtice water pollution control plant are located immediately west of the DN site and Darlington Provincial Park is located further to west on the Lake Ontario shoreline. The urban areas within the LSA include residential, commercial and employment areas which are generally located in the Municipality of Clarington south of the 3rd Concession and in the City of Oshawa south of Conlin Road. The rural areas of the LSA include agricultural areas, rural hamlets and conservation uses which are generally located to the north of these roads. The Clarington Energy Business Park (~ 129 hectares) is located immediately west of the DN site.

The DN site is identified in the Durham Region Official Plan land use schedule but there is no land use designation or pertinent site specific policy. A number of the policies in this Official Plan pertain to the DN site. The Municipality of Clarington designates the majority of the DN site as a "Utility". This Official Plan also identifies a Waste Disposal Assessment Area (i.e., the Northwest Landfill Area) on the DN site. Adjacent lands have a variety of land use designations in official plans depending on the applicable jurisdiction (Durham Region versus Municipality of Clarington).

Lake-based uses include recreational fishing and boating. Fishing occurs near the DN site but is not generally focused on the site, rather the general area.

4.7 Socio-Economic Environment

The socio-economic description is presented in the context of the following environmental elements:

- population
- economy
- community infrastructure and services
- residents and communities

4.7.1 Population

In the RSA, between 2001 and 2010, Durham Region's population grew by over 20%. The fastest growth occurred in urban centres within the Towns of Whitby and Ajax and the Municipality of Clarington. This rapid population growth is largely a product of development and economic growth in the Greater Golden Horseshoe. In fact, population growth in Durham Region outpaced that of Ontario. The demographic mix and aging trend in the RSA population is similar to that experienced in the province.

In the LSA, the Municipality of Clarington had an estimated 2010 population of approximately 87,500 and the City of Oshawa approximately 151,470. In 2006, the census population in the LSA was approximately 198,200 persons, which represented approximately 34% of the RSA population and over 85% of the combined total population of the municipalities of Clarington and Oshawa.

4.7.2 Economy

Economy and Business Activity

In the RSA, Durham Region has a diverse economy, with the key sectors being in manufacturing, automotive, energy, agri-business, tourism, health care and education. Data from the past two censuses (2001, 2006) indicated that employment rates in Durham Region have traditionally been higher and unemployment rates lower than those observed in Ontario as a whole.

The LSA, based on 2006 census data, had both an employment rate and an unemployment rate lower than those in RSA. Within the LSA municipalities, the major private sector employers in Oshawa are all associated with the automobile manufacturing sector. In Clarington, the major private sector employer is OPG. In the public sector, the major employers are largely health care organizations, educational institutions; and municipal, provincial and federal governments.

There are strong forecasts of overall economic development in Durham Region. For example, the Durham Region Planning and Economic Development Department has indicated that one of the key focal points identified for business growth in the Region was on continuing to build and leverage the Durham Energy Industry Cluster as an economic engine for growth in the region, province and the country. At the LSA level, the Municipality of Clarington has experienced considerable growth over the past decade and economic development officials anticipate continued growth in employment and business activity, largely associated with population growth rather than expansion in the industrial or commercial sectors. Likewise, the City of Oshawa has seen, as an indicator of business activity, the non-residential taxable assessment (i.e., commercial, industrial, farmland and managed forests assessment) in the City of Oshawa grow by approximately 115% from approximately $1.4 billion in 2002 to approximately $3 billion in 2009.

Tourism

In the RSA, Durham Region offers a variety of advantages to visitors to the area, including many in the Municipality of Clarington and Oshawa. In 2008, Durham Region had over 5,200 businesses providing tourism-related products and services and attracted over 2.9 million visitors generating close to $200 million in spending.

Income

Statistics Canada data from 2006 indicated the average household income in the RSA was approximately $86,400, higher than the Ontario average of approximately $78,000. Between 2001 and 2006, the average household income in RSA increased at 2.9% per year. In the LSA, the average household income was approximately $74,000, almost 15% lower than the RSA average. Between 2001 and 2006, it increased by 2.5% annually.

4.7.3 Community Infrastructure and Services

Housing and Property Values

In the RSA, data from the Toronto Real Estate Board show that between 2001 and 2010, the average housing price in Durham Region steadily increased from approximately $192,000 in 2001, to $304,000 in 2010, or by 58%. The general trend of increasing residential property values in the LSA over the past 10 years (52% increase) is similar to that of the RSA.

In the LSA, there was a 4.2% increase in total private dwellings from 2001 to 2006. The Municipality of Clarington has experienced more residential growth over the past five years than most municipalities in Durham Region, and virtually all of this growth in housing has been in the urban areas. Downtown Oshawa has been designated as an urban growth centre by the Province of Ontario and housing growth in Oshawa has largely occurred within the downtown area and the existing urban boundaries.

Municipal Infrastructure

The supply of water within the RSA/LSA is derived from a combination of lake Ontario and groundwater aquifers. Water from groundwater aquifers is drawn from both municipal wells and treated by the municipality, but also from private wells, which are not treated by the municipality. Durham Region has 13 water supply plants (WSPs), 6 of which are surface water-based and 7 are groundwater-based facilities. Of the 13 plants, five draw water from Lake Ontario. In the LSA, the Municipality of Clarington is serviced by three water treatment and supply facilities; one each in Bowmanville, Newcastle and Orono. The Bowmanville WSP and Newcastle WSP are lake-based municipal water systems, while the Orono WSP is a groundwater-based municipal water system. Water supply to the City of Oshawa is managed through the Oshawa WSP which serves the City as well as the urban areas of Courtice in the municipality of Clarington. In the SSA, domestic (i.e., potable) water is currently supplied to DNGS via a single connection to the Durham Region water main on South Service Road.

Across the RSA and LSA, the responsibility for the management of sanitary sewage and conventional waste lies with the Durham Region. For sanitary sewage, at the DN site, wastewater is pumped or gravity drained to the onsite DNGS Sewage Treatment Plant located centrally at the south end of the DN site. As part of its program of ongoing site improvements, OPG has initiated the process for increasing domestic (and firewater) delivery to DNGS and connecting the station to the municipal sanitary sewer system. Conventional waste generation from OPG at the DN site is managed through industrial/commercial contracts. The DN site tests waste materials for radioactivity prior to release for recycling or disposal.

Municipal Finance and Administration

In 2009 the region had revenues of approximately $1 billion. The municipal assessment base (current value) was in the order of $65 billion. Within this total, the Municipality of Clarington reflected $8.6 billion and the City of Oshawa, $13.8 billion. In 2009, the distribution of expenditures varied depending on jurisdiction but the main categories included social and family services, transportation services, recreation and cultural services, environmental services and protection services.

Health and Safety Facilities and Services

Residents within the RSA are served by the Central East Local Health Integration Network, and for hospital services, by four Durham area hospitals. Durham Region also convenes the Durham Nuclear Health Committee which serves as a forum for discussing and addressing radiological emissions from nuclear facilities in the Region and their human health implications.

In the RSA, emergency medical services (i.e., paramedic services) are provided by Durham Region Emergency Medical Services, a division of Durham Region Health Department. Policing in the RSA is carried out by the Durham Region Police Service. Fire services within the LSA are provided by the Municipality of Clarington and the City of Oshawa; Durham Region is not responsible for fire services.

The DN site operates a fully staffed, trained and equipped fire services department whose objective is to respond to any fire event on-site within 10 minutes. The fire protection program is based on *CSA N293-07 Fire Protection for CANDU Nuclear Power Plants*. OPG's site security program at the DN site has continued to evolve in order to meet all regulatory requirements and commitments in its operating license.

Educational Facilities and Services

There are five school boards servicing residents within the RSA/LSA, including two public school boards, two catholic school boards and one French school board.

Community and Recreational Facilities and Services

Durham Region offers to its residents and visitors over 3,290 ha of municipally-owned open space, 580 km of recreational trails and over 290,900 m^2 of indoor and outdoor recreational facilities. There are also hundreds of community facilities within the RSA.

There are 31 community and recreational features located within the LSA nearest the DN site (i.e., approximately 3 to 6 km from the centre of the DN site). This includes parks, childcare centres, sports fields, community centres, churches, and trails.

The DN site offers several sports fields for use by local residents and the Waterfront Trail traverses through the DN site for approximately 7.5 km.

4.7.4 Residents and Community

For the purposes of this assessment, the description of existing environmental conditions relevant to the discussion of people's use and enjoyment of private property and public attitudes is focused on the LSA and the DN site neighbours in particular (i.e., the Municipality of Clarington) and is largely derived from public attitude research recently undertaken by OPG.

Use and Enjoyment of Property

People's use and enjoyment of property and whether the DN site is one of those factors, indicates that most respondents (43%) feel that "nothing" influences their use and enjoyment of property and for the most part "everything is fine". For DN site neighbours, 60% responded that the DN site does not affect their use or enjoyment of property. Those that did identify an effect indicated that the site has increased traffic congestion on local roads, decreased their property value, and is a source of concern over their safety.

Community Character

In terms of physical character within the LSA, the shoreline of Lake Ontario is a defining feature of the community (e.g., Darlington Provincial Park). The economic character of the LSA is defined by prominent industrial employers such as General Motors in Oshawa, and St. Marys Cement and the DN site in Clarington. From a community image perspective, there are no strong indications that a stigma has been attributed to Clarington because of the presence of the DN site as evident by the few LSA respondents (1%) indicating that the DN site is an influence on community character or image.

Community Cohesion

The results of the public attitude research show that there is a strong sense of belonging and most people feel that there is a common vision among residents in the LSA (76% "very" and "somewhat"). Roughly one-third of the respondents state that their community is "very cohesive". Assessments of community cohesion are similar regardless of the perceived distance from the DN site, employment by OPG, and most demographic characteristics.

Community and Personal Well-being

For feelings of personal health in the LSA 79% of the respondents (80% in the RSA) described this as either "excellent" or "good". OPG was cited by a several respondents (5%) as a negative influence of feelings of personal health. With respect to the DN site, the presence or proximity of the facility to people's homes and the risk of leaks and spills were identified as the major issues.

With respect to the LSA specifically, 86% of the respondents describe their sense of personal safety as "excellent" or "good". Policing was identified as having the most positive influence on people's sense of personal safety in the LSA.

With respect to community satisfaction within the LSA specifically, the public attitude research indicates that almost all respondents are either “very” or “somewhat satisfied” with living in their community.

Based on the results of the public attitude research, proximity to the DN site is not considered to be a major factor in people’s attitudes toward key aspects of their community.

For community well-being, public attitude results strongly indicate that the majority of respondents across the LSA consider the negative consequences related to increasing urbanization as the greatest threats to community well-being over the next decade. Respondents from within the LSA identified a large variety of features seen as important to the maintenance and enhancement of their community well-being, with municipal infrastructure and services, and community services being the most important.

4.8 Traffic and Transportation

The description is presented in the context of road traffic operations (vehicular movements and road traffic interaction characteristics) and road safety characteristics in the vicinity of DNGS.

4.8.1 Road Traffic Operations

The discussion of existing conditions in terms of traffic and transportation is primarily focused within the LSA since it is within this zone that potential consequences of the Project will be experienced. Within the LSA, the key roadways and intersections that represent the routes that converge upon or diverge from, the DN site include the following:

- Courtice Road/Durham Regional Road 34
- Solina Road
- Holt Road
- Maple Grove Road
- Waverley Road/Martin Road/Durham Regional Road 57
- South Service Road
- Baseline Road
- Bloor Street
- Highway 2/King Street

From an employee travel pattern perspective, the main access into the DN site is via Holt Road. Turning movement counts confirmed that many employees commute from the north via Holt Road, while another sizeable group travels from the east via Highway 401, exiting at the Waverley Road interchange and taking South Service Road to Holt Road. A third group travels from the west via Highway 401 arriving at the DN site using the Holt Road exit from Highway 401. A small number of employees arrive via the South Service Road westbound.

To further characterize the road traffic operations, OPG undertook different traffic-related analyses described below.

The intersection capacity analysis indicated that the existing LSA road network generally operates at a satisfactory level of service. Intersections of potential concern are South Service Road at Holt Road and the adjacent intersections of South Service Road at Highway 401 Eastbound Ramps (Waverley Road interchange) and South Service Road at Waverley Road.

The link capacity analysis indicated that the LSA road links examined generally operate satisfactorily under existing conditions.

A screenline analysis was performed to determine the utilization and remaining available capacity of the main road links across the LSA network. The traffic operations across all of the screenlines considered are satisfactory under the existing conditions. Most road segments have large amounts of unused capacity available, with the exception of Regional Road 57 between Baseline Road and Highway 2/King Street.

4.8.2 Road Safety

In terms of the 2008 collision rates, most locations (~90%) within the LSA were also determined to range in the low to moderate levels, with 7 locations having collision rates above the provincial average.

4.9 Physical and Cultural Heritage

Physical and Cultural Heritage consists of an archaeology component and a built heritage and cultural landscapes component.

Archaeology refers to Aboriginal and Euro-Canadian resources comprising both sub-surface features and artifacts that pertain to archaeological sites (including marine archaeological sites) and areas of archaeological potential.

Built heritage and cultural landscapes refers to Euro-Canadian resources pertaining to built heritage features such as architecture or above-ground structural remains and artifacts, or cultural landscape units such as farm complexes, roadscapes, waterscapes, railscapes, historical settlements, cemeteries or commemorative sites/plaques.

4.9.1 Archaeology

European settlement in the LSA started in the late 1700s. The temporal span of Aboriginal sites stretches from the late Paleo-Indian period between approximately 10,500 and 9,000 years Before Present through to the late 19th century.

Two Euro-Canadian archaeological resources, the Brady site and Crumb site, were identified during the NND Project EA studies within the DN site (although beyond the current SSA). These sites were subjects of Stage 4 mitigation in 2010 and 2011, respectively, to ameliorate environmental effects of the NND Project. During the Brady site excavation, a small collection of

Aboriginal artifacts was found. None of these archaeological resources will be affected by the Project. Two other provincially registered archaeological resources near the SSA were deemed to no longer exist, having been disturbed by the construction of the DNGS and associated transformer station.

One remaining archaeological concern within the SSA is the possibility of an unmarked pioneer cemetery, known as the Van Camp cemetery. The presence, location and removal of the Van Camp cemetery is unconfirmed by the archival research conducted; and examination of engineering plans indicate that its possible location was extensively altered during DNGS construction. Without the confirmation that the cemetery has been closed, there is a small possibility that there are remnants of the cemetery extant within the SSA.

4.9.2 Built Heritage and Cultural Landscapes

A cultural heritage landscape represents a defined geographical area of heritage significance that has been modified by human activities. For the SSA, it has been determined that it has been subjected to almost complete alteration and little to no remnants of an agricultural landscape remain. In the area just outside of the DN site/SSA, it consists of a mid-to-late 19th century cultural heritage landscape that retains a high degree of heritage integrity. Lands in this zone contain a wide number of intact, active 19th century agricultural landscape units.

4.10 Aboriginal Interests

The DN site is located within lands associated with the Williams Treaties. Signatory First Nations to these treaties as well as other Aboriginal communities that have been engaged by OPG and/or CNSC on this project include:

- Williams Treaties First Nations
    - Alderville First Nation
    - Mississaugas of Scugog Island First Nation
    - Curve Lake First Nation
    - Chippewas of Georgina Island First Nation
    - Hiawatha First Nation
    - Chippewas of Mnjikaming First Nation (Rama)
- Mississaugas of New Credit First Nation
- Mohawks of the Bay of Quinte First Nation
- Chippewas of Nawash Unceded First Nation
- Saugeen First Nation
- Six Nations of the Grand River
- Huron Wendat First Nation
- Kawartha Nishnawbe

- Métis Nation of Ontario
- Oshawa and Durham Region Métis Council

OPG solicited traditional knowledge during its Aboriginal engagement program. Specifically, with respect to traditional knowledge, the *Métis Nation of Ontario – Southern Ontario Métis Traditional Plant Use Study* (MNO 2010) was used by OPG in its conduct of this EA Screening Report. During the EA process, the Mississaugas of Scugog Island indicated that they were in possession of traditional knowledge relevant to the site. OPG has subsequently met with the Mississaugas of Scugog Island First Nation in April 2012 and OPG and CNSC staff will continue to engage them on this matter.

4.10.1 Traditional Land and Resource Use

The on-land portion of the SSA is fully occupied by OPG and is located in an area where public access is not allowed. Therefore, it is not possible for there to be any land based traditional activities in this area. It is possible that the Lake Ontario portion of the study areas could be used for fishing but there is no evidence to suggest this traditional activity has occurred. It is also possible that some traditional plant collection activity occurs in the rural areas of the LSA and RSA. However, the land is predominantly private in nature and therefore any plant collection would be likely limited to any public greenspace areas and personal properties.

4.10.2 Ceremonial Sites and Significant Features

Based on information gathered by OPG, no ceremonial sites or features of cultural or spiritual importance were identified. Some archaeological artefacts pertaining to Aboriginal Peoples and heritage were identified as isolated find spots outside of the SSA on the DN site (see section 4.10.1 of this EA Screening Report). These findings confirmed that hunting and gathering activities occurred in this area however, they were not of the nature to suggest historical Aboriginal settlement or representing archaeological findings of significance or concern.

4.11 Human Health

The context for human health considerations is the World Health Organization definition of health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". The general approach to assessment of human health and safety in this EA Screening Report uses this definition.

4.11.1 Physical Well-being

Physical well-being refers to the state of a person functioning without disease, illness or injury. It is influenced by biophysical environmental and socio-economic factors.

The health and safety of humans (both workers and members of the public) have been considered directly or indirectly in the discussion throughout the preceding sections for the biophysical environment including air quality, noise, surface water and groundwater. Brief summaries are provided below relative to a human health context.

Air quality is typical of that of Southern Ontario, and under existing conditions in the LSA, air contaminant concentrations are well below applicable AAQC which are set to be protective of human health. The noise environment in the vicinity of the DN site is typical of an urban setting.

Within the LSA, water for potable purposes is drawn from the lake at the Bowmanville WSP and the Oshawa WSP. Water available for public consumption is required to conform to the Ontario Drinking Water Quality Standards set out by the OMOE.

In terms of recreational use of the lake water (e.g., swimming), the primary concern is bacteria. Under existing conditions there is a very low probability that the water temperature increase due to the DNGS thermal plume affects bacterial growth in Lake Ontario.

Groundwater within the DN site is not used for potable purposes, given its industrial setting. In general, the groundwater on site eventually discharges to Lake Ontario where it contributes only a small fraction of the total discharge to Lake Ontario, and does not have a measurable effect on overall lake water quality.

OPG's current Occupational Health and Safety Management System is designed to ensure employees work safely in a healthy and injury-free workplace.

Socio-economic elements of Physical Well-being have been discussed in preceding sections and are summarized in section 4.7.3 of this EA Screening Report with respect to health and safety facilities and services, municipal infrastructure and services, and housing.

For nuclear-related projects, radiation and radioactivity in a human health context are of public concern and are elaborated upon below.

<u>Radiation and Radioactivity</u>

The total annual dose from natural background sources is estimated at 1.84 mSv on average in Canada. This includes approximately 0.07 mSv/year from anthropogenic sources (e.g., nuclear weapon test fallout, exposures from technological processes and consumer products and services). However, this is highly variable and a wide range of annual doses is observed and is reported by Health Canada (HC 2000) as 1.2 to 3.2 mSv/year. The estimated background dose around DNGS is 1.4 mSv/year, which includes activities at DNGS.

Radiation doses to nuclear energy workers (NEWs), non-NEWs on the DN site and visitors to the DN site are measured or calculated by OPG and access and movement of non-NEWs are controlled by OPG to ensure that radiation doses to these workers (non-NEWs) as a result of licensed activities on site do not exceed 1 mSv/year, the regulatory limit for individuals who are not NEWs.

As a result of monitoring, radiation doses to NEWs at the DN site are known to be well below the regulatory limits of 50 mSv per one-year dosimetry period, and

100 mSv per five year dosimetry period. Average and maximum individual doses for different categories of workers were provided in OPG's disposition to technical review comments on the EIS (Comment #80 in OPG 2012). In addition, OPG implements comprehensive ALARA programs, including detailed radiation work planning and monitoring. Further details on worker dose assessment are provided below.

Collective dose is a measure of the total amount of radiation exposure to everyone affected by an activity. There are no regulatory or recommended limits relating to collective dose; however, collective dose is reported as a measure of ALARA performance. The total collective doses to workers on the DN site for 2009 and 2008 was 3.12 person-Sieverts (P-Sv) and 1.73 P-Sv, respectively. From 1998 to 2007, the annual collective dose for workers ranged from 0.69 to 4.07 P-Sv. The variations in collective dose from year to year are due primarily to the number and scope of outages.

The average individual doses to DN workers in 2009 and 2008 were 1.5 and 1.2 mSv, respectively. The average individual doses from 1998 to 2007 ranged from 0.75 to 2.18 mSv.

With respect to radiation doses to members of the public, the total dose calculated by OPG to the most exposed critical group (i.e., infant at the dairy farm) in 2009 as a result of operation of DNGS was 7×10^{-4} mSv. This dose is less than 1% of the regulatory limit for members of the public of 1 mSv/year. The highest dose calculated over the last ten years (2002-2011), has been 1.7×10^{-3} mSv in 2003. The 2010 REMP report (OPG 2011a) indicates that the most exposed critical group dose as a result of operation of DNGS was 6×10^{-4} mSv.

In addition, the theoretical incremental dose from the operation of DNGS is a small fraction of the annual dose from natural background radiation in Canada (1.84 mSv/year) and, as such, would not affect the physical well-being of members of the public. Since this dose is primarily due to air emissions and, as the result of increased atmospheric dispersion with increasing distance, the resultant air concentrations of radioactive emissions from the DN site will also decrease with increasing distances. Therefore, the doses and risks to people who live further away from the site will also decrease with increasing distance.

4.11.2 Mental Well-being

Public attitude research was used to gauge the mental well-being of the public with respect to personal health, personal safety, community, the DN site and traffic. The results are summarized below.

Seventy-nine percent of the public attitude research respondents described their feeling of personal health as either "excellent" or "good". Twenty-eight percent of the respondents rated their personal health as "excellent' while very few (4%) rated it as "poor".

Consistent with their feelings of personal health, 86% of the respondents also described their sense of personal safety as "excellent" or "good". Slightly over one-third of respondents provided the highest rating of “excellent” and very few respondents stated “poor”.

Public attitude research indicates that almost all respondents are either “very” or “somewhat satisfied” with living in their community, with 63% of the LSA respondents being “very satisfied”.

Public attitude research results also indicate that a strong majority of LSA respondents (90%) are confident in the safety of the existing DN site and its on-going operations.

During the Site Neighbour Survey conducted by OPG for this EA Screening Report, a few respondents indicated that it would be “more dangerous accessing and exiting our property because of increased traffic” and that one of the main reasons for effects to use and enjoyment of property was traffic.

With respect to workers, OPG has extensive health and safety programs, policies and procedures in place. These programs help to ensure workers’ sense of well-being and security.

4.11.3 Social Well-being

Social well-being for the public includes elements such as population and demographics, employment and income, community and recreational facilities and services, and community cohesion which are summarized below.

Public attitude research indicated that low population levels and densities that contribute to a small town feel were considered by many respondents (9% in LSA and 11% in RSA) as an important attribute that supports community well-being, while increased development, expansions of subdivisions and overpopulation were seen as threats to community well-being by 18% of LSA and 23% of RSA respondents.

With respect to employment, the employment rate in the LSA increased from 60.3% in 1996 to 62.4% in 2006, with a corresponding decrease in unemployment from 9.8% to 7.0%. This trend was observed throughout both the Municipality of Clarington and the City of Oshawa.

Residents of Clarington and Oshawa have access to a wide variety of public and privately operated community and recreational facilities and amenities that contribute to their quality of life. In general, the more urbanized areas (e.g., Oshawa and Bowmanville) have the largest concentrations of such features in the LSA. In addition, the DN site offers several sports fields for use by local residents.

For community cohesion, the results of the public attitude research show that there is a strong sense of belonging and most people feel that there is a common vision among residents in the LSA (76% “very” and “somewhat”). Roughly one-third of the respondents state that their community is “very cohesive”.

With respect to the social well-being of workers, OPG is a major employer of workers in the RSA and LSA. Therefore, OPG and the DN site in particular, contribute to overall community and personal well-being, with over 2,600 people OPG staff employed on the DN site. As of 2007, OPG was the second-largest private employer in the RSA.

4.12 Non-human Biota

The methodology used in the evaluation of effects on non-human biota (i.e., ecological risk assessment or ERA) considered four steps as provided in the various regulatory frameworks as follows:

- problem formulation stage, in which the various chemicals of concern, receptors, exposure pathways, and scenarios are identified
- exposure assessment, where predicted exposures are calculated for the various receptors and constituents of potential concern (COPCs)
- hazard assessment, in which exposure limits for the COPCs are determined
- risk characterization stage, where the exposure and hazard assessment steps are integrated

At the problem formulation stage, in order to establish existing environmental conditions for non-human biota, data was collected as part of the existing conditions studies, with a focus on the southwest quadrant of the DN site, in combination with the information gathered during NND.

A screening procedure using measured site concentrations was applied to identify the conventional COPCs. Of the 15 COPCs identified, only chromium, copper, cobalt, hydrazine and iron are associated with operations of DNGS.

Seven radionuclides were selected to be used in the risk assessment due to their prevalence in the environment, historical concerns regarding environmental concentrations and relevance to nuclear power generation. These radionuclides were: Carbon-14, tritium (H-3), Strontium-90, Cobalt-60, Cesium-134, Cesium-137 and Iodine-131.

Ecological receptors, representative of the various feeding habits and characteristics of the species present at the site, were selected to evaluate potential risks to non-human biota exposed to radioactive and non-radioactive releases at the DN site.

Screening Index values for the indicator species for each COPC were developed. A Screening Index value (SI) is used to provide a quantitative measure of risk.

A conceptual site model was developed for the DN site that illustrates the environmental fate and transport of COPC following their release, and the various pathways through which each receptor may become exposed.

Table 4.12-1 discusses the risks associated with exposure to conventional and radiological COPCs for the existing conditions at the DN site (i.e., existing scenario). The findings are a combination of the results related to the NND Project EA and the results for the south-west corner which was not considered in the NND Project EA, referred to as the DNGS ERA.

Table 4.12-1 Potential Risks to Non-human Biota from the Existing Scenario

Potential Risk	Results
Aquatic Environment	▪ no adverse effects to aquatic receptors for exposures in Lake Ontario (NND ERA), Coot's Pond (NND ERA) and two small watercourses in the south-west corner of the DN site to COPCs (DNGS ERA)
Sediment	▪ no adverse effects in the sediment environment for exposures in Lake Ontario (NND ERA), Coot's Pond (NND ERA) and two small watercourses in the south-west corner of the DN site to COPCs (DNGS ERA)
Amphibians and Reptiles	▪ no adverse effects in amphibian and reptile populations were occurring in Coot's Pond (NND ERA) ▪ exceedance of chromium and strontium thresholds for amphibians and reptiles associated with the two small watercourses in south-west corner of the DN site (DNGS ERA) ▪ unlikely that the presence of chromium and strontium in the two waterbodies small watercourses in the south-west corner of the DN site would result in adverse effects in frog populations because: o high degree of uncertainty in the factors contributing to the threshold value o presence of healthy amphibian populations on the DN site o source of the strontium is unknown in these two waterbodies as it is not the result of emissions from DNGS
Terrestrial Plants and Earthworms	▪ terrestrial plant and earthworm populations at the DN site are not expected to experience adverse effects from COPCs present in the soil (DNGS ERA)
Terrestrial Mammals and Birds	▪ no adverse effects to terrestrial receptors (NND ERA) ▪ no adverse effects to waterfowl in Lake Ontario and Coot's Pond (NND ERA) ▪ American robin was above threshold value for selenium

Potential Risk	Results
	(DNGS ERA) ▪ adverse effects, however, were considered unlikely because: o robins do not stay at one location while foraging on site, and therefore, the mean concentration is a better estimation of the overall exposure than maximum concentration o using mean selenium concentrations from the site results in an SI value below the threshold
Radiological COPCs	▪ all of the SI Values for radioactive COPCs at maximum concentrations across the site are several orders of magnitude below threshold values indicating that for the radiological COPCs, there are no ecological risks identified across the site for the existing scenario (NND and DNGS ERAs)

5 ASSESSMENT OF ENVIRONMENTAL EFFECTS

5.1 Description of Assessment Method

The assessment of the direct effects of the project on the environment was carried out in a step-wise manner as follows:

- identification of project-environment interactions with potential adverse environmental effects
- consideration of mitigation measures for potential adverse effects
- identification of residual effects that may remain following mitigation
- evaluation of the significance of any residual effects

5.2 Identification of Project-Environment Interactions

The assessment considered refurbishment, normal operations and effects as a result of malfunctions and accidents, effects of the project on the environment and cumulative effects.

The environment was divided into environmental and project components. Table 5.2-1 shows this level of detail and is based on OPG's EIS. Each project-environment interaction was assessed using criteria such as regulatory standards and guidelines, existing conditions, scientific literature and professional judgement to determine whether they were likely to result in a measurable change in the environment.

5.3 Consideration of Mitigation Measures for Potential Adverse Effects

Each potential adverse effect resulting from a measurable change in the environment was considered to identify, where appropriate, possible means of mitigation to eliminate, reduce or control the effect. DNGS is an operating facility with many years of operating experience and numerous features and operational practices are already in place to mitigate environmental effects. Some of those features are described in the following sections to highlight the range of control measures in place at the facility.

5.4 Identification of Residual Effects that May Remain Following Mitigation

Following identification of feasible mitigation measures, each likely adverse effect was re-evaluated to identify if there were any residual adverse effects. A residual effect is one which remains after mitigation has been put into place and would be measurable or observable on the selected VEC. The criteria used in the assessment were based on regulatory standards and guidelines, the scientific literature and existing conditions.

5.5 Evaluation of the Significance of any Residual Effects

Most of the likely adverse effects resulting from a measurable change in the environment were found to have no residual adverse effect and were not assessed further. Either the effect was well below the criterion established for deeming it adverse or a feasible mitigation measure was identified that if implemented would result in no residual effect. For those where there was a residual effect, the methodology for the evaluation of the significance of residual environmental effects is described below.

Table 5.5-1 outlines the specific measurement parameters used for the assessment of each of the biophysical environmental components and socioeconomic effects, respectively. In general, the measurement ranges represent a typical ranking of low, medium or high (or variations).

Within the context of this EA Screening Report, to determine whether a residual effect is significant, both of the following criteria need to be satisfied:

- A medium or high rating is attained for all of the attributes involving magnitude, geographic extent, duration, frequency, and reversibility.
- A medium or high rating is attained for ecological context, physical human health or psycho-socio human health, societal value or sustainability.

Conversely, if a low rating is achieved for any of the attributes involving magnitude, geographic extent, duration, frequency, or reversibility; or, if a low rating is achieved for the ecological and human health contexts (where applicable), then the effect is considered to be “not significant”.

In the case of malfunction and accidents (i.e., unlikely events), frequency was not used as a criterion in the significance determination since, it would by nature, always have a low frequency (i.e., occurs once).

Should an effect be deemed significant, the likelihood of the effect occurring (i.e., probability) would be determined, consistent with the Canadian Environmental Assessment Agency's (1994) Reference Guide on determining whether a project is likely to cause significant adverse environmental effects.

Table 5.2-1 Potential Project-Environment Interactions (● = potential interaction)

Environmental Components and Sub-Components	Atmospheric Environment		Surface Water Environment				Aquatic Environment		Terrestrial Environment			Geological and Hydrogeological Environment			Radiation & Radioactivity Environment					Land Use	Traffic & Transportation		Physical & Cultural Heritage Resources		Socio-Economic Environment				Aboriginal Interests		Human Health		Non-Human Health	
	Air Quality	Noise	Lake Circulation	Lake Water Temperature	Site Drainage and Water Quality	Shoreline Processes	Aquatic Biota	Aquatic Habitat	Vegetation Communities and Species	Bird Communities and Species	Landscape Connectivity	Soil Quality	Groundwater Quality	Groundwater Flow	Radioactivity in Atmospheric Environment	Radioactivity in Surface Water and Aquatic Environment	Radioactivity in Terrestrial Environment	Radioactivity in Hydrogeological Environment	Radioactivity in Humans	Land Use	Road Traffic Operations	Road Safety	Archaeology	Built Heritage and Cultural Landscapes	Population	Economy	Community Infrastructure and Services	Residents and Communities	Traditional Land and Resource Use	Ceremonial Sites and Significant Features	Health and Well-Being of the General Public	Health and Safety of Workers	Terrestrial Environment	Aquatic Environment
Project Works & Activities																																		
Refurbishment Phase																																		
Mobilization and Preparatory Works	●	●			●				●	●					●		●		●	●	●	●				●	●	●				●	●	
Shutdown, Defuelling and Dewatering of the Reactors			●	●	●							●	●	●	●	●	●	●	●													●	●	●
Construction of Retube Waste Storage and Other Support Buildings	●	●			●				●	●				●					●	●			●	●		●	●	●	●	●		●		
Removal of Reactor Components and Placement of Wastes into Storage															●	●	●	●	●													●	●	●
Transportation of Refurbishment L&ILW to Off-site Waste Management Facility	●	●															●		●	●	●	●				●	●	●	●	●		●	●	
Management of Non-Radioactive Refurbishment Waste	●	●																		●							●							
Balance of Plant Repair, Maintenance and Upgrades	●	●																																
Refilling, Refuelling and Restarting the Reactors															●	●	●	●	●													●	●	●
Workforce, Payroll and Purchasing	●	●			●				●	●	●									●	●	●			●	●	●	●						
Continued Operaton Phase																																		
Operation of the Reactor Core																			●													●		
Operation of the Primary Heat Transport and Moderator Systems															●	●	●	●	●												●	●	●	●
Operation of Active Ventilation and Active Plant Drainage Systems												●	●		●	●	●	●	●							●	●				●	●	●	●
Operation of Fuel Handling and Storage Systems															●				●												●	●	●	
Operation of Special Safety and Safety-Related Systems																																		
Operation of Secondary Heat Transport System and Turbine-Generator Sets	●	●																								●	●	●			●			
Operation of Station Water Systems			●	●	●	●	●	●								●			●							●	●				●			●
Operation of Electrical Power Systems	●	●																								●	●	●			●			
Operation of Site Services and Utilities		●										●	●	●									●	●		●	●	●						
Construction of Additional Storage Buildings at DWMF	●	●							●	●									●	●			●	●		●	●	●	●	●	●	●		
Management of Operational L&ILW															●		●		●		●	●									●	●	●	
Transportation of L&ILW to Off-site Waste Management Facility	●	●															●		●		●	●				●	●	●	●	●	●	●	●	
Management of Conventional Wastes	●	●																									●						●	
Maintenance of Major Systems and Components	●	●	●	●	●	●									●	●	●	●	●	●								●			●	●	●	●
Placement of Reactors into End-of-Life Shutdown State			●	●	●	●									●	●	●	●	●												●	●	●	●
Physical Presence of the Station																				●					●	●	●	●						
Workforce, Payroll and Purchasing	●	●																			●	●			●	●	●	●						

Table 5.5-1 Criteria for Determination of Significance of Adverse Environmental Effects

Effects Criteria	**Effects Level Definition**		
	LOW	**MEDIUM**	**HIGH**
Magnitude	Effect exceeds baseline conditions; however, is less than reference criteria or guideline values.	Effect will likely exceed reference criteria or guideline values but has limited effect on VEC or pathway to VEC.	Effect will likely exceed reference criteria or guideline values and may cause an effect on VEC or pathway to VECs.
Geographic Extent	Effect limited to Site Study Area.	Effect limited to Local Study Area.	Effect extends into the Regional Study Area.
Duration/ Timing	Effect is limited to short-term events (i.e., Refurbishment phase).	Effect is limited to the Operation and Maintenance phase and/or the Decommissioning phase.	Effect extends beyond the Decommissioning phase.
Frequency	Occurs on one occasion or rarely.	Occurs intermittently on more than one occasion.	Occurs often and at regular and frequent intervals.
Reversibility	Effect is reversible (i.e., ceases once source/stressor is removed).	Effect persists for some time after source/stressor is removed, but eventually ceases (i.e., reversible during the lifetime of the Project)	Effect is not readily reversible.
Effect on Physical Human Health	Effect exceeds baseline conditions; however, is less than reference criteria or guideline values.	Effect will likely exceed reference criteria or guideline values but has limited effect on human health or pathway to human health.	Effect will likely exceed reference criteria or guideline values and may cause an effect on human health or pathway to human health.
Effect on Psycho-social Human Health	Effect is not generally noticeable to the public.	Effect is somewhat noticeable, but not generally of concern to the public.	Effect is noticeable, and of concern to the public and as such, may affect people's sense of health, safety and well-being.
Ecological Importance of VEC	The VEC is common and abundant within the Local Study Area.	The VEC is less common and of limited abundance within the Regional Study Area.	The VEC is less common and of limited abundance within Ontario.
Societal Value of VEC	The VEC plays a limited and indirect role in maintaining the economic base, social structure, community stability and the character of local communities.	The VEC plays an important yet indirect role in maintaining the economic base, social structure, community stability, and the character of local communities or people's sense of health, safety and well-being.	The VEC plays a highly important and direct role in maintaining the economic base, social structure, community stability, and the character of local communities or people's sense of health, safety and well-being.
Sustainability	The effect does not affect the existence of the VEC or its continued use.	The effect will substantially inhibit the use of the resource during the life of the project. The VEC will still be available thereafter.	The effect will, within a very short time, permanently affect the life of the VEC and, hence, its ability to continue to be available for use by future generations.

6 EFFECTS OF THE PROJECT ON THE ENVIRONMENT

6.1 Atmospheric Environment

6.1.1 Air Quality

Description of Effect

During the refurbishment phase, construction activities would be occurring in addition to the activities associated with existing operations. Most of the refurbishments activities involve interior construction. The bounding scenario for modeling atmospheric effects evaluated the construction of the Heavy Water Storage Building, the Retube Waste Storage Building and the Island Support Annex and an increase in worker vehicle traffic to the site. The resulting contaminants of concern at the nearest off-site receptor are SPM and NO_2 attributed to vehicle emissions; however, the increases in concentration of these contaminants during construction at the nearest off-site receptor are still below the AAQC.

During the continued operation phase, the DNGS site will operate as it currently does. The primary sources of emissions to air from the DNGS facility are related to combustion equipment (NO_x, SPM, SO_2 and CO) for testing emergency and back-up power equipment, and emissions of treatment chemicals from the steam generators (acetic acid, ammonia, formic acid, glycolic acid and hydrazine) mainly released on start-up.

The bounding scenario for assessing continued operations is the replacement of the steam generators. The modeling predicts that the maximum concentrations from the Refurbishment phase emissions are higher than the steam generator replacement phase except for NO_2 emissions.

Air emissions from the continued operations must comply with the requirements of the DNGS Environmental Compliance Approval (formerly known as a Certificate of Approval) issued by the OMOE.

Mitigation

In assessing air quality effects, in-design mitigation measures (i.e., implementation of good industry management practices) were considered during both phases of the Project. Examples of good industry management practices for particulate control include watering (or application of other dust suppressant) of exposed soil surfaces; maintaining roads clear of soil carryout; and ensuring vehicles and other combustion equipment is properly maintained.

All of the predicted air concentrations are well below applicable criteria, and no additional mitigation measures are identified beyond the implementation of in-design mitigation measures.

Residual Effect

All of the predicted air concentrations from the Project are well below applicable criteria. As such, no residual adverse effects to air quality are expected.

Significance of Effect

Not significant.

6.1.2 Noise Effect

Description of Effect

The refurbishment phase will result in additional noise from exterior construction activities which will be at a distance of 1,400 m from the nearest receptors and limited to areas south of the powerhouse and DWMF. Shift changes during refurbishment will produce the greatest amount of traffic-related noise, however, this is predicted to be less than 1 decibel, and would not be measurable.

During the continued operations phase, additional noise that may occur from exterior construction and/or steam generator replacement are bounded by the predicted noise effects during refurbishment and would not be measurable. Similarly, the operation of the DNGS will not change from the acceptable baseline conditions and, therefore, not considered further.

Mitigation

In assessing noise effects, in design mitigation measures (i.e., Good Industry Management Practices) were considered. Examples of Good Industry Management Practices of relevance to Noise include requirements to maintain construction and operating equipment in proper mechanical condition, and the need to comply with applicable noise standards and regulations.

Residual Effect

Noise level increases during the Refurbishment phase are predicted to be less than 1 decibel from baseline and would not be measurable. Continued operations noise levels would be comparable to baseline conditions. As such, no residual adverse effects from noise are expected.

Significance of Effect

Not significant.

6.2 Surface Water Environment

6.2.1 Lake Circulation

Description of Effect

Alongshore currents in front of the DN site are deflected as a result of the operation of the DNGS diffuser and any measurable change to these currents will be proportional to the number of units in operation. Accordingly, any changes to lake circulation associated with refurbishment outages, maintenance outages or the placement of reactors into end-of-life shutdown state would be reflective of conditions returning closer to pre-DNGS conditions. As such, adverse effects are not predicted.

Considering potential climate change over the extended life of the Project and, in particular, decreased Lake Ontario water levels (estimated to be 0.5 m), the bounding scenario for assessing effects on lake circulation resulting from the Project is four units in operation under predicted climate change conditions for the 2050s.

The deflection of alongshore currents in front of the DN site will likely be greater than under current DNGS operating conditions as reduced water depths near the DNGS diffuser will reduce the capacity of the ambient water to dissipate the energy of the discharge jets. It is also recognized that a reduction in lake water levels could potentially result in increased occurrences of drawdown of surface or near-surface waters into the intake and/or recirculation of CCW discharges into the intake under calm conditions or low current speeds (less than 10 cm/s). However, based on the historical studies of recirculation of the DNGS CCW flows into the intake, this is not expected to result in an adverse effect on lake circulation. Effects on lake circulation as a pathway to other effects are discussed further in section 6.3.2 of this EA Screening Report.

Mitigation

None.

Residual Effect

No residual adverse effects are expected.

Significance of Effect

Not significant.

6.2.2 Lake Temperature

Description of Effect

Any measurable change to lake temperature will be proportional to the number of units in operation. Accordingly, any changes to lake temperature associated with refurbishment outages, maintenance outages or the placement of reactors into end-of-life shutdown state would be reflective of conditions returning closer to pre-DNGS conditions. As such, adverse effects are not predicted.

Considering potential climate change over the extended life of the Project and, in particular, increased water temperatures and decreased water levels in Lake Ontario, the bounding scenario for assessing effects on lake water temperature resulting from this Project work and activity is four units in operation under predicted climate change conditions for the 2050s.

It is recognized that a reduction in lake water levels could potentially result in a marginal increase in the occurrence of drawdown of warmer surface waters and/or recirculation of CCW thermal discharges into the intake under calm conditions or low current speeds. However, based on the historical studies of recirculation of the DNGS CCW flows into the intake, adverse effects on lake water temperature are not anticipated and, as such, the potential effects resulting from the Project are not considered further. This conclusion will be confirmed as part of OPG's ongoing Lake Ontario Thermal and Current Monitoring Program. Discussion of thermal effects to aquatic habitat/biota can be found in section 6.3.3 of this EA Screening Report.

Mitigation

None.

Residual Effect

No residual adverse effects are expected.

Significance of Effect

Not significant.

6.2.3 Drainage and Water Quality – Lake Water Quality

To consider potential effects on lake water quality resulting from discharges via the CCW discharge diffuser, an analysis of liquid effluents was conducted for chemical parameters regulated through the provincial Municipal/Industrial Strategy for Abatement (MISA) program and the DNGS CofA (see tables F-1, F-2A and F-2B of OPG's Surface Water Environment TSD for regulatory limits and objectives).

An assessment of the historical performance of systems generating regulated liquid effluents was completed by OPG. Based on plant monitoring data and mixing calculations, the performance of these systems (in terms of compliance with the applicable regulatory requirements) during both the Refurbishment and Continued Operation phases was predicted.

For historical context, OPG did conduct effluent monitoring in the 1990s for a comprehensive list of contaminants, the result of which, subsequently informed a subset of contaminants to be regulated under the MISA process. To further address regulatory requirements, DNGS has made a number of changes either to remove source terms and/or treatment system upgrades to improve water quality over the years.

From a CofA perspective, through its operating history, DNGS has applied for and obtained a number of CofAs. In 2006, these CofAs were consolidated into a single comprehensive CofA for Industrial Sewage Works (OMOE 2006) which included cooling water system, water treatment plant, boiler blowdown, condensate and feedwater, active (radioactive) liquid waste, inactive drainage, yard drainage and sewage treatment plant. Effluent monitoring, limits and objectives have been developed in consultation with the OMOE.

Description of Effect

A likely measurable effect is attributed to the shutdown of units to be refurbished or during maintenance outages during the Continued Operations phase since flows from some of the DNGS systems generating liquid effluent streams that discharge to the lake via the CCW discharge diffuser decrease in proportion to the number of units shut down. The refurbishment bounding scenario for EA purposes assumes that a maximum of two reactors at a time will be shut down. At the start of the outage, there may be an increase in some liquid waste effluent streams due to draining of systems; however, once completed, proportional decreases in liquid effluent flow rates are anticipated.

The results of the liquid effluents assessment concluded that an adverse effect on lake water quality during refurbishment was not likely; however, the effect of reduced deflection of alongshore currents has the potential to affect dilution factors (i.e., reductions in concentration) within the RSA. The results of the plume modeling indicate that, during the Refurbishment phase, depending on the modeled scenario, there will be some increases as well as some marginal decreases in the predicted dilution factors at the water supply plant intakes within the RSA and at the locations monitored in 2007-2008 as part of the NND EA baseline characterization. The marginal decreases in dilution factors will not likely result in an adverse effect on WSP water intake quality in terms of conventional parameters during the Refurbishment phase.

It is further noted that the ecological risk assessment to aquatic biota in the NND Project EA showed no adverse effects to Lake Ontario aquatic biota due to the operations of DNGS (OPG 2009).

The liquid effluents assessment showed that the station water systems resulting in liquid effluent discharges to Lake Ontario do not have an adverse effect on lake water quality under baseline conditions (i.e., as DNGS currently operates). Considering potential climate change over the extended life of the Project (i.e., predicted climate changes for the 2050s) and, in particular, potential increases in Lake Ontario water temperatures and decreases in lake water levels, it is acknowledged that mixing and dilution of liquid effluents discharged to Lake Ontario may be altered.

The results of the plume modeling indicate that during the Continued Operation phase, depending on the modeled scenario, there will be increases as well as marginal decreases in the predicted dilution factors at the water supply plant intakes within the RSA and at the locations monitored in 2007-2008 as part of the NND Project EA baseline characterization (under both the climate change and worst-case climate change scenarios assessed). The marginal decreases in dilution factors (e.g., dilution factor of 19 for worst case climate change scenario at the Bowmanville WSP intake vs. a dilution factor of 22 for existing conditions) do not suggest an adverse effect resulting from the Continued Operation phase of DNGS.

Mitigation

In assessing liquid effluent effects, implementation of good industry management practices was considered during both phases of the Project:

- As required, water impacted by radioactive or conventional contaminants, discharged from liquid effluent streams to the environment (via the yard drainage system or directly to Lake Ontario) will be tested and/or treated in conformance with current regulatory requirements including, but not limited to, OMOE CofA and MISA objectives and/or criteria.
- Domestic sewage will be directed to the municipal wastewater treatment plant.
- During refurbishment or maintenance activities, sufficient flow will be maintained through the CCW discharge system to ensure that regulatory requirements are met prior to release to the environment.

Residual Effect

In light of the implementation of good industry management practices, including compliance with current regulatory requirements, no residual adverse effects are expected.

Although no residual adverse effects to water quality are expected as a result of the Project, water quality as a pathway to VECs in other environmental components is considered as it may be relevant to Non-human Biota in section 6.12.

Given that full characterization of liquid effluents last occurred in the 1990s, a follow-up program to confirm that there are no residual adverse effects to water quality from liquid effluents is outlined in section 12 of this EA Screening Report.

Significance of Effect

Not significant.

6.2.4 Drainage and Water Quality – Stormwater Quality

Description of Effect

DNGS currently does, and will continue to, comply with all applicable regulatory requirements associated with stormwater management. Neither the DNGS-specific CofA nor MISA, however, specify an on-going requirement to monitor and report stormwater quality.

A likely measurable change to stormwater quality resulting from the remaining Project works and activities (i.e., Mobilization and Preparatory Works, Construction of Retube Waste Storage and Other Support Buildings, and Workforce, Payroll and Purchasing) are attributed to interactions with storm runoff and stormwater discharges to Lake Ontario from the DN site. However, considering the in-design mitigation measures (i.e., good industry management practices during all phases of the Project with respect to stormwater management), no adverse effects are predicted on stormwater quality resulting from these Project works and activities.

With respect to the Continued Operations phase, while some parameters were measured in stormwater runoff from the DN site at concentrations greater than the typical urban runoff water quality values and/or the guideline criteria against which the stormwater quality data were compared, there is minimal risk to aquatic biota for the following reasons:

- Storm water drains typically discharge water for brief periods of time during storm events, resulting in only periodic and short-term discharges.
- Recent stormwater sampling undertaken as part this EA Screening Report showed that the effluent satisfied the acute lethality toxicity test requirements.
- Stormwater discharges are integrated into Lake Ontario and are captured in the measured data used for the ecological risk assessment to aquatic biota in the NND EA, which showed no adverse effects to Lake Ontario aquatic biota due to the operations of DNGS (OPG 2009a).

From a radiological perspective, tritium levels in stormwater are elevated (up to 5,430 Bq/L in some subcatchments) compared to background levels of tritium in surface water (5 to 26.2 Bq/L) in the LSA or precipitation (23 to 61 Bq/L in the SSA). OPG (2012) has attributed these elevated levels to washout during periods of precipitation since the locations in question are in closest proximity to the powerhouse and roof top stacks. Given the REMP program's main objective to ensure that the significant human exposure pathways and radionuclides for the most affected receptors are routinely monitored and that the estimated doses to members of the public in the vicinity of DNGS are in the range of 0.001 mSv/year which is well below the annual radiation dose limit of 1 mSv, no health concerns are predicted related to the measured tritium concentration in stormwater.

Mitigation

In assessing effects to stormwater, implementation of good industry management practices was considered during both phases of the Project:

- Sediment control practices, dewatering water treatment, if necessary, stormwater conveyance systems and conventional stormwater treatment methods such as stormwater management ponds and oil-grit separators.
- All water impacted by radioactive or conventional contaminants, will be tested and/or treated in conformance with current regulatory requirements including, but not limited to, OMOE CofA and MISA requirements.
- Dust and sediment control measures will be implemented to minimize suspended sediment concentrations in surface water.
- Storage tanks (e.g., for fuel oil) will have secondary containment of storage tanks to contain any releases from spillage or tank rupture.

Residual Effect

Stormwater quality meets current regulatory requirements and satisfied acute lethality toxicity test requirements. There is minimal risk to aquatic biota and human health from the surface water pathway. Implementation of good industry management practices during all phases of the Project will further reduce any adverse effects. As such, no residual adverse effects are predicted.

A follow-up program to confirm that there are no residual adverse effects to stormwater quality is outlined in section 12 of this EA Screening Report.

Significance of Effect

Not significant.

6.2.5 Shoreline Processes

Description of Effect

The existing presence of rock armour along the DNGS frontage, operation of the diffuser manifold and the offshore deflective processes of St. Marys Cement wharf have altered sediment supply and transport mechanics in the immediate vicinity of the DN site since commissioning in 1993 and are not considered to have resulted in any adverse environmental effects on shoreline processes, such as sediment transport.

A likely measurable effect to sediment transport is attributed to the shutdown of units to be refurbished or during maintenance outages during the Continued Operations phase due to reduced discharges (to half of existing conditions flows for refurbishment), and the concomitant reduction in penetrating current velocities. However, given the limited sediment supply in the SSA, the offshore deflective processes of St. Marys Cement wharf and the high energy nearshore environment, no adverse environmental effects are predicted (e.g., alteration of sediment-dependant features, such as fillet beaches).

Considering potential climate change over the extended life of the Project and, in particular, decreased Lake Ontario water levels (estimated to be 0.5 m), the bounding scenario for assessing effects on lake circulation resulting from the Project is four units in operation under predicted climate change conditions for the 2050s. Although this water level decrease may lead to a slightly increased turbulent mixing zone associated with the diffuser discharge, it is considered unlikely that there will be any resultant measurable changes to sediment transport, and therefore, no adverse effects. Climate change may also alter existing wave run-up characteristics along the adjacent shorelines and the rate of existing bluff erosion contributing to local material supply; however, this potential change is considered to be independent of the presence and operation of the DNGS facility and as such does not constitute a project-environment interaction.

Mitigation

None.

Residual Effect

No residual adverse effects are expected.

Significance of Effect

Not significant.

6.3 Aquatic Biota

6.3.1 Impingement and Entrainment

Description of Effect

Fish impingement (when an adult or juvenile fish in the cooling water intake flow is too large to pass through the debris screen and is deposited in the screenhouse trash bin) and entrainment (when an egg or larval in the cooling water intake flow is small enough to pass through the debris screen is transported through the whole cooling system and returned to the lake in the thermal diffuser) is an ongoing effect of operations at the DNGS. During the refurbishment phase, fish impingement and entrainment would still occur but it would not result in increased fish losses over existing levels.

DNGS is an operating station and current patterns of impingement and entrainment described below are considered likely changes and effects associated with the Project. Impingement and entrainment effects will continue to occur during the refurbishment and continued operation of the station.

Fish loss associated with impingement and entrainment is typically estimated using either of two extrapolation models: i) age-1 equivalence; and, ii) production foregone. The age-1 equivalence model expresses losses in terms of fish that would have survived to some future age and adjusts for losses to account for natural mortality that would have occurred between the age of entrainment for example, and the age of equivalence. Production foregone expresses losses in terms of reduction in prey biomass such as alewife available to predators. It is a measure of future biomass production that would occur in the absence of entrainment and impingement.

<u>Impingement</u>

Impingement studies were conducted over the 1993-1996 period, 2006-2007 and more recently in 2010-2011.

In the 2006-2007 impingement study only 8 species were impinged of which Alewife and Round Goby represented 85.9% and 8.5% of the total (i.e., 94% together), respectively. From a production foregone perspective, it was estimated to be 229 kg (range from 229 to 422 kg if all reactor units impinge as much as Unit 4).

An estimated annual total of 274,931 fish consisting of 13 species were impinged in 2010/2011. Approximately 55% of the fish were the invasive Round Goby. Alewife comprised 42% of the fish impinged. All other fish species comprised the remaining 3%. One American Eel, a species of conservation concern, was impinged. From these estimated annual impingement totals, extrapolated losses were calculated and are provided in table 6.3-1.

Table 6.3-1 Estimates of Annual Equivalent Loss from Impingement at the Darlington Nuclear Generating Station, May 2010 – April 2011

Taxa	Number of Equivalent Age 1+	Total Annual Impingement Weight (kg)	Total Future Production Foregone (kg)	Total Biomass Lost (kg)	Lost Fishery Yield (kg)
Alewife	56,515	994.14	576.65	1,570.79	N/A
Brown Bullhead	7	0.01	0.60	0.61	0.21
Emerald Shiner	1,006	0.32	0.09	0.41	N/A
Pumpkinseed	132	0.49	2.59	3.09	0.75
Rainbow Smelt	20,114	33.42	111.93	145.35	87.30
Round Goby	3,860,403	1,307.85	207.27	1,515.12	N/A
Slimy Sculpin	264,535	14.1	2.53	16.63	N/A
Smallmouth Bass	0	0.08	0.04	0.12	0.01
Threespine Stickleback	20	0.01	0.00	0.01	N/A
Unid Sculpin	39,281	1.75	0.13	1.88	N/A
Unid Sunfish	8	0.04	0.14	0.18	0.04
White Sucker	21	2.35	2.57	4.92	0.56
Yellow Perch	10	0.18	0.93	1.11	0.35
Total	4,242,050	2,354.75	905.47	3,260.22	89.22

Unid = unidentified
N/A = not applicable
Unid sculpin – likely slimy sculpin

As seen in table 6.3-1, round goby dominated the age-1 equivalence losses (91%); whereas from a production foregone perspective, Alewife formed the largest component (64%) of the estimated 905 kg lost.

In comparing 2010/2011 impingement fish losses relative to biological and economic metrics (Senes 2011), the following is noted:

- Lost fishery yield was relatively small (89 kg) and consisted almost exclusively of Rainbow Smelt (almost 98%).
- The production foregone of Alewife and Rainbow smelt are negligible when considering the biomass of each species available in Lake Ontario.
- Losses in terms of economic value were considered negligible when considering recent commercial harvest estimates (suckers, Brown Bullhead, Yellow Perch, sunfish).

Entrainment

Entrainment data from 2004 estimated that 15,631,833 eggs and 1,201,943 larvae were entrained annually. These entrained organisms represented 1,318 age-1 equivalent Rainbow Smelt and Alewife. In 2006, it was estimated that 605,059 eggs and 6,996,246 larvae were entrained. These entrained organisms represented 11,548 age-1 equivalent Alewife, Common Carp and Freshwater

Drum (Common Carp represented over 90% of age-1 fish). Overall, results indicated that entrainment numbers were relatively low compared to lake-wide populations of smelt, Alewife and carp.

For aquatic invertebrates, a total of 263,163 invertebrates were collected over the duration of the 2006 entrainment study. The most abundant invertebrate taxa collected were copepods/cladocerans (83.5%), spiny water fleas (8.1%), rotifers (6.3%), amphipods (1.6%) and Mysids (<1%). Most of these taxa are plankton (copepods/cladocerans, spiny water fleas, rotifers). Plankton are drifting organisms - plant (phytoplankton), animal (zooplankton) - which inhabit the open water column (pelagic zone) and are usually microscopic in size. Because of their small size they are subject to movement by currents, storms and upwelling events. Power plant studies conducted elsewhere have shown high entrainment survival rates for aquatic invertebrates and plankton.

<u>Overall</u>

It is anticipated that relatively small numbers of fish and aquatic invertebrates will comprise intake losses associated with impingement and entrainment during continued operation due to the effectiveness of the intake design and placement. These losses are not expected to result in measurable changes to population size, production or status of the VEC indicator species. It is recognized, however, that this assessment is based upon information representative of present conditions. Lake Ontario is an ecosystem that can rapidly change (e.g., the presence of invasive Round Goby in the last decade).

Although the aquatic biota losses to impingement and entrainment have historically been, and are expected to remain small relative to populations and other biological and economic metrics, this is considered an adverse effect of the Project and is further considered in terms of mitigation measures and residual effects.

Mitigation

To date, the operation of the DNGS CCW has resulted in relatively low estimated losses of fish (predominantly prey species) from impingement and entrainment. As an interim measure, and considering the DNGS will be subjected to operational changes during refurbishment, OPG will mitigate the current impingement and entrainment losses by means of offsetting (i.e., habitat compensation).

However, given the dynamic nature of the Lake Ontario ecosystem, it is recognized that in the future, the aquatic species assemblage could change. As such, as part of an EA follow-up program, an adaptive management program to address this matter is outlined in section 12.2 of this EA Screening Report. In order to mitigate/reduce future losses, and to comply with the requirements of a section 32 authorization under the *Fisheries Act* for the continued operation of the DNGS, OPG shall research and incorporate additional mitigation measures to an extent that is reasonably and economically feasible. If required, OPG shall implement offsetting measures to address any potential loss to the fisheries.

Compensatory measures to address any potential loss to the fisheries (either current losses or potential future losses) are prioritized as follows on 1) habitat restoration, 2) creation, and 3) enhancements. The identified habitat compensation projects would be evaluated and selected over time, in consultation with DFO, with advice from the CNSC, OMNR and Conservation Authorities, in support of native species conservation on the north shore of Lake Ontario.

Residual Effect

The residual effect consists of:

- impingement and entrainment losses of aquatic biota (fish and invertebrates) at comparable levels to the existing operations
- continuously occurring over the life of the refurbishment and operation phases of the Project while the CCW system is operating
- losses are small relative to species with lake-wide populations (e.g., Rainbow Smelt, Alewife) with little commercial value of the species being affected which are predominantly prey fish
- losses of Slimy Sculpin are relatively small; however, it is a species of provincial fisheries management interest that is in decline

Significance

Using the two-step process and the criteria outlined in section 5.5 of this EA Screening Report, the significance of the residual effect of impingement and entrainment is as follows:

- Magnitude: Low – Losses are low relative to lake-wide populations, species at risk and/or other metrics (e.g., abundance estimates, commercial catches)
- Spatial extent: Low – Limited to the SSA
- Duration/timing: Medium – Will occur during the refurbishment phase (at lower losses due to unit outages) and over the 30 years of continued operations
- Frequency: High – Continuous with operational and seasonal fluctuations
- Reversibility: High – Affected aquatic biota are permanently lost

Given that at least one criterion was rated low, advancement to the second step of significance determination was not warranted; however for information purposes, the remaining Step 2 criteria are as follows:

- Effect on Physical Human Health: Low – No effect
- Effect on Psycho-social Human Health: Low – No effect
- Ecological Importance (of VEC): Low – The affected VECs are common and abundant within the LSA

- Societal Value (of VEC): Low – Plays a limited and indirect role in maintaining the economic base, social structure, community stability and the character of local communities
- Sustainability: Low – The effect does not affect the VECs or its continued use and affected species will persist in abundance despite the losses

Therefore, the conclusion is that the residual adverse environmental effect is minor in nature and not significant. Details of the EA follow-up program to verify this prediction are provided in section 12 in this EA Screening Report.

6.3.2 Physical Effects from the Diffuser

Description of Effect

The operation of the diffuser does create localized scouring. Based on the assessment in OPG's Surface Water TSD, the limited influence of the localized diffuser scouring (i.e., affects sand deposition within an 8 m radius around each of the 90 DNGS diffuser ports) is anticipated to remain unchanged during the continued operations for the DNGS as OPG has no plans to modify the CCW system at this time. It has been concluded that there would be no measurable change to available benthic invertebrate habitat as a result of the continued operation of the DNGS.

The actions of the CCW diffuser jets (see section 4.3.1 of this EA Screening Report for a description) has the potential to affect larvae of certain fish species (e.g., passively drifting larvae of whitefish, herring, Emerald Shiner) by physically displacing them offshore into less hospitable environments.

A number of factors contribute to the nature of this potential effect:

- Naturally-occurring offshore currents do occur in the SSA from time to time.
- In spring 2011, larval abundance in the vicinity of the diffuser was low; however, the affected area is quite large and some fish species' larvae passively drift alongshore.
- There is low relative abundance of fish species offshore of the diffuser and no evidence of predation on larvae; however, the 2011 spring gillnetting study was not designed to specifically address the larval displacement matter or extent of loss to predators.

Mitigation

Given the above, it is concluded that there is currently limited potential for a likely measurable interaction and no anticipated effects that would result in measurable change in species populations are predicted. As such, no mitigation measures have been identified.

Residual Effect

No residual effects are expected.

Significance

Not significant.

6.3.3 Thermal Effects from the Diffuser

Description of Effect

Round Whitefish presence is expected during late fall when adults move inshore to spawn. Spawning generally occurs at depths of 3 to 13 m. Eggs are deposited on rocky substrates in late fall/early winter (late November to December). These eggs develop over winter and hatch in early spring (late March to early April). The larvae stay on the bottom for the first 3 weeks then rise off the bottom to move inshore to feed. During the summer, young fish feed at mid-depths in the nearshore areas and start moving offshore to deeper waters in the fall.

Given its thermal sensitivity and management/conservation interest by DFO and the OMNR, the Round Whitefish is used as the fish VEC in assessing thermal effects. Although, the exact location(s) of Round Whitefish spawning habitat is unknown in the vicinity of the DN site, Round Whitefish larvae have been recently captured in the general vicinity of the diffuser. For this reason, a conservative approach to assessing effects on Round Whitefish was used, whereby it was assumed that this species could be spawning within the vicinity of the diffuser thermal plume.

The Griffiths (1980) study is the key study that has provided the following information for the assessment of thermal effects on Round Whitefish in this EA:

- The most sensitive time period is during the development of the embryos which, for assessment purposes, spans from December 1st to April 17th.
- The aforementioned embryo development period is broken down into 3 blocks (1 to 3) with Blocks 1 and 3 showing greater sensitivity to temperature changes than Block 2.
- A short term/acute (i.e., short term exposure to temperatures that over a longer period of exposure could be lethal) temperature criterion of 5 ºC was adopted based on Griffiths (1980) noting adequate protection for embryo survival (>75%) would occur if periodic increases (i.e., 6 hrs/day) were less than 5°C (absolute temperature value).

- A long term/chronic (i.e., long term continuous exposure to a sub-lethal level) temperature criterion of 3.5 ºC was adopted based on Griffiths (1980) noting adequate protection for embryo survival (>75%) would occur if continuous temperature increases (i.e., over the length of the embryonic development period) were less than 3.5°C (absolute temperature value).

Similarly, the assessment of thermal effects for the Pickering Nuclear Generating Station (PNGS) (PNGS 2010) derived temperature criteria based on Griffiths (1980) study; however it used slightly different acute (hourly and 24 hour criteria) and chronic temperature criteria (Maximum Weekly Average Temperature or MWAT). Additional work on thermal-related matters is being undertaken by the CANDU Owners Group, and as part of the EA follow-up program, temperature criteria and other assessment metrics based on Griffiths (1980) will be compared with the results of this study.

Temperature criteria for other life stages (larvae and juveniles) were based on Wismer and Christie (1987).

It is anticipated that climate change as well as the DNGS thermal diffuser will contribute to elevated water temperatures in the SSA during the Project. For example, Lehman (2002) projected an increase in the temperature of Lake Ontario's surface mixed layers of +4-7 ºC by the end of the century. The warm winter of 2011/2012 described in this section provides a snapshot of potentially warmer winters in the future. In order to address climate change, as part of adaptive management under EA follow-up, should future monitoring identify thermal effects of concern, OPG shall undertake a review of available thermal discharge mitigation techniques to determine if additional technically and economically feasible opportunities are available to further reduce the potential for effects during the Continued Operations phase. This is detailed further in section 12.2 of this EA Screening Report.

<u>Winter 2011 (January onwards)</u>

Temperatures did exceed 3.5 ºC periodically for one bottom monitoring station in the Mixing Zone, with the duration ranging from 35 to 40 hours.

The same bottom monitoring station in the Mixing Zone noted above recorded 8 short-term exceedances of the 5°C criterion between the end of January and beginning of March before the monitoring station was lost due to inclement weather. These exceedances were each less than 6 hours in duration. A maximum temperature of 6.47 ºC was recorded on one occasion and the remaining exceedances were between 5 and 6 ºC.

In addition, in the first half of April, as the lake began to warm up, exceedances of the 5°C criterion at all monitoring stations were noted as follows:

- Temperatures at the reference locations not influenced by DNGS increased to 5°C by April 8, 2011 with the shallower locations warming up faster than the deeper locations and ranged between 5°C and 6°C.

- Offshore locations within the Mixing Zone show a similar increase, though there is a slight lag in time, with temperatures reaching 5°C by April 12, 2011, and were on average between 5°C and 5.5°C from April 12 through to April 22, 2011.
- Temperature in the nearshore locations within the Mixing Zone reached 5°C by April 11, 2011, when some locations consistently ranged between 5°C and 6°C with occasional spikes above 6°C.

The temperature increases occur consistently across all depths and indicate a general warming trend in the lake and there is no indication of unusual warming occurring within the Mixing Zone. Based on typical embryo development times, and actual observations in the field, larvae would begin to hatch at this time (mid-April). As a result, the higher temperatures around mid-April at all monitoring sites are considered normal, and are not expected to have adverse effects on the hatching larvae when comparing the difference between reference sites and the Mixing Zone.

It should be noted that the monitoring period was limited to the latter half of the embryonic development period (i.e., Blocks 2 and 3) and that between March 15, 2011 and May 19, 2011, only 3 units were in operation. As well, the lake temperatures were generally colder than average, which is a contributing factor to the lack of effects predicted.

No adverse effects to Round Whitefish eggs are predicted because:

- no consistent exceedance of the chronic 3.5°C criterion over the embryonic development period
- one monitoring station out of 20 (within or near the mixing zone) showed exceedances of the acute 5°C criterion
- the frequency (8 short-term exceedances of the 5°C criterion) and duration (< 6 hours) is much less when compared to the frequency and duration for which Griffiths (1980) reported effects (i.e., <75% embryo survival when eggs were submitted daily to a 6 hour temperature pulse greater than 5°C)
- the lake warming observed in the first half of April was consistent across all monitoring stations (i.e., reference vs. Mixing Zone locations)

Temperatures remained within the optimal range from April to May for larval development and as such, no adverse biological effects are anticipated due to thermal discharges during the spring when larvae would be present in the inshore areas.

<u>Winter 2011/2012 (December to March)</u>

In order to document a warm winter scenario within the draft EA Screening Report, OPG analysed the results from the monitoring stations from the beginning of December 2011 to mid March 2012 (Golder 2012c). As such, the results presented reflect preliminary conclusions that will be updated with the additional

Block 3 temperature data and other technical considerations. The conclusions on significance are not anticipated to change.

No exceedance of the chronic 3.5 ºC criterion was noted for any of the bottom monitoring stations for the entire length of the monitored embryonic development period. However, with the exception of a two to three week period in the latter half of January, temperatures (from a 7-day rolling average temperature perspective) were generally at or above 3.5 ºC for some Mixing Zone stations (1 of 3 locations in the nearshore; all locations in the offshore) and 3 of 4 offshore stations located outside the Mixing Zone.

The data show that temperatures exceeded the 5°C criterion on one or more occasions during the period of January to March 2012, depending on the specific monitoring location at stations in the Mixing Zone (both nearshore and offshore), offshore outside of the Mixing Zone, and one of the reference locations. Offshore monitoring stations in and outside of the Mixing Zone had the greatest frequency of exceedances of the 5°C criterion.

In order to assess effects, it was estimated that Block 1 started on December 15, 2011 (i.e., embryos present) based on optimum spawning temperatures. In addition, two reference locations were used to compare to monitoring stations in and around the Mixing Zone in order to predict changes (i.e., reductions in embryo survival) attributed to the diffuser across Block 1 and Block 2 embryo development phases. Since temperature ranges were reported by Griffiths (1980), the mid point was used for comparison purposes. Finally, only full data sets were used; however, there are no indications that the locations for which full data were not available would be any different from those locations for which full data were available.

Temperature effects during the period December 2011 to March 2012 were assessed with respect to the 3.5°C benchmark for the 7-day rolling average temperatures and the following is preliminarily noted:

- Relative to reference conditions, temperatures decreased more slowly in some locations in December such that Block 1 embryos could have experienced warmer temperatures than normal.
- Four stations located in the offshore part of the Mixing Zone, 1 station in the nearshore part of the Mixing Zone and 4 stations in the offshore outside of the Mixing Zone showed a predicted 2% decrease in survival to 87% under the 7-day rolling average temperatures compared to the predicted 89% survival at reference locations.
- No decreases in embryo survival were predicted during Block 2 when comparing stations influenced by the diffuser to reference locations.
- Predicted survival remained above the 75% benchmark below which effects on local populations may occur.

Temperature effects during the period December 2011 to March 2012 were also assessed against the 5°C benchmark for the hourly average temperatures.

For offshore locations within the Mixing Zone, predicted Block 1 embryo survival ranged from 89.7% to 85.5% (i.e., up to a 4.8% change from the baseline). Predicted Block 2 embryo survival showed no change from baseline except for a 0.15% change at one monitoring location located at the end of the diffuser (TD35-12).

For offshore locations outside of the Mixing Zone, predicted Block 1 survival ranged from 89.8% to 88.2% (i.e., up to a 2.1% change from the baseline) and no changes were predicted for Block 2 embryo survival.

For nearshore locations within the Mixing Zone, predicted Block 1 embryo survival was estimated at 85.8% (i.e., a 4.7% change from the baseline) and no changes were predicted for Block 2 embryo survival.

Predicted survival remained above the 75% benchmark below which effects on local populations may occur.

Overall

During a colder than average winter (2010/2011), no adverse effects to Round Whitefish eggs are predicted because of the infrequent exceedances of the 3.5 °C chronic criterion and the 5°C acute criterion.

During one of the warmer winters on record (2011/2012), the survival rate of Block 1 embryos at the affected locations within the Mixing Zone and outside of the Mixing Zone was preliminarily estimated at >85%. The predicted negligible effects of temperature increases on Block 2 embryo survival did not decrease the survival rate at any of the locations.

The initial analysis has predicted relatively low reductions in embryo survival due to temperature effects during a warm winter. However, the temperature data for the entire Block 3 period was not available at the time of the writing of this draft EA Screening Report. In addition, the predicted embryo survival reductions are preliminary in nature, subject to further refinements, and are derived from a single report (Griffiths 1980). Therefore, in order to be conservative given those constraints, this is considered an adverse effect of the Project and is further considered in terms of mitigation measures and residual effects.

The revised EA Screening Report, to be submitted to the Commission in September 2012 for consideration during a public hearing in November 2012, will include this updated information and analysis.

A follow-up program to verify thermal effect predictions to Round Whitefish is outlined in section 12 of this EA Screening Report.

Mitigation

Given the predicted minor decreases in embryo survival relative to levels below which effects on local populations may occur, no mitigation measures are identified at this time; pending the additional Block 3 analysis and other refinements.

As part of adaptive management under EA follow-up, should future monitoring identify thermal effects of concern, OPG shall undertake a review of available thermal discharge mitigation techniques to determine if additional technically and economically feasible opportunities are available to further reduce the potential for effects during the Continued Operations phase. If required, OPG shall implement offsetting measures to address any potential loss to the fisheries.

Offsetting measures to address any potential loss to the fisheries are prioritized as follows on 1) habitat restoration, 2) creation, and 3) enhancements. The identified habitat compensation projects would be evaluated and selected over time, in consultation with DFO, with advice from the CNSC, OMNR and Conservation Authorities, in support of native species conservation on the north shore of Lake Ontario. This is detailed further in section 12.2 of this EA Screening Report.

Residual Effect

Residual effects are most likely during a warm winter scenario as is evident from the winter of 2011/2012. During a warm winter, the residual effect is predicted to consist of reductions in embryo survival. Spatially, this is predominantly in offshore areas in and around the Mixing Zone (i.e., deeper than 10 m) and to a lesser degree, nearshore areas (i.e., less than 10 m in depth) within the Mixing Zone. Temporally, it was noted that offshore locations generally had more frequent exceedances of the 3.5°C and 5°C temperature criteria than nearshore locations during a warm winter period. The magnitude of the effect (i.e., reductions in embryo survival) is also generally greatest in the offshore areas compared to the nearshore areas. Though Round Whitefish can spawn at bottom depths of up to 13 m, nearshore areas represent more optimal spawning depths than offshore areas. Therefore, the part of the SSA that may not be at the optimal spawning depth for Round Whitefish is predicted to be subjected to the greatest thermal effects from a spatial and temporal perspective.

Significance

Using the two-step process and the criteria outlined in section 5.5 of this EA Screening Report, the significance of the residual effect from thermal discharges is as follows:

- Magnitude: Low – Predicted reductions in embryo survival are likely low relative to the Round Whitefish populations that exist on the north shore of Lake Ontario; however, this is constrained by the lack of knowledge of the exact spawning locations for Round Whitefish (intended to be addressed in the future by the RWAP)
- Spatial extent: Low – In a warm winter, largely limited to offshore locations within and outside of the Mixing Zone in the SSA, and to a lesser degree, nearshore locations within the Mixing Zone; in a colder winter, limited to an offshore location in the Mixing Zone
- Duration/timing: Medium – Will occur during the refurbishment phase (likely at lower magnitudes due to unit outages) and over the 30 years of continued operations

- Frequency: Medium – Will depend on how warm the bottom temperatures are during a given winter; however, will likely occur to varying degrees each winter during the Refurbishment and Continued Operations phases with operational fluctuations, given the colder than average and warmer than average winters examined to date
- Reversibility: Medium – Affected Round Whitefish may be acutely and/or chronically affected (i.e., mortality and/or non-lethal effects); however, the reversibility of the effect to the population will be, in part, dependant on the inter-annual variability of the bottom temperatures

Given that at least one criterion was rated low, advancement to the second step of significance determination was not warranted; however for information purposes, the remaining Step 2 criteria are as follows:

- Effect on Physical Human Health: Low – No effect
- Effect on Psycho-social Human Health: Low – No effect
- Ecological Importance (of VEC): Medium – Round Whitefish is less common and of limited abundance within the Regional Study Area
- Societal Value (of VEC): Low – Plays a limited and indirect role in maintaining the economic base, social structure, community stability and the character of local communities
- Sustainability: Low – In the absence of use of the Round Whitefish VEC as a resource (e.g., commercial or traditional fishery) the effect does not affect the existence of the VEC or its continued use

Therefore, the conclusion is that the residual adverse environmental effect is minor in nature and not significant. Details of the EA follow-up program to verify this prediction are provided in section 12 in this EA Screening Report

6.4 Terrestrial Environment

Description of Effect

Vegetation

The construction of new buildings during both the Refurbishment phase and the Continued Operation phase may result in the loss of turf area and/or small areas of associated cultural meadow that are located throughout the station area. Any such loss will not result in a measurable change in function since the amount of habitat to be removed is small relative to the amount of cultural meadow habitat available for wildlife use both within the SSA and throughout the remainder of the DN Site. From a groundwater perspective, no effects to the Shrub Bluff communities VEC are anticipated as modeling indicates that the Project will not substantially alter groundwater conditions.

Activities associated with the Refurbishment and Continued Operation phases are expected to result in increased dust (i.e., suspended particulate matter or SPM) generation, which, in sufficient quantity can lead to effects on vegetation communities and species. Currently, an accepted quantitative threshold for effects of SPM on vegetation does not exist due to insufficient data. Therefore estimated concentrations were compared to OMOE and federal air quality objectives which are intended to be protective of human health and the environment. Modeling of atmospheric concentrations of SPM for maximum emissions estimated a total 24 hour concentration between 70.8 $\mu g/m^3$ to 73.1 $\mu g/m^3$, which is well below the MOE 24 hour threshold of 120 $\mu g/m^3$. The predicted total annual SPM concentrations ranged between 16.9 $\mu g/m^3$ to 17.0 $\mu g/m^3$, which is also below the Federal-Provincial Committee on Air Pollution's National Air Quality Objectives annual threshold of 60 $\mu g/m^3$. Similarly, predicted maximum concentrations of combustion gases (NO_x and SO_x) were well below federal benchmark levels that are considered protective of terrestrial vegetation.

The Shrub Bluff communities in the SSA (VEC for this environmental component) are located in the southwest corner of the DN site and generally well-removed from construction activities. It is not expected that there will be a measurable response to Project-generated dust in these vegetation communities (or the associated wildlife).

Any short term effects to vegetation located closer to sources will be limited to the immediate roadside areas and cultural communities located in near proximity to the construction of new buildings at the existing DWMF. These will be buffered by the relatively robust and/or previously disturbed roadside and cultural communities, dominated by non-native species that do not provide high functioning wildlife habitat attributes. Therefore, no adverse effects are anticipated.

Bird Communities and Species

An increase to noise levels associated with project activities was identified as having the potential to affect bird communities and species. Several anthropogenic sources currently influence noise at site, including the DNGS, CN railway and St Marys Cement. Maximum noise levels modeled for the site indicated only negligible, potentially non-measurable, increases to noise levels at the waterfront, and therefore no measurable effects are expected to waterfowl (the VEC for this environmental component).

Landscape Connectivity

Increased traffic on-site may result in increased wildlife mortality due to collisions with vehicles for those species whose movement pathways intersect with access roads. However, measurable changes to wildlife populations are not expected since wildlife inhabiting the DN site are generally common species.

Landscape connectivity via the East-West corridor is expected to experience greater disturbance during the Refurbishment phase and a similar level of disturbance as existing conditions during the Continued Operations phase as the main access road for the workforce (Park Road) crosses this corridor. However connectivity beneath the road associated with the CN right-of-way will remain.

Mitigation

In assessing terrestrial effects, in design mitigation measures (i.e., implementation of good industry management practices) were considered during both phases of the Project. Examples of good industry management practices of relevance to dust control include:

- watering (or application of other dust suppressant) of exposed soil surfaces
- maintaining roads clear of soil carryout
- ensuring vehicles and other combustion equipment is properly maintained

To address potential effects on landscape connectivity, OPG will:

- enhance wildlife crossings where feasible and to the extent practicable, consisting of the installation of funnel fencing directing wildlife to an area beneath the roadway (e.g., Park Road, Holt Road) and adjacent to the CN railway

Residual Effect

There will be a small loss of common vegetation whose function will not change. Dust generation will be mitigated by good industry management practices; will be at levels below air quality objectives; and will not interact with sensitive vegetation communities in the SSA.

Increased noise levels from the Project will be negligible.

Increased wildlife mortality may result of common species at levels that are not expected to be measurable at the population level.

Landscape connectivity will experience some disturbance due to increased traffic above baseline during the Refurbishment phase, however, connectivity will be maintained and opportunities for wildlife crossing enhancements if feasible and practicable will further mitigate the disturbance.

As such, no residual adverse effects to the terrestrial environment are expected.

Significance

Not significant.

6.5 Geological / Hydrogeological Environment

6.5.1 Soil Quality

Description of Effect

Potential effects on soil quality will largely be as a result of changes to it associated with excavation and grading for new buildings and the operation of the stormwater management systems.

Excavation and movement of soil for the construction of new buildings have the potential to affect soil quality through the distribution of in situ contamination within the soils. Most notably, the soil in some sections of the Protected Area may contain tritium in the soil moisture. If the tritium is from atmospheric deposition, it is expected the concentrations in the soil will be relatively low and less than the Ontario Drinking Water Quality Standard. If the tritium from the IWST spill (see section 4.5.3 in this EA Screening Report) remains in the area the concentrations may be higher, however, based on the results of the groundwater flow modeling and observations in down-gradient monitoring wells, it is expected that the tritium associated with this spill will have migrated and dispersed in the groundwater system by the time the Project proceeds resulting in low residual concentrations. In addition, bedrock in this area is known to be petroliferous and contains low levels of various petroleum-related compounds. OPG has detailed how it will manage potentially contaminated soil in its dispositions to technical review comments on the EIS (Comment #3 in OPG 2012).

Stormwater management facilities will collect stormwater from parking lots area and new building facilities which, if infiltrated to the subsurface, has the potential to impact soil quality. As well, because new construction (and associated excavation) will take place within the Protected Area, the possibility for distribution of contaminated soil is acknowledged (as described above). However, industry standard practices are effective in addressing these potential effects (see mitigation measures described below). Changes in soil quality as a result of the Project are not predicted to cause adverse effects in the geological and hydrogeological environment.

Although no measurable changes in soil quality are likely as a result of the Project, soil quality as a pathway to VECs in other environmental components is considered as it may be relevant to Non-human Biota in section 6.12 of this EA Screening Report.

Mitigation

In assessing soil quality effects, implementation of good industry management practices was considered during both phases of the Project. Examples of good industry management practices as they relate to waste (e.g., contaminated soil) management and stormwater management include:

- soil excavated or handled during the Project be characterized following which it be handled, managed and disposed of appropriately based on its environmental properties and regulatory requirements
- good practice as it relates to stormwater management typically includes, among other actions, sediment control practices, stormwater conveyance systems and conventional stormwater treatment methods such as stormwater management ponds and oil-grit separators

Residual Effect

Given the implementation of good industry management practices in dealing with soil and stormwater, no residual adverse effects are expected.

Significance

Not significant.

6.5.2 Groundwater Quality

Description of Effect

In general, baseline groundwater in the SSA, including the Protected Area is of good quality. With a few exceptions, no contaminants were found to exceed the applicable (non-potable) quality criteria. For those exceptions, many of the exceedances can be attributed to naturally-occurring bedrock conditions (e.g., benzene and petroleum hydrocarbons were detected above their respective criteria but this is likely due to the presence of petroleum-related compounds in the bedrock).

Emissions of tritium from the operation of DNGS have resulted in elevated tritium concentrations in groundwater in the Protected Area and surrounding area, with concentrations decreasing with increased distances from DNGS. The elevated tritium concentrations in groundwater are attributed to atmospheric washout or wet deposition of emissions from vents and stacks and subsequent infiltration into the groundwater system. This condition is likely to continue during the Refurbishment and Continued Operations phases of the Project. Tritium concentrations in precipitation were found at a maximum concentration of about 2,000 Bq/L inside the Protected Area. Groundwater concentrations attributable to the infiltration of precipitation are of the same magnitude (i.e., 1,340 Bq/L) and remain well below the Ontario Drinking Water Standard of 7,000 Bq/L. As such, this is not considered to represent an adverse effect in the geological and hydrogeological environment. It should be noted that elevated tritium levels were identified in a box drain sump in the Protected Area above historical precipitation values. OPG has attributed this to the proximity of the sump to vents and stacks, groundwater connectivity as well as the hydraulic characteristics of the sump. OPG has indicated that the buildings are not considered to be sources of tritium in the box drains.

With respect to the IWST spill, the actual measured travel times and the groundwater flow model travel times provide a reasonable time estimate range (i.e. 2 to 8 years from December 2009) for the tritium plume to migrate to the forebay. The range of concentrations (i.e. 20,000 to 88,000 Bq/L) is likely to be representative of typical concentrations, although peak concentrations may be higher and are greater the Ontario Drinking Water Standard of 7,000 Bq/L. An environmental site assessment is underway to further define the distribution and extent of the contamination of the IWST spill in groundwater, including peak concentrations, and will serve as a basis to determine appropriate mitigating actions. Future actions pertaining to this spill are outside of the scope of this EA Screening Report, as it deals with an existing matter, and not an effect caused by the Project being assessed.

Because new construction (and associated excavation) will take place within the Protected Area, the possibility for contact with impacted groundwater is acknowledged, and OPG has detailed how it will manage potentially contaminated groundwater from conventional and radiological contaminant perspectives (see OPG's dispositions of technical review comments on the EIS:

Comment #3 in OPG 2012) . Changes in groundwater quality as a result of new building construction are not considered to represent an adverse effect in the geological and hydrogeological environment.

Stormwater management facilities have the potential to add contaminants to the groundwater system. Shallow groundwater in the developed areas of the site generally does not contain these contaminants based on sampling in the SSA, indicating that current stormwater management practices do not contribute to the degradation of the shallow groundwater quality (i.e., industry standard practices are effective in addressing this potential effect). Changes in groundwater quality as a result of stormwater management are not considered to represent an adverse effect in the geological and hydrogeological environment.

It is anticipated that climate change will result in a lowering of the water level in Lake Ontario and a likely equal (or proportional) lowering of the water table along with higher average precipitation. While climate change may have an effect during the Continued Operations phase of the Project, these effects are expected to be minor and similar to the normal conditions given that the groundwater flow directions and discharge to Lake Ontario will remain the same.

Although no measurable changes in groundwater quality are likely as a result of the Project, groundwater quality as a pathway to VECs in other environmental components is considered as it may be relevant to Human Health and to Non-human Biota in section 6.11 and section 6.12; respectively of this EA Screening Report.

Mitigation

In assessing effects to groundwater quality, implementation of good industry management practices was considered during both phases of the Project. Examples of good industry management practices of relevance to groundwater quality include:

- good practice as it relates to spill prevention includes that secondary containment of storage tanks (e.g., for fuel oil) be provided to control and contain any releases from spillage or tank rupture; and that accidental spills or releases to the environment be cleaned up such that there are no residual impacts on the environment
- good practice as it relates to effluent management includes that water impacted by radioactive or conventional contaminants, discharged from any liquid effluent stream to the environment (via the yard drainage system or directly to Lake Ontario) be treated as necessary to meet regulatory requirements and that no effluents are allowed to infiltrate the ground surface
- good practice as it relates to managing groundwater when undertaking excavations in the Protected Area
- good practice as it relates to stormwater management typically includes, among other actions, sediment control practices, stormwater conveyance

systems and conventional stormwater treatment methods such as stormwater management ponds and oil-grit separators

Residual Effect

Given the implementation of good industry management practices in dealing with effluents, spill prevention, groundwater and stormwater, no residual adverse effects are expected.

Significance

Not significant.

6.5.3 Groundwater Flows

Description of Effect

Some Project works and activities will potentially alter groundwater conditions, notably, the construction of new buildings, operation of services and utilities (e.g., stormwater management system) and the ongoing presence of new buildings and hard services associated with them. Changes to groundwater recharge or infiltration can alter the general configuration of the water table.

The groundwater in the Protected Area and in other areas potentially affected by the Project (e.g., DWMF) does not contain ecosystems that are dependent on groundwater flow or discharge with one exception. Sensitive ecosystems have been identified in the southwest corner of the SSA that are dependent on groundwater discharge. Two creeks are located within this area: the Southwest Boundary Creek (also known as Tributary A) and the Southwest Creek (also known as Tributary B) (see figure 4.2-2 in OPG's Geological and Hydrogeological Environment TSD). Both creeks have been deemed to be non-fish bearing as described in section 4.3.1 in this EA Screening Report.

Considering the physical changes in conditions at DNGS as a result of the Project (e.g., new building footprints) the maximum net drawdown in the interglacial deposit as a result of the Project was modeled at less than 0.2 m (i.e., slight reduction in recharge) and is limited in extent and duration. These modeling results indicate that the change in groundwater flow is both small and limited to an area where ecosystems are not dependent upon groundwater flow. Therefore, no adverse effects on groundwater flows are predicted to result from the Project.

Mitigation

No mitigation measures have been identified as changes to groundwater flow are both small and limited to an area where ecosystems are not dependent upon groundwater flow.

Residual Effect

No residual effects are expected.

Significance

Not significant.

6.6 Land Use

Description of Effect

Planned future development scenarios may result in residential development in the western portion of Bowmanville toward DNGS and employment development to the west of DNGS (Clarington Energy Business Park). A number of developments are proposed in proximity to the DN site, including sensitive land uses (e.g., new residential subdivision development including schools).

The Project will offer employment opportunities that may combine with unrelated municipal growth and development to increase pressure for land uses in the LSA, and most notably in the Contiguous Zone for emergency planning purposes that are incompatible with the continuing presence and operation of DNGS (the Contiguous Zone extends approximately 3 km from the DNGS reactors). This is considered a likely adverse effect and is further considered in terms of mitigation measures and residual effects.

Mitigation

To address the likely environmental effect on land use, OPG will:

- continue to monitor land use activity and policies in proximity to DNGS and consult with municipalities concerning risk of incompatible uses and effects on implementation of emergency plans
- continue to engage the Region of Durham concerning Regional Official Plan Amendment application to implement the Growing Durham Study, Preferred Growth Scenario and Policy Directions, and land use policy in the DNGS emergency planning Contiguous and Primary Zones

Residual Effect

Considering implementation of the identified mitigation measures, no residual adverse effects on land use are expected as a result of the Project.

Significance

Not significant.

6.7 Traffic and Transportation

Description of Effect

Four time horizons (i.e., 2014, 2018, 2021 and 2031) that represent milestone development and operating conditions at the DN site were adopted for assessment purposes. To ensure appropriate conservatism in the assessment, the time horizons selected, and the conditions at those times, considered all relevant activities potentially occurring on the DN site including (as applicable at each horizon) existing DNGS operations, DWMF operations, DNGS Refurbishment Project and the NND Project. The analysis considered the baseline condition at each time horizon to represent whatever other activities were occurring on the site (e.g., NND), and then considered the addition of the Project-related traffic. As well, the analysis at each time horizon assumed system improvements made by the jurisdiction responsible for the roads network.

Despite system improvements that will be made by the jurisdiction responsible for the roads network, some intersections and road links are projected to experience adverse effects (i.e., decreased Levels of Service) in the future as a result of combined baseline and Project-related traffic. The assumed improvements will alleviate most effects, but some effects of a short-term and periodic nature may remain. These conditions are likely to be experienced at only a few intersections and road links located generally between Courtice Road and Waverley Road, south of Highway 2.

Mitigation

The assessment of effects on road traffic operations determined that there is likely to be some decrease in system performance as a result of the Project.

Accordingly, additional mitigation measures are identified to further ameliorate the likely environmental effects:

- Implementation of practicable travel demand management initiatives to reduce and control DN site traffic during peak periods. Travel demand management opportunities include the consideration of shift changes at times other than traditional peak travel periods, shuttle/transit service to DN site, and carpool incentives.
- OPG will engage in an on-going process with interested agencies (i.e., OPG, Ontario Ministry of Transportation, the Region of Durham and the Municipality of Clarington) to develop a coordinated program of road and transit improvements to maintain safe and efficient transportation operations in the LSA (i.e., as an element of a Traffic Management Plan).

Residual Effect

The decreases in system performance as a result of the Project will be further mitigated (i.e., reduced) by the implementation of practical travel demand initiatives and a Traffic Management Plan. As such, no residual adverse effects are expected.

Significance of Effect

Not significant.

6.8 Socio-economic

A number of beneficial effects of the Project are anticipated in the areas of employment, business activity, tourism, municipal finance and administration, housing and property values, educational facilities and services.

The following addresses potential adverse socio-economic effects arising from biophysical effects of the project.

6.8.1 Economy

Description of Effect

It was determined that nuisance and traffic-related effects during the Project will not have the potential to be disruptive to business activities or farm/agri-business activities for DN site neighbours as no substantial increases in dust, noise or traffic over existing conditions are expected at potentially sensitive business locations. However, there remains the potential for the Project-related traffic during the Refurbishment phase to disrupt the movement of slow moving farm vehicles that utilize local roads, including the South Service Road.

Mitigation

A Traffic Management Plan (included as a mitigation measure for effects on Traffic and Transportation, see section 6.7 of this EA Screening Report) will be implemented with the objective of reducing disruption and maintaining safe traffic conditions during the Refurbishment phase, including with regard for slow-moving farm vehicles and school vehicles.

Residual Effect

Given the implementation of a Traffic Management Plan and the predictions of no substantial increases in dust, noise or traffic over existing conditions at potentially sensitive business locations, no residual adverse effects are expected.

Significance

Not significant.

6.8.2 Community Infrastructure and Services

Description of Effect

Noticeable nuisance effects are not anticipated as a result of the Project at any off-site residential neighbourhood. Accordingly, the likelihood of measurable changes in residential property values in the LSA including in close proximity to the DN site due to changes in noise, dust, traffic or the presence of the station (i.e., stigma) is considered to be extremely low.

The Project and its associated population are not expected to place demands on the municipal infrastructure (i.e., water, sewer, conventional waste) that would exceed its existing or planned capacities.

Effects of the Project are not likely to disrupt activities conducted at fire service facilities as they are not likely to be directly affected by changes in noise or dust. Increased traffic levels are not anticipated to disrupt operations, provided that ongoing improvements continue to the local and regional road networks to maintain acceptable levels of service.

The Project is not expected to have any direct adverse effects on the recreational facilities and amenities on the DN site because these facilities will not be displaced by the Project activities. OPG is also committed to working with community stakeholders to maintain public access to the portion of the Waterfront Trail that traverses the DN site. The Project is not likely to result in a loss of open space that is currently accessible to the public and the new buildings and structures associated with the Project are not likely to result in a noticeable difference in the existing industrial character of the southern portions of the DN site. Furthermore, changes in noise and dust levels are not anticipated to be of sufficient magnitude to disrupt people's use of the recreational features on the DN site.

It is also not expected that any community or recreational facilities located off-site will experience any nuisance disruption as a result of the Project.

Some residents and visitors to the neighbourhoods nearest the DN site are likely to notice increased vehicle traffic. However, because increased traffic will likely be noticeable only during shift changes at the site, this short term effect is not expected to be of sufficient magnitude to be a chronic source of disruption to the use or enjoyment of community and recreational facilities on or off the DN site.

Mitigation

In considering likely effects on community infrastructure and services, actions and programs were considered as "in-design" mitigation measures in evaluating likely environmental effects:

- A Traffic Management Plan (included as a mitigation measure for effects on Traffic and Transportation, see section 6.7 of this EA Screening Report) will be implemented with the objective of reducing disruption and maintaining safe traffic conditions during the Refurbishment phase.
- Practicable travel demand management initiatives will be implemented to reduce and control DN site traffic during peak periods may also further reduce disruption to the use or enjoyment of community and recreational facilities on or off the DN site.
- OPG will continue to keep its neighbours and the broader public informed concerning activities at the DN site as appropriate to each phase of the Project.
- OPG will continue to work with its community stakeholders in maintaining safe public access to the portion of the Waterfront Trail that traverses the DN site.
- Good industry management practices of relevance to air quality (see section 6.1.1 in this EA Screening Report) will be implemented.

Residual Effect

Given the traffic-related and air quality-related mitigation measures along with the measures to communicate and work with stakeholders, no residual adverse effects are expected.

Significance

Not significant.

6.8.3 Residents and Communities

Description of Effect

Decreased use and enjoyment of private property typically result from noticeable increases in nuisance effects such as noise and dust, and increased traffic associated with a project. In the case of the Project, dust levels off the DN site are not anticipated to be of a concentration that would represent a nuisance effect. The construction activities associated with the Project will be shielded by buildings that already exist and therefore, there will be no measurable noise increase at any of the residential receptors. The changes in night-time noise levels at the nearest residential locations east of the DN site are expected to be barely perceptible increases.

Increased traffic levels on local roads in the vicinity of the DN site are anticipated during shift changes. Although the Project will add traffic to the road network, upon the completion of improvements to the transportation infrastructure by local and regional municipalities, the ability of people to access their properties should not be adversely affected.

There are no Project related reasons that people could not continue to use and enjoy their private property as they do currently. The Project is not expected to adversely affect traffic safety or levels of services. The Project will not result in any direct adverse effects on community character, nor is the attribution of a new “stigma” likely.

Overall, widespread measureable changes to people’s use and enjoyment of private property attributable to the Project are not anticipated.

Refurbishment activities on the DN site are not expected to noticeably increase noise or dust levels in the built up areas of Bowmanville or Courtice. While it can be expected that general activity in downtown Bowmanville will increase with greater population levels, its character will not be directly affected by on-site activities as no measurable nuisance, traffic or visual effects directly attributable to the Project are anticipated in these downtown areas. Residents of the rural neighbourhood nearest the DN site are likely to notice some increased vehicle traffic on local roads, including additional trucks and other heavy vehicles during the Refurbishment phase, however, the increase is not expected to result in a fundamental change in the character of the neighbourhood.

Mitigation

Several of the mitigation measures described in section 6.8.2 of this EA Screening Report will also be effective in addressing potential effects on residents and communities:

- A Traffic Management Plan (included as a mitigation measure for effects on traffic and transportation, see section 6.7 of this EA Screening Report) will be implemented with the objective of reducing disruption and maintaining safe traffic conditions including with regard for slow-moving farm vehicles and school vehicles, during the Refurbishment phase.

- OPG will continue to keep its neighbours and the broader public informed concerning activities at the DN site as appropriate to each phase of the Project.
- Good industry management practices of relevance to air quality (see section 6.1.1 in this EA Screening Report) will be implemented.

Residual Effect

Given the traffic-related and air quality-related mitigation measures along with the measures to communicate with stakeholders, no residual adverse effects are expected.

Significance

Not significant.

6.9 Physical and Cultural Heritage

Description of Effect

Most of the SSA is developed land that was highly disturbed during the original construction of DNGS. A Stage 1 Archaeological Assessment (ASI 2009) undertaken indicated that there was no potential for archaeological resources in the SSA where proposed ground disturbing activities are proposed. Accordingly, only a single potential archaeological or cultural heritage resource, the Van Camp family cemetery, has been identified within the SSA; and its presence is not confirmed. No ground disturbing activities are proposed within the scope of the Project at the potential cemetery location.

Mitigation

The Project is not expected to affect the potential Van Camp cemetery; however, because the presence of the cemetery and its precise location are not known, actions will be taken to protect the potential cemetery should it be encountered:

- Protection and avoidance is the preferred option for archaeological resources with cultural heritage value or interest.
- If the possible Van Camp cemetery location may be impacted, a Preliminary Cemetery Investigation will be carried out which will involve the mechanical removal of topsoil and fill under the supervision of a licensed archaeologist. The exposed subsoil would then be shovel-shined and examined for the presence of grave shafts.
- If human remains are identified and impacts are unavoidable, the cemetery will be closed in accordance with the *Cemeteries Act* (R.S.O. 1990) and all burial remains re-interred in a local cemetery.

Residual Effect

No residual adverse effects are expected because in the unlikely event that the Van Camp cemetery is encountered, the mitigation measures and associated regulatory requirements identified will ensure that it is addressed appropriately.

Significance of Effect

Not significant.

6.10 Aboriginal Interests

Description of Effect

Because the terrestrial area of the SSA is not used by Aboriginal people, changes to traditional land and resource use as a result of Project works and activities are unlikely. There is no evidence of traditional land and resource use by Aboriginal people along the Lake Ontario shoreline in the SSA; and there are no planned Project-related activities on the Lake Ontario shoreline that would impact this traditional use should it exist. There are no proposed aquatic or terrestrial effects from the Project that may impact traditional land and resource use should it occur in the LSA or RSA. As there is no evidence to date of traditional use and there are no proposed activities that would occur in this area there is no likely effect of the Project on traditional land and resource use.

The shipment of low and intermediate level refurbishment and operational waste to off-site waste management facilities (i.e., WWMF) will be less than 10 shipments per month. This activity will not add measurable additional traffic to the roadways, nor will it add measurably to the radioactive dose rate to receptors on the transportation routes. Transportation of such materials will comply with existing approved systems, including appropriate licenses and transport packages. As such, it does not warrant further consideration in terms of potential effects on Aboriginal interests.

There are no ceremonial sites or significant features identified to date within the SSA; therefore there are no interactions between this environmental sub-component and the Project. OPG is not aware of any ceremonial sites or features within the LSA or RSA with potential to be affected by the works and activities associated with the Project. Therefore there are no potential adverse environmental effects of the Project on ceremonial sites or significant features.

Mitigation

Given the absence to date of traditional use, ceremonial sites and significant features in the SSA, no mitigation measures have been identified.

Residual Effect

No residual adverse effects are expected.

Significance

Not significant.

6.11 Human Health

6.11.1 Physical Well-being

Description of Effect

Radiation and Radioactivity: Doses to Workers

Through monitoring, radiation doses to NEWs at the DN site are known to be well below the regulatory limits; the same overall regulatory compliance will be the case for the Project. The maximum annual individual NEW doses during both phases of the Project are expected to be well below the regulatory limit of 100 mSv per 5 years with a maximum of 50 mSv in any one year.

Doses to individual workers carrying out refurbishment activities are expected to be within regulatory limits, but the collective dose to these workers will be higher than that associated with normal operations. There are no regulatory or recommended limits relating to collective dose; however, collective dose is reported as a measure of ALARA performance. During the continued operation phase, worker doses are expected to be generally comparable to doses to workers under existing conditions, which are well below regulatory limits. Table 6.11-1 provides the collective dose information for the Project. These are bounding dose estimates for the purposes of the assessment. ALARA optimization has yet to be completed.

Table 6.11-1 Estimated Collective Doses for Workers during Refurbishment and Continued Operations Phases

Phase / Activity	Collective Dose Information
Refurbishment:	
▪ reactor retube and feeder replacement	27 person-Sv per unit
▪ other refurbishment activities	5 person-Sv per unit
▪ unloading and transferring retube waste containers	0.1 person-Sv
Continued Operations:	
▪ normal operations	0.69 to 4.07 person-Sv
▪ steam Generator replacement	1.5 person-Sv per unit

During the removal of reactor components, workers may be exposed to alpha radiation. OPG has recently made enhancements to its Radiation Protection Program regarding alpha monitoring and control (i.e., monitoring, procedures, dosimetry).

During both phases of the Project, access and movement of non-NEWs involved in the work will be controlled by OPG through well-established programs and procedures. Radiation doses to these workers (non-NEWs) as a result of licensed activities on the site will also be controlled by OPG, thus ensuring that they do not exceed 1 mSv/year, the regulatory limit for individuals who are non-NEWs. For example, for non-NEWs that are required to enter the Protected Area, these individuals are not permitted to perform radioactive work and are required to wear a thermoluminescent dosimeter. An Exposure Control Level of 0.1 mSv/year is established within OPG's Radiation Protection Program for non-NEWs to ensure that they do not receive any recordable dose on their dosimeter and thus do not approach the dose limit. These controls are currently in place and will remain during Refurbishment phase.

Radiation and Radioactivity: Doses to the General Public

The Project's interaction with the environment is as a potential contributor to radiation dose to humans primarily as a result of possible emissions to environmental media and gamma radiation.

The releases of radioactivity to the environment arising from the Refurbishment phase and Continued Operations phase are expected to be comparable to the baseline conditions; hence the doses to members of the public will also be comparable.

Annual radiation doses to members of the public as a result of the existing operations of the DN site are calculated by OPG. The dose estimates are made for members of potential critical receptor groups that reside in the vicinity of the DN site and represent individuals whose location, habits or diet may cause them to receive a higher dose (on average) than individuals in other exposed population groups. Therefore, doses to critical groups represent the maximum realistic impact to humans of radiological emissions from the DN site. For example, the DNGS historical maximum critical group dose takes into account, amongst other things, Cs-137 in soil, gross beta levels in surface water, and OBT levels in fish, all of which were elevated above provincial background levels in the LSA in 2009.

The total annual doses in 2009 for critical groups ranged from 3×10^{-5} mSv (infant in Oshawa) to 7×10^{-4} mSv (infant at dairy farm in Clarington). Given that Bowmanville will likely continue to grow in the future during the Continued Operations phase of the Project, it has been estimated that the nearest future resident of Bownmanville critical group would receive a dose of approximately 6.7×10^{-4} mSv/year. The estimated total annual dose to all of these critical groups is less than 1% of the regulatory limit for members of the public of 1 mSv/year and is an even smaller fraction of the annual dose from natural background radiation in Canada of about 1.84 mSv/year. Furthermore, these very small doses will be primarily due to air emissions and as a result of increased atmospheric dispersion with distance, the air concentrations of radionuclides and associated dose and risk will decrease with increasing distance from the site.

Therefore, no adverse effects are predicted to the public as a result of radiation and radioactivity effects from the Project.

Other Biophysical Factors

For air quality, during Refurbishment phase activities, products of vehicle combustion are expected to increase; however, the maximum concentrations in air are predicted to remain within their respective AAQC. The Continued Operations phase will be comparable to existing conditions from an emissions perspective and it is predicted that air concentrations of these chemicals under existing conditions are below applicable AAQC. Further, other metrics (e.g., risk levels) for certain chemicals (i.e., hydrazine, morphaline) are below acceptable levels/values. Finally, the DNGS will continue to be in compliance with its Environmental Compliance Approval for air. Therefore, no adverse effects on human health are predicted from non-radioactive atmospheric emissions of the Project.

For noise, DNGS operations will continue to be in compliance with applicable noise standards; therefore, no adverse effects of noise on sensitive receptors are predicted.

For surface water, liquid effluents as well as the thermal input to Lake Ontario as a result of the existing operation of DNGS will continue during both phases of the Project and will, in fact, diminish during the Refurbishment phase because of unit outages. Because these conditions will be the same or less than current conditions (i.e., limited water temperature increase, conform to the Ontario Drinking Water Quality Standards set out by the OMOE, compliance with MISA and CofA regulatory requirements, no evidence of bacterial issues or aesthetic effects), no effects on the Bowmanville and Oshawa WSPs are anticipated. In terms of recreational use of the lake water (i.e., swimming), water temperature increase due to the DNGS thermal plumes is not expected to reach recreational areas and, therefore, is not expected to affect bacterial growth in Lake Ontario. Therefore, no adverse effects on human health are predicted from potential surface water effects of the Project.

For groundwater, OPG has confirmed that benzene in the basement spaces of the Powerhouse are at concentrations well below the occupational exposure limit and do not represent a health risk to workers. Worker exposure to potential radiologically and conventionally contaminated soils and groundwater during excavations in the Protected Area would be addressed by the implementation of appropriate worker personal protection and safety precautions according to relevant legislation and OPG policies, procedures and plans. Therefore, no adverse effects on human health are predicted from potential groundwater effects of the Project.

Socio-economic Factors

The Project is not anticipated to place additional demands on fire services beyond that which would occur due to the normal projected population growth. A measurable change on the overall demand relating to health care services in Oshawa or the Municipality of Clarington is also not anticipated. Finally, the Project and its associated population are not expected to place demands on the municipal system (i.e., water, sewer, conventional waste) that would exceed its existing or planned capacities.

Mitigation

Because there are no likely effects of the Project on the physical well-being aspects of human health, no mitigation measures are identified.

Though not considered mitigation, OPG programs currently in place at DNGS have been successfully demonstrated as effective for their purposes and were assumed to remain in place and be similarly effective during the Project (see section 3.5 of this EA Screening Report).

Residual Effect

No residual adverse effects are expected to the physical well-being aspects (i.e., radiation, biophysical factors and socio-economic factors) of human health.

Significance

Not significant.

6.11.2 Mental Well-being

Description of Effect

Based on public attitude research, no changes to people's feelings of personal health or personal safety and community satisfaction are anticipated as a result of the Project. Further, the events at Fukushima have not resulted in significant changes in behaviours or opinion towards OPG's nuclear facilities. The information that supports this includes both ad hoc discussions with the public, local media coverage and formal and informal polling (see OPG's dispositions of technical review comments on the EIS: Comment #108 in OPG 2012).

From a traffic perspective, increased traffic levels are anticipated during the Refurbishment phase; however, assumed infrastructure improvements and the implementation of traffic management strategies will mitigate this. It is expected that there will be no residual adverse effects on the mental well-being aspect of human health as a result of potential traffic effects.

From a worker perspective, OPG has extensive health and safety programs, policies and procedures in place at their nuclear facilities and these, or similar, are expected to be applied during both the Project.

Mitigation

Beyond the mitigation measures identified for traffic and transportation (see section 6.7 of this EA Screening Report), no other mitigation measures have been identified.

Residual Effect

No residual adverse effects are expected.

Significance

Not significant.

6.11.3 Social Well-being

Description of Effect

Positive effects of the Project are anticipated social elements such as population and demographics, employment and income, community cohesion and social well–being of workers. For community / recreational facilities and services, changes in noise and dust levels are not anticipated to be of sufficient magnitude to disrupt people's use of the recreational features on the DN site (i.e., indirect effects). The Project is also not expected to result in any disruption to use of off-site recreational facilities. No adverse effects are predicted to the social well-being aspect of human health as a result of the Project.

Mitigation

Beyond the mitigation measures identified for community infrastructure and services that deal with disruption of recreational facilities (see section 6.8.2 of this EA Screening Report), no other mitigation measures have been identified.

Residual Effect

No residual adverse effects are expected.

Significance

Not significant.

6.12 Non-human Biota

The assessment on non-human biota examined three Project-related scenarios, as follows:

- existing scenario (i.e., DNGS operating) as described in section 4.12 of this EA Screening Report
- refurbishment scenario (i.e., DNGS Refurbishment and Continued Operation)
- cumulative scenario (i.e., refurbishment scenario plus NND Project operating)

Only radiological effects are evaluated for the refurbishment and cumulative scenarios as it is not expected that the concentrations of conventional constituents associated with the activities will meaningfully increase.

Description of Effect

<u>Refurbishment Scenario</u>

Refurbishment and Continued Operation phases are not expected to be associated with releases of conventional COPCs, therefore, only the potential effects associated with radiological doses on non-human biota have been evaluated.

In addition, radionuclide concentrations are not expected to increase from current levels and therefore the only changes in dose are a reflection of accumulation in the soil over time.

All SI values for radioactive COPCs at maximum concentrations in the south-west corner of the DN site are several orders of magnitude below threshold values indicating that radiological risk to ecological receptors is very low.

Cumulative Scenario

Based on the maximum predicted radiological concentrations within different environmental pathways across the DN site, all risk factors are well below threshold values indicating that there will be no adverse effects in ecological receptors exposed to radionuclide releases associated with the combined operation of DNGS and NND.

Mitigation

No mitigation measures have been identified as all risk factors are well below threshold values indicating that there will be no adverse effects in ecological receptors exposed to radionuclide releases.

Residual Effect

No residual adverse effects are expected.

Significance

Not significant.

7 MALFUNCTIONS AND ACCIDENTS

The CEA Act requires that every EA of a project include consideration of the environmental effects of malfunctions or accidents that may occur in connection with the project. Malevolent events have not been considered in this environmental assessment, as CNSC staff are of the view that security issues are being appropriately managed by the ongoing regulatory process and that they do not warrant special consideration in this EA.

The identification of malfunctions and accidents for the Project addresses events within the following categories:

- Conventional (non-radiological) malfunctions and accidents, which are conventional events that involve only non-radiological substances with no potential for a release of radioactivity.
- Radiological malfunctions and accidents, which are events that involve radioactive components (e.g., processing, handling and storing nuclear wastes; removal and preparation of steam generators for transportation) and the potential for release of radioactivity.
- Transportation accidents, which are those malfunctions and accidents related to the off-site transportation of low and intermediate-level radioactive wastes.

- Out-of-core criticality, which are those malfunctions and accidents that involve criticality events outside of the reactor core which may result in an acute release of radioactivity to the environment.
- Nuclear accidents, which are events that are assumed to involve the operation of the reactor and may involve damage to the fuel bundles and/or the reactor core and which could result in an acute release of radioactivity to the environment.

7.1 Conventional Malfunctions and Accidents

The methodology used to derive the malfunction and accident scenarios to be considered for the effects assessment involved the following steps:

1. Identify credible events that have a reasonable probability of occurrence (5%) over the life time of the project (i.e., credible events). It is in the order of 10^{-3} per year or greater.
2. Screen each credible event to establish if it could result in a consequence (e.g., environmental) that should warrant further consideration.
3. Advance for subsequent evaluation of those events that, on the basis of the screening, were determined to potentially result in an environmental consequence.

The screening decision is based on whether there is a plausible mechanism for and interaction with the environment, the size of the spill, potential chemical concentrations and relative toxicity of the chemicals involved. In general, for conventional releases, one bounding chemical and one bounding oil spill were identified for further evaluation.

The screening of conventional malfunctions and accidents considered the Refurbishment and Continued Operations phases of the Project. Since there were no residual effects of conventional scenarios for the refurbishment activities, no further assessment was required and no bounding scenarios were carried forward. Assessment of the continued operations phase is based on the following bounding scenarios:

- spill of transformer oil on land
- spill of fuel into the lake
- spill of chemicals (hydrazine)
- fire and explosion (fire in fuel oil storage)

The bounding scenario is expected to have greater potential environmental effects than the other scenarios within the category. It was assumed that the continued operations of the refurbished DNGS reactors will be the same as the current operations. The development of the malfunction and accident scenarios did consider operating experience from other CANDU facilities.

7.1.1 Spill of Transformer Oil

This bounding scenario is the result of a fire where the deluge water and transformer oil (225,000L) are released outside of the secondary containment onto an outdoor surface. The oil is spilled to the ground and might reach water bodies via the stormwater management system and ponds. Stormwater will not be released if it does not meet regulatory requirements, and access to the ponds by waterfowl and wildlife use will be restricted.

Due to the mitigation and spill response measures that will be in place, no measureable effects to surface water, groundwater and hydrogeology are expected as a result of this bounding scenario. No residual effects to the aquatic environment or terrestrial environment are expected as a result of this bounding spill.

7.1.2 Spill of Fuel into the Lake

This bounding scenario is an accident that could result in a release of 30,000L of fuel into Lake Ontario. Local changes in water quality are expected immediately following the accident, but it is anticipated that mitigation measures will contain potential effects within a limited area. The soluble portion of the oil will disperse and degrade quickly, and the insoluble portion would be accumulated on the bottom and the shore in close proximity to the point of release and would be cleaned up.

Exposure of oil residues to aquatic and terrestrial environment are expected to be limited in spatial and temporal extent with the implementation of mitigation measures and no adverse effects are anticipated. No residual effects to surface water and human health are expected from this scenario.

7.1.3 Spill of Chemicals (Hydrazine)

Hydrazine (35 or 55 weight percent) is used in small quantities and is stored in 850L totes. It was chosen as the bounding chemical since transportation of other chemicals is limited or non-existent. This bounding scenario assumes that the contents of the tote are spilled, forms a pool and releases vapours to the atmosphere.

The selection of a bounding chemical spill scenario (other than oil and fuel spill scenarios) focused on the toxicity of each chemical, the potential for spilling the chemical (usually in storage or in on-site transit) and the potential environmental effects.

Workers involved in the cleanup of the spill will be exposed to increased levels of hydrazine in the atmosphere, but will be protected with appropriate personal protective equipment. No members of the public reside in the area of perceivable effects. Monitoring and cleanup activities in Lake Ontario and stormwater management areas would be undertaken until it was determined that there were no risks to humans, non-human biota or measurable effects on the aquatic environment.

No residual effects to terrestrial environment, public or human health are expected from this bounding scenario.

7.1.4 Fire and Explosion (Fire in Fuel Oil Storage)

This scenario is a spill from a fuel oil storage tank that contains approximately 978,000L of fuel. This scenario requires a release of oil followed by ignition of the released fuel and exposure to a high radiation fire for a prolonged period.

Short-term effects are expected in the vicinity of the fire from burning of fuel, but no long-term effects to air quality are expected. Workers may be exposed to smoke or heat from the event, but due to fire protection services and fire prevention methods, the probability of this scenario occurring is reduced; therefore, there is a low probability of effects to workers. Due to the limited atmospheric pathway from a fuel fire to the public, no adverse health effects to member of the public are anticipated.

7.2 Radiological Malfunctions and Accidents

Potential radiological malfunctions and accidents that could occur during the Project were identified by reviewing each of the Project works and activities to identify any scenarios that could occur while they are being carried out that could result in a release of radioactivity to the environment. Additionally, previously completed EAs for the PNGS and DNGS facilities were reviewed to determine if there were any radiological malfunctions and accidents identified for similar activities that have been carried out. Tables 7.5-1 (Refurbishment phase) and 7.5-2 (Continued Operations phase) in the EIS briefly describe each postulated radiological malfunction and accident and the associated screening decision.

The screening decision is based on whether each scenario could reasonably be expected to result in a potentially measurable adverse environmental effect considering project-specific features that would be available to prevent or control the occurrence itself, as well as to mitigate possible effects of the event. These events were then reviewed against similar events to define the bounding scenarios for further evaluation.

After the screening assessment, the following bounding scenarios have been identified for radiological malfunctions and accidents and were carried forward for further assessment:

- retube waste container drop and loss of containment
- on-site traffic accident involving a DSC transporter
- spill of tritiated moderator heavy water from ruptured pipe
- irradiated fuel damage in the irradiated fuel bay

The detailed assessment of these scenarios is provided in the next sections with much of the information derived from DNGS Safety Report (OPG 2009b).

The assessment of the potential effects of bounding scenarios on a member of the public is based on the radiation dose limits (e.g., whole body, thyroid) which are set for events of given frequency (five classes of events, ranging from a frequency of $> 10^{-2}$ to $\leq 10^{-5}$). These public dose limits are the licensing requirements for the DNGS. Table 7.2-1 describes these limits in further detail.

Table 7.2-1 Radiation Dose Limits to a Member of the Public for an Event of a Given Frequency (based on AECB 1980)

Event Class	Qualitative Event Frequency Criteria	Quantitative Event Frequency Criteria, f (expected frequency in occ/reactor-year)[1]	Individual Dose Limit (Sv)	
			Whole Body	Thyroid
1	Greater than 50 percent chance of occurring in the lifetime of a single reactor, or More frequently than twice in the lifetime of a 4-unit station	$f>10^{-2}$	0.0005	0.005
2	About once in the lifetime of an 8-unit station	$10^{-2} \geq f > 10^{-3}$	0.005	0.05
3	About once in the lifetime of a population of one hundred similar reactor units	$10^{-3} \geq f > 10^{-4}$	0.03	0.3
4	Low probability postulated failure	$10^{-4} \geq f > 10^{-5}$	0.1	1
5	Very low probability postulated failure	$f \leq 10^{-5}$	0.25	2.5

[1] OPG 2009b

7.2.1 Retube Waste Container Drop

The refurbishment waste container is designed to survive the highest handling elevation (~ 4 m drop) or equivalent impact with minimal loss of solid contents. It is possible that a small crack could occur and any volatile material within the container could escape (e.g., very fine radioactive particulates or C-14 present as a gas). The bounding malfunction and accident considers the drop of a refurbishment waste container loaded with pressure tubes.

Description of Effect

Human Health

The bounding case is a drop of a refurbishment container containing pressure tubes. The resulting hypothetical public dose for the most exposed member of the public, a hypothetical person located at the DN site boundary (minimum of 914 m from the reactor core) is predicted to be less than 0.001 mSv (for nine month decayed waste). This is a small fraction (< 1%) of the regulatory limit on annual dose to members of the public and a small increment to the average level of natural background radiation a member of the public in Canada receives (1.84 mSv/year).

The hypothetical dose to a maximally exposed worker at the DWMF from the bounding malfunction and accident for a retube waste container drop has been conservatively estimated to be less than 2 mSv for nine-month decayed waste, assuming 30 minutes of exposure.

Non-human Biota

For non-human biota, exposure resulting from the release was assumed to occur for one hour even though the release would essentially be instantaneous. Using a meadow vole as an example the dose to the vole was estimated at 2.78×10^{-9} Gy, which is well below the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) (2008) acute dose guideline for mammals of 1 Gy.

Mitigation

A comprehensive on-site and off-site emergency response plan is in place at the DN site. Response teams are drilled and equipped to respond to emergencies. In case of such an accident, the building would be evacuated and posted to prevent unauthorized entry to keep doses ALARA. Also, appropriate remedial actions will be taken. Worker intervention can help to minimize or prevent radiological consequences from an initiating event. DWMF personnel and the DNGS emergency response team can implement emergency measures as appropriate, including fire suppression, radiological monitoring, and restriction of access in the vicinity of the accident location.

In the event of an emergency situation, the Shift Manager (in the role of the Emergency Response Manager) would implement on-site protective measures. This includes dismissing non-essential staff (in a controlled manner), to avoid radiation exposure and authorizing emergency exposures (for site staff).

All emergency staff receive a pre-job briefing prior to dispatch in the field, including personal protective equipment to be worn based on the event. On-site shift staff are assigned to Radiation Exposure Permit set-up for emergency use only. This Radiation Exposure Permit invokes dose and dose rate alarm settings on the electronic personal dosimeter.

Residual Effect

Radiation doses to workers and the public from the “retube waste container drop” scenario are expected to be well below regulatory limits. Also, radiation doses to non-human biota are expected to be below no-effects levels reported by UNSCEAR (2008). Implementation of emergency response plans will keep doses ALARA.

No adverse residual effects on workers, the public and non-human biota from retube waste container loss of containment event are anticipated. Therefore, no adverse residual effects on human health or on populations of non-human biota are expected.

Significance

Not significant.

7.2.2 On-Site Traffic Accident Involving a DSC Transporter

Description of Effect

<u>Human Health</u>

The drop of a DSC due to an unforeseeable accident during on site transfer was chosen to represent a bounding event. Due to the DSC design (e.g., transfer clamp), only airborne releases of tritium and krypton-85 from the DSC cavity, based on failure of 30 percent of a DSC's used fuel content is considered for this assessment. The assessment of the effects of the release of tritium and krypton-85 following the bounding accident is based on releases of 1.02×10^{12} Bq of tritium and 5.68×10^{12} Bq of krypton-85.

The dose to members of the public at the DNGS property boundary was conservatively calculated at 0.0015 mSv, based on DWMF Safety Report (OPG 2009c) methodology assumptions. This is a small fraction (0.15%) of the regulatory limit on the 1 mSv annual dose to members of the public.

The maximum dose to a worker at the DWMF from the bounding malfunction and accident was estimated to be 4.5 mSv, based on DWMF Safety Report methodology (OPG 2009c), which is a small fraction of the 50 mSv regulatory limit for workers.

<u>Non-human Biota</u>

The effects to non-human biota in the terrestrial environment were assessed, assuming that a plume of tritium oxide and krypton-85 is dispersed by ground level winds.

The estimated dose from tritium and krypton-85 to biota 200 m from the source following a bounding accident was calculated to be less than 0.03 Gy which is less than 3% of the no-effect level (1 Gy) reported by UNSCEAR (2008).

Mitigation

In case of an accident, appropriate remedial actions will be taken. Worker intervention can help to minimize or prevent radiological consequences from an initiating event. DWMF personnel and the DNGS Emergency Response Team can implement emergency measures as appropriate, including fire suppression, radiological monitoring, and restriction of access in the vicinity of the accident location. A comprehensive on-site and off-site emergency response plan is in place at DNGS. Response teams are drilled and equipped to respond to emergencies.

Additional emergency response particulars outlined in mitigation part of section 7.2.1 in this EA Screening Report would be applicable as well in protecting workers.

Residual Effect

Radiation doses to workers and the public from the "on-site traffic accident involving a DSC transporter" scenario are expected to be well below regulatory limits. Also, radiation doses to non-human biota are expected to be below no-effects levels reported by UNSCEAR (2008). Implementation of emergency response plans will minimize doses in this type of event.

No adverse residual effects on workers, the public and non-human biota from an on-site traffic accident involving a DSC transporter event are anticipated. Therefore, no adverse residual effects on human health or on populations of non-human biota are expected.

Significance

Not significant.

7.2.3 Spill of Tritiated Moderator Heavy Water from Ruptured Pipe

Description of Effect

<u>Human Health</u>

A break in the D_2O transfer system moderator water piping was chosen to represent a bounding event involving the release of tritium outside of containment during continued operations following refurbishment.

The atmospheric pathway assumes a 12 hour release of tritium emissions from the powerhouse ventilation system. For the assessment of doses from a release to the atmosphere, the maximum dose to a member of the public at the site boundary was estimated to be approximately 0.89 mSv, approximately 50% of the average annual dose from background radiation of 1.84 mSv and below the regulatory limit of 1 mSv/year.

For the aquatic pathway, the scenario assumes a 4 minute discharge of tritiated water to the CCW duct, resulting in an estimated release of approximately 2.27×10^{15} Bq of tritium. This is approximately equivalent to the 1992 tritium spill from a moderator heat exchanger which occurred at PNGS A.

Using the results of the 1992 spill to assess potential effects at DNGS, the maximum concentration was 12% of the Ontario Drinking Water Standard of 7,000 Bq/L. The peak concentration measured at the Ajax Water Supply Plant (approximately 5.5 km west of PNGS) was 835 Bq/L. The peak concentration measured at the F.J Horgan facility (approximately 10 km west of PNGS) was 605 Bq/L.

In the event of an accidental release, the WSPs would increase their surveillance and would shut down the water supply if necessary. However, assuming a person drank 2 L of water per day (average drinking water consumption rate) containing 835 Bq/L of tritium, for one day, the tritium intake would be 1,670 Bq (i.e., 2 L x 835 Bq/L). This would result in an incremental dose of much less than 0.001 mSv, which is an extremely small fraction of the background radiation dose in Canada of 1.84 mSv/year. In addition, the greater flow at DNGS as well as the diffuser discharge design (i.e., substantial mixing at the point of discharge) ensures additional dilution for any potential releases from the station. Finally, the WSPs near DNGS (Bowmanville WSP is 7 km to the East) are further away compared to WSPs near PNGS.

Worker dose has not been estimated. Workers are protected according to the general procedures which would be invoked in the event of an emergency situation as described in the OPG Radiation Protection Program and Nuclear Emergency Plans. Elements of these procedures are captured in the mitigation section below.

Non-human Biota

Doses to mammals (meadow vole) and fish (fish near outfall) were calculated. The highest calculated dose to non-human biota from the representative radiological accident was 0.02 Gy to a meadow vole, well below the nominal dose of 1 Gy indicated by UNSCEAR (2008) as protective of populations of non-human biota exposed acutely to ionizing radiation. Therefore, no effects are expected to occur in populations of non-human biota exposed from radiological accidents.

Mitigation

In the event of such a spill, the OPG's Liquid Emission Response Procedure would ensure that the Emergency Response Team would be mobilized to contain the spill, stop the source where possible, and direct the subsequent clean-up and notification procedures where appropriate. In addition, the PNERP and in particular the Liquid Emergency Response Plan would be implemented. In the event of such a spill, the local water supply plants would be notified and shut-down well in advance of the spill reaching them, thereby mitigating the effect of potential exposure through water.

Additional emergency response particulars outlined in mitigation part of section 7.2.1 in this EA Screening Report would be applicable as well in protecting workers.

Residual Effect

Radiation doses to the public from the "spill of tritiated moderator heavy water" scenario are expected to be well below regulatory limits. Also, radiation doses to non-human biota are expected to be below no-effects levels reported by UNSCEAR (2008). Implementation of emergency response plans will keep doses ALARA.

No adverse residual effects on workers, the public and non-human biota from spill of tritiated moderator heavy water are anticipated. Therefore, no adverse residual effects on human health or on populations of non-human biota are expected.

Significance

Not significant.

7.2.4 Irradiated Fuel Damage in the Irradiated Fuel Bay

Description of Effect

This scenario assumes that a full fuel module (96 bundles) is dropped from its maximum elevation (1 m in the reception bay or 4 m in the storage bay) onto the bay floor. The free inventory of noble gases is assumed to be instantly released followed by leaching from the fuel pellets.

Human Health

The maximum predicted doses to the critical individual at the site boundary due to the airborne release for a dropped fuel module in IFB is 0.07 mSv whole body (OPG 2009i) which is 1.4 % of the Class 2 dose limit. Even with no credit for the decontamination of effluents by the contaminated exhaust system, the calculated doses are well below the regulatory limits. This dose was only 3% of the annual dose from natural background radiation in Canada of 1.84 mSv.

Worker dose has not been estimated. Workers are protected according to the general procedures which would be invoked in the event of an emergency situation as described in the OPG Radiation Protection Program and Nuclear Emergency Plans. Elements of these procedures are captured in the mitigation section below.

Non-human Biota

The dose to humans from irradiated fuel damage in the IFB is only a small fraction of the dose from a spill of tritiated moderator heavy water. Consequently the dose to biota from irradiated fuel damage in the IFB would be bounded by the dose from the tritiated moderator heavy water spill, which was 0.02 Gy to a meadow vole, well below the nominal dose of 1 Gy indicated by UNSCEAR (2008) as protective of populations of non-human biota exposed acutely to ionizing radiation.

Mitigation

If such an event were to occur, the OPG's Emergency Operating Procedures would be enacted to direct the subsequent clean-up and notification procedures where appropriate.

Additional emergency response particulars outlined in mitigation part of section 7.2.1 in this EA Screening Report would be applicable as well in protecting workers.

Residual Effect

No residual effects on the public and non-human biota from the irradiated fuel damage in the irradiated fuel bay are anticipated. Workers are protected according to the general procedures invoked in the event of an emergency situation.

Significance

Not significant.

7.3 Transportation Accident

For the transportation of radioactive material, OPG operates a Radioactive Material Transportation (RMT) program that provides a fleet of tractors, trailers and specialized packaging, a maintenance facility and support staff. Radioactive materials that may be transported offsite include: tritiated heavy water, refurbishment waste and operational low and intermediate level waste.

OPG has an excellent radioactive materials transportation safety record. In an average year for the overall OPG RMT program, over 800 shipments of radioactive materials are consigned, and/or carried by OPG, traveling approximately 500,000 km. Materials shipped include contaminated tools and equipment, low and intermediate level radioactive waste, solid and liquid samples, used fuel, and tritiated heavy water which is currently transported off-site from PNGS and the Bruce Power Nuclear Generating Station for processing to remove tritium.

OPG's RMT program is supported by the following components:

- packaging designed, fabricated, and tested in accordance with applicable regulations and standards, such as the *Packaging and Transport of Nuclear Substances Regulations*
- regular audits and reviews of transportation procedures
- an on-going Transportation of Dangerous Goods Class 7 (radioactive materials) training program
- rigorous transportation package inspection and maintenance, long service life packages are also subject to an aging management program
- over-sight of high-hazard and non-routine shipments
- a Transportation Emergency Response Plan that is audited both internally and externally by authorities like Transport Canada

In the more than 35 years that OPG has been transporting radioactive materials, and more than 11.5 million km travelled, only five shipments have been involved in minor traffic accidents. Three accidents involved trucks transporting low level waste and two involved the transportation of heavy water. There were no releases to the environment as a result of these accidents.

Future transportation of L&IL radioactive materials to an off-site licensed facility will be conducted under the RMT program as outlined above. These shipments will be essentially the same as the current L&ILW shipments which occur as part of the routine reactor operation. The bounding volume of LLW that would require shipment to an offsite facility for processing and storage is estimated at approximately 800 m^3 which would result in approximately 40 truck shipments per year of 20 m^3 each, or three to four truck shipments per month during the 30-year operating life of the DNGS after refurbishment. The bounding volume of ILW that would require shipment to an offsite facility is approximately 50 m^3 per year, which would require two to three truck shipments per year during the operating period. During the refurbishment year for a reactor, approximately three to four additional shipments per day would be required for refurbishment waste shipment.

Extensive mitigation measures are in place to prevent a release of radioactivity resulting from a transportation accident involving a shipment of low or intermediate level waste. Though transportation accidents are possible, and these accidents have occurred in the past, no release of radioactivity has occurred from these past events due to the robustness of the packaging and the other precautions taken to ensure the safety of workers and members of the public. Consequently, it is not anticipated that a measurable environmental effect will result from a transportation accident.

Therefore, this accident category is not assessed further.

7.4 Out-of-core Criticality

The term criticality safety is used to describe the measures that are undertaken to prevent an inadvertent sustained nuclear chain reaction outside the reactor core. The focus of this section is criticality safety of fresh and spent fuel bundles at DNGS.

Natural uranium or depleted uranium in fresh or spent fuel bundles cannot sustain nuclear chain reactions in air or in light water. This means that there is no criticality concern during storage and handling of natural or depleted uranium fuel bundles. Therefore, storage and handling of fresh or spent fuel bundles outside the reactor core will be subcritical under normal and credible abnormal conditions, and there are no plausible accidents and malfunctions that warrant further consideration.

7.5 Nuclear Accidents

7.5.1 Background and Methodology

Nuclear accidents are those that involve the operation of the reactor and may involve damage to the fuel bundles and/or the reactor core and which could result in a release of radioactivity to the environment. The fundamental causes of nuclear accidents are well understood and an extensive body of knowledge and expertise exists in Canada and internationally. The underlying principles of reactor safety are to ensure that measures are in place to control the nuclear chain reaction, cool the fuel and ultimately contain any radioactivity that may be released from the reactor should the first two functions prove unsuccessful. Control is achieved by automatic power regulation and shutdown systems, supplemented by operator action if needed. Cooling can be provided by a number of alternative primary, backup and emergency heat sinks, and containment is achieved by strong physical barriers around the reactor and its components to isolate them from the natural environment. In addition to the plant process systems, there is a group of independent, poised safety systems with no process function, known as the special safety systems. These consist of two reactor shutdown systems, the emergency coolant injection system and the containment system.

Underlying the design and operation of CANDU reactors including DNGS is the concept of defence-in-depth. Defence-in-depth refers to a number of defence or preventative measures that decrease the risk of accidents or the resulting consequences. Key CANDU station design and operational provisions include, amongst others:

- two separate, diverse and redundant fast-acting reactor shutdown systems
- robust containment structure connected to a vacuum building to prevent overpressure
- multiple means of providing cooling water and/or heat sinks to cool reactor fuel
- multiple physical barriers to prevent release of fission products to the environment
- three separate redundant electrical power supplies
- reliable process systems
- reliable safety systems
- well established procedures
- well trained competent operating and maintenance staff
- in the event of a nuclear accident, well developed emergency preparedness plans and procedures

A major nuclear accident at a CANDU reactor such as DNGS could occur only if there were an imbalance between heat produced in the fuel and heat removed by the engineered cooling systems. The severity of the accident depends on the amount of fuel that overheats and the duration and magnitude of the temperature excursion until cooling can be restored. For example, an accident may affect only fuel in a single fuel channel or may cause damage to much of the fuel in the reactor, with a number of combinations in between. In general, the more severe an accident, the more equipment failures and human errors are necessary for it to occur, and therefore, the less likely the event.

Whatever the nature of the accident, these events can pose a threat to the environment only if radioactivity escapes from DNGS in an uncontrolled manner. This would require an accident causing major damage to fuel in the reactor core, a mechanism for release from containment and an internal driving force (primarily related to the inability to remove heat) sufficient to expel the radioactivity into the environment.

In general the following steps were undertaken to assess nuclear accidents:

- a review of the plant design and existing safety documentation is provided
- beyond design basis accidents (BDBAs) are discussed and the representative nuclear accident(s) is identified for purposes of this EA Screening Report

- the consequences of the radioactive release from the representative nuclear accident(s) to humans and non-human biota are assessed

7.5.2 Plant Design and Safety Improvements

The DNGS basic design philosophy to limit the consequences of incidents and an expansion of the key features (i.e., related to inherent safety, redundancy and reliability, and preventing the plant's uncontrolled response to incidents) of defence-in-depth at DNGS are provided in section 7.7.1.3 of the EIS.

In advance of the Project, OPG has initiated the conceptual design for several planned safety improvements. These safety improvements and their associated Safety Improvement Opportunities (SIOs) are described in table 7.5-1 below.

Table 7.5-1 Safety Improvements and Associated Safety Improvement Opportunities

Safety Improvement	Safety Improvement Opportunities
Containment Filtered Venting System (CFVS)	The objective of the CFVS is to provide a filtered pressure relief path from containment to the atmosphere. This addition, in conjunction with additional relief capacity for the reactor shield tanks, is aimed at ensuring containment integrity post severe, multi-unit, BDBAs.
Powerhouse Steam Venting System (PSVS)	Duplication of PSVS singleton programmable logic controllers. The objective of this SIO is to improve the reliability of powerhouse venting. Powerhouse venting is an important mitigating action post secondary side (steam and feedwater) line breaks occurring in the powerhouse.
Third Emergency Power Generator	This SIO is aimed at improving the reliability of emergency back-up power for a variety of common mode failures (including improved seismic capacity and flood protection).
Improvements to the Emergency Heat Sink	This SIO is aimed at providing a new, independent water supply directly to the Heat Transport System. This will enhance the operators' ability to respond to a BDBA and further reduces the already low likelihood of a BDBA from progressing to a severe accident.

OPG has made substantial progress in both evaluating the lessons learned from the events at Fukushima, as well as conducting a rigorous review of the preparedness of its stations to deal with beyond design basis events. The review also considered radiological personal protective equipment, including instrumentation and the availability of dosimetry. To date, no major issues requiring immediate corrective or compensatory measures have been identified.

OPG has already undertaken several actions which will address conditions such as those which occurred at Fukushima (OPG 2011b):

- Severe Accident Management Guidelines have been implemented at DNGS.
- The schedule for installation of Passive Autocatalytic Re-combiners (PARS) has been advanced to be completed between 2011 and 2014, prior to the start of the first refurbishment outage – PARS is meant to prevent hydrogen accumulation to protect containment in the event of an accident.
- Changes have been made to improve response to severe beyond design basis flooding for emergency power generator fuel delivery equipment.
- Additional emergency mitigating equipment will be procured to address the total loss of AC power and to provide an alternate and independent supply of water as an emergency heat sink.
- OPG is evaluating the capabilities to provide make-up water to the moderator system and evaluating alternate means of providing water to containment coolers and recovery of water collected inside containment.

OPG is also undertaking the necessary studies to augment current operator response capabilities by pre-staging provisions to allow for remote water addition to the IFBs using portable pumps.

7.5.3 Identification of Nuclear Accident Scenarios

Representative nuclear accident scenario(s) are selected and used to describe the radioactive releases and environmental effects that, though unlikely to occur during the remaining design lifetime of DNGS following refurbishment, are considered in this EA Screening Report.

Probabilistic Risk Assessment (PRA) provides a systematic approach to estimating the likelihood (frequency) and consequences (radiation dose) of accidents that could lead to release of radioactivity to the environment. The scope of PRA addresses the full range of accident consequences, from the relatively benign to the most severe that are physically possible, including events involving multiple reactors.

Such a PRA has recently been completed for Darlington, referred to as the Darlington Risk Assessment (DARA). PRA is carried out in three stages or "Levels"; Level 1 calculates the frequency of various degrees of damage to the reactor core, Level 2 examines the interaction of these accidents with the containment system to determine the frequency of various levels of release to the environment; and Level 3 estimates the offsite health and economic consequences and risks arising from such releases. The analysis is focused on risk contributions from accidents originating from within the station associated with at-power operation.

It is the overall objective of PRA to generate results that are as realistic as possible, however, the analysis of severe accidents involves complex events and phenomena for which there is limited experience and data. These gaps are addressed by treating the phenomena in a conservative manner such that the frequencies and consequences reported are expected to reflect the upper end of the associated uncertainty bands.

The PRA results of particular interest to EA are those generated by the Level 2 PRA. At the beginning of the Level 2 analysis the results of the Level 1 were organized into a set of Plant Damage States (PDS) (see table 7.7-3 in the EIS) in order to reflect the potential for challenge to containment systems. PDS1-4 represent accidents involving severe core damage to one or more reactors, whereas PDS5 and 6 represent accidents involving only limited core damage, including those whose consequences have already been addressed in the DNGS Safety Report (OPG 2009b).

Accident sequences representing PDS 1-4 are associated with severe core damage and were combined with event trees representing the response of containment systems and structures to the physical challenges resulting from accident progression. Each event tree outcome was allocated to one of the DARA Release Categories (RCs) based on its release characteristics.

Updated DARA Level 2 results for the RCs and PDS5-6, including frequencies and general descriptions are shown in table 7.5-2. These results reflect a version of the DARA modified to incorporate the impact of modelling enhancements and the potential safety improvements discussed in table 7.1.2, such that it represents the state of the plant as it will exist post-refurbishment. The analysis was carried out assuming all four reactor units are initially operating at power and is based on conceptual design features rather than the specifics of installed equipment. The assignment of probabilities to represent the SIO design changes is judged to be sufficient to approximate the reduction in accident frequency achievable. Per the requirements of CNSC's regulatory standard S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*, the station PRA will be updated to reflect the detailed design and as-installed configuration prior to bringing refurbished units back on-line. Updates will be provided to the CNSC as part of this process. A description of the model enhancements and results are provided in AMEC NSS (2011).

Table 7.5-2 Description and Frequencies of Release Categories

Release Category	**Description**[1]	**Frequency**[2, 3]
RC1	Very large release with potential for acute offsite radiation effects and/or widespread contamination	5.1×10^{-8}
RC2	Early release in excess of 1×10^{14} Bq of Cs-137 but less than RC1	3.6×10^{-7}
RC3	Late release in excess of 1×10^{14} Bq of Cs-137 but less than RC1	0
RC4	Early release in excess of 1×10^{15} Bq of I-131 but less than 1×10^{14} Bq of Cs-137	5.7×10^{-8}
RC5	Late release in excess of 1×10^{15} Bq of I-131 but less than 1×10^{14} Bq of Cs-137	0
RC6	Release arising due to greater than normal containment leakage but below RC4/5 definition	0
RC7	Release arising due to normal containment leakage less than RC6	1.7×10^{-6}
RC8	Basemat melt-through to bedrock	0
PDS5	Transient leading to limited core damage at one reactor unit with release initially into containment	2.8×10^{-3}
PDS6	Transient leading to limited core damage at one reactor unit with release initially bypassing containment	2.4×10^{-5}

1 “Early” implies that the bulk of the release occurs within 24 hours of the onset of the accident. “Late” implies that the bulk of the release occurs more than 24 hours after the onset of the accident.
2 Frequency = occurrences/reactor-yr
3 Use of “0” indicates that there were no accident sequences allocated to that category or that the frequency is negligible

Based on the Scoping Information Document, nuclear malfunctions and accident events with potential off-site consequence that have a frequency greater than 1×10^{-6} occurrences per year were identified for consideration in the EA. Based on the PSA Level 2 and Scoping Information Document criteria, only RC7, PDS5 and 6 were found to have mean frequencies in excess of 1×10^{-6} occurrences per reactor-year. OPG’s outage assessment indicates that outage risks are bounded by the “at-power” risks discussed in the PRA. As such the representative nuclear accident identified for use in this EA is developed based on the results of the PRA. Of the three categories, the largest overall release is that associated with RC7 and this was selected as the category for further evaluation.

RC7 Category Description

RC7 is comprised of two different general types of sequences; those involving a severe accident at a single unit and those involving two or more units simultaneously. Because neither type of sequence leads to containment failure, the release characteristics are of a similar order of magnitude such that they can be assigned to RC7 for PRA purposes. For the EA, a single set of release characteristics from which to determine offsite effects is used.

Approximately 96% of the RC7 frequency of 1.5×10^{-6} occurrences per reactor-year arises from single unit events and 4% from multiple unit events. The cumulative frequency of the multiple-unit events contributes about 6×10^{-8} occurrences per reactor-year, which is well below the 1×10^{-6} occurrences per reactor-year threshold for consideration in the EA. Given the exceedance of the frequency threshold for the multi-unit even sequence, the representative event for calculating offsite impacts should be a sequence involving a severe accident at a single reactor unit with an intact containment envelope, where the unaffected reactors are brought to a safe shutdown state.

The characteristic of an RC7 accident sequence is that there are no substantive releases early in the accident progression because containment pressure is generally maintained below atmospheric pressure by the action of the vacuum system. Only where there is a rapid generation of steam inside containment during accident progression does containment pressure exceed atmospheric for a brief period. Once the vacuum is depleted and accident progression terminated, the Emergency Filtered Air Discharge System (EFADS) is placed into service to maintain pressure sub-atmospheric indefinitely. This will result in a controlled discharge from containment through a filtered pathway, which removes all but trace quantities of particulate and chemically reactive materials from the effluent stream, leaving only noble gases. The EFADS has sufficient capacity to absorb much of the radioactive iodine released into containment during accident progression. However, analysis indicates that most particulate material will be deposited on surfaces and in water pools inside containment before it ever reaches the filter system, which is connected to the vacuum building at a location remote from the vaults containing the reactors.

Inspection of the many individual accident sequences allocated to RC7 indicates that the majority involve a severe accident in a containment in which all subsystems (containment isolation, air cooling units, hydrogen igniters and the EFADS) operate as designed. It was recognized that, at some point in time, discharge of long-lived noble gases would be required so a representative sequence was selected in which discharge from the EFADS was predicted earlier in the simulation, in order to obtain bounding estimates of potential radiological releases for the single-unit accident.

Description of Accident Sequence

The main features of this sequence are:

- initiation by a spontaneous pipe rupture in the Heat Transport System inside containment
- failure of emergency coolant injection in all modes
- failure of moderator cooling due to unavailability of either the moderator heat exchangers or moderator pumps
- consequential failure of accident-unit reactor vault air cooling units (ACUs) at the onset of the accident
- the emergence part-way through the accident sequence of a small leakage pathway through the containment envelope via an open three-inch diameter pressure relief line from the shield tank to an expansion tank located outside containment – the shield tank is not initially part of the containment envelope but becomes so during accident progression

Hydrogen igniters in all units and ACUs in the three other reactor units that form part of the containment envelope are available. Containment isolation is initially successful, and EFADS is available when required. The small containment impairment causes more rapid rate of depletion of the vacuum reserve and an earlier requirement for EFADS to be placed in service. EFADS is initiated at around 37 hours and continues to discharge over the remaining 131 hours of the simulation. About 85% of the noble gas inventory is released over that period with only trace quantities of other fission products. This is both because there is sufficient time for aerosols to be deposited inside containment prior to pressure reaching the point at which EFADS is expected to be activated and because the EFADS filter is credited as removing most of any residual aerosol material from the effluent.

The extended duration of this release means that meteorological conditions, including wind direction, will vary substantially over time. As a result, it is unlikely that doses to individuals close to the plant will be large enough to mandate short term emergency response actions, although some action may be taken on a precautionary basis. Similarly, the very low levels of particulates in the discharge would not be expected to require any longer term actions to avoid dose due to radioactivity deposited on the ground.

7.5.4 Assessment of Effects

Description of Effect

Health risks from stochastic effects (i.e., risk of cancer) of radiation exposure were calculated from the 50-year committed dose using the linear-no-threshold model (i.e., Risk = “Accident Frequency” x “Dose” x “Probability of latent cancer fatality per unit of dose”), summed over RCs 1, 2, 4, 7 and PDS 5 and 6. A probability of about 0.05 latent effects per Sv of exposure was used (BEIR 2006). The Mean Individual Latent Effect risk is conservatively estimated as 3.8×10^{-6}

effects/site-year, which is well below OPG's Safety Goals on this matter (i.e., Safety Goal Limit = 1 x 10^{-4} effects/site-yr, Target = 1 x 10^{-5} effects/site-yr). The intent of the Safety Goals is to ensure that the radiological risk to the public is low in comparison to risks from background public exposure.

Potential health effects arising from doses estimated for the representative RC7 accident are assessed in terms of:

- individual dose to a maximum exposed individual located 1 km away
- collective dose to members of the public within 100 km of the DN site

Individual dose estimates for a prolonged release duration (~ 72 hrs) representative of RC7 were obtained by developing dose distributions from multiple calculations using meteorological records extracted from site data for a representative calendar year. Calculations took into account variation in wind direction over the duration of the release with the mean values for the highest onshore sector reported. This resulted in a more realistic estimate than reported for RC7 in table 7.7-6 of the EIS, which assumed a constant wind direction which is more appropriate for a release of a short duration.

The doses arising from the representative RC7 accident can be summarized as follows:

- the total (all radionuclides) early dose (i.e., first 7 days) from the accident to an individual 1km from the release point is estimated at 5.7 mSv
- the total early dose decreases rapidly with increasing distance (see figure 7.5-1)
- the dose to the thyroid of someone who lives 1 km from the release point is estimated at 6.5 mSv, the thyroid dose also decreases rapidly with distance (see figure 7.5-1)
- due to the nature of RC7 and the characteristics of the radionuclide releases, for practical purposes, essentially the entire dose is delivered in the first year following the accident and no chronic phase is predicted
- the collective dose to people who are living within 100 km of the site at the time of the accident for current and various future population projections is estimated as follows: 2006 – 49 p-Sv; 2013 – 54 p-Sv; 2031 – 68 p-Sv; 2055 – 81 p-Sv

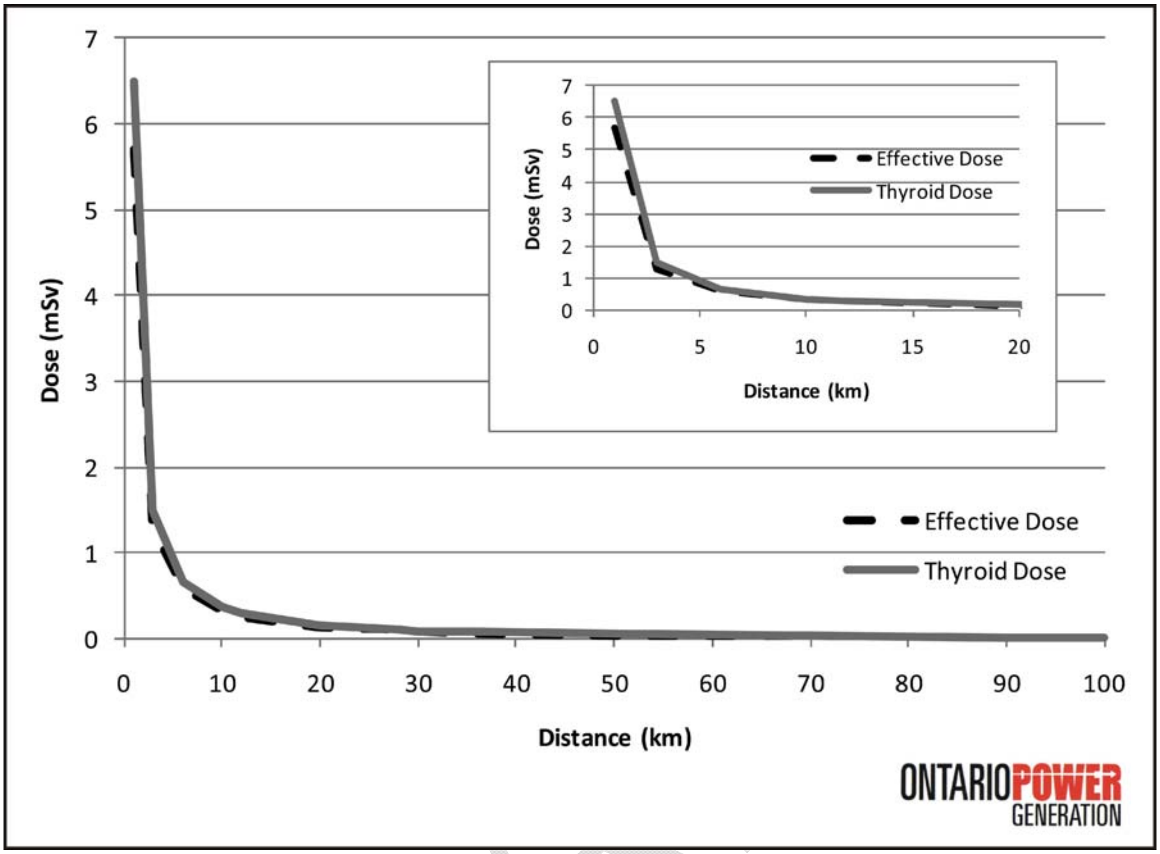


Figure 7.5-1 Mean Early Individual Dose (mSv) – RC7 (source: AMEC NSS 2011)

The PNERP from the Province of Ontario (Province of Ontario 2009) provides Protective Action Levels (PALs) as guidance for when to consider implementing various protective actions in the event of a nuclear emergency (see table 7.7-2 of the EIS). The total dose of 5.7 mSv is in the range where the Provincial PALS in PNERP suggest sheltering (1 to 10 mSv) might be considered up to 3 km (see figure 7.5-1) but well below the dose at which evacuation would be indicated (> 10mSv). Sheltering is not credited in the dose calculations. Sheltering refers to taking immediate shelter in a location readily accessible to the individual by sealing a single area from outside contamination.

The thyroid dose to the same individual is below the Provincial PALS for consideration of sheltering (10 mSv). Further, the total dose to an individual living 1 km from the point of release at the time of the accident is about 3 times the average annual dose of about 1.84 mSv from natural background radiation. Depending on various factors, including geographical location, annual background doses in Canada range from 1.2 to 3.2 mSv/y (Health Canada 2000). Finally, no chronic phase is predicted as a comparison of individual doses after Year 1 and Year 50 shows no difference (AMEC NSS 2011).

From a collective dose perspective, it can be seen in table 7.5-3 that the estimated collective dose from the representative RC7 accident (i.e., 54 p-Sv in 2031) is a small fraction (less than 1%) of the annual collective dose to the same population and an even smaller fraction of the unavoidable dose from a lifetime of exposure to natural background sources of radiation. Indeed, the collective dose from such an accident is a small fraction of the variation in dose arising from natural background.

Table 7.5-3 Collective Effective Dose from Natural Background Radiation to Population Within 100 km of DNGS

	Dose (person-Sv)		
	2006	**2031**	**2084**
Dose over year	12,700	17,000	25,600
Dose over 50 years	637,000	850,000	1,280,000

Workers are protected according to the general procedures which would be invoked in the event of an emergency situation as described under mitigation measures outlined in section 7.2.1 of this EA Screening Report.

The Ontario PNERP Master Plan (Province of Ontario 2009) outlines the responsibilities of the various agencies in the event of a nuclear and/or radiological emergency. In the event of a nuclear and/or radiological emergency, the federal government will manage nuclear liability issues. The *Nuclear Liability and Compensation Act* specifies that compensation to third parties for injury or damage caused by a nuclear incident would be assessed and paid under the provisions of this act.

The PNERP Master Plan also states that the nuclear installations are responsible for monitoring and decontamination of both evacuees and emergency workers.

OPG's public attitude research that it undertook as part of this EA and for the NND EA along with post-Fukushima community consultation efforts (Comment #108 in OPG 2012) have shown little concern from residents living in close proximity to the DNGS (e.g., Public attitude research results indicate that 90% of LSA respondents are confident in the safety of the existing DN site and its on-going operations). It is recognized, however, if the representative RC7 accident were to occur resulting in sheltering, it is highly likely that some effects would occur at both the individual and community level that could be deemed psychosocial. The severity and duration of these effects would likely be related to the length of time the protective actions were in place, the amount of radiation released from the plant, and the information provided to residents by OPG and regulatory authorities. Effects to some individuals could include fear, anxiety, a sense of loss of control, and a feeling of hopelessness (Sorensen et al. 1987). Disruption of lifestyles, increased stress, and negative effects to community well-being could occur in reaction to the accident occurring and the subsequent need for sheltering. These potential effects would be felt most strongly in the areas closest to the DNGS.

Hypothetical Dose to Non-Human Biota

Screening dose calculations were made for representative biota (mammals, birds, vegetation) nearest DNGS (and therefore exposed to the highest acute doses. Also, models and parameters were used that ensured the predicted doses would not underestimate the actual doses received should an accident occur. Predicted doses were compared to guidelines from UNSCEAR (2008) and were found to be well below guideline values (e.g., 2.49 x 10^{-6} Gy to vegetation on site vs. guideline value of 1 Gy). The atmospheric and aquatic dispersion of emissions would result in a decrease in the dose received by biota with increasing distance from the site. Consequently, doses to biota at distance from DNGS are expected to be lower than those nearest the plant.

Overall

Although the dose (individual and collective) and other aspects from the accident will remain relatively low, given the potential for associated psycho-social effects, this is considered an adverse effect of the Project and is further considered in terms of mitigation measures and residual effects.

Mitigation

For the representative RC7 accident, timing delays in releases and protective measures can avert much of the dose. There is considerable opportunity to implement a variety of protective actions as considered appropriate by the Province of Ontario. Emergency Response Plans developed by the Province and the designated municipalities (e.g., the Region of Durham) and OPG would all be activated.

Protective actions can function as mitigating measures. For the representative RC7 accident, in the scenario of the airborne release of noble gases in the early phase, sheltering could mitigate against external exposure from noble gases.

A variety of measures could be implemented after the accident to assist in mitigating some of these anticipated effects, and to maintain OPG's credibility with the public. Such measures could include regular publication of radiation monitoring results, an information centre where both the media and the public could obtain credible information regarding issues such as decontamination activities, repairs to the reactor, or any anticipated changes to emergency response and alerting procedures. These measures would likely enable the community to return to normalcy and lessen the likelihood of long-lasting effects.

Overall, a residual effect would remain and is discussed further below.

Residual Effect

The unlikely bounding nuclear accident scenario would result in a controlled release of noble gases over an approximate one-week period through a filtered pathway. Predicted individual dose at 1 km is approximately three times higher than annual dose from natural background radiation, but is below guideline values. Sheltering may be required up to 3 km from the DN site. The collective dose from the representative accident is a small fraction (less than 1%) of the annual collective dose to the same population. Psycho-social effects from such an accident are anticipated but mitigation measures would likely enable the community to return to normalcy and lessen the likelihood of long-lasting effects.

The doses to non-human biota from the acute phase of the representative nuclear accident are well below current UNSCEAR guidelines and no population level effects would be expected. Therefore, no residual adverse effects to non-human biota are expected.

Significance

Using the two-step process and the criteria outlined in section 5.5 of this EA Screening Report, the significance of the residual effect of the bounding nuclear accident scenario to the Member of the Public VEC is as follows:

- Magnitude: Low – Predicted individual dose is approximately three times higher than annual dose from natural background radiation, but is below guideline values.
- Spatial extent: Medium – Limited to the LSA (i.e., need for sheltering extends 3 km from the DN site).
- Duration/timing: Low – Controlled release over an approximate one-week period through a filtered pathway, with no chronic phase predicted.
- Frequency: Not applicable – It would occur once.
- Reversibility: Medium – Effects may persist beyond the release period.

Given that at least one criterion was rated low, advancement to the second step of significance determination was not warranted; however for information purposes, the remaining Step 2 criteria are as follows:

- Effect on Physical Human Health: Low – Below guideline values and collective dose from the representative accident is a small fraction (less than 1%) of the annual collective dose to the same population
- Effect on Psycho-social Human Health: Medium – Effect is somewhat noticeable (i.e., need for sheltering) in the short term, but not generally of concern to the public provided OPG implements mitigation measures that would likely enable the community to return to normalcy and lessen the likelihood of long-lasting effects
- Ecological Importance (of VEC): Low – Not relevant to the Members of the Public VEC
- Societal Value (of VEC): Medium – People's sense of health, safety and well-being would be affected; however, the mitigation measures would likely enable the community to return to normalcy and lessen the likelihood of long-lasting effects
- Sustainability: Low – Not relevant to the Members of the Public VEC

Therefore, the conclusion is that the residual adverse environmental effect is minor in nature and not significant.

8 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The Scoping Information Document requires consideration of how the environment could adversely affect the project. The assessment is also required to take into account any potential effects of climate change on the project, including an assessment of whether the project might be sensitive to changes in climate conditions during its life span. There are a number of natural hazards in both the physical and the biological environments that potentially may affect the project.

The reactors, and other important safety systems and structures are designed to limit the consequences of common mode incidents (e.g. earthquakes, external explosions, turbine disintegration and fires). The general design philosophy requires that the following capabilities are maintained (OPG 2010a):

- the capability to shut down the reactor
- the capability to ensure the reactor remains shut down
- the capability to remove decay heat from the reactor
- the capability to monitor the status of the Nuclear Steam Supply System and containment

It is also a requirement that systems, other than the reactor proper, containing substantial amount of radionuclides (such as the irradiated fuel bay) not be unacceptably damaged.

This design philosophy ensures that the station will be protected against the effects of the environment (e.g., severe weather) on the project.

8.1 Flooding

Three sources of potential flood risk to the DN site were identified as coastal flooding, on-site or near-by watercourse flooding and direct surface runoff.

<u>Coastal Flooding</u>

The DN site is protected from high lake levels by the protected face of the shoreline in front of DNGS (OPG 2010a), which is built to an elevation of approximately 78.5 m IGLD (International Great Lakes Datum), which is more than 2 m higher than the 1 in 100 year water level combined with the estimated maximum storm surge and more than 1 m higher than the 1 in 500 year water level combined with the estimated maximum storm surge. No residual adverse effects due to coastal flooding are expected.

<u>Watercourse Flooding</u>

Based on a flood hazard assessment undertaken as part of the NND EA, the risk of flooding at the DN site from the two surrounding watersheds (Tooley Creek to the west; Darlington Creek to the east) is considered negligible and no residual adverse effects due to nearby watercourse flooding are expected.

<u>Direct Surface Run-off</u>

The storm runoff generated at the DN site is conveyed off-site to neighbouring land or directly to Lake Ontario via natural channels/swales and outfalls. The stormwater management system for the DN site was designed to meet the requirements of the National Building Code applicable at the time of construction of DNGS (i.e., designed to accommodate up to 76 mm of precipitation per 12 hour period). Similarly, any new stormwater management structures will comply with the National Building Code in place at the time of construction and no residual adverse effects due to nearby watercourse flooding are expected.

Other Flood Hazards

Other potential flood hazards were considered (e.g., in the flood hazard assessment undertaken as part of the NND EA), including lake ice, landslides or avalanche, and tsunamis. No residual adverse effects due to flooding hazards are predicted. Seismically-induced hazards are discussed further in section 8.4 of this EA Screening Report.

8.2 Severe Weather

Tornadoes

In the rare event of a tornado, damage to the DNGS reactor buildings is unlikely due to the robust construction. A tornado characterized by a maximum wind speed of 418 km/h was considered in the design of DNGS (OPG 2010a). A representative set of tornado-generated missiles was also considered in the station design. Damage to other buildings or systems on the DN site, including the used fuel dry storage facilities, might occur as a result of strong winds, rapid pressure change, tornado-generated projectiles and/or the collapse of other structures or buildings. Various operational and safety systems could be compromised by building or system damage and/or power outages, and the on-site road systems might be damaged or obstructed. However, due to the station design to protect against common mode incidents, the essential station capabilities would be maintained and no residual adverse effects due to tornadoes are expected.

Tropical Cyclones

Tropical cyclone activity at the DN site is rare due to the large distance from the Atlantic Ocean; however, can still result in high rainfalls and gusty winds when it occurs. The National Building Code specifies the appropriate design requirements for such an event based on the 1 in 100 year storm (i.e., Hurricane Hazel). No residual adverse effects due to tropical cyclones are expected.

Thunderstorms and Hail storms

Thunderstorms and hail storms can result in damage to external structures, buildings and systems directly through high winds, heavy rain and lightning. Operational and safety systems can be affected by power outages. However, as noted above, the structures associated with DNGS are designed and constructed so as to resist damage resulting from extreme weather-related events including power outages. No residual adverse effects to due thunderstorms and hail storms are expected.

Freezing Rain

Ice storms resulting in freezing rain can damage light structures such as power transmission lines because of the weight of accumulated ice. Structures at DNGS have been exposed to various weather conditions for approximately 20 years, including the January 1998 ice storm, and no significant damage to the station structures has occurred during this period. No residual adverse effects due to freezing rain are expected.

8.3 Biophysical Environment

Invasive Mussels

DNGS has identified mussel growth on portions of the water intake structures and implements a semi-continuous chlorination program to reduce infestation into the station. The total chlorine residual in the station outfall at the property limit is maintained at or below 0.01 ppm, as required by the OMOE. In the screenhouse, the problem of the invasive Zebra and Quagga Mussels and/or empty shells accumulating in sumps can be adequately addressed by monitoring and periodic removal using vacuum trucks. Inspection and cleaning strategies of the DNGS existing intake structure are currently in place to control mussel colonization.

Algae

For algae, it is anticipated that urban growth will result in increased runoff in the local watersheds over the next 30 years, which will contribute to increased growth of shoreline algae (i.e., *Cladophora*). Shoreline algae can move offshore and become entrained within the DNGS intake structure. However because of the design of the intake structure at DNGS, water supply problems with algae are infrequent and manageable with the screenhouse debris system.

Fish

Fish impingement at DNGS is quite small relative to similar sized stations with conventional intakes due to the design of the intake structure. Fish that are impinged are removed in the screenhouse debris system and, therefore, do not adversely affect the station.

Ice

On average, Lake Ontario in the vicinity of the DN site is ice-free year round, and since the intake is in approximately 10 m of water, it is not expected that ice will affect water intake for the station. In addition, DNGS has a frazil ice protection system which prevents the formation of frazil ice on the bar screens and on the travelling water screens in the intake. Frazil ice can occur when the water temperature is below its freezing temperature (i.e., supercooled).

Silt

The processes of sediment erosion, transport, accretion and re-suspension in the vicinity of the DN site are complex and are affected by a number of natural (i.e., high energy lake environment) and anthropogenic influences (i.e., diffuser, St. Marys wharf). These observations indicate that silt accumulation in the vicinity of the DNGS intake structure is unlikely to affect the station.

No residual adverse effects due to the biophysical effects identified in the preceding sections are expected.

8.4 Seismicity

General

The DN site lies within the western Lake Ontario region in the tectonically stable interior of the North American continent, which has been characterized by low rates of seismicity (OPG 2009d).

Earthquake occurrences described by Natural Resources Canada (NRCan 2011a) indicate a small cluster of earthquakes (Magnitudes generally between 3.0 and 4.5) south of Toronto with a larger cluster associated with the Ottawa Valley and Western Quebec. One earthquake with a magnitude between 5.0 and 5.9 was recorded approximately 100 km south of the DN site.

Seismic Assessment in Relation to the DNGS Site

This seismic discussion is presented to update recent information on seismic assessment in relation to the DNGS site.

Consistent with the regulatory requirement to examine aspects affecting life extension of nuclear power plants as well as guidance from other sources, evaluations of the effects of seismicity on existing nuclear power plant facilities are based on probabilistic methods for the assessment of earthquake ground shaking hazard.

The DNGS probabilistic seismic hazard assessment (PSHA) and other seismic-related evaluations have been updated to reflect recent findings and refinements regarding: paleoseismicity, magnetic lineaments, earthquake catalogue data, and seismicity in source zones. The following paragraphs summarize the main findings.

Tuttle and Dyer-Williams (2010) performed a paleoseismic investigation of the region (i.e., liquefaction features in river systems and shoreline bluffs) surrounding the Darlington site to look for evidence of past large earthquakes. It identified paleoearthquakes associated with the river systems but not the shoreline bluffs. The study estimated the Moment Magnitudes and relative weighting for different paleoearthquake scenarios and incorporated this into the PSHA as alternative maximum observed earthquakes for the regional seismic source hosting these earthquakes.

A lineament is a linear feature seen in topography, bathymetry, or geophysical data. Some lineaments have no connection with deeper geological processes such as earthquakes. Some other lineaments may correspond to geological features, either ductile (ancient shear zones) or brittle (joints or faults). Experience has shown that even if a lineament is associated with a fault, almost all faults in

Eastern Canada have not moved for many millions of years and have no evidence for more recent activity (less than 10,000 years) (NRCan 2011b).

Vasudevan and Eaton (2009) assessed the correlation between magnetic lineaments and recorded earthquakes and earthquake clusters in regions with both low and high seismicity and concluded that unless magnetic lineaments are strongly associated with recorded earthquake epicenters, magnetic lineaments per se are not reliable identifiers of local seismic sources.

The most recently available earthquake data from Canadian and United States sources, along with specific earthquakes documented in recent research, were added to the project earthquake catalogue. Appropriate scalings, conversions and corrections were applied to the data. The updated earthquake catalogue was incorporated into the PSHA model.

Local seismic source zones (see figure 6.3-1 in the EIS) were evaluated as contributors to the seismic hazard. The seismogenic potential of Niagara-Pickering Linear Zone, based on recent research (e.g., Vasudevan and Eaton (2009)), was reduced from 0.35 to 0.12. This reduces the potential rupture length, maximum magnitude and its effect on the hazard at the DN site. The Mississauga Magnetic Domain was assessed a probability of being seismogenic of 0.2. The Clarendon-Linden fault system is the local source with the highest (0.4) seismogenic potential. The modified seismogenic potentials of the local source zones were incorporated in the PSHA model.

Many of the large source zone models based on geologic/tectonic structures have the DN site located in a source that includes high rates of activity. The assumption of uniform seismicity within large source regions was dropped from the PSHA model because techniques used for seismicity modeling can allow for spatially varying rates within a source (OPG 2011c).

The ground shaking hazards were then derived from the model as rock outcrop uniform hazard response spectra (UHRS) and were used in the DARA seismic PRA (OPG 2011d). The effects of the updates described previously in this section and in section 6.3 of the EIS can be seen in the reduced DARA UHRS spectral accelerations compared to that of NND.

<u>Results of the Updated Seismic Hazard on DNGS</u>

Seismically qualified safety-related DNGS structures, systems and components were designed in the 1980s for a design basis earthquake (DBE) determined for the DN site in accordance with the CSA N289 series of standards. The DNGS DBE was specified at a probability of 1×10^{-3} per year and is represented by a ground response spectrum with a peak ground acceleration of 0.08g.

Current seismic standards, such as CSA N289.1-08 (CSA 2008) require use of the 1×10^{-4} per year probability level for design of new nuclear power plants and for evaluation of the seismic capacity of existing plants. Probabilistically-based Seismic Margin Assessment and seismic PRA are accepted methodologies (e.g., CSA N289.1-08) for evaluation of the effects of lower probability earthquakes on existing plants like DNGS. The ongoing ISR process will examine in detail the current seismic standard relative to the seismic PRA.

Using information from the studies described in section 6.3 of the EIS, OPG has performed a seismic PRA (OPG 2011e) for DNGS. The seismic PRA quantifies the seismic capabilities of safety-related structures, systems and components needed to safely shutdown, remove decay heat, maintain containment function, monitor control systems and limit radioactive material releases following a seismic event. The approximate peak ground acceleration of the DARA mean 1×10^{-4} per year UHRS is 0.11 g (see table 6.3-1 of the EIS). The subsequent analyses in the seismic PRA concluded that the DNGS structures, systems and components can safely shutdown, remove decay heat, maintain containment function, monitor control systems and limit radioactive material releases following the DARA mean 1×10^{-4} per year earthquake ground motion. Therefore, no residual adverse effects due to the seismic hazards effects are expected.

<u>Hazards due to Seismically-related Phenomena</u>

In accordance with industry practice and regulatory guidance (non-EA related), other seismically induced hazards that could also potentially affect the DN site and DNGS structures, systems and components, were evaluated.

Tsunamis are long-period gravity waves generated by seismically-induced sub-aqueous flows or lakebed ruptures resulting in a sudden disturbance of the water surface. Natural Resources Canada has estimated the maximum tsunami wave height to be 1-2 m in Lake Ontario. An earthquake large enough to initiate tsunami waves that would overtop the existing DNGS shoreline protective structures would be of lower probability than 2×10^{-5} per year. Level 1 PRA's permit application of a subjective probability factor of 0.01 when an event is judged to be unlikely to occur based on existing information. This is lower than the DARA mean 1×10^{-4} per year earthquake considered in this EA and as such, reflects an over-estimation of the likely effects from a tsunami. With this context in mind, the margin provided by the shoreline protective structures against a postulated tsunami-initiating regional earthquake and PRA subjective factor, no residual adverse effects due to tsunamis are expected.

Seiches are standing waves which typically occur in closed or partially enclosed bodies of water. The reported wave height of historical seismically-induced seiche events in Lake Ontario is much less than 2 m, which can be accommodated by the shoreline protection at the DNGS site (OPG 2009e). No residual adverse effects due to seismic seiches are expected.

With respect to dam failures, there are no human-built water retaining structures within the Darlington Creek watershed or other DN site vicinity watersheds.

Geotechnical hazards, such as seismically induced slope instability, liquefaction and subsidence have been assessed (e.g., OPG 2011d). The DNGS site has permanent natural and cut slopes. The slopes are designed for static conditions for various groundwater conditions and for the dynamic effects of earthquakes.

Slope design was determined to satisfy the intent of appropriate codes and standards (e.g., National Building Code of Canada).

With respect to liquefaction, the glacial till at the DN site is highly consolidated and is not susceptible to liquefaction. The liquefaction potential of the fill materials (e.g., granular engineered fill) has been considered. The potential for looser sandy materials in the fill is discussed further in OPG's dispositions to technical review comments on the EIS (Comment #53 in OPG 2012). OPG has concluded that there is low potential for subsurface liquefaction in and around the DNGS protected area, and this hazard was therefore screened out from further consideration from an EA perspective. The modification of sedimentary rock outcrop motion by the till and fill materials has been accounted for in the seismic PRA. Relative seismic movements at connections between buried piping and ducts and plant structures have been addressed by design.

The effects of seismically induced geotechnical hazards at the DNGS site and on safety-related DNGS structures, systems and components were evaluated and determined to have been satisfactorily addressed. No residual adverse effects due to seismically-induced geotechnical effects are expected. Details of an EA follow-up program to verify the low potential for subsurface liquefaction in the Protected Area is described in section 12 of this EA Screening Report.

With respect to volcanism, there is no evidence of rocks of volcanic origin or of volcanism having occurred during the most recent geological era within 150 km of the DN site. Volcanism is not considered to be a significant contributor to seismic hazard at DNGS.

8.5 Climate Change

The document entitled *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners* (FPTCCCEA 2003) outlines a procedure within this EA process for assessing whether:

- a proposed project may contribute to greenhouse gas (GHG) emissions
- climate change may have an impact on a project

With respect to GHG emissions, OPG estimated 4,320 tonnes/yr of CO_2-eq during for refurbishment activities, 1,818 tonnes/yr of CO_2-eq during normal operations and 2,710 of CO_2-eq during potential steam generator replacement activities. The Project's GHG emissions in comparison to Ontario's total GHG emissions in any given year (estimated in 2005 to be over 2 x 10^8 tonnes) are negligible (much less than 0.01%).

8.5.1 Impacts from Climate Change

Activities related to the refurbishment phase of the project are relatively short in duration; however, the continued operation phase of the project extends to 2060 and, therefore, may be subject to changes in climate.

The key physical structures and systems of the DNGS that have a potential sensitivity to climate change are:

- power block
- ancillary facilities
- breakwater
- CCW
- stormwater management system
- electrical power systems

The climate change parameters that are considered to have a potential interaction with the DNGS physical structures and systems are:

- precipitation – overall, average precipitation is expected to decrease, but precipitation occurs in a more intense manner
- frequency and severity of extreme weather events – storms, not exclusively precipitation events (e.g., lightning, tornadoes, hurricanes), are expected to be more severe and occur more frequently
- Lake Ontario effects:
  - surface water mixed layers expected to increase by approximately 3-5ºC by 2050 due to warmer air temperatures
  - water levels expected to decrease by as much as 0.49 m; however, it must be noted that the level of Lake Ontario is controlled for navigation purposes

Each of the project's physical structures and systems has been evaluated against each climate parameter and assessed for potential sensitivity. Table 6.4-3 in OPG's EIS provides the results of the screening exercise and identifies the sensitivity ranking assigned for each physical structure or system related to the project. The components interactions deemed as warranting further analysis were assessed to determine: 1) the sensitivity of the project physical structures or systems to the meteorological parameters; and 2) the risk level of any impact to the public or the environment. The one interaction identified from this project is between the stormwater management system and extreme precipitation events and is described further below.

Stormwater management systems are typically sized for the 100-year design storm or the prevailing Regional Storm Event. The effect of exceeding the design capacity of the stormwater system because of an increase in the frequency and/or severity of extreme precipitation events may include overflow of the system and some localized flooding and soil erosion. However, there will be no adverse effects to any structures or equipment at the DNGS nor any risk to the public or the environment as a result of a stormwater system overflow. The stormwater management system for the DN site was designed to meet the requirements of the National Building Code applicable at the time of construction. Similarly, any new structures will comply with the National Building Code in place at the time of construction. Further, any localized soil erosion which may occur due to flooding of the stormwater system is easily repairable as part of the ongoing maintenance program. Should the Regional Storm Event ever be redefined in the future, OPG will re-evaluate the stormwater management system and make appropriate modifications. Given these considerations, no effects from increased frequency and/or severity of extreme precipitation events are expected on the DNGS stormwater management system.

Although this analysis has indicated there is no risk to the public or environment, as part of an adaptive management strategy to be developed for the DN site, the project physical structures and systems that could be affected by a change in climate parameters will be monitored by OPG and modifications implemented, if required.

9 ASSESSMENT OF CUMULATIVE EFFECTS

9.1 Assessment Method

The basic procedural steps that OPG followed in performing the cumulative effects assessment are as follows:

1. Identification of the residual adverse effects of the Project.
2. Identification of other projects or activities whose effects could potentially coincide with the residual effects of the DNGS Refurbishment Project. Consistent with general EA practice, the identification of other projects and activities is limited to the RSA.
3. Determination of the likelihood of coincidence of these effects and any VEC in terms of:
    a. the similarity (type) of effects from other projects and activities that might add to those likely to be caused by the DNGS Refurbishment Project
    b. the timeframe during which these other effects might coincide with those caused by the Project
    c. the geographical area in which these other effects might coincide with those caused by the Project, limited to the effects of other projects located or proposed within the RSA
4. Assessment of the overall cumulative effects and their significance for those Project residual effects which have been determined as likely to coincide with the effects of other projects and activities on any VEC.

A cumulative effect is a residual adverse effect of the project in combination with similar effects of other past, present or foreseeable projects. The effects of past projects and activities are reflected in the baseline conditions of the for the Project. The cumulative effects assessment focuses on the potential of present and future project and activities. Past and existing projects and are described in section 8.2.1 of OPG's EIS and planned and foreseeable projects are described in sections 8.2.2 and 8.2.3, respectively.

This cumulative effects assessment does not consider the potential effects of postulated malfunction or accident scenarios because postulated malfunction and accident scenarios are considered to be hypothetical and have a very low probability of occurrence.

The Project will result in residual adverse effects on the aquatic environment resulting from impingement and entrainment losses associated with continued operation of the once through CCW. No other residual effects are anticipated from this project, and are not considered further for the cumulative effects assessment. It should be noted, however, that radiological health effects, and traffic, air and noise and socio-economic effects were given further special consideration by OPG in a cumulative effects context because of public interest.

9.2 Determination of Effects

9.2.1 Cumulative Effects to Aquatic Environment

Section 8.3.5 of the EIS discusses the screening of the projects and activities that potentially overlap with the Project. Through screening, several facilities in the RSA have been identified as having the potential to contribute to a cumulative effect based on the identified residual effect of the Project:

- DNGS operation (pre-refurbishment operation in parallel with refurbishment outages)
- NND operation
- PNGS operations
- St. Marys Cement operation
- operation and expansion of other municipal water treatment and pollution control plants

The Project predicted some impingement and entrainment losses of aquatic biota and potential residual thermal effects on Round Whitefish embryo survival as a result of the operations of the CCW.

OPG's aquatic cumulative effects assessment focused on the intake end of the station's CCW system and the potential for the continued operation of the intake to interact with the operation of other industrial / municipal water intakes located along the north shore of Lake Ontario within the offshore part of the defined RSA (see table 8.4-1 in the EIS). DNGS, PNGS and the future NND make up 99% of the future flows from water intakes along the north shore of Lake Ontario in the RSA.

The opportunity for temporal overlap of intake effects and diffuser effects of all 14 existing and proposed units at the two nuclear sites (four existing and up to four proposed units at the DN site plus six operational units remaining at the PN site) will be limited as the remaining PNGS units approach the end of their planned service lives. Based on OPG's current business planning for PNGS, the remaining PNGS units are expected to be permanently shut down, one by one, beginning in 2018 and ending in 2020. Overlapping this period, the four DNGS units are expected to be in refurbishment outages from 2016 through 2024, up to two units at a time, and the first two NND units are expected to come into service by about 2020 with up to two additional units by about 2025.

PNGS has also installed barrier nets at its intake, which has resulted in an 80% reduction in impingement. Impingement levels in 2010 at DNGS (274,931 fish) are somewhat less than those occurring 35 km west at PNGS with the barrier net (304,593 fish). A similar or better performance than DNGS is assumed for the NND intake, should a once-through CCW system be chosen. Further, the Government Response (GC 2012) and associated Joint Review Panel (JRP) Report (JRP 2011) for the NND Project identify impingement/entrainment-related measures (e.g., JRP Recommendation # 32) that will further reduce impingement / entrainment-related effects for NND. In addition, under NND, JRP Recommendations #33 and 37 along with the associated Government Response (GC 2012) are intended to address cumulative effects related matters.

At PNGS, regulatory authorities (CNSC and Environment Canada) and OPG have determined that there is an adverse effect on Round Whitefish due to thermal discharges and are currently determining the path forward on this matter. Metapopulation linkages along the northshore for this species are unknown; however, the JRP Report (JRP 2011), specifically JRP Recommendation #29, directs DFO to require OPG to better define Round Whitefish population elements.

For NND, should a once through CCW system be chosen, the Government Response (GC 2012) and associated JRP Report (JRP 2011) identify thermal-related measures (e.g., JRP Recommendation #s 32 and 34) that will further reduce thermal-related effects.

Finally, OPG has committed to a RWAP (see section 4.3.4 in this EA Screening Report) with key regulatory stakeholders to gain a better understanding of the current status of the Round Whitefish and the effects that may be contributing to its population decline and to provide a long-term framework for assessment and potential management actions.

Adverse cumulative effects of the impingement and entrainment losses associated with individual power plant CCW intakes and other industrial / municipal water intakes is not measurable for aquatic life at the population level. Thermal contributions from other industrial / municipal water users are likely negligible given the low intake flows when compared to the current and future nuclear generating stations. Therefore, no mitigation measures beyond those already proposed for the Project and the NND Project (including the additional mitigation and monitoring undertaken during the NND EA review process) are considered necessary. In addition, the adaptive management element of the RWAP and the adaptive management framework outlined in section 12.2 of this EA Screening Report will ensure that future changes to the climate and Lake Ontario ecosystem and subsequent potential changes to thermal, impingement and entrainment effects are considered appropriately.

9.2.2 Radiological Effects to Humans

No adverse residual radiological health effects were predicted due to the very low emission and exposure levels expected with the proposed Project design and mitigation measures. The human health component of radiation and radioactivity were given further special consideration in a cumulative effects context because of public interest.

For OPG's screening of potential interactions of radiological effects between the DNGS and other projects, the only other projects and activities with radiological dose effects that overlap the dose effects of the Project both temporally and spatially, are located within the DN site (i.e., DWMF operation and expansion, NND operation, DNGS decommissioning).

Cumulative Dose to Members of the Public

Cumulative radiation doses to members of the public due to low levels of radiation from the Project, together with low levels of radiation from the other identified present and future on-site projects and activities were estimated. The total annual cumulative dose to members of the public at the DN site boundary is estimated to be less than 0.007 mSv/year. This is less than 1 % of the 1 mSv/year regulatory limit for members of the public.

No residual adverse human health effects are considered likely to result from the estimated low cumulative dose to the most exposed members of the public. No mitigation measures beyond those already identified for the existing DNGS operation and the Project are considered necessary.

Cumulative Dose to Workers at the DN Site

The dose contributions from all past, present and future nuclear projects and operations at the DN site (as listed in table 8.4-3 of the EIS) are included in the occupational dose measurements when/as those activities occur. The dose planning and monitoring program for the DNGS Refurbishment Project will implicitly incorporate the dose contributions from all on-site operational and refurbishment activities.

For all NEWs involved in the Project and other on-site operational and refurbishment activities, the annual cumulative doses are expected to remain well below the regulatory limit (100 mSv per five-year dosimetry period with a maximum of 50 mSv in any one-year dosimetry period).

No residual adverse human health effects are considered likely to result from the expected low cumulative doses to on-site workers. No mitigation measures beyond those already identified for the existing DNGS operation and the Project are considered necessary.

9.2.3 Cumulative Effects of Growth and Development

No adverse residual traffic, air and noise and socio-economic effects are likely to result from the Project. The local community raised concerns regarding the concentration of development activities planned for the Municipality of Clarington (i.e., OPG listed 20 different activities in the EIS). Therefore, the potential cumulative effects were further assessed by OPG based on public concern.

Traffic Effects

Substantial traffic volumes on roadways in the LSA are expected during the Project from the contribution of on-going DNGS operations, the NND project and other foreseeable projects. Planned intersection improvements in the LSA, when completed, are expected to mitigate the combined effects of DN projects and operations, the St. Marys Cement operation and other background traffic.

Traffic effects such as road network improvements are beyond OPG's control and are subject to outside approvals and funding. The potential consequence, if the assumed improvements are delayed or not implemented at all, is that the magnitude and geographical extent of project traffic effects on regional roads could be greater than OPG predicted in the NND EA. OPG has committed to a Traffic Management Plan for the NND project and the Project. Depending on the timing, these projects, the plans will be integrated to ensure that the traffic effects remain as low as predicted in the EIS for both the NND and DNGS Refurbishment projects.

Air and Noise Effects

No residual effects on local air quality or noise were identified as likely to result from the Project which included good industry management practices as mitigation measures for dust related matters. Mitigation measures proposed by the other project proponents, and the provisions of the Region's Master Plan, OPG's proposed Dust Management Program and Nuisance Effects Management Plan for residential properties along transportation routes affected by the NND Project will serve to deal with the cumulative air quality and noise effects of the other seven projects and activities considered in section 8.4.4.3 of the EIS.

Socio-economic Effects

No residual adverse effects on community infrastructure were identified as likely to result from the Project. The water supply and sewage treatment needs of the other projects considered in cumulative effects assessment are not expected to exceed the existing or planned capacities of the municipal system.

10 PUBLIC PARTICIPATION

10.1 CNSC-led Public Participation

10.1.1 Commencement of the Environmental Assessment

The RAs have established a "Registry" for the assessment in accordance with section 55 of the CEA Act. Under the CEA Act, the Registry consists of two complementary components: an Internet site and a project file. CNSC staff posted a Notice of Commencement of the EA for this project on the Canadian Environmental Assessment Registry (CEAR), an Internet site which is established and maintained by the CEA Agency.

10.1.2 Scoping Information Document

CNSC provided the public with an opportunity to comment on the draft Scoping Document, from July 21, 2011 to August 22, 2011. The request for public comment on the draft Scoping Document was posted on the CNSC web site and on the CEAR; emailed to the CNSC subscription list; and mailed directly to stakeholders who had previously expressed an interest in nuclear-related projects. In addition, the draft Scoping Information Document was made available for viewing at various public libraries and mailed directly to Aboriginal groups. In total, 20 different groups or individuals submitted comments during this period. All comments were dispositioned and addressed in the revised Scoping Information Document as appropriate. The proposed Scoping Information Document was considered by the Commission in an abridged hearing, with the Commission approving the Scoping Information Document in October 2011. DFO concurred with the Scoping Information Document as well.

10.1.3 Conduct of Technical Review

All of the technical review comments submitted by the RAs (with expertise being provided by other federal authorities) on OPG's EIS and supporting documentation, and OPG's subsequent dispositions (OPG 2012) are included in CNSC's project file. This document is available to the public upon request through a notice posted on CNSC's website and the CEAR. As well, this document is posted on OPG's website to facilitate public access. OPG's EIS, TSDs and other related information can also be found on OPG's website regarding the DNGS refurbishment project.

10.1.4 Participant Funding

The CNSC announced on January 31, 2012 that it was offering up to $150,000 under its Participant Funding Program to help members of the public, Aboriginal groups, and other interested stakeholders participate in the EA process for the refurbishment and continued operation of the DNGS. The deadline for submitting funding applications to the CNSC was March 30, 2012.

Participant funding was made available by the CNSC:

- for the provision of new, distinctive and valuable information to the CNSC through informed and topic-specific interventions
- to help members of the public, Aboriginal groups, and other interested stakeholders participate in the EA process for the refurbishment and continued operation of the Darlington Nuclear Generating Station (i.e., review and provide comments on the draft EA Screening Report, as well as prepare and participate in the public hearing process for the proposed EA Screening Report in November, 2012)

A Funding Review Committee, independent from the CNSC, was established to review the funding applications received, and to make recommendations on the allocation of up to $150,000 to eligible applicants.

Based on the recommendations of the Funding Review Committee, the CNSC staff have awarded funding to the recipients listed below:

- Williams Treaties First Nation
- International Institute of Concern for Public Health
- Lake Ontario Waterkeeper
- East Toronto Youth Nuclear Group
- Northwatch
- Durham Nuclear Awareness

Further information on participant funding specific to this Project and CNSC's Participant Funding Program in general can be found at: http://www.nuclearsafety.gc.ca/eng/getinvolved/participant-funding-program/index.cfm

10.1.5 Draft EA Screening Report

The draft EA Screening Report will be made available for review and comment starting on June 4, 2012 for a period of 45 days ending July 18, 2012. The draft report and an invitation to comment on it will be sent directly to federal authorities, relevant provincial authorities and Aboriginal groups. A letter will also be sent to interested parties informing them that the draft EA Screening Report is available for review and comment. The draft EA Screening Report will be made available at the Oshawa and Bowmanville libraries and the CNSC Library. A notice of the availability of the report will be posted on the CNSC web site and the CEAR, and emailed to the CNSC subscription list.

10.2 Proponent-led Public Participation

OPG initiated a communications and consultation program for the Project from its commencement in February 2010 through to submission of the EIS to the CNSC and will continue throughout the regulatory process and beyond. The program is intended to fulfill all of the consultation requirements specified in CEA Act and

NSCA legislation. A range of stakeholders was identified from, but not limited to, the following categories:

- federal government departments and agencies responsible for review or with a role in the EA and project approval process (including the CNSC)
- provincial government ministries and agencies
- regional and local municipal government agencies
- Aboriginal peoples (special engagement program)
- conservation authorities
- elected officials (all levels of government)
- local, regional and national non-governmental organizations
- residents/general public
- OPG employees
- print and broadcast media

In addition to pre-submission meetings with federal, provincial and municipal government departments, ministries and agencies, various methods were used to communicate and consult with the public and other stakeholders. These included:

- initial notification letters to stakeholders regarding the commencement of the EA and subsequent update letters in the spring and fall 2011
- a series of three Project EA newsletters to date distributed to approximately 96,000 households and businesses in the local communities informing them about the EA studies for this Project and how they could provide input
- a Project website established to provide information to and receive input from interested persons as an enhancement of the public consultation program
- a toll-free phone line was established to provide an opportunity for individuals in the community and other stakeholders to contact the EA study team to obtain information, ask questions and voice their comments or concerns

More active methods included:

- regular meetings with existing and new stakeholder committees, including the Durham Nuclear Health Committee, the Pickering Community Advisory Committee, the Darlington Community Advisory Committee, and the Darlington Planning and Infrastructure Information Sharing Committee
- periodic briefing sessions and workshops with key stakeholders, including:

    - three site stakeholder workshops consisting of an introductory session in September 2010, a workshop focusing on VECs in November 2010, and a workshop focusing on potential effects of the Project and mitigation measures held in May, 2011
    - roundtable discussions with labour and education groups and non-governmental organizations
- community information sessions in Bowmanville, Newcastle, Courtice and Oshawa in June 2011 whose purpose was to provide an update to community residents with preliminary results from the EA studies, solicit public feedback (e.g., mitigation, cumulative effects, significance criteria) and inform residents about details of the Project to date

As part of the consultation program, OPG offered funding to local municipalities to enable them to undertake independent technical peer reviews of the EIS and ensure that municipal concerns are addressed. The Municipality of Clarington and the Region of Durham both accepted this offer.

OPG provided opportunities for employees to learn about and discuss the Project EA through a number of forums, including employee Lunch and Learn sessions, employee information sessions, articles in employee newspapers and an internal Project web site.

OPG also undertook a special program for engaging Aboriginal stakeholders which is summarized below.

OPG solicited the views of First Nations, Métis councils and other Aboriginal organizations that may have a historical relationship with, or interest in, the RSA for this project which extends approximately 20 km east, west and north of the DN site. This is the area within which there is the potential for cumulative biophysical and socio-economic effects.

Information sharing and engagement was undertaken at key points in the Project to ensure that identified First Nations, Métis councils and organizations had adequate time to receive notification of developments and information about the project, and share information should they wish to do so. These included notification and update letters, and associated follow-up calls; engagement activities with Métis groups; and a round table discussion with Alderville First Nation and the Mississaugas of Scugog Island First Nation.

Documentation, tracking and follow-up of all stakeholder contacts, comments and questions were an important aspect of the communications and consultation program for the Project. OPG developed and maintained a stakeholder comment database throughout the EA studies to track all stakeholder comments and issues, as well as the responses provided.

11 CONCLUSION

CNSC staff and DFO along with federal authorities reviewed the EIS and supporting information by OPG. On the basis of its review of the documentation, CNSC staff and DFO conclude that, taking into account the findings of the EIS, including the identified mitigation measures, the works and activities associated with the DNGS Refurbishment and Continued Operation Project are not likely to cause significant adverse effects on the environment.

This conclusion serves as the basis for recommending to the Commission and DFO to take a course of action in accordance with subsection 20 (1) of the CEA Act to determine that the project is not likely to cause significant adverse effects on the environment.

12 FOLLOW-UP PROGRAM

12.1 Follow-up

The Scoping Information Document requires that the assessment include a preliminary design and implementation plan for a follow-up program. Section 12.0 of the EIS provides this preliminary plan for follow-up.

The follow-up program for this project would be conducted as per the requirements set out in the CEA Act. As per subsection 38(1) of the CEA Act, CNSC and DFO as RAs consider that a follow-up program for this project is appropriate in the circumstances and delegate the design of the follow-up program (as per subsection 17(2) of the CEA Act) to OPG. Details of the program will be developed in consultation with the RAs and other stakeholders as appropriate. Should this project proceed to licensing under the NSCA or authorization under the *Fisheries Act*, conditions can be included in these regulatory instruments to ensure that the components of the follow-up program are implemented.

The proposed schedule would be developed after, as appropriate, statistical evaluation of the length of time needed to detect effects given estimated baseline variability, likely environmental effect size and desired level of statistical confidence in the results (Type 1 and Type 2 errors). To address this, OPG proposes that a consultative process begin in 2013, with the appropriate federal regulators, to determine the aspects of the EA Follow-up Program that require confirmatory baseline data to determine measurable environmental change to verify EA predictions.

New mitigation measures would be justified if either the implemented mitigation measures were found to be ineffective, or would be justified if unforeseen adverse effects were observed through the follow-up monitoring. This process would help ensure continual improvement in the environmental performance of DNGS. If the results of the monitoring program provide results that do not prove useful in assessing the effectiveness of mitigation measures, the RAs would determine whether it was more appropriate to revise the monitoring program or whether mitigation was warranted on the basis of a precautionary approach.

Table 12.1-1 provides a listing of the follow-up activities that will be specifically developed for the Project. It is anticipated that many of these activities will be incorporated into DNGS's overall Environmental Management System or through other mechanisms like the RWAP.

The proposed approach for developing the details of the follow-up is as follows: 1) review the preliminary program; 2) determine the scope and timing of each of the identified program elements (including details of the monitoring parameters, locations, frequency, duration); 3) identify how the proposed program elements might be incorporated into or coordinated with impending or on-going DN Site monitoring programs; 4) determine the frequency and the method of reporting results to the RAs, public and other stakeholders; 5) review the details of all proposed program elements with the RAs and other regulatory agencies, as appropriate; 6) review and discuss the program with other stakeholders, as appropriate; 7) incorporate appropriate elements of the program into the existing or ongoing DN Site and monitoring programs; 8) determine decision points which monitoring and mitigation measures may need to be revised based on exceeded thresholds, occurrence of unforeseen effects, and other established criteria; and 9) identify appropriate measures that may be taken to rectify unacceptable results, such as to mitigate any unpredicted adverse effects or to improve the effectiveness of specific aspects of the monitoring and reporting.

Table 12.1-1 Follow-up Activities

Environmental Component	EA Prediction or Mitigation Measure	Methods	Expected Timing and Duration
Surface Water	No residual adverse effects from liquid effluents.	Review the DNGS effluent monitoring program relative to that of applicable CSA standards and subsequent confirmation through applicable ERA results in order to verify the EA predictions related to liquid effluents. At a minimum, this shall include: ▪ broad spectrum characterization of effluent (parameters beyond those currently contained in license/permits) ▪ screening of these parameters for inclusion in the site's operational ERA ▪ review of the adequacy of the existing effluent and environmental monitoring programs based on the site's ERA	To be coordinated with OPG's review of new standards against current programs
Surface Water	No residual adverse effects to stormwater quality.	Conduct a Stormwater Control Study for areas that are subject to refurbishment activities within the protected area during the refurbishment of the first unit for two representative storm events (spring and summer storm) to confirm that the project has not adversely affected storm water quality. OPG to analyze the stormwater based on historical findings, including, but not limited to, MISA parameters such as total suspended solids, total phosphorus, aluminum, iron, oil and grease, ammonia and ammonium and chemical oxygen demand.	One season of monitoring is proposed during the Refurbishment phase. The need for additional monitoring beyond one season will be determined based on the monitoring results.

Environmental Component	EA Prediction or Mitigation Measure	Methods	Expected Timing and Duration
Aquatic Habitat / Biota	No significant residual adverse effects to Round Whitefish as a result of thermal discharges.	Monitor data on cooling water discharge temperature and plume characteristics and interpret in relation to fish habitat and susceptibility of VEC species. Temperature criteria and other assessment metrics based on Griffiths (1980) will be compared with the results of the ongoing CANDU Owners Group study examining thermal effects to Round Whitefish eggs.	Two monitoring periods are planned (not withstanding any additional monitoring to be developed as part of an adaptive management program): ▪ One winter season (November to April) during the Refurbishment phase ▪ One winter season (November to April) following restart of all reactors The comparison with the CANDU Owners Group study will occur once the study is published.
Aquatic Habitat / Biota	No significant residual adverse effects to aquatic biota as a result of impingement and entrainment.	Monitor entrainment and impingement mortality associated with the DNGS intake.	Three components make up this program (not withstanding any additional monitoring to be developed as part of an adaptive management program): ▪ Entrainment monitoring with larger sample size and invertebrate component – prior to refurbishment outage ▪ Benthic invertebrate community study - prior to

Environmental Component	EA Prediction or Mitigation Measure	Methods	Expected Timing and Duration
			refurbishment outage ▪ Impingement and entrainment – two years of monitoring following restart of all reactors
Malfunctions and Accidents	Design changes related to SIOs will reduce accident frequency achievable.	The assignment of probabilities to represent the SIO design changes is judged to be sufficient to approximate the reduction in accident frequency achievable. Per the requirements of CNSC S-294, the station PRA will be updated to reflect the detailed design and as-installed configuration prior to bringing refurbished units back on-line.	Prior to bringing refurbished units back on-line with updates provided to CNSC as part of this process.
Effects of the Environment on the Project	Low potential for liquefaction potential of fill materials in the Protected Area.	Undertake a full review of available documentation regarding fill materials and their liquefaction potential in the Protected Area. Should sufficient verification not be realized for the prediction of low liquefaction potential, OPG shall undertake a liquefaction assessment of fill materials as appropriate.	Prior to bringing refurbished units back on-line.

12.2 Adaptive Management

The EA Follow-up Program will include adaptive management in both its design and implementation where appropriate. The EA Follow-up Program will develop an environmental monitoring program capable of measuring change at a resolution sufficient to prevent unacceptable effects to a sensitive receptor, such as a VEC or indicator species.

The general framework that will be further developed between OPG and the RAs to incorporate adaptive management into the EA Follow-up program as follows:

1. Develop environmental monitoring including performance thresholds.
2. Implement environmental monitoring.
3. Review environmental monitoring results. If a performance threshold is exceeded then:
   a. assess implementation of economically achievable mitigation options
   b. implement compensation if warranted
   c. repeat monitoring per step 2
4. Environmental Program Review (Continuous Improvement) – repeat per step 1.

<u>Impingement and Entrainment</u>

In the event that an adaptive management performance threshold is exceeded in the future (e.g., "unacceptable" levels of impingement and entrainment losses especially in reference to provincial or federal species at risk), OPG will consider and document the mitigation options that may be feasible as part of the development of a CCW adaptive management plan. Mitigation options will be assessed to determine if the measures are economically achievable to return the system performance to the acceptable level. Mitigation options that may be considered in the future as part of the adaptive management program could include a fish return system, indirect intake modifications (fish deterrent systems) and direct intake modifications (physical intake barriers).

If CCW adaptive management mitigation options are not found to be economically achievable in the future, commensurate to the environmental risk/effect, OPG would propose compensatory measures to address any potential loss to the fisheries habitat, prioritized as follows; 1) restoration, 2) creation, and 3) enhancements.

OPG has produced a draft adaptive management framework that expands upon the matters outlined above (Senes and MMM Group 2012).

Thermal Effects

In the event that future monitoring provides new insights (i.e., exceedance of a performance threshold), OPG would employ the adaptive management process as generally described above to ensure that the potential for effects are managed appropriately. This would include a review of available thermal discharge mitigation techniques to determine if additional technically and economically feasible opportunities are available to further reduce the potential for effects during the Continued Operations phase. This is specifically identified as a future environmental management option to address potential concerns for Round Whitefish eggs and larvae, should the potential effects of climate change cause, for example, significant increases in winter season lake bottom temperatures. If thermal mitigation options are not found to be economically achievable in the future, commensurate to the environmental risk/effect, offsetting measures to address any potential loss to fisheries will be implemented by OPG, prioritized as follows; 1) restoration, 2) creation, and 3) enhancements.

13 REFERENCES

13.1 List of OPG Documents

Environmental Impact Statement – SENES Consultants Limited and MMM Group Limited

Atmospheric Environment TSD – SENES Consultants Limited

Malfunctions and Accidents TSD – SENES Consultants Limited

Geological and Hydrogeological Environment TSD – CH2M HILL Canada Limited

Surface Water Environment TSD – Golder Associates Limited

Aquatic Environment TSD – SENES Consultants Limited

Terrestrial Environment TSD – Beacon Environmental Limited

Traffic and Transportation TSD – MMM Group Limited

Socio-Economic Environment TSD – AECOM Canada Limited

Land Use TSD – MMM Group Limited

Non-Human Health (Ecological Risk Assessment) TSD – SENES Consultants Limited

Aboriginal Interests TSD – SENES Consultants Limited

Human Health TSD – SENES Consultants Limited

Physical and Cultural Heritage Resources TSD – Archaeological Services Incorporated

Radiation and Radioactivity Environment TSD – SENES Consultants Limited

Communications and Consultation TSD – Haussmann Consulting Incorporated

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14 ABBREVIATIONS AND ACRONYMS

AAQC	Ambient Air Quality Criterion
ACU	Air Cooling Unit
ALARA	As Low As Reasonably Achievable
CCW	Condenser Cooling Water (also Condenser Circulating Water)
CCME	Canadian Council of Ministers of the Environment
CEA Act	*Canadian Environmental Assessment Act*
CEAR	Canadian Environmental Assessment Registry
CFVS	Containment Filtered Venting System
CN	Canadian National
CNSC	Canadian Nuclear Safety Commission
CofA	Certificate of Approval
COPC	Constituent of Potential Concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
D_2O	Deuterium Oxide (heavy water)
DARA	Darlington Risk Assessment
DBE	Design Basis Earthquake
DFO	Fisheries and Oceans Canada
DN	Darlington Nuclear
DNGS	Darlington Nuclear Generating Station
DSC	Dry Storage Container
DWMF	Darlington Waste Management Facility
EA	Environmental Assessment
EFADS	Emergency Filtered Air Discharge System
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	*Ontario Endangered Species Act*
FFAA	Fuelling Facilities Auxiliary Areas
GHG	Greenhouse Gas
HWSB	Heavy Water Storage Building
IFB	Irradiated Fuel Bay
IGLD	International Great Lakes Datum

ILW	Intermediate Level Waste
ISR	Integrated Safety Review
IWST	Injection Water Storage Tank
L&ILW	Low and Intermediate Level Waste
LOMU	Lake Ontario Management Unit
LSA	Local Study Area
MISA	Municipal/Industrial Strategy for Abatement
MNO	Métis Nation of Ontario
MWAT	Maximum Weekly Average Temperature
NEW	Nuclear Energy Worker
NND	New Nuclear – Darlington
NSCA	*Nuclear Safety and Control Act*
OBT	Organically Bound Tritium
OMNR	Ontario Ministry of Natural Resources
OMOE	Ontario Ministry of the Environment
OPG	Ontario Power Generation Inc.
PDS	Plant Damage State
PHTS	Primary Heat Transport System
PNERP	Provincial Nuclear Emergency Response Plan
PNGS	Pickering Nuclear Generating Station
PRA	Probabilistic Risk Assessment
PROL	Power Reactor Operating License
PSHA	Probabilistic Seismic Hazard Assessment
PSVS	Powerhouse Steam Venting System
PWQO	Provincial Water Quality Objective
RA	Responsible Authority
REMP	Radiological Environmental Monitoring Program
RMT	Radioactive Material Transportation
RSA	Regional Study Area
RWC	Retube Waste Containers
RWAP	Round Whitefish Action Plan
RWSB	Retube Waste Storage Building
SARA	*Species At Risk Act*

SGSB	Steam Generator Storage Building
SHTS	Secondary Heat Transport System
SI	Screening Index
SPM	Suspended Particulate Matter
SSA	Site Study Area
TRF	Tritium Removal Facility
UFDS	Used Fuel Dry Storage
UHRS	Uniform Hazard Response Spectrum
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
VEC	Valued Ecosystem Component
VOC	Volatile Organic Compound
WSP	Water Supply Plant
WWMF	Western Waste Management Facility