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Meeting Date: February 27, 2020
File No.:

To: Chair and Members
Lambton Area Water Supply System Joint Board of Management

From: Clinton Harper
General Manager

Subject: Radiological Effluent Monitoring at LAWSS

Recommendation

"That the LAWSS Joint Board of Management **RECEIVE** as information and that staff proceed with <Option Selection>."

Background:

At the December 5, 2019 meeting of the LAWSS Board, staff were directed to provide a report back with options for testing of radiologically contaminated raw water at LAWSS. The testing would be used to protect LAWSS from an emergency release event at the Nuclear Generating Station (BNGS) if no advanced warning is received. This report provides background information on what the issue is with radiological material in source water, how it is currently being tested for in Lake Huron (Appendix A) and what can be done at LAWSS.

Comments**:**

Heavy water is D_2O (Deuterium Oxide). BNGS uses CANDU reactors. These are pressurized heavy water reactors, which use D_2O in their moderator system. D_2O slows (moderates) the neutrons in the reactor to a speed at which they are able to bump into other atoms to cause them to break apart. When they break apart they create the heat that then travels in a closed loop to the boilers where it creates steam out of the water flowing through another loop, this steam then travels to the turbine, which spins the generator to make electricity. The BNGS has real time detection of D_2O in its light cooling water system.

All potential effluent from the site is captured and stored in tanks. The contents of the tanks are tested for a variety of parameters prior to being cleared for release into Lake Huron. If the contents of the tanks do not meet the allowable release limit(s) it is cycled back through the system for further treatment, until it meets the release limits.

The Canadian Nuclear Safety Board (CNSB) conducts an Independent Environmental Monitoring Program (IEMP) of the lake water near the BNGS. As an initial step, I

requested that the CNSB consider using the LAWSS intake as a sample location for their IEMP going forward. If the LAWSS intake could be incorporated into the existing system used by the Federal Government to double check the BNGS I thought it would go a long way to relieve any anxiety related to this issue. If it was determined the LAWSS intake couldn't be used, I requested LAWSS be provided access to the Federal Laboratory if LAWSS decided to complete its own independent testing. The response I receive the CNSB was as follows:

"In terms of responding to your questions regarding the CNSC Independent Environmental Monitoring Program (IEMP), we have the following information to offer:

1. *The CNSC's IEMP is intended to complement existing and ongoing compliance activities to verify that the public and the environment around CNSC-regulated facilities are not adversely affected by releases to the environment.*
2. *CNSC IEMP sampling locations are near and far field locations generally within or around 20 km from the Bruce site. Locations beyond 20 km could be chosen as a background or reference locations.*
3. *In 2019, the sampling campaign was modified to respond to requests and concerns from Indigenous communities. Sampling in communities was completed further afield, and the communities understood that these locations were beyond reference or background locations and any results of contaminants found would likely be natural background variations.*

Based on this information, the CNSC IEMP wouldn't be in a position to include the LAWSS intake, as it is located much further afield than the ±20 km distance that the IEMP samples within. The CNSC's IEMP does take a sample near the Kincardine Water Supply Plan, which is 15 km SSW of the Bruce site. These results can be found at http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/bruce.cfm with the specific sample being BP22-W12.

I would encourage the LAWSS to consider using this result, along with the results from the Bruce Power Environmental Monitoring Program as an analogue for your purpose. Furthermore, the CNSC laboratory isn't a contract lab that accepts samples from outside sources, nor is it a provincial licensed drinking water testing laboratory. I would encourage the LAWSS to contract a certified laboratory for radionuclide testing should you still feel that testing is required."

After considering the background information provided in Appendix A and the response from the CNSC detailed above, if the Board wished to proceed with independent testing one of the following options could be implemented.

Option #1: Enhanced Sample Protocol

OCWA completes approx. 2250 samples annually for water quality on LAWSS behalf. Similarly to what is already completed at the Kincardine and Saugeen Shores water treatment plants, grab samples could be collected from the LAWSS WTP intake and sent away for testing. Please note that the turn around for Tritium and Gross Alpha/Beta analysis is expected to be 14 days. This option requires that the Board trust that emergency notification infrastructure, and real-time testing currently employed, is adequate in the event of a major leak.

Option #2: Purchase/Install On-line Water Radioactivity Monitoring

Similar to turbidity, pH, temperature, chlorine, fluoride, pressure, conductivity and streaming current it is possible to install an on-line monitor that measures radioactivity. The online monitoring equipment is intended to provide real-time monitoring of drinking water and would be integrated into current operation.

Option #3: Annual Review

In the response from the CNSC it is suggested that LAWSS consider using the results from the IEMP, along with the results from the Bruce Power Environmental Monitoring Program be used as an analogue for our purpose. The updated annual environmental report from the Bruce is due to be published on May. If the Board believes the current real-time warning and monitoring systems are sufficient, an annual report could be prepared by staff in the summer that provides the Board with a summary that highlights drinking water aspects of the BrucePower and CNSC reporting. This option also requires that the Board trust that emergency notification infrastructure, and real-time testing, is adequate in the event of a major leak.

Consultation:

OCWA Operational Staff, BrucePower staff, the Canadian Nuclear Safety Commission staff, representatives at the Kincardine and Saugeen Shores water operating authority, SGS London and equipment suppliers.

Financial Implications:

The financial implications for the three options provided are as follows:

Option #1	Enhanced Sample Protocol Standard (14 days): Enhanced Sample Protocol Rush (5 days):	$323/sample $969/sample
Option #2	Purchase/Install/Commission On-line Water Radioactivity Monitoring (Wilma System quote attached)	$90,000 USD
Option #3	Annual Review and staff report	none

*taxes are not included

This report was prepared by Clinton Harper

Attachment(s): Appendix A

Figure 2: Annual Average Tritium Concentrations (Bq/L) In Municipal Water Supply Plants Near the Bruce Power Sirte Over Time.

Appendix A

What is Tritium?

Tritium is a radioactive form, or "isotope", of hydrogen. It has two neutrons where regular hydrogen does not have any, which makes tritium unstable and therefore radioactive. It is also produced as a by-product of nuclear reactors.

Like all radioactive isotopes, tritium decays. As it decays it gives off, or emits, beta radiation.

The Canadian Nuclear Safety Commission (CNSC) regulates releases of tritium by nuclear reactors and tritium processing facilities to ensure the health and safety of workers and the public, and the protection of the environment.

Tritium in Drinking Water

The most common form of tritium is tritiated water (HTO). This happens when a tritium atom replaces a hydrogen atom in water (H_2O) to form HTO. HTO has the same chemical properties as water and is also odourless and colourless.

The standard international unit for measuring radioactive decay or radioactivity is the becquerel (Bq). The amount of tritium in water is measured in becquerels per litre (Bq/l). Water with a tritium activity of 1 Bq/l, contains less than 1 tritium atom per 100,000 million (1 in 10^{17}) molecules.

The highest average annual tritium level measured in the drinking water of Canadian communities neighbouring nuclear facilities is about 18 Bq/l. This is well below drinking water limits recommended by Health Canada of 7,000 Bq/l.

Health Effects of Tridium

Tritium is a relatively weak source of beta radiation. The beta particle itself does not have enough energy to penetrate the skin. However, it can pose a health risk if taken directly into the body in extremely large quantities; for example, a person would need to take in billions of becquerels before seeing a health effect.

Tritium molecules can enter the body by breathing air containing tritium, or by ingesting tritiated food and water. Tritiated water can be absorbed through the skin like regular water. Most tritium leaves the body as tritiated water in urine, breath moisture and perspiration. Most inhaled tritiated hydrogen gas is exhaled immediately.

A radiation dose from tritium is like a radiation dose from any other type of radiation, including natural background radiation and doses received during medical procedures. In Canada, members of the public receive annual doses of radiation from tritium of 0.0001 to 0.013 millisieverts (mSv), although very few, if any, members of the public receive

doses in the upper end of this range. Near nuclear facilities, where tritium levels are slightly higher, the average annual dose to adults is about 0.0015 mSv. These doses are well below the public dose limit of 1 mSv as set in the *Radiation Protection Regulations*, and the average Canadian dose due to natural background radiation of 1.8 mSv.

Studies have not shown health effects at a chronic exposure below about 100 mSv. The regulatory public dose limit of 1 mSv is equivalent to 1% of this amount.

Source: Canadian Nuclear Safety Commission Fact Sheet (https://nuclearsafety.gc.ca/eng/resources/fact-sheets/tritium.cfm)

Highlights from BrucePower 2018 Environmental Protection Report

Lake Huron Historical Tritium Water Sample Results

Background levels of tritium are a combination of natural cosmogenic sources (produced by the action of cosmic rays) and residual fallout from historical nuclear weapons testing. Atomic Energy Canada Limited (AECL) developed a mathematical model for estimating background Lake Huron tritium activity from cosmogenic sources and fallout from nuclear weapons testing source. A graphical representation of this is shown in Figure 1. Natural Lake Huron tritium levels, in the absence of Canadian Deuterium Uranium (CANDU) Reactor tritium emissions, are estimated to be 1.6 Bq/L.

The impact of site emissions on the local water supply plants varies and is dependent on the distance from the stations, lake current direction, and general dispersion conditions. In order to minimize the impact of emissions, Bruce Power has a long-standing stakeholder commitment to keep the municipal water supply plants annual average tritium levels below 100 Bq/L. As shown in Figure 2, the annual average tritium concentrations at all local water supply plants have remained relatively constant. Concentrations are well below 100 Bq/L and remain a small fraction of the provincial drinking water limit of 7,000 Bq/L.

Municipal Water Supply

Municipal drinking water sources are sampled twice per day during regular business hours from two Water Supply Plants on Lake Huron near the Bruce Power site.

- Southampton Water Supply Plant, 22 km NE of Bruce A
- Kincardine Water Supply Plant, 15 km SW of Bruce B

Municipal drinking water well samples are also collected and analyzed. Weekly composite samples are analyzed for tritium by liquid scintillation counting (a process that measures the activity of a sample of radioactive material) and monthly composite samples are analyzed for gross beta by proportional counting and a gross gamma screening. The 2018 annual average for tritium at the Kincardine WSP was 5.0 Bq/L and at the Southampton WSP was 9.9 Bq/L. In 2018, the water from the WSPs were well below the annual average Ontario Drinking Water Standard of 7000 Bq/L and also below the 100

Bq/L (annual average) objective set forth in a stakeholder commitment with the Municipalities.

Source: 2018 BrucePower Environmental Protection Report https://s14083.pcdn.co/wp-content/uploads/2019/04/2018-Environmental-Protection-Report.pdf

Canadian Nuclear Safety Commission Independent Environmental Monitoring Program

Under the *Nuclear Safety and Control Act* (NSCA), the licensee of each nuclear facility is required to develop, implement and maintain an environmental monitoring program to demonstrate that the public and the environment are protected from emissions related to the facility's nuclear activities. The results of these monitoring programs are submitted to the Canadian Nuclear Safety Commission (CNSC) to ensure compliance with applicable guidelines and limits, as set out in regulations that oversee Canada's nuclear industry. As part of the CNSC's regulatory oversight, CNSC staff also conduct extensive compliance verification activities. These include reviews of the licensees' environmental protection programs to ensure they are adequate, as well as regular inspections to ensure the programs are being implemented accordingly.

The CNSC has implemented its Independent Environmental Monitoring Program (IEMP) to verify that the public and the environment around licensed nuclear facilities are safe. It is separate from, but complementary to, the CNSC's ongoing compliance verification program. The IEMP involves taking samples from public areas around the facilities, and measuring and analyzing the amount of radiological (nuclear)and hazardous substances in those samples. CNSC staff collect the samples and send them to the CNSC's laboratory for testing and analysis.

The IEMP is implemented for facilities in all segments of the nuclear fuel cycle: uranium mines and mills, uranium and nuclear processing facilities, nuclear power plants, research and medical isotope production facilities, and waste management facilities. The CNSC's program aligns with those of other national and international regulatory bodies and complements the CNSC's ongoing environmental protection activities.

CNSC regulatory oversight reports

The CNSC publishes annual regulatory oversight reports on the nuclear industry, which include results from the IEMP and other compliance verification activities. These reports focus on the licensees' annual performance in 14 safety and control areas, including environmental protection, radiation protection, conventional health and safety, waste management, and emergency management.

The reports are discussed at public Commission meetings. The CNSC encourages the public and Indigenous groups to comment on these reports.

Independent Environmental Monitoring Program: Bruce A and B Nuclear Generating Stations

Bruce Power is licensed by the CNSC to operate the Bruce A and B nuclear generating stations, located along the eastern shore of Lake Huron in Kincardine, Ontario. The Bruce Power site includes the Bruce A and Bruce B nuclear power plants, which house eight Canadian Deuterium Uranium (CANDU) reactors. All eight of these units are currently operational, with a production capacity of 6,232 megawatts of electricity per day. Bruce Power also operates the Central Maintenance and Laundry Facility (CMLF) at the Bruce Power site.

Releases result from the operation of the Bruce Power site, the OPG WWMF and the CNL Douglas Point Waste Management Facility. The predominant releases from the Bruce Power site are from the BNGS. Bruce Power runs a comprehensive environmental protection program to monitor and control nuclear and hazardous substances released from the Bruce Nuclear Generating Station (BNGS), determine concentrations of contaminants in the environment and assess exposure to the public.

The Independent Environmental Monitoring Program (IEMP) results for 2013 through 2016 confirm that the public and the environment around the site are safe and that there are no expected health impacts.

The IEMP results indicate that the public and the environment around the BNGS are protected and that there is no unreasonable risk to health and the environment. The IEMP results are consistent with the results submitted by Bruce Power, demonstrating that the licensee's environmental protection program protects the health and safety of people and the environment.

Source: Canadian Nuclear Safety Commission Independent Environmental Monitoring Program (IEMP) http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/index-iemp.cfm

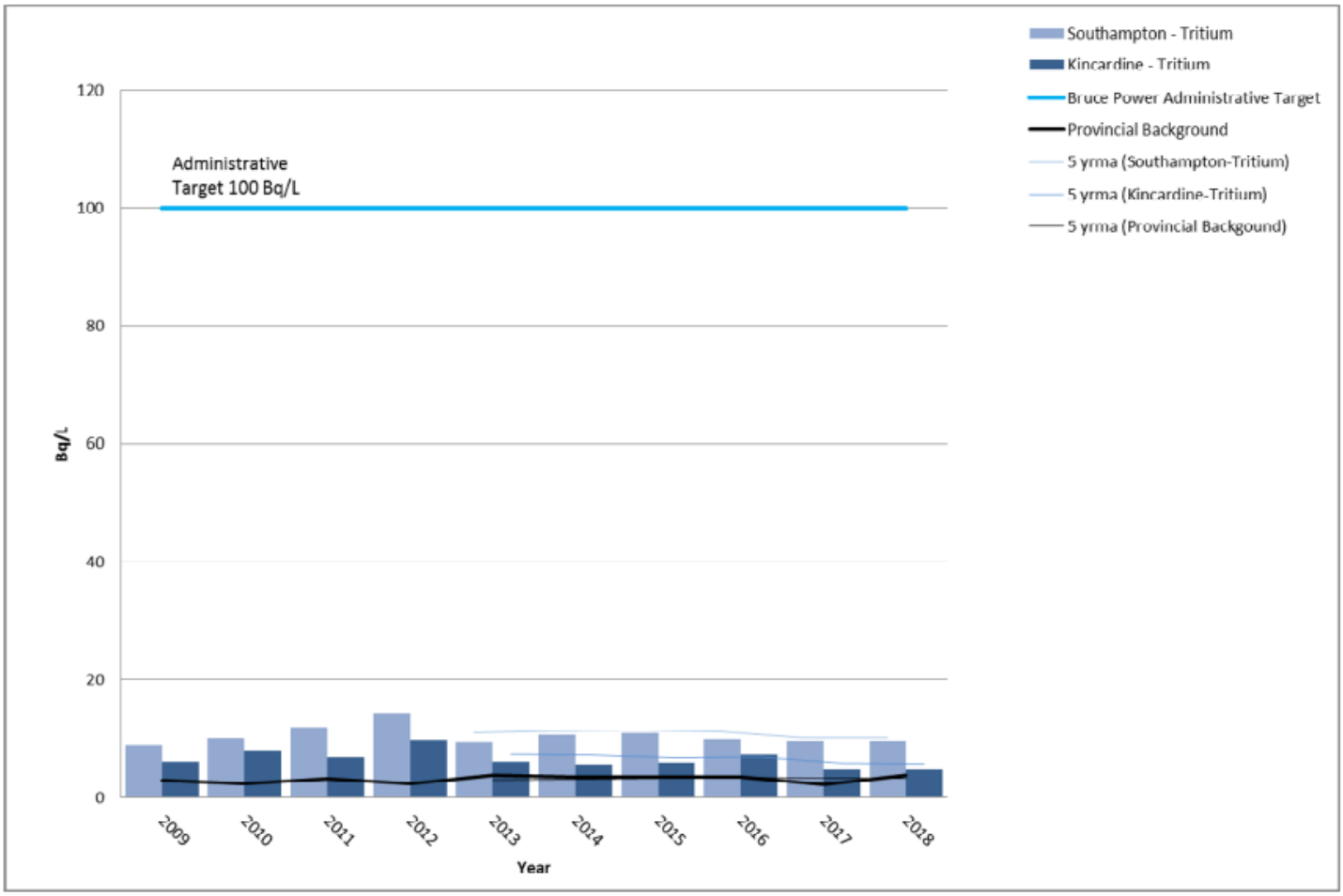

Figure 2: Annual Average Tritium Concentrations (Bq/L) In Municipal Water Supply Plants Near the Bruce Power Sirte Over Time.

Note: Bruce Power's commitment is 100 Bq/L at the Municipal Water Supply Plant (monthly and annual) Ontario Drinking Water Standard is 7000 Bq/L at the Municipal Water Supply Plant (annual).