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# Supplementary Information

# Renseignements supplémentaires

## Written submission from Frank R. Greening

## Mémoire de Frank R. Greening

**Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2018**

**Rapport de surveillance réglementaire des sites de centrales nucléaires au Canada : 2018**

Commission Meeting

Réunion de la Commission

**November 6, 2019**

**Le 6 novembre 2019**

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Filed by Email on October 2, 2019

To whom it may concern:

Please accept this email as my *2nd submission* as an intervenor comment on the CNSC's September 2019 draft *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2018*. In this 2nd submission I address some questions concerning tritium emissions data in Table H.6 of the CNSC's *2018 Oversight Report*, and in particular the value of $7.70 \times 10^{15}$ Bq quoted as the currently applicable Derived Release Limit (DRL) for tritiated water (HTO) emissions from the Western Waste Management Facility (WWMF).

OPG monitors waterborne emissions from the WWMF via the storm water runoff and subsurface drainage systems. The only radionuclides detected in this water are tritium and gross beta-emitters, both of which have been increasing since 2010 and peaked in 2016 at $6.12 \times 10^{11}$ Bq (11.6 Ci) per year for tritium and $4.62 \times 10^{8}$ Bq (0.0042 Ci) per year for gross beta.

However, as with the WWMF's airborne emissions, there are significant *unmonitored* waterborne radionuclide emissions from this facility. Principal among these emissions is the significant amount of tritium in the LLSB and IC sump water which is sent to the Bruce water treatment plant and subsequently discharged into the *Baie du Doré* at the north end of the Bruce Power site; however, it is important to note that *these releases are not included in the WWMF annual emissions data*.

Nevertheless, the quantification of these fugitive waterborne tritium emissions from the WWMF is discussed in the report: *Deep Geologic Repository Pre-Closure Safety Assessment (V1)*, NWMO Report DGR-TR-2009-09, issued August 2009. Based on the data presented in Section 3.4.2 of this NWMO report, about 50 $m^3$ of sump water is collected per year from the WWMF site containing an average of $1.26 \times 10^{10}$ $Bq/m^3$ of tritium. Hence, it may be concluded from this NWMO Report that there are about $6.3 \times 10^{11}$ Bq (17.0 Ci) of *unmonitored* waterborne tritium releases from the WWMF per year. This is approximately equal to the ***highest reported*** waterborne tritium emission of $6.12 \times 10^{11}$ Bq per year in the period 2011 - 2018, in which case the reported emissions are ~ 50% of the true emissions.

Additional problems with estimating the true waterborne tritium emissions from OPG's WWMF stem from uncertainties in the waterborne tritium DRL of $7.70 \times 10^{15}$ Bq/year reported for this facility. The methodology used for the determination of DRLs for waterborne emissions from nuclear power stations in Canada is described in detail in the CANDU Owners Group Report COG-06-3090-R2-I published in 2008. However, this methodology is strictly only applicable to emissions in effluent streams with known, and relatively constant flow rates. While these conditions are reasonably well satisfied for the CANDU power reactors at Darlington, Bruce and Pickering, this is certainly *not* the case for effluent streams at OPG's WWMF. Thus, in OPG's *Environmental Risk Assessment for the Western Waste Management Facility*, Report No. 01098-REP-07701-00011-R000, issued in April 2016 we read in Section 2.2.4.2:

*The WWMF drains into a wetland area (also known as the "Wetland") to the east of the site from an intermittent connection with the east storm water hybrid pond. The water in the South Railway Ditch (SRD) flows along the east edge of the Wetland. This Wetland has experienced large fluctuations in water level over the years. These fluctuations are dependent on the outflow culvert, which is the point of drainage discharge for the wetland. The outflow of the Wetland drains into the SRD at WTL-1. The SRD subsequently flows to Stream C, which is a man-made stream that was developed to divert water from a former tributary of the Little Sauble River. Stream C flows through the Bruce nuclear site to drain into the southwest corner of Baie du Doré.*

However, in Section 3.3.3 of OPG's *Environmental Risk Assessment for the Western Waste Management Facility* Report we also read:

*It should be noted that the general public has no direct access to on-site surface water. They may be exposed to the surface water from Baie du Doré, the receiving waterbody for WWMF surface water, where a dilution factor of 20 is expected. However, for the purposes of the screening assessment, the on-site concentration data from the field measurements at the WWMF have been used.*

OPG's *Environmental Risk Assessment for the Western Waste Management Facility* Report further states, (with no justification!), that its risk assessment study for the WWMF is based on results for the entire Bruce site, with the Critical Groups taken as BF14 (adult) and BMF3 (infant), which are both located many kilometers to the south-east of the WWMF, well away from any major surface water bodies. Meanwhile, the all-important Critical Groups located on the shores of the *Baie du Doré* , such as those at BR1 and BR48, *are completely ignored*.

The history of the monitoring of waterborne emissions from the storage of radioactive waste at the Bruce site begins in 1966 with the establishment of the Bruce Nuclear Power Development (BNPD) Radioactive Waste Operations Site No. 1, (RWOS 1), followed in 1976 by RWOS 2. (The RWOS 2 facility was renamed the Western Waste Management Facility (WWMF) in the year 2001 after the establishment of a lease agreement between OPG and Bruce Power.) Release limits for the BNPD's radioactive waste operations were first published in a report by D. A. Lee entitled: *The Derived Release Limits of Radionuclides in Airborne and Liquid Effluents from the BNPD Radioactive Waste Operations Site No. 2*, Ontario Hydro Health Physics Department (HPD) Report, issued April 1975.

In the case of waterborne emissions, the 1975 HPD Report notes that the pathways by which radionuclides could be discharged from the storage facilities into water supplies available to the public are by "*contamination of the surface water run-off or by water leakage from the waste containment structures to the lower aquifer.*" The Report further notes that, as this contaminated water moves away from the site, the activity levels of the radionuclides will be significantly reduced by (i) dilution with other water sources; (ii) adsorption by soils and sediments, and (iii) radioactive decay. However, the 1975 HPD Report also notes that the water movement across the BNPD site is complex and there is "*insufficient data to estimate the expected reduction in activity levels in the liquid effluents released to the environment*". Because of this concern, the 1975 HPD report concludes:

*A total curie DRL for each radionuclide cannot be readily applied to the waste operations site because the total amount of water flow from the entire site is not accurately known and could be highly variable.*

This conclusion was reached in 1975, but we obviously need to consider if the state of knowledge of surface water flow at the Bruce site has improved over the past 45 years. Unfortunately, as described below, it appears that very little additional date on this topic has been obtained since 1975. Thus, consider the following NWMO Report (prepared by AMEC NSS), entitled: *Maximum Flood Hazard Assessment*, Report No: NWMO DGR-TR-2011-35, issued March 2011, where we read:

*Stream 'C' is the only natural watercourse that traverses the Bruce nuclear site. Stream 'C' is a former tributary of the Little Sauble River that was diverted, and presently flows in a constructed channel to Baie du Doré during the initial development of the Bruce nuclear site in the 1960s. The drainage area of Stream 'C' is reported to be 1,042 ha at the North Access Road. A portion of Stream 'C' is located in proximity to the DGR site (within about 600 m). No historic data on Stream 'C' water levels through the Bruce nuclear site are available with this watercourse.*

However, NWMO's 2011 *Maximum Flood Hazard Assessment* Report does include calculations of water flows in Stream C during periods of heavy precipitation. These calculations show that the maximum flow for the catchment area adjacent to the *Baie du Doré* is between 158 $m^3$/s and 236 $m^3$/s depending on the hydrologic model used. Thus, it is clear that the rate of flow of tritium-contaminated water into the *Baie du Doré* is highly variable and unpredictable over the short-term. Nevertheless, it is worth considering first-order estimates of the long-term average waterborne tritium emissions from the WWMF, as embodied in the DRL for waterborne tritium emissions from this site.

In order to estimate the DRL for waterborne tritium emissions from the WWMF, we shall consider the radiological dose received by a member of an appropriate critical group due to the ingestion of tritiated water from a source located at a residence in close proximity to the WWMF – henceforth referred to in this report as R1. We also assume that this drinking water is drawn from the same source (such as a well on R1) for an entire year.

We shall represent the average specific activity of tritium in the drinking water source by $A_{HTO}$ (Bq/$m^3$) and assume that the drinking water consumption rates, Q ($m^3$/year), for an adult and a 1-year old infant, are 1.0 $m^3$/year and 0.40 $m^3$/year, respectively. In addition, we take the dose conversion factors for an adult and a 1-year old infant to be $2.0 \times 10^{-11}$ and $5.0 \times 10^{-11}$ Sv/Bq, respectively. It follows that the radiological dose received by an individual living at R1 due to ingestion of tritium-contaminated water is given by:

$$\text{Dose (Sv/year)} = A_{HTO}\ (\text{Bq/m}^3) \times Q\ (\text{m}^3\text{/year}) \times \text{DCF (Sv/Bq)}$$

For the calculation of a tritium DRL for the WWMF we set this dose to the legal limit of 1 mSv/year and determine the drinking water activity required to produce this annual dose. In this way we arrive at a tritium specific activity of $5.0 \times 10^7$ Bq/m$^3$. Then, to proceed further with this calculation, we need estimates of the effluent flow rate and the degree of mixing between this effluent and the waters of the *Baie du Doré*. But this brings us back to the problem: "*the total amount of water flow from the entire site is not accurately known and could be highly variable*".

However, rather than making my own guess as to what the time-averaged liquid effluent flow rate from the WWMF might be, I ask the CNSC to provide this information, as well as values for all the other parameters that are used in the calculation such as the effluent effective width and depth, lateral and longitudinal dispersion coefficients, etc. Finally, I would ask the CNSC to confirm that the resulting DRL is *precisely* $7.70 \times 10^{15}$ Bq, *not* $7.69 \times 10^{15}$ or $7.71 \times 10^{15}$ Bq, i.e. that this quantity is known to a precision of better than 1%.

Sincerely,

Dr. F. R. Greening