SUBMISSIONS TO CNSC
ON OPG'S PROPOSAL TO REFURBISH
FOUR DARLINGTON NUCLEAR REACTORS:

OR HOW NOT TO EXTEND THE LIFE OF AGING REACTORS IN ONTARIO

July 18, 2012

Sierra Club Canada
www.sierraclub.ca

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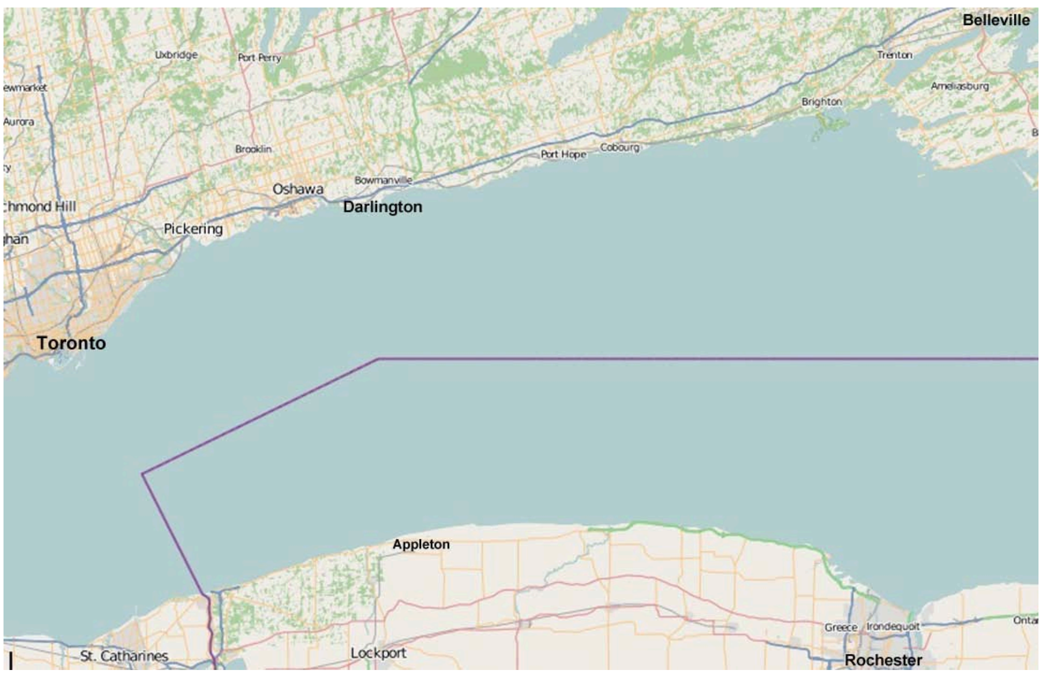
1. INTRODUCTION

These are the submissions of Sierra Club Canada and the Sierra Club Canada, Ontario Chapter to the Canadian Nuclear Safety Commission (CNSC) about the many inadequacies of the Environmental Impact Statement (EIS) prepared for the Darlington Nuclear Generating Station Refurbishment and Continued Operation Project (DNGS Project) proposed by Ontario Power Generation Inc. (OPG). The project is located on the Darlington Nuclear (DN) site on the north shore of Lake Ontario, approximately 70 km east of Toronto and approximately 60km from Appleton, New York, if measured from shore to shore.



Source: openstreetmap.org

OPG say the project will only result in one residual effect – fish impingement from the intake pipes - that's it. OPG states that this conclusion is particularly noteworthy since no residual radiological health effects on humans or non-human biota were determined likely as a result of the deconstruction, the rebuild, the continued operations, or as a result of malfunctions or nuclear accidents. The cracking of aging concrete containing the old reactors is evidently not a cause for concern for OPG since it was never mentioned, let alone assessed, in the extensive thousand page report.

Statutory Requirements

Even before public hearings on the CNSC's Scoping Document of the project are held – expected in November of 2012 – a $600-million contract has already been awarded to SNC Lavalin to begin planning the refurbishment.

According to the CEAA (s. 11), as early as practicable in the planning stages of the Project and before irrevocable decisions are made, the necessary EA must be completed satisfactorily before the CNSC can make any decision with respect to a license amendment. The CNSC cannot grant requisite license amendments until it is satisfied that the Project will not likely cause significant adverse environmental effects taking into account the implementation of mitigation measures. Before issuing any license amendments under the NSCA, the CNSC must be satisfied that, based on the Screening Report and taking into account mitigation measures, there will be no "significant adverse environmental effects" (CEAA, Section 5, Subsection 20 (1)), see EIS section 1.2.1.4.

Given the Government of Canada and Ontario's domestic, regional and international obligations, the abject failure to establish and enforce protective human health and environmental nuclear-related standards is clearly unacceptable, as is the federal and Ontario governments complicity in an environmental assessment lacking both substance and process.

2. HIGHLIGHTS

There are a number of significant adverse, indeed catastrophic, human health and environmental effects of the project that have not been adequately addressed, let alone assessed or regulated either in Ontario or in the Great Lakes region.

In particular, there is no safe exposure to Tritium: see *Tritium on Tap – Keep radioactive tritium out of our drinking water*, SCC, 2009, www.sierraclub.ca/en/publications/tritium-tap.

Tritium is a known carcinogen, and is also known to cause birth defects. Tritium replaces ordinary non-radioactive hydrogen and travels throughout the body in organic compounds found in food. Once in the human body, tritium - radioactive hydrogen atoms - disintegrate inside DNA, ejecting high-velocity beta particles that can break chemical bonds. The UK's *Committee Examining Radiation Risks of Internal Emitters* (CERRIE) calls attention to the dangers for pregnant women and fetuses. Ingestion, inhalation or absorption of tritium can lead to stillbirths and malformations. It has also been established that there are higher rates of childhood leukemia near nuclear plants in Canada, Germany and the United States – the result of chronic exposure to radioactive pollution from reactors. *Tritium on Tap*, p. 11

The acceptable drinking water guideline for tritium in Canada is 7,000 becquerels per litre (bq/L). By contrast, the European Union guideline is 100bq/L. California's Public Health Goal calls for a limit of 14.8 bq/L. OPG claims a Voluntary Commitment Level for Annual Average Tritium Concentrations at only nearby water supply plants at 100 Bq/L (OPG 2010). However, any release of Tritium into the water supply is contrary to the public interest.

Our review of the EIS highlights the following issues:

2.1 Compromised Concrete to Containment Structures

- OPG failed to consider, and the CNSC has so far failed to require, an analysis of the alkali-silica reaction (ASR) in aging nuclear containment structures. This reaction is caused by the interaction of water and concrete and is identified as the cause of degradation in nuclear containment structures.
- At the Seaborne Nuclear station in the United States, structural integrity issues include:
    - how the concrete has already been affected by the reactions,
    - what effect the reactions have had on the rebar that supports the concrete, and
    - the rate of degradation, given the strength of the concrete had been reduced by 22 percent compared to samples taken at the time the concrete was poured in 1979, causing stress, cracking and larger fissures.

    For more information see: www.seacoastonline.com/apps/pbcs.dll/article?AID=/20120424/NEWS/204240409/-1/NEWSMAP (Seacoastonline, April 24,2012)
- At Quebec's sole atomic power station, Gentilly-2, eroding concrete has prompted the CNSC to suggest that any provincial attempt to refurbish and re-license the 30-year-old plant must satisfy federal concerns over the

aging concrete's ability to stand up to another two or three decades of service.

Of particular concern for any "life extension" is the dome-shaped containment building that encloses the 675-megawatt CANDU 6 reactor, which sits on a seismic fault line. The metre-thick, steel-reinforced concrete structure serves as the final physical barrier against radioactive contamination escaping into the atmosphere, says a 2010 report by CNSC.

Despite those long-term concerns, the CNSC last year renewed the plant's operating license until 2016

For more information see: http://news.nationalpost.com/2012/07/08/decaying-concrete-raising-concerns-at-canadas-aging-nuclear-plants/ (National Post, July 8, 2012).

2.2 2009 Tritium Spill by OPG Compromised EIA Results

- OPG admits that water quality samplings referred to in the EIS are compromised because of a 2009 spill of tritium-contaminated water, see 4.6.4. 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.
- OPG says sampling results at the water supply plants did not indicate any measurable impact on drinking water supplies with an average result between 8 to 9 Bq/L, which is less than typical background levels of 12 Bq/L.
- According to OPG, the yard drainage system in the incident area was "cleaned" to remove any residual spill water and we are assured that follow-up sampling confirmed that there was no significant amount of residual spill water that could be discharged to the lake. Surface soil samples, taken from the spill area, were analyzed and the results show tritium levels below the Ontario Drinking Water Standard of 7,000 Bq/L. but no precise number was given.

- Groundwater samples collected from monitoring wells and drains sump boxes during this EA indicated tritium levels above the 7,000 Bq/L standard. At the site, the tritium concentration increased from 513 Bq/L (Dec 15, 2009) to 19,100 Bq/L (April 19, 2010) and was at 1,350 Bq/L on September 27, 2010. This increase and decrease in the tritium concentration is a result of the IWST spill, see 4.6.4. Predictive modelling of the likely fate of the tritium in groundwater resulting from the IWST spill suggested that the plume's eventual discharge into the Forebay, and then Lake Ontario.

2.3 Damage from Refurbishment and Continued Operations

AIR

- There are no specific regulatory limits on tritium concentrations in air. However, such concentrations are allegedly implicitly limited by the regulatory dose limit, see 4.7.3.1. In the Regional Study Area, the annual averages of the measured tritium concentrations in 2009 ranged from 0.2 to 0.3 Bq/m^3. These values are higher than the annual average concentrations measured in 2009.
- Even where there are no or low standards, and even when OPG admits that the refilling, refueling and restarting of the reactors during the refurbishment will likely cause air emissions, see Table 5.2-1, no adverse or residual effects to Air Quality are considered by OPG to be significant.
- As shown in Table 3.3-5, the measured C-14 concentrations in air in 2009 at locations within the Site Study Area ranged from 267 to 272 Bq/kg-C, which is slightly higher than the C-14 concentrations in air measured in 2009 at provincial background locations (232 to 266 Bq/kg-C), but similar to those concentrations measured in the Site Study Area using the passive sampler. P 42.
- The external gamma dose rate in air is due to presence of radioactive noble gases, I-131 and skyshine (Ir-192).There is no monitoring of the external gamma dose rate in air from noble gases, I-131 and skyshine (Ir-192) within the Regional Study Area defined in this Environmental Assessment. P 42.

- Even where there may be a standard, regulatory agencies do not have the mandate to monitor and enforce compliance as in the case of radioactive particulate, an important indicator during nuclear malfunctions and emergencies. Health Canada used to report the radioactive particulate deposition rate from at least 25 locations across Canada; however, Health Canada discontinued these analyses in 1997, see 4.7.3.3. OPG does not report annual background measurements.

WATER

- OPG admits that the Operation of Active Ventilation and Active Plant Drainage Systems are likely measureable from the releases of contaminants in the ventilation system and subsequent washout from precipitation, as well as the operation of the stormwater management system, that may contribute to effects on groundwater quality, see Table 5.6-1.
- OPG's assessment failed to consider the impacts of the potential release from the dewatering of the reactors because with its assessment model only "long term changes to the site were simulated as opposed to short-term effects that may be associated with dewatering, for example", see 5.6.3. Groundwater.
- 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 and remain well below the Ontario Drinking Water Standard of 7,000 Bq/L.
- That OPG, let alone CNSC, would consider elevated levels of tritium precipitation at 2,000 Bq/L acceptable, given comparative standards of public acceptability, and would fail to disclose the concentration number from the infiltration of it to groundwater, is an affront to the public interest.
- As shown in Table 3.3-17, all of the radionuclides measured in the stormwater samples are below the corresponding detection limit with the exception of tritium. The tritium concentrations range from 36 to 5,430 Bq/L, which are below the provincial water quality objective (PWQO) and the Ontario drinking water quality standard for tritium of 7,000 Bq/L (MOE 1994, 2007).

SOIL

- There are no specific regulatory limits for radionuclide concentrations in soil; however, radionuclide concentrations in soil are limited implicitly by the regulatory limit on annual dose (from all exposure pathways) to the member of the public. P. 48, technical document. Soil samples are not collected within the Regional Study Area defined in this Environmental Assessment, and are not required for the effects assessment. There are no monitoring locations within the Site Study Area that OPG routinely collects soil samples for radioactivity analysis. P. 49

- There are no specific regulatory limits for the concentration of radionuclides in sediment; however, radionuclide concentrations in sediment are allegedly limited implicitly by the regulatory limit on the annual dose to members of the public, see 4.7.6. But sediment samples are not collected within the Regional Study Area defined in this Environmental Assessment, and are not required for the effects assessment.

2.4 Humans - Radiation Dose to Members of the Public

- Annual radiation doses to members of the public as a result of the operations of the DN site are calculated by OPG. The dose estimates are not required to include those resulting from naturally occurring or anthropogenic radioactivity which is not attributable to the facility. P. 70 As a result, when OPG says the measurement is at or below the implicit limits to the general public that number is site specific and does not take into account cumulative impacts, see 4.7.8.1.

- Collective Dose - There are no regulatory or recommended limits relating to collective dose for humans, where the collective dose is the total dose of radiation that a given population is exposed to. However, collective dose is routinely reported as a measure of ALARA performance for nuclear workers. OPG reports collective dose annually in the CANDU Owners Group, p 79.

2.5 Nuclear Malfunctions and Accidents

- Despite the events at Chernobyl and Fukushima, OPG refuses to consider Nuclear Accidents involving out of core criticality which may result in an "acute release of radioactivity into the environment". Why? According to OPG: "Out of core criticality events are not considered credible scenarios", 7.3.1.

- The credible scenarios are defined as those that have a reasonable probability of occurrence (5% or greater) during the life time of the project. It is in the order of 10-3 per year or greater (MOE 2007c). A creditable scenario does not include a beyond design event to OPG.

- Current seismic standards, such as CSA N289.1-08 (CSA 2008) require use of the 1 x 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. In other words, there are lower standards of protection for older plants, despite concerns with concrete integrity in older plants. OPG is satisfied that earthquakes with recurrence intervals of up to 10,000 years are below OPG's respective limits. Therefore, no residual adverse effects due to the seismic hazards effects are expected by OPG.

2.6 Transboundary Impacts

- Sierra Club Canada gives notice that it intends to invite Sierra Club New York to petition the federal Minister of Environment and Minister of Foreign Affairs to assess the transboundary effects of the proposed project under section 46 of the *Canadian Environmental Assessment Act*. OPG admits the project would cause transboundary air and water pollution, yet it has failed to account for and assess, the likely transboundary environmental and human health impacts of the proposed project. Further, the CNSC has failed to require this information.

- The Ministers are requested to ensure an independent and comprehensive assessment because the project would likely cause significant adverse transboundary environmental effects as set out in the 1991 *Canada-United States Air Quality Agreement*, operationalized by

Article V. Importantly, this EA would not be artificially narrowed by removing the need to consider alternatives to the refurbishment project, as is the case of OPG's current EIS.

3. DESCRIPTION OF PROJECT

The 1990 DNGS reactors are housed in four rectangular, reinforced concrete Reactor Buildings that serve as a support and enclosure for the reactors and some of their associated equipment. The Reactor Vault is that portion of the Reactor Building which forms part of the containment envelope. The vault contains a Reactor Core consisting of the Reactor Assembly (a cylindrical reactor vessel with horizontal fuel channel assemblies) and a number of Reactivity Control Devices.

The Heavy Water Management Systems includes heavy water supply, collection and transfer, "cleanup" and upgrading, and vapour recovery and resin handling systems. The Tritium Removal Facility (TRF) includes processes to "remove" tritium from the heavy water, and store the tritium that results.

The used fuel removed from the reactor is transferred by the fuelling machines to one of two Irradiated Fuel Bays located in the FFAAs. The used fuel is stored in these in-station bays for at least 10 years before being loaded into Dry Storage Containers (DSCs) and transferred to the Darlington Waste Management Facility (DWMF), commissioned in late 2007.

Excluding the heavy water (D20), water for all other purposes is drawn from Lake Ontario through the intake tunnel and into the forebay, which is common to all four units, and from the forebay through separate pumphouses to the individual unit. The Condenser Cooling Water (CCW) System and the Service Water System are served by separate pumps, including intake and waste discharge structures.

Following a period of initial storage for at least 10 years in the Irradiated Fuel Bays, the used fuel is transferred to the DWMF for interim storage until a long-term waste management facility, being developed as part of a federal government program becomes available. Low and intermediate level waste (L&ILW) is packaged in the station and transported to OPG's Western Waste Management Facility (WWMF) at the Bruce Nuclear facilities in central Ontario for processing and storage.

OPG admits that, in general, the limiting factor for the design life of a CANDU reactor is the degradation of reactor components due to their accumulated exposure to operating conditions, see 2.1. According to OPG, refurbishment of CANDU reactors is an aspect of their design and accepted as a requirement at some point in their operational service life. The DNGS reactors were designed for a nominal operating life of approximately 30 years prior to replacement of certain main components. However, OPG fails to directly acknowledge that the integrity of compromised concrete around the containment structures is an emerging issue for refurbishment proposals both in Quebec and the United States.

Without CNSC approval to complete the refurbishment operation, it is currently anticipated that the four DNGS units will be shut down, one by one, from 2048-2055. Consistent with the planning assumption in the Preliminary Decommissioning Plan for DNGS (OPG 2007c), the units could be shut down as early as 2020-2023 (after 30 years of operation) or as late as 2030-2033 (after 40 years of operation), see 8.2.1.

Instead of approving the extension of these aging reactors, we recommend an orderly decommissioning of the reactors, at the earliest possible time.

4. DESCRIPTION OF THE ENVIRONMENTAL INJUSTICE

Given the failure of governments to set and enforce human health and environmental protection standards, large groups of people in Ontario and the Great Lakes are subject to environmental discrimination. In other words, targeted communities are required to suffer a disproportionate amount of adverse health effects and environmental degradation, compared to other populations. This is an affront to their individual and collective human rights.

It is impossible to count how many times OPG was satisfied, in the absence of applicable standards, to claim that the project would not cause measurable change given “background” concentrations of chemical and radioactive contamination. It is as if we say these people are already prostitutes, we are just negotiating the price.

Nuclear Oasis

Dr. Alan Marshall’s “Social Equity in Nuclear Waste Management” explains that the social science literature about radioactive stigma is quite extensive. Dr. Alan Marshall in the Department of Environmental Humanities at the School of Social

Studies at Masaryk University in Brno, Czech Republic in 2005 reviews social science literature concerning siting decisions about radioactive waste dumps and other nuclear power industry facilities in numerous countries around the world.

South eastern Ontario communities host on-site storage of large amounts of both high-level and so-called "low" level radioactive wastes, not to mention "routine" radioactivity and toxic chemical releases into the environment from daily operations at nuclear power plants occur. A dozen OPG Candu reactors operate nearby, and upwind, generating vast amounts of radioactive waste, much of it stored onsite.

The numerous nuclear facilities in the eastern Greater Toronto Area (Pickering nuclear power plant, Darlington nuclear power plant, Port Hope nuclear facilities, etc.) can be regarded as a linear "nuclear oasis," hugging the Lake Ontario shoreline. (Blowers, A., Lowry, D., and Solomon, B.D., 1991, The International politics of nuclear waste, London: Macmmillan; Blowers, A., 1999, Nuclear waste and landscapes of risk, Landscape Research, 24(3), 241-263).

The Greater Toronto Area's nuclear establishment (as at OPG, CNSC, etc.) is very actively attempting to "re-locate" much of its radioactive waste (at Pickering and Darlington nuclear power plants' dozen reactors just east of Toronto, and just west of Port Hope) onto another, more remote "nuclear oasis" – at Bruce Nuclear Complex on Ontario's Lake Huron shore. The Deep Geologic Repository (DGR), or, more aptly, DUD, for Deep Underground Dump for all of Ontario's so-called "low-level" and "intermediate-level" radioactive wastes would provide a "final resting place" for such materials from 20 of Canada's 22 reactors, raising the specter that the two additional reactors (at Point Lepreau, New Brunswick and Gentilly, Quebec) might simply get "lumped in" in the end, making the DUD a national "low" and "intermediate" level radioactive waste dump.

The proposed dumpsite is just one kilometer (about a half mile) from the Lake Huron shore, raising the specter of radioactive leaks into the drinking water supply for many tens of millions of people downstream in the U.S., Canada, and a large number of Native American First Nations on both sides of the border. As more and more of those people downstream learn about the proposal, including those in Michigan, just 50 miles across Lake Huron from Bruce, popular resistance to the proposal will surely intensify.

Given the close proximately of the Darlington nuclear power plants to the United States border, and the predominant wind directions, we anticipate that the refurbishment proposal, if approved, would result in significant transboundary environmental impacts. In light of the federal government's responsibilities under the *Canada – US Air Quality Agreement* and *Canadian Environmental Assessment Act* we are forwarding a copy of our submission to the New York State Attorney General.

To advocate or authorize the building of new or extended nuclear reactors at the Darlington site, knowing what has happened at Chernobyl and at Fukushima, it is not only unwise but could be seen as a crime against current and future generations. Based on the precautionary principle, we need to anticipate, not dismiss, as OPG has done, the worst possible accident scenario at the DN site – partial or complete core meltdowns coupled with partial or complete loss of containment. Recall from Fukushima, meltdowns are inevitable if reactor cooling is inadequate.

5. NO STANDARDS – NO ASSESSMENT

We are assured that each of the relevant Project works and activities was considered individually to determine if there was a plausible mechanism for the Project to interact with the environment. The identification of relevant physical and operational features of the Project and their potential interactions with the environment was based on the experience and professional judgment of technical specialists involved in the assessment, see 3.2.4.

However, this basis of knowledge is obviously not informed by comparative analysis and protective standards.

Similarly, where the likely adverse effect was determined to be measurable but "so small that it was clearly not of concern", no further assessment was conducted. Particularly in the area of Human Health and Radiation, the process by which OPG dismisses what it admits as likely impacts, is almost magical.

Yet OPG says its planning for the mitigation of potential adverse environmental effects is consistent with the precautionary principle as it is outlined in the document published by the Canadian Privy Council Office, Framework for the Application of Precaution in Science-based Decision Making About Risk (CPCO 2003). This included, specifically, recognition of uncertainty inherent in an EA process and the importance of off-setting actions such as peer review of the technical studies supporting the EIS. Given the serious gaps found in the EIS, an independent third party peer review is recommended.

OPG admits that regulatory standards, particularly for its Radiological Environmental Monitoring Program (REMP) are often non-existent. In the discussion of existing conditions in terms of radiation and radioactivity, the data are compared to regulatory limits or standards where they are available and applicable. In cases where reference values are not available, the measured concentrations in the various media are limited implicitly by the regulatory limits on annual dose to the average member of the most highly exposed group in the public, see 4.7

Indeed, OPG concedes that few regulatory criteria relate directly to radionuclide concentrations in the environment (e.g., atmospheric, terrestrial, surface water and aquatic, and geological and hydrogeological components). Nonetheless, radionuclide concentrations in these environmental components are said to be indirectly regulated through the management and control of their consequential effects on humans, as represented by radiation dose limits and to a lesser degree, by consequential effects on non-human biota. Dose limits do not apply, however, in the context of non-human biota.

As we demonstrated, the health based protections for humans, on a comparative basis with other jurisdictions, are not at all adequate for humans, let alone as a reference point for other environmental features, including wildlife.

Transportation of nuclear waste from DNGS to off-site storage or disposal was not determined to be a Project work and activity that would represent a measurable change and possible effect on the environment, see 5.9.1. In any event, OPG expects that the typical rate of L&ILW shipment off-site will be less than 10 shipments per month. This activity will not add measurable additional traffic to the roadways and, according to OPG, does not warrant further consideration from a traffic perspective, see 5. 9.4.2.

5.1 AIR

In particular, there are no specific regulatory limits on tritium concentrations in air, however, such concentrations are implicitly limited by the regulatory dose limit, see 4.7.3.1. In the RSA, the annual averages of the measured tritium concentrations in 2009 ranged from 0.2 to 0.3 Bq/m3. <u>These values are higher than the annual average concentrations measured in 2009.</u>

OPG admits that tritium in air around the Darlington facilities is higher than the provincial average. [1]

Active Ventilation System

The functions of the DNGS 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. So-called "noble gases" are a group of chemical elements with very similar properties. Under standard conditions, they are all odorless, colorless, monatomic gases, with very low chemical reactivity. The six noble gases that occur naturally are helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), and the radioactive radon (Rn). Radon is usually isolated from the radioactive decay of dissolved radium compounds.

According to OPG at 2.5.3.1, gaseous emissions at DNGS are generated as follows:

- Radioiodine is a product of fission reactions which is usually contained within the sealed fuel bundle elements. Gaseous radioiodine may escape into the Primary Heat Transport System (PHTS) if a small defect occurs in a fuel element seal
- Radioactive noble gases are a product of fission reactions and can also be released to the PHTS if a small defect occurs in a fuel element seal. Noble gases cannot be effectively filtered but strict quality control in the manufacturing and testing of fuel elements has resulted in very low noble gas emissions (such emissions are monitored)
- Gaseous tritium in the form of tritiated water vapour is produced in heavy water systems that are exposed to the neutron-rich environment of the reactor core when a deuterium atom (heavy hydrogen isotope) in a heavy

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[1] In the RSA, the annual averages of the measured tritium concentrations in 2009 ranged from 0.2 to 0.3 Bq/m3. These values are higher than the annual average concentrations measured in 2009 at the provincial background locations outside of the study areas of <0.2 Bq/m3 but similar to the concentrations measured in the RSA from 1998 to 2008 (0.2 to 0.6 Bq/m3).

The annual average airborne tritium concentrations measured at locations within the LSA during 2009 ranged from <0.3 to 0.7 Bq/m3 which are higher than the concentrations measured at provincial background locations during 2009 (<0.2 Bq/m3), but similar to the concentrations measured in the LSA from 1998 to 2008 (0.3 to 1.4 Bq/m3).

In the SSA, the annual average airborne tritium concentrations measured in 2009 ranged from 0.3 to 2.1 Bq/m3 which are higher than the concentrations measured at provincial background locations during 2009 (<0.2 Bq/m3), but similar to the concentrations measured in the SSA from 1998 to 2008 (0.3 to 3.9 Bq/m3).

water molecule absorbs a neutron. Ventilation systems continuously monitor for tritium releases and the heavy water is detritiated in the TRF

- Radioactive particulates are formed as products of fission reactions or by neutron absorption in various materials (called "activation products") and released to the Reactor Building or Irradiated Fuel Bays atmosphere
- Carbon-14 is created in the reactor through neutron activation, primarily in the Moderator and released to ventilation exhaust stacks

At times, gases may be contained (delayed) before release to allow time for radioactive isotopes to decay, thus reducing emissions to the environment.

There are no specific regulatory limits on C-14 or External Gamma radiation concentrations in air against which measured data can be compared. Therefore, the measured data is compared against the measured values taken in provincial locations, see 4.7.3.4., and 4.7.3.5.

Even when OPG admits that the Refilling, Refuelling and Restarting of the Reactors during the refurbishment will likely cause air emissions with measurable changes in the Atmospheric Environment, see Table 5.2-1, no adverse or residual effects to Air Quality are considered to be significant, see 5.2.4.3.

Even where there may be a standard, regulatory agencies do not have the mandate to monitor and enforce compliance as in the case of radioactive particulate, an important indicator during nuclear malfunctions and emergencies. Health Canada used to report the radioactive particulate deposition rate from at least 25 locations across Canada; however, Health Canada discontinued these analyses in 1997, see 4.7.3.3. OPG does not report annual background measurements.

5.2 WATER

OPG admits that changes in surface water conditions as a result of the Project may contribute to effects on human health, and on non-human biota, see 4.3.6. In particular, it admits that Tritium and gross beta are emitted from DNGS in liquid effluents and could be ingested by people that get their drinking water from Lake Ontario, see 4.7.5.1. We review the analysis below.

2009 OPG SPILL OF TRITIUM

OPG states that their sampling results for this EIA were skewed by the 2009 spill at the DN facility. OPG reveals that the water quality samplings in this EIS are compromised because of the 2009 spill of tritium-contaminated water, see 4.6.4. 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.

Sampling results at the water supply plants (on an increased frequency) did not indicate any measurable impact on drinking water supplies with an average result between 8 to 9 Bq/L which is less than typical background levels of 12 Bq/L.

At the site, the tritium concentration increased from 513 Bq/L (Dec 15, 2009) to 19,100 Bq/L (April 19, 2010) and was at 1,350 Bq/L on September 27, 2010. This increase and decrease in the tritium concentration is a result of the IWST spill, see 4.6.4. Predictive modelling of the likely fate of the tritium in groundwater resulting from the IWST spill suggested that the plume eventually discharges into the Forebay, and then Lake Ontario.

According to OPG, the yard drainage system in the incident area was "cleaned" to remove any residual spill water and we are assured that follow-up sampling confirmed that there was no significant amount of residual spill water that could be discharged to the lake. Surface soil samples, taken from the spill area, were analyzed and the results show tritium levels below Ontario Drinking Water Standard of 7,000 Bq/L.

Groundwater samples collected from monitoring wells and box drains sumps during this EA indicated tritium levels above the 7,000 Bq/L standard. OPG's voluntary commitment level for tritium concentrations at nearby WSPs is an annual average <100 Bq/L, see 4.7.5.1.

OPG concedes that the tritium in groundwater concentrations outside of the IWST spill is the result of atmospheric deposition of tritium from vents and stacks in the Protected Area.

Carbon-14 and gamma-thorium series and gamma-uranium series were also released. Carbon-14 was detected with a concentration of 1.20 Bq/L . The Ontario Drinking Water Standard for Carbon-14 is 200 Bq/L.

All of these numbers are unacceptable.

Regional Study Area

The generic RSA was modified slightly for the Surface Water Environment. The RSA extends along the shoreline approximately 20 km west and east of the DN site and into the Lake approximately 5 km. Based on previous thermal plume modelling results, according to OPG, it is unlikely that the Project would have a measurable cumulative effect on Lake Ontario beyond 5 km from the shore. 4.3.1

Note that this self-imposed limitation on the scope of the EIS discounts the impacts on water quality beyond 5 km from the shore and based on the narrow issue of thermal, that is the heating of the Lake because of elevated temperature of the discharge water, rather than the full range of potential impacts.

5.3 STORMWATER TOXINS

A DNGS Stormwater Monitoring Program was conducted in Fall 2010 and Spring 2011 to update the quality data on stormwater discharges into Lake Ontario within the SSA, see 4.3.4.2.

<u>Concentrations of aluminum, iron, zinc, lead, copper, cobalt and cadmium were elevated</u> in some of the samples collected during the 1996, 2001 and 2010/2011 sampling events. The 2010/2011 average recorded zinc concentration was approximately 54.7 µg/L which exceeds the Provincial Water Quality Objective (PWQO) of 20 µg/L and the Durham Region Sewer Use By-Law limit (40 µg/L).

In short, in 2010/2011, the following metal concentrations were above the Durham Region Sewer Use By-Law limits: copper, lead, zinc and manganese. Concentrations of boron, iron, cadmium, cobalt, copper, Cr(VI), lead, molybdenum, vanadium and zinc exceeded the PWQO guidelines.

Surface Water

OPG admits that the Shutdown, Defuelling and Dewatering of the Reactors are likely to cause measurable changes in surface water related to the release of liquid effluents from various reactor process systems and thermal discharges from the Condenser Circulating Water (CCW) System resulting in changes to the flow dynamics, thermal regime and water quality characteristics in the Lake, see Table 5.3.1. The likely effects include water impacted by radioactive or conventional contaminants, discharged from liquid effluent stream to the environment via the yard drainage system or directly to Lake Ontario, sufficient flow maintained through the CCW system, see Mitigation measures at 5.3.7.2.

Despite these admissions, as well as low or non-existent standards, OPG determined that the only surface water concern that OPG was prepared to admit the project will have potential negative impacts related to fish impingement. Operation of DNGS condenser cooling water system (CCW) involves the return to the lake of warmed water through a series of diffuser nozzles. The continuation of this discharge of warm water to the lake during the Continued Operation phase of the Project has a potential to affect aquatic habitat, see Table 5.4.1.

Yet, as shown in Table 3.3-13, the annual average tritium concentrations measured in the 2009 surface water samples collected from WSPs within the Regional Study Area ranged from 5 to 6.2 Bq/L, which is slightly higher than the tritium concentrations measured at the provincial background locations (<1.8 to 5.2 Bq/L), but within the range of those concentrations measured at WSPs in the Regional Study Area from 1998 and within the Local Study Area ranged from 5 to 6.7 Bq/L and 6.2 to 26.2 Bq/L, respectively. These annual average tritium concentrations are higher than the tritium concentrations measured at the provincial background locations (<1.8 to 5.2 Bq/L). OPG has not conducted sampling of surface water in the Site Study Area since 1999.

Groundwater

OPG admits that the Operation of Active Ventilation and Active Plant Drainage Systems have likely measureable releases of contaminants in the ventilation system and subsequent washout from precipitation, as well as the operation of the stormwater management system, that may contribute to effects on groundwater quality, see Table 5.6-1.

Importantly, OPG's assessment failed to consider the impacts of the potential release from the dewatering of the reactors because with its assessment model only "long term changes to the site were simulated as opposed to short-term effects that may be associated with dewatering, for example", see 5.6.3.

Yet OPG admits that initial dewatering may result in a temporary increase in radiological emissions from Reactor Building ventilation exhaust and from the RLWMS. As described in Section 2.5.3.1, radioactive airborne emissions are monitored and released through the Active Ventilation System. After a unit has been defuelled and dewatered, there will be a reduction in total station liquid effluent discharges (approximately proportional to the number of units shut down) such as cooling water thermal discharge, service water, boiler blowdown and water treatment plant effluent, see 2.4.2.

OPG also admits that emissions of tritium from the operation of DNGS have resulted in elevated tritium concentrations in groundwater in the Protected Area and surrounding it. 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 ongoing operation of the station.

Unsurprisingly, OPG found no residual adverse effects on Groundwater Quality are predicted in the Geological and Hydrogeological Environment as a result of the Project, see 5.6.5.3.

Precipitation

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 and remain well below the Ontario Drinking Water Standards of 7,000 Bq/L.

That OPG, let alone CNSC, would consider elevated levels of tritium precipitation at 2,000 Bq/L acceptable given comparative standards of public acceptability, and would fail to disclose the concentration number from the infiltration of it to groundwater, is an affront to the public interest.

Even where there are standards, they are not protective. The measured tritium concentrations in precipitation in 2009 at locations in the RSA ranged from 7 to 12 Bq/L, which are similar to those concentrations measured in the RSA from 1998 to 2008 (5 to 19 Bq/L). These concentrations remain well below the Ontario Drinking Water Quality Standard for tritium of 7,000 Bq/L. However, the standard does not adequately protect health or the environmental when compared to other jurisdictions.

Moreover, the concentration of tritium is expressed here as background, which is already too high and does not take into account the extra loading from the proposed extension of the life of these four reactors for another 30 to 40 years.

5.4 SOIL AND TERRESTRIAL ENVIRONMENT

OPG admits that radioactivity in soil presents a potential exposure pathway to humans through external gamma radiation, ingestion, inhalation of re-suspended soil and ingestion of vegetables grown in soil, see 4.7.4.2. Soil is also a pathway through animal products via animal consumption.

However, there are no specific regulatory limits for the radionuclide concentrations in soil. Radionuclide concentrations in soil are allegedly limited implicitly by the regulatory limit on annual dose (from all exposure pathways) to the member of the public, but in any event, radioactivity in soil data for the RSA were not compiled.

There are no specific regulatory limits for the concentration of radionuclides in milk, see 4.7.4.4.

There are no specific regulatory limits for the concentration of radionuclides in sediment. However, radionuclide concentrations in sediment are allegedly limited implicitly by the regulatory limit on the annual dose to members of the public, see 4.7.6. But sediment samples are not collected within the Regional Study Area defined in this Environmental Assessment, and are not required for the effects assessment.

Nevertheless, OPG was confident to say changes in Soil Quality as a result of the Project are not considered to represent an adverse effect in the Geological and Hydrogeological Environment. Accordingly, no further evaluation of the effects of the Project on Soil Quality is warranted, see 5.6.4.1.

OPG admits that there are a number of predicted changes in conditions in the Terrestrial Environment as a result of the Project, including the potential to affect rare vegetation communities located along the lakeshore bluff, increased traffic (and associated dust and noise) and human presence may disrupt connectivity and wildlife use of the DN site, see Table 5.5.1.

On the Park Road access into the DNGS are wildlife corridors that separate different populations of wildlife. Increased traffic and constructions due to refurbishment may disturb the east-west wildlife corridors (5-42, 43). Although OPG suggest adding fencing to redirect animals from approaching the roadways, the report would be more conclusive should there be statistics on the rate and type of wildlife crossing the corridors. The report should include more specific predictions on wildlife impacts including species type, morbidity, and mortality rate.

5.5 HUMAN HEALTH

Before or during Phase I (Preparation for Safe Storage), the potential radiation hazards to humans are likely to be associated with any handling of used fuel, tritiated heavy water, filters and resins, performing decontamination work and working in gamma radiation fields in station systems and components. At the beginning of Phase II (Safe Storage and Monitoring), the radiation hazard will primarily be due to tritium and this hazard will decay significantly over the course of this phase. Used fuel will continue to be stored in the station IFBs for at least ten years after shutdown and the work required to transfer this fuel to an off-site long-term facility or on-site interim dry storage will continue, see 2.9.7.1.

OPG admits that most of the following activities will likely cause measurable changes to human health.

Table 5.7-1: Project-Environment Interactions with Likely Measurable Changes in the Radiation and Radioactivity Environment

Project Works and Activities	Rationale
REFURBISHMENT PHASE	
Mobilization and Preparatory Works	Preparation of reactor vaults is expected to result in gamma radiation that will interact with the terrestrial and human components of the radiation and radioactivity environment.
Shutdown, Defuelling and Dewatering of the Reactors	Defuelling and dewatering the reactors is expected to interact with all components of the radiation and radioactivity environment through air and water emissions, and gamma radiation.
Construction of Retube Waste Storage and Other Support Buildings	Construction of buildings associated with the Project is not expected to interact with the radiation and radioactivity environment; however, workers will be exposed to radiation that they would not routinely be exposed to.
Removal of Reactor Components and Placement of Wastes into Storage	Removal of reactor components and placement of wastes into storage is expected to interact with all components of the radiation and radioactivity environment through air and water emissions, gamma radiation and alpha radiation.
Transportation of Refurbishment L&ILW to Off-site Waste Management Facility	Transportation of Refurbishment L&ILW to an off-site facility is expected to increase the gamma radiation (in terrestrial environment) and increase the doses to workers and members of the public.
Balance of Plant Repair, Maintenance and Upgrades	Balance of plant repair, maintenance and upgrades is expected to increase the radiation dose to workers.
Refilling, Refuelling and Restarting the Reactors	Refuelling and restarting the reactors is expected to interact with all components of the radiation and radioactivity environment through air and water emissions, and gamma radiation.

CONTINUED OPERATION PHASE	
Operation of the Reactor Core	Operation of the reactor core is expected to increase the radiation dose to workers.
Operation of the Primary Heat Transport and Moderator Systems	Operation of reactor process systems is expected to interact with all components of the radiation and radioactivity environment through air and water emissions, and gamma radiation.
Operation of Active Ventilation and Active Plant Drainage Systems	Operation of active ventilation and active plant drainage system is expected to interact with all components of the radiation and radioactivity environment through air and water emissions.
Operation of Fuel Handling and Storage Systems	New and used fuel handling is expected to interact with components of the radiation and radioactivity environment through air, surface water, gamma radiation and an increase in the radiation dose to workers.
Operation of Station Water Systems	Operation of station water systems is expected to interact with the surface water and aquatic environment, and humans through water emissions.
Construction of Additional Storage Buildings at DWMF.	Construction of additional storage buildings at DWMF is expected to interact with the radiation and radioactivity environment through gamma radiation and non-NEWs will be exposed to radiation that they would not routinely be exposed to.
Management of Operational L&ILW	Management of operational L&ILW is expected to result in airborne emissions, increased gamma radiation (in the terrestrial environment) and increased doses to workers and members of the public.
Transportation of L&ILW to Off-site Waste Management Facility	Transportation of operational L&ILW to an off-site facility is expected to result in increased gamma radiation (in terrestrial environment) and increase in doses to workers and members of the public.
Maintenance of Major Systems and Components	Maintenance of major components and activities is expected to interact with all components of the radiation and radioactivity environment through emissions and gamma radiation.
Placement of Reactors into End-of-Life Shutdown State	Placement of reactor into end-of-life shutdown state is expected to interact with all components of the radiation and radioactivity environment through air and water emissions, and gamma radiation.

Despite this huge range of activities, almost by magic, OPG declares: "Because there are no likely effects of radioactivity on humans, no mitigation measures are Identified", see 5.7.6 Mitigation Measures

No residual effects are predicted to the general public or to workers, see 5.7.7.

It must be emphasized that the annual radiation doses to members of the public as a result of the operation of the DN site as do not include exposures from naturally occurring or anthropogenic sources or radioactivity that is not attributable to the facility.

Thus, when OPG says the measurement is at or below the implicit limits to the general public that number is site specific and does not take into account cumulative impacts, see 4.7.8.1.Unlike the required "collective dose" rate for nuclear workers, there is no collective dose rate for the general public, nor to assess human impacts beyond those specifically located at the site, see 4.7.8.2. This assessment is unacceptable.

5.6 RADIOLGICAL MALFUNCTIONS AND ACCIDENTS

OPG says: The focus of the assessment is on those events that are considered credible in the context of the specific project. It is not the intent of this EA to address all conceivable abnormal occurrences, but rather, to address only those that have a reasonable probability of occurring considering the specific aspects of site conditions and project design, 7.1.

Core Meltdown – Not Considered

OPG refuses to consider Nuclear Accidents involving out of core criticality which may result in an "acute release of radioactivity into the environment". Why? According to OPG: "Out of core criticality events are not considered credible scenarios", 7.3.1.

The credible scenarios are defined as those that have a reasonable probability of occurrence (5% or greater) during the life time of the project. It is in the order of 10-3 per year or greater (MOE 2007c) A creditable scenario does not include a beyond design event to OPG.

The Fukushima Event and Relevance to DNGS Refurbishment Project

On March 11, 2011 a magnitude 9 earthquake triggered a tsunami which subsequently resulted in a level 7 event, the highest on the International Nuclear Event Scale, at the Fukushima Daiichi Nuclear Power Plant (NPP) in Japan. The incident has been determined a beyond-design-basis event, meaning that the earthquake and tsunami were more severe than the hypothetical earthquakes and tsunamis the plant had been designed to withstand during the risk assessment process.

It has been stated that a disaster such as that of Fukushima could not occur here because Ontario's nuclear reactors and various operating facilities are not located on a fault line. However, this statement ignores several important points as explained by a local group with historic knowledge, *Families Against Radiation Exposure (FARE)*, see: www.ph-fare.com/content/oral-presentation-by-fare-to-review-paneldarlington-hearings

Seismology is not a predictive science. Earthquakes can happen anywhere – not only along known fault lines, but very often in places where they are not expected. In the summer of 2010, we experienced an earth tremor of mangitude 3.2 within Ontario. We also have the fault area that created the Fossmill Drainage that flows into the Ottawa Valley, and we know that in our continent, as in every other, the earth's crust is constantly moving on plates, and seismic activity cannot be predicted.

Furthermore, the damage to the Fukushima nuclear plant reactors was caused by power failure. This can happen without earthquakes. For example, it can be a result of other natural catastrophic events such as a hurricane. Nuclear disasters can arise without earthquakes and without power failure, for example by human error.

OPG's Admissions

While OPG refuses to entertain core criticalities and beyond-design events, except for the total loss of AC power for which it recommends obtaining additional generators (see 7.10.2.3), it does admit at 7.5.2 that the following initiating events be screened for creditability as "Common Mode Failures":

- Design basis earthquake;
- Turbine generator missiles;
- Tornado;

- External explosion (rail line blast);
- Tritium removal facility hydrogen explosion;
- Toxic / corrosive chemical rail line accidents;
- Internal fires.

Transport? Not a problem

While OPG assures that the off-site transport of retube waste packages will meet the packaging requirements that will prevent the packages from opening under accident scenarios when being transported from Darlington to the WWMF in Bruce, it makes the following admission:

A small crack could occur and any volatile material within the container could escape. Some fraction of potentially releasable components, such as very fine radioactive particulates or Carbon-14 (C-14) present as a gas such as carbon dioxide, could escape in a drop scenario. Small amounts of tritium might also be present as residual tritiated water. Tritium is also highly retained within zirconium alloys. The most restrictive case is a container filled with only pressure tubes.

Even though we have demonstrated that there are no Canadian or Ontario exposure standards for humans to C-14 and those for tritium are wholly inadequate, we are assured by OPG: the resulting hypothetical public dose for the most exposed member of the public, a hypothetical person located at the DN site boundary is predicted to be less than 1 µSv , a small fraction of unavoidable baseline annual dose, or indeed, the temporal and spatial variation of the baseline annual dose, see. 7.5.4.

It should be noted that this scenario only considers the drop of one container and only at the site. It does not consider an accident with a truckload of containers, anywhere on the long journey to the Bruce site, crossing many waterways and potentially explosive situations. It is satisfied if background levels are considered reasonable and therefore, justified.

Ruptured Pipes – Not on our watch

This scenario involves pipe ruptures at various locations in the main moderator system and in the moderator auxiliary systems, including the heavy water and rod cooling system. OPG admits at 7.5.4.4: tritium release following a pipe break can occur as a result of liquid D2O released into the lake, and due to evaporation from wetted surfaces or pools of spilled moderator. Public doses are maximized if a large amount of moderator is spilled into a large area that is not serviced by a vapour recovery system, or if the D2O is released into the CCW duct.

On the assumption of a total of 40 Mg of tritiated water reached the CCW duct, OPG assures that an estimated release of approximately 2.27×10^{15} Bq of tritium is approximately equivalent to the 1992 tritium spill from a moderator heat exchanger which occurred at the Pickering Nuclear Plant.

The maximum concentrations observed at the nearest water supply plants due to the 1992 PNGS A release were only approximately 10% of the Ontario Drinking Water Standard (7,000 Bq/L). The peak concentration measured at the Ajax Water Treatment 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. Based on the experience of the 1992 PNGS tritium release, it is reasonable to expect that for a similar size release from DNGS." These numbers are unacceptable.

None of these actual examples of tritium releases into water supply plants are acceptable as health or environmental protective. The scenario also fails to consider cumulative impacts of these releases to groundwater, sediment and Lake Ontario. What cumulative impact assessment has been done in this EIS, was limited, at most, to the Regional Study Area.

Darlington Waste Management Facility (DWMF)

The DWMF was commissioned in late 2007. It currently includes a Processing Building where Dry Storage Containers (DSCs) with used fuel are prepared for storage, and one Storage Building. The existing Storage Building is a single-storey, commercial-type concrete structure sized to accommodate approximately 480 Dry Storage Containers (DSCs). The current plan for this facility is to expand it in phases as needed to accommodate the used nuclear fuel from DNGS to the end of the station's planned or (if refurbished) extended operating life, see 8.2.1.

Under normal operating conditions, no airborne emissions are expected. Gamma radiation levels are expected to increase over time, but the related dose rate is expected to remain less than 10 µSv/a at the DN site boundary. This dose rate is expected to gradually decrease as the radioactivity continues to decay. The EA conducted for the DWMF concluded that the facility, even at maximum storage capacity, would not result in any adverse residual radiological effects taking into account the proposed design and mitigation measures.

The total annual cumulative dose to members of the public at the DN site boundary, attributable to OPG sources at the DN site, is estimated to be less than 7 µSv/a. This estimated total annual dose is less than 1% of the CNSC's regulatory limit for members of the public (1,000 µSv/a) and within the variability of natural background dose (averaging about 1,840 µSv/a across Canada). Furthermore, an individual dose rate of less than 10 µSv/a is considered to represent a "risk level that would generally be regarded as negligible in comparison with other risks". OPG and our regulatory agencies do not present a health-based standard but one that compares relative risk, an unacceptable approach from a public interest perspective.

According to FARE, it has been estimated that Darlington's ageing reactors have produced to date 5,000 tonnes of highly radioactive used fuel. The "clean-up" process will, over a period of many years, put a large amount of contaminated material back into the air; transport waste through the streets of Port Hope from one site in the town to another site in the town; deposit it in a wetland area that drains into Lake Ontario; and construct, of all things, a children's playground. FARE submitted a letter of concern to the CNSC. This letter was posted on its website, at www.phfare.com/index.php?article=159 , and was turned over to the municipality. This, too, had no effect.

Concrete

There was no discussion of the integrity to concrete issue related to aging nuclear reactors, highlighted above.

Severe Weather and Seismic (Earthquake) Risks

Tornadoes

According to the EIA at 6.2.2.1, the distribution of tornadoes, particularly in Ontario, appears to be random and extremely localized. A tornado usually affects a limited area and only for a short period of time; however, serious property damage and injury, including fatalities, may occur along its path. In the RSA, one tornado per 10,000 km2 can be expected annually (Environment Canada 2008a).

OPG admits that damage to 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 with no additional analysis, OPG boasts that 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.

Seismicity – Earthquakes – never!

Consistent with the regulatory requirement to examine aspects affecting life extension of nuclear power plants (e.g., CNSC RD-360, 2008a and CNSC S-294, 2005) as well as guidance from other sources (e.g., IAEA SSG-9), 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, see 6.3.

Tuttle and Dyer-Williams (2010) performed a paleoseismic investigation of the region surrounding the Darlington site to look for evidence of past large earthquakes. River systems both north and south of the Oak Ridges Moraine between the Humber River in the west and Cobourg Creek in the east were investigated. Earthquakes can induce liquefaction features in susceptible sand and silt deposits. The East Branch Don River, Rouge River and West Duffins Creek were selected for river surveys of liquefaction features based on their having suitable sedimentary conditions for the preservation of liquefaction features and river cut bank exposure conditions.

Earthquake-induced sand dikes and soft sediment deformation structures were identified at a number of locations on the East Branch Don River and the Rouge River. The paleoliquefaction features in the Don and Rouge Rivers provide evidence for at least two earthquakes. Tuttle and Dyer-Williams (2010) note that other paleoearthquakes may have occurred at times when the ground water table was below the elevation of the susceptible materials. Some weight is given to these paleoearthquakes being associated with the Mississauga Magnetic Domain, the Niagara-Pickering Linear Zone and the Georgian Bay Linear Zone.

OPG dismisses the risk by claiming the magnitudes reduce the potential rupture length, maximum magnitude and its effect on the hazard at the DN site.

Clarendon-Linden Fault system

The Clarendon-Linden fault system is a broad zone of small faults with small displacements in the lower Paleozoic bedrock (Figure 6.3-1). The fault system is as much as 150 km long and 7 to 17 km wide. 6.3.2 OPG concedes that the Clarendon-Linden fault system is the local source with the highest (0.4) seismogenic potential. While it does not appear to be strongly associated with MN 2-5 or MN > 5 seismicity, there is strong geologic evidence for multiple episodes of reactivation and for it extending to seismogenic depths (10-20 km).

Even if OPG is prepared to dismiss magnitude earthquakes as probable, it does admit that Ground Shaking Hazard at DNGS is an issue. The hard rock ground motions were scaled to the toplayer ("rock outcrop") of the 200 m thick sedimentary rock underlying the DNGS structures. The scaling was based on amplification factors derived from shear wave velocity and dynamic parameters determined for the sedimentary rock (UNPSWP 1979). A recently completed shear wave velocity investigation at the DN site determined that shear wave velocities in the sedimentary rock were higher than indicated by the single borehole 1979 study, see 6.3.2.

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 (SMA) 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. **In other words, there are lower standards of protection for older plants, despite concerns with concrete integrity in older plants.** OPG is satisfied that earthquakes with recurrence intervals of up to 10,000 years are below OPG's respective limits. Therefore, no residual adverse effects due to the seismic hazards effects are expected by OPG.

In short, OPG concludes at 7.10.2.2 that in most cases, external hazards are adequately characterized by the current design basis and no major challenges to overall plant operability, relative to the design basis events were identified. Except for flood risk, where further mitigation measures have purportedly been incorporated.

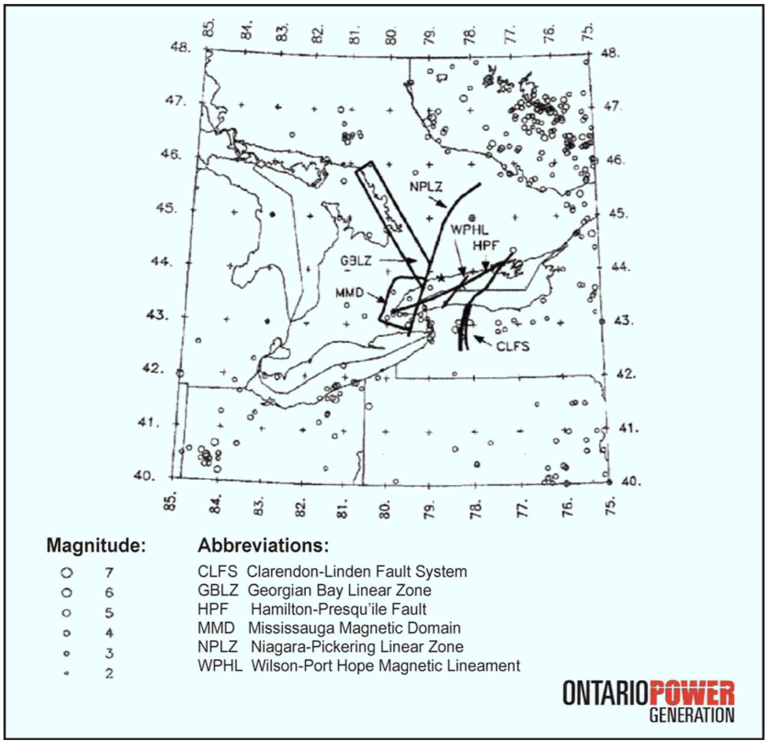

Image source: Ontario Power Generation

6. TRANSBOUNDARY

The Great Lakes, with 20% of the planet's surface fresh water, are the drinking water supply for 40 million people in Canada, the U.S. and a large number of First Nations. The lake is in stress because of the failure to treat it as a priority, finite, and essential resource, deserving of the utmost protection.

Study Area

The CNSC 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 Scoping Information Document suggested the study areas for consideration.

The Regional Study Area (RSA) is that area beyond the Local Study Area within which there is the potential for cumulative and socio-economic effects. It includes the municipalities that are within 20 km of DNGS. Aquatically, it extends westerly along Lake Ontario to the Pickering Nuclear Generating Station (approximately

35 km) and easterly for approximately 35 km, out to a distance of approximately 1 km from shore of Lake Ontario.

This extent for the RSA is considered appropriate by OPG given the nature of the Project activities (e.g., focused within the DNGS Protected Area) and that a number of previous EAs conducted at the DN site and the Pickering nuclear generating station have not suggested cumulative effects at greater distance, see 3.1.3).

The generic RSA was modified slightly for the Surface Water Environment. The RSA extends along the shoreline approximately 20 km west and east of the DN site and into the Lake approximately 5 km. Based on previous thermal plume modelling results, OPG says it is unlikely that the Project would have a measurable cumulative effect on Lake Ontario beyond 5 km from the shoreline. 4.3.1

Note that this self imposed limitation on the scope of the EIS discounts the impacts on water quality beyond 5 km from the shore and based on the narrow issue of thermal heating of the Lake because of the elevated temperature of the discharge water, rather than the full range of potential impacts.

Moreover, OPG admits that Tritium is present in the waters of the Great Lakes from atmospheric deposition, as well as emissions from DN and other reactors. The 2008 and 2009 tritium concentrations measured in three of the Great Lakes (Lake Ontario, Lake Huron and Lake Superior) ranged from <2.3 to 5.2 Bq/L. These concentrations are similar to the range of concentrations measured in surface water at other provincial locations, as shown in Table 3.3-14.

Yet, recall there are no regulatory limits on tritium concentrations in air against which the measured data can be compared or evaluated, let alone properly assessed.

OPG's Failure to Consider, and CNSC's Failure to Require, the Transboundary Impacts

Sierra Club Canada is an equal partner in a bi-national environmental organization with the Sierra Club U.S., the largest and oldest environmental organization in the United States (SC US). The SC US has chapter organizations in each state, including New York State which is within 60 km of the proposed project site, on the southern shore of Lake Ontario.

In addition to the submissions Sierra Club Canada makes on its own behalf to the CNSC, Sierra Club Canada gives notice it intends to invite Sierra Club New York to petition the federal Minister of Environment and Minister of Foreign Affairs to assess the transboundary effects of the proposed project under section 46 of the *Canadian Environmental Assessment Act.*

According to the limited information provided in its EIS, OPG admits the project would cause transboundary air and water pollution. Yet, OPG's EIS has failed to account for, and assess, the likely transboundary environmental and human health impacts of the proposed project, especially by the increased loading of Tritium in the air and water.

Further, the CNSC has failed to require this information. Therefore, the Minister through its responsible authority - the Canadian Nuclear Safety Commission – is requested to ensure an independent and comprehensive assessment because the project would likely cause significant adverse transboundary environmental effects.

7. CANADA – US AIR QUALITY AGREEMENT

Members of Sierra Club New York Chapter have standing to file the section 46 petition because they have an interest in lands on which the project may cause significant adverse environmental effects and they are situated within 60 km of the border. These transboundary interests are also established in the 1991 *Canada-United States Air Quality Agreement.*

The objective of the parties is to control transboundary air pollution between the two countries and is made operational, in part, by Article V where they agree to undertake environmental impact assessment and, as appropriate, avoid or take mitigation measures concerning proposals that could cause significant transboundary air pollution. Since 1994 the parties have been notifying each other of pollution sources within 100 km or 62 miles of the border. Canadian assessment and prior notification obligations under the Agreement are made effective in domestic law under the CEAA, sections 46-47. Importantly, this EA would not be artificially narrowed by removing the need to consider alternatives to the refurbishment project, as is the case of OPG's current EIS.[2]

We also recommend that the Great Lakes International Joint Commission intervene, as discussed below.

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[2] Transboundary air pollution refers to air pollution whose physical origin is situated wholly or in part with the area under jurisdiction of one Party and which has adverse effects, other than effects of a global nature, in the area under the jurisdiction of the other Party; and "Air Pollution" means the introduction by humans, directly or indirectly, of substances into the air resulting in deleterious effects of such a nature as to endanger human health, harm living resources and ecosystems and materials property ands impair or interfere with amenities and other legitimate uses of the environment, see Article 1 Definitions, http://www.ec.gc.ca/cleanair-airpur/ 1991 Canada-United States Air Quality Agreement.*

8. CONCLUSION AND RECOMMENDATIONS

Section 11 of the EIS deals with the so-called "follow-up program", but few details are provided on critical aspects of the proposed project, including the Radiological Environmental Monitoring Program and transboundary impacts. Without this information, it is impossible for the CNSC or the public to assess the adequacy of the EIS, especially given recent concerns about the integrity of concrete surrounding old nuclear facilities.

In short, OPG's EIS fails to comply with the requirements set out in section 16 of the CEAA that specify the elements necessary to be contained in a compliant EIS.

Consequently the CNSC is also out of compliance with section 34(a) of CEAA which states that the panel is to "ensure that the information required for an assessment by a review panel is obtained and made available to the public".

Given the government of Canada and Ontario's domestic, regional and international obligations, the abject failure to establish and enforce protective human health and environmental nuclear-related standards and to be complicit in an environmental assessment lacking in both substance and process, is totally unacceptable. The inherent and highly risky nature of the proposed project, both for this and future generations, speaks to the need for a precautionary, not a cavalier approach.

8.1 RECOMMENDATIONS

8.1.1 OPG to Undertake Peer Review – CNSC Not Proceed Until Done

OPG assures that its EIS is consistent with the precautionary principle as it is outlined in the document published by the Canadian Privy Council Office, *Framework for the Application of Precaution in Science-based Decision Making About Risk* (CPCO 2003). This included, specifically, a recognition of uncertainty inherent in an EA process and the importance of off-setting actions such as peer review of the technical studies supporting the EIS, a comprehensive public (and other stakeholder) consultation program, and the importance of an EA follow-up program that incorporates monitoring and adaptive management principles to evaluate the performance and success of mitigation measures and respond appropriately based on the outcomes, see 3.2.4.

Consequently, we expect OPG to subject its EIA to independent third-party peer review, including on the issue of concrete integrity, and that the CNSC not proceed with the license amendment process before that review is completed and publically commented upon in a transparent process.

8.1.2 Royal Commission Inquiry Into the Future of Nuclear Power in Canada

We support the request for a non-partisan Royal Commission of Inquiry into the Future of Nuclear Power in Canada and ask the Joint Panel Review to endorse this request. We ask for a moratorium on new licenses for nuclear power plants, be it for new build or refurbishment projects, or off-site transportation of nuclear wastes and storage of nuclear wastes produced by nuclear reactors in Canada until that Inquiry is complete.

We support the implementation of funding availability for peer-reviewed scientific epidemiological studies of populations situated in and around nuclear facilities and refineries, as well as studies of the natural environment.

8.1.3 No Safe Exposure to Tritium

It is the position of the Sierra Club and other parties that any release of tritium into water is contrary to the public interest. The goal of non-exposure to tritium in drinking water is consistent with the precautionary principle and responsible public policy. It should serve as a baseline in the CNSC assessment of the OPG EIS.

8.1.4 IJC Reference and Great Lakes Water Quality Agreement Amendments

It is unknown how many new nuclear and extension licenses are being sought in and approved by jurisdictions within the Great Lakes region.

We support the call to include nuclear issues in the new Great Lakes Water Quality Agreement (GLWQA) and to achieve a proper reference regarding nuclear issues to the IJC from the US and Canadian governments in a special report on nuclear issues and a new IJC Nuclear Task Force to produce such a report. The new GLWQA must include language that explains the critical importance of including radionuclides in the process of ridding the Great Lakes of persistent toxic substances and protecting the Great Lakes ecosystem from any further contamination from emissions or accidents involving radionuclides.

As recommended, this can be done in the context of the 2011-2013 Priority "Examining how low probability—high impact events—such as incidents related to nuclear energy, are addressed in the Great Lakes." Greater follow-up on the many concerns of the first IJC Nuclear Task Force is required as shown in the reports "Inventory of Radionuclides for the Great Lakes" (www.ijc.org/php/publications/html/invrep/index.html), and "Report of Bioaccumulation of Elements to Accompany the Inventory of Radionuclides in the Great Lakes Basin" (www.ijc.org/rel/boards/nuclear/bio/index.html).

We also recommend the Task Force compile an inventory of proposed and under review licensing applications for new and extended nuclear facilities, that is updated on a public registry, to assist with meaningful cumulative impact and risk assessment.

ABOUT SIERRA CLUB CANADA

Sierra Club Canada has worked on issues of environmental importance for nearly fifty years. Our national office, based in Ottawa, opened in 1989, and in 1992 we incorporated to create a truly national presence.

Today, we have five chapters across the country: British Columbia Chapter, Prairie Chapter, Ontario Chapter, Quebec Chapter and Atlantic Canada Chapter - in addition to our dozens of local groups in communities all across Canada from Cape Breton to Vancouver Island. The Sierra Youth Coalition is our youth affiliate.

Our web site is located at www.sierraclub.ca