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2018 PICKERING NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

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**2018 Pickering Nuclear Groundwater
Monitoring Program Results****P-REP-10120-10044-R000**

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Executive Summary

Pickering Nuclear Generating Station (PNGS) has a mature and robust groundwater monitoring program in place to address the following primary objectives:

1. Confirm predominant on-site groundwater flow characteristics at the PNGS site;
2. Monitor changes to on-site groundwater quality to ensure timely detection of inadvertent releases to groundwater; and
3. Ensure that there are no adverse off-site impacts from PNGS groundwater.

In 2018, groundwater samples were collected as per the Sampling and Analysis Plan (SAP) developed for the site, from a total of 146 sampling locations.

The findings with respect to the above objectives are:

- The predominant shallow groundwater flow patterns remain unchanged in 2018 from the original site groundwater flow interpretations established in 2002. The foundation till drainage system located beneath the Turbine Auxiliary Bay is the lowest groundwater discharge point and forms an artificial hydraulic sink, directing site groundwater away from the lake.
- The groundwater data collected from many of the key areas at PNGS indicate that tritium concentrations have remained constant or decreased, which indicate stable or improved environmental performance. There was an emerging groundwater matter identified at the Unit 1 area in 2018. The corrective actions undertaken to address the source have proven to be effective. Tritium concentrations have subsequently declined in the area and monitoring will continue.
- In 2018, there were no indications of adverse off-site impacts from PNGS groundwater. Tritium concentrations at perimeter groundwater monitoring locations remained low. Municipal drinking water samples collected from downstream Water Supply Plants (WSP), as part of the annual OPG PNGS Environmental Monitoring Program (EMP), were well below the Ontario Drinking Water Quality Standard (ODWQS) for tritium of 7,000 Bq/L.

1.0 INTRODUCTION

Ontario Power Generation (OPG), Pickering Nuclear Generating Station (PNGS), has a mature and robust annual groundwater monitoring program in place. The program examines the chemical, radiological, and physical characteristics of the groundwater beneath the site.

The specific objectives of this program are:

1. **Objective 1:** Confirm predominant on-site groundwater flow characteristics at the PNGS site;
2. **Objective 2:** Monitor changes to on-site groundwater quality to ensure timely detection of inadvertent releases to groundwater; and
3. **Objective 3:** Ensure that there are no adverse off-site impacts from PNGS groundwater.

This report presents groundwater data collected at PNGS for the period from January 1st to December 31st, 2018, and the associated interpretation of this data.

2.0 2018 PROGRAM DESIGN

The design of the PNGS groundwater monitoring program is risk-based in nature. The 2018 groundwater Sampling and Analysis Plan (SAP) was developed to meet the three objectives listed above.

The methodology used to collect data and subsequently draw conclusions for each objective is discussed in further detail below.

2.1 Objective 1 Methodology

Groundwater flow interpretations for PNGS were first established in 2002. On an annual basis, the SAP requires that a set of water levels be collected from specific groundwater monitoring wells in order to verify that the original interpretations have not changed, and that OPG continues to have a sound understanding of groundwater flow patterns at the site. In the fourth quarter of 2018 (2018 Q4), water level readings were collected from select monitoring locations. The data was subsequently used to calculate the groundwater elevation at each monitoring well and generate contour illustrations to visually verify the flow patterns.

2.2 Objective 2 Methodology

In 2018, as per the SAP, groundwater samples were collected from various locations, including monitoring wells, foundation drains, sumps, and groundtubes (146 sampling locations in total). Figure 1 (Page 9 of this report) shows these locations, and it can be seen that the majority of data was collected from locations near the operating reactors.

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The 2018 SAP specified the sampling locations, the frequency of sampling at each location (e.g. quarterly, annually), and the parameters for analysis.

Groundwater samples were collected from the following key areas in 2018:

- Unit 1 to 4 Reactor Buildings (RBs);
- Unit 5 to 8 RBs;
- Irradiated Fuel Bays (IFBs);
- Upgrading Plant Pickering (UPP);
- Emergency Power Generator (EPG) Area; and
- Standby Generator (SG) Areas.

Groundwater samples were collected by qualified OPG chemical technicians. Prior to sample collection, each monitoring well was purged to remove standing water, ensuring that representative groundwater flowed into the well. Collected samples were predominantly analyzed for tritium. Selected samples were analyzed for petroleum hydrocarbons (PHCs) and benzene / toluene / ethylbenzene / xylenes (BTEX).

Groundwater samples were analyzed by Kinectrics Analytical Inc. (Kinectrics) for PHCs and BTEX. Tritium was analyzed by the OPG PNGS Chemistry Laboratory.

The groundwater data generated from the sampling program was subsequently analyzed to either support previous conclusions, identify adverse trends, or demonstrate no significant change.

2.3 Objective 3 Methodology

The 2018 SAP included the sampling of monitoring well clusters at the site boundary in order to confirm that there are no adverse off-site impacts from PNGS groundwater. These locations can also be seen on Figure 1 (Page 9). The site perimeter monitoring well locations were chosen to facilitate the evaluation of both lateral and vertical groundwater quality. The methodology for groundwater collection and analysis, as well as for data evaluation, was the same for the site perimeter wells as what is described above for Objective 2.

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3.0 2018 PROGRAM RESULTS

3.1 Objective 1 Results

The predominant groundwater flow patterns remain unchanged in 2018 from the original site groundwater flow interpretations from 2002.

PNGS’s groundwater flow systems are categorized into the following four hydrostratigraphic units (HU):

- Shallow/Water Table;
- Intermediate Overburden (HU6);
- Deep Overburden (HU7); and
- Deep Bedrock (HU8).

In 2018, groundwater level measurements were collected from wells installed in each HU (total of 80 wells). The data was interpreted and used to confirm the horizontal and vertical groundwater flow directions.

The shallow groundwater elevation data was plotted and the resulting contour illustration is shown on Figure 2 (Page 11 of this report). The PNGS shallow groundwater contours show that the East Landfill (northeast of the PNGS) remains the major local recharge area with groundwater flowing radially from the landfill towards the station buildings to the southwest, and towards the lake in the southeast.

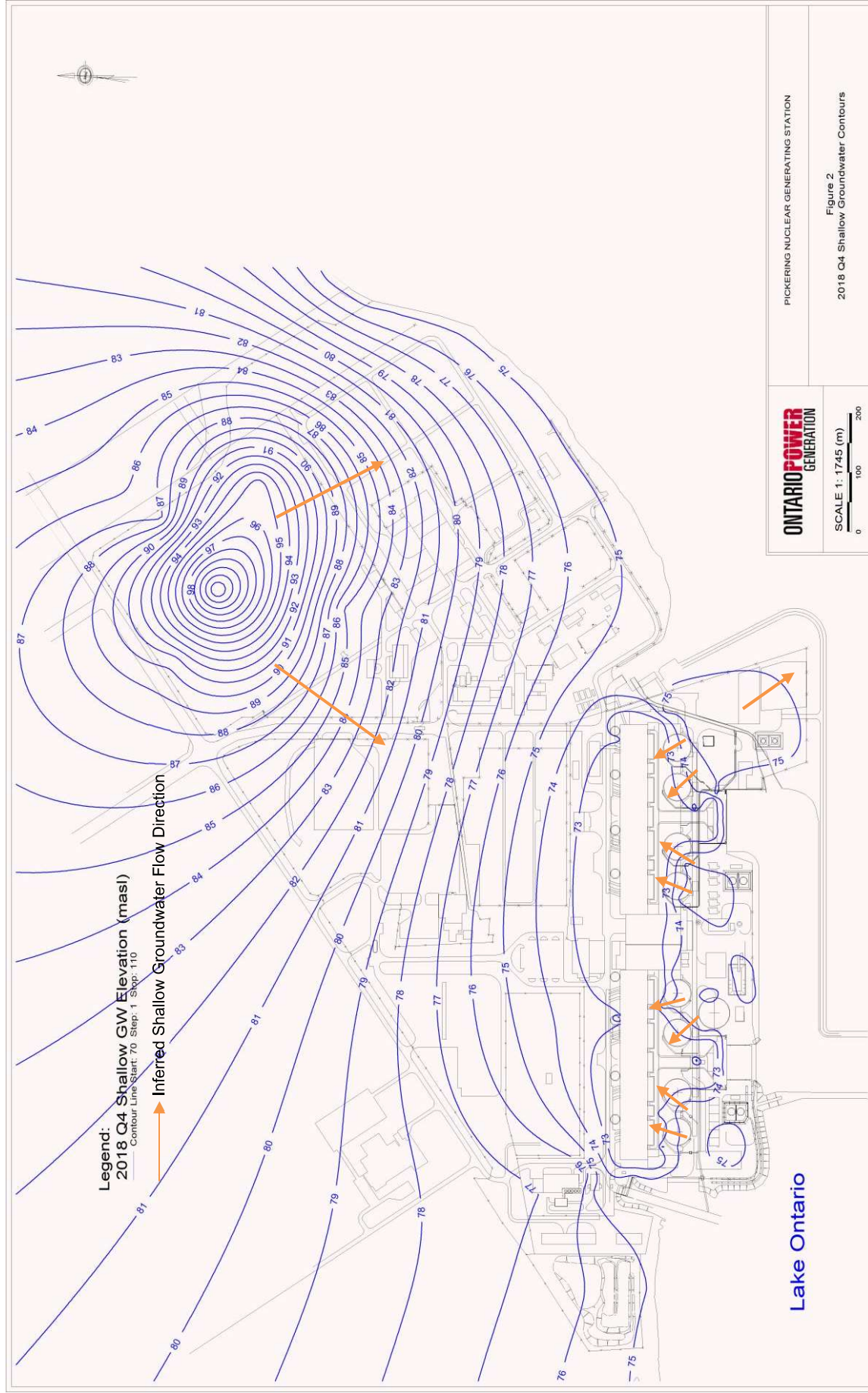
Closer to the reactor units, groundwater flows north towards the Turbine Auxiliary Bay (TAB). The foundation till drainage system located beneath the TAB is the lowest groundwater discharge point and forms an artificial hydraulic sink. The TAB foundation drains collect groundwater and terminate in the TAB Inactive Drainage (IAD) sumps associated with each reactor unit. These sumps also collect other station process water. The combined discharge from the IAD sumps is eventually discharged via a monitored pathway.

The Vacuum Building Ramp Sump (VBRS), located east of the Vacuum Building (VB), also acts as another hydraulic sink, diverting a portion of groundwater in the Unit 1 and 2 areas towards the VBRS. At the extreme south side of the site, there is a small groundwater flow component towards the lake. Vertically, groundwater flows predominantly downward from the water table (shallow groundwater) to the deep overburden bedrock HUs.

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PICKERING NUCLEAR GENERATING STATION
ONTARIO POWER GENERATION
SCALE 1: 1745 (m)
0 100 200
Figure 2
2018 Q4 Shallow Groundwater Contours

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3.2 Objective 2 Results

In 2018, the groundwater data collected from many of the key areas at PNGS indicate that tritium concentrations have remained constant or decreased, which indicate stable or improved environmental performance.

An adverse condition was identified at the Unit 1 area in 2018. Further details are provided below. The corrective actions undertaken to address the source have proven to be effective. Tritium concentrations have declined in the area and monitoring continues.

3.2.1 Sampling and Analysis Changes

In 2018, there were circumstances that resulted in deviations from the SAP. These deviations are documented below.

- MW-064-21 could not be sampled in 2018 Q2, as the location was not accessible.
- IFBA-GT-2A could not be sampled in 2018 Q3, as the location was not accessible.
- Samples could not be collected from U8 MK42 during any of the quarters in 2018 because the sump was found to be dry.
- Samples could not be collected from various RB foundation drainage groundtubes throughout the year because they were found to be dry.
- 17 monitoring wells not included in the SAP were sampled in the Unit 1 area to support the investigation of an emerging issue, as detailed in the next section.
- The TAB foundation drain samples could not be collected because the drains were either dry or not accessible for sampling (due to safety reasons or the water level in the sump being higher than the sampling point). Continued efforts are being put forth by OPG with respect to improving the sampling methodology at these locations.

3.2.2 Unit 1 to 4 Reactor Building Area Overview

The original source of tritium in groundwater in the Unit 1 area of PNGS was attributed to historical leakage from the moderator purification room sump and the Spent Resin Storage Tank (SRST) vault sumps. This prompted continued and regular groundwater monitoring in this area in order to track the movement of the plume.

In 2018, an adverse condition was identified in the Unit 1 area groundwater, which was attributed to a component leaking inside the moderator purification room. Corrective actions were undertaken and have been successful in addressing the source as supported by the data discussion below in Section 3.2.2.1.

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In the Unit 4 area, tritium in groundwater is present due to historical leakage from the SRST vault sump, MK6. Corrective actions were previously undertaken in order to address the source and continue to be successful.

In 2018, groundwater surveillance continued in the Unit 1 to 4 area in conjunction with a thorough and detailed investigation to address the tritium concentrations seen in Unit 1 groundwater. The 2018 groundwater sampling results are presented in Table A-1 (Appendix A) and Figure 3 (Page 16 of this report). In Figure 3, the tritium concentrations are represented using colour-gradient scaled circles.

Key sampling locations are discussed in further detail below by specific area.

3.2.2.1 Unit 1 and 2 Area

In 2018, the highest concentration of tritium in groundwater was found at the Unit 1 RB groundtube location, U1-RBFD-1. This was identified in 2018 Q1. Groundtubes are rudimentary wells that were installed when the station was built and perform similarly to monitoring wells. Essentially, these sample locations are steel tubes that are perforated along its side-wall close to the bottom of the tube. The perforations allow groundwater to enter the tube. Around the RBs, the groundtubes terminate in the foundation drains encircling the RBs, within the shallow groundwater regime.

Following the identification of elevated tritium concentrations in the groundtube, the frequency of monitoring at the groundtubes and surrounding monitoring wells was immediately increased. A team was formed to locate the source of the leak and establish a plan for repair. Based on a very extensive and thorough investigation, the elevated tritium in the Unit 1 foundation drains was found to originate from a valve leaking inside the Unit 1 moderator purification room. The valve was subsequently repaired. Deficiencies in the moderator purification room which had allowed a path to groundwater were also identified and successfully repaired. A post maintenance test was performed, which confirmed the effectiveness of the repair. Since the repairs were completed, a significant decrease in tritium concentrations in groundwater has been observed, confirming that there are no on-going leaks. Groundwater monitoring continues in this area.

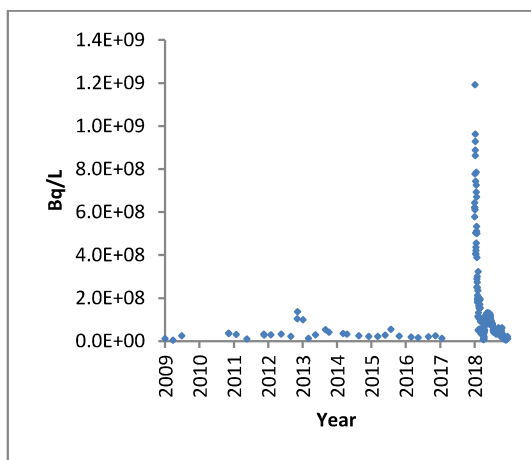
Graphs 1 to 4 on the following page illustrate the tritium concentrations over time for the Unit 1 RB foundation drainage groundtubes. In addition, data for the VBRS is also presented. As mentioned in Section 3.1, the VBRS acts as a hydraulic sink, diverting a portion of groundwater in the Unit 1 and 2 areas.

As can be seen on Figure 3 (Page 16), groundwater tritium concentrations in monitoring wells located between Unit 1 and the VB were elevated in 2018 due to the movement of groundwater towards the VBRS.

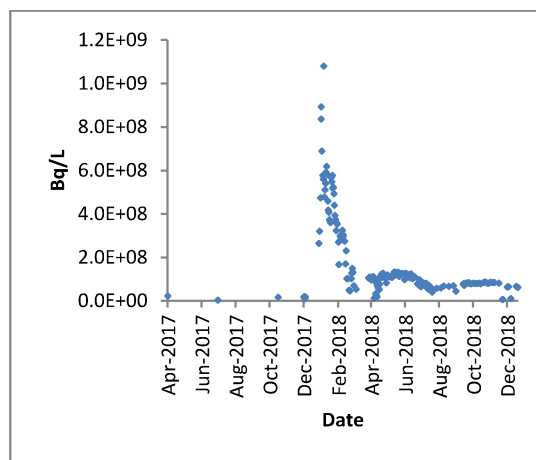
There is also slightly elevated tritium concentrations in the groundwater monitoring wells located to the northeast of the Unit 1 RB. This can be seen in Figure 3. The results in this area will continue to be monitored.

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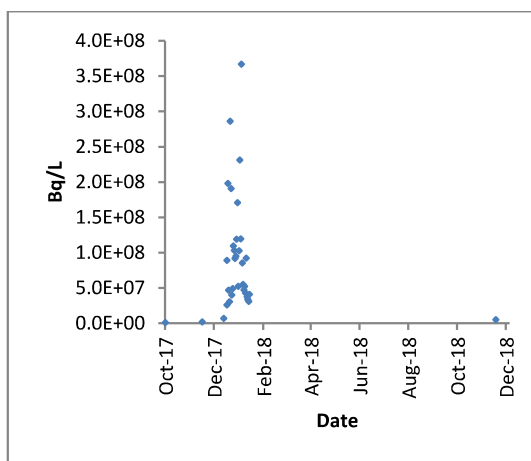
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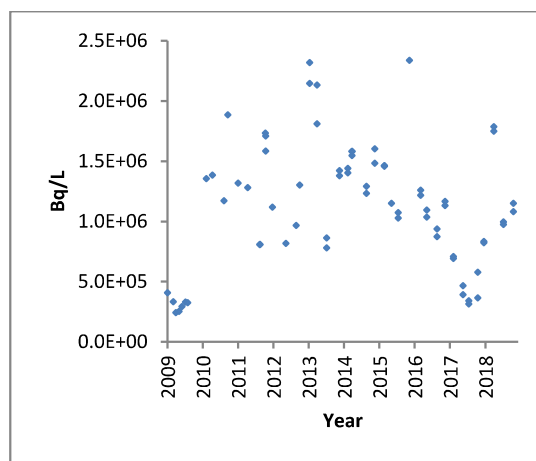
Graph 1: U1-RBFD-1 Tritium Data



Graph 2: U1-RBFD-2 Tritium Data



Graph 3: U1-RBFD-3 Tritium Data



Graph 4: VBRS Tritium Data

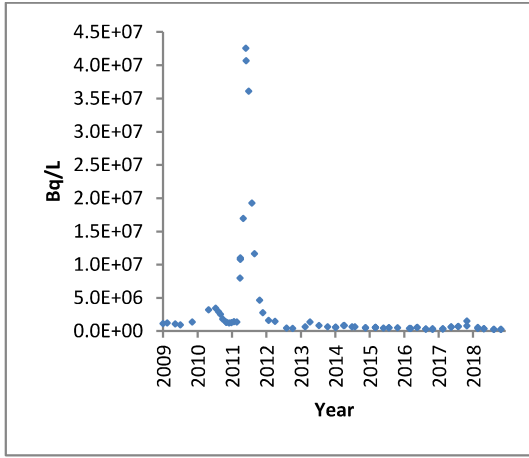
3.2.2.2 Unit 3 and 4 Area

In the Unit 3 and 4 area, the results from the RB groundtubes as well as from the monitoring wells located within the Reactor Auxiliary Bay (RAB) were stable. The concentration at MW-242-25 (which is adjacent to SRST vault sump, MK6) continues to remain low. This indicates that the repairs undertaken at MK6 in 2013 have been effective. The tritium concentration at downgradient monitoring well MW-243-29, also located in the RAB, did not show any significant changes. Graphs 5 and 6 below illustrate the results for these monitoring wells.

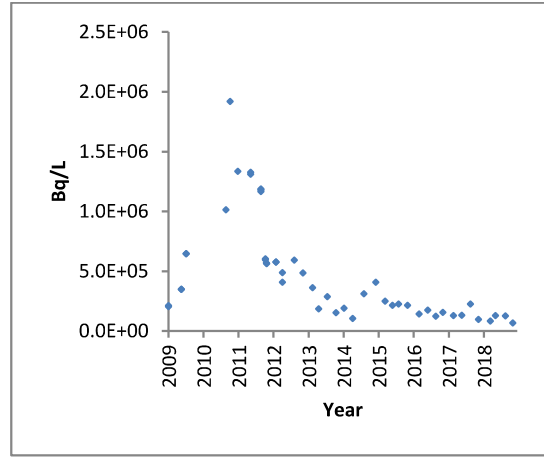
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Graph 5: MW-242-25 Tritium Data

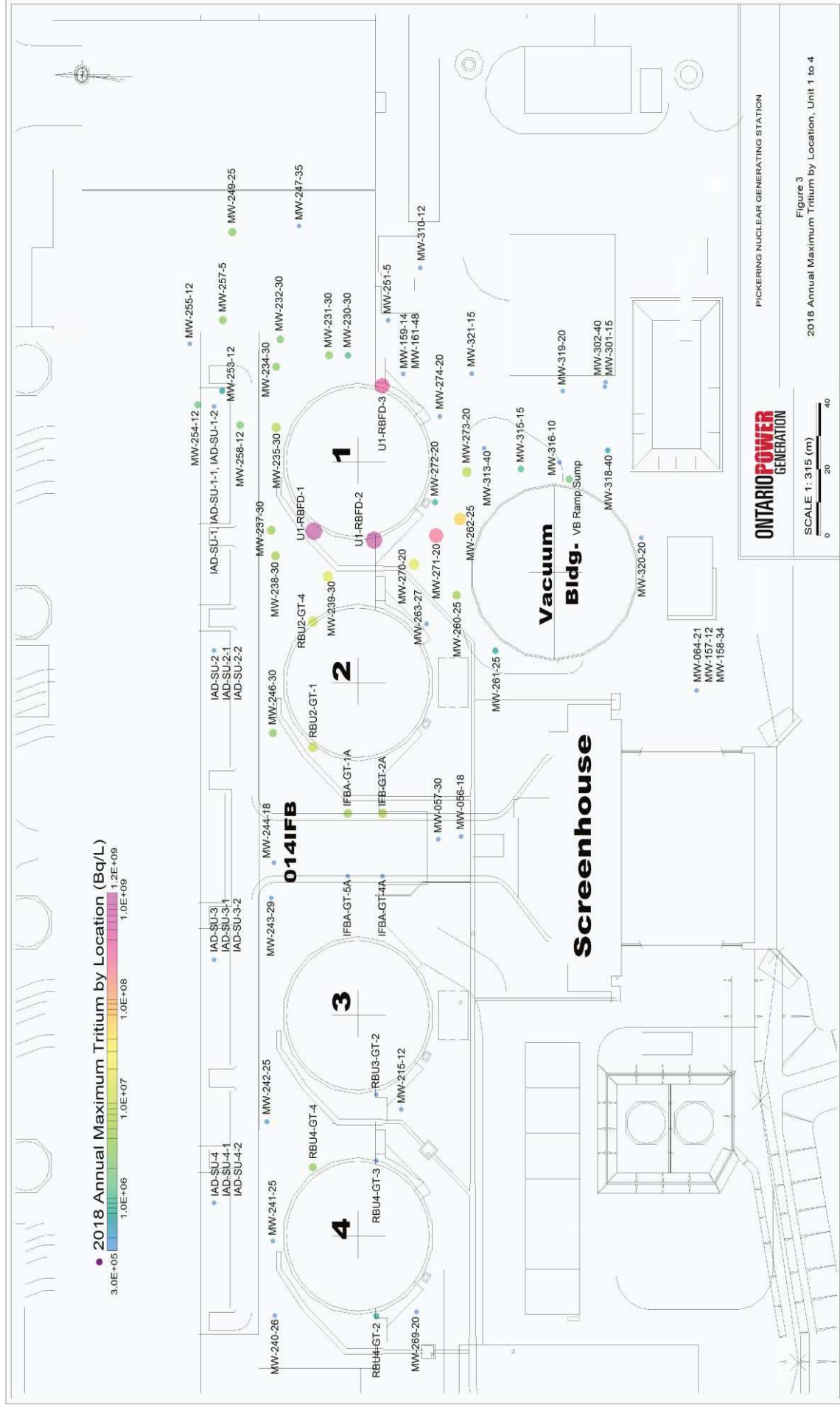


Graph 6: MW-243-29 Tritium Data

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3.2.3 Unit 5 to 8 Reactor Building Area Overview

Historically, the source of tritium in the Unit 5 to 8 area was attributed to releases from the RB foundation drainage sumps (designated as U5 MK26, U6 MK30, U7 MK36, and U8 MK42). These sumps collect groundwater from the foundation drainage rings that surround the RBs and pump the collected water to the Radioactive Liquid Waste Management System (RLWMS). The back-flow of tritiated water is prevented by a non-return valve on the sump discharge line; however, it was found that the valves were failing due to sludge build-up. This allowed tritiated water to leak back into the sumps, back up into the RB foundation drains and infiltrate the surrounding groundwater environment. Since this discovery, a preventative maintenance program has been in place to proactively address the issues identified for the RB foundation drainage sumps and the non-return valves.

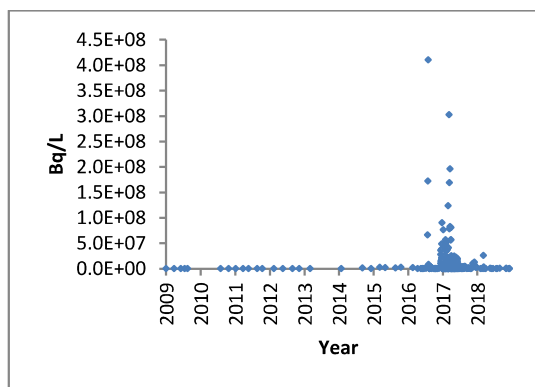
In 2016, an adverse condition was identified in the Unit 5 area due to degraded construction joints in the Unit 5 moderator room floor. A thorough investigation was undertaken, followed by repairs, which have proven to be successful.

In 2018, groundwater surveillance continued in the Unit 5 to 8 area. The 2018 groundwater sampling results are presented in Table A-4 (Appendix A) and Figure 4 (Page 22 of this report). Again, in Figure 4, the tritium concentrations are represented using colour-gradient scaled circles.

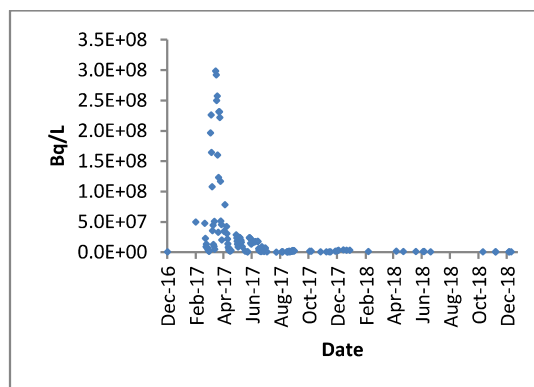
Key sampling locations are discussed in further detail below by specific area.

3.2.3.1 Unit 5 Area

The samples collected from the Unit 5 RB area in 2018 indicate that tritium concentrations in groundwater have declined following the repairs completed on the moderator room floor construction joints during the previous year. Graphs 7 to 12 below present the data from the Unit 5 RB foundation drainage groundtubes (RBU5-GT-1 to RBU5-GT-4), the U5 MK26 sump, and monitoring well MW-267-17. Groundwater monitoring will continue in this area to track the movement of tritium.



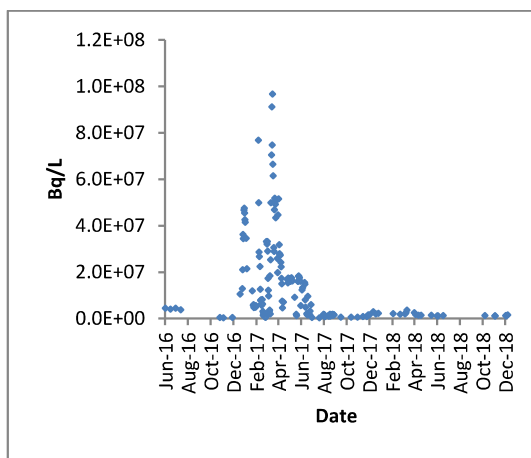
Graph 7: RBU5-GT-1 Tritium Data



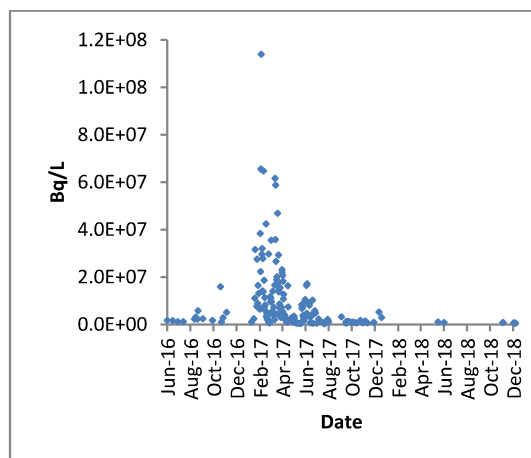
Graph 8: RBU5-GT-2 Tritium Data

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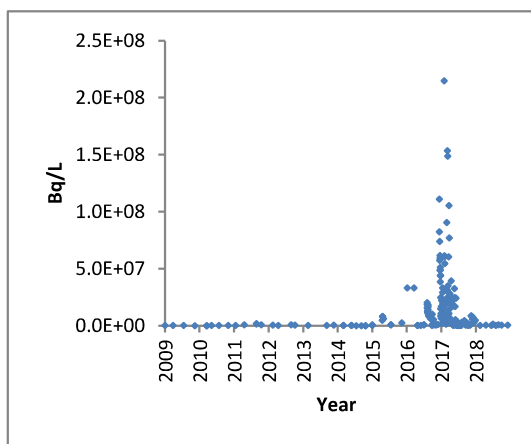
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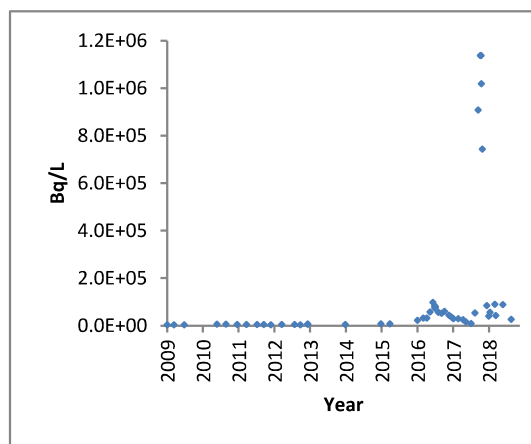
Graph 9: RBU5-GT-3 Tritium Data



Graph 10: RBU5-GT-4 Tritium Data



Graph 11: U5 MK26 Tritium Data



Graph 12: MW-267-17 Tritium Data

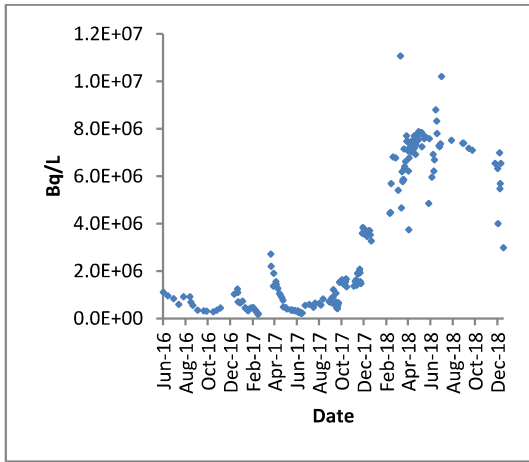
3.2.3.2 Unit 6 Area

In the Unit 6 area, a concentration increase was noted in the groundtubes in Q1 2018. Based on the operating experience at Unit 5, the moderator floor construction joints at Unit 6 were inspected and repaired in 2018 during a planned outage. A post-dye test indicated that the repairs were successful. Graphs 13 to 17 on the following page present the data from the Unit 6 RB foundation drainage groundtubes (RBU6-GT-2 to RBU6-GT-4), the U6 MK30 sump, and monitoring well MW-266-19. Throughout the remainder of 2018, the tritium concentrations in the groundtubes fluctuated, but an overall decreasing trend was seen. This area will continue to be monitored.

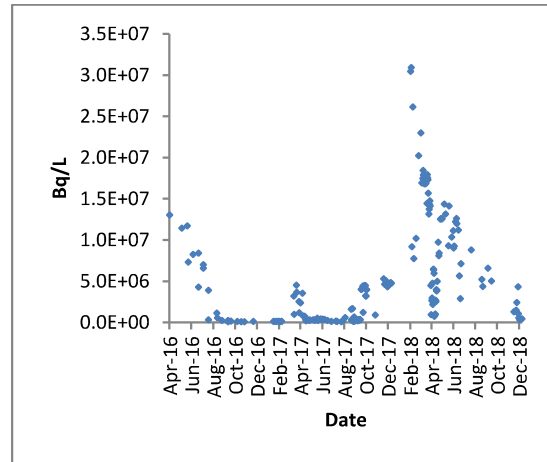
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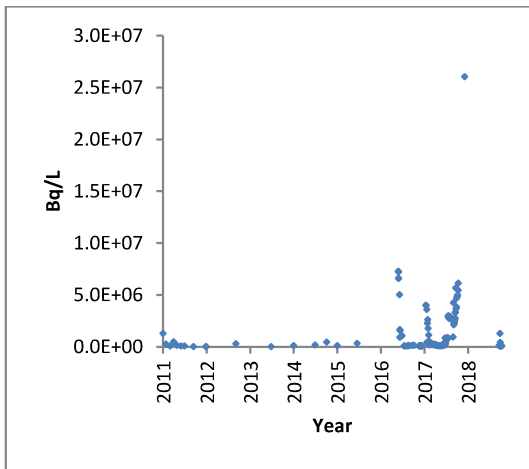
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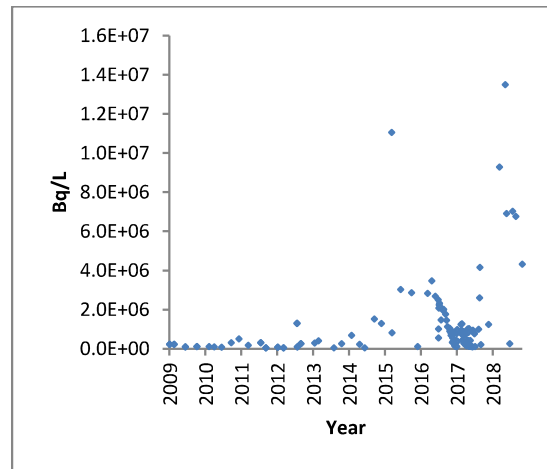
Graph 13: RBU6-GT-2 Tritium Data



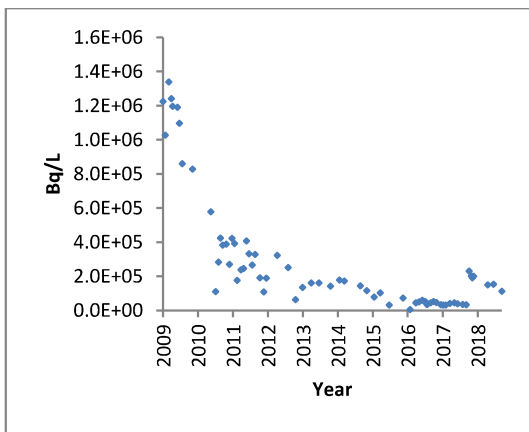
Graph 14: RBU6-GT-3 Tritium Data



Graph 15: RBU6-GT-4 Tritium Data



Graph 16: U6 MK30 Tritium Data



Graph 17: MW-266-19 Tritium Data

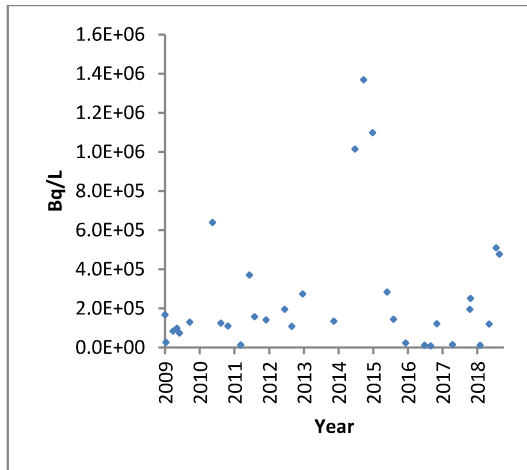
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3.2.3.3 Unit 7 Area

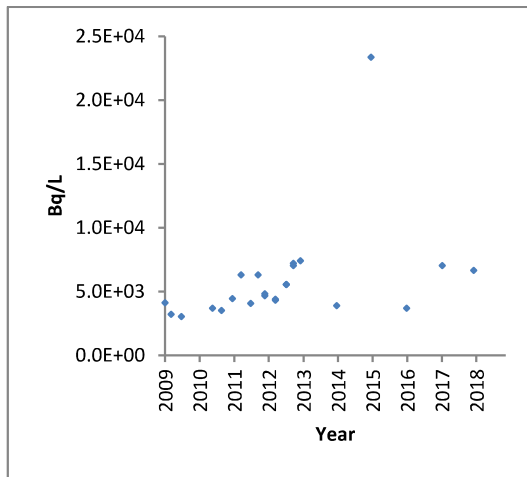
In 2018, there were no emerging issues identified for the Unit 7 area. Graphs 18 to 20 below illustrate the data for RBU7-GT-1, U7 MK36, and MW-265-12.



Graph 18: RBU7-GT-1 Tritium Data



Graph 19: U7 MK36 Tritium Data



Graph 20: MW-265-12 Tritium Data

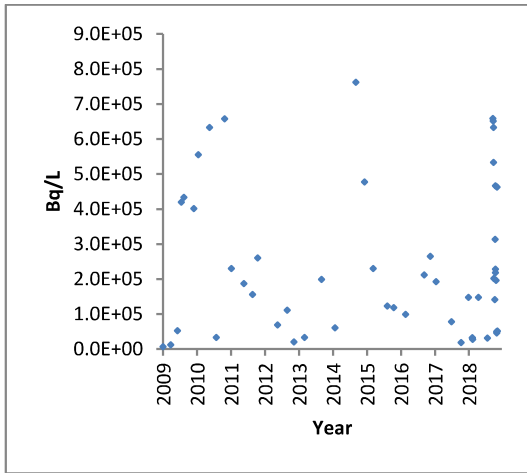
3.2.3.4 Unit 8 Area

In the Unit 8 area, there appeared to be an increase in tritium concentrations at two groundtubes in 2018 Q4; however these concentrations subsequently decreased. The concentration at MW-264-10 remained low in 2018. Graphs 21 to 23 on the following page illustrate the data for RBU8-GT-1, and RBU8-GT-2, and MW-264-10. Groundwater monitoring will continue in this area.

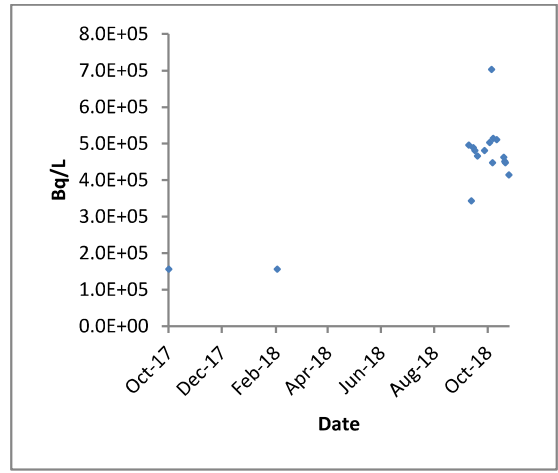
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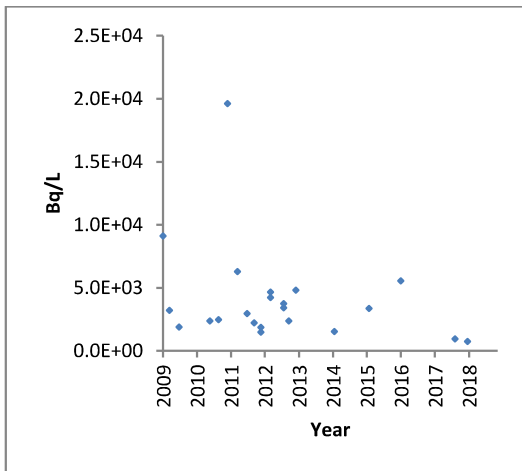
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Graph 21: RBUS-GT-1 Tritium Data



Graph 22: RBUS-GT-2 Tritium Data

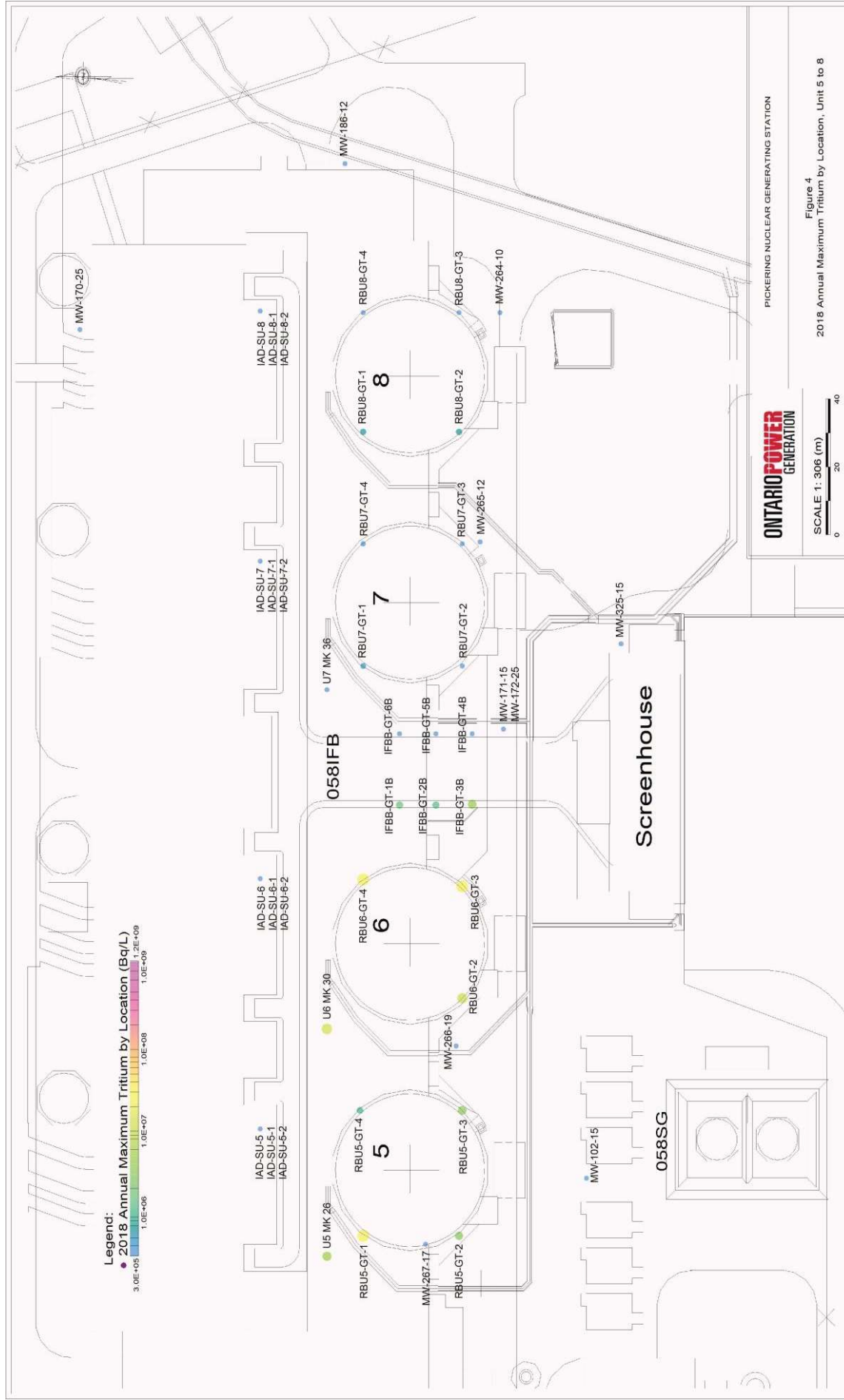


Graph 23: MW-264-10 Tritium Data

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3.2.4 Irradiated Fuel Bay Areas

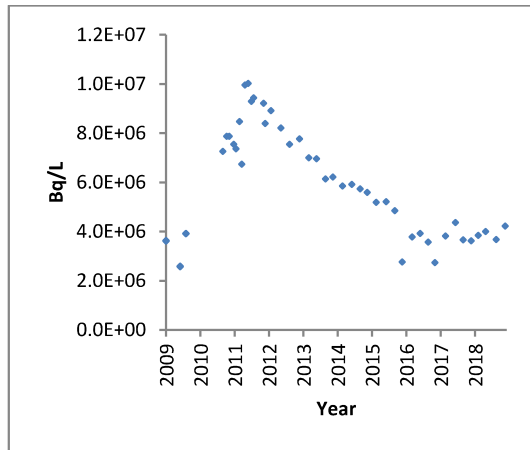
3.2.4.1 IFB-A

The groundwater results collected from sampling locations in the Irradiated Fuel Bay area located between Units 2 and 3 (IFB-A) are described below.

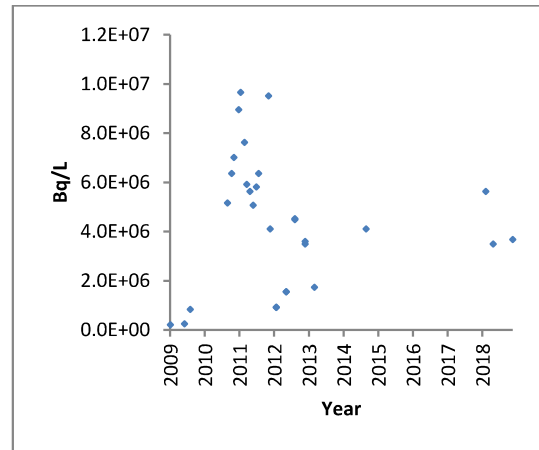
The eastern groundtubes (IFBA-GT-1A and IFB-GT-2A) showed higher tritium concentrations than those to the west (IFBA-GT-4A and IFB-GT-5A). This is expected given that the western edge of the tritium plume in the Unit 1 area extends towards the IFB-A. As mentioned previously, groundwater in the protected area eventually flows north towards the low-lying TAB sumps.

The tritium results from the upgradient monitoring well MW-056-18 and the downgradient monitoring well MW-244-18 did not show any significant changes. Tritium concentrations at upgradient well MW-057-30 had been increasing slowly between 2015 and 2017; however the 2018 results indicate that the concentrations have decreased.

Tritium concentrations over time for the IFB-A groundtubes and monitoring wells are presented in Graphs 24 to 30 below. The results are also presented in Table A-2 (Appendix A) and Figure 3 (Page 16 of this report).



Graph 24: IFBA-GT-1A Tritium Data

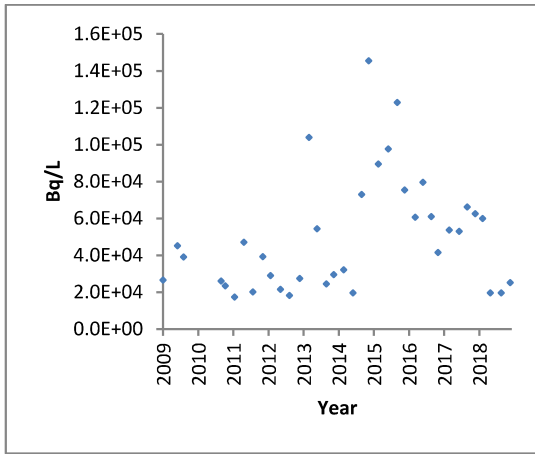


Graph 25: IFBA-GT-2A Tritium Data

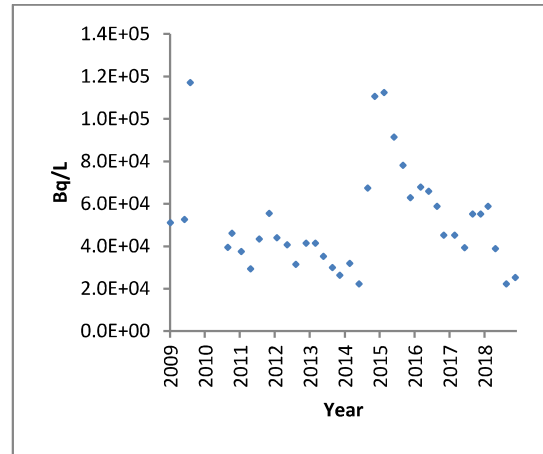
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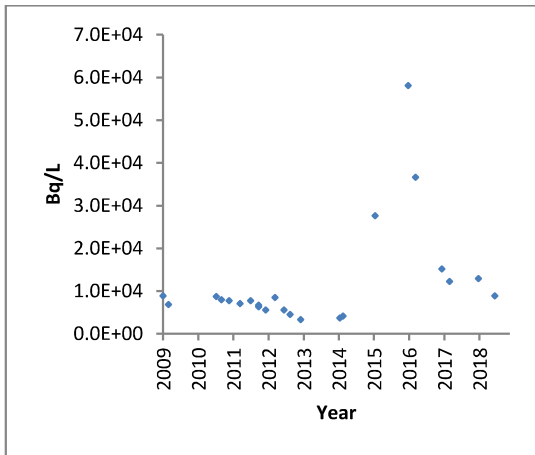
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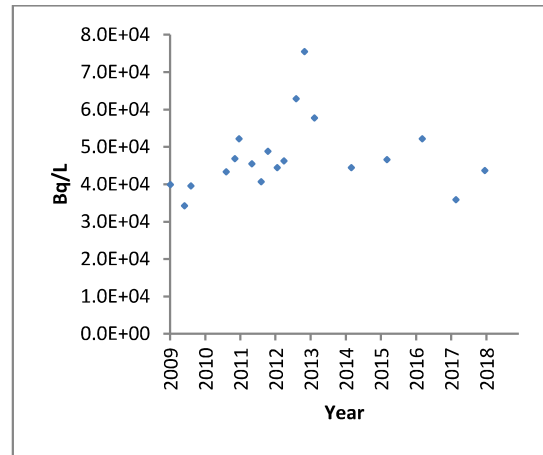
Graph 26: IFBA-GT-4A Tritium Data



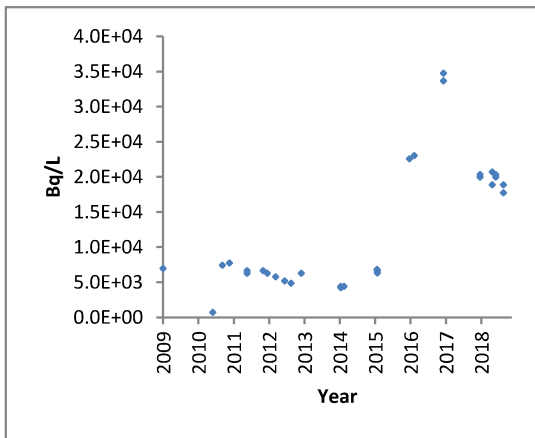
Graph 27: IFBA-GT-5A Tritium Data



Graph 28: MW-056-18 Tritium Data



Graph 29: MW-244-18 Tritium Data



Graph 30: MW-057-30 Tritium Data

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3.2.4.2 IFB-B

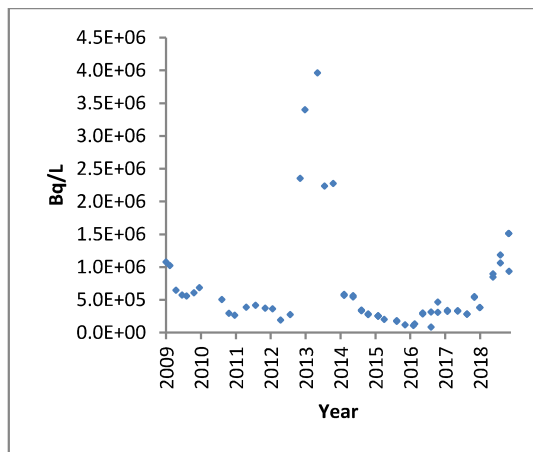
At the IFB-B area (located between Units 6 and 7), increases in tritium concentration were observed in the western groundtubes in 2018, due to the expected movement of tritium in groundwater from the Unit 5 area. The results from the other IFB-B sampling locations were stable. Further discussion is provided below.

In the western groundtubes (IFBB-GT-1B, IFBB-GT-2B, and IFBB-GT-3B), a steady increase in tritium concentrations was observed during the course of the year. This is most likely attributed to the expected movement of tritium in groundwater in a westerly direction from the Unit 5 area. Under Project #13-40703, the repair of discovery cracks in the bay itself were undertaken in April to August of 2018. Prior to this, in 2016 and 2017, the IFB-B sumps were inspected for cracks and subsequently cleaned and repaired. A similar increase in the western IFB groundtubes was seen in 2013 and attributed to the expected movement of groundwater in the area. As mentioned previously, groundwater eventually flows north and is captured by the low-lying TAB sumps.

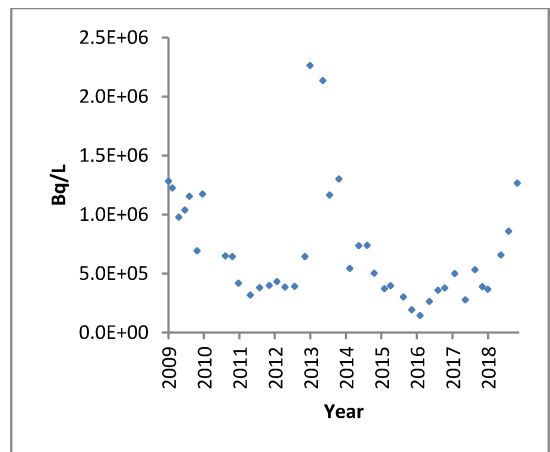
There were no significant changes in tritium concentrations in the eastern groundtubes (IFBB-GT-4B, IFBB-GT-5B, and IFBB-GT-6B). This also further supports that there is likely no new source of tritium in the area.

The two upgradient monitoring wells (MW-171-15 and MW-172-25) continued to show low tritium concentrations.

Tritium concentrations over time for the IFB-B groundtubes and monitoring wells are presented in Graphs 31 to 38 below. The results are also presented in Table A-2 (Appendix A) and Figure 4 (Page 22 of this report).



Graph 31: IFBB-GT-1B Tritium Data

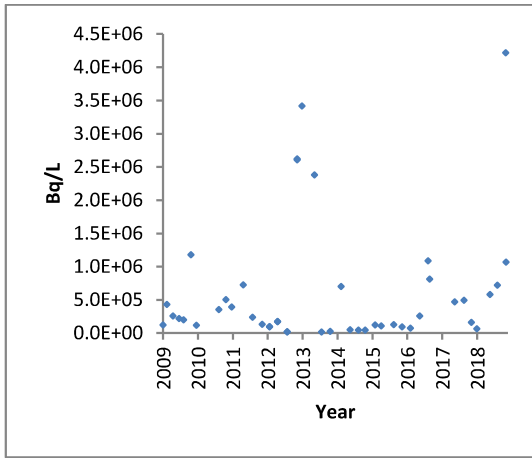


Graph 32: IFBB-GT-2B Tritium Data

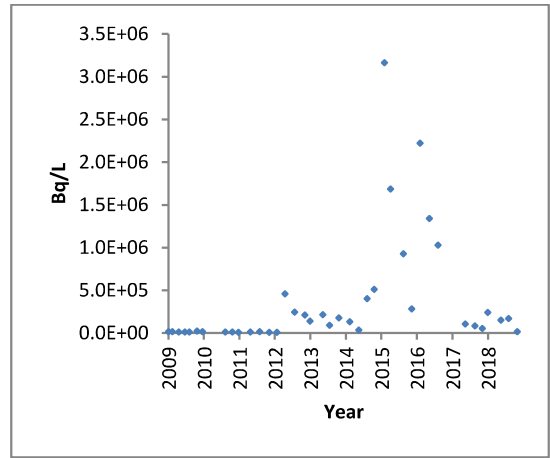
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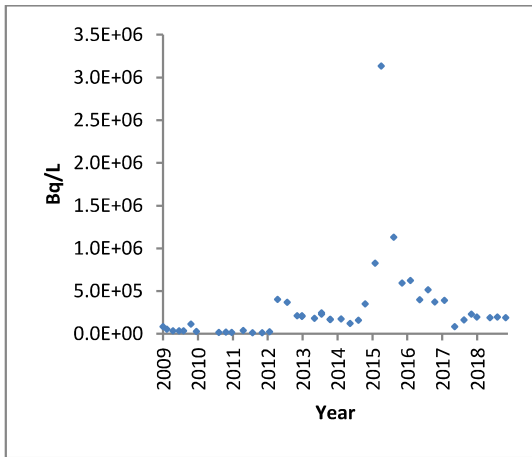
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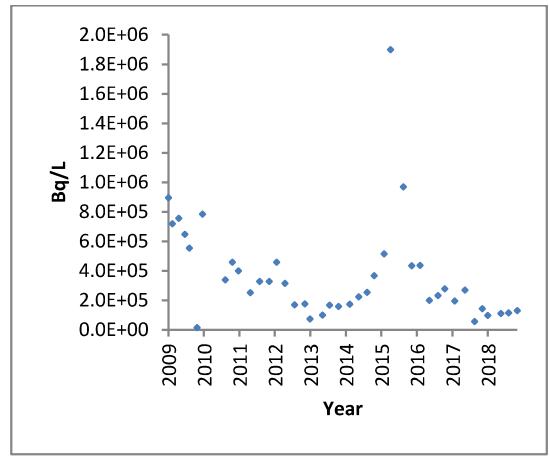
Graph 33: IFBB-GT-3B Tritium Data



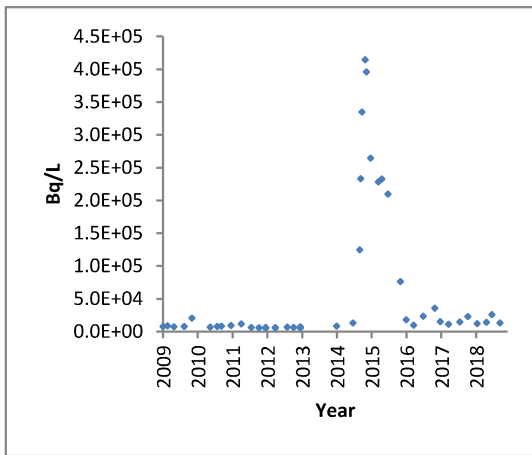
Graph 34: IFBB-GT-4B Tritium Data



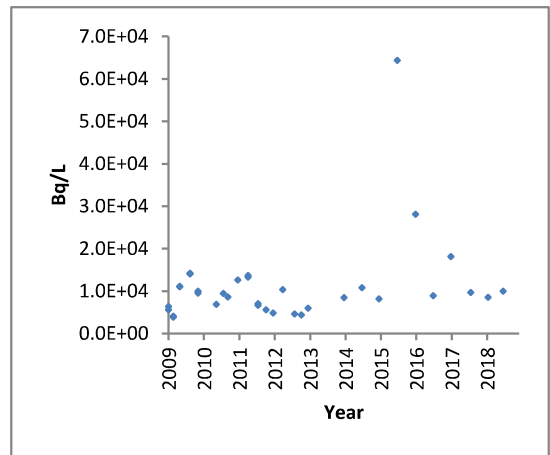
Graph 35: IFBB-GT-5B Tritium Data



Graph 36: IFBB-GT-6B Tritium Data



Graph 37: MW-171-15 Tritium Data



Graph 38: MW-172-25 Tritium Data

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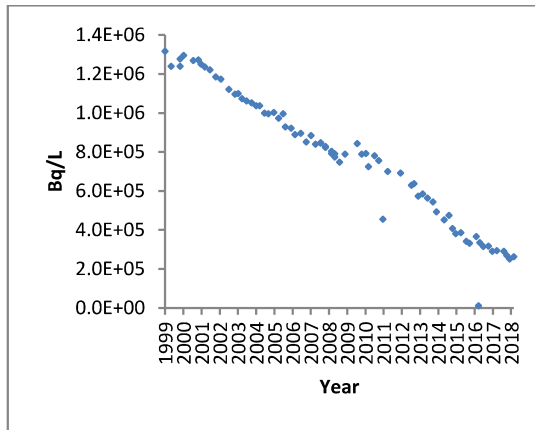
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3.2.5 Upgrading Plant Pickering Area

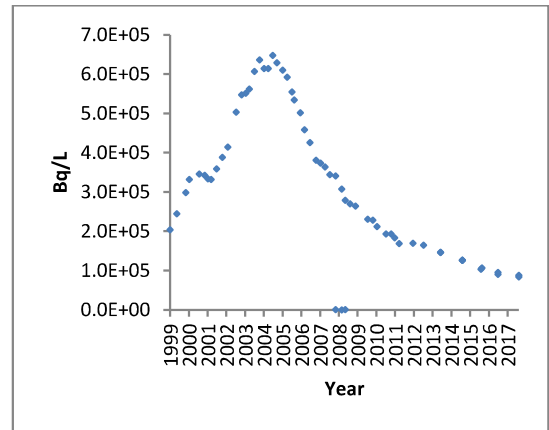
The groundwater results from the UPP area monitoring wells indicate that there is no new source of tritium in groundwater in this area. The legacy tritium in groundwater present in this area is due to past work practices that resulted in discharges of tritiated water to the ground. These practices were discontinued in 1997.

Tritium concentrations at the legacy source area, MW-090-20, continue to decrease as would be expected, given that there is no new source of tritium. In the downgradient monitoring well, MW-076-20, tritium concentrations also continue to decline after a peak seen in 2005. A portion of the outer edge of the UPP tritium plume is directed westwards towards the warehouse due to a preferential groundwater pathway created by a subsurface utility pipe. Monitoring well MW-096-20, located by the warehouse, had shown a generally increasing trend until about 2011; however, recent concentrations have stabilized.

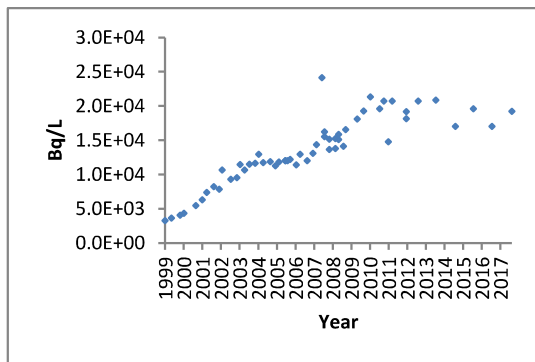
Tritium concentrations over time for the above-mentioned monitoring wells are presented below in Graphs 39 to 41. The results for the locations sampled in the UPP area are presented in Table A-5 (Appendix A) and Figure 5 (Page 28 of this report).



Graph 39: MW-090-20 Tritium Data



Graph 40: MW-076-20 Tritium Data



Graph 41: MW-096-20 Tritium Data

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3.2.6 Emergency Power Generator Area

Groundwater monitoring in the EPG area is conducted to detect leaks in underground fuel oil piping, and the results indicate that the area remains free of fuel oil contamination.

The 2018 analytical results are presented in Table A-7 (Appendix A). Five monitoring wells (MW-121-15, MW-123-15, MW-124-15, MW-125-15, and MW-322-15) were sampled for PHC fractions and BTEX. PHCs and BTEX were not detected above the analytical Method Detection Limits (MDL), with the exception of the PHC F3 fraction at MW-125-15, which was detected at 183 µg/L (slightly above the MDL of 100 µg/L). This result is significantly lower than the standard for PHC F3 found in Ministry of Environment Conservation and Parks' (MECP's) Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, 2011, Table 3: Non-Potable Site Condition Standards, which is used as a guideline, and hence does not warrant further investigation.

3.2.7 Standby Generator Areas

In 2018, groundwater wells in the PNGS SG areas were sampled to confirm whether the biodegradation of residual subsurface fuel oil is occurring. A total of 18 groundwater monitoring wells were monitored for groundwater/fuel oil product levels and sampled for BTEX, PHCs and Polycyclic Aromatic Hydrocarbons (PAHs) in 2018.

A review of the 2018 data indicates that the natural attenuation of residual fuel oil in groundwater continues to occur at these areas.

As recommended in 2016, the monitoring and sampling frequency for these areas will take place on a biennial basis, with the next scheduled sampling event planned for 2020.

3.3 Objective 3 Results

In 2018, there were no indications of adverse off-site impacts from PNGS groundwater. The results from the site perimeter monitoring well locations are presented in Table A-6 (Appendix A) and Graphs 42 to 69 that start on the next page. The annual maximum tritium concentrations at these locations are presented in Figure 6 (Page 35 of this report).

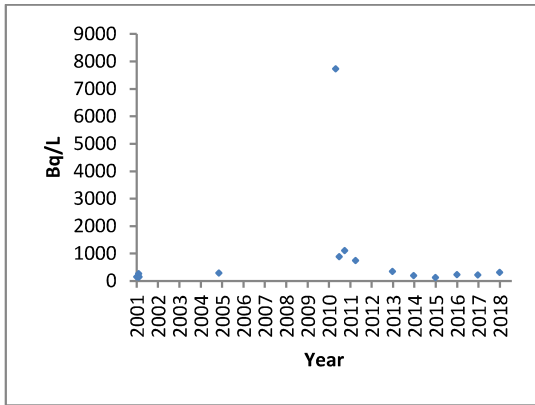
As can be seen, tritium concentrations at the perimeter of PNGS remained low. A wet air deposition investigation showed that the upper tritium concentration found in rainwater sampled on-site is approximately 3.70×10^4 Bq/L (1.00 µCi/kg).

As part of the annual OPG PNGS Environmental Monitoring Program, municipal drinking water samples are collected from the downstream Water Supply Plants (WSPs). In 2018, the data from this sampling demonstrated that the annual average tritium concentration at each WSP was well below the Ontario Drinking Water Quality Standard (ODWQS) for tritium of 7,000 Bq/L. This further supports that there were no indications of adverse off-site impacts from PNGS groundwater.

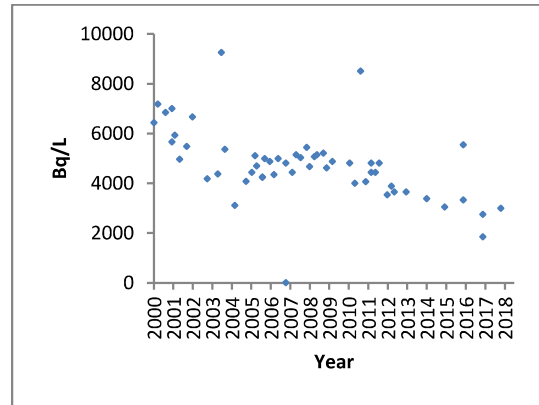
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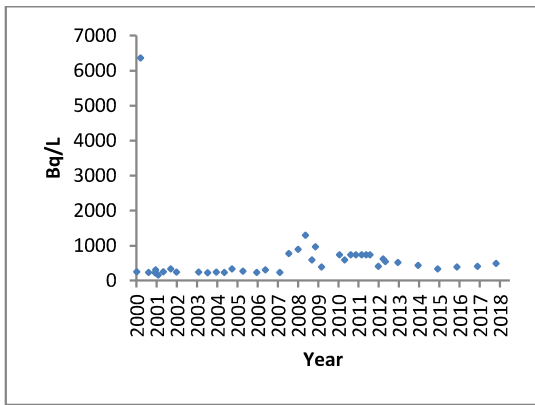
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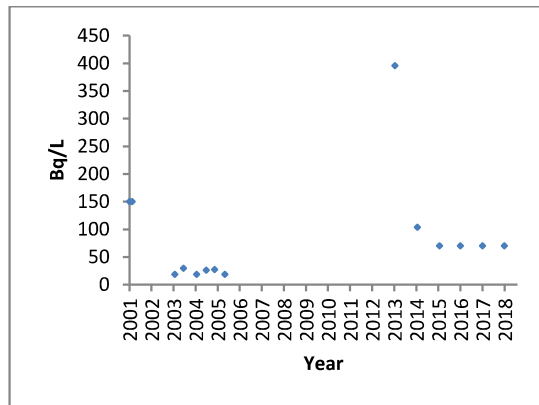
Graph 42: MW-156-20 Tritium Data



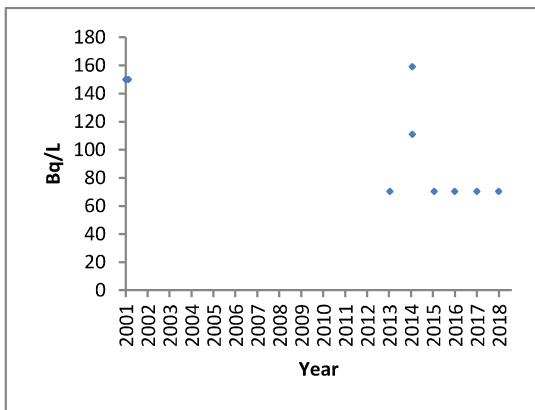
Graph 43: MW-164-13 Tritium Data



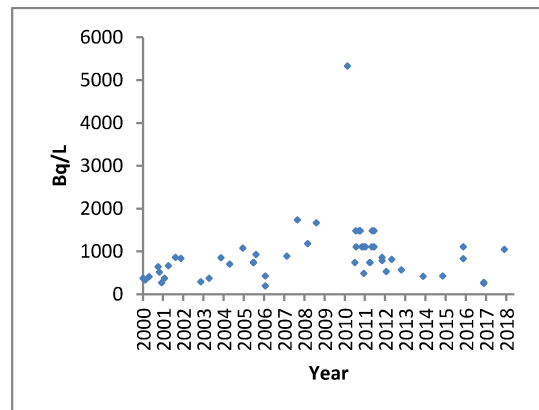
Graph 44: MW-165-24 Tritium Data



Graph 45: MW-176-23 Tritium Data



Graph 46: MW-177-35 Tritium Data

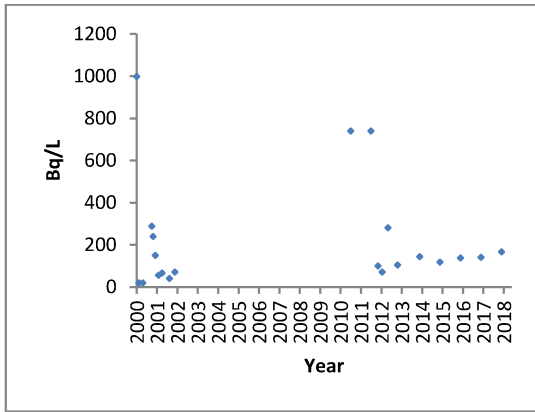


Graph 47: MW-183-10 Tritium Data

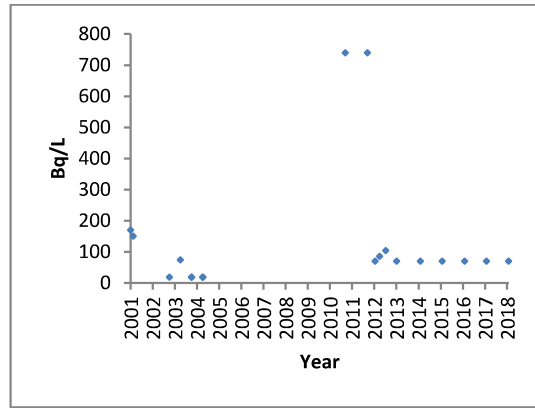
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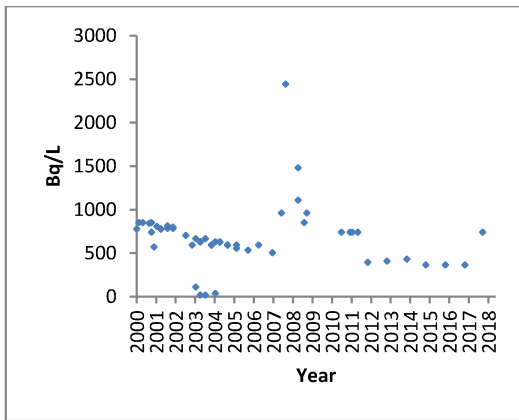
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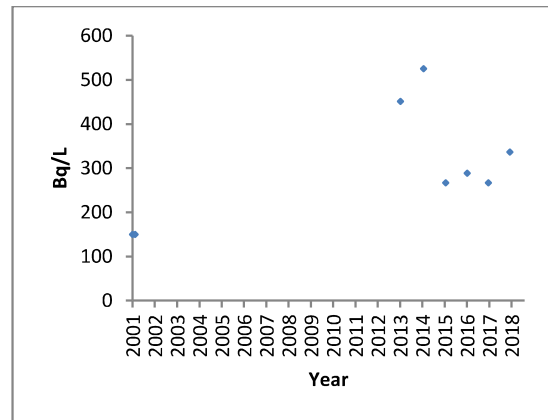
Graph 48: MW-184-27 Tritium Data



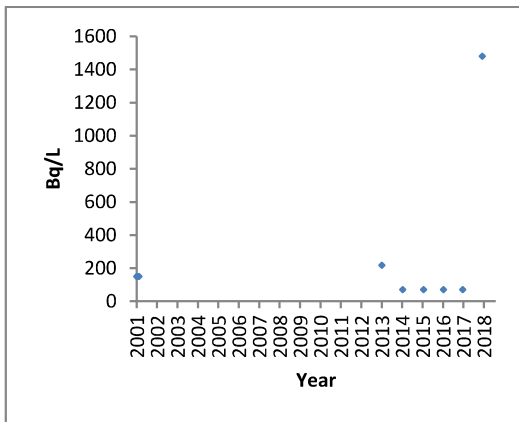
Graph 49: MW-185-39 Tritium Data



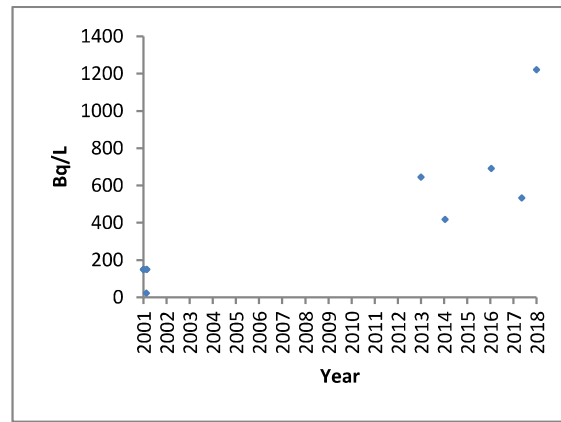
Graph 50: MW-192-18 Tritium Data



Graph 51: MW-193-37 Tritium Data



Graph 52: MW-194-57 Tritium Data

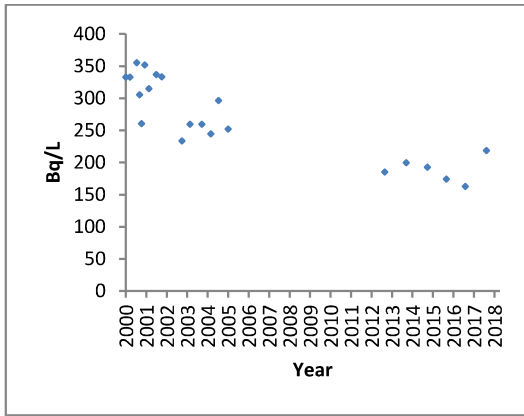


Graph 53: MW-197-15 Tritium Data

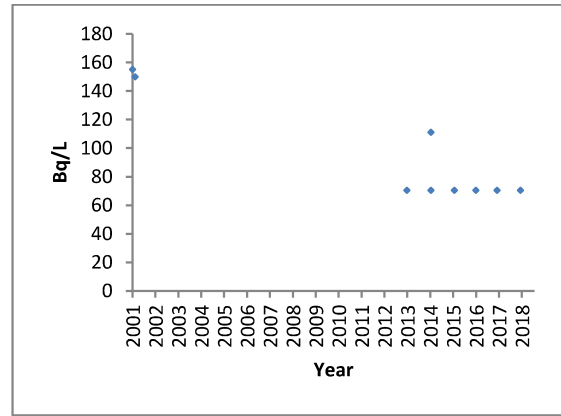
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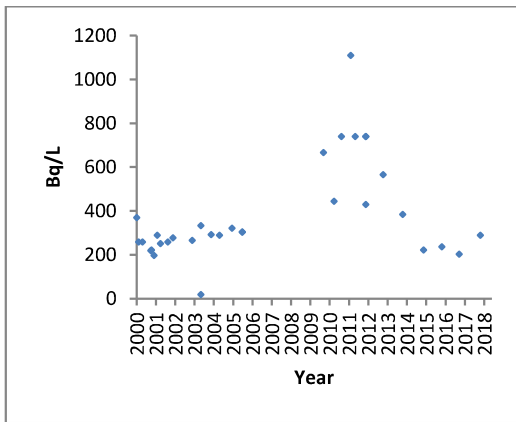
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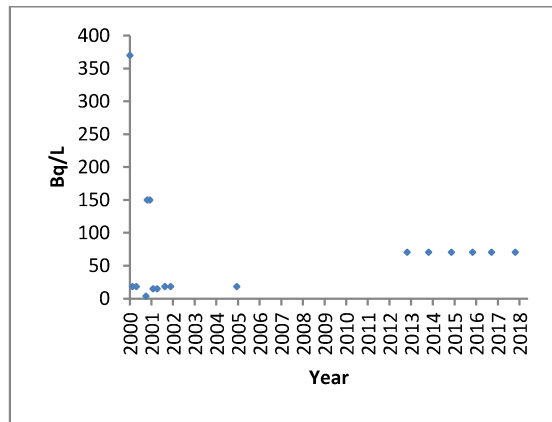
Graph 54: MW-198-20 Tritium Data



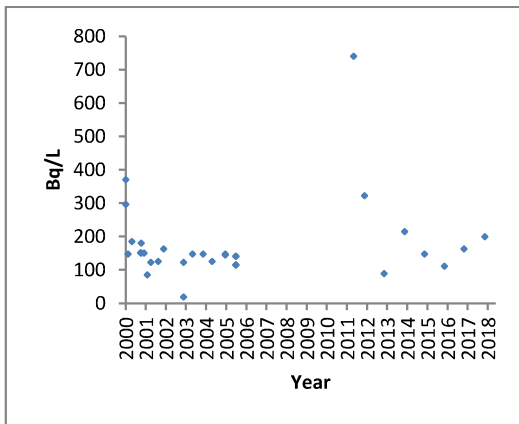
Graph 55: MW-199-38 Tritium Data



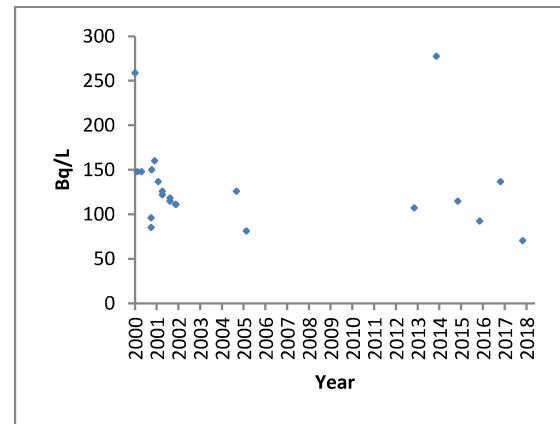
Graph 56: MW-200-22 Tritium Data



Graph 57: MW-201-39 Tritium Data



Graph 58: MW-204-24 Tritium Data

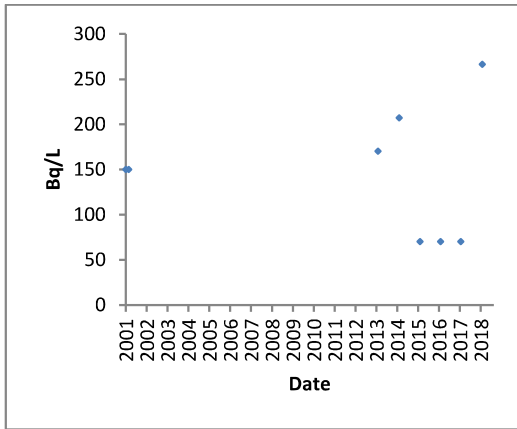


Graph 59: MW-205-35 Tritium Data

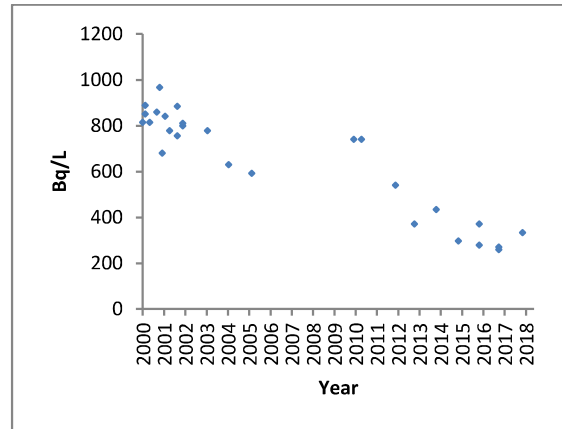
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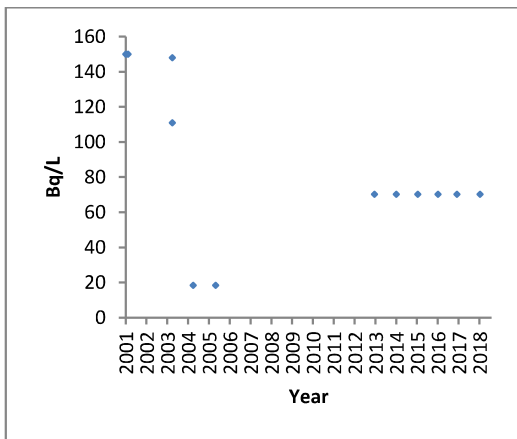
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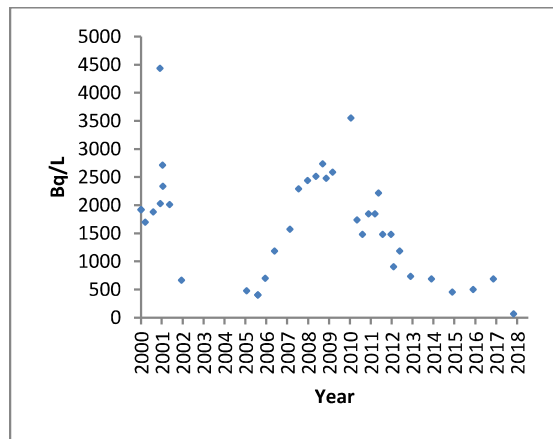
Graph 60: MW-206-65 Tritium Data



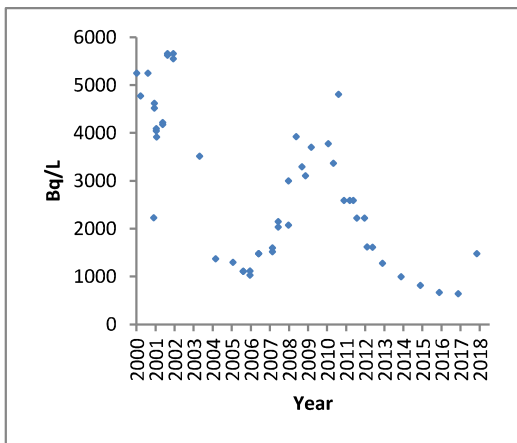
Graph 61: MW-216-15 Tritium Data



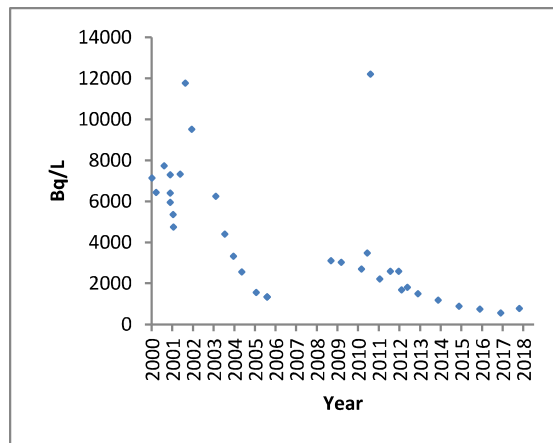
Graph 62: MW-217-32 Tritium Data



Graph 63: MW-222-10 Tritium Data



Graph 64: MW-223-32 Tritium Data



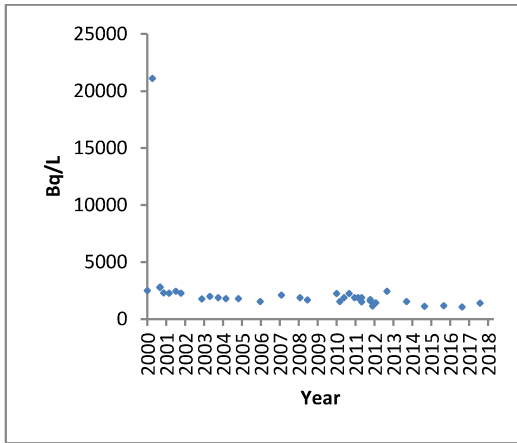
Graph 65: MW-224-42 Tritium Data

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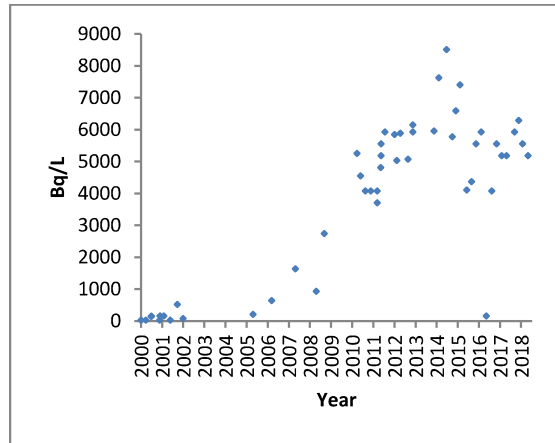
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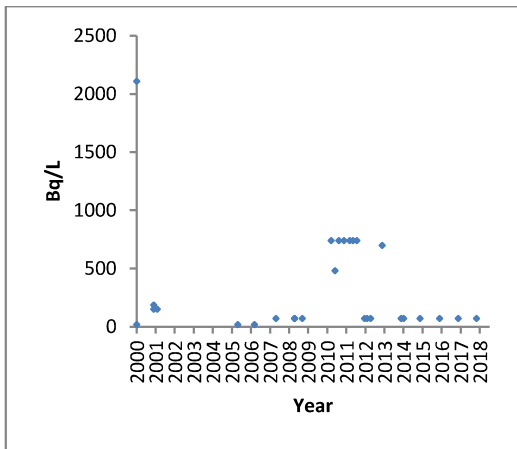
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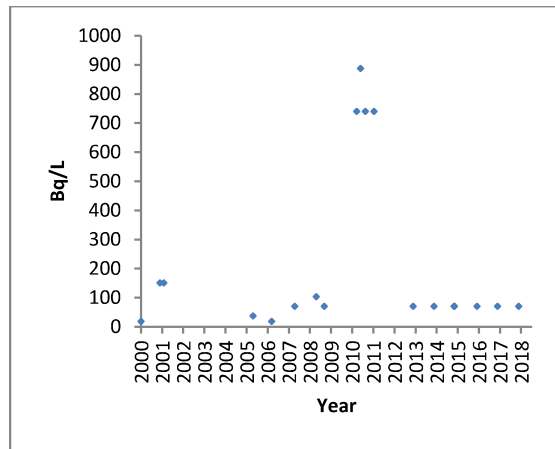
Graph 66: MW-225-12 Tritium Data



Graph 67: MW-226-22 Tritium Data



Graph 68: MW-227-40 Tritium Data



Graph 69: MW-228-57 Tritium Data

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4.0 2018 PROGRAM QUALITY ASSURANCE/QUALITY CONTROL

The Quality Assurance and Quality Control measures for the groundwater monitoring program encompass all activities in field sample collection, laboratory analysis, and laboratory quality control. The objective is to provide confidence in the interpretation of the PNGS groundwater monitoring data through a systematic and documented process.

4.1 Quality Assurance Programs for Laboratories

Kinectrics is accredited to ISO 17025 by the Standards Council of Canada for environmental tests. The laboratory is also ISO 9001 registered. Many of the conventional contaminants are governed by criteria established in MECP's "Guidelines for Use at Contaminated Sites in Ontario", and a companion document entitled 'Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario'. Kinectrics has developed their analytical protocols to meet the recommended analytical protocols documented in these publications.

The PNGS Chemistry Lab is accredited by the Canadian Association for Laboratory Accreditation to ISO 17025 for specific tests listed in the scope of accreditation. It also performs laboratory activities according to a documented quality assurance program.

4.2 Quality Control Results

Duplicates, field blanks, and trip blanks were collected at a prescribed frequency to measure sampling and analytical performance.

In 2018, 31 field duplicate samples were collected. The results and calculated relative percentage difference (to understand the sampling precision) are presented in Table A-8 (Appendix A). The percentage difference in results between the parent sample and the duplicate sample ranged from 0 to 32 percent. Only 1 out of 31 sample pairs showed greater than 20 percent variation in concentration values. Given that 97% of the duplicate samples were within acceptable variation, the field technique and the laboratory's analytical methods employed were determined to be reproducible and reliable.

The field blank and trip blank results, presented in Table A-8 (Appendix A), showed that all results were non-detectable. Therefore, no contamination of the samples occurred during the handling and transportation of the samples.

5.0 SUPPLEMENTARY STUDIES AND AUDITS

There were no supplementary studies initiated or completed in 2018, other than the investigations already discussed in this report.

There were no audits completed on the PNGS groundwater program in 2018.

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6.0 CSA N288.7 UPDATE

OPG has committed to the Canadian Nuclear Safety Commission (CNSC) to be compliant with Canadian Standards Association (CSA) N288.7, "Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills", for the Pickering site (including PNGS and PWMF) by December 31, 2020. In 2018, OPG retained a vendor to assist with the implementation of the standard. In the previous year, a gap analysis was conducted between PNGS's current groundwater monitoring program and the mandatory clauses of the CSA standard. The work is progressing as planned and an update will again be provided in the 2019 report.

7.0 ACRONYMS

µCi/kg	Micro curie per Kilogram
µg/L	Micro grams per Litre
Bq/L	Becquerel per Litre
BTEX	Benzene / Toluene / Ethylbenzene / Xylene
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
EPG	Emergency Power Generator
HU	Hydrostratigraphic Unit
IAD	Inactive Drainage
IFB	Irradiated Fuel Bay
MDL	Method Detection Limit
MECP	Ministry of Environment Conservation and Parks
ODWQS	Ontario Drinking Water Quality Standard
OPG	Ontario Power Generation Inc.
PAH	Polycyclic Aromatic Hydrocarbon
PHC	Petroleum Hydrocarbon
PNGS	Pickering Nuclear Generating Station
RAB	Reactor Auxiliary Bay

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RB	Reactor Building
RLWMS	Radioactive Liquid Waste Management System
SAP	Sampling and Analysis Plan
SG	Standby Generator
SRST	Spent Resin Storage Tank
TAB	Turbine Auxiliary Bay
UPP	Upgrading Plant Pickering
VB	Vacuum Building
VBRS	Vacuum Building Ramp Sump
WSP	Water Supply Plant