

Environmental Emissions Data for Darlington Nuclear

Q3 2017

OVERVIEW

This report summarizes Darlington Nuclear’s environmental emissions data for Q3 2017. Darlington Nuclear Generating Station has four reactor units and a total generation capacity of 3,512 megawatts. The station is located in the Municipality of Clarington in Durham Region. Refurbishment of Darlington Unit 2 started in October 2016.

This report includes:

- **Radioactive Effluents:** Releases to air and water were less than one per cent of regulatory limits.
- **Darlington Waste Management Facility:** Monitoring results for air emissions, storm water, and perimeter dose rate confirmed the integrity of the facility.
- **Groundwater Monitoring:** OPG continued to analyze groundwater results to examine trends.
- **Spills to the Environment:** There were no spills to the environment that were reportable to a regulatory authority.

Note: The contents of this report are consistent with environmental data OPG is required to provide to the Canadian Nuclear Safety Commission (CNSC) on a quarterly basis. These reporting requirements are periodically revised.

ENVIRONMENTAL EMISSIONS MANAGEMENT

OPG has an environmental management program to ensure its activities are conducted in a manner that minimizes any adverse impact on the public and the environment. OPG’s environmental program conforms to CNSC requirements for environmental protection and the International Organization for Standardization (ISO) standard for environmental management systems. The quality assurance programs for OPG’s chemistry and health physics laboratories conform to the requirements of national and international standards.

As part of OPG’s environmental management program, OPG has established an effluent monitoring and control program that is based on the “ALARA” principle. That is, measures are in place to ensure emissions to the environment are kept As Low As Reasonably Achievable while taking social and economic factors into account.

MONITORING OF RADIOACTIVE EFFLUENTS

Release Limits & Action Levels

OPG uses **radiation dose limits** specified in federal legislation to derive Release Limits for the radionuclides that may be released to air and water from its nuclear facilities. Darlington Nuclear must maintain its radiological emissions well below these limits to meet the terms of its operating licence.

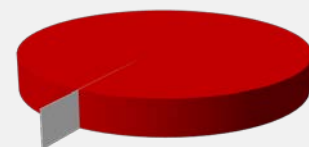
OPG also sets Action Levels that are much lower than the Release Limits to identify and control emissions before a limit can be reached.

Public Radiation Dose Data

The radiation dose to the public resulting from the operation of Darlington Nuclear is a very small fraction of the estimated annual average background radiation dose around the station.

Annual environmental monitoring program results for Darlington Nuclear, including an assessment of radiation dose to the public, are available at:
www.opg.com/news-and-media/Pages/reports.aspx

Natural Background Radiation > 99.9%



Darlington Nuclear Contribution < 0.1%

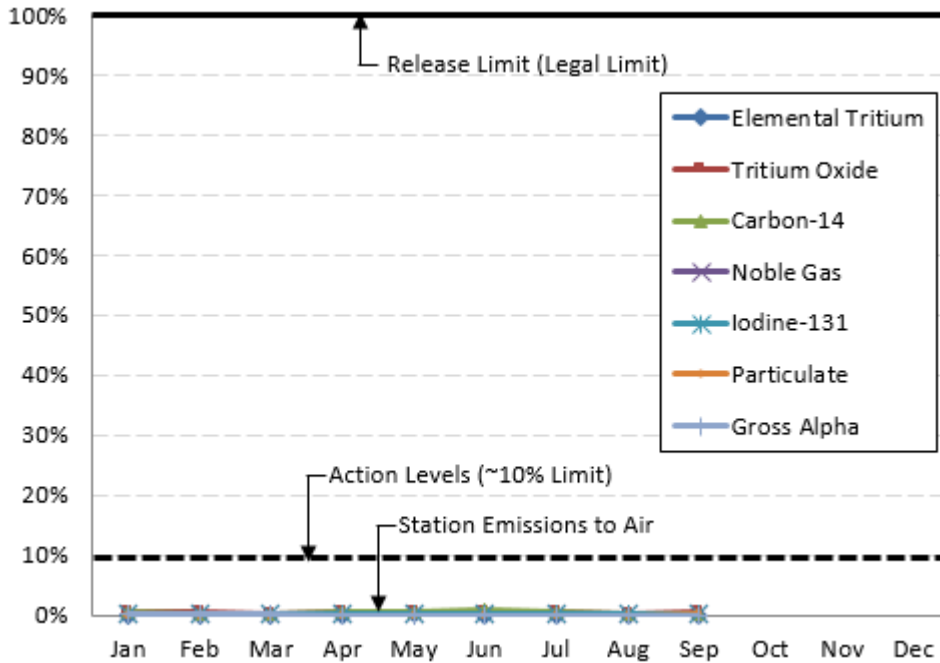
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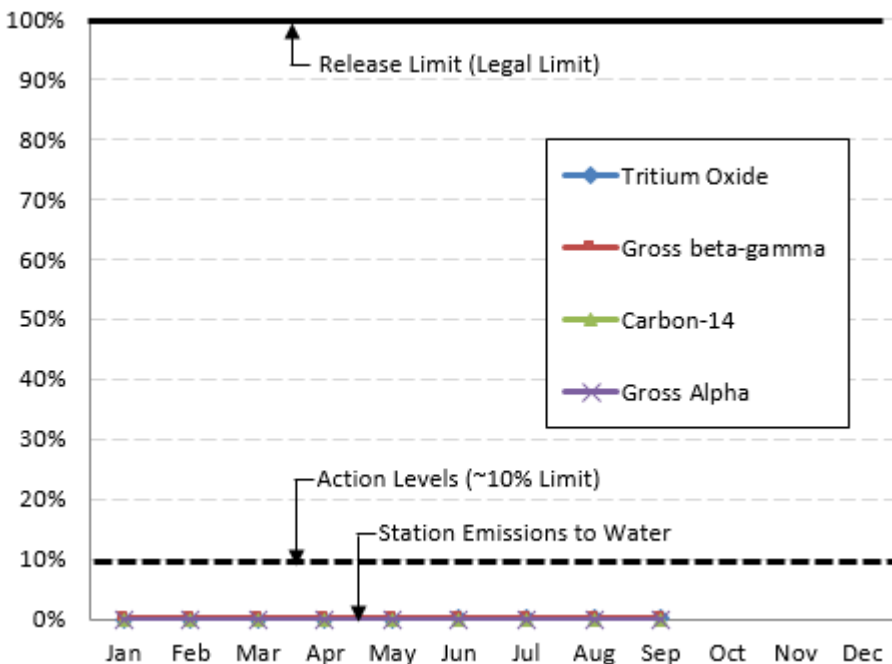
Performance Results

Darlington Nuclear’s emissions are monitored to track performance. For Q3 2017, Darlington Nuclear’s radiological emissions to air and water remained less than one per cent of the Release Limits and no Action Levels were exceeded. (Appendix A, Tables A.1 and A.2) The following graphs show Darlington Nuclear’s radiological emissions for the year to date as a percentage of the Release Limits.

Air Emissions as a Per Cent of Release Limits



Water Emissions as a Per Cent of Release Limits



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DARLINGTON WASTE MANAGEMENT FACILITY

Radiological air emissions, storm water, and radiation dose monitoring requirements for the Darlington Waste Management Facility were met in Q3 2017 and no issues were identified. (Appendix A, Tables A.3 and A.4)

GROUNDWATER MONITORING

Groundwater monitoring is conducted at monitoring wells around the Darlington site perimeter, including along the Lake Ontario shoreline, to confirm that there are no adverse off-site impacts from tritium in groundwater. (Appendix A, Table A.5)

There are no regulatory limits associated with the concentration of tritium in groundwater at Darlington Nuclear as the site is considered for industrial use with non-potable groundwater.

RELEASES OF HAZARDOUS SUBSTANCES (NON-RADIOACTIVE)

Darlington Nuclear complies with numerous regulatory requirements for controlling and monitoring releases of hazardous substances to the environment. Darlington Nuclear reports releases of hazardous substances to Environment Canada's National Pollutant Release Inventory (NPRI). Tools and resources for accessing, analyzing and interpreting NPRI data are available on the [NPRI website](#). Darlington Nuclear's carbon dioxide emissions are well below the threshold for mandatory reporting to federal and provincial authorities. Greenhouse gas data and information for reporting facilities are available on the [Greenhouse Gas Emissions Reporting Program \(GHGRP\) website](#).

SPILLS TO THE ENVIRONMENT

OPG has extensive programs to ensure the risk of spills to the environment is effectively assessed and managed. All spills are reported by OPG to the appropriate federal, provincial and municipal authorities as required.

OPG classifies its reportable spills as Category A, B or C spills based on the actual or potential impacts. Category A spills are considered very serious due to the scale of injury or damage, health effects, or safety impairment. Category B spills are considered serious due to localized injury or impacts to property. Category C spills are all other reportable spills that are less serious than Category A and B spills.

There were no reportable spills at Darlington Nuclear in Q3 2017.

APPENDIX A

ENVIRONMENTAL EMISSIONS DATA

Environmental Emissions Data for Darlington Nuclear

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Table A.1: Airborne Radionuclide Releases

	Elemental Tritium (Bq)	Tritium Oxide (Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Bq)	Gross Alpha (Bq)	
SUMMARY: ANNUAL								
Release Limit (Bq/year) ^(a)	8.5×10^{17}	5.9×10^{16}	3.5×10^{14}	4.5×10^{16}	1.4×10^{12}	6.7×10^{11}	1.0×10^{11}	
Total Releases as of Q3 2017	6.8×10^{13}	1.7×10^{14}	1.1×10^{12}	1.1×10^{13}	$<1.1 \times 10^8$	2.0×10^7	$<2 \times 10^6$	
DETAILS: WEEKLY^(b)								
Action Level (Bq/week) ^(c)	1.7×10^{15}	1.2×10^{14}	7.0×10^{11}	8.9×10^{13}	2.8×10^9	1.3×10^9	Not specified ^(d)	
Jan.	Week 1	3.6×10^{11}	2.7×10^{12}	3.0×10^{10}	2.7×10^{11}	$<2.8 \times 10^6$	3.0×10^5	$<1 \times 10^5$
	Week 2	4.8×10^{11}	3.9×10^{12}	3.4×10^{10}	4.4×10^{11}	$<3.4 \times 10^6$	3.0×10^5	$<1 \times 10^5$
	Week 3	7.2×10^{11}	4.3×10^{12}	2.4×10^{10}	4.5×10^{11}	$<3.0 \times 10^6$	4.4×10^5	$<1 \times 10^5$
	Week 4	4.0×10^{11}	3.9×10^{12}	3.5×10^{10}	2.7×10^{11}	$<3.1 \times 10^6$	2.7×10^5	$<1 \times 10^5$
	Week 5	5.5×10^{11}	4.3×10^{12}	3.2×10^{10}	4.4×10^{11}	$<2.8 \times 10^6$	2.9×10^5	$<1 \times 10^5$
Feb.	Week 6	9.7×10^{11}	3.3×10^{12}	1.9×10^{10}	9.1×10^{11}	$<3.0 \times 10^6$	3.2×10^5	$<1 \times 10^5$
	Week 7	3.2×10^{11}	4.4×10^{12}	2.0×10^{10}	5.8×10^{11}	$<2.9 \times 10^6$	2.6×10^5	$<1 \times 10^5$
	Week 8	3.2×10^{11}	3.5×10^{12}	1.5×10^{10}	3.1×10^{11}	$<2.8 \times 10^6$	3.1×10^5	$<1 \times 10^5$
	Week 9	2.5×10^{11}	4.1×10^{12}	1.4×10^{10}	3.2×10^{11}	$<3.0 \times 10^6$	5.3×10^5	$<1 \times 10^5$
Mar.	Week 10	1.6×10^{11}	4.2×10^{12}	1.4×10^{10}	4.4×10^{11}	$<3.1 \times 10^6$	4.9×10^5	$<1 \times 10^5$
	Week 11	5.3×10^{10}	3.4×10^{12}	2.0×10^{10}	3.0×10^{11}	$<2.7 \times 10^6$	3.4×10^5	$<1 \times 10^5$
	Week 12	5.0×10^{11}	3.4×10^{12}	1.8×10^{10}	2.8×10^{11}	$<2.7 \times 10^6$	5.5×10^5	$<1 \times 10^5$
	Week 13	2.6×10^{11}	3.4×10^{12}	2.8×10^{10}	2.4×10^{11}	$<2.5 \times 10^6$	3.4×10^5	$<1 \times 10^5$
Apr. ^(e)	Week 14	4.2×10^{11}	3.6×10^{12}	2.9×10^{10}	2.0×10^{11}	$<2.7 \times 10^6$	3.8×10^5	1×10^4
	Week 15	2.6×10^{11}	3.5×10^{12}	3.7×10^{10}	2.1×10^{11}	$<2.7 \times 10^6$	6.1×10^5	1×10^4
	Week 16	5.1×10^{11}	3.5×10^{12}	4.3×10^{10}	1.5×10^{11}	$<2.7 \times 10^6$	4.1×10^5	1×10^4
	Week 17	1.9×10^{11}	8.2×10^{12}	3.7×10^{10}	1.5×10^{11}	$<2.9 \times 10^6$	4.7×10^5	1×10^4
	Week 18	1.1×10^{12}	9.9×10^{12}	3.0×10^{10}	3.4×10^{11}	$<2.9 \times 10^6$	3.0×10^5	1×10^4
May ^{(e) (f)}	Week 19	4.9×10^{13}	5.1×10^{12}	2.7×10^{10}	3.4×10^{11}	$<2.9 \times 10^6$	3.0×10^5	1×10^4
	Week 20	6.9×10^{12}	4.0×10^{12}	3.5×10^{10}	1.4×10^{11}	$<3.0 \times 10^6$	4.8×10^5	1×10^4
	Week 21	6.6×10^{11}	4.6×10^{12}	4.1×10^{10}	1.8×10^{11}	$<2.8 \times 10^6$	4.6×10^5	1×10^4
	Week 22	3.2×10^{11}	5.1×10^{12}	5.2×10^{10}	3.3×10^{11}	$<2.8 \times 10^6$	4.2×10^5	1×10^4
Jun. ^(e)	Week 23	2.3×10^{11}	7.9×10^{12}	5.2×10^{10}	2.1×10^{11}	$<2.8 \times 10^6$	3.9×10^5	1×10^4
	Week 24	1.0×10^{11}	3.8×10^{12}	6.0×10^{10}	1.7×10^{11}	$<2.8 \times 10^6$	1.1×10^6	1×10^4
	Week 25	4.1×10^{11}	5.4×10^{12}	5.6×10^{10}	1.5×10^{11}	$<2.8 \times 10^6$	5.8×10^5	1×10^4
	Week 26	2.1×10^{11}	5.4×10^{12}	4.8×10^{10}	2.4×10^{11}	$<3.0 \times 10^6$	3.8×10^5	1×10^4
Jul.	Week 27	6.7×10^{11}	9.2×10^{12}	2.4×10^{10}	2.5×10^{11}	$<2.7 \times 10^6$	4.0×10^5	1×10^4
	Week 28	2.4×10^{11}	3.9×10^{12}	2.6×10^{10}	1.5×10^{11}	$<2.7 \times 10^6$	7.1×10^5	2×10^4
	Week 29	7.7×10^{10}	3.0×10^{12}	1.9×10^{10}	2.6×10^{11}	$<2.8 \times 10^6$	5.4×10^5	2×10^4
	Week 30	2.1×10^{11}	4.2×10^{12}	1.8×10^{10}	1.1×10^{11}	$<2.9 \times 10^6$	4.5×10^5	1×10^4
	Week 31	2.5×10^{11}	4.3×10^{12}	3.6×10^{10}	3.9×10^{11}	$<2.8 \times 10^6$	8.0×10^5	2×10^4

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		Elemental Tritium (Bq)	Tritium Oxide (Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Bq)	Gross Alpha (Bq)
Aug.	Week 32	2.1×10^{11}	3.0×10^{12}	1.9×10^{10}	1.5×10^{11}	$<2.6 \times 10^6$	6.6×10^5	2×10^4
	Week 33	2.3×10^{11}	3.2×10^{12}	1.6×10^{10}	1.7×10^{11}	$<2.6 \times 10^6$	8.5×10^5	2×10^4
	Week 34	2.4×10^{11}	3.6×10^{12}	2.2×10^{10}	8.9×10^{10}	$<2.6 \times 10^6$	7.1×10^5	2×10^4
	Week 35	2.2×10^{11}	3.3×10^{12}	1.7×10^{10}	1.5×10^{11}	$<2.6 \times 10^6$	4.8×10^5	2×10^4
Sep.	Week 36	2.0×10^{11}	3.6×10^{12}	1.6×10^{10}	3.7×10^{11}	$<2.7 \times 10^6$	6.3×10^5	1×10^4
	Week 37	1.8×10^{11}	3.3×10^{12}	1.3×10^{10}	2.4×10^{11}	$<2.9 \times 10^6$	5.2×10^5	2×10^4
	Week 38	1.7×10^{11}	4.0×10^{12}	1.5×10^{10}	1.5×10^{11}	$<2.5 \times 10^6$	9.2×10^5	1×10^4
	Week 39	1.2×10^{11}	4.4×10^{12}	1.6×10^{10}	1.5×10^{11}	$<2.5 \times 10^6$	9.6×10^5	1×10^4

- (a) The derived Release Limit for a given radionuclide is the release rate of that radionuclide to air or surface water during normal operation of a nuclear facility over the period of a calendar year, which would result in an individual receiving a dose equal to the regulatory annual dose limit for a member of the public.
- (b) Analysis of air emissions is conducted weekly to monitor against internal performance targets. Emissions are reported using the fiscal calendar and months contain either four or five weeks. Values prefixed by an "<" indicate that reported results were less than the instrument detection limits.
- (c) Exceedances of Action Levels must be reported by OPG to the CNSC. To prevent an Action Level from being reached, OPG has set Internal Investigation Levels that require emissions to be reviewed when they reach the high end of the normal range. Corrective actions are taken if necessary. There were no CNSC Action Level exceedance events in the third quarter of 2017.
- (d) Action Level for gross alpha is not specified because it is not a routinely monitored radionuclide group at Darlington Nuclear as the activity is below the threshold value for monitoring.
- (e) The decrease in gross alpha releases starting in the second quarter was primarily due to a longer counting time performed on the particulate filter papers analyzed by the outside laboratory, and raw count data were used in the calculation.
- (f) The increase in elemental tritium releases in May (week 19) was primarily due to a mispositioned valve. Corrective actions were immediately taken by Operations to redirect residual elemental tritium to Air Clean up System. A procedural update was subsequently initiated to rectify the deficiencies.

Table A.2: Waterborne Radionuclide Releases

	Tritium Oxide (Bq)	Gross Beta-Gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
SUMMARY: ANNUAL				
Release Limit (Bq/year) ^(a)	5.3×10^{18}	7.1×10^{13}	9.7×10^{14}	3.2×10^{14}
Total Releases as of Q3 2017	2.9×10^{14}	1.9×10^{10}	7.4×10^8	$<7 \times 10^5$
DETAILS: MONTHLY^(b)				
Action Level (Bq/month) ^(c)	4.3×10^{16}	5.7×10^{11}	7.8×10^{12}	Not specified ^(d)
January	1.4×10^{13}	2.1×10^9	1.3×10^7	$<8 \times 10^4$
February	7.6×10^{12}	1.8×10^9	1.2×10^8	$<6 \times 10^4$
March	6.3×10^{12}	1.7×10^9	1.5×10^7	$<4 \times 10^4$

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	Tritium Oxide (Bq)	Gross Beta-Gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
April	1.2×10^{13}	2.0×10^9	3.2×10^7	$<7 \times 10^4$
May	1.2×10^{13}	1.9×10^9	2.0×10^7	$<7 \times 10^4$
June	3.3×10^{13}	1.8×10^9	1.3×10^8	$<6 \times 10^4$
July	4.1×10^{13}	3.0×10^9	5.0×10^7	$<1 \times 10^5$
August	5.1×10^{13}	2.3×10^9	1.1×10^8	$<8 \times 10^4$
September	1.2×10^{14}	2.9×10^9	2.6×10^8	$<1 \times 10^5$

- (a) The derived Release Limit for a given radionuclide is the release rate of that radionuclide to air or surface water during normal operation of a nuclear facility over the period of a calendar year, which would result in an individual receiving a dose equal to the regulatory annual dose limit for a member of the public.
- (b) Analysis of water emissions is conducted monthly to monitor against internal performance targets. Monthly emissions are reported using the fiscal calendar and months contain either four or five weeks. Months with five weeks typically report higher releases relative to months with four weeks. For 2017, January, April, July, October and December have five weeks.
- (c) Exceedances of Action Levels must be reported by OPG to the CNSC. To prevent an Action Level from being reached, OPG has set Internal Investigation Levels that require emissions to be reviewed when they reach the high end of the normal range. Corrective actions are taken if necessary. There were no CNSC Action Level exceedance events in the third quarter of 2017.
- (d) Action Level for gross alpha is not specified because it is not a routinely monitored radionuclide group at Darlington Nuclear as the activity is below the threshold value for monitoring.

Table A.3: Darlington Waste Management Facility Emissions

	Air - Particulate (Bq) ^(a)	Storm Water - Tritium (Bq/L) ^(b)	Storm Water - Gross Gamma (Bq/L) ^(b)
Jul.	Week 27	407	<8.14
	Week 28	333	<8.14
	Week 29	259	<6.66
	Week 30	222	<8.14
	Week 31	444	<7.03
Aug.	Week 32	370	<6.66
	Week 33	333	<8.14
	Week 34	370	<8.14
	Week 35	407	<6.66
Sep.	Week 36	296	<7.03
	Week 37	370	<6.66
	Week 38	111	<7.03
	Week 39	333	<8.14

- (a) All weekly results were below the Action Level of 1.3×10^9 Bq.
- (b) Storm water at the Darlington Waste Management Facility is sampled to assess the integrity of waste storage structures. Results were less than the internal administrative limits set to detect potential leaks.

While station emissions typically remain at consistently low levels, small fluctuations do occur because of changing operating conditions (e.g. unit outages), work activities, and equipment issues.

A becquerel (Bq) is the standard international unit for measuring radioactive decay or radioactivity. One becquerel is the decay of one atom of a radioisotope per second, and is an extremely small amount of radioactivity. Becquerel is a measure of the rate (not energy) of radiation emission from a source.

Another unit of measuring radioactivity is the curie (Ci). 1 Ci = 3.7 x 10¹⁰ Bq.

Table A.4: Darlington Waste Management Facility Perimeter Fence Dose Rates

	Average Air Kerma Rate ($\mu\text{Gy}/\text{hour}$) ^(a)
Location	Q3
DW1, Pole 1	0.056
DW2, Pole 20	0.065
DW3, Pole 19	0.108
DW4, Pole 18	0.097
DW5, Pole 17	0.090
DW6, Pole 13	0.066
DW7, Pole 9	0.093
DW8, Pole 8	0.109
DW9, Pole 7	0.096
DW10, Pole 6	0.078
DW11, Pole 5	0.058
DW12, Pole 3	0.056

- (a) Average ambient dose rates are measured at perimeter fences by Thermoluminescent Dosimeters to demonstrate that potential doses due to radiation fields from waste management facility operations are well within allowable limits and pose a negligible risk for the public, the workers and the environment. Dose rate monitoring results are compared to an internal target dose rate standard of 0.5 $\mu\text{Gy}/\text{hour}$. This target is derived from the 1 mSv/year dose limit specified in federal legislation for a member of the public and assumes exposure for a working year (2,000 hours).

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Table A.5: Results for Tritium in Groundwater at Darlington Site Perimeter Monitoring Locations

	Tritium (Bq/L) ^(a)
	2016 ^(b)
MW-006-9	<100
MW-007-2	<100
MW-008-20	<100
MW-015A-19	<100
MW-016A-10	<100
MW-016C-4 ^(c)	480
MW-017B-15	<100
MW-018A-11	<100
MW-018C-4	<100
MW-027-29	<100
MW-028-14	<100
MW-029-6	<100
MW-032-13	<100
MW-033-8	<100
MW-042-20	<100
MW-043-8	<100
MW-045-10	<100
MW-046-6	<100
MW-052-15	<100
MW-058-6	<100
MW-059-12	<100
MW-070-55	<100
MW-071-37	<100
MW-072-3	<100
MW-078-18	<100
MW-079-4	<100
MW-081-17	<100
MW-082-6	<100
MW-095-13	<100
MW-096-6	<100

- a) Values prefixed by an “<” indicate that reported results were less than the instrument detection limits.
- b) In 2016, monitoring wells were sampled on an annual basis. The wells are labelled as “MW-XXX-YY”: the first number (XXX) identifies the well and the second number (YY) is the depth of the well in metres.
- c) The slightly higher tritium concentration at MW-016C-4 is attributed to a spill which occurred in 2009, and is expected to continue to decrease over time as the source term diminishes.