



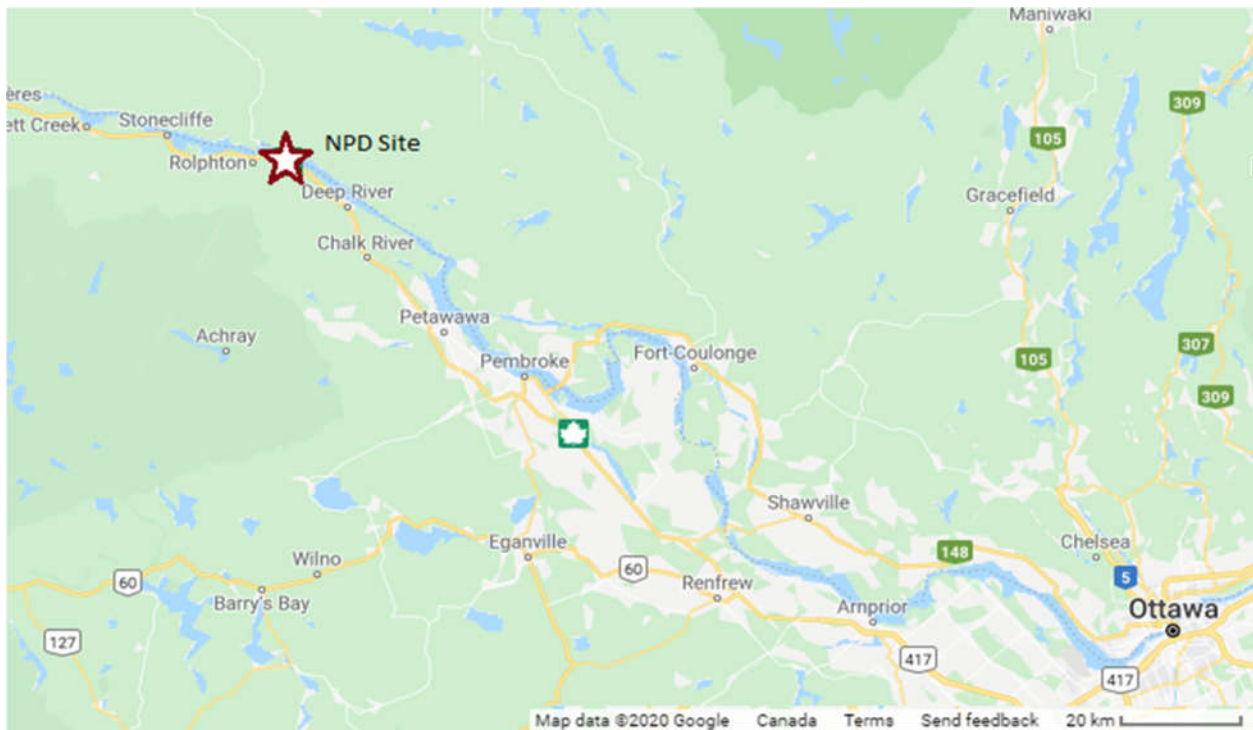
## SUMMARY OF ENVIRONMENTAL PERFORMANCE AT THE NPD SITE

This summary describes the results of the effluent and environmental monitoring activities at the Nuclear Power Demonstration site (NPD) for calendar year 2020.

The NPD site is located just east of Rolphton, Ontario (Figures 1 and 2). It contains the partially decommissioned NPD Nuclear Generating Station which was the first Canadian nuclear power reactor and the prototype for the CANDU® reactor design.

For 25 years the NPD reactor produced sustainable, carbon free energy and operated as a training center for nuclear operators and engineers from Canada and around the world. Operations at NPD ended in 1987, after which the first stages of decommissioning were completed, including the removal of all nuclear fuel from the site and the draining of the systems. The site has been in a safe shutdown state for over 30 years.

***CNL is committed to achieving high standards of operational safety. The results of effluent and environmental monitoring demonstrate that safe performance continues to be achieved at the NPD site.***



**Figure 1: Location of the NPD Site**

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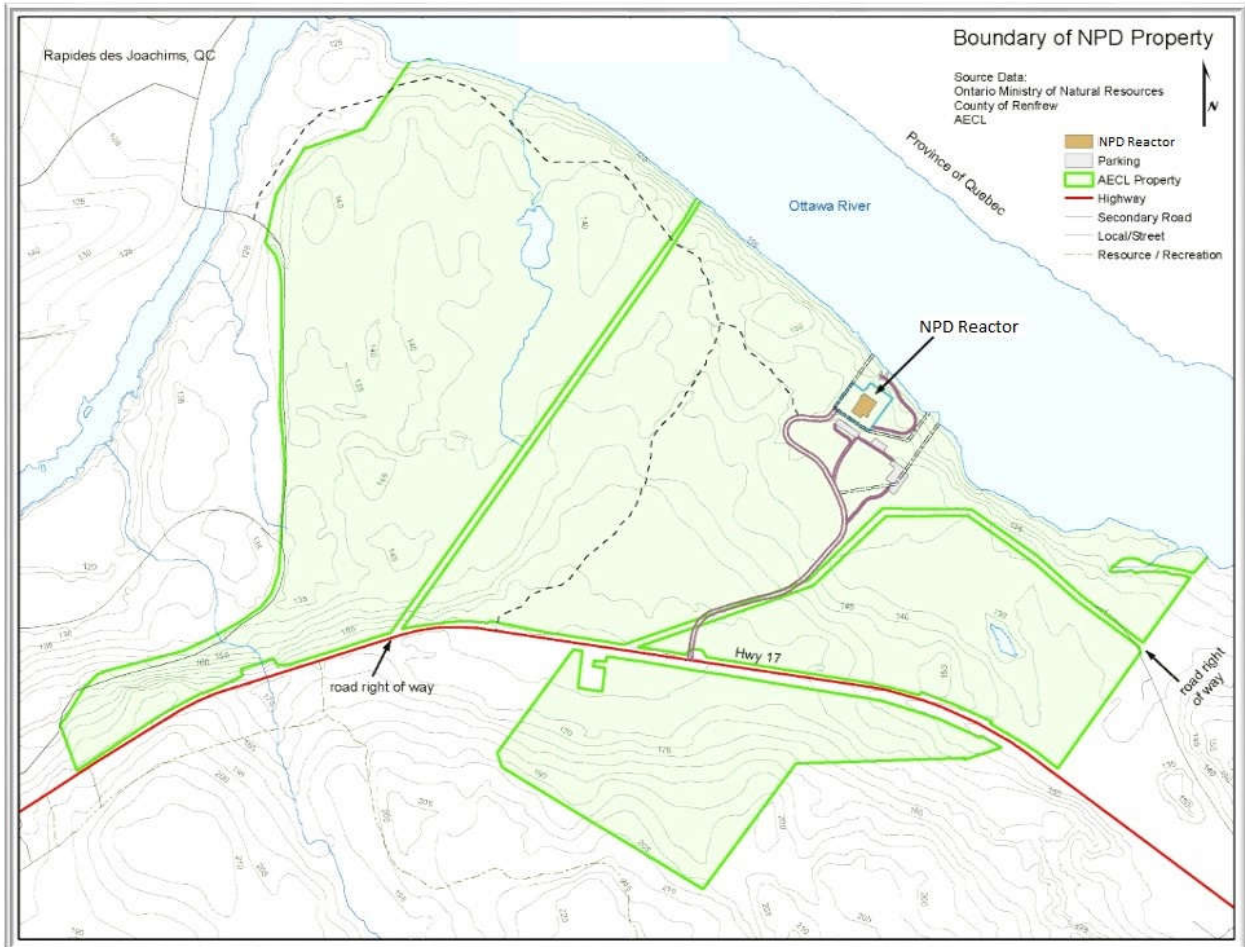


Figure 2: NPD property and location of NPD Reactor



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## ACRONYMS

CNL	Canadian Nuclear Laboratories
CO <sub>2</sub> e	CO <sub>2</sub> equivalent
DRL	Derived Release Limit
EIS	Environmental Impact Statement
HEPA	High-Efficiency Particulate Air
GHG	Greenhouse Gas
MAC	Maximum Acceptable Concentration
NPD	Nuclear Power Demonstration
NPRI	National Pollutant Release Inventory
VKT	Vehicle Kilometres Travelled



## EFFLUENT MONITORING PROGRAM

The Effluent Monitoring Program at the Nuclear Power Demonstration (NPD) site is compliant with CSA Standard N288.5, Effluent monitoring for Class I nuclear facilities. The Effluent Monitoring Program at NPD consists of:

- An annual check against the National Pollutant Release Inventory (NPRI) reporting requirements;
- An annual check against the Greenhouse Gas (GHG) Emissions reporting requirements;
- Monitoring and reporting any losses of halocarbon refrigerants and fire suppressants over 10 kg, in compliance with the Federal Halocarbon Regulations;
- Airborne release monitoring through tritium and gross beta analysis of the ventilation stack emissions (Table 1); and
- Waterborne release monitoring through tritium and gross beta analysis of water flowing through Manhole #2 (Table 2).

### ***National Pollutant Release Inventory***

For most of 2020, the majority of NPD staff worked from home due to the Covid-19 pandemic and activities on-site were reduced. As a result the reporting threshold of 20,000 hours worked on-site during the calendar year was not met.

The sources of NPRI emissions from the NPD site were virtually unchanged for the 2020 reporting period and were minimal. These included:

- The intermittent burning of diesel fuel in the emergency generator;
- Unpaved road dust; and,
- Minor solvent use.

### ***Greenhouse Gas Emissions***

The NPD site would be required to report greenhouse gas emissions if the site emitted over 10,000 tons of CO<sub>2</sub> equivalent (CO<sub>2</sub>e) during the 2020 reporting period. The sources of greenhouse gas emissions at NPD were minimal and included on site transportation, minor emissions from a former landfill and intermittent use of the diesel generator. The NPD site did not meet the reporting thresholds for Greenhouse Gas Emissions in 2020.

### ***Halocarbons***

All of the halocarbon-containing equipment at the NPD site contains far below the reporting threshold of 10 kg charging capacity of halocarbons. Therefore no reporting (as per sections 32 and 33 of the [Federal Halocarbon Regulations](#)) was required.



### Radiological Airborne Releases

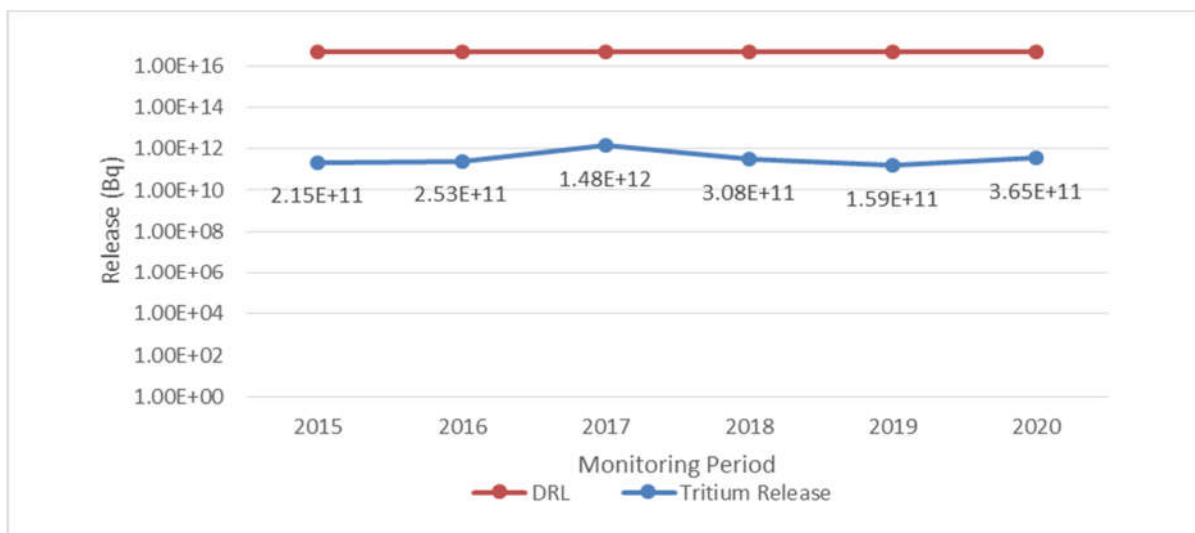
The 45.7 meter tall ventilation stack is the only airborne effluent monitoring point at the NPD site. It is used to ventilate the nuclear side of the NPD facility. The ventilation system is only operated when staff must enter the nuclear site of the facility for activities such as inspections and maintenance. Air emitted from the stack passes through a High-Efficiency Particulate Air (HEPA) filter which has an efficiency of 99.97% removal of airborne particulate. Parameters that require monitoring from the ventilation system are fan runtime, tritium and gross beta activity. In 2020 the ventilation system was operated for a total of 462.5 hours (fan runtime). Airborne effluent monitoring results for tritium and gross beta are presented in Table 1.

**Table 1: Airborne Effluent Monitoring Results for 2020**

Radionuclide	Release for 2020 (Bq)	DRL (Bq/year)	% DRL	Average (Bq) 2015-2019
Tritium	3.65E+11 <sup>[a]</sup>	4.52E+16	<0.01	4.83E+11
Gross Beta	4.43E+04 <sup>[b]</sup>	3.83E+12 <sup>[c]</sup>	<0.01	<7.19E+04

- a. The 2020 November sample was less than the equipment lower limit of detection and for this month, an upper limit equal to the critical level was used in the release calculation.
- b. Except for one month (2020 May), all values used were less than the equipment lower limit of detection and an upper limit equal to the critical level was used in the release calculation.
- c. Gross Beta DRL is based on Cs-137, the most restrictive radionuclide.

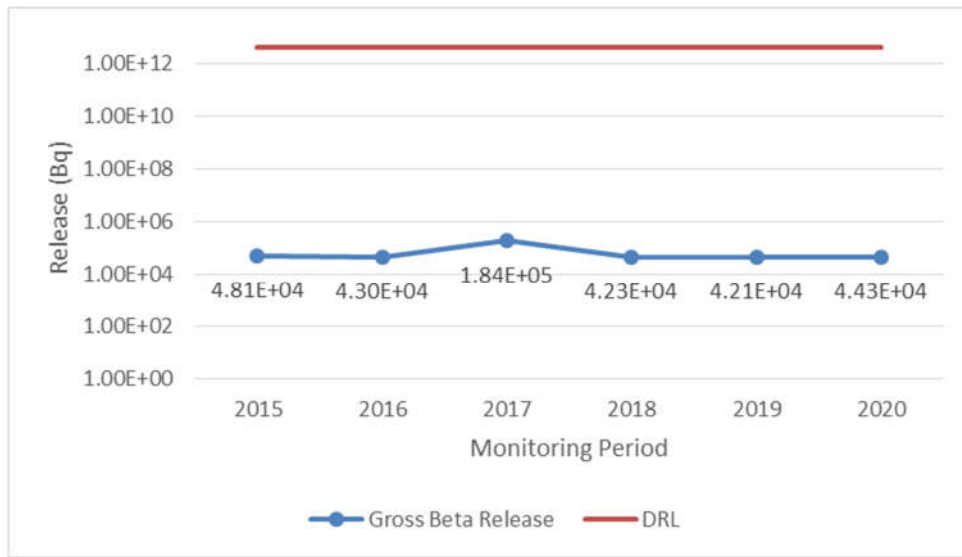
The total airborne tritium release in 2020 was 3.65E+11Bq compared with a DRL of 4.52E+16 Bq/year, which is less than 0.01% of the Derived Release Limit (DRL) for tritium. The average airborne release for 2015 to 2019 for tritium is 4.83E+11 Bq. The results for 2020 are in line with previous years and as shown in Figure 3 there is no adverse trend.



**Figure 3: Airborne Release Trend for Tritium (2015-2020)**



The total airborne gross beta release was  $4.43\text{E}+04$  Bq compared with a DRL of  $3.83\text{E}+12$  Bq/year, which is less than 0.01% of the DRL for gross beta. Average airborne release for 2015 to 2019 for gross beta was  $<7.19\text{E}+04$  Bq. The results for 2020 are in line with previous years and as shown in Figure 4 there is no adverse trend.



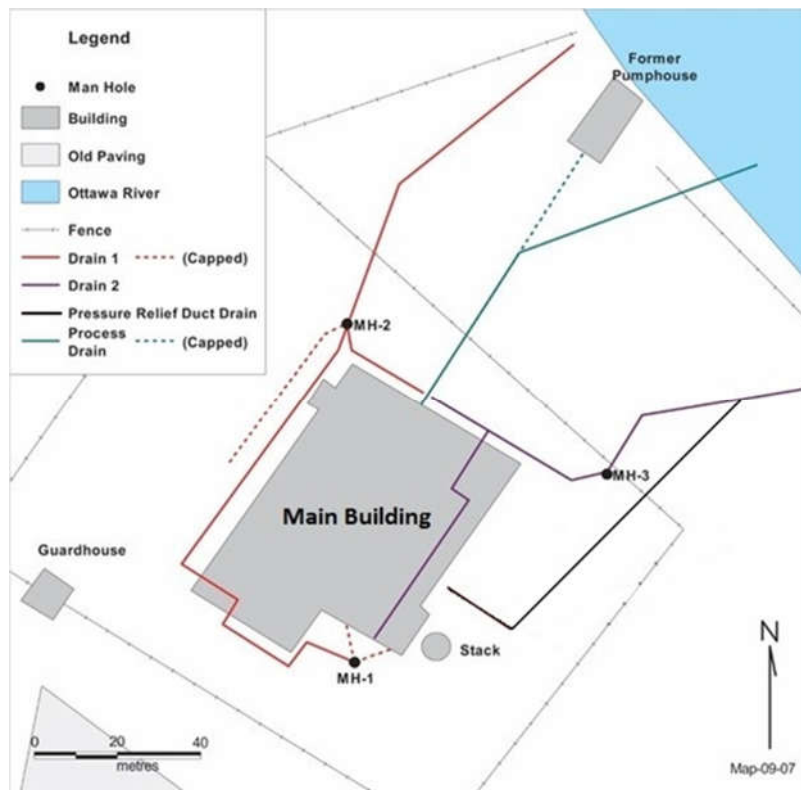
Note: 2015, 2016, and 2019 results were based on values that were all at the Minimum Detectable Activity.

**Figure 4: NPD Airborne Release Trend for Gross Beta (2015-2020)**

In Figures 3 and 4, the minor increase in tritium and gross beta releases in 2017 are due to a six-month long asbestos abatement campaign in the NPD facility. The ventilation stack was shut off for this campaign and air was filtered through temporary HEPA filters. Tritium releases were conservatively estimated and gross beta releases were based on measurements obtained directly on the HEPA filters, without crediting the HEPA filter efficiency of 99.97% removal of particulate, resulting in the apparent increase in tritium and gross beta releases.

### **Liquid Releases**

Manhole #2 is located over Drain 1 which collects groundwater and precipitation diverted from around the Main Building and has a continuous release to the Ottawa River (see Figure 5). Manhole #2 is the sampling location for Drain 1 and is monitored for flow, tritium and gross beta activity. An estimated  $181\,422\text{ m}^3$  of groundwater was diverted via Manhole #2 in 2020.



**Figure 5: Drainage systems around the NPD facility (“Main Building”). Manhole #1 and Manhole #2 (MH-2) are located over Drain 1. Manhole #2 is regularly monitored because it is the downstream access point of Drain 1 and captures water that flows through Manhole #1 (MH-1). Manhole #3 is located over Drain 2. It has no measureable flow, and as such it is not an effluent monitoring location. The Process Drain (green line) is no longer used.**

**Error! Reference source not found.** shows the monitoring results from Manhole #2.

**Table 2: Liquid Effluent Monitoring Results for 2020**

Location	Radionuclide	Release for 2020 (Bq)	DRL (Bq/year)	% DRL	Average (Bq) 2016-2019
Manhole #2	Tritium	6.67E+09 <sup>[a]</sup>	4.33E+17	<0.01	1.77E+10
	Gross Beta	2.05E+08	2.56E+13 <sup>[b]</sup>	<0.01	7.83E+07

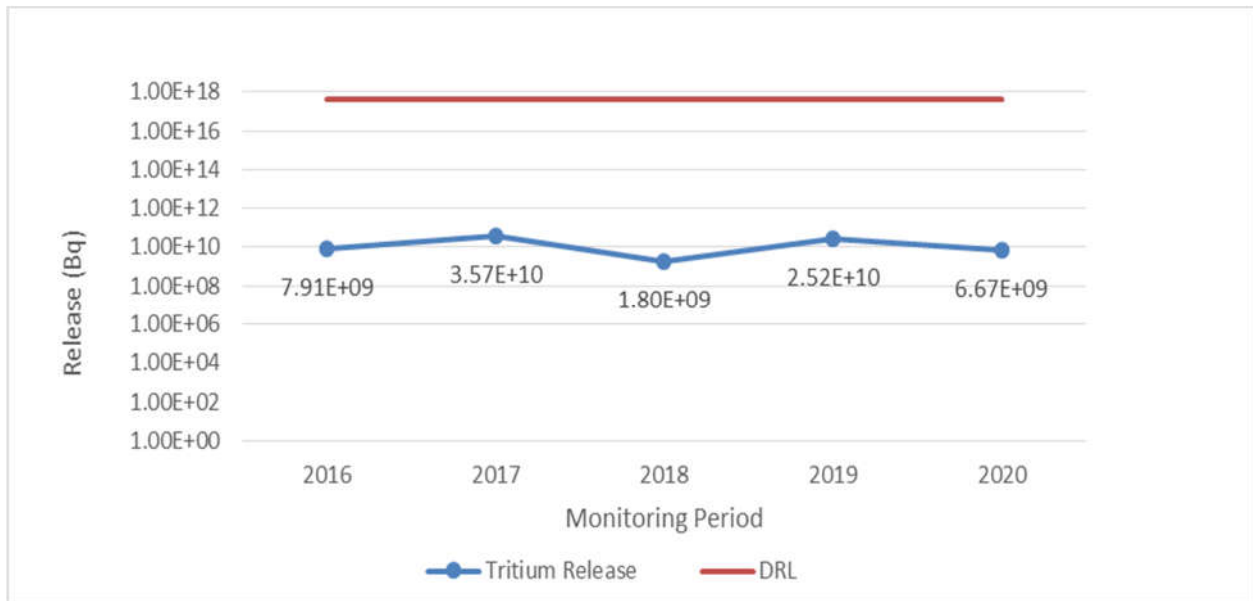
<sup>[a]</sup> Both samples for tritium were less than the equipment lower limit of detection and an upper limit equal to the critical level was used in the release calculation.

<sup>[b]</sup> Gross Beta DRL is based on Cs-137, the most restrictive radionuclide.

The total tritium release from Manhole #2 was  $6.67\text{E}+09$  Bq compared to the DRL of  $4.33\text{E}+17$  Bq/year, which is less than 0.01% of the DRL for tritium. Both samples for tritium were less than the equipment lower limit of detection and an upper limit equal to the critical level was used in the release calculation.

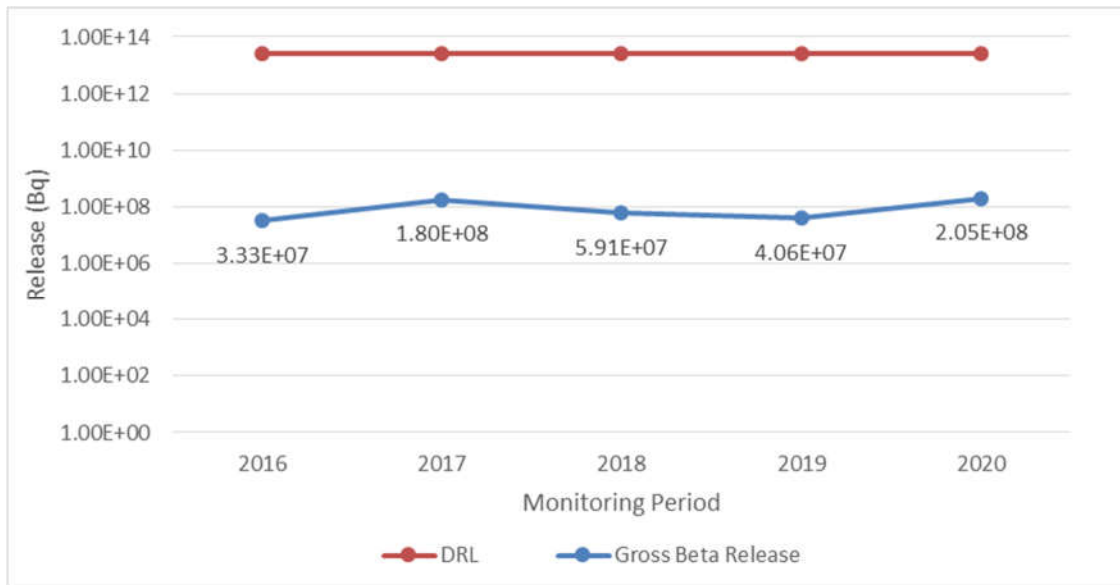
The total gross beta release from Manhole #2 was  $2.05\text{E}+08$  Bq, compared to the DRL of  $2.56\text{E}+13$  Bq/year which is less than 0.01% of the DRL for gross beta.

The average tritium and gross beta releases from 2016 to 2019 were  $1.77\text{E}+10$  Bq and  $7.83\text{E}+07$  Bq respectively. As can be seen in Figure 6 and Figure 7 below, there is no evidence of an adverse trend. Note that the years before 2016 are not available because monitoring of Manhole #2 in accordance with CSA N288.5 commenced in 2016.



**Figure 6: Annual Tritium Release from Manhole #2 (2016 – 2020)**





**Figure 7: Annual Gross Beta Release from Manhole #2 (2016 – 2020)**

### NPD SITE MONITORING

Additional monitoring around the NPD site consists of monitoring of radioactivity in the Ottawa River as well as tritium analysis of water from surface soil and vegetation. Additional analyses may be performed if gross measurements differ from normal. For example, Sr-90 analysis for the Ottawa River is performed when gross beta levels are significantly higher than normal. No additional analyses were required in 2020.

Results of monitoring of radioactivity in the Ottawa River upstream (Rolphton) and downstream (Deep River) of the NPD site from 2015 to 2020 are shown in Table 3, and the sampling locations are shown in Figure 8. The monitoring results were compared to the federal [Guidelines for Canadian Drinking Water Quality](#) which are listed in Table 4 below.

Maximum acceptable concentrations (MACs) in drinking water have been established for natural and artificial radionuclides that are most commonly detected in Canadian water supplies. In 2020, all measured radionuclides were below their respective drinking water guidelines.

**Table 3: Radioactivity in Ottawa River Water upstream and downstream of NPD 2015-2020**

Location & Parameter	2015	2016	2017	2	2	5-Year	2020 Average	2020
<b>Rolphton (ORR) – approximately 4 km Upstream of NPD</b>								
Tritium (Bq/L)	V 1.7 ± 0.1	2.1 ± 0.1	3.5 ± 0.2	2.62 ± 0.2	2.77 ± 0.2	V 2.5 ± 0.1	1.88 ± 0.1	2.40 ± 0.46 (Sep)
Gross Beta (Bq/L)	0.04 ± 0.001	0.046 ± 0.012	0.046 ± 0.012	0.047 ± 0.012	0.041 ±	0.044 ± 0.005	0.044 ± 0.004	0.055 ± 0.015
Gross Alpha (Bq/L)	0.0091 ±	0.0072 ±	0.0074 ±	0.0068 ±	0.0075 ±	0.0076 ±	0.01 ± 0.001	0.017 ± 0.003 (Jan)
Total Strontium (Bq/L)	0.0019 ±	NA	NA	NA	N	NA	NA	NA
<sup>137</sup> Caesium (Bq/L)	V 0.0012 ±	V 0.0006 ±	V 0.0003 ±	V 0.0003 ±	V 0.0005 ±	V 0.0006 ±	< 0.0004	< 0.0005
<b>Deep River (ORD) – approximately 15 km Downstream of NPD</b>								
Tritium (Bq/L)	V 1.4 ± 0.1	2.2 ± 0.1	3.6 ± 0.2	2.7 ± 0.2	2.8 ± 0.2	V 2.5 ± 0.1	2.09 ± 0.1	2.99 ± 0.56 (Jul)
Gross Beta (Bq/L)	0.039 ±	0.052 ± 0.013	0.054 ± 0.013	0.053 ± 0.013	0.046 ±	0.049 ± 0.006	0.048 ± 0.004	0.059 ± 0.016 (Jun)
Gross Alpha (Bq/L)	0.0079 ±	0.0065 ±	0.007 ±	0.0059 ±	0.0066 ±	0.0068 ± 0.0003	0.01 ± 0.001	0.014 ± 0.003 (Jan)
Total Strontium (Bq/L)	V 0.0027 ±	NA	NA	NA	NA	NA	NA	NA
<sup>137</sup> Caesium (Bq/L)	V 0.002	V 0.0006 ±	< 0.0004	< 0.0004	< 0.0004	V 0.0008 ± 0	< 0.0007	< 0.0008

1. Represents the uncertainty in the counting statistics, except for the 5-year averages, where it represents the uncertainty in the result population (i.e. one standard deviation of the annual averages).
2. < Indicates that the result is below the detection limit (L<sub>d</sub>) but higher than the critical level (L<sub>c</sub>). The measured value rather than the value of the L<sub>d</sub> is shown in the table.
3. NA Analysis that is no longer conducted (e.g., Sr-90 in surface water is only conducted when gross beta levels are significantly higher than normal).
4. V Indicates that one or more of the values used to calculate the result is below the critical level (L<sub>c</sub>) and/or the detection level (L<sub>d</sub>).

**Note 1:** Results are annual averages. Grab samples are taken on a daily basis. Tritium, gross beta and gross alpha analysis is done on monthly composites. Cs-137 analysis is completed biannually on 3 month composites.

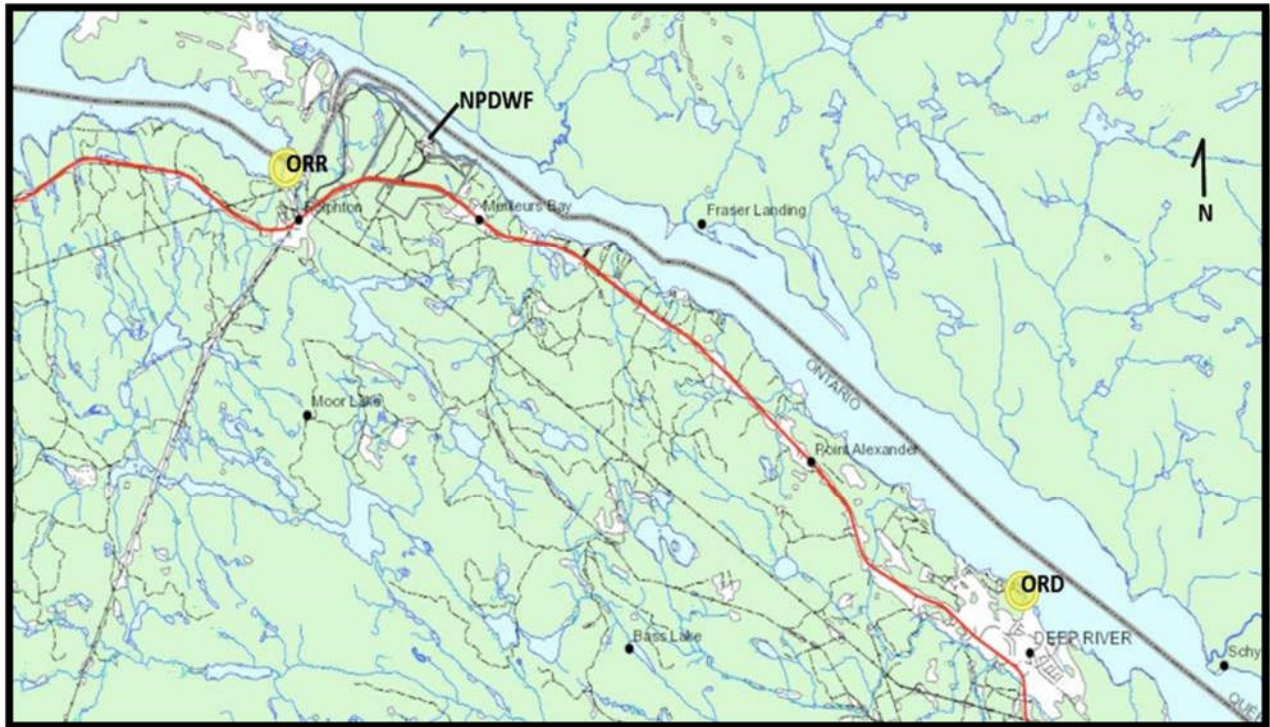
**Note 2:** In 2016 the CNL EMP moved from reporting a ±1 sigma uncertainty to a method (described in the CSA N288.4) that more accurately represents the uncertainty associated with the measured value. This has, in general, resulted in a higher reported uncertainty than what has been seen in previous years.



**Table 4: Health based drinking water guidelines for radioactive parameters**

5. Radioactive Parameter	6. Maximum Acceptable Concentration (MAC) or Screening Level
7. <sup>137</sup> Caesium	8. MAC = 10 Bq/L
9. Gross Alpha <sup>a</sup>	10. Screening Level = 0.5 Bq/L
11. Gross Beta <sup>b</sup>	12. Screening Level = 1 Bq/L
13. <sup>90</sup> Strontium	14. MAC = 5 Bq/L
15. Tritium	16. MAC = 7,000 Bq/L

- a. Screening level for gross alpha activity is based on the alpha emitter with the strictest MAC (<sup>226</sup>Ra) expected to be present.
- b. Screening level for gross beta activity is protective of all beta-emitting species that can be expected to be found in drinking water, including radioiodines and <sup>90</sup>Sr.



**Figure 8: Ottawa River Sampling Locations in the Vicinity of the NPD site.**

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Toll Free: 1-866-513-2325

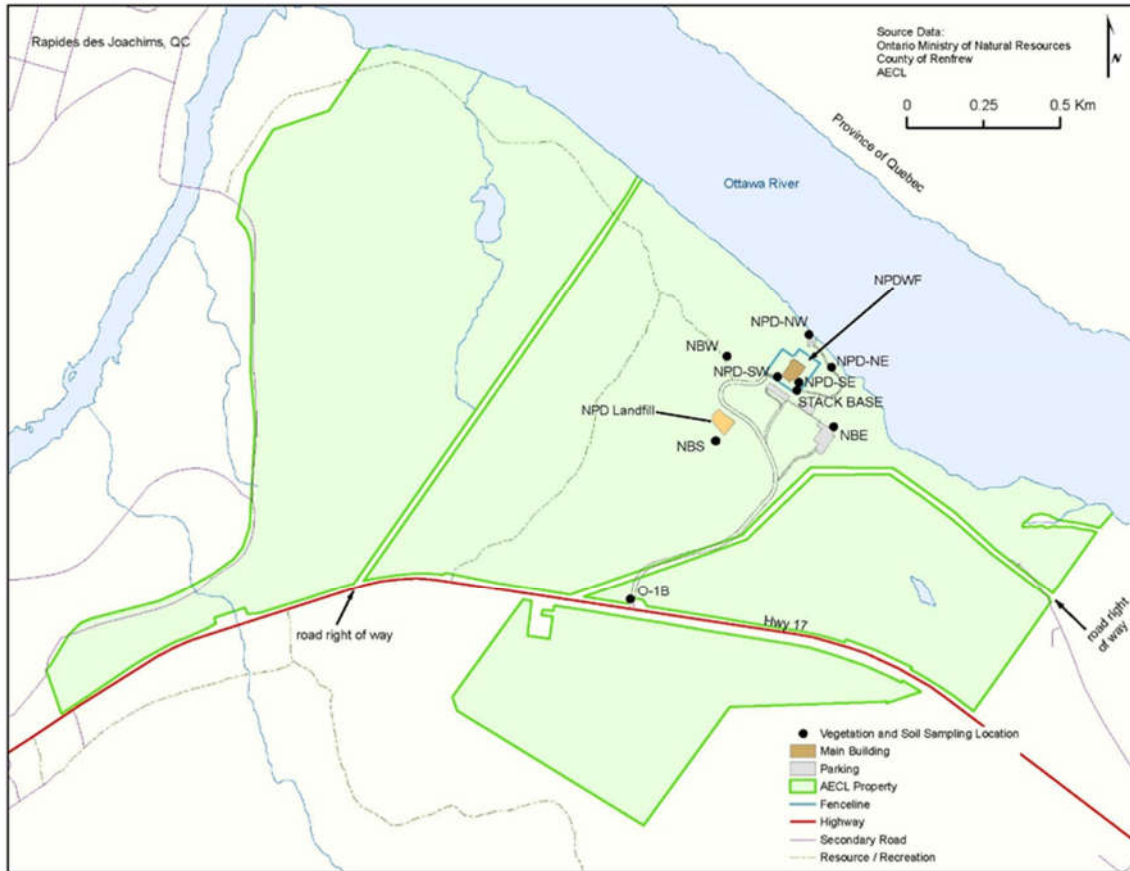
Laboratoires de Chalk River  
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Tritium analysis of water from surface soil and vegetation for the past five years is shown in Table 5 and sampling locations are shown in Figure 9. Monitoring results from 2020 were within the range that has been historically observed since monitoring began. Monitoring at the stack base commenced in 2013. All other locations have been monitored since the late 80s or early 90s. The highest tritium concentration measured in 2020 (52 Bq/L) in a vegetation sample collected at the base of the NPD stack, was about 0.7% of the Maximum Acceptable Concentration (MAC) for tritium in drinking water. The data confirm the continued atmospheric release of small quantities of tritium from the NPD facility, but also confirm that these releases have no significant environmental effects.

**Table 5: Tritium Analysis of Water from Surface Soil and Vegetation. Results from the past five years (2015 – 2020).**

	Sampling Station Number	2015	2016	2017	2018	2019	2020
Vegetation-Free Water (Bq/L)	NPD-NE	39	37	32	38	10	19
	NPD-SE	35	46	34	97	98	19
	NPD-SW	22	76	11	73	47	35
	NPD-NW	12	42	18	28	8	30
	Stack Base	102	125	145	504	1082	52
	O1B	< 2	18	<3	48	3	4
	NB-W	7	44	9	58	22	8
	NB-S	< 3	21	2	44	6	2
	NB-E	223	21	40	41	7	10
Soil Water (Bq/L)	NPD-NE	24	10	36	18	12	10
	NPD-SE	10	13	14	77	21	7
	NPD-SW	15	15	8	43	14	6
	NPD-NW	25	9	10	26	10	5
	Stack Base	34	35	138	259	156	23
	O1B	7	<3	<2	12	3	2
	NB-W	13	13	8	23	14	5
	NB-S	5	<3	4	15	1	1
	NB-E	9	5	4	16	6	6



**Figure 9: Sampling Locations for surface soil and vegetation sampling.**

## CONCLUSION

Results of effluent and environmental monitoring at the NPD site demonstrate that the public and the environment around the NPD site continue to be protected. For any inquiries about monitoring results, please contact [ermstakeholder@cnl.ca](mailto:ermstakeholder@cnl.ca).