ONTARIO POWER GENERATION

Report

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Title:

2019 PICKERING NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

2019 Pickering Nuclear Groundwater Monitoring Program Results

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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 2019, groundwater samples were collected as per the Sampling and Analysis Plan developed for the site, from a total of 135 sampling locations.

The findings with respect to the above objectives are:

- The predominant shallow groundwater flow patterns remain unchanged in 2019 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 8 area in 2019. The corrective actions undertaken the address the source have been effective. Tritium concentrations have subsequently declined in the area and monitoring will continue.
- In 2019, 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, as part of the annual OPG PNGS Environmental Monitoring Program, were well below the Ontario Drinking Water Quality Standard 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, 2019, and the associated interpretation of this data.

2.0 2019 PROGRAM DESIGN

The design of the PNGS groundwater monitoring program is risk-based in nature. The 2019 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 2019 (2019 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 2019, as per the SAP, groundwater samples were collected from various locations, including monitoring wells, foundation drains, sumps and groundtubes (135 sampling locations in total). Figure 1 (Page 8 of this report) shows these locations. It can be seen that the majority of data was collected from locations near the operating reactors.

Please refer to Section 7.0 of this report for an understanding of the sampling location nomenclature used in the groundwater program.

The 2019 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 2019:

- Unit 1 to 4 Reactor Buildings (RBs);
- Unit 5 to 8 RBs;
- Irradiated Fuel Bays (IFBs);
- Upgrading Plant Pickering (UPP);
- Former Water Treatment Plant Settling Basin (FWTPSB) Area; and
- Emergency Power Generator (EPG) Area.

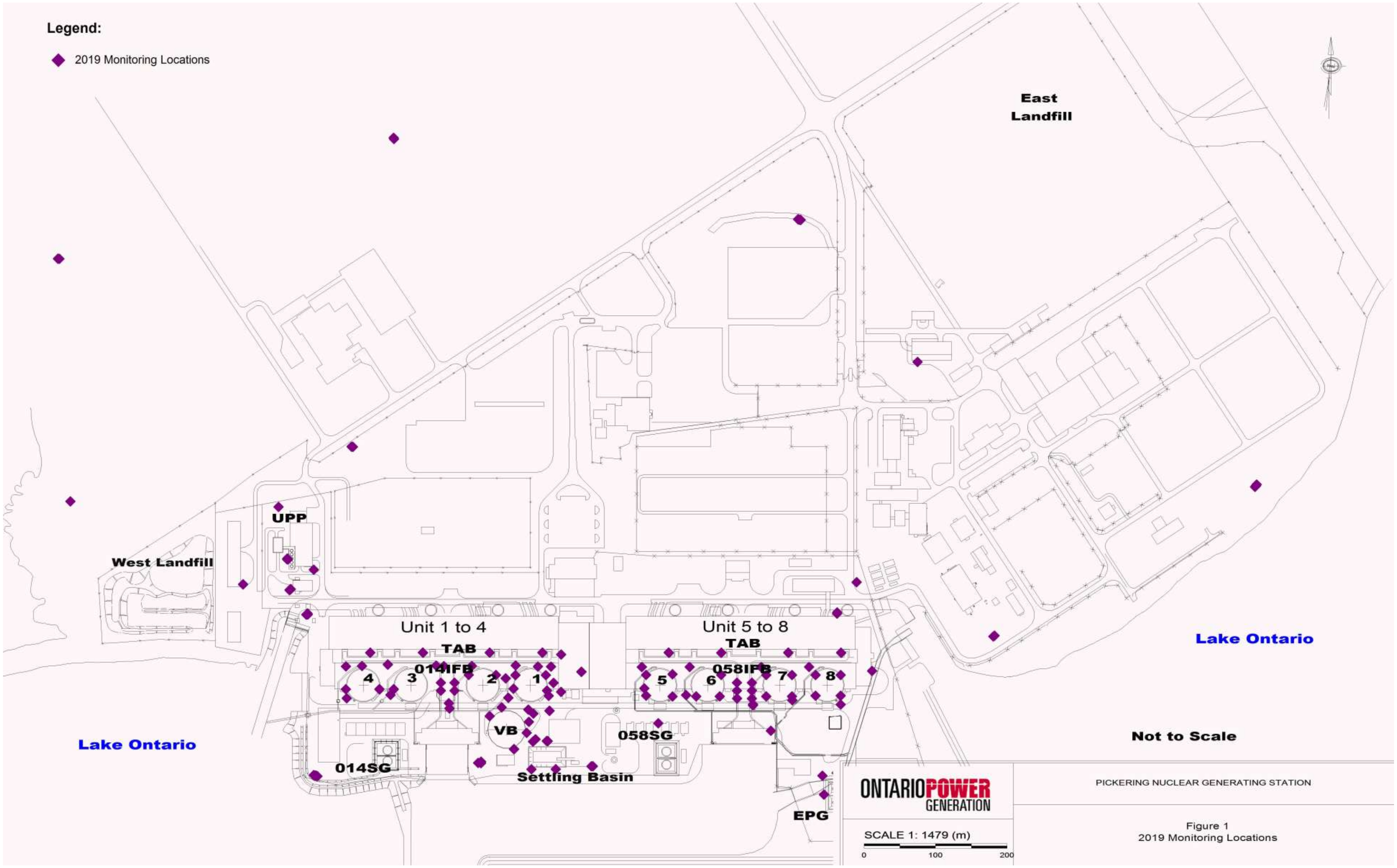
Groundwater samples were collected by qualified OPG chemical technicians. Prior to sample collection, each monitoring well was purged to remove standing water, ensuring that representative groundwater flowed into the well. Collected samples were predominantly analyzed for tritium. Selected samples were analyzed for Petroleum Hydrocarbons (PHCs), Benzene / Toluene / Ethylbenzene / Xylenes (BTEX) and Volatile Organic Compounds (VOCs).

Groundwater samples were analyzed by Kinectrics Analytical Inc. (Kinectrics) for PHCs, BTEX and VOCs. 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 2019 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 8). 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.



Legend:
2019 Monitoring Locations
East
Landfill
UPP
West Landfill
Unit 1 to 4
TAB
014IFB
4
3
2
1
VB
Unit 5 to 8
TAB
058IFB
5
6
7
8
058SG
014SG
Settling Basin
EPG
Lake Ontario
Lake Ontario
Not to Scale
ONTARIOPOWER GENERATION
SCALE 1: 1479 (m)
0
100
200
PICKERING NUCLEAR GENERATING STATION
Figure 1
2019 Monitoring Locations

3.0 2019 PROGRAM RESULTS

3.1 Objective 1 Results

The predominant groundwater flow patterns remain unchanged in 2019 from the original site groundwater flow interpretations from 2002.

PNGS's groundwater flow systems are categorized into the following four Hydrostratigraphic Units (HU):

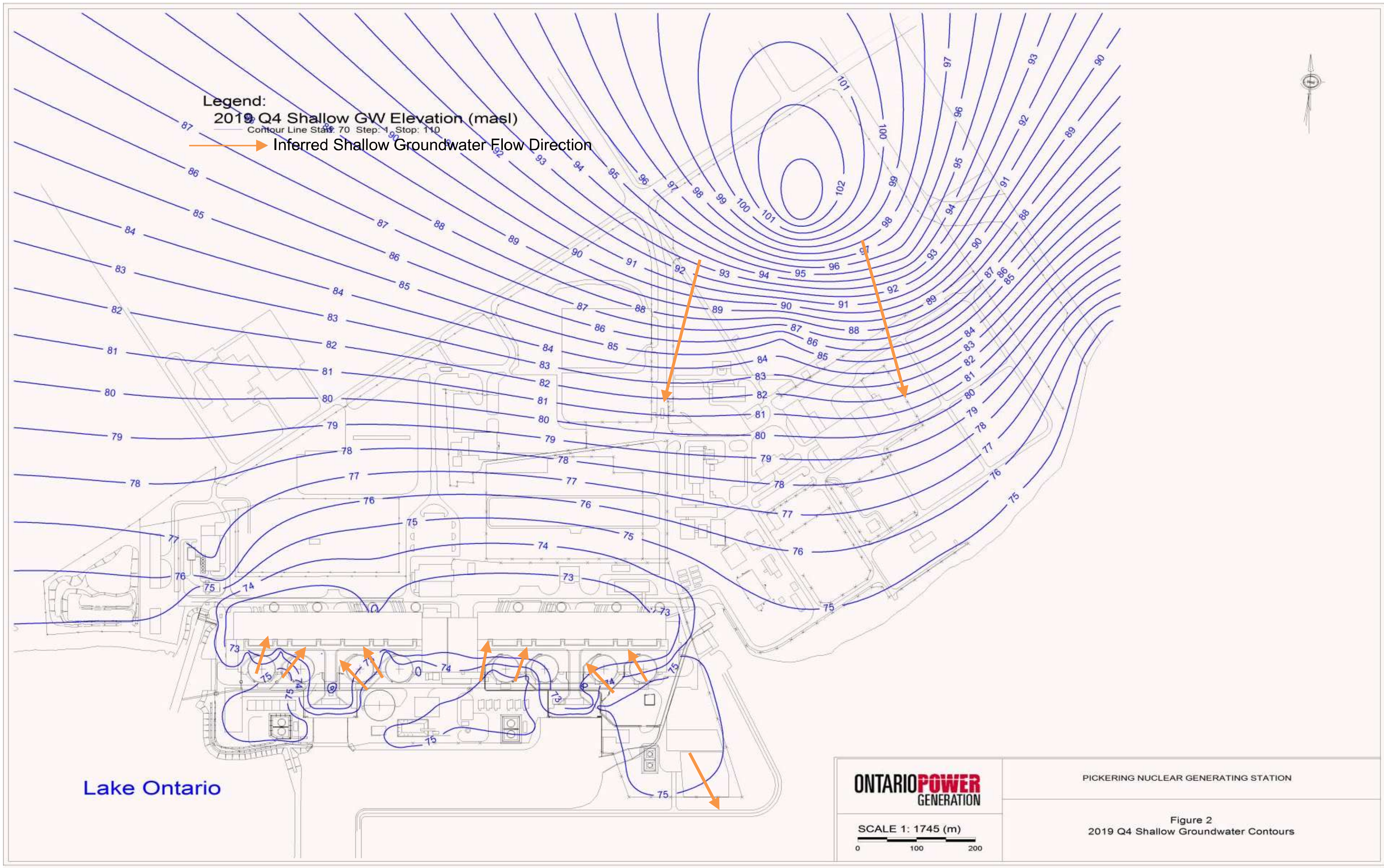
- Shallow/Water Table;
- Intermediate Overburden (HU6);
- Deep Overburden (HU7); and
- Deep Bedrock (HU8).

In 2019, groundwater level measurements were collected from wells installed in each HU (total of 78 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 10 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.



Legend:
2019 Q4 Shallow GW Elevation (masl)
Contour Line Start: 70 Step: 1 Stop: 110
Inferred Shallow Groundwater Flow Direction
Lake Ontario
ONTARIO POWER GENERATION
SCALE 1: 1745 (m)
0 100 200
PICKERING NUCLEAR GENERATING STATION
Figure 2
2019 Q4 Shallow Groundwater Contours

3.2 Objective 2 Results

In 2019, 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 emerging groundwater issue at the Unit 8 area was identified in 2019. The likely source was identified and addressed, after which tritium concentrations trended downward. Further discussion is provided in the appropriate section below.

3.2.1 Sampling and Analysis Changes

In 2019, there were circumstances that resulted in deviations from the SAP. These deviations are documented below.

- MW-064-21 and MW-206-65 could not be sampled in 2019 Q2, as the locations were not accessible.
- IFBA-GT-2A and IFBB-GT-4B could not be sampled in 2019 Q3, as the locations were not accessible.
- MW-215-12 could not be sampled in 2019 Q4, as the location was not accessible
- U8 MK42 could not be sampled in 2019 Q4 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.
- 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.
- One trip blank sample was not collected due to oversight.

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 in 2018 and have been successful in addressing the source as supported by the 2019 data (Section 3.2.2.1).

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.

The 2019 groundwater sampling results are presented in Table A-1 (Appendix A) and Figure 3 (Page 14 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.

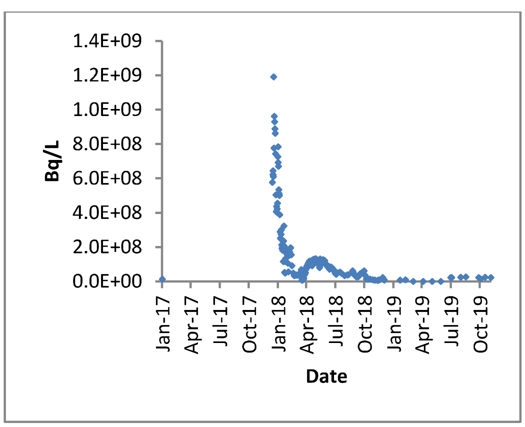
3.2.2.1 Unit 1 and 2 Area

In 2019, tritium concentrations in the Unit 1 RB groundtubes were closely monitored as a follow-up to mitigation activities undertaken in the previous year to address an emerging issue. 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.

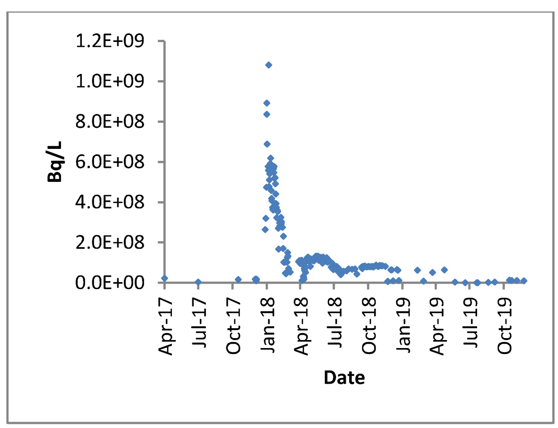
Graphs 1 to 4 illustrate the tritium concentrations over time for the Unit 1 RB foundation drainage groundtubes. In addition, data for the VBRS is also presented. As mentioned in Section 3.1, the VBRS acts as a hydraulic sink, diverting a portion of groundwater in the Unit 1 and 2 areas.

As can be seen on Figure 3 (Page 14), groundwater tritium concentrations in monitoring wells located between Unit 1 and the VB were elevated in 2019 due to the movement of groundwater towards the VBRS. There is also elevated tritium concentrations in the groundwater monitoring wells located to the northeast and west of the Unit 1 RB, as would be expected. This can be seen in Figure 3.

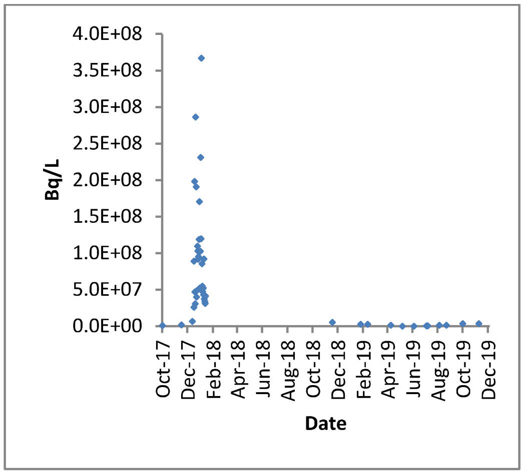
The results in this area will continue to be monitored as part of the routine program.



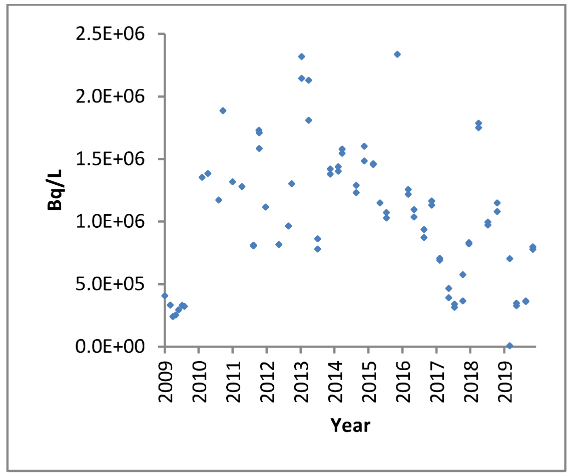
Graph 1: U1-RBFD-1 Tritium Data



Graph 2: U1-RBFD-2 Tritium Data



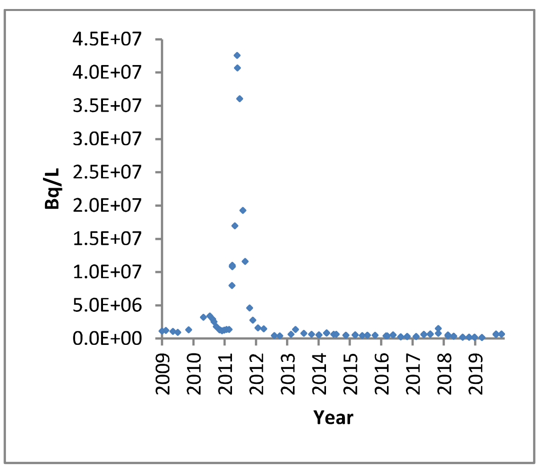
Graph 3: U1-RBFD-3 Tritium Data



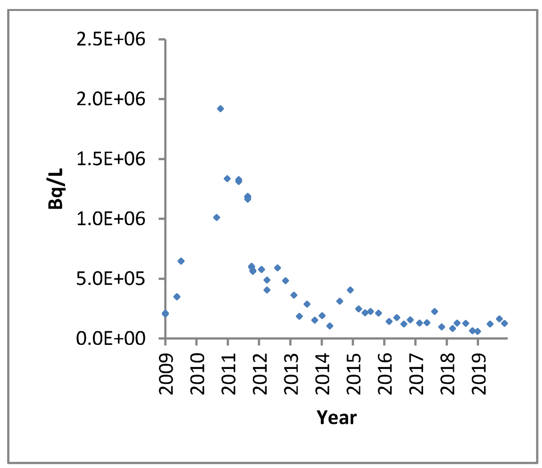
Graph 4: VBRS Tritium Data

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 illustrate the results for these monitoring wells.



Graph 5: MW-242-25 Tritium Data



Graph 6: MW-243-29 Tritium Data

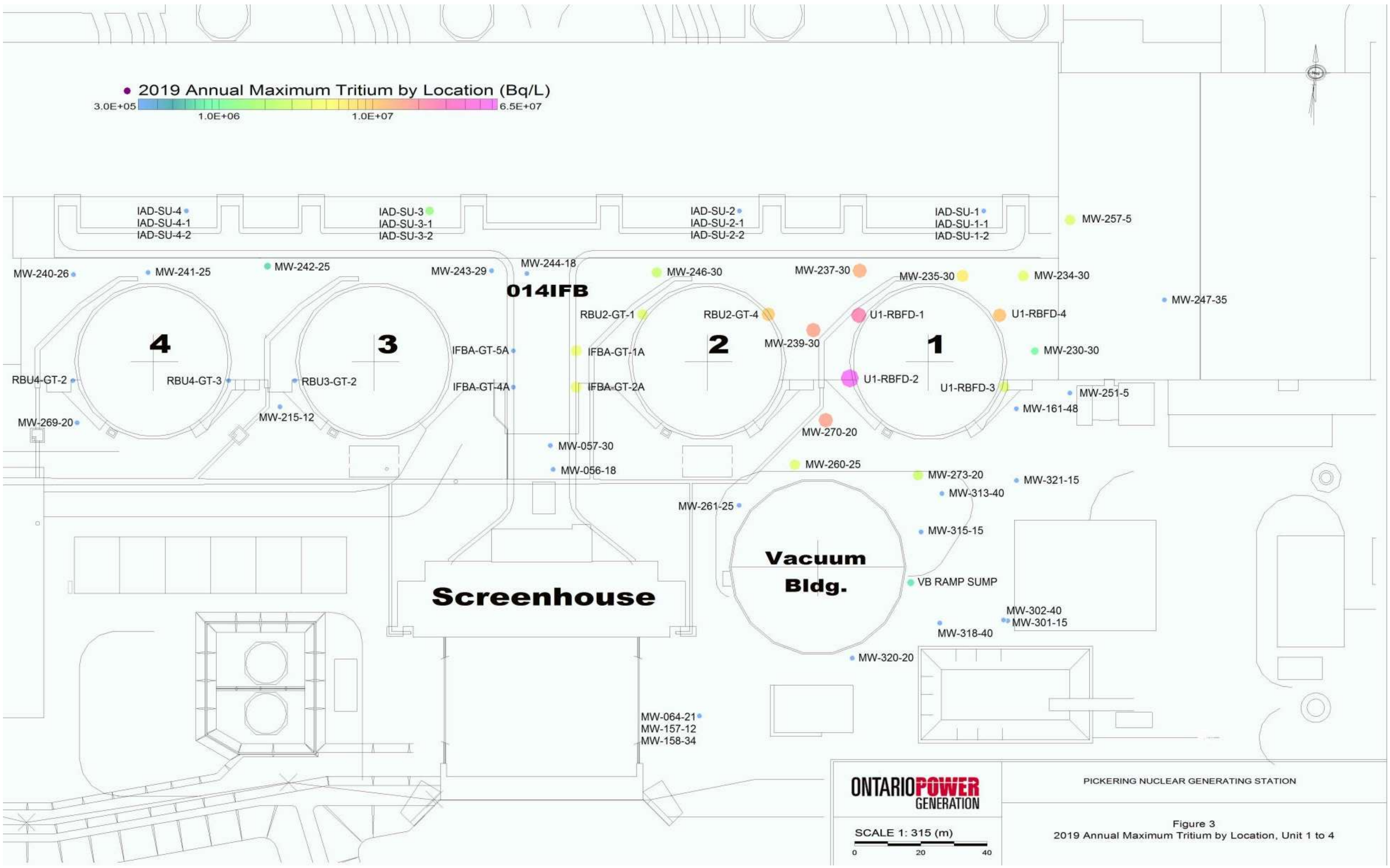


Figure 3
2019 Annual Maximum Tritium by Location, Unit 1 to 4

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 not operating as designed, 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. Similar repairs were also implemented at Unit 6.

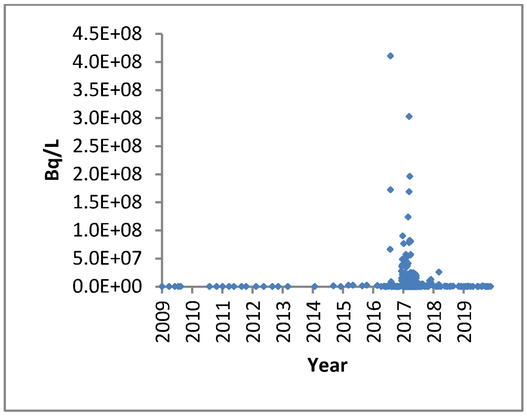
In 2019, an emerging issue was identified in the Unit 8 area. Following a thorough investigation, it was determined that a valve in the RAB was the likely contributing factor. The valve was repaired and groundwater monitoring continues in the Unit 8 area. Further details are provided below in Section 3.2.3.4

The 2019 groundwater sampling results are presented in Table A-2 (Appendix A) and Figure 4 (Page 21 of this report). The tritium concentrations in Figure 4 are represented using colour-gradient scaled circles.

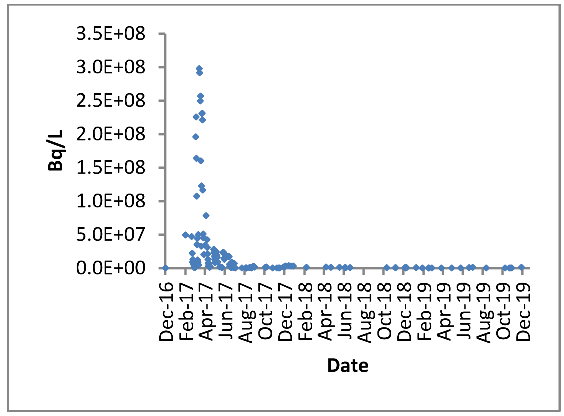
Key sampling locations are discussed in further detail below by specific area.

3.2.3.1 Unit 5 Area

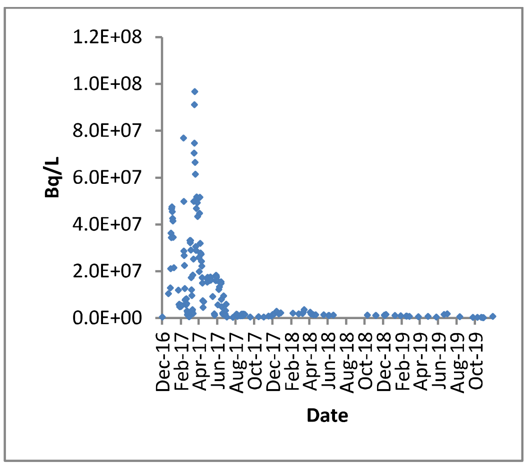
The samples collected from the Unit 5 RB area in 2019 indicate that tritium concentrations in groundwater have continued to decline following the repairs completed on the moderator room floor construction joints in 2017. Graphs 7 to 12 present the data from the Unit 5 RB foundation drainage groundtubes (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.



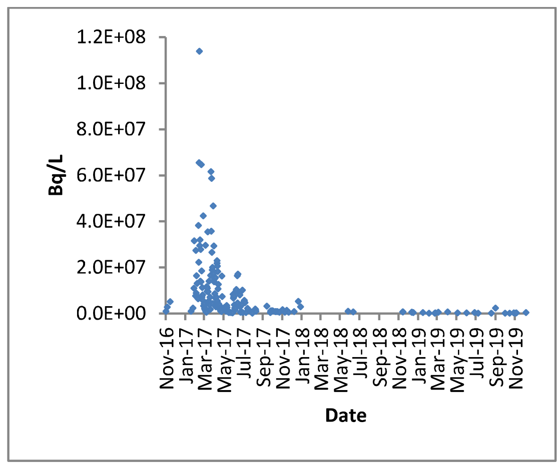
Graph 7: RBU5-GT-1 Tritium Data



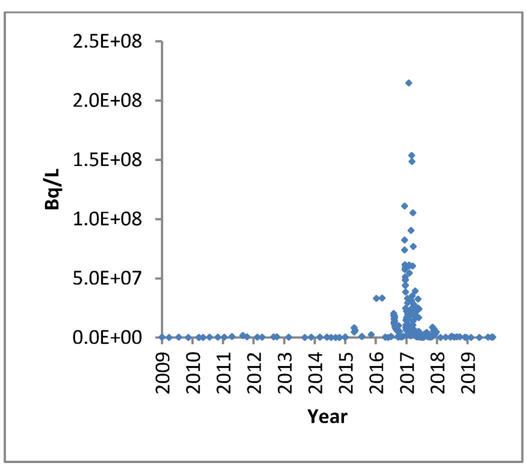
Graph 8: RBU5-GT-2 Tritium Data



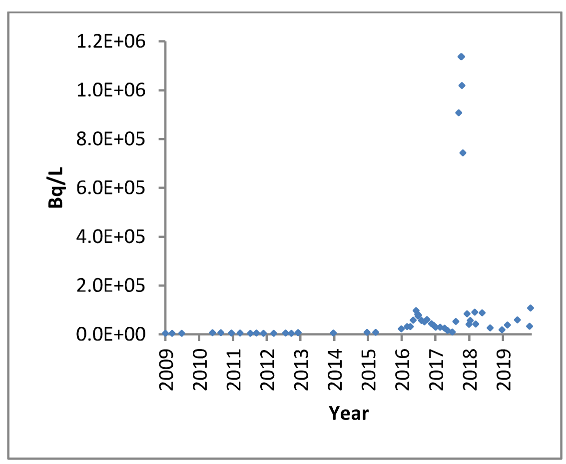
Graph 9: RBU5-GT-3 Tritium Data



Graph 10: RBU5-GT-4 Tritium Data



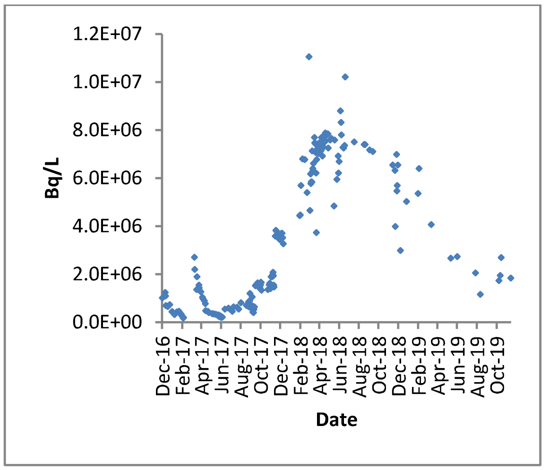
Graph 11: U5 MK26 Tritium Data



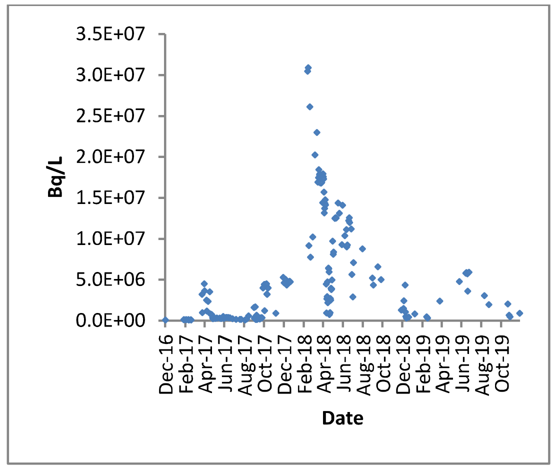
Graph 12: MW-267-17 Tritium Data

3.2.3.2 Unit 6 Area

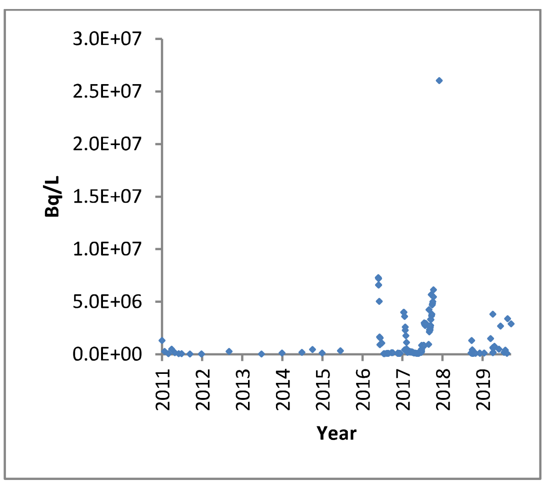
In the Unit 6 area, 2019 groundwater tritium concentrations remained stable. Elevated concentrations were identified during the previous year and repairs were undertaken based on the operating experience at Unit 5, which proved to be successful. Graphs 13 to 17 present the data from the Unit 6 RB foundation drainage groundtubes (RBU6-GT-2 to RBU6-GT-4), the U6 MK30 sump and monitoring well MW-266-19. This area will continue to be monitored.



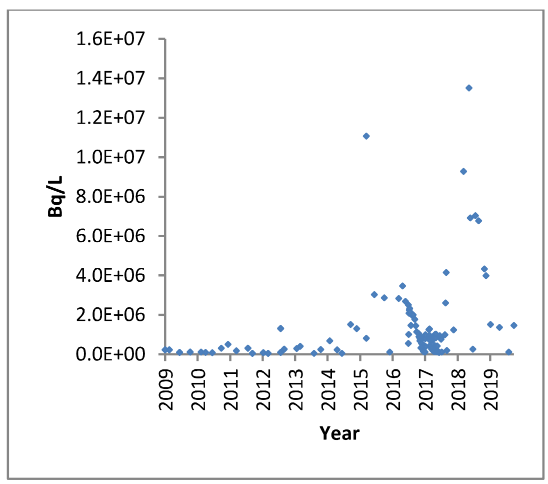
Graph 13: RBU6-GT-2 Tritium Data



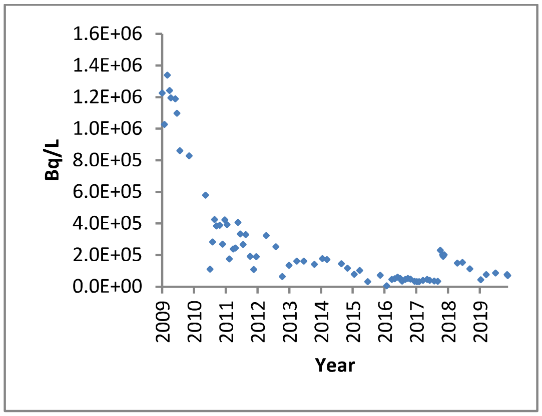
Graph 14: RBU6-GT-3 Tritium Data



Graph 15: RBU6-GT-4 Tritium Data



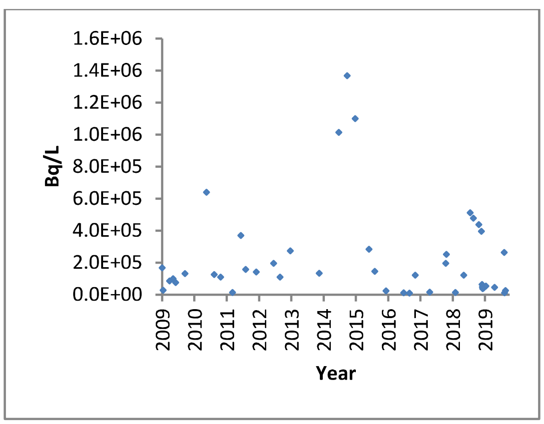
Graph 16: U6 MK30 Tritium Data



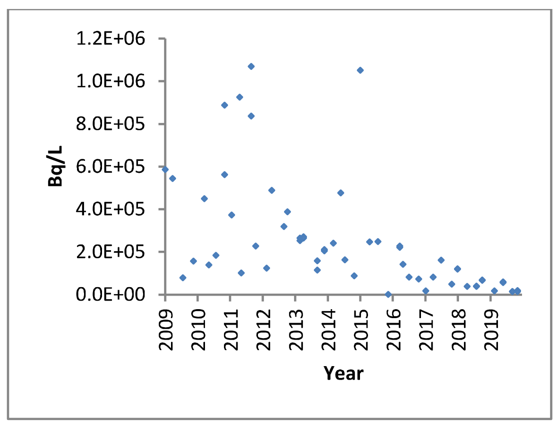
Graph 17: MW-266-19 Tritium Data

3.2.3.3 Unit 7 Area

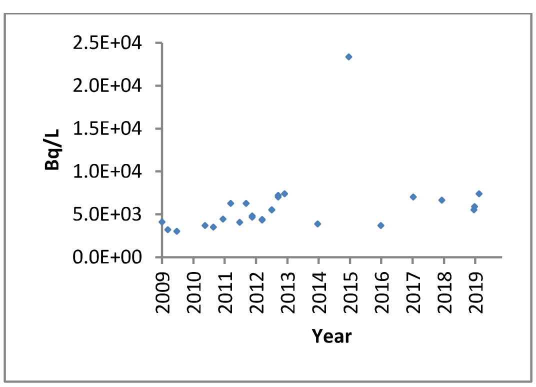
In 2019, there were no emerging issues identified for the Unit 7 area. Graphs 18 to 20 illustrate the data for RBU7-GT-1, U7 MK36 and MW-265-12.



Graph 18: RBU7-GT-1 Tritium Data



Graph 19: U7 MK36 Tritium Data

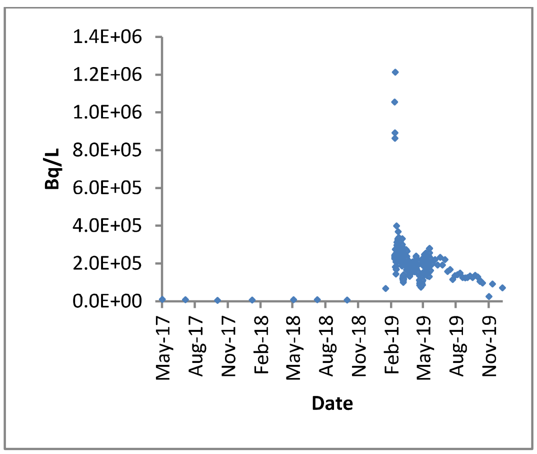


Graph 20: MW-265-12 Tritium Data

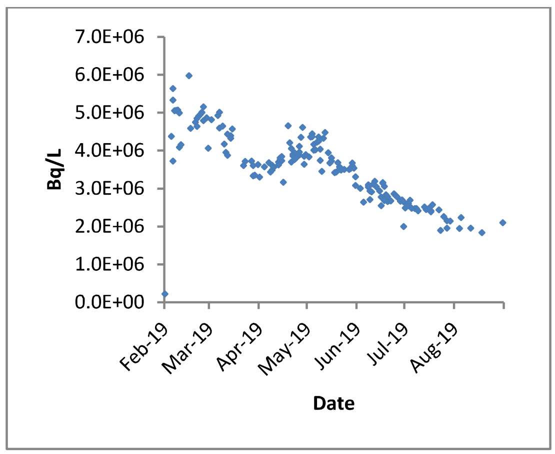
3.2.3.4 Unit 8 Area

In the Unit 8 area, there was an increase in tritium concentration noted in the TAB IAD sump (IAD-SU-8) in 2019 Q1. This can be seen in Graph 21. This low-lying sump collects groundwater in the Unit 8 area, as well as other process water. There are two groundwater inputs into the sump (IAD-SU-8-1 and IAD-SU-8-2). It was determined that elevated tritium was seen at IAD-SU-8-1, as per Graph 22, which was contributing to the overall elevated concentrations of tritium in the sump itself. A multi-disciplinary team was formed in order to identify the likely source of tritium. The frequency of sampling at the Unit 8 area was also increased. Through the investigation and elimination of potential sources, it was determined that a valve in the RAB was the likely contributing factor. Groundwater flows north from underneath the RAB towards the TAB IAD foundation drainage and sumps. The valve was subsequently repaired and tritium concentrations at IAD-SU-8 and IAD-SU-8-1 have been trending downwards. Groundwater monitoring continues in this area to monitor the trend.

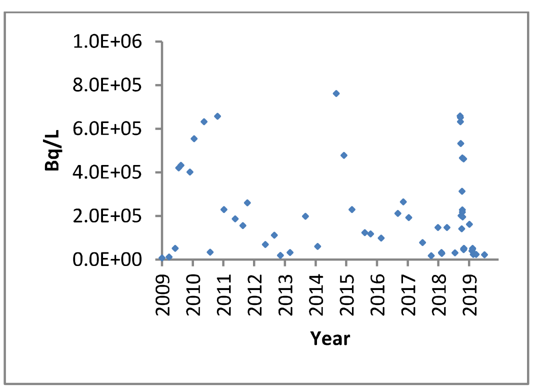
Graphs 23 to 28 illustrate the tritium data for the Unit 8 RB foundation drainage groundtubes, U8 MK42 and monitoring well MW-264-10.



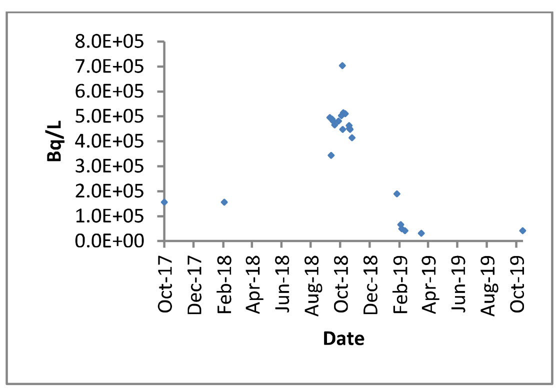
Graph 21: IAD-SU-8 Tritium Data



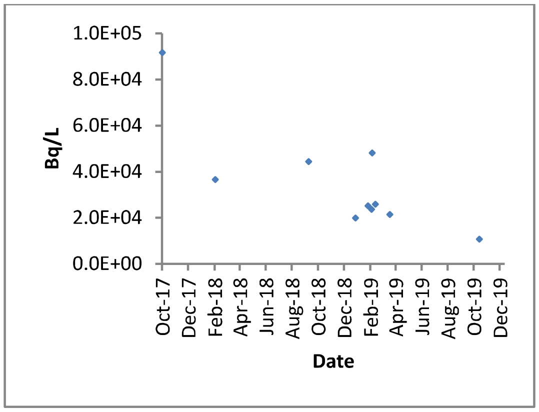
Graph 22: IAD-SU-8-1 Tritium Data



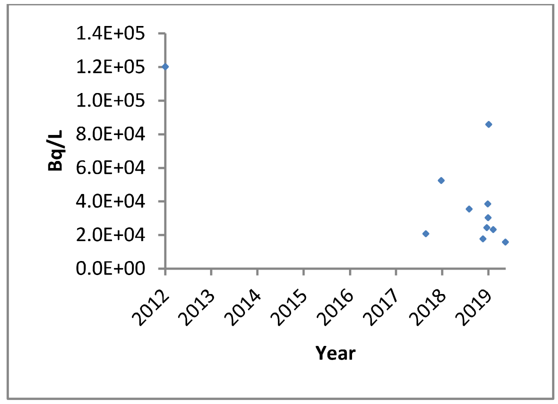
Graph 23: RBU8-GT-1 Tritium Data



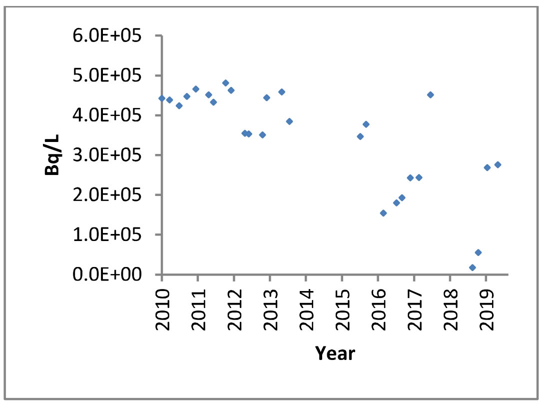
Graph 24: RBU8-GT-2 Tritium Data



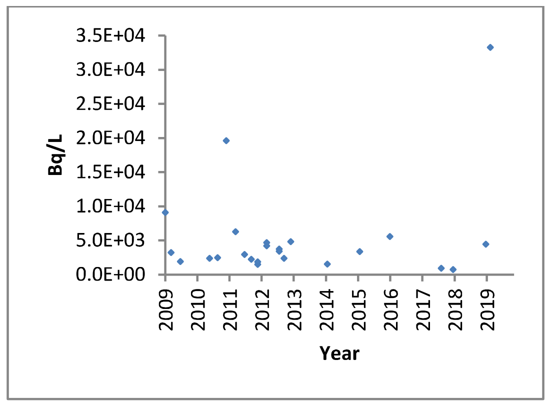
Graph 25: RBU8-GT-3 Tritium Data



Graph 26: RBU8-GT-4 Tritium Data



Graph 27: U8 MK42 Tritium Data



Graph 28: MW-264-10 Tritium Data

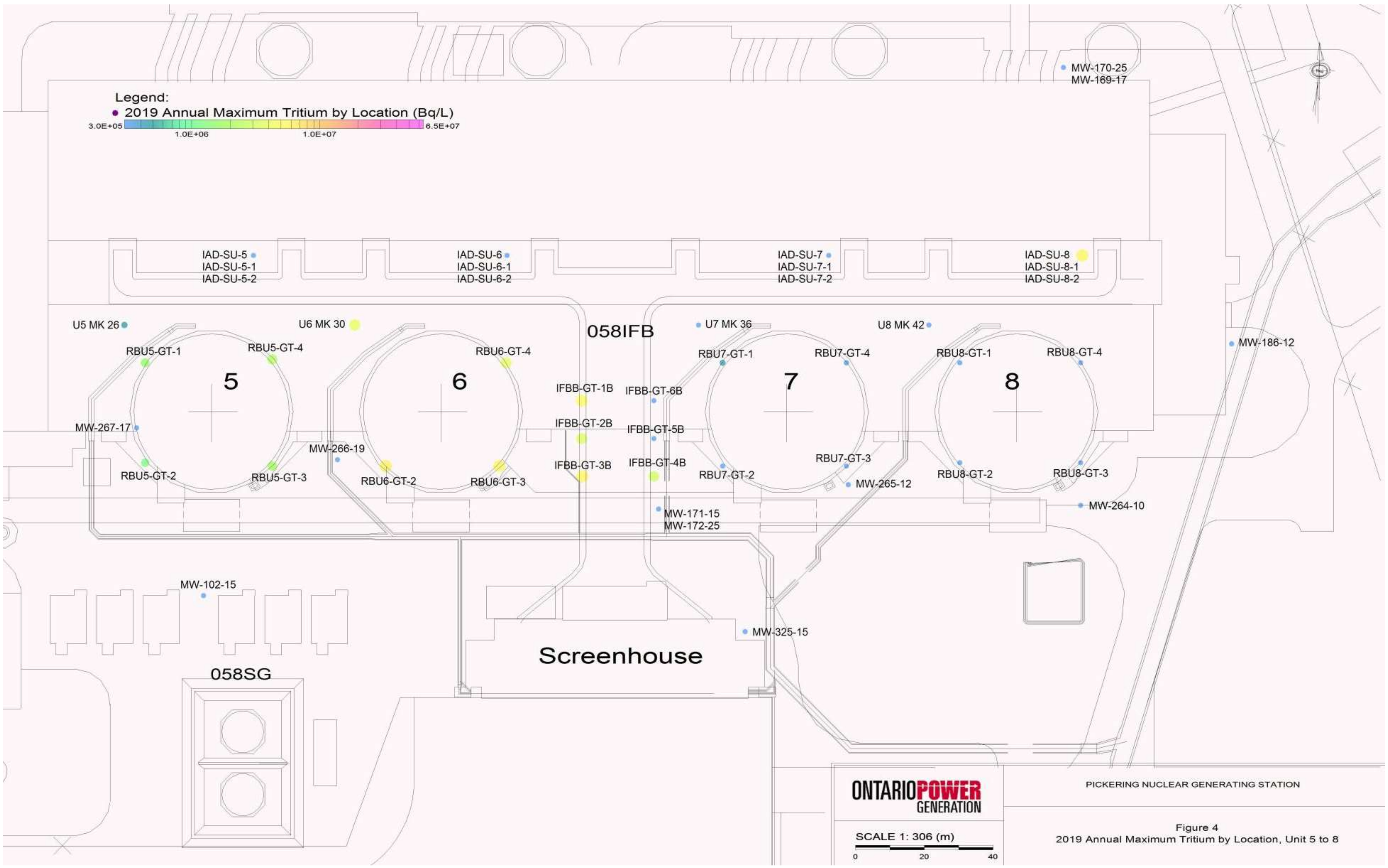


Figure 4
2019 Annual Maximum Tritium by Location, Unit 5 to 8

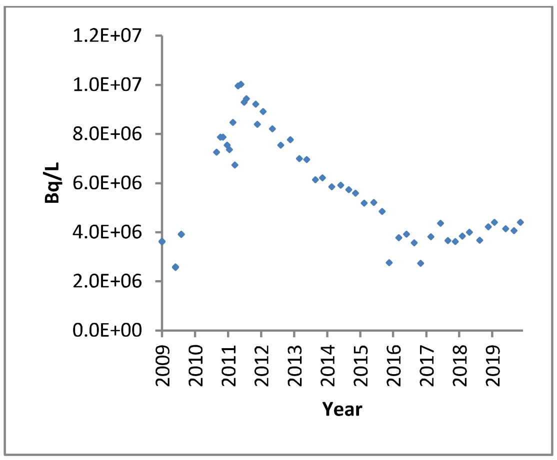
3.2.4 Irradiated Fuel Bay Areas

3.2.4.1 IFB-A

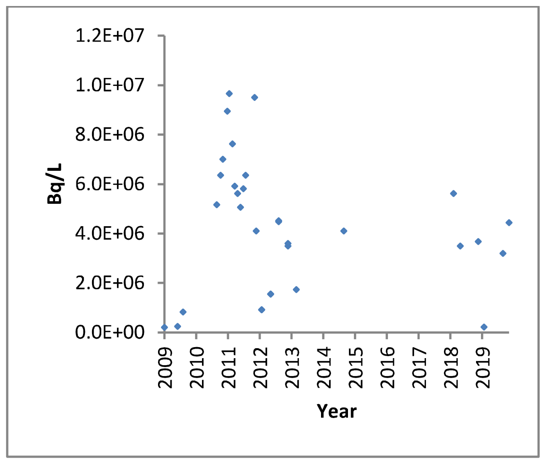
The groundwater results collected from sampling locations in the Irradiated Fuel Bay area located between Units 2 and 3 (IFB-A) are described below.

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.

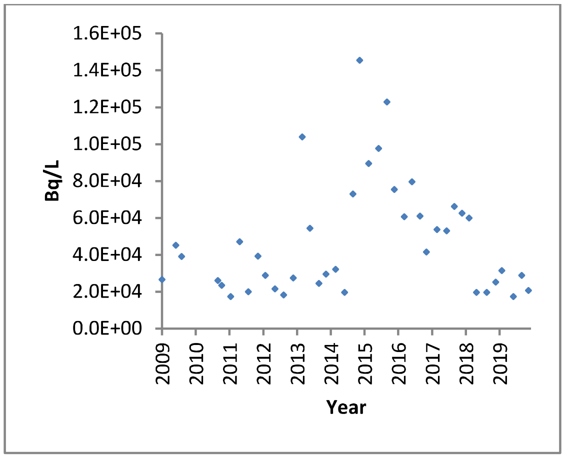
Tritium concentrations over time for the IFB-A groundtubes and monitoring wells are presented in Graphs 29 to 35. The results are also presented in Table A-3 (Appendix A) and Figure 3 (Page 14 of this report).



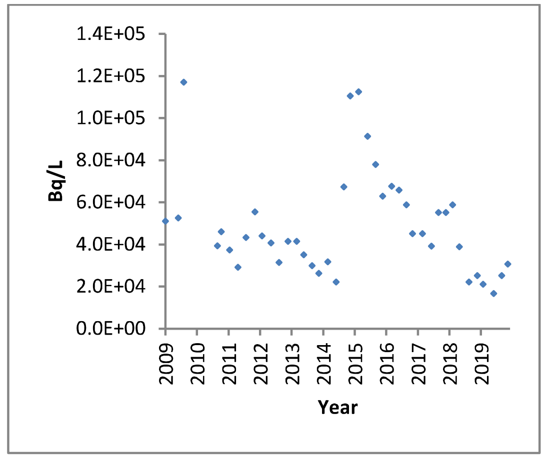
Graph 29: IFBA-GT-1A Tritium Data



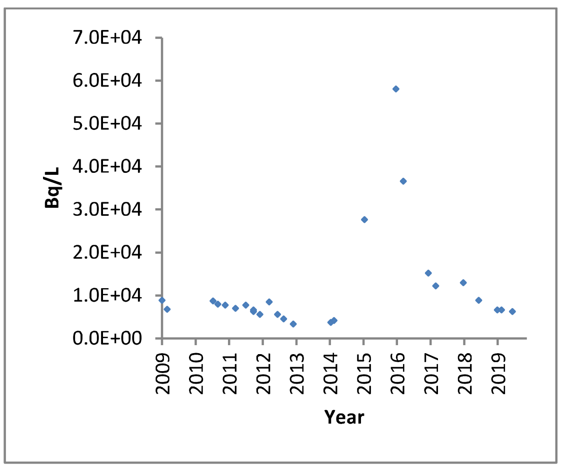
Graph 30: IFBA-GT-2A Tritium Data



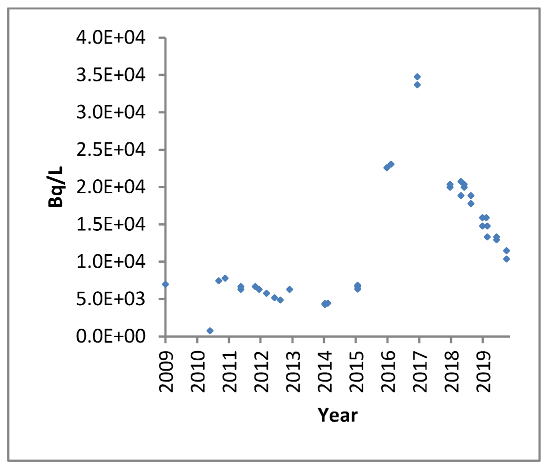
Graph 31: IFBA-GT-4A Tritium Data



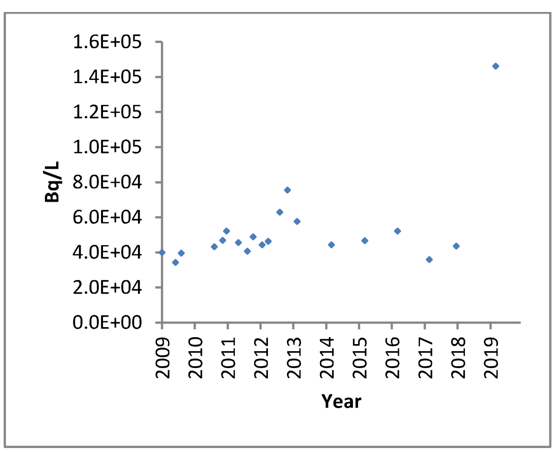
Graph 32: IFBA-GT-5A Tritium Data



Graph 33: MW-056-18 Tritium Data



Graph 34: MW-057-30 Tritium Data



Graph 35: MW-244-18 Tritium Data

3.2.4.2 IFB-B

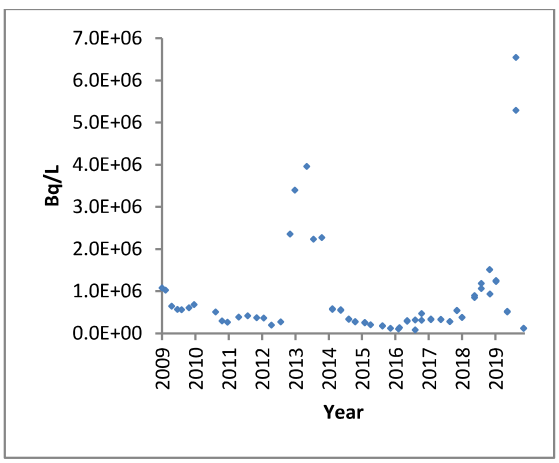
The groundwater results collected from sampling locations in the Irradiated Fuel Bay area located between Units 6 and 7 (IFB-B) are described below.

In 2019, tritium concentrations in the western groundtubes (IFBB-GT-1B, IFBB-GT-2B and IFBB-GT-3B) decreased as compared to 2018. Fluctuations at these groundtubes are expected as the tritium in groundwater in the Unit 5 area slowly moves in a north-easterly direction towards the TAB IAD sumps.

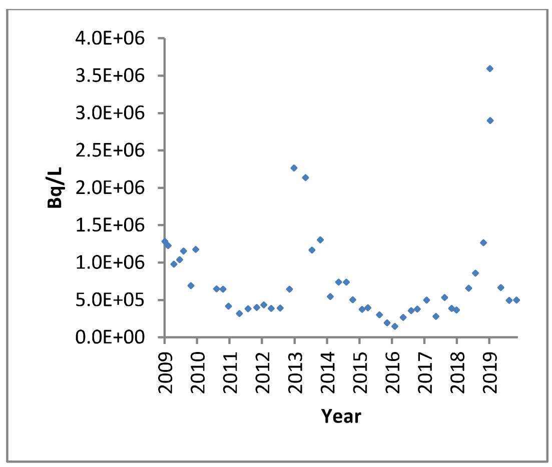
There were no significant changes in tritium concentrations in eastern groundtubes IFBB-GT-5B and IFBB-GT-6B in 2019. Eastern groundtube IFBB-GT-4B showed an increase in 2019 Q1. It was confirmed that there were no issues with the operation of the IFB-B. The tritium concentration subsequently declined over the course of the year.

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

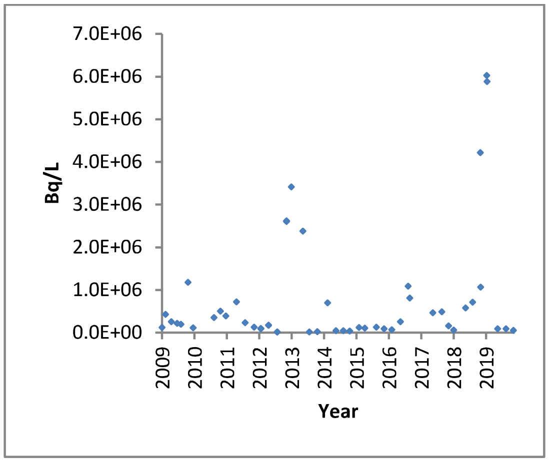
Tritium concentrations over time for the IFB-B groundtubes and monitoring wells are presented in Graphs 36 to 43. The results are also presented in Table A-3 (Appendix A) and Figure 4 (Page 21 of this report).



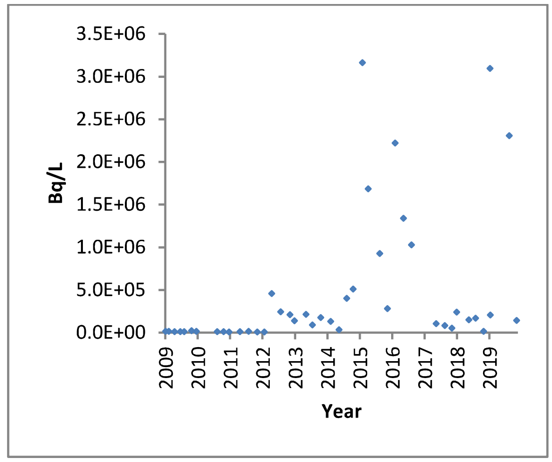
Graph 36: IFBB-GT-1B Tritium Data



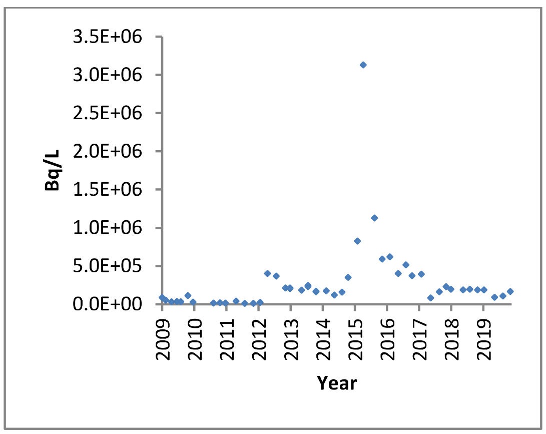
Graph 37: IFBB-GT-2B Tritium Data



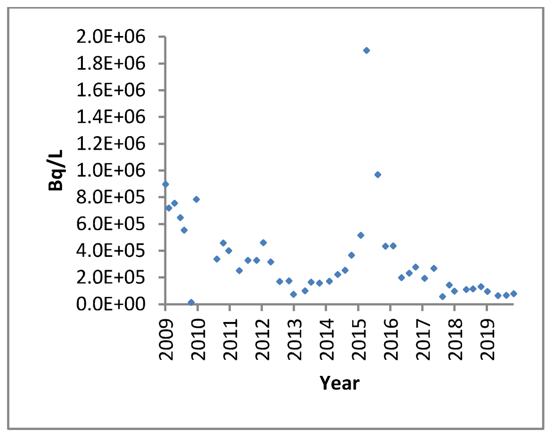
Graph 38: IFBB-GT-3B Tritium Data



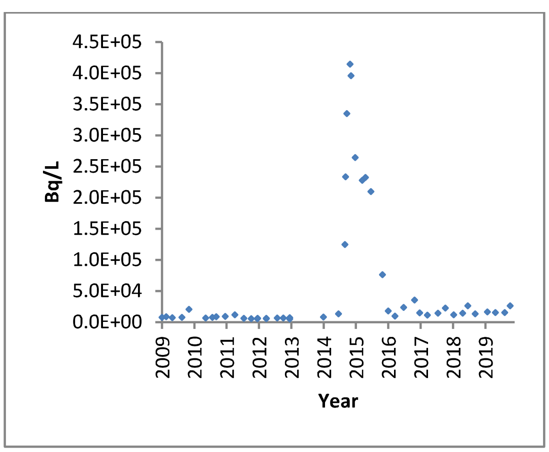
Graph 39: IFBB-GT-4B Tritium Data



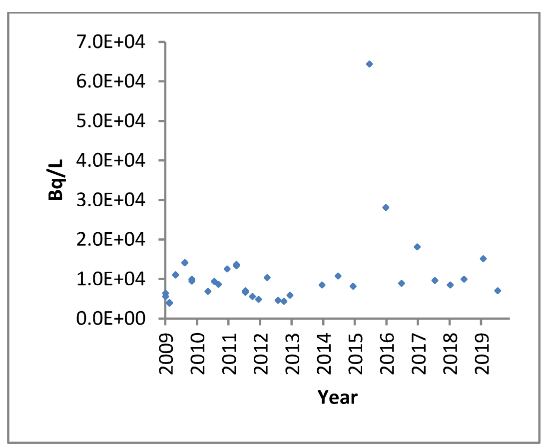
Graph 40: IFBB-GT-5B Tritium Data



Graph 41: IFBB-GT-6B Tritium Data



Graph 42: MW-171-15 Tritium Data



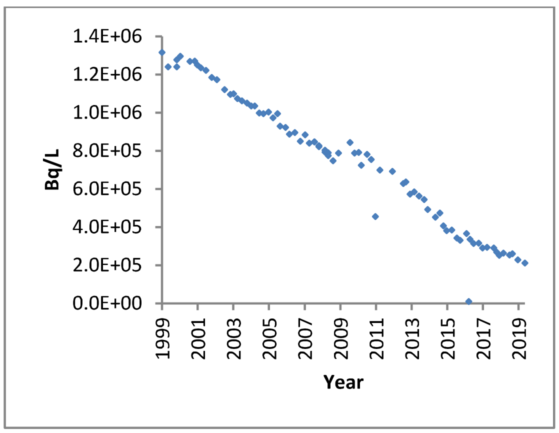
Graph 43: MW-172-25 Tritium Data

3.2.5 Upgrading Plant Pickering Area

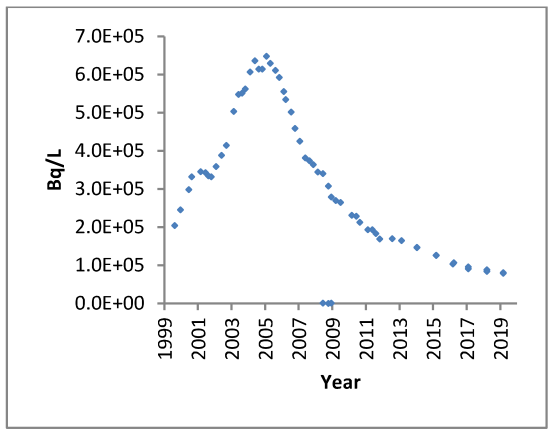
The groundwater results from the UPP area monitoring wells indicate that there is no new source of tritium in groundwater in this area. The legacy tritium in groundwater present in this area is due to past work practices that resulted in discharges of tritiated water to the ground. These practices were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

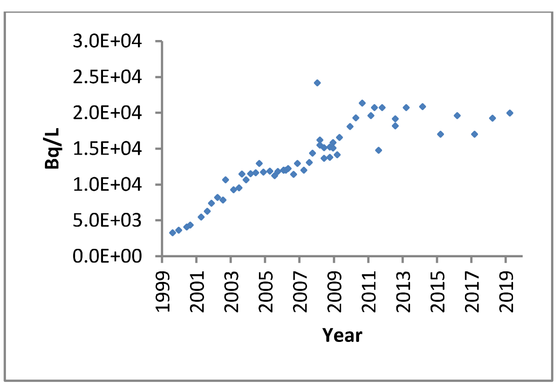
Tritium concentrations over time for the above-mentioned monitoring wells are presented in Graphs 44 to 46. The results for the locations sampled in the UPP area are presented in Table A-4 (Appendix A) and Figure 5 (Page 27 of this report).



Graph 44: MW-090-20 Tritium Data



Graph 45: MW-076-20 Tritium Data



Graph 46: MW-096-20 Tritium Data

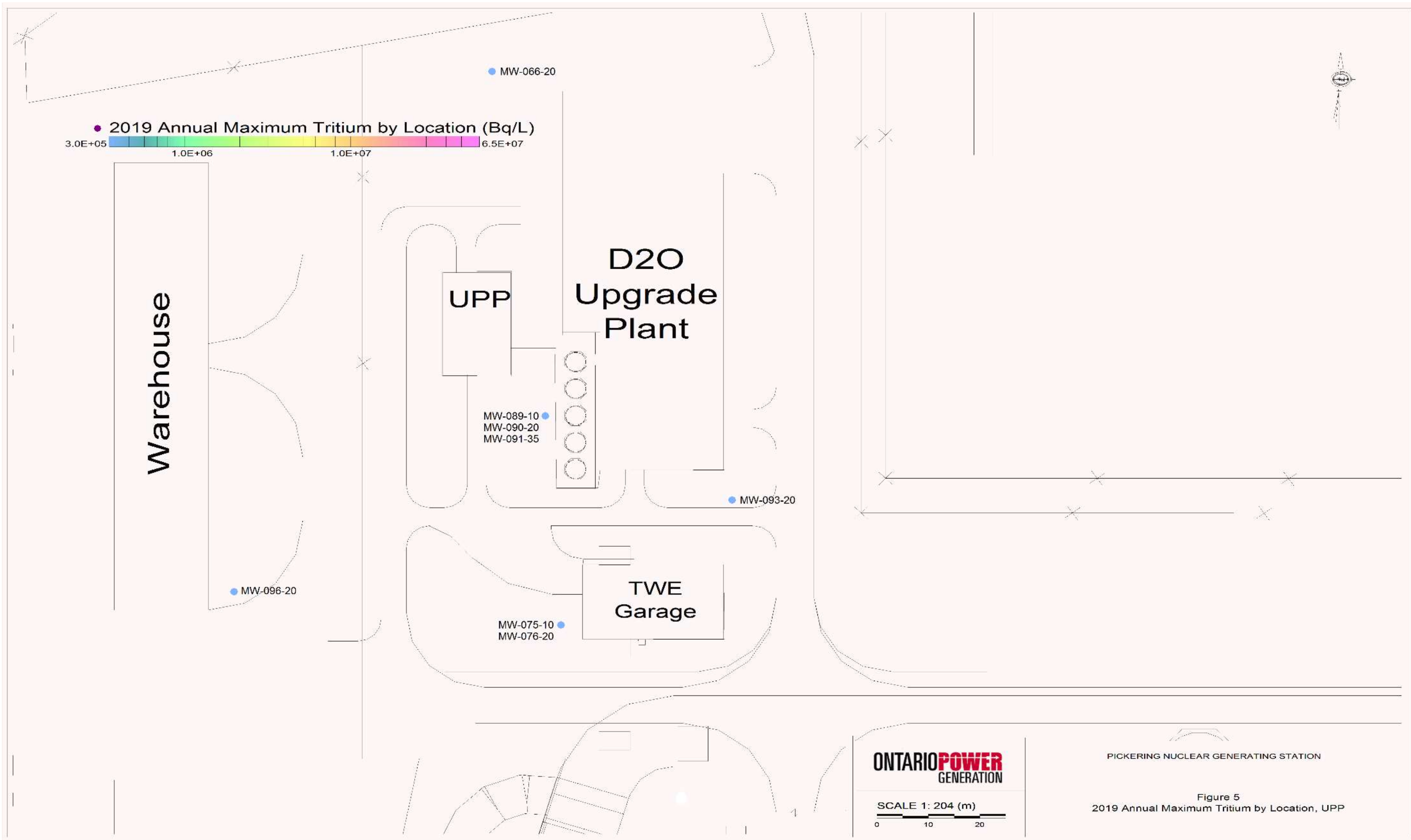


Figure 5
2019 Annual Maximum Tritium by Location, UPP

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 2019 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) at any of the locations.

3.2.7 Former Water Treatment Plant Settling Basin Area

Groundwater monitoring in the FWTPSB area is conducted biennially to re-confirm there is no migration from the legacy source area underneath the basin.

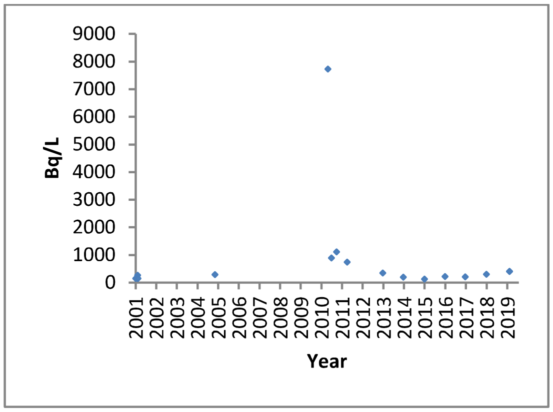
The 2019 analytical results are presented in Table A-8 (Appendix A). Four monitoring wells (MW-301-15, MW-303-20, MW-304-20 and MW-317-20) were sampled for PHC fractions, BTEX and VOCs. There parameters were not detected above MDLs at any of the locations.

3.3 Objective 3 Results

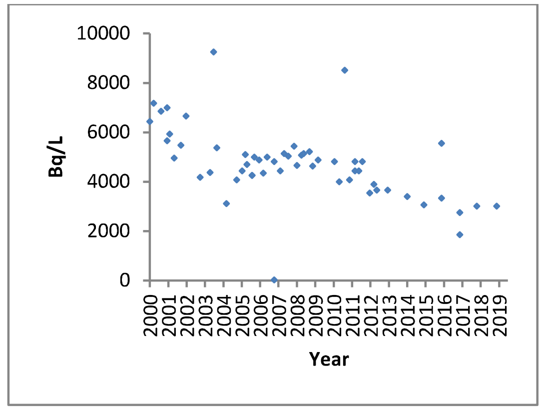
In 2019, there were no indications of adverse off-site impacts from PNGS groundwater. The results from the site perimeter monitoring well locations are presented in Table A-6 (Appendix A) and Graphs 47 to 73. The annual maximum tritium concentrations at these locations are presented in Figure 6 (Page 34 of this report).

As can be seen, tritium concentrations at the perimeter of PNGS remained low, although some monitoring wells exhibited slight increases in tritium concentrations during 2019. 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).

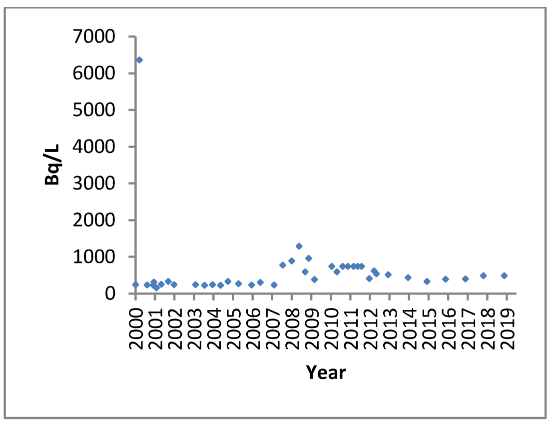
As part of the annual OPG PNGS Environmental Monitoring Program (EMP), municipal drinking water samples are collected from the downstream Water Supply Plants (WSPs). In 2019, the data from this sampling demonstrated that the annual average tritium concentration at each WSP was well below the Ontario 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.



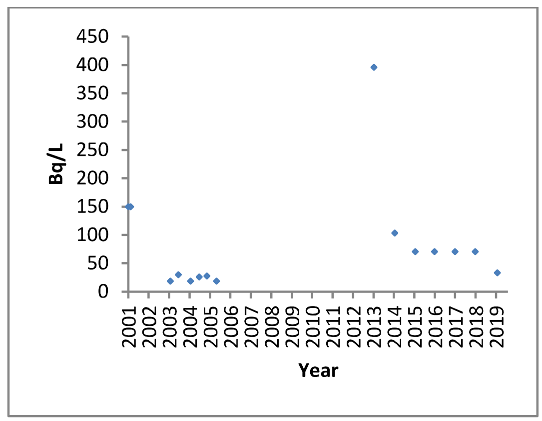
Graph 47: MW-156-20 Tritium Data



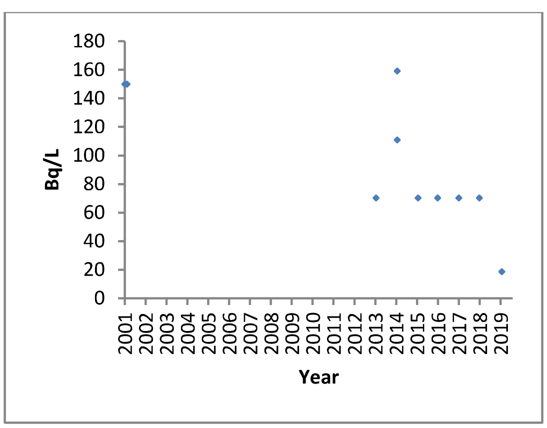
Graph 48: MW-164-13 Tritium Data



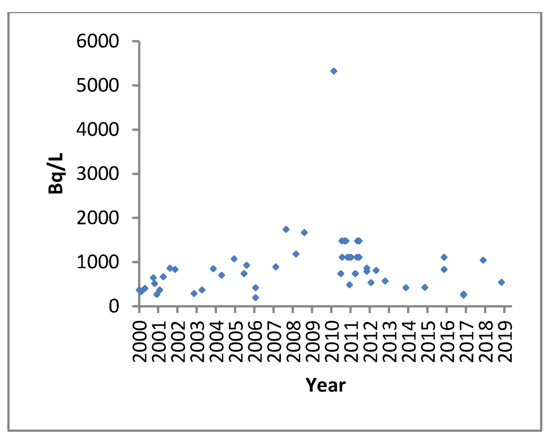
Graph 49: MW-165-24 Tritium Data



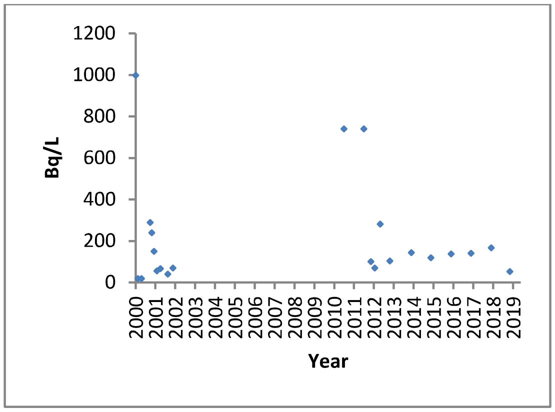
Graph 50: MW-176-23 Tritium Data



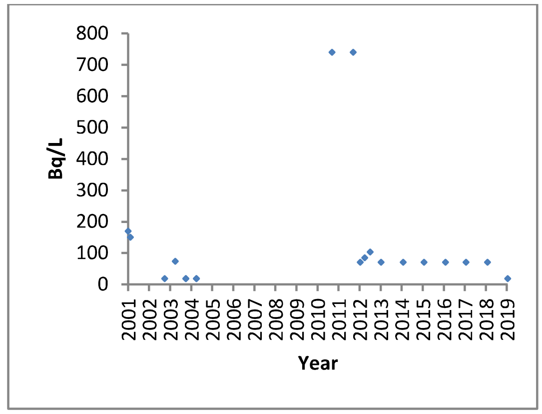
Graph 51: MW-177-35 Tritium Data



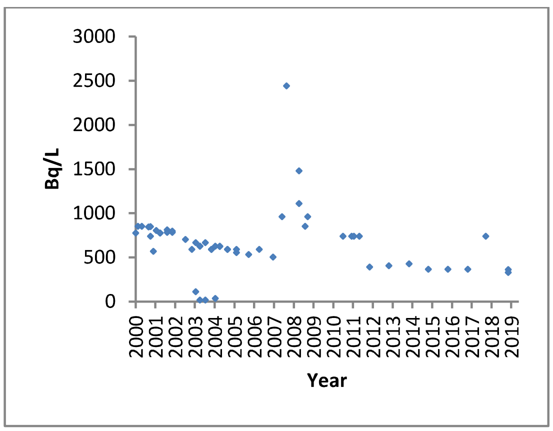
Graph 52: MW-183-10 Tritium Data



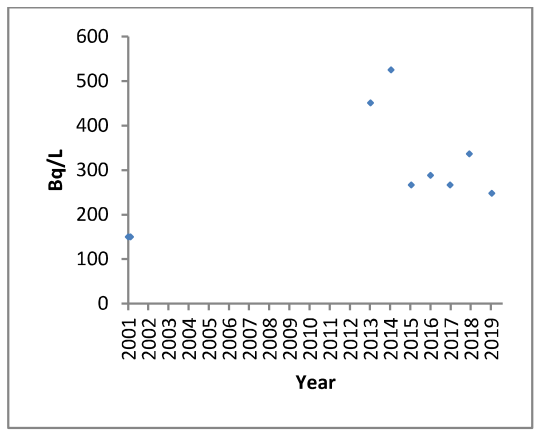
Graph 53: MW-184-27 Tritium Data



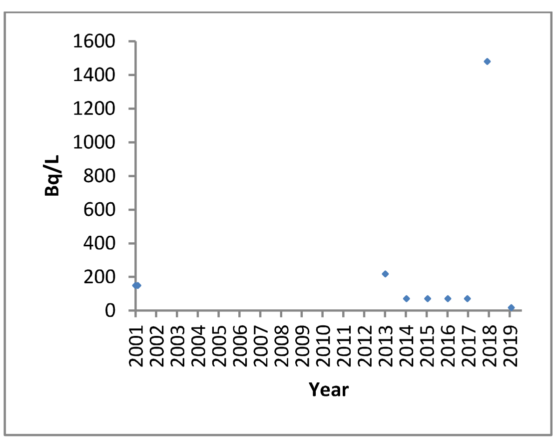
Graph 54: MW-185-39 Tritium Data



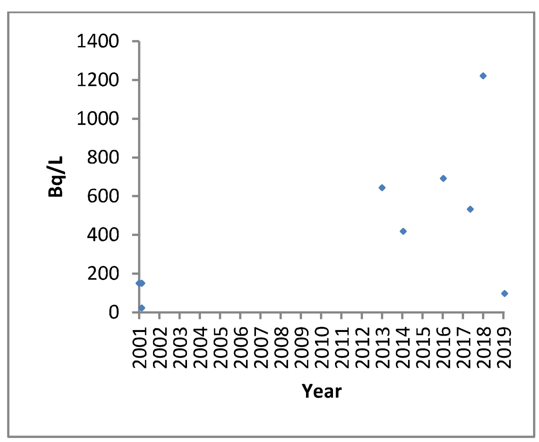
Graph 55: MW-192-18 Tritium Data



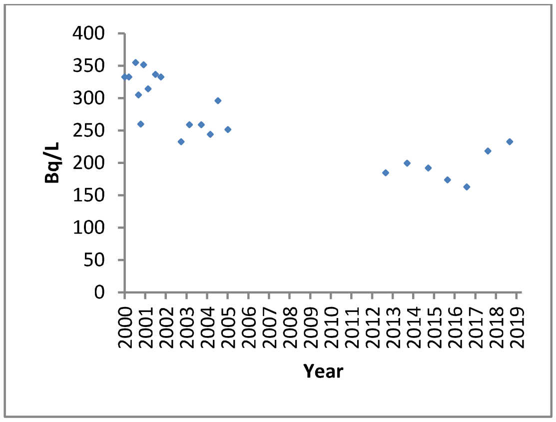
Graph 56: MW-193-37 Tritium Data



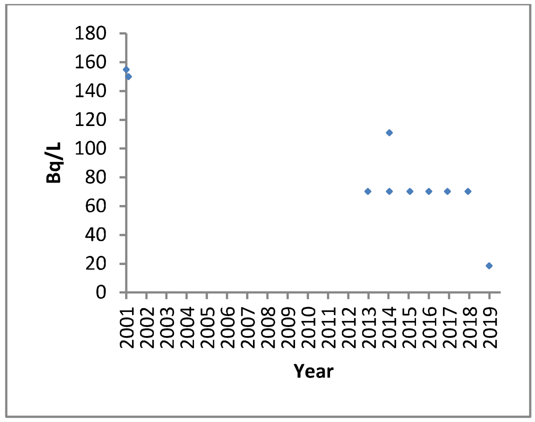
Graph 57: MW-194-57 Tritium Data



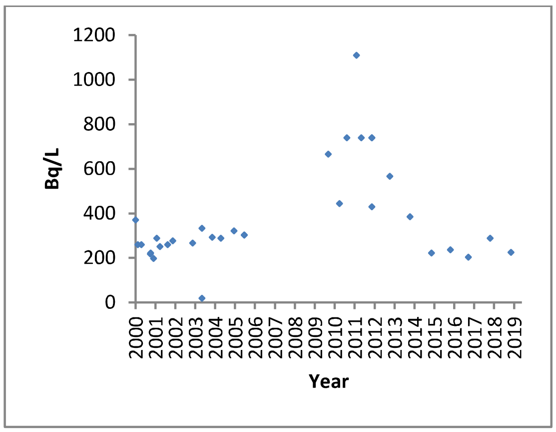
Graph 58: MW-197-15 Tritium Data



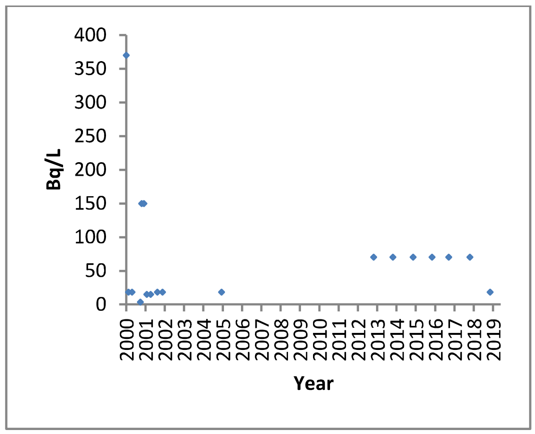
Graph 59: MW-198-20 Tritium Data



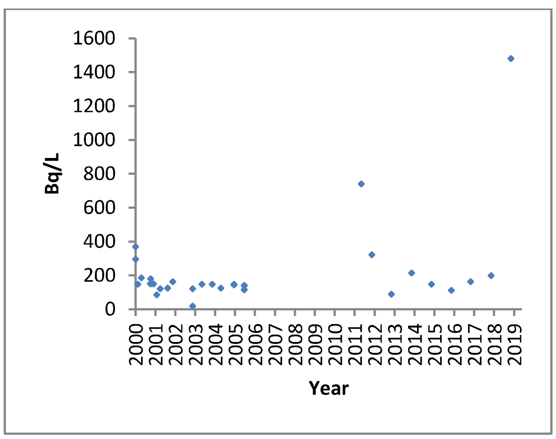
Graph 60: MW-199-38 Tritium Data



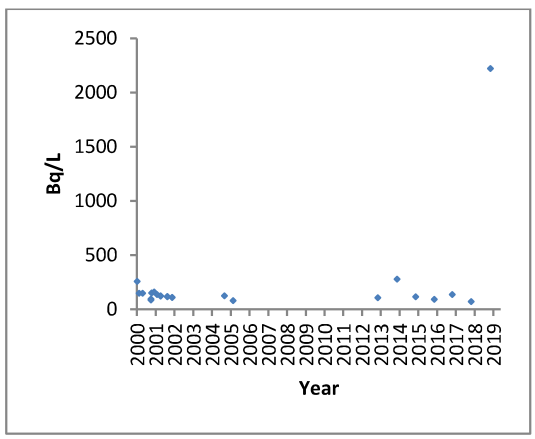
Graph 61: MW-200-22 Tritium Data



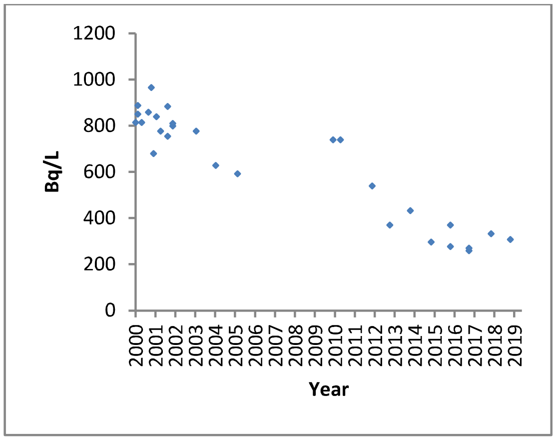
Graph 62: MW-201-39 Tritium Data



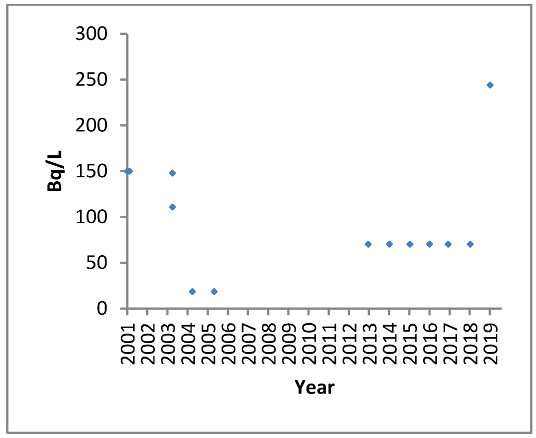
Graph 63: MW-204-24 Tritium Data



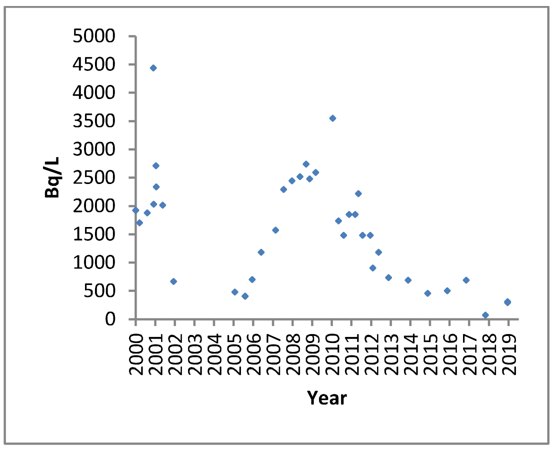
Graph 64: MW-205-35 Tritium Data



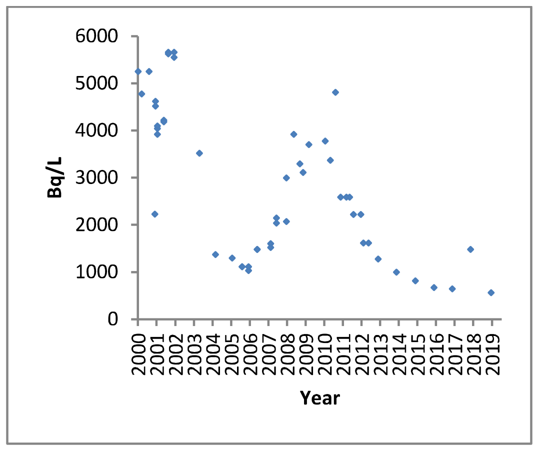
Graph 65: MW-216-15 Tritium Data



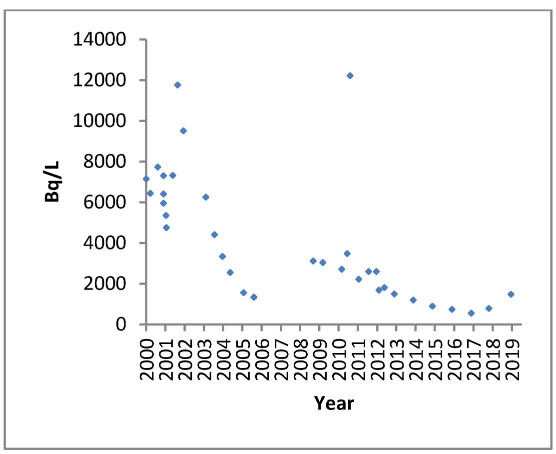
Graph 66: MW-217-32 Tritium Data



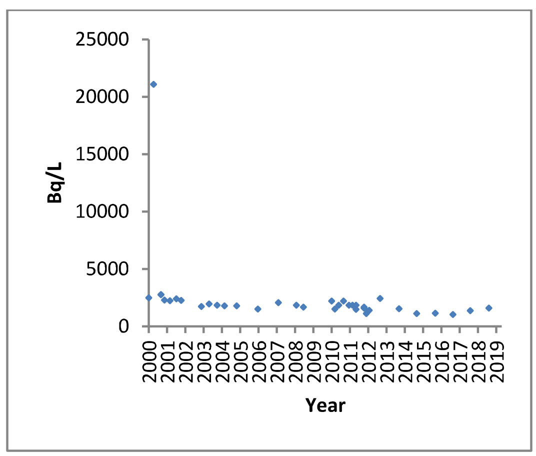
Graph 67: MW-222-10 Tritium Data



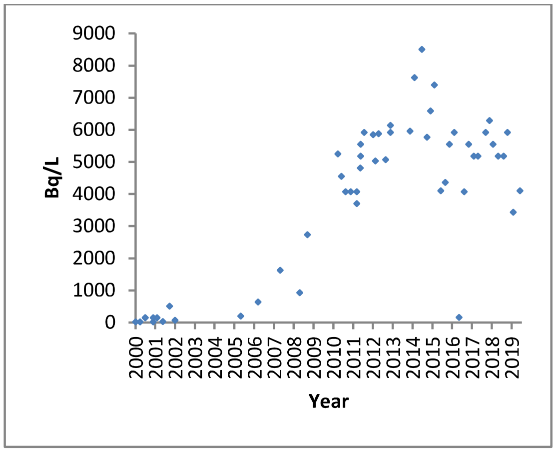
Graph 68: MW-223-32 Tritium Data



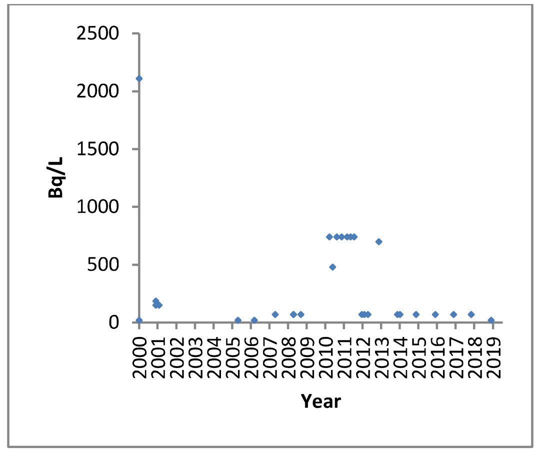
Graph 69: MW-224-42 Tritium Data



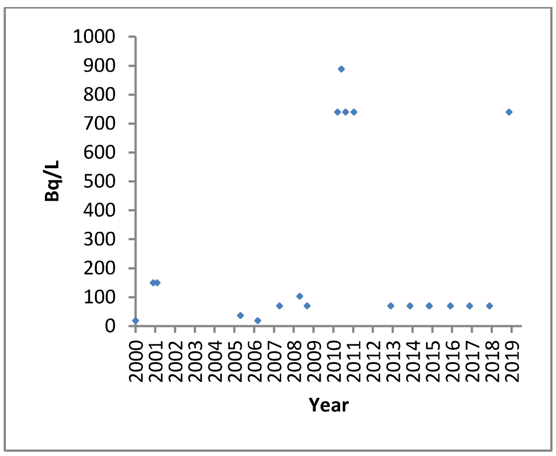
Graph 70: MW-225-12 Tritium Data



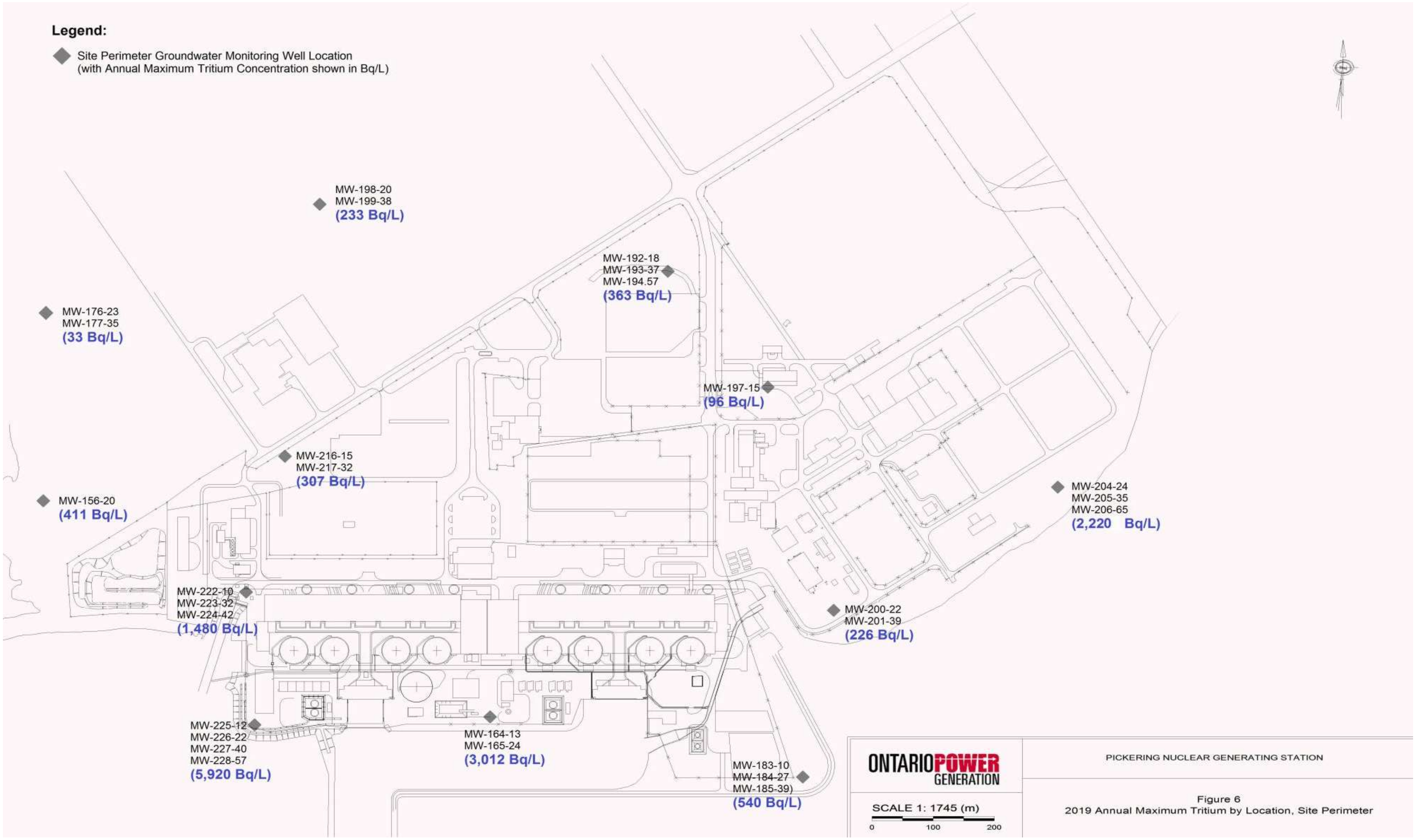
Graph 71: MW-226-22 Tritium Data



Graph 72: MW-227-40 Tritium Data



Graph 73: MW-228-57 Tritium Data


Legend:
Site Perimeter Groundwater Monitoring Well Location
(with Annual Maximum Tritium Concentration shown in Bq/L)
MW-198-20
MW-199-38
(233 Bq/L)
MW-192-18
MW-193-37
MW-194.57
(363 Bq/L)
MW-176-23
MW-177-35
(33 Bq/L)
MW-197-15
(96 Bq/L)
MW-216-15
MW-217-32
(307 Bq/L)
MW-204-24
MW-205-35
MW-206-65
(2,220 Bq/L)
MW-156-20
(411 Bq/L)
MW-222-10
MW-223-32
MW-224-42
(1,480 Bq/L)
MW-200-22
MW-201-39
(226 Bq/L)
MW-225-12
MW-226-22
MW-227-40
MW-228-57
(5,920 Bq/L)
MW-164-13
MW-165-24
(3,012 Bq/L)
MW-183-10
MW-184-27
MW-185-39)
(540 Bq/L)
ONTARIO POWER GENERATION
SCALE 1: 1745 (m)
0
100
200
PICKERING NUCLEAR GENERATING STATION
Figure 6
2019 Annual Maximum Tritium by Location, Site Perimeter

4.0 2019 PROGRAM QUALITY ASSURANCE/QUALITY CONTROL

The Quality Assurance and Quality Control (QA/QC) 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 International Organization for Standardization (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 Ministry of Environment, Conservation and Parks' (MECP) "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 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 2019, 35 field duplicate samples were collected. The results and calculated Relative Percentage Difference (RPD), to understand the sampling precision, are presented in Table A-9 (Appendix A). The majority of sample pairs (32 out of 35) showed a RPD below 20 percent. Two pairs exhibited RPDs slightly greater than 20 percent, while one pair of samples had an RPD of 195%. Given that 91% 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-9 (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 2019.

The PNGS groundwater monitoring program was audited in 2019 as part of OPG's nuclear oversight audit. There were no findings reported.

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 Pickering Waste Management Facility) by December 31, 2020. In 2019, OPG continued to work on the implementation of the mandatory clauses of the CSA standard. The work is progressing as planned and an update will again be provided in the 2020 report.

7.0 NOMENCLATURE OF SAMPLING LOCATIONS

Sampling Location Type	Identifier	Explanation of Nomenclature
Monitoring Well	MW-*XXX*-*YY*	*XXX* represents a unique identifier *YY* represents the depth of the monitoring well in feet
Reactor Building Foundation Drainage Groundtube	RBU*X*-GT-*Y*	*X* represents the unit associated with the groundtube *Y* represents the position (1 is northwest, 2 is southwest, 3 is southeast, 4 is northeast)
Reactor Building Foundation Drainage Sump	U*X* MK *YY*	*X* represents the unit associated with the sump *Y* is a unique identifier
Irradiated Fuel Bay Groundtube	IFBA-GT-*X*A IFBB-GT-*X*B	*X* is a unique identifier
TAB Foundation Drainage	IAD-SU-*X*-*Y*	*X* represents the unit associated with the foundation drainage *Y* represents the orientation of the drainage line (1 is north and 2 west)
TAB Inactive Drainage Sump	IAD-SU-*X*	*X* represents the unit associated with the sump

8.0 ACRONYMS

μCi/kg	Micro curie per Kilogram
Bq/L	Becquerel per Litre
BTEX	Benzene / Toluene / Ethylbenzene / Xylene
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
EMP	Environmental Monitoring Program
EPG	Emergency Power Generator
FWTPSB	Former Water Treatment Plan Settling Basin
HU	Hydrostratigraphic Unit
IAD	Inactive Drainage
IFB	Irradiated Fuel Bay
ISO	International Organization for Standardization
MDL	Method Detection Limit
MECP	Ministry of Environment, Conservation and Parks
ODWQS	Ontario Drinking Water Quality Standard
OPG	Ontario Power Generation Inc.
PHC	Petroleum Hydrocarbon
PNGS	Pickering Nuclear Generating Station
QA/QC	Quality Assurance/Quality Control
RAB	Reactor Auxiliary Bay
RB	Reactor Building
RLWMS	Radioactive Liquid Waste Management System
RPD	Relative Percentage Difference
SAP	Sampling and Analysis Plan
SRST	Spent Resin Storage Tank
TAB	Turbine Auxiliary Bay
UPP	Upgrading Plant Pickering
VB	Vacuum Building
VBRS	Vacuum Building Ramp Sump
VOC	Volatile Organic Compound
WSP	Water Supply Plant

Appendix A: Tables A-1 to A-9

Table A-1

Units 1 to 4 and Vacuum Building Areas

2019 Tritium Results

Sample Location Name	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
MW-064-21	Bq/L	--	NA	--	--
MW-157-12	Bq/L	--	5,994	--	--
MW-158-34	Bq/L	--	1,480	--	--
MW-161-48	Bq/L	106,560	106,560	85,840	96,200
MW-215-12	Bq/L	8,880	7,770	9,250	NA
MW-230-30	Bq/L	873,200	814,000	954,600	954,600
MW-234-30	Bq/L	3,355,900	3,922,000	2,249,600	2,530,800
MW-235-30	Bq/L	4,847,000	5,180,000	6,438,000	6,660,000
MW-237-30	Bq/L	3,885,000	13,801,000	7,548,000	8,806,000
MW-239-30	Bq/L	15,947,000	16,206,000	14,652,000	14,874,000
MW-240-26	Bq/L	1,480	--	--	--
MW-241-25	Bq/L	3,330	3,330	6,660	6,290
MW-242-25	Bq/L	234,210	170,200	691,900	636,400
MW-243-29	Bq/L	60,310	122,840	165,020	126,540
MW-246-30	Bq/L	2,697,300	2,504,900	2,227,400	2,608,500
MW-247-35	Bq/L	740	--	--	--
MW-251-5	Bq/L	153,180	85,840	140,970	192,030
MW-257-5	Bq/L	3,222,700	3,470,600	2,878,600	2,882,300
MW-260-25	Bq/L	991,600	1,135,900	1,435,600	3,618,600
MW-261-25	Bq/L	52,540	19,240	19,610	24,790
MW-269-20	Bq/L	4,440	5,180	3,700	5,920
MW-270-20	Bq/L	7,437,000	5,920,000	7,178,000	16,391,000
MW-273-20	Bq/L	2,812,000	276,020	666,000	447,700
MW-301-15	Bq/L	23,310	30,710	11,100	10,360
MW-302-40	Bq/L	740	--	--	--
MW-313-40	Bq/L	35,520	--	--	--
MW-315-15	Bq/L	311,540	104,710	177,230	278,240
MW-318-40	Bq/L	2,960	--	--	--
MW-320-20	Bq/L	7,030	5,243	7,770	8,880
MW-321-15	Bq/L	83,620	107,670	79,180	66,230
RBU2-GT-1	Bq/L	2,072,000	621,600	558,700	3,452,100
RBU2-GT-4	Bq/L	8,399,000	4,292,000	1,476,300	10,138,000
RBU3-GT-2	Bq/L	27,010	19,610	12,580	12,580
RBU4-GT-2	Bq/L	NA	NA	30,340	20,720
RBU4-GT-3	Bq/L	NA	NA	39,590	35,520
U1-RBFD-1	Bq/L	8,658,000	326,340	24,975,000	23,051,000
U1-RBFD-2	Bq/L	61,790,000	63,640,000	3,466,900	12,617,000
U1-RBFD-3	Bq/L	2,634,400	1,372,700	1,287,600	3,544,600
U1-RBFD-4	Bq/L	NA	1,568,800	NA	11,174,000
VB Ramp Sump	Bq/L	703,000	348,540	361,860	777,000

Notes:

-- denotes no sample required

NA denotes that results were not available because samples could not be collected

Table A-2
Unit 5 to 8 Areas
2019 Tritium Results

Sample Location Name	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
MW-102-15	Bq/L	7,400	--	--	--
MW-169-17 *	Bq/L	61,050	--	--	--
MW-170-25	Bq/L	34,780	39,220	--	--
MW-186-12	Bq/L	1,110	1,110	--	--
MW-187-15 *	Bq/L	2,220	--	--	--
MW-264-10	Bq/L	4,440	33,300	--	--
MW-265-12	Bq/L	5,920	7,400	--	--
MW-266-19	Bq/L	42,920	76,960	86,950	76,220
MW-267-17	Bq/L	18,500	38,480	59,940	107,670
MW-325-15	Bq/L	4,070	--	--	--
RBU5-GT-1	Bq/L	751,100	399,600	1,628,000	287,860
RBU5-GT-2	Bq/L	577,200	662,300	1,261,700	1,143,300
RBU5-GT-3	Bq/L	1,076,700	1,520,700	1,853,700	754,800
RBU5-GT-4	Bq/L	536,500	743,700	2,375,400	451,400
RBU6-GT-2	Bq/L	6,401,000	4,070,000	2,053,500	2,697,300
RBU6-GT-3	Bq/L	817,700	5,883,000	5,920,000	2,031,300
RBU6-GT-4	Bq/L	120,990	3,811,000	2,682,500	3,389,200
RBU7-GT-1	Bq/L	436,600	52,910	44,400	262,330
RBU7-GT-2	Bq/L	249,010	89,170	NA	87,320
RBU7-GT-3	Bq/L	183,520	34,040	NA	29,600
RBU7-GT-4	Bq/L	335,220	21,830	147,260	14,800
RBU8-GT-1	Bq/L	162,430	24,050	22,940	NA
RBU8-GT-2	Bq/L	189,070	31,820	NA	41,070
RBU8-GT-3	Bq/L	48,100	21,460	NA	10,730
RBU8-GT-4	Bq/L	85,840	23,310	15,910	NA
U5 MK 26	Bq/L	193,880	150,590	444,000	477,300
U6 MK 30	Bq/L	3,996,000	1,372,700	121,730	1,461,500
U7 MK 36	Bq/L	17,760	56,240	14,800	18,870
U8 MK 42	Bq/L	55,130	268,990	276,020	NA

Notes:
-- denotes no sample required
NA denotes that results were not available because samples could not be collected
* denotes that samples were collected to support investigative work outside of the routine program

Table A-3
Irriadiated Fuel Bays
2019 Tritium Results

Sample Location Name	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
014 IFB					
MW-056-18	Bq/L	6,660	--	6,290	--
MW-057-30	Bq/L	15,910	14,800	12,950	10,360
MW-244-18	Bq/L	146,150	--	--	--
IFBA-GT-1A	Bq/L	4,403,000	4,144,000	4,070,000	4,403,000
IFBA-GT-2A	Bq/L	216,820	NA	3,204,200	4,440,000
IFBA-GT-4A	Bq/L	31,450	17,390	28,860	20,720
IFBA-GT-5A	Bq/L	21,090	16,650	25,160	30,710
058 IFB					
MW-171-15	Bq/L	16,280	15,170	15,170	25,900
MW-172-25	Bq/L	15,170	--	7,030	--
IFBB-GT-1B	Bq/L	1,254,300	506,900	5,291,000	121,730
IFBB-GT-2B	Bq/L	3,596,400	666,000	492,100	499,500
IFBB-GT-3B	Bq/L	6,031,000	90,280	94,720	58,090
IFBB-GT-4B	Bq/L	3,096,900	NA	2,308,800	142,080
IFBB-GT-5B	Bq/L	188,700	91,760	107,300	167,240
IFBB-GT-6B	Bq/L	93,980	64,010	65,490	78,070

Notes:
-- denotes no sample required
NA denotes that results were not available because samples could not be collected

Table A-4

Upgrading Plant Pickering

2019 Tritium Results

Sample Location Name	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
MW-066-20	Bq/L	141	--	--	--
MW-075-10	Bq/L	76,590	--	--	--
MW-076-20	Bq/L	80,660	--	--	--
MW-089-10	Bq/L	62,900	--	--	--
MW-090-20	Bq/L	253,080	260,110	229,030	211,640
MW-091-35	Bq/L	20,350	--	--	--
MW-093-20	Bq/L	3,330	--	--	--
MW-096-20	Bq/L	19,980	--	--	--

Notes:

-- denotes no sample required

Table A-5
TAB Inactive Drainage
2019 Tritium Results

Sample Location Name	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
IAD-SU-1	Bq/L	14,430	12,210	8,880	13,690
IAD-SU-1-1	Bq/L	NA	NA	NA	NA
IAD-SU-1-2	Bq/L	NA	NA	NA	NA
IAD-SU-2	Bq/L	26,270	32,190	21,090	88,800
IAD-SU-2-1	Bq/L	NA	NA	NA	NA
IAD-SU-2-2	Bq/L	NA	NA	NA	NA
IAD-SU-3	Bq/L	18,130	1,457,800	1,298,700	488,400
IAD-SU-3-1	Bq/L	NA	NA	NA	NA
IAD-SU-3-2	Bq/L	NA	NA	NA	NA
IAD-SU-4	Bq/L	9,990	21,830	9,250	22,940
IAD-SU-4-1	Bq/L	NA	NA	NA	NA
IAD-SU-4-2	Bq/L	NA	NA	NA	NA
IAD-SU-5	Bq/L	3,700	2,960	1,850	2,960
IAD-SU-5-1	Bq/L	NA	NA	NA	NA
IAD-SU-5-2	Bq/L	NA	NA	NA	NA
IAD-SU-6	Bq/L	4,440	3,700	2,960	6,290
IAD-SU-6-1	Bq/L	NA	NA	NA	NA
IAD-SU-6-2	Bq/L	NA	NA	NA	NA
IAD-SU-7	Bq/L	12,580	10,360	23,310	14,430
IAD-SU-7-1	Bq/L	NA	NA	NA	NA
IAD-SU-7-2	Bq/L	NA	NA	NA	NA
IAD-SU-8	Bq/L	1,213,600	279,350	220,520	128,760
IAD-SU-8-1	Bq/L	5,975,130	4,654,600	2,861,210	NA
IAD-SU-8-2	Bq/L	NA	NA	NA	NA

Notes:
NA denotes that results were not available because samples could not be collected

Table A-6
Site Boundary Areas
2019 Tritium Results

Sample Location Name	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
MW-156-20	Bq/L	--	411	--	--
MW-164-13	Bq/L	--	3,012	--	--
MW-165-24	Bq/L	--	488	--	--
MW-176-23	Bq/L	--	33	--	--
MW-177-35	Bq/L	--	< 18.5	--	--
MW-183-10	Bq/L	--	540	--	--
MW-184-27	Bq/L	--	52	--	--
MW-185-39	Bq/L	--	< 18.5	--	--
MW-192-18	Bq/L	--	363	--	--
MW-193-37	Bq/L	--	248	--	--
MW-194-57	Bq/L	--	< 18.5	--	--
MW-197-15	Bq/L	--	96	--	--
MW-198-20	Bq/L	--	233	--	--
MW-199-38	Bq/L	--	< 18.5	--	--
MW-200-22	Bq/L	--	226	--	--
MW-201-39	Bq/L	--	< 18.5	--	--
MW-204-24	Bq/L	--	1,480	--	--
MW-205-35	Bq/L	--	2,220	--	--
MW-206-65	Bq/L	--	NA	--	--
MW-216-15	Bq/L	--	307	--	--
MW-217-32	Bq/L	--	244	--	--
MW-222-10	Bq/L	--	307	--	--
MW-223-32	Bq/L	--	562	--	--
MW-224-42	Bq/L	--	1,480	--	--
MW-225-12	Bq/L	--	1,606	--	--
MW-226-22	Bq/L	5,180	5,920	3,434	4,107
MW-227-40	Bq/L	--	< 18.5	--	--
MW-228-57	Bq/L	--	740	--	--

Notes:
-- denotes no sample required
NA denotes that results were not available because samples could not be collected

Table A-7
EPG Area
2019 Analytical Results

Sample Location Name	Parameter	Units	Quarter 3
MW-121-15	Benzene	ug/L	< 0.5
	Toluene	ug/L	< 0.5
	Ethylbenzene	ug/L	< 0.5
	M&p-xylenes	ug/L	< 0.4
	O-Xylene	ug/L	< 0.3
	PHC F1 C06-C10	ug/L	< 25
	PHC F2 C10-C16	ug/L	< 100
	PHC F3 C16-C34	ug/L	< 100
	PHC F4 C34-C50	ug/L	< 100
MW-123-15	Benzene	ug/L	< 0.5
	Toluene	ug/L	< 0.5
	Ethylbenzene	ug/L	< 0.5
	M&p-xylenes	ug/L	< 0.4
	O-Xylene	ug/L	< 0.3
	PHC F1 C06-C10	ug/L	< 25
	PHC F2 C10-C16	ug/L	< 100
	PHC F3 C16-C34	ug/L	< 100
	PHC F4 C34-C50	ug/L	< 100
MW-124-15	Benzene	ug/L	< 0.5
	Toluene	ug/L	< 0.5
	Ethylbenzene	ug/L	< 0.5
	M&p-xylenes	ug/L	< 0.4
	O-Xylene	ug/L	< 0.3
	PHC F1 C06-C10	ug/L	< 25
	PHC F2 C10-C16	ug/L	< 100
	PHC F3 C16-C34	ug/L	< 100
	PHC F4 C34-C50	ug/L	< 100
MW-125-15	Benzene	ug/L	< 0.5
	Toluene	ug/L	< 0.5
	Ethylbenzene	ug/L	< 0.5
	M&p-xylenes	ug/L	< 0.4
	O-Xylene	ug/L	< 0.3
	PHC F1 C06-C10	ug/L	< 25
	PHC F2 C10-C16	ug/L	< 100
	PHC F3 C16-C34	ug/L	< 100
	PHC F4 C34-C50	ug/L	< 100
MW-322-15	Benzene	ug/L	< 0.5
	Toluene	ug/L	< 0.5
	Ethylbenzene	ug/L	< 0.5
	M&p-xylenes	ug/L	< 0.4
	O-Xylene	ug/L	< 0.3
	PHC F1 C06-C10	ug/L	< 25
	PHC F2 C10-C16	ug/L	< 100
	PHC F3 C16-C34	ug/L	< 100
	PHC F4 C34-C50	ug/L	< 100

Table A-8
FWTPSB Area
2019 Analytical Results

Sample Location Name	Parameter	Units	Quarter 3
MW-301-15	(cis+trans)-1,3-Dichloropropene	ug/L	< 0.5
	1,1,1,2-Tetrachloroethane	ug/L	< 0.5
	1,1,1-Trichloroethane	ug/L	< 0.5
	1,1,2,2-Tetrachloroethane	ug/L	< 0.5
	1,1,2-Trichloroethane	ug/L	< 0.5
	1,1-Dichloroethane	ug/L	< 0.5
	1,1-Dichloroethene	ug/L	< 0.5
	1,2-Dichlorobenzene	ug/L	< 0.5
	1,2-Dichloroethane	ug/L	< 0.5
	1,2-Dichloropropane	ug/L	< 0.5
	1,3-Dichlorobenzene	ug/L	< 0.5
	1,4-Dichlorobenzene	ug/L	< 0.5
	Acetone	ug/L	< 30
	Benzene	ug/L	< 0.5
	Bromodichloromethane	ug/L	< 2
	Bromoform	ug/L	< 5
	Bromomethane	ug/L	< 0.5
	Carbon Tetrachloride	ug/L	< 0.2
	Chlorobenzene	ug/L	< 0.5
	Chloroform	ug/L	< 1
	Cis-1,2-Dichloroethene	ug/L	< 0.5
	Cis-1,3-Dichloropropene	ug/L	< 0.3
	Dibromochloromethane	ug/L	< 2
	dichlorodifluoromethane	ug/L	< 2
	Dichloromethane	ug/L	< 5
	Ethylbenzene	ug/L	< 0.5
	Ethylene Dibromide	ug/L	< 0.2
	M&p-xylenes	ug/L	< 0.4
	Methyl Ethyl Ketone	ug/L	< 20
	Methyl Tert Butyl Ether	ug/L	< 2
	Methyl-i-butyl Ketone	ug/L	< 20
	n-Hexane	ug/L	< 0.5
	O-Xylene	ug/L	< 0.3
	PHC F1 C06-C10	ug/L	< 25
	PHC F2 C10-C16	ug/L	< 100
	PHC F3 C16-C34	ug/L	< 100
	PHC F4 C34-C50	ug/L	< 100
	Styrene	ug/L	< 0.5
	Tetrachloroethene	ug/L	< 0.5
	Toluene	ug/L	< 0.5
	Total Xylenes	ug/L	< 0.5
	Trans-1,2-Dichloroethene	ug/L	< 0.5
	Trans-1,3-Dichloropropene	ug/L	< 0.3
	Trichloroethene	ug/L	< 0.5
	Trichlorofluoromethane	ug/L	< 5
	Vinyl Chloride	ug/L	< 0.5

Sample Location Name	Parameter	Units	Quarter 3
MW-303-20	(cis+trans)-1,3-Dichloropropene	ug/L	< 0.5
	1,1,1,2-Tetrachloroethane	ug/L	< 0.5
	1,1,1-Trichloroethane	ug/L	< 0.5
	1,1,2,2-Tetrachloroethane	ug/L	< 0.5
	1,1,2-Trichloroethane	ug/L	< 0.5
	1,1-Dichloroethane	ug/L	< 0.5
	1,1-Dichloroethene	ug/L	< 0.5
	1,2-Dichlorobenzene	ug/L	< 0.5
	1,2-Dichloroethane	ug/L	< 0.5
	1,2-Dichloropropane	ug/L	< 0.5
	1,3-Dichlorobenzene	ug/L	< 0.5
	1,4-Dichlorobenzene	ug/L	< 0.5
	Acetone	ug/L	< 30
	Benzene	ug/L	< 0.5
	Bromodichloromethane	ug/L	< 2
	Bromoform	ug/L	< 5
	Bromomethane	ug/L	< 0.5
	Carbon Tetrachloride	ug/L	< 0.2
	Chlorobenzene	ug/L	< 0.5
	Chloroform	ug/L	< 1
	Cis-1,2-Dichloroethene	ug/L	< 0.5
	Cis-1,3-Dichloropropene	ug/L	< 0.3
	Dibromochloromethane	ug/L	< 2
	dichlorodifluoromethane	ug/L	< 2
	Dichloromethane	ug/L	< 5
	Ethylbenzene	ug/L	< 0.5
	Ethylene Dibromide	ug/L	< 0.2
	M&p-xylenes	ug/L	< 0.4
	Methyl Ethyl Ketone	ug/L	< 20
	Methyl Tert Butyl Ether	ug/L	< 2
	Methyl-i-butyl Ketone	ug/L	< 20
	n-Hexane	ug/L	< 0.5
	O-Xylene	ug/L	< 0.3
	PHC F1 C06-C10	ug/L	< 25
	PHC F2 C10-C16	ug/L	< 100
	PHC F3 C16-C34	ug/L	< 100
	PHC F4 C34-C50	ug/L	< 100
	Styrene	ug/L	< 0.5
	Tetrachloroethene	ug/L	< 0.5
	Toluene	ug/L	< 0.5
	Total Xylenes	ug/L	< 0.5
	Trans-1,2-Dichloroethene	ug/L	< 0.5
	Trans-1,3-Dichloropropene	ug/L	< 0.3
	Trichloroethene	ug/L	< 0.5
	Trichlorofluoromethane	ug/L	< 5
	Vinyl Chloride	ug/L	< 0.5
MW-304-20	(cis+trans)-1,3-Dichloropropene	ug/L	< 0.5
	1,1,1,2-Tetrachloroethane	ug/L	< 0.5
	1,1,1-Trichloroethane	ug/L	< 0.5
	1,1,2,2-Tetrachloroethane	ug/L	< 0.5
	1,1,2-Trichloroethane	ug/L	< 0.5

Sample Location Name	Parameter	Units	Quarter 3
MW-304-20 (continued)	1,1-Dichloroethane	ug/L	< 0.5
	1,1-Dichloroethene	ug/L	< 0.5
	1,2-Dichlorobenzene	ug/L	< 0.5
	1,2-Dichloroethane	ug/L	< 0.5
	1,2-Dichloropropane	ug/L	< 0.5
	1,3-Dichlorobenzene	ug/L	< 0.5
	1,4-Dichlorobenzene	ug/L	< 0.5
	Acetone	ug/L	< 30
	Benzene	ug/L	< 0.5
	Bromodichloromethane	ug/L	< 2
	Bromoform	ug/L	< 5
	Bromomethane	ug/L	< 0.5
	Carbon Tetrachloride	ug/L	< 0.2
	Chlorobenzene	ug/L	< 0.5
	Chloroform	ug/L	< 1
	Cis-1,2-Dichloroethene	ug/L	< 0.5
	Cis-1,3-Dichloropropene	ug/L	< 0.3
	Dibromochloromethane	ug/L	< 2
	dichlorodifluoromethane	ug/L	< 2
	Dichloromethane	ug/L	< 5
	Ethylbenzene	ug/L	< 0.5
	Ethylene Dibromide	ug/L	< 0.2
	M&p-xylenes	ug/L	< 0.4
	Methyl Ethyl Ketone	ug/L	< 20
	Methyl Tert Butyl Ether	ug/L	< 2
	Methyl-i-butyl Ketone	ug/L	< 20
	n-Hexane	ug/L	< 0.5
	O-Xylene	ug/L	< 0.3
	PHC F1 C06-C10	ug/L	< 25
	PHC F2 C10-C16	ug/L	< 100
	PHC F3 C16-C34	ug/L	< 100
	PHC F4 C34-C50	ug/L	< 100
	Styrene	ug/L	< 0.5
	Tetrachloroethene	ug/L	< 0.5
	Toluene	ug/L	< 0.5
	Total Xylenes	ug/L	< 0.5
	Trans-1,2-Dichloroethene	ug/L	< 0.5
	Trans-1,3-Dichloropropene	ug/L	< 0.3
	Trichloroethene	ug/L	< 0.5
	Trichlorofluoromethane	ug/L	< 5
	Vinyl Chloride	ug/L	< 0.5
MW-317-20	(cis+trans)-1,3-Dichloropropene	ug/L	< 0.5
	1,1,1,2-Tetrachloroethane	ug/L	< 0.5
	1,1,1-Trichloroethane	ug/L	< 0.5
	1,1,2,2-Tetrachloroethane	ug/L	< 0.5
	1,1,2-Trichloroethane	ug/L	< 0.5
	1,1-Dichloroethane	ug/L	< 0.5
	1,1-Dichloroethene	ug/L	< 0.5
	1,2-Dichlorobenzene	ug/L	< 0.5
	1,2-Dichloroethane	ug/L	< 0.5
	1,2-Dichloropropane	ug/L	< 0.5

Sample Location Name	Parameter	Units	Quarter 3
MW-317-20 (continued)	1,3-Dichlorobenzene	ug/L	< 0.5
	1,4-Dichlorobenzene	ug/L	< 0.5
	Acetone	ug/L	< 30
	Benzene	ug/L	< 0.5
	Bromodichloromethane	ug/L	< 2
	Bromoform	ug/L	< 5
	Bromomethane	ug/L	< 0.5
	Carbon Tetrachloride	ug/L	< 0.2
	Chlorobenzene	ug/L	< 0.5
	Chloroform	ug/L	< 1
	Cis-1,2-Dichloroethene	ug/L	< 0.5
	Cis-1,3-Dichloropropene	ug/L	< 0.3
	Dibromochloromethane	ug/L	< 2
	dichlorodifluoromethane	ug/L	< 2
	Dichloromethane	ug/L	< 5
	Ethylbenzene	ug/L	< 0.5
	Ethylene Dibromide	ug/L	< 0.2
	M&p-xylenes	ug/L	< 0.4
	Methyl Ethyl Ketone	ug/L	< 2
	Methyl Tert Butyl Ether	ug/L	< 2
	Methyl-i-butyl Ketone	ug/L	< 20
	n-Hexane	ug/L	< 0.5
	O-Xylene	ug/L	< 0.3
	PHC F1 C06-C10	ug/L	< 25
	PHC F2 C10-C16	ug/L	< 100
	PHC F3 C16-C34	ug/L	< 100
	PHC F4 C34-C50	ug/L	< 100
	Styrene	ug/L	< 0.5
	Tetrachloroethene	ug/L	< 0.5
	Toluene	ug/L	< 0.5
	Total Xylenes	ug/L	< 0.5
	Trans-1,2-Dichloroethene	ug/L	< 0.5
	Trans-1,3-Dichloropropene	ug/L	< 0.3
	Trichloroethene	ug/L	< 0.5
	Trichlorofluoromethane	ug/L	< 5
	Vinyl Chloride	ug/L	< 0.5

Table A-9
Quality Control Results

Parent and Duplicate Sample	Analyte	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
MW-057-30 Field Duplicate	H3	Bq/L	14,800	13,320	13,320	11,470
MW-057-30 Regular Sample	H3	Bq/L	15,910	14,800	12,950	10,360
Relative Percentage Difference			**7%**	**11%**	**3%**	**10%**
MW-076-20 Field Duplicate	H3	Bq/L	79,180	--	--	--
MW-076-20 Regular Sample	H3	Bq/L	80,660	--	--	--
Relative Percentage Difference			**2%**	--	--	--
MW-156-20 Field Duplicate	H3	Bq/L	--	403	--	--
MW-156-20 Regular Sample	H3	Bq/L	--	411	--	--
Relative Percentage Difference			--	**2%**	--	--
MW-161-48 Field Duplicate	H3	Bq/L	114,330	108,040	75,850	95,460
MW-161-48 Regular Sample	H3	Bq/L	106,560	106,560	85,840	96,200
Relative Percentage Difference			**7%**	**1%**	**12%**	**1%**
MW-170-25 Field Duplicate	H3	Bq/L	35,520	--	--	--
MW-170-25 Regular Sample	H3	Bq/L	34,780	--	--	--
Relative Percentage Difference			**2%**	--	--	--
MW-192-18 Field Duplicate	H3	Bq/L	--	329	--	--
MW-192-18 Regular Sample	H3	Bq/L	--	363	--	--
Relative Percentage Difference			--	**10%**	--	--
MW-222-10 Field Duplicate	H3	Bq/L	--	292	--	--
MW-222-10 Regular Sample	H3	Bq/L	--	307	--	--
Relative Percentage Difference			--	**5%**	--	--
MW-242-25 Field Duplicate	H3	Bq/L	237,910	174,270	599,400	677,100
MW-242-25 Regular Sample	H3	Bq/L	234,210	170,200	691,900	636,400
Relative Percentage Difference			**2%**	**2%**	**14%**	**6%**
MW-301-15 Field Duplicate	H3	Bq/L	22,570	30,340	9,990	9,620
MW-301-15 Field Sample	H3	Bq/L	23,310	30,710	11,100	10,360
Relative Percentage Difference			**3%**	**1%**	**11%**	**7%**
IFBB-GT-1B Field Duplicate	H3	Bq/L	1,246,900	521,700	6,549,000	122,470
IFBB-GT-1B Regular Sample	H3	Bq/L	1,254,300	506,900	5,291,000	121,730
Relative Percentage Difference			**1%**	**3%**	**21%**	**1%**
VB Ramp Sump Field Duplicate	H3	Bq/L	8,140	327,820	367,040	799,200
VB Ramp Sump Regular Sample	H3	Bq/L	703,000	348,540	361,860	777,000
Relative Percentage Difference			**195%**	**6%**	**1%**	**3%**
U7 MK 36 Field Duplicate	H3	Bq/L	NA	59,200	14,430	14,430
U7 MK 36 Regular Sample	H3	Bq/L	17,760	56,240	14,800	18,870
Relative Percentage Difference			**NA**	**5%**	**3%**	**27%**

Notes:
-- denotes no sample required
NA denotes that results were not available because samples could not be collected

Table A-9
Quality Control Results

Sample Location Name	Parameter	Units	Quarter 3	Relative Percentage Difference
MW-123-15 Field Duplicate	Benzene	ug/L	< 0.5	0%
MW-123-15 Regular Sample	Benzene	ug/L	< 0.5	
MW-123-15 Field Duplicate	Ethylbenzene	ug/L	< 0.5	0%
MW-123-15 Regular Sample	Ethylbenzene	ug/L	< 0.5	
MW-123-15 Field Duplicate	M&p-xylenes	ug/L	< 0.4	0%
MW-123-15 Regular Sample	M&p-xylenes	ug/L	< 0.4	
MW-123-15 Field Duplicate	O-Xylene	ug/L	< 0.3	0%
MW-123-15 Regular Sample	O-Xylene	ug/L	< 0.3	
MW-123-15 Field Duplicate	PHC F1 C06-C10	ug/L	< 25	0%
MW-123-15 Regular Sample	PHC F1 C06-C10	ug/L	< 25	
MW-123-15 Field Duplicate	PHC F2 C10-C16	ug/L	< 100	0%
MW-123-15 Regular Sample	PHC F2 C10-C16	ug/L	< 100	
MW-123-15 Field Duplicate	PHC F3 C16-C34	ug/L	< 100	0%
MW-123-15 Regular Sample	PHC F3 C16-C34	ug/L	< 100	
MW-123-15 Field Duplicate	PHC F4 C34-C50	ug/L	< 100	0%
MW-123-15 Regular Sample	PHC F4 C34-C50	ug/L	< 100	
MW-123-15 Field Duplicate	Toluene	ug/L	< 0.5	0%
MW-123-15 Regular Sample	Toluene	ug/L	< 0.5	
MW-301-15 Field Duplicate	(cis+trans)-1,3-Dichloropropene	ug/L	< 0.5	0%
MW-301-15 Regular Sample	(cis+trans)-1,3-Dichloropropene	ug/L	< 0.5	
MW-301-15 Field Duplicate	1,1,1,2-Tetrachloroethane	ug/L	< 0.5	0%
MW-301-15 Regular Sample	1,1,1,2-Tetrachloroethane	ug/L	< 0.5	
MW-301-15 Field Duplicate	1,1,1-Trichloroethane	ug/L	< 0.5	0%
MW-301-15 Regular Sample	1,1,1-Trichloroethane	ug/L	< 0.5	
MW-301-15 Field Duplicate	1,1,2,2-Tetrachloroethane	ug/L	< 0.5	0%
MW-301-15 Regular Sample	1,1,2,2-Tetrachloroethane	ug/L	< 0.5	
MW-301-15 Field Duplicate	1,1,2-Trichloroethane	ug/L	< 0.5	0%
MW-301-15 Regular Sample	1,1,2-Trichloroethane	ug/L	< 0.5	
MW-301-15 Field Duplicate	1,1-Dichloroethane	ug/L	< 0.5	0%
MW-301-15 Regular Sample	1,1-Dichloroethane	ug/L	< 0.5	
MW-301-15 Field Duplicate	1,1-Dichloroethene	ug/L	< 0.5	0%
MW-301-15 Regular Sample	1,1-Dichloroethene	ug/L	< 0.5	
MW-301-15 Field Duplicate	1,2-Dichlorobenzene	ug/L	< 0.5	0%
MW-301-15 Regular Sample	1,2-Dichlorobenzene	ug/L	< 0.5	
MW-301-15 Field Duplicate	1,2-Dichloroethane	ug/L	< 0.5	0%
MW-301-15 Regular Sample	1,2-Dichloroethane	ug/L	< 0.5	
MW-301-15 Field Duplicate	1,2-Dichloropropane	ug/L	< 0.5	0%
MW-301-15 Regular Sample	1,2-Dichloropropane	ug/L	< 0.5	
MW-301-15 Field Duplicate	1,3-Dichlorobenzene	ug/L	< 0.5	0%
MW-301-15 Regular Sample	1,3-Dichlorobenzene	ug/L	< 0.5	
MW-301-15 Field Duplicate	1,4-Dichlorobenzene	ug/L	< 0.5	0%
MW-301-15 Regular Sample	1,4-Dichlorobenzene	ug/L	< 0.5	
MW-301-15 Field Duplicate	Acetone	ug/L	< 30	0%
MW-301-15 Regular Sample	Acetone	ug/L	< 30	
MW-301-15 Field Duplicate	Benzene	ug/L	< 0.5	0%
MW-301-15 Regular Sample	Benzene	ug/L	< 0.5	
MW-301-15 Field Duplicate	Bromodichloromethane	ug/L	< 2	0%
MW-301-15 Regular Sample	Bromodichloromethane	ug/L	< 2	

Sample Location Name	Parameter	Units	Quarter 3	Relative Percentage Difference
MW-301-15 Field Duplicate	Bromoform	ug/L	< 5	0%
MW-301-15 Regular Sample	Bromoform	ug/L	< 5	
MW-301-15 Field Duplicate	Bromomethane	ug/L	< 0.5	0%
MW-301-15 Regular Sample	Bromomethane	ug/L	< 0.5	
MW-301-15 Field Duplicate	Carbon Tetrachloride	ug/L	< 0.2	0%
MW-301-15 Regular Sample	Carbon Tetrachloride	ug/L	< 0.2	
MW-301-15 Field Duplicate	Chlorobenzene	ug/L	< 0.5	0%
MW-301-15 Regular Sample	Chlorobenzene	ug/L	< 0.5	
MW-301-15 Field Duplicate	Chloroform	ug/L	< 1	0%
MW-301-15 Regular Sample	Chloroform	ug/L	< 1	
MW-301-15 Field Duplicate	Cis-1,2-Dichloroethene	ug/L	< 0.5	0%
MW-301-15 Regular Sample	Cis-1,2-Dichloroethene	ug/L	< 0.5	
MW-301-15 Field Duplicate	Cis-1,3-Dichloropropene	ug/L	< 0.3	0%
MW-301-15 Regular Sample	Cis-1,3-Dichloropropene	ug/L	< 0.3	
MW-301-15 Field Duplicate	Dibromochloromethane	ug/L	< 2	0%
MW-301-15 Regular Sample	Dibromochloromethane	ug/L	< 2	
MW-301-15 Field Duplicate	dichlorodifluoromethane	ug/L	< 2	0%
MW-301-15 Regular Sample	dichlorodifluoromethane	ug/L	< 2	
MW-301-15 Field Duplicate	Dichloromethane	ug/L	< 5	0%
MW-301-15 Regular Sample	Dichloromethane	ug/L	< 5	
MW-301-15 Field Duplicate	Ethylbenzene	ug/L	< 0.5	0%
MW-301-15 Regular Sample	Ethylbenzene	ug/L	< 0.5	
MW-301-15 Field Duplicate	Ethylene Dibromide	ug/L	< 0.2	0%
MW-301-15 Regular Sample	Ethylene Dibromide	ug/L	< 0.2	
MW-301-15 Field Duplicate	M&p-xylenes	ug/L	< 0.4	0%
MW-301-15 Regular Sample	M&p-xylenes	ug/L	< 0.4	
MW-301-15 Field Duplicate	Methyl Ethyl Ketone	ug/L	< 20	0%
MW-301-15 Regular Sample	Methyl Ethyl Ketone	ug/L	< 20	
MW-301-15 Field Duplicate	Methyl Tert Butyl Ether	ug/L	< 2	0%
MW-301-15 Regular Sample	Methyl Tert Butyl Ether	ug/L	< 2	
MW-301-15 Field Duplicate	Methyl-i-butyl Ketone	ug/L	< 20	0%
MW-301-15 Regular Sample	Methyl-i-butyl Ketone	ug/L	< 20	
MW-301-15 Field Duplicate	n-Hexane	ug/L	< 0.5	0%
MW-301-15 Regular Sample	n-Hexane	ug/L	< 0.5	
MW-301-15 Field Duplicate	O-Xylene	ug/L	< 0.3	0%
MW-301-15 Regular Sample	O-Xylene	ug/L	< 0.3	
MW-301-15 Field Duplicate	PHC F1 C06-C10	ug/L	< 25	0%
MW-301-15 Regular Sample	PHC F1 C06-C10	ug/L	< 25	
MW-301-15 Field Duplicate	PHC F2 C10-C16	ug/L	< 100	0%
MW-301-15 Regular Sample	PHC F2 C10-C16	ug/L	< 100	
MW-301-15 Field Duplicate	PHC F3 C16-C34	ug/L	< 100	0%
MW-301-15 Regular Sample	PHC F3 C16-C34	ug/L	< 100	
MW-301-15 Field Duplicate	PHC F4 C34-C50	ug/L	< 100	0%
MW-301-15 Regular Sample	PHC F4 C34-C50	ug/L	< 100	
MW-301-15 Field Duplicate	Styrene	ug/L	< 0.5	0%
MW-301-15 Regular Sample	Styrene	ug/L	< 0.5	
MW-301-15 Field Duplicate	Tetrachloroethene	ug/L	< 0.5	0%
MW-301-15 Regular Sample	Tetrachloroethene	ug/L	< 0.5	
MW-301-15 Field Duplicate	Toluene	ug/L	< 0.5	0%
MW-301-15 Regular Sample	Toluene	ug/L	< 0.5	
MW-301-15 Field Duplicate	Total Xylenes	ug/L	< 0.5	0%
MW-301-15 Regular Sample	Total Xylenes	ug/L	< 0.5	
MW-301-15 Field Duplicate	Trans-1,2-Dichloroethene	ug/L	< 0.5	0%
MW-301-15 Regular Sample	Trans-1,2-Dichloroethene	ug/L	< 0.5	

Sample Location Name	Parameter	Units	Quarter 3	Relative Percentage Difference
MW-301-15 Field Duplicate	Trans-1,3-Dichloropropene	ug/L	< 0.3	0%
MW-301-15 Regular Sample	Trans-1,3-Dichloropropene	ug/L	< 0.3	
MW-301-15 Field Duplicate	Trichloroethene	ug/L	< 0.5	0%
MW-301-15 Regular Sample	Trichloroethene	ug/L	< 0.5	
MW-301-15 Field Duplicate	Trichlorofluoromethane	ug/L	< 5	0%
MW-301-15 Regular Sample	Trichlorofluoromethane	ug/L	< 5	
MW-301-15 Field Duplicate	Vinyl Chloride	ug/L	< 0.5	0%
MW-301-15 Regular Sample	Vinyl Chloride	ug/L	< 0.5	

Table A-9

Quality Control Results

Name	Reading Name	Units	Quarter 3
MW-125-15 Field Blank	Benzene	ug/L	< 0.5
	Ethylbenzene	ug/L	< 0.5
	M&p-xylenes	ug/L	< 0.4
	O-Xylene	ug/L	< 0.3
	PHC F1 C06-C10	ug/L	< 25
	Toluene	ug/L	< 0.5
MW-301-15 Trip Blank	Cis-1,2-Dichloroethene	ug/L	< 0.5
	Cis-1,3-Dichloropropene	ug/L	< 0.3
	Dibromochloromethane	ug/L	< 2
	dichlorodifluoromethane	ug/L	< 2
	Dichloromethane	ug/L	< 5
	Ethylbenzene	ug/L	< 0.5
	Ethylene Dibromide	ug/L	< 0.2
	M&p-xylenes	ug/L	< 0.4
	Methyl Ethyl Ketone	ug/L	< 20
	Methyl Tert Butyl Ether	ug/L	< 2
	Methyl-i-butyl Ketone	ug/L	< 20
	n-Hexane	ug/L	< 0.5
	O-Xylene	ug/L	< 0.3
	Styrene	ug/L	< 0.5
	Tetrachloroethene	ug/L	< 0.5
	Toluene	ug/L	< 0.5
	Total Xylenes	ug/L	< 0.5
	Trans-1,2-Dichloroethene	ug/L	< 0.5
	Trans-1,3-Dichloropropene	ug/L	< 0.3
	Trichloroethene	ug/L	< 0.5
	Trichlorofluoromethane	ug/L	< 5
	Vinyl Chloride	ug/L	< 0.5
	(cis+trans)-1,3-Dichloropropene	ug/L	< 0.5
	1,1,1,2-Tetrachloroethane	ug/L	< 0.5
	1,1,1-Trichloroethane	ug/L	< 0.5
	1,1,2,2-Tetrachloroethane	ug/L	< 0.5
	1,1,2-Trichloroethane	ug/L	< 0.5
	1,1-Dichloroethane	ug/L	< 0.5
	1,1-Dichloroethene	ug/L	< 0.5
	1,2-Dichlorobenzene	ug/L	< 0.5
	1,2-Dichloroethane	ug/L	< 0.5
	1,2-Dichloropropane	ug/L	< 0.5
	1,3-Dichlorobenzene	ug/L	< 0.5
	1,4-Dichlorobenzene	ug/L	< 0.5
	Acetone	ug/L	< 30
	Benzene	ug/L	< 0.5
	Bromodichloromethane	ug/L	< 2
	Bromoform	ug/L	< 5
	Bromomethane	ug/L	< 0.5
	Carbon Tetrachloride	ug/L	< 0.2
	Chlorobenzene	ug/L	< 0.5
	Chloroform	ug/L	< 1