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Title:

**2021 PICKERING NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS**

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**2021 Pickering Nuclear Groundwater  
Monitoring Program Results****P-REP-10120-10048**

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Prepared By: Neera Sundaralingam,  
M.Env.Sc., G.I.T.  
Ecometrix Incorporated.

Reviewed By: Vinroy Thorpe  
Assistant Environmental Advisor  
Environment Programs - Nuclear

Reviewed By: Elizabeth Haack, Ph.D., P.Chem.  
Ecometrix Incorporated.

Reviewed By: Vanessa Tang  
Section Manager, Environment  
Operations Support, Pickering

Reviewed By: Steve Livingstone, M.Sc., P.Geo  
Ecometrix Incorporated.

Reviewed By: Kristina Brama  
Senior Manager, Environment,  
Health and Safety - Nuclear

Approved By: Craig Axler  
Director, Environment Health and  
Safety - Nuclear

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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 three primary objectives:

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

The findings in 2021 with respect to the above objectives are:

- Objective 1:
  - The groundwater data collected from the SSCs indicate stable tritium concentration consistent with results for previous years. An emerging issue was identified at the western Unit 5 to 8 irradiated fuel bays (IFBs), which is likely a result of groundwater moving from Unit 6, beneath the IFB-B area and ultimately towards the TAB IAD sumps.
  - In 2021, thicknesses of free-phase hydrocarbon product in select wells were measured, and hydrocarbon concentrations in groundwater were measured in one well (MW-287-15). The 2021 results for PHC product thickness and hydrocarbons in groundwater in these areas were consistent with monitoring results in recent years.
- Objective 2: Tritium concentrations within the site boundary wells and shoreline wells are stable and are within historical ranges. Off-site impacts to groundwater are not observed.
- Objective 3: The predominant groundwater flow patterns remain unchanged in 2021 from the recent years' interpretations.

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## 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 following three primary objectives are addressed by specific objectives detailed in the N288.7-compliant PNGS Groundwater Protection Plan (GWPP) and Groundwater Monitoring Program (GWMP) (Ecometrix, 2020a):

- Monitor changes to on-site groundwater quality to ensure timely detection of inadvertent releases to groundwater; which include Objectives 1 to 4 of the PNGS groundwater monitoring program (GWMP) (Ecometrix, 2020a):
  - PNGS GWMP Objective 1: Tritium concentrations in groundwater near SSCs.
  - PNGW GWMP Objective 2: Dissolved iron concentrations in groundwater at East and West Landfills. Will be addressed in the 2022 groundwater monitoring program due to biennial sampling.
  - PNGW GWMP Objective 3: Petroleum hydrocarbon (PHC) concentrations in groundwater at Units 1 to 4 Standby Generators (SGs), Units 5 to 8 SGs, Emergency Power Generators (EPG), and EPG3. Only Units 1 to 4 SGs are addressed in the 2021 groundwater monitoring program. The remaining locations are addressed in the 2022 groundwater monitoring program due to biennial sampling.
  - PNGW GWMP Objective 4: PHC concentrations in groundwater at Fukushima Diesel Generators and Standby Boiler will be addressed in the 2022 groundwater monitoring program due to biennial sampling.
- Ensure there are no adverse off-site impacts from PNGS groundwater, as described by Objective 5 of the PNGS GWMP:
  - Tritium concentrations in groundwater in Perimeter Wells - monitor tritium in site perimeter wells to establish tritium concentrations at the PNGS site boundaries and to confirm no adverse off-site impacts.
- Confirm predominant on-site groundwater flow characteristics at the PNGS site, as described by Objective 6 of the PNGS GWMP:
  - Hydraulic Head Measurements - provide head measurements in selected monitoring wells to confirm the groundwater flow conditions and to support interpretation of constituent migration in groundwater.

The groundwater sampling and monitoring program conducted in 2021 followed the Sampling and Analysis Plan (SAP) for 2021 (OPG, 2020). This report presents groundwater data collected at PNGS for the period from January 1<sup>st</sup> to December 31<sup>st</sup>, 2021.

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## 1.1 Summary of Hydrogeological Characteristics at the PNGS

Eight hydrostratigraphic units (HUs) have been identified beneath PNGS through historical assessments. Of the eight HUs, four main groundwater flow systems have been identified for the site:

- Shallow/Water Table (HU 1-3);
- Intermediate Overburden (HU6);
- Deep Overburden (HU7); and
- Deep Bedrock (HU8).

Hydrostratigraphic units 4 and 5 are not always observed, and where they are observed, are generally thin and are grouped into the shallow groundwater system. The shallow groundwater system is an aquifer, and the intermediate overburden and bedrock groundwater flow systems are considered to be aquitards. The deep overburden groundwater system may represent an aquifer. Groundwater migration into this HU from overlying HUs is considered to be limited due to the low permeability of the till materials in HU 6.

## 2.0 2021 PROGRAM DESIGN

The groundwater monitoring program design is detailed in the PNGS GWPP and GWMP (Ecometrix, 2020a). The N288.7-compliant 2021 SAP was developed to meet the relevant components of the objectives listed above.

Sample results of the groundwater quality monitoring are provided in Appendix A.

### 2.1 Objective 1 Methodology

#### 2.1.1 Tritium Concentrations in Groundwater Near SSCs

In 2021, as per the SAP, groundwater samples were collected from locations, including monitoring wells, foundation drains, sumps and groundtubes (125 sampling locations in total). Figure 1 shows these locations. Most of the locations sampled are near the operating reactors. Refer to Section 6.0 of this report for details on the sampling naming/location nomenclature used in the groundwater program.

The 2021 SAP specified the sampling locations and the frequency of sampling tritium concentrations in groundwater at each location (e.g., quarterly, annually).

Groundwater samples were collected from the following key areas in 2021:

- Unit 1 to 4 Reactor Buildings (RBs);
- Unit 5 to 8 RBs;

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- Irradiated Fuel Bays (IFBs) for Unit 1 to 4 and Unit 5 to 8; and
- Upgrading Plant Pickering (UPP).

Water levels were collected prior to collection of samples for analysis of tritium concentrations by qualified OPG chemical technicians. Following measurement of the water level and prior to sample collection, each monitoring well was purged to remove standing water, ensuring that representative groundwater flowed into the well. Collected samples were analyzed for tritium concentrations by the OPG PNGS Chemistry Laboratory.

The groundwater data generated from the sampling program was subsequently analyzed to either support previous conclusions, identify trends, reflect improvements or demonstrate no significant change. Sample results of groundwater tritium concentrations for Objective 1 are presented in Appendix A (Table A-1, Table A-2, Table A-3 and Table A-4).

### 2.1.2 PHC concentrations in groundwater at Units 1 to 4 SGs, Units 5 to 8 SGs, EPG and EPG3

A monitored natural attenuation program (MNA) was implemented in area of the Units 1- 4 Standby Generators (U1-4SGs), Units 5-8 SGs (U5-8 SGs) and U1-4 overflow tank area in 2011 following remedial activities. MNA programs are long-term because hydrocarbon degradation occurs through natural microbial processes. Groundwater monitoring results in these three areas have previously been reported under separate cover. The MNA program in these areas was incorporated into the GWMP developed for the site in 2019. The SG-A area is monitored annually and is discussed further in this report. The other two areas (SG-B and SG-A overflow tank area) are monitored biennially and will be discussed in 2022

In 2021, as per the SAP and the GWMP (Ecometrix, 2020a), six groundwater wells were monitored quarterly (Q1-Q4) for water levels and petroleum hydrocarbon free-phase product thickness near the U1–4 SGs. If free-phase product was present in the wells, thickness of the product and depth to water were the only measurements taken. If free-phase product was not present, groundwater samples were collected for analysis of PHCs including benzene, toluene, ethylbenzene and xylenes (BTEX), PHC Fractions 1-4 (PHC F1 to PHC F4), and dissolved iron. Figure 2 shows the locations of the six wells that were monitored in 2021.

Groundwater was sampled using low-flow methodology. Free-phase product was not measurable in Q2 and Q4 for MW-287-15; this well was thus sampled for PHC F1-F4, BTEX and dissolved iron. Samples analyzed for PHC F1 to F4, BTEX and dissolved iron were submitted to Bureau Veritas, a laboratory accredited to ISO/IEC 17025. Conventional sample results of Objective 1 are presented in Appendix A (Table A-5a and Table A-5b).

## 2.2 Objective 2 Methodology

The 2021 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. Boundary wells are located across the entire site in directions upgradient or cross-gradient to the SSCs and provide spatial information on background groundwater quality conditions. Figure 3 shows the

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locations of the site perimeter wells. Sample results of Objective 2 are presented in Appendix A (Table A-6)

The methodology for groundwater collection, analysis and data evaluation in the perimeter wells was the same as what is described above for Objective 1.

## 2.3 Objective 3 Methodology

Groundwater flow interpretations for PNGS were first established in 2002. On an annual basis, the GWMP requires that a set of water levels be collected from specific groundwater monitoring wells at the site over a short period of time (days). The intent of the program is to verify that groundwater flow conditions, which are the basis for interpreting the migration of constituents in groundwater, have not changed and that OPG continues to have a sound understanding of groundwater flow patterns at the site. In Q4, water level readings were collected from monitoring well locations across the site over a period of 6 days. The data was subsequently used to calculate the groundwater elevation at each monitoring well and generate water elevation contours, from which groundwater flow directions are inferred.

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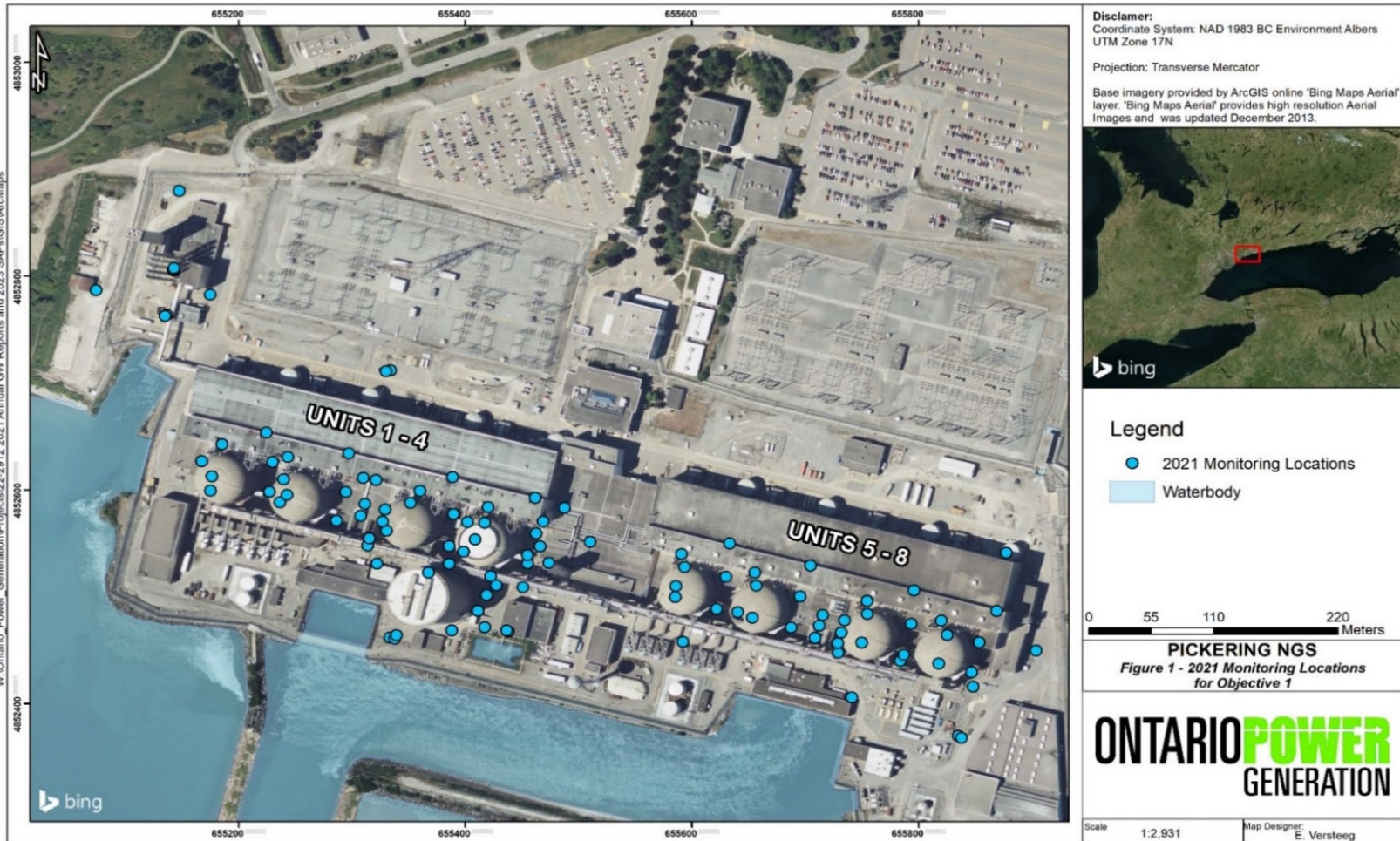


Figure 1: 2021 Monitoring Locations for Objective 1

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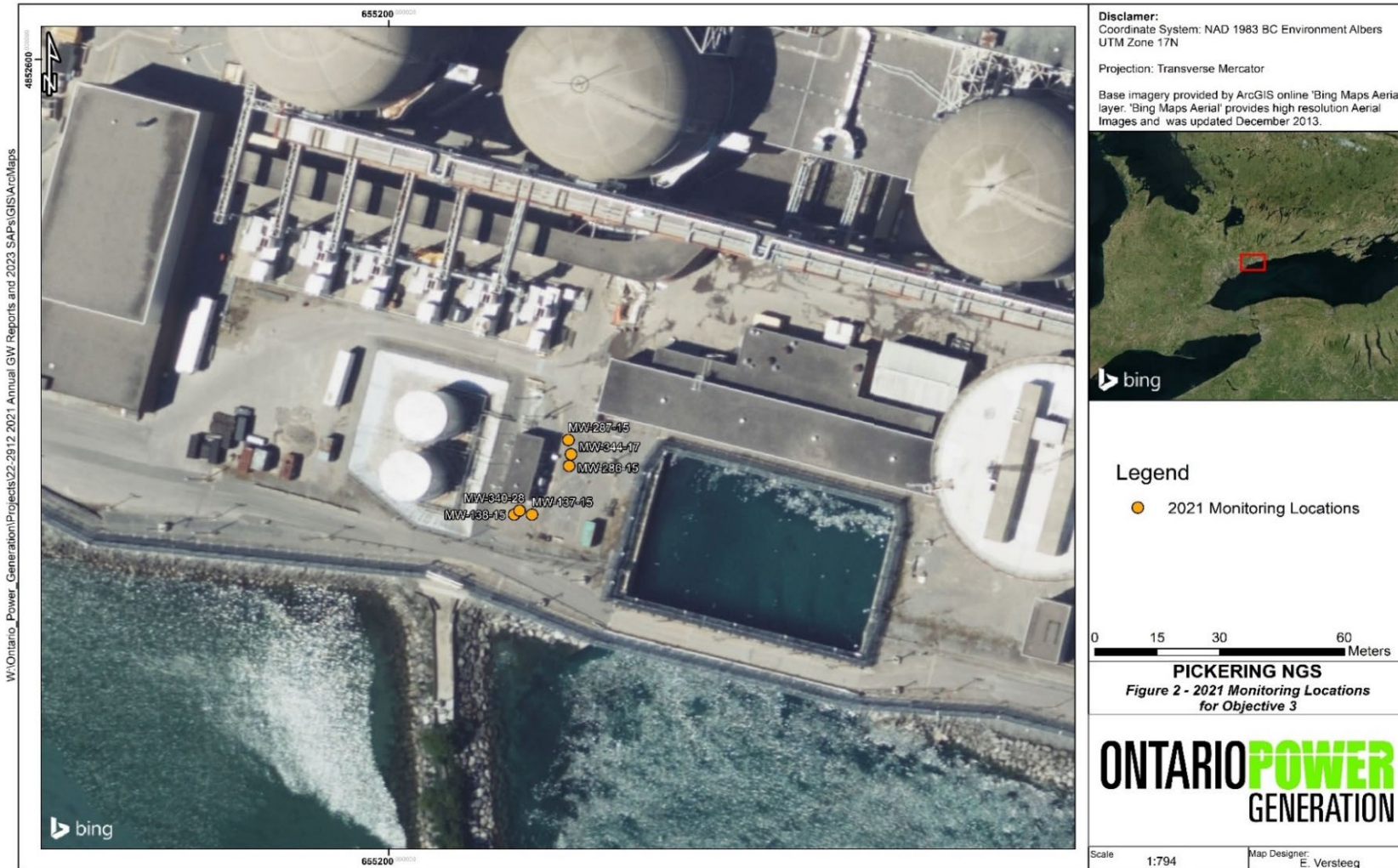


Figure 2: 2021 Monitoring Locations for Objective 1

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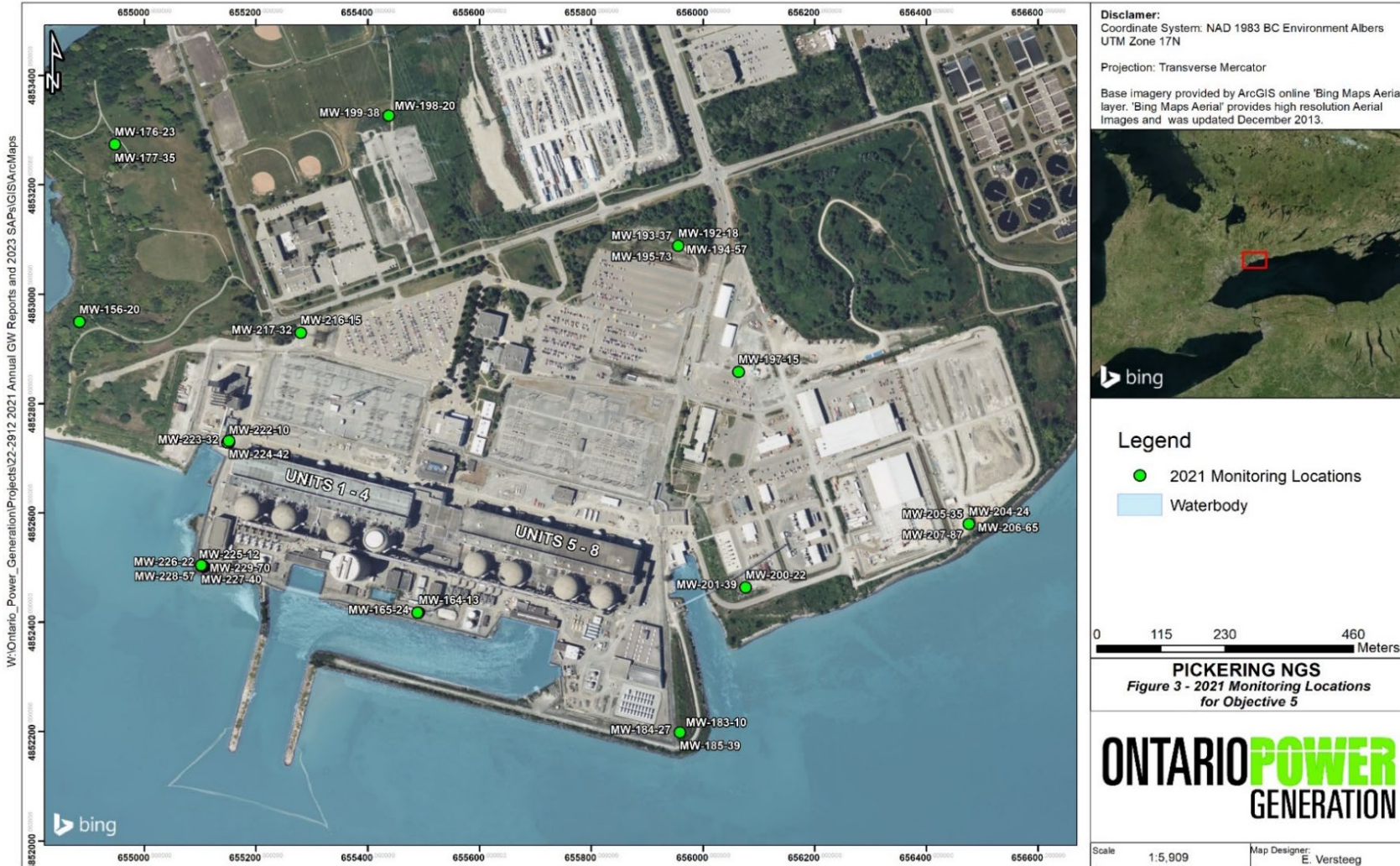


Figure 3: 2021 Monitoring Locations for Objective 2

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**3.0 2021 PROGRAM RESULTS**

**3.1 Objective 1 Results – Tritium Concentrations in Groundwater Near SSCs**

In 2021, the groundwater data collected from the areas surrounding SSCs at PNGS indicate that tritium concentrations in groundwater have remained, overall, constant over time, which confirms stable environmental performance. An emerging issue was noted in the Units 5 to 8 Irradiated Fuel Bay (IFB-B) area in 2021. This is attributed to the movement of tritium in groundwater on the east side of Unit 6. Investigations are ongoing and groundwater monitoring shall continue in this area. Further discussion is provided in the sections below.

**3.1.1 Unit 1 to 4 Reactor Building Area Overview**

In 2020, a heavy water leak was identified in the Unit 1 Heat Transport purification room. Corrective actions have been completed and tritium concentrations in groundwater in the vicinity of the leak has shown a decline during the 2021 monitoring program. Further details are provided below in Section 3.1.1.1.

The 2021 groundwater sampling results within the area of Units 1 to 4 are presented in Table A-1 (Appendix A). Figure 4 to Figure 6 display the distributions of maximum annual tritium concentrations within the vicinity of the Unit 1 to 4 area and Units 1 to 4 IFBs in HU 1-3, HU 6 and HU 7.

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





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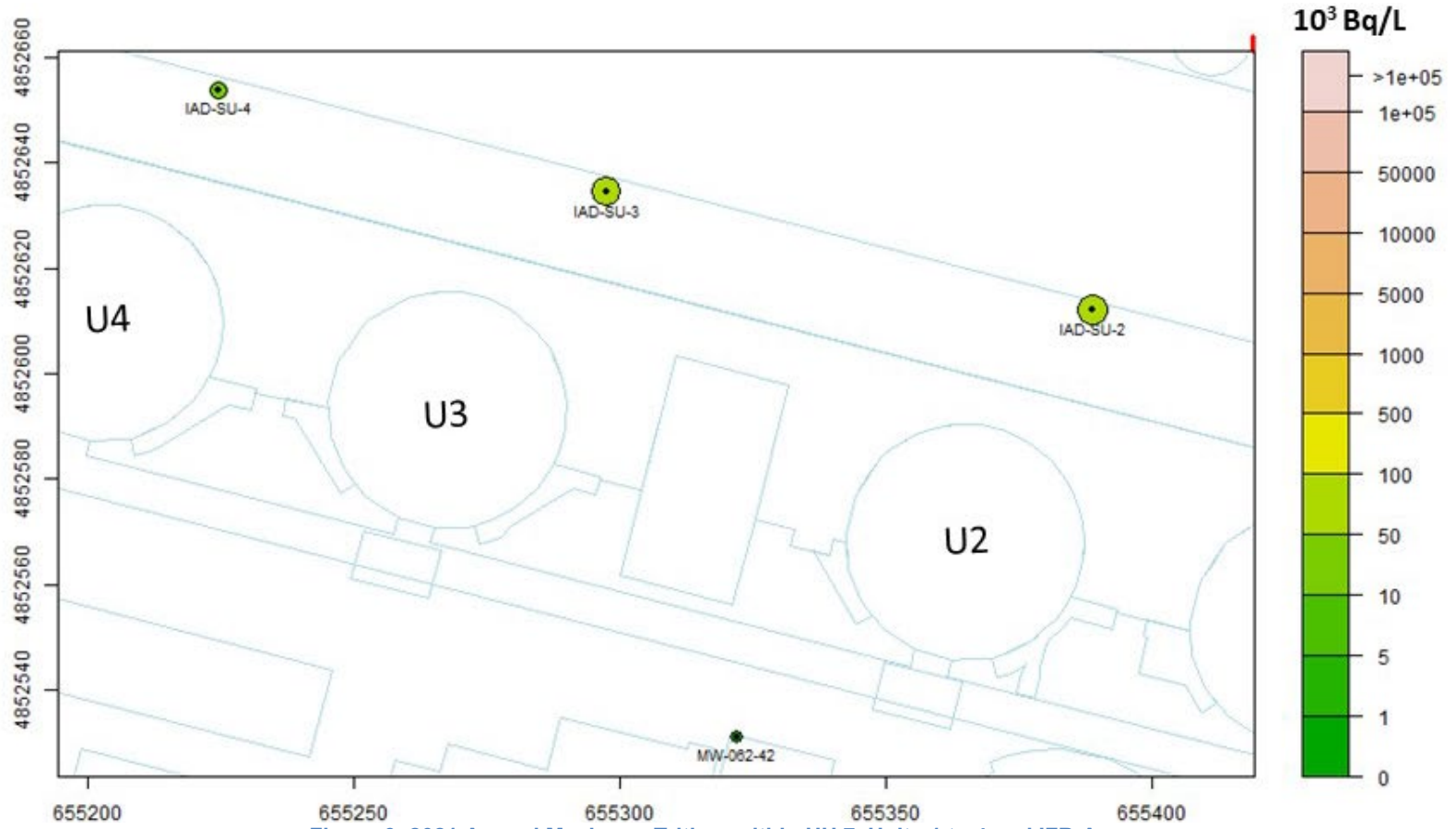


Figure 6: 2021 Annual Maximum Tritium within HU 7, Units 1 to 4 and IFB-A

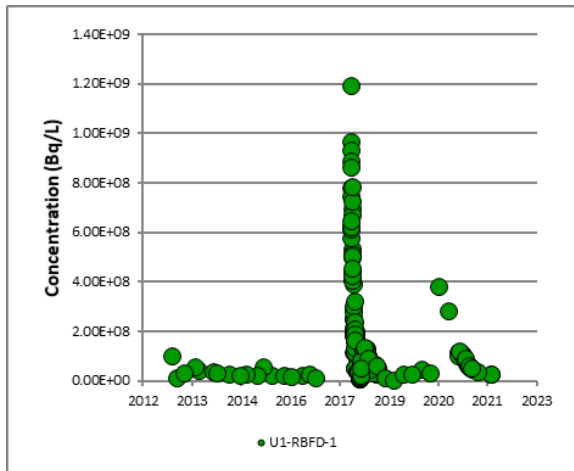
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3.1.1.1 Unit 1 and 2 Area

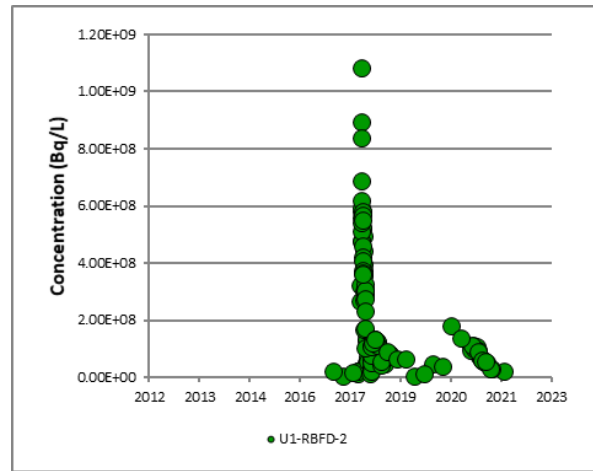
Tritium concentrations within groundtubes (U1-RBFD-1 to U1-RBFD-3), monitoring wells towards the south-southeast (MW-261-25, MW-270-20, MW-273-20, MW-313-40, MW-315-15, MW-320-20 and MW-313-40) and the Vacuum Building ramp sump (VBRS) increased during Q4 of 2020 and early-to-mid 2021. These concentrations then decreased in subsequent quarterly sampling events at these locations, indicating that the repairs were successful. The tritiated plume in groundwater in this area migrated primarily south towards the VBRS, located east of the Vacuum Building (VB), which acts as a hydraulic sink and collects a portion of groundwater in the Unit 1 and 2 area (Ecometrix, 2020b). The tritium plume within shallow groundwater that is associated with the leak is shown in Figure 4.

Tritium concentrations fluctuated at a groundwater monitoring well located to the northeast of Unit 1 (MW-234-30) in 2021, but remained within historical ranges. Groundwater in the area of Unit 1 is also known to migrate north towards the actively pumped TAB foundation drains and west towards Units 1-4 IFBs (Ecometrix, 2020b). Groundwater monitoring at this area will be continued.

Graphs 1 to 11 display tritium concentrations over time at groundtubes and select monitoring wells mentioned above, and the VBRS.



Graph 1: U1-RBFD-1 Tritium Data

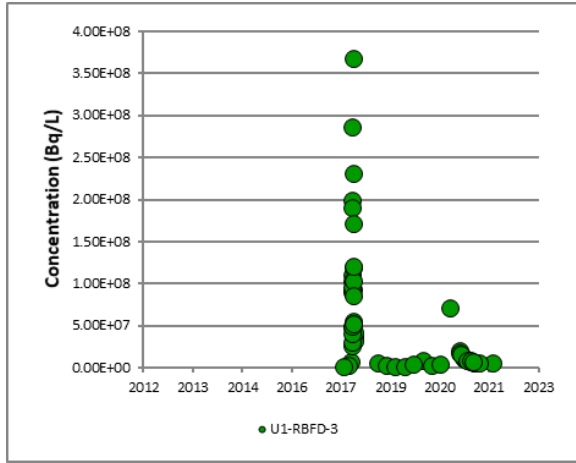


Graph 2: U1-RBFD-2 Tritium Data

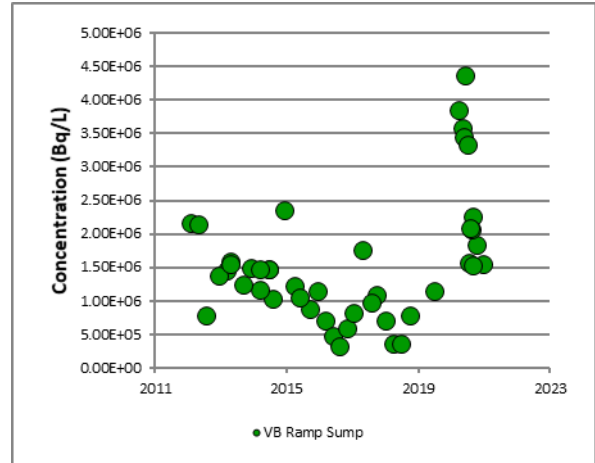
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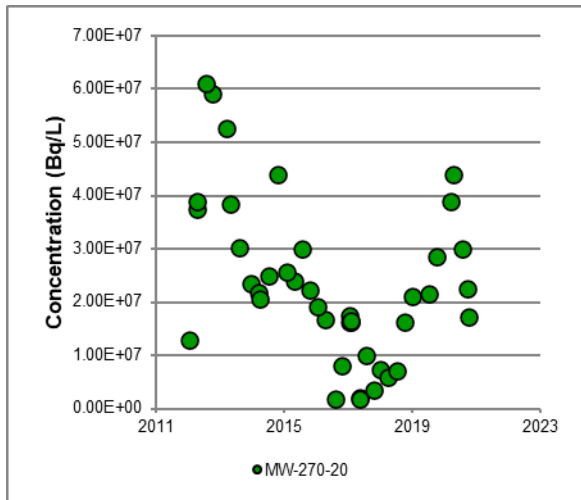
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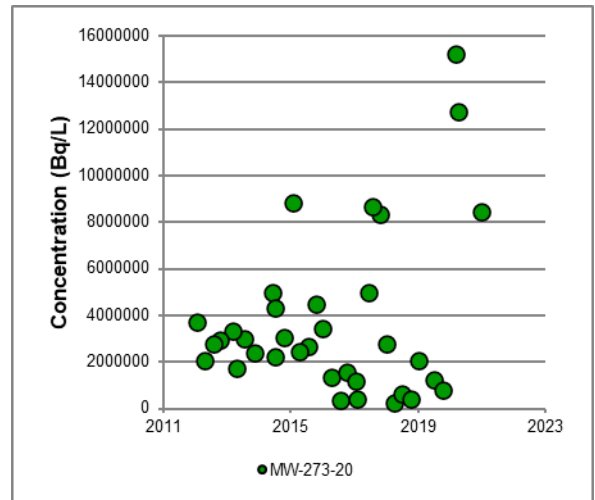
Graph 3: U1-RBFD-3 Tritium Data



Graph 4: VBRS Tritium Data



Graph 5: MW-270-20 Tritium Data

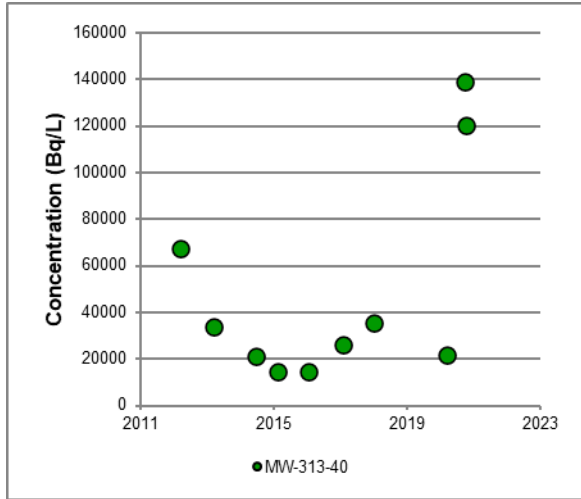


Graph 6: MW-273-20 Tritium Data

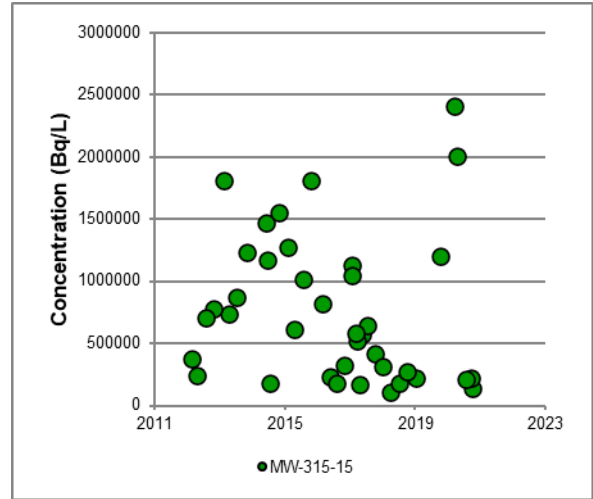
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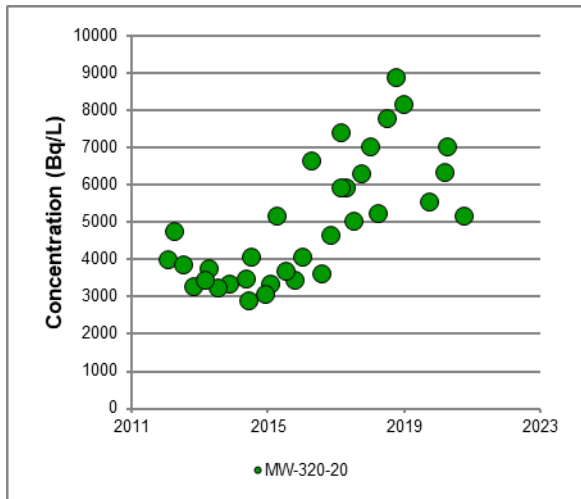
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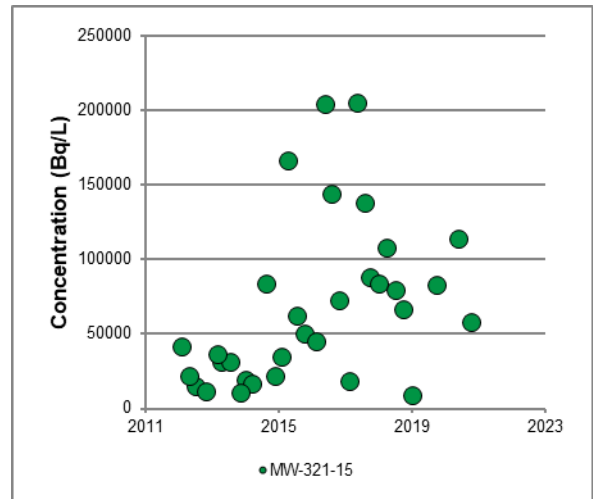
**Graph 7: MW-313-40 Tritium Data**



**Graph 8: MW-315-15 Tritium Data**



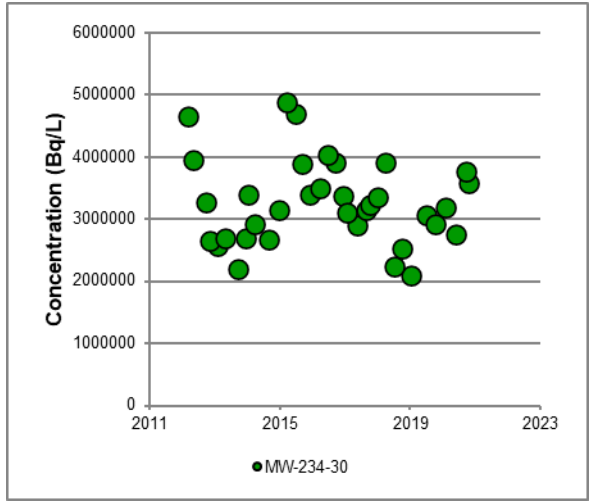
**Graph 9: MW-320-20 Tritium Data**



**Graph 10: MW-321-15 Tritium Data**

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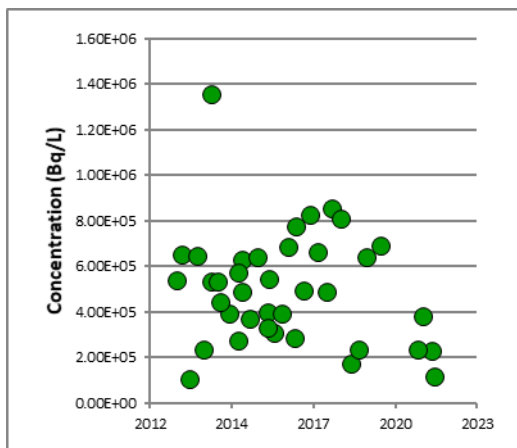


Graph 11: MW-234-30 Tritium Data

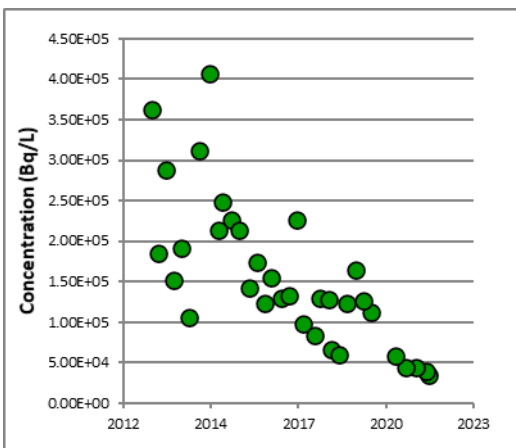
3.1.1.2 Unit 3 and 4 Area

In the Unit 3 and 4 area, tritium concentrations measured in RB groundtubes, as well as in the monitoring wells located within the Reactor Auxiliary Bay (RAB), were stable or decreasing in 2021. Tritium concentration at downgradient monitoring well MW-243-29 located in the RAB, continues to decline.

Graphs 12 to 13 illustrate the results for selected monitoring wells within the vicinity of Unit 3 and Unit 4.



Graph 12: MW-242-25 Tritium Data



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## 3.1.2 Unit 5 to 8 Reactor Building Area Overview

The 2021 groundwater sampling results are presented in Table A-2 (Appendix A). Distributions of the annual maximum tritium concentrations in the area of Units 5 to 8 within HU1-3, HU 6 and HU 7 are presented in Figure 7 to Figure 9.

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

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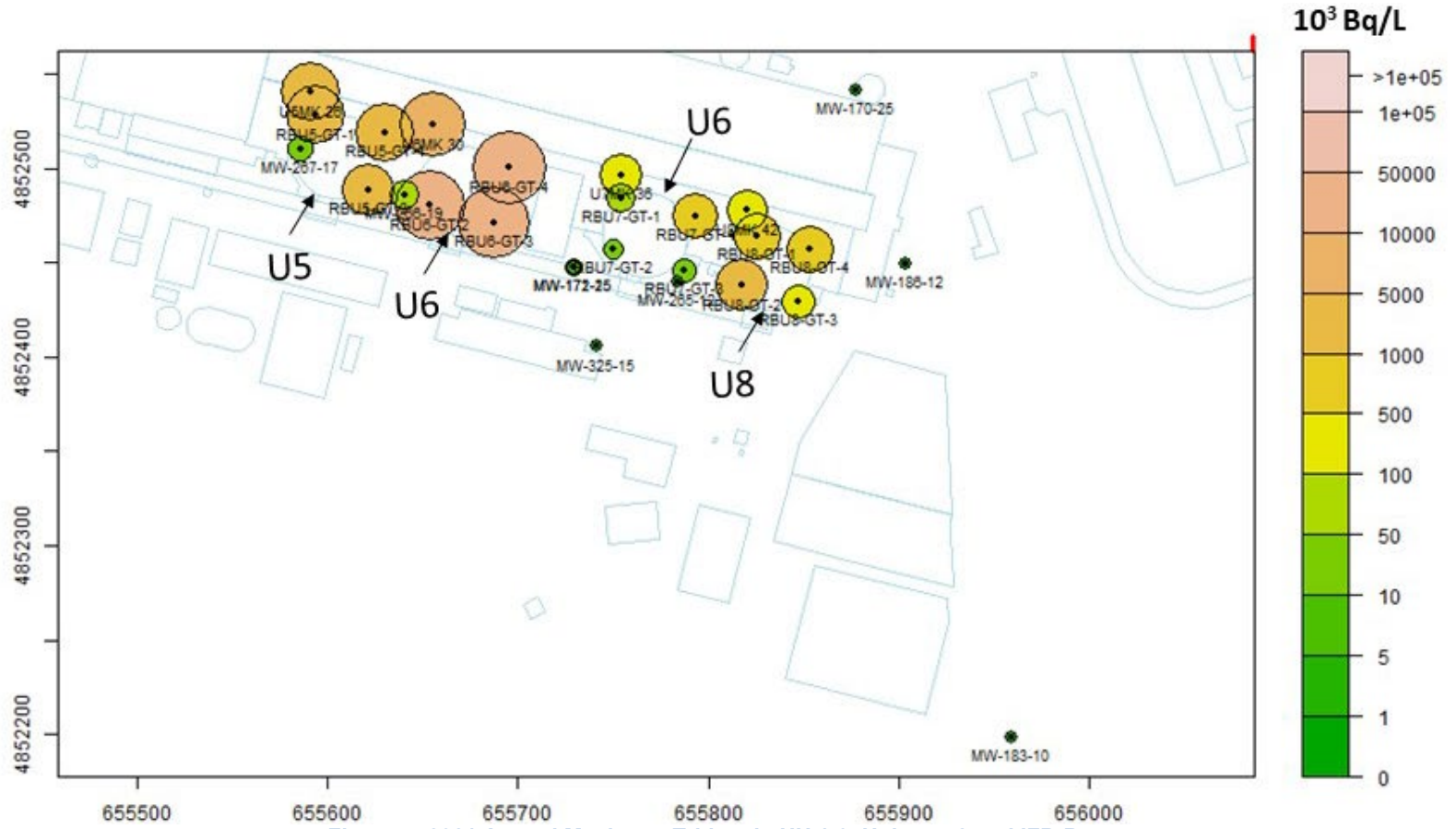


Figure 7: 2021 Annual Maximum Tritium in HU 1-3, Unit 5 to 8 and IFB-B

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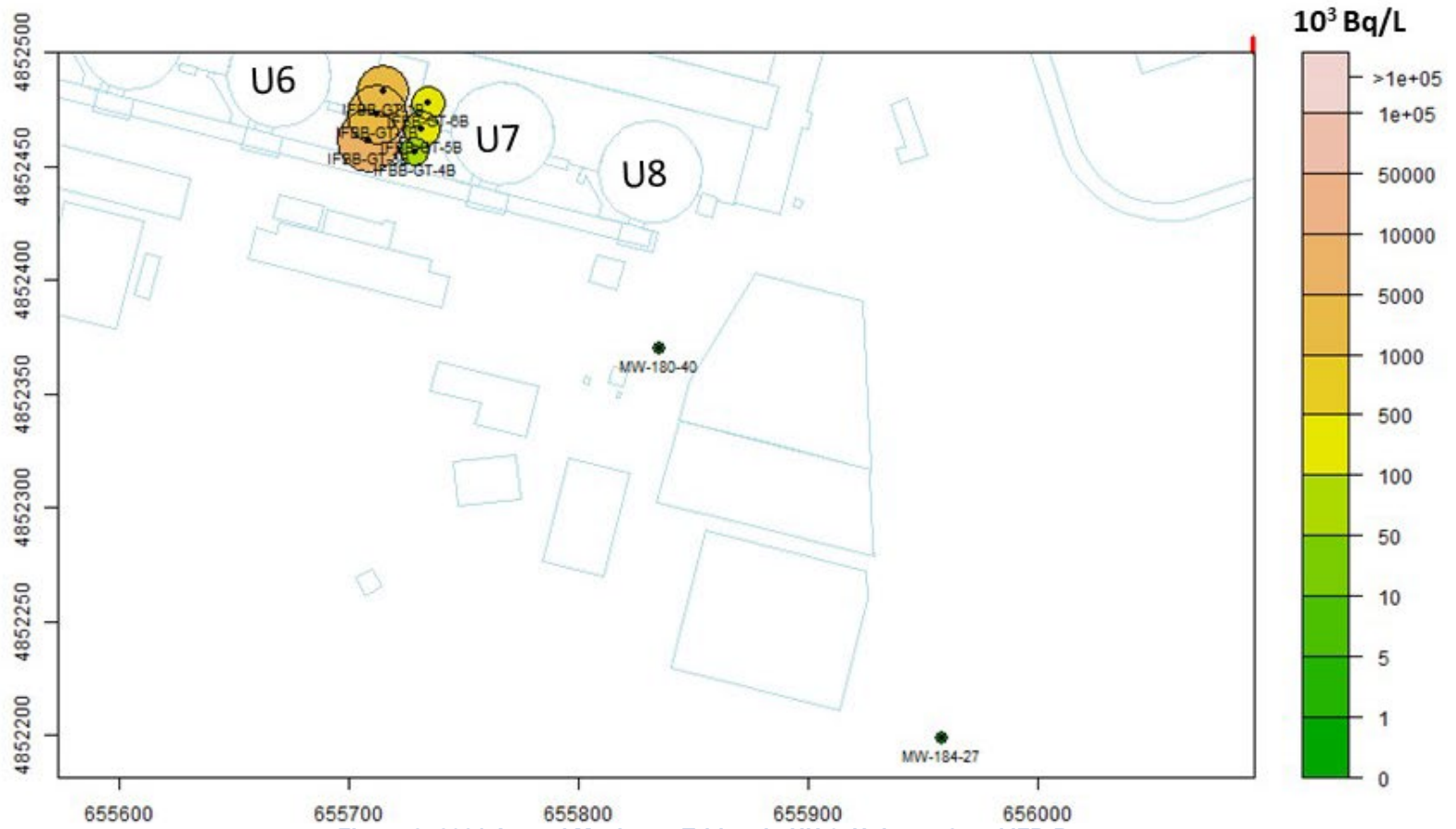


Figure 8: 2021 Annual Maximum Tritium in HU 6, Unit 5 to 8 and IFB-B

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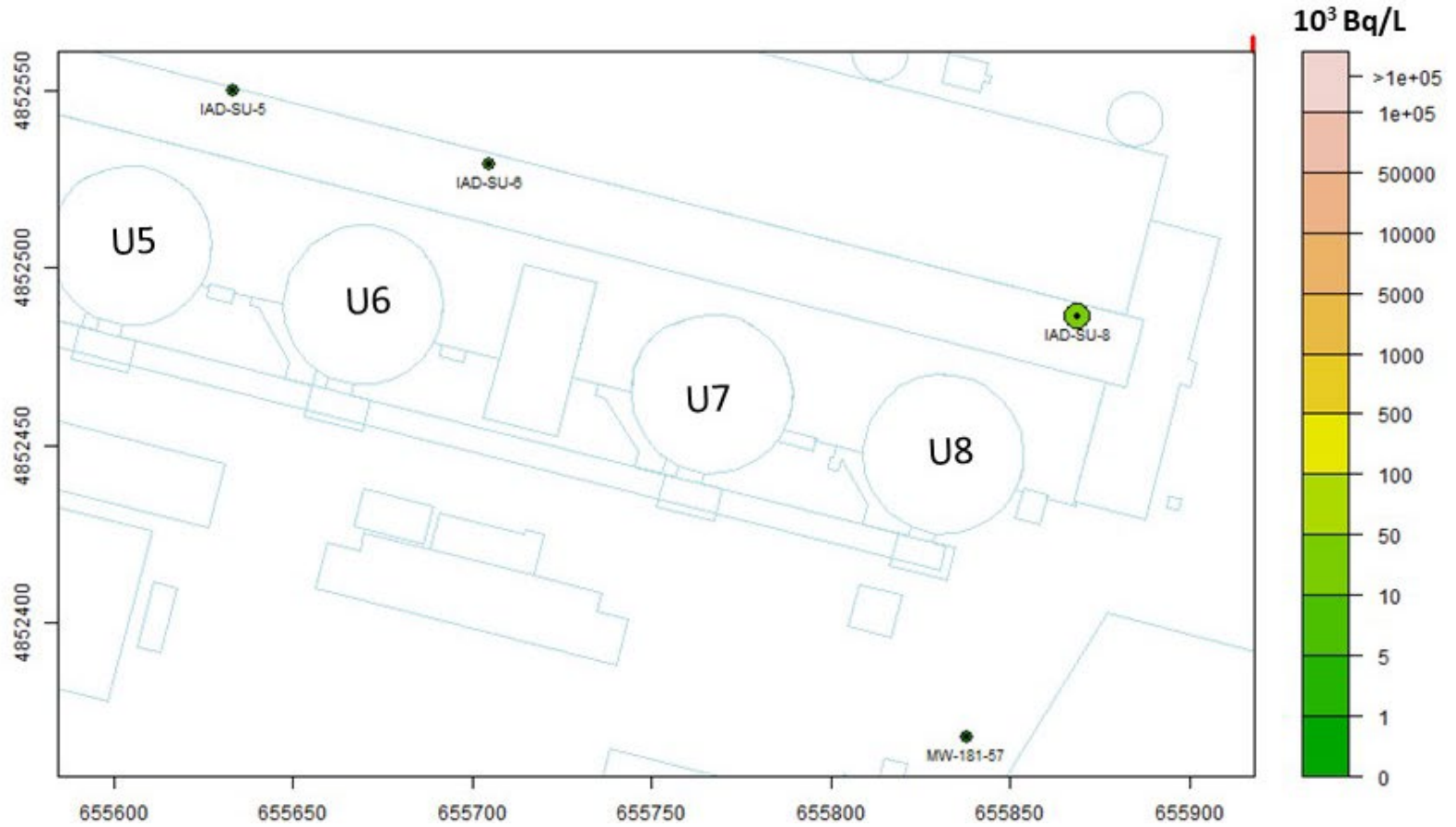


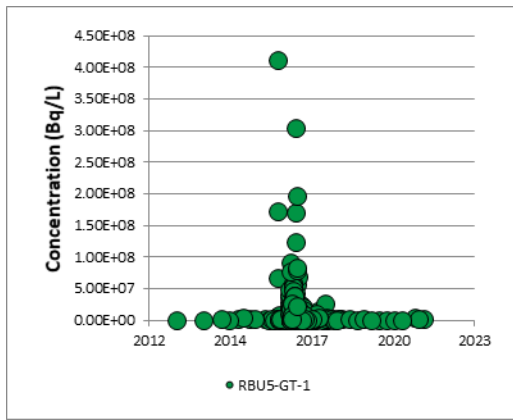
Figure 9: 2021 Annual Maximum Tritium in HU 7, Unit 5 to 8

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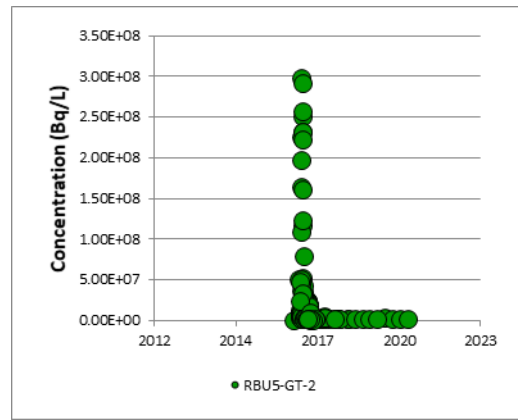
**3.1.2.1 Unit 5 Area**

The samples collected from the Unit 5 RB area in 2021 indicate that tritium concentrations in groundwater have declined in this area following the repairs completed on the moderator room floor construction joints.

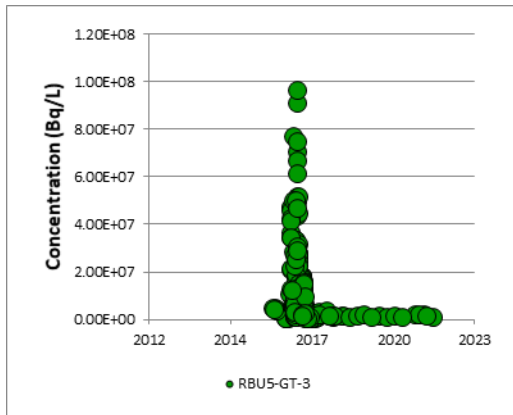
Graphs 14 to 19 present data from the Unit 5 RB foundation drainage groundtubes (RBU5-GT-1 to RBU5-GT-4), the U5 MK26 sump and MW-267-17, respectively.



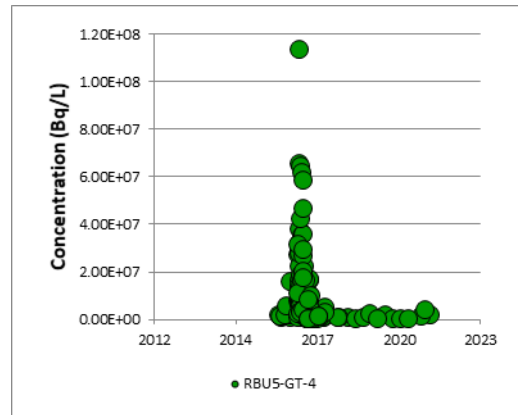
**Graph 14: RBU5-GT-1 Tritium Data**



**Graph 15: RBU5-GT-2 Tritium Data**

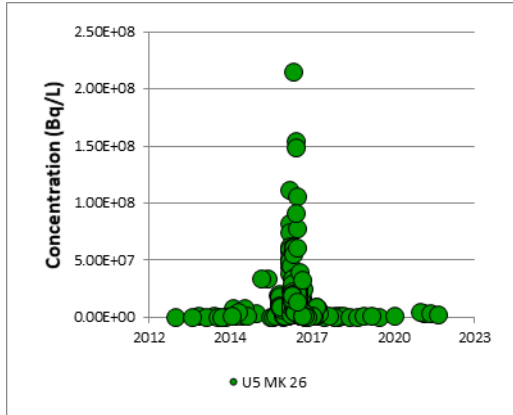


**Graph 16: RBU5-GT-3 Tritium Data**

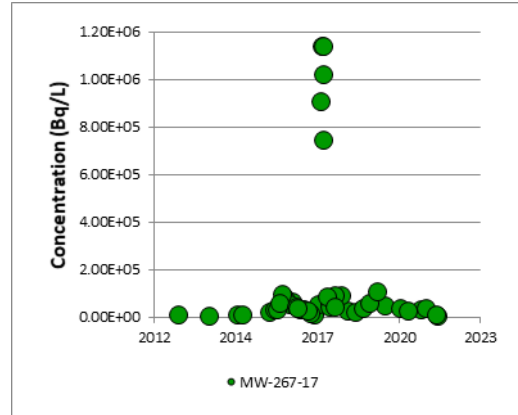


**Graph 17: RBU5-GT-4 Tritium Data**

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Graph 18: U5 MK26 Tritium Data

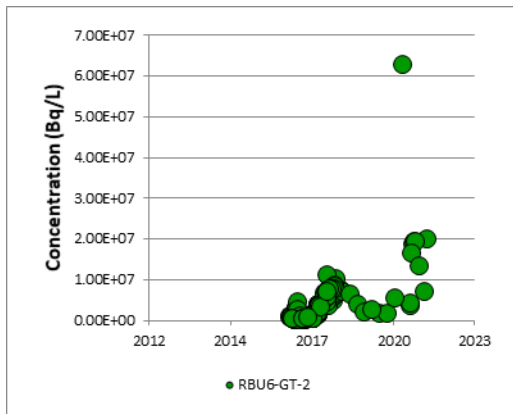


Graph 19: MW-267-17 Tritium Data

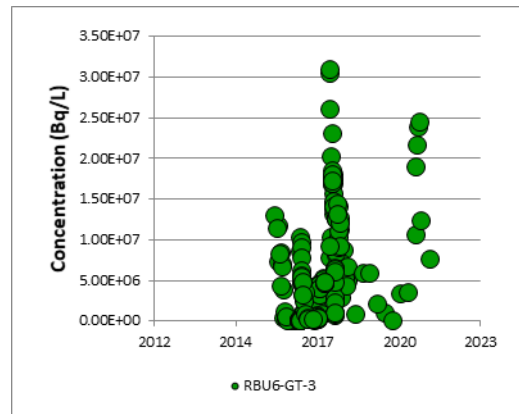
3.1.2.2 Unit 6 Area

An increase in tritium concentrations in groundwater was observed in the Unit 6 RB foundation drainage groundtubes, Unit 6 MK30 sump and the closest groundwater monitoring well MW-266-9 in 2020, and also in early 2021, which were likely attributed to a valve leak. The concentrations in the groundtubes, sump and monitoring well decreased during later months in 2021, indicating that the repairs were successful at addressing the tritium influence to groundwater from the valve leak.

Graphs 20 to 24 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.



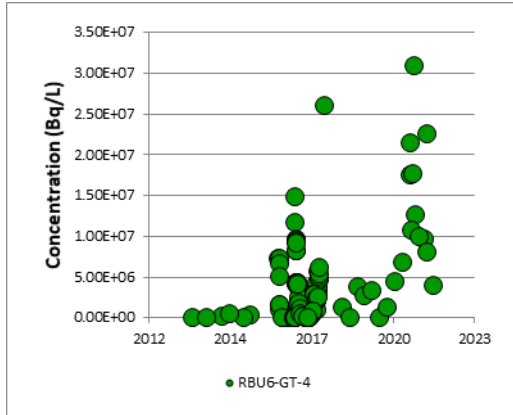
Graph 20: RBU6-GT-2 Tritium Data



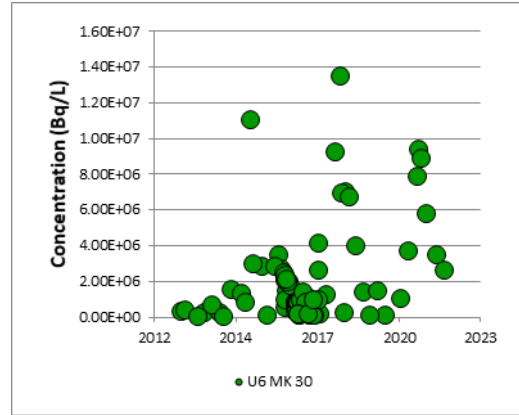
Graph 21: RBU6-GT-3 Tritium Data

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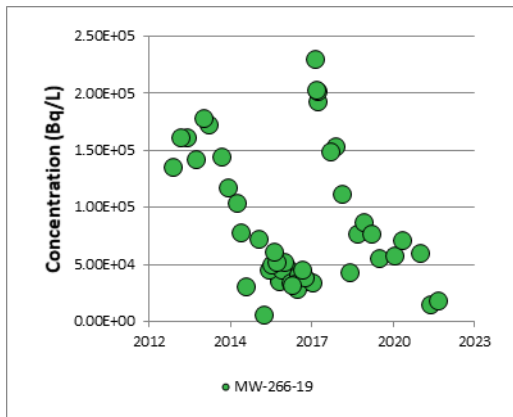
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**Graph 22: RBU6-GT-4 Tritium Data**



**Graph 23: U6 MK30 Tritium Data**



**Graph 24: MW-266-19 Tritium Data**

### 3.1.2.3 Unit 7 Area

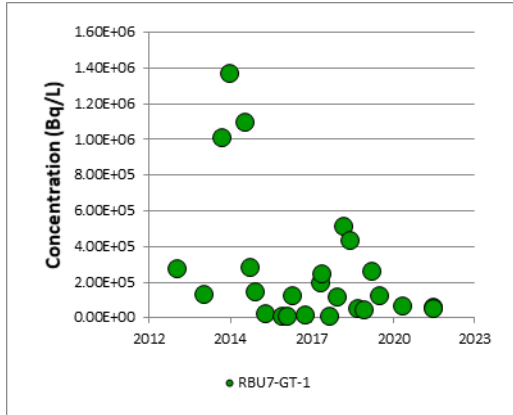
In 2021, there were no emerging issues and this area will continue to be monitored.

Graphs 25 to 31 illustrate the data for RBU7-GT-1, RBU7-GT-4, U7 MK36, MW-265-12 and MW-325-15.

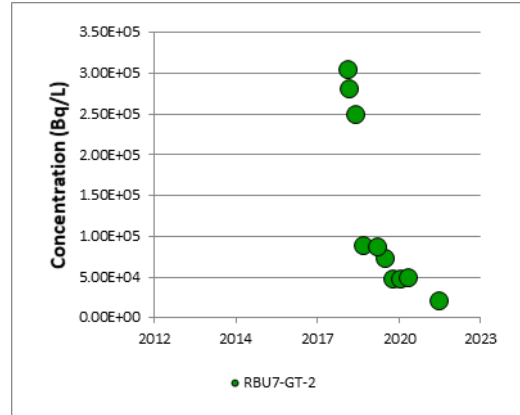
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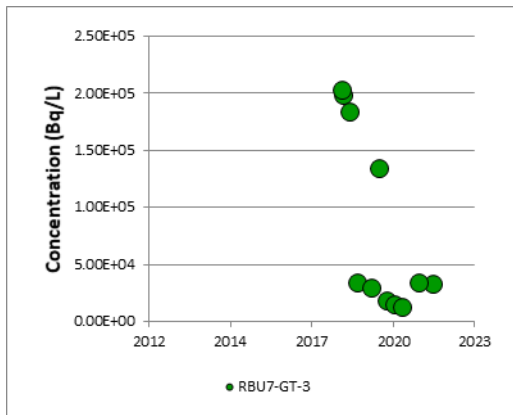
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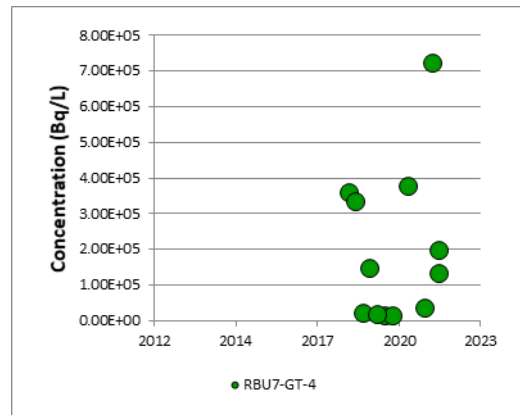
Graph 25: RBU7-GT-1 Tritium Data



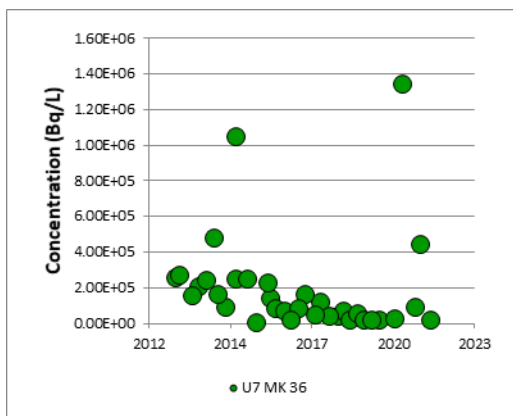
Graph 26: RBU7-GT-2 Tritium Data



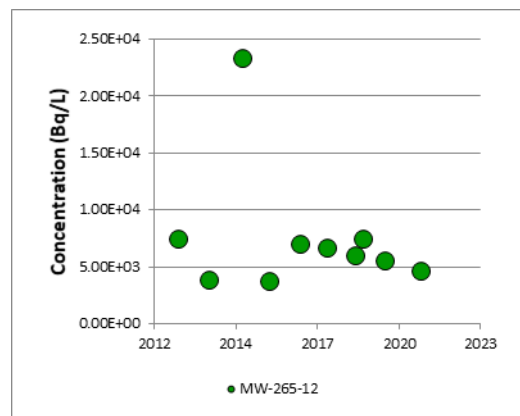
Graph 27: RBU7-GT-3 Tritium Data



Graph 28: RBU7-GT-4 Tritium Data

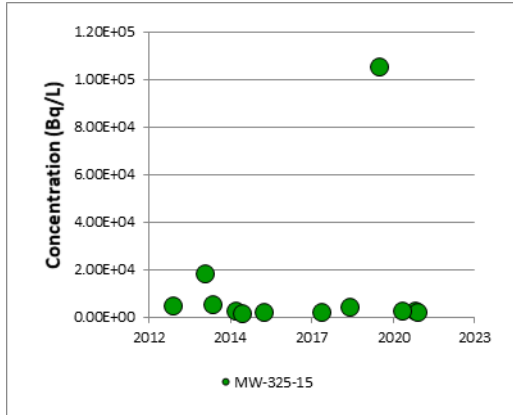


Graph 29: U7 MK36 Tritium Data



Graph 30: MW-265-12 Tritium Data

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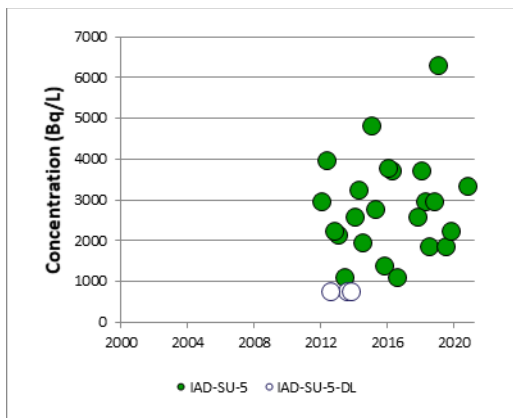


**Graph 31: MW-325-15 Tritium Data**

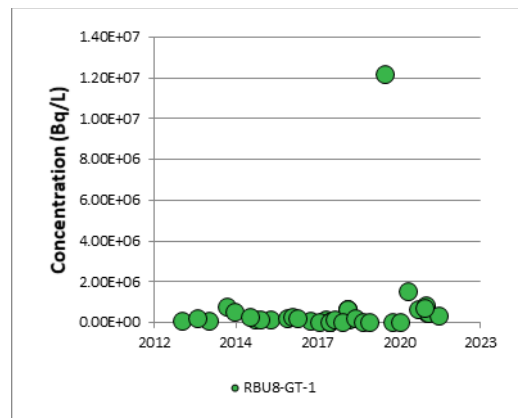
**3.1.2.4 Unit 8 Area**

In 2021, tritium concentrations in the Unit 8 TAB IAD sump were monitored as a follow up to mitigation activities undertaken to address a valve issue in the RAB. Groundwater flows north from underneath the RAB towards the TAB IAD foundation drainage and sumps. The tritium concentrations at IAD-SU-8 have continued to trend downwards since.

Graphs 32 to 38 illustrate the tritium data for the Unit 8 RB foundation drainage groundtubes, U8 MK42 and monitoring well MW-264-10.



**Graph 32: IAD-SU-8 Tritium Data**

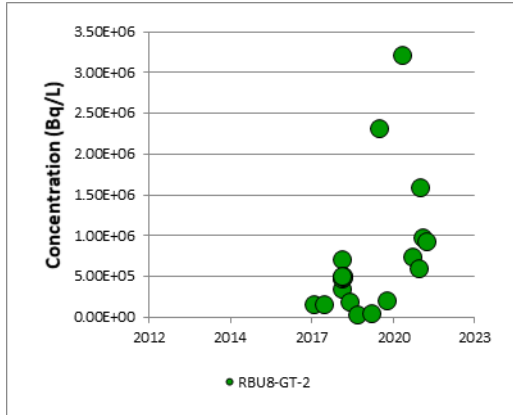


**Graph 33: RBU8-GT-1 Tritium Data**

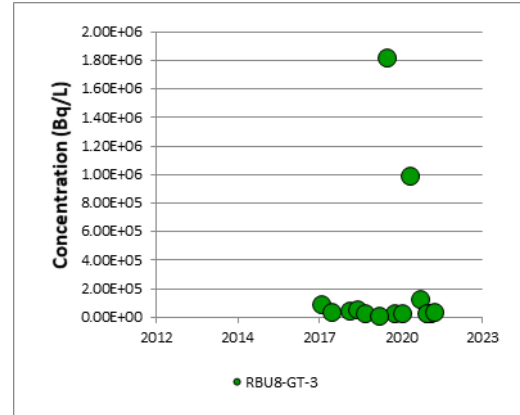
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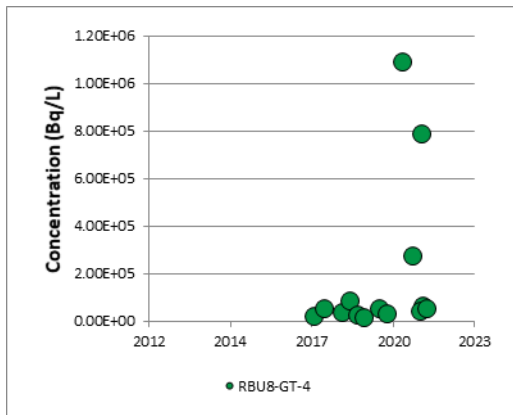
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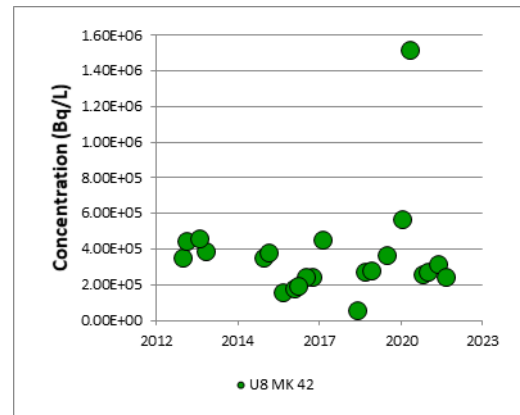
Graph 34: RBU8-GT-2 Tritium Data



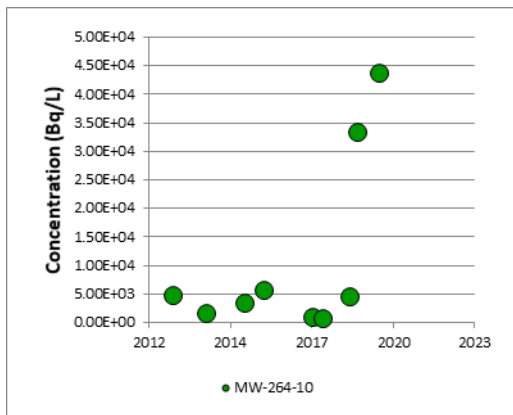
Graph 35: RBU8-GT-3 Tritium Data



Graph 36: RBU8-GT-4 Tritium Data



Graph 37: U8 MK42 Tritium Data



Graph 38: MW-264-10 Tritium Data

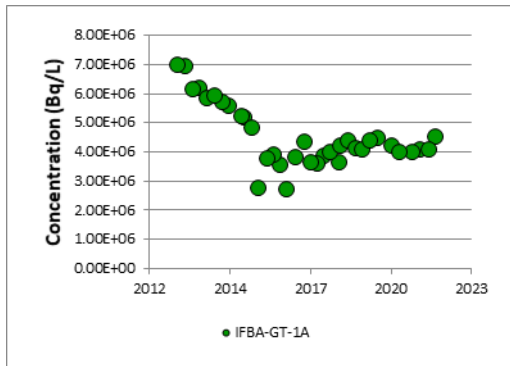
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### 3.1.3 Irradiated Fuel Bay Areas

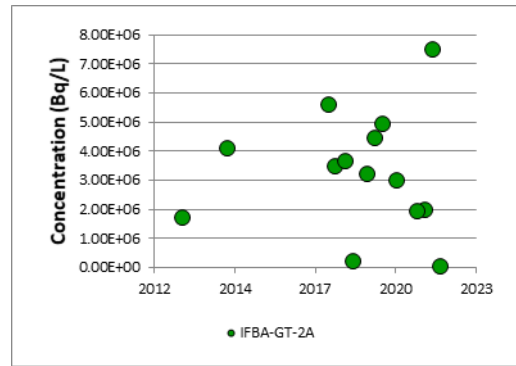
#### 3.1.3.1 IFB-A

In 2021, the eastern groundtubes (IFBA-GT-1A and IFBA-GT-2A) showed higher tritium concentrations than those to the west (IFBA-GT-4A and IFBA-GT-5A). Concentrations in the western groundtubes appear to be increasing. Two monitoring wells (MW-244-18 and MW-057-30) in the vicinity of the IFBs displayed an emerging trend. This is expected given that the western edge of the tritium plume associated with the 2020 heavy water release originating in the Unit 1 area extends towards the IFB-A, as groundwater in the Unit 1 area migrates towards the Units 1 to 4 IFB-A and TAB foundation drains in addition to the VBRS. Groundwater in the protected area eventually flows north towards the low-lying TAB sumps which is eventually discharged via a monitored pathway.

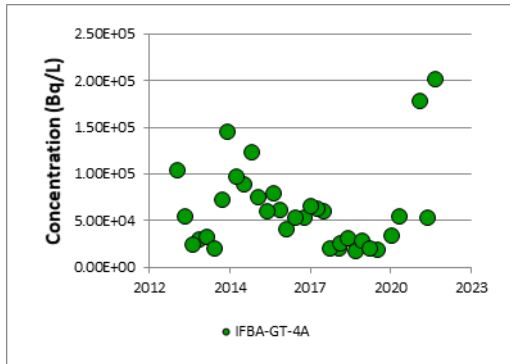
Tritium concentrations over time for the IFB-A groundtubes and selected monitoring wells are presented in Graph 39 to 44. The 2021 tritium sample results are presented in Table A-3. (Appendix A). Figure 4 to Figure 6 also display the annual maximum tritium distributions of the Unit 1 to 4 IFBs in HU 1-3, HU 6 and HU 7.



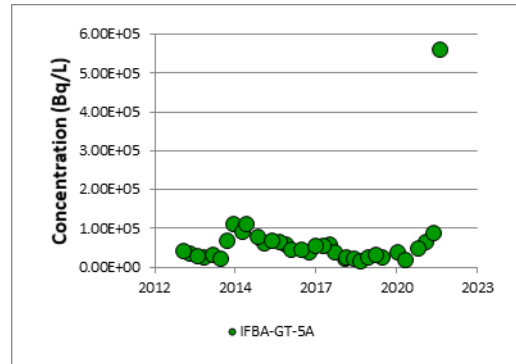
Graph 39: IFBA-GT-1A Tritium Data



Graph 40: IFBA-GT-2A Tritium Data

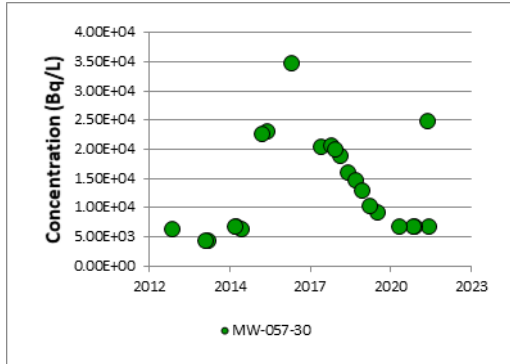


Graph 41: IFBA-GT-4A Tritium Data

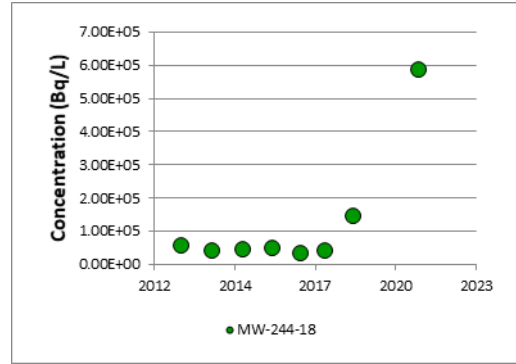


Graph 42: IFBA-GT-5A Tritium Data

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Graph 43: MW-057-30 Tritium Data



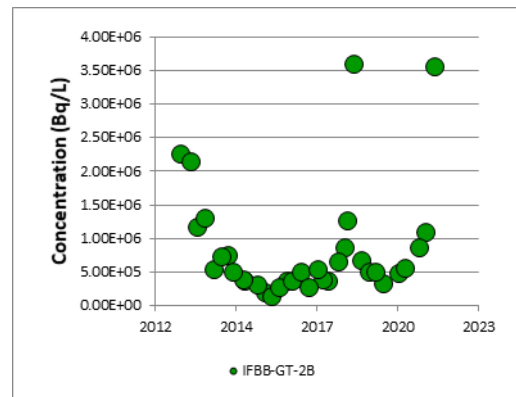
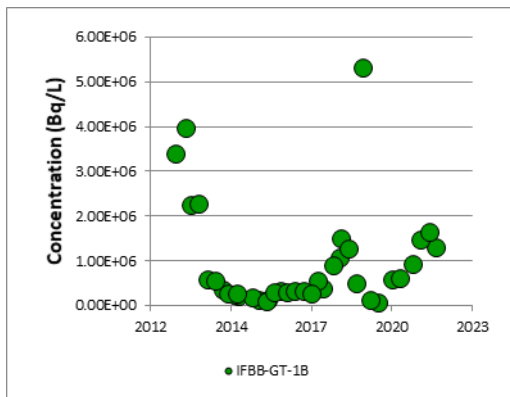
Graph 44: MW-244-18 Tritium Data

3.1.3.2 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.

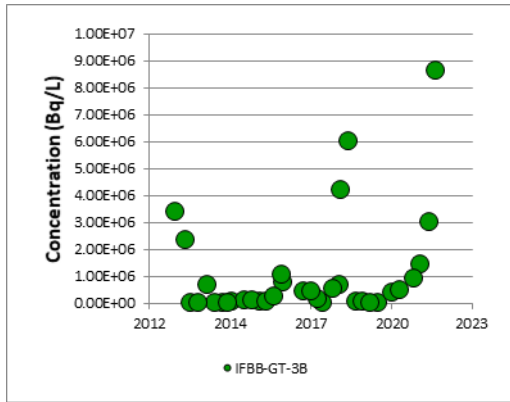
In 2021, tritium concentrations in the western groundtubes (IFBB-GT-1B, IFBB-GT-2B and IFBB-GT-3B) increased relative to 2020 and tritium concentrations at IFBB-GT-3B indicate an upward trend. Monitoring wells MW-171-15 and MW-172-25 located further south from the Unit 5-8 continued to show tritium concentrations within historical range. In addition, tritium concentrations in the eastern groundtubes (IFBB-GT-4B, IFBB-GT-5B and IFBB-GT-6B) remain stable. A review of the available groundwater flow conditions suggests groundwater moves from Unit 6, beneath the IFB-B area and ultimately towards the TAB IAD sumps. As such, the recent increases in tritium concentrations in the western groundtubes within the IFB-B area likely reflect the elevated concentrations observed in Unit 6 groundtubes in 2021. This area will continue to be monitored.

Tritium concentrations over time for the IFB-B groundtubes and monitoring wells are presented in Graphs 45 to 52. The 2021 tritium sample results are presented in Table A-3 (Appendix A). Figure 7 and Figure 8 also display tritium distributions of the Unit 5 to 8 IFBs in HU 1-3 and HU 6. Tritium distributions at IFB-B are shown below in Figure 10.

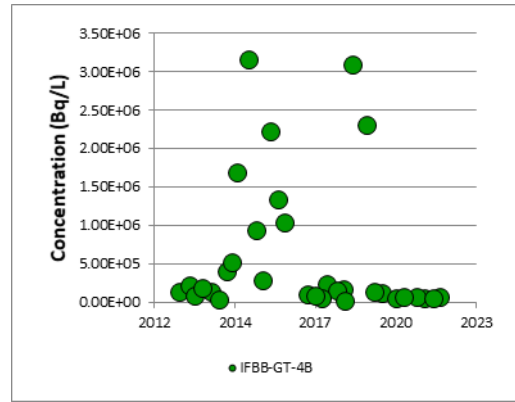


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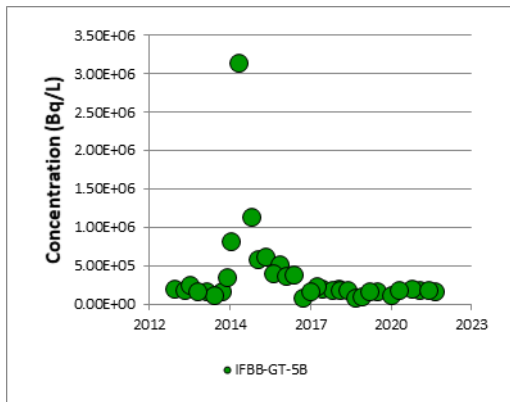
**Graph 45: IFBB-GT-1B Tritium Data**



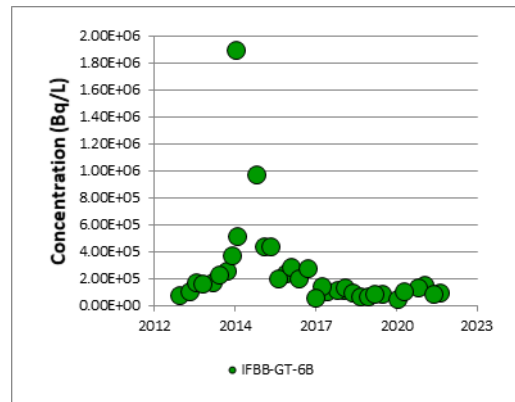
**Graph 46: IFBB-GT-2B Tritium Data**



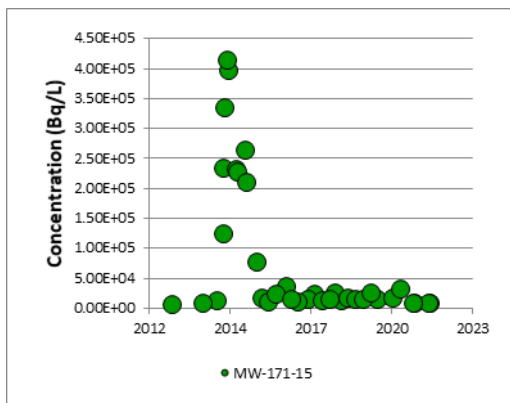
**Graph 47: IFBB-GT-3B Tritium Data**



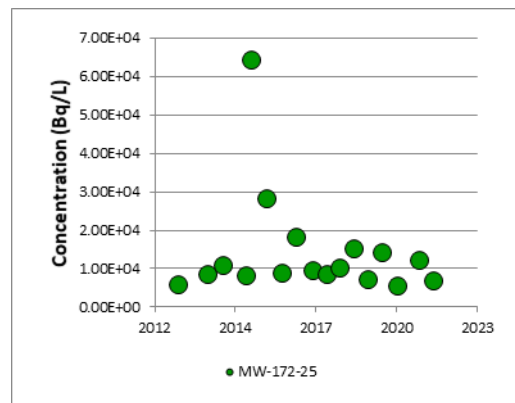
**Graph 48: IFBB-GT-4B Tritium Data**



**Graph 49: IFBB-GT-5B Tritium Data**



**Graph 50: IFBB-GT-6B Tritium Data**



**Graph 51: MW-171-15 Tritium Data**

**Graph 52: MW-172-25 Tritium Data**

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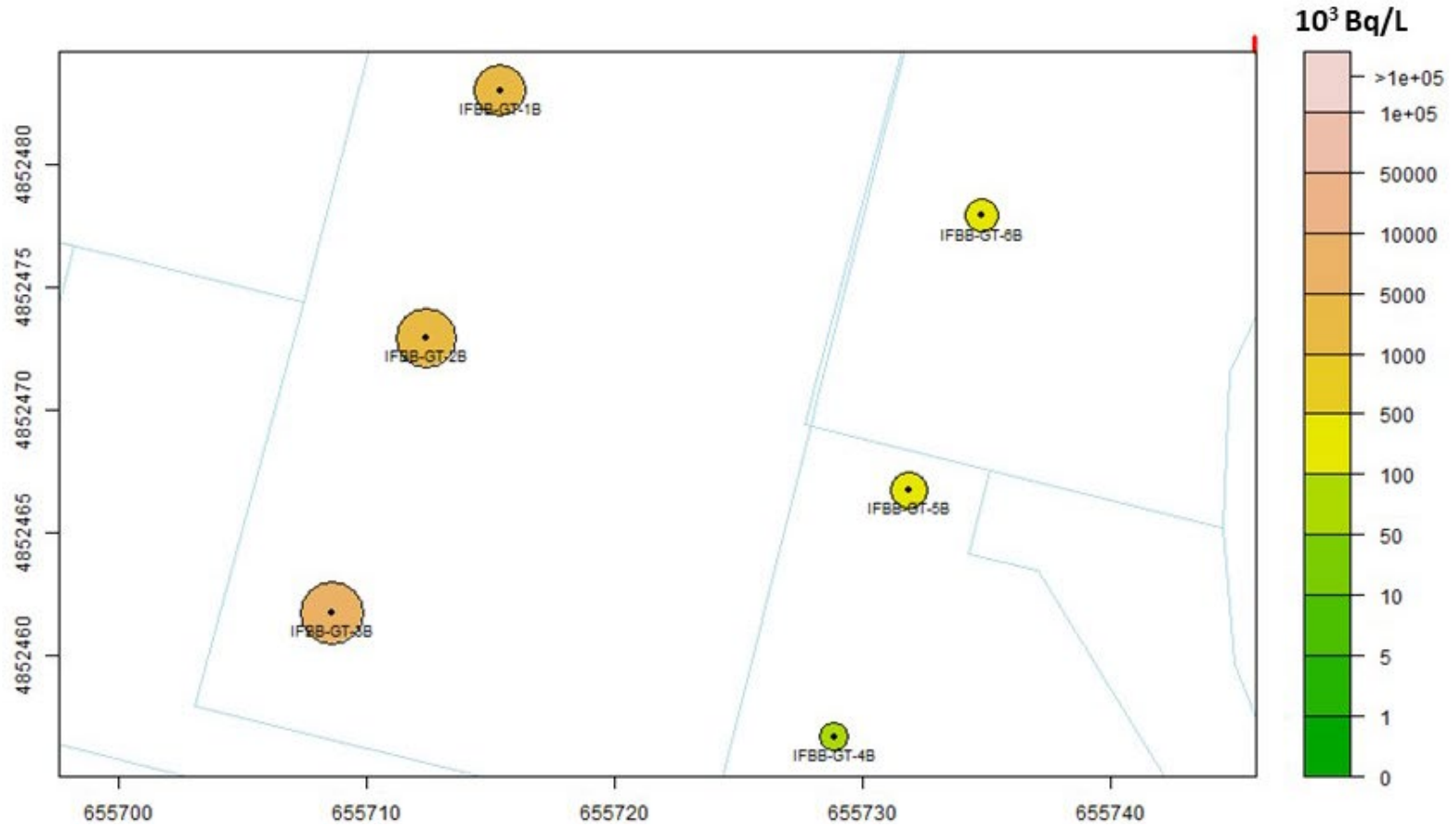


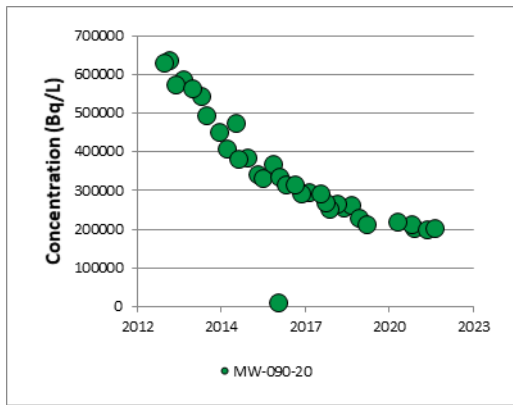
Figure 10: 2021 Annual Maximum Tritium at IFB-B

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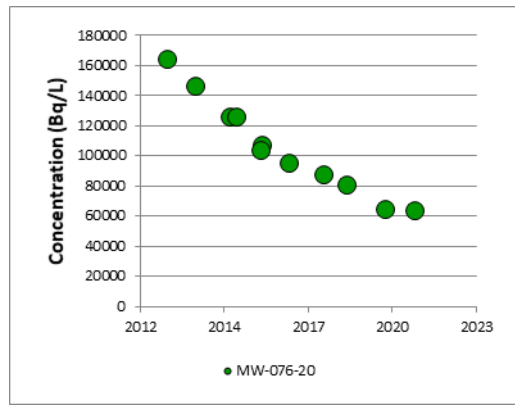
### 3.1.4 Upgrading Plant Pickering Area

In 2021, tritium concentrations in this area continue to decrease or have been shown to be stabilized.

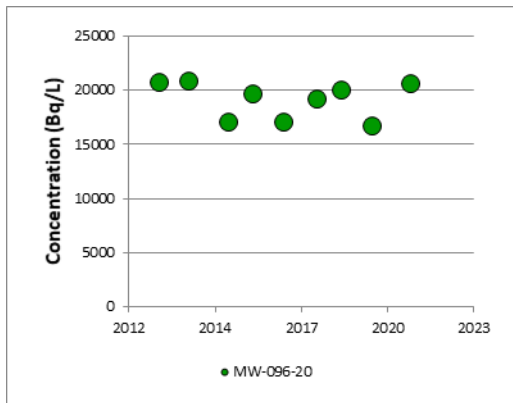
Tritium concentrations over time for the UPP area are presented in Graph 53 to 55. The 2021 sample results for tritium concentrations in groundwater at the locations sampled in the UPP area are presented in Table A-4 (Appendix A). Figure 11 and Figure 12 display the annual maximum tritium concentration distributions within HU 1-3 and HU 6 in the UPP area.



**Graph 53: MW-090-20 Tritium Data**



**Graph 54: MW-076-20 Tritium Data**



**Graph 55: MW-096-20 Tritium Data**

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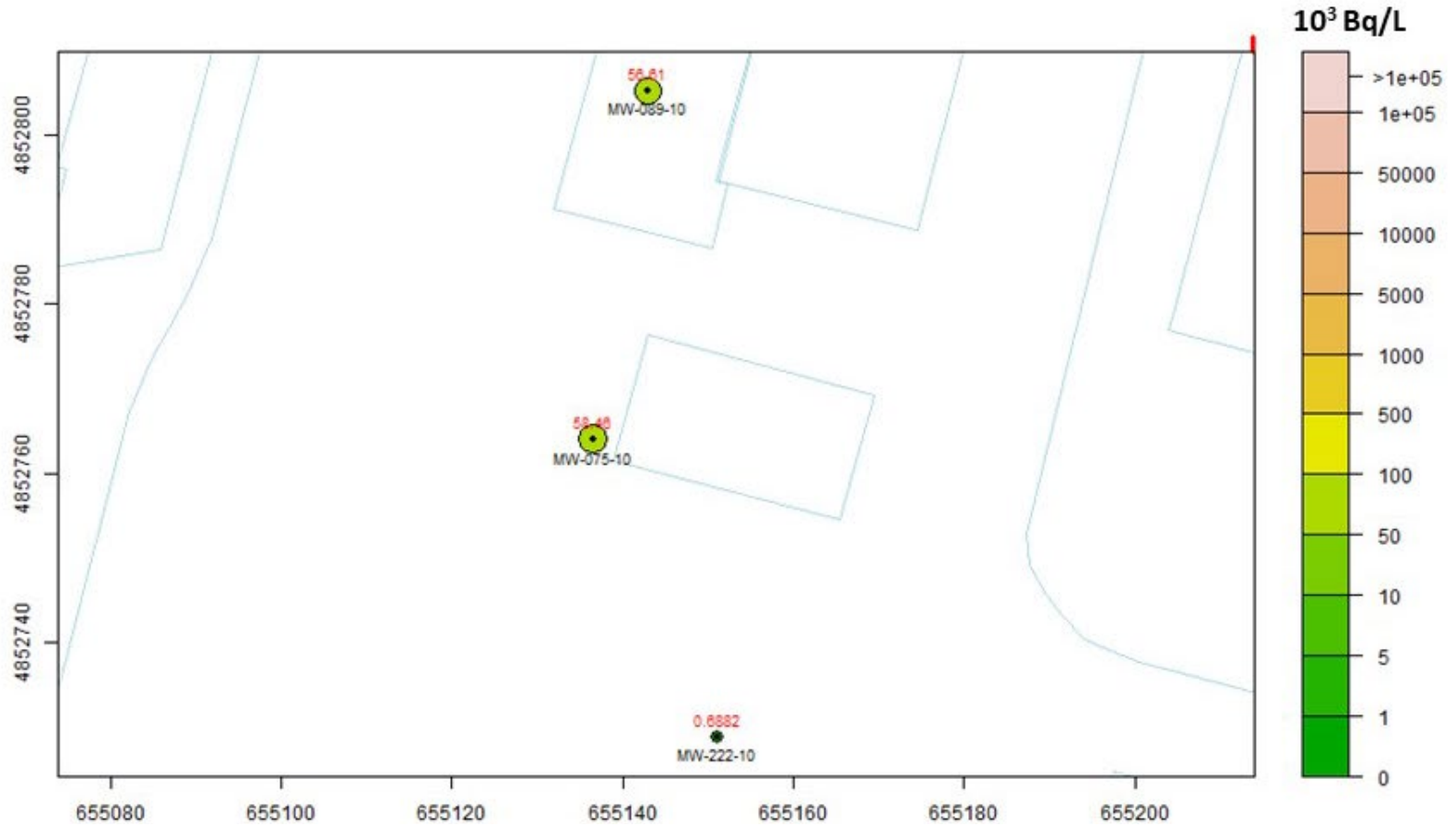


Figure 11: 2021 Annual Maximum Tritium in HU 1-3, UPP

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Figure 12: 2021 Annual Maximum Tritium in HU 6, UPP

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**3.2 Objective 1 Results - PHC concentrations in groundwater at Units 1 to 4 SG, Units 5 to 8 SG, EPG and EPG3**

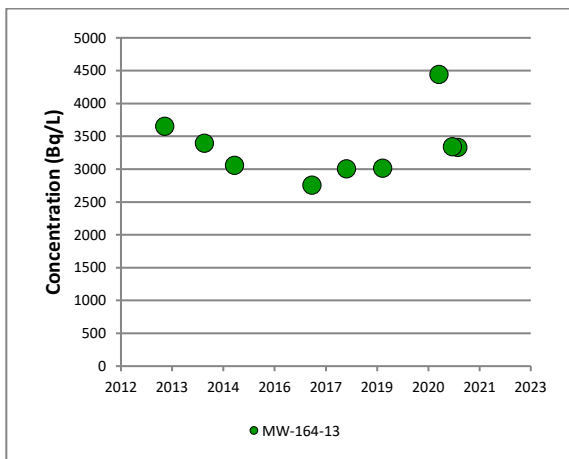
In 2021, six monitoring wells were monitored within the vicinity of U1-4 SG's. The monitoring wells were monitored for groundwater/fuel oil product levels and sampled for PHC F1 to F4, BTEX and dissolved iron, where product was not present. Monitoring well MW-287-15 was sampled and analyzed for PHC F1 to F4, BTEX and dissolved iron in Q2 and Q4. Product was present in that well and remaining wells in Q1 and Q3. The 2021 results for PHC product thickness and hydrocarbons in groundwater in these areas were consistent with monitoring results in recent years.

**3.3 Objective 2 Results**

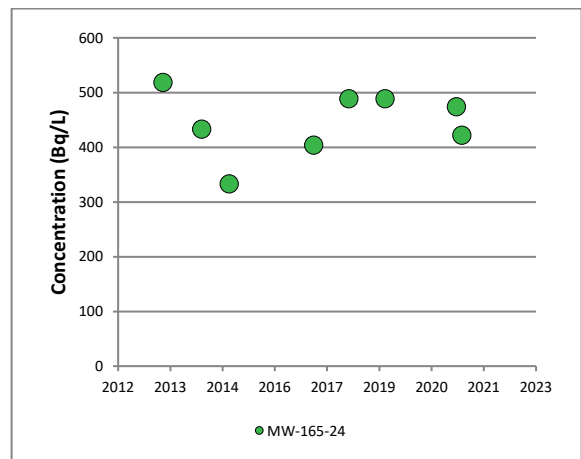
**3.3.1 Site Perimeter Overview**

In 2021, concentrations of tritium in groundwater within the boundary perimeter wells were low (less than 700 Bq/L) and are considered to reflect background conditions. Shoreline wells MW-164-13 and MW-165-24, are located southeast of the Unit 1 and 2 reactor buildings. Shoreline wells MW-225-12 and MW-226-22, are located southwest of the Unit 3 and 4 reactor buildings. Shoreline wells MW-183-10 and MW-184-27 are located southeast of the Unit 5-8 reactor buildings and the overall site. Shoreline wells MW-222-10 and MW-223-32 are located south of the UPP area. Tritium concentrations from 2021 in these shoreline wells are within historical ranges and are stable, and demonstrate off-site impacts are not observed.

Table A-6 (Appendix A) summarizes the tritium concentrations at each of the perimeter wells as well as additional samples collected at these wells, and the annual maximum tritium concentrations within HU1-3, HU 6, HU 7 and HU 8 are in Figure 13 to Figure 16. Tritium results within the shoreline wells are shown below in Graphs 56 to 63.



**Graph 56: MW-164-13 Tritium Data**

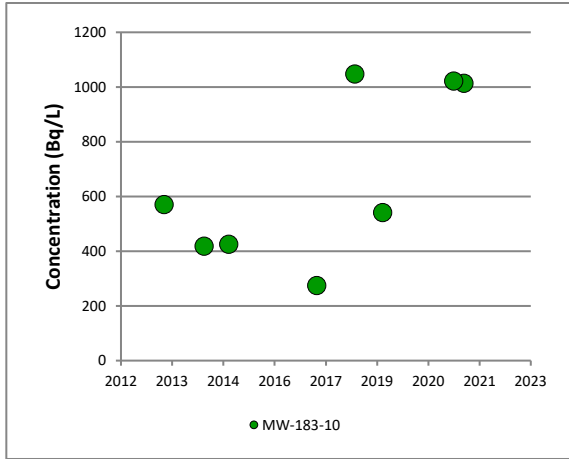


**Graph 57: MW-165-24 Tritium Data**

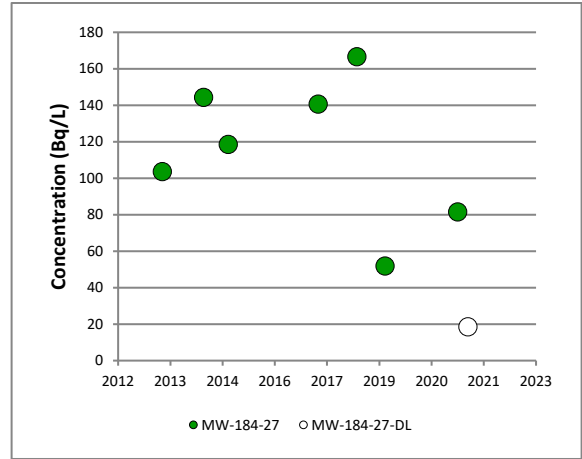
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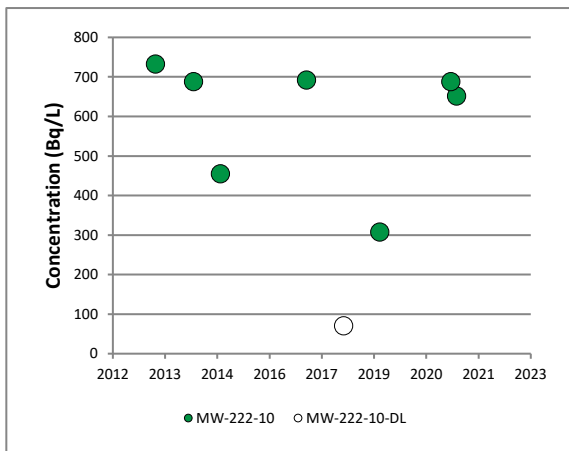
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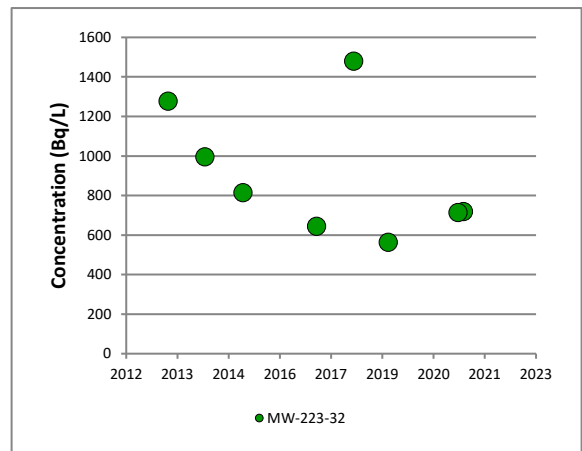
Graph 58: MW-183-10 Tritium Data



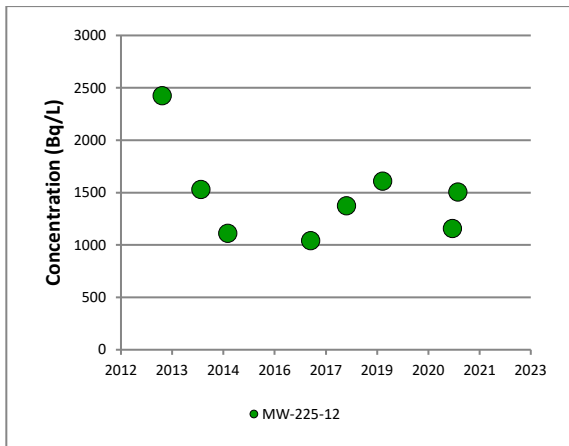
Graph 59: MW-187-27 Tritium Data



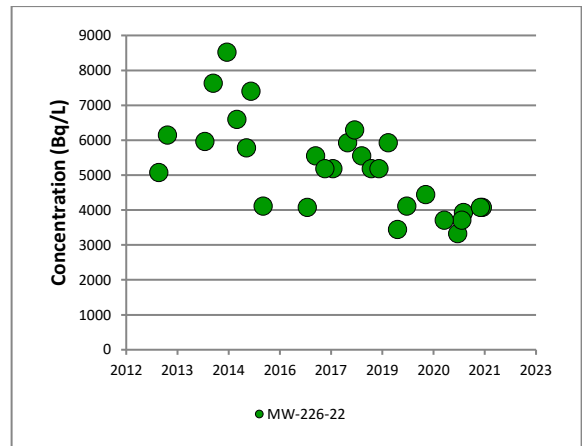
Graph 60: MW-222-10 Tritium Data



Graph 61: MW-223-32 Tritium Data



Graph 62: MW-225-12 Tritium Data



Graph 63: MW-226-22 Tritium Data

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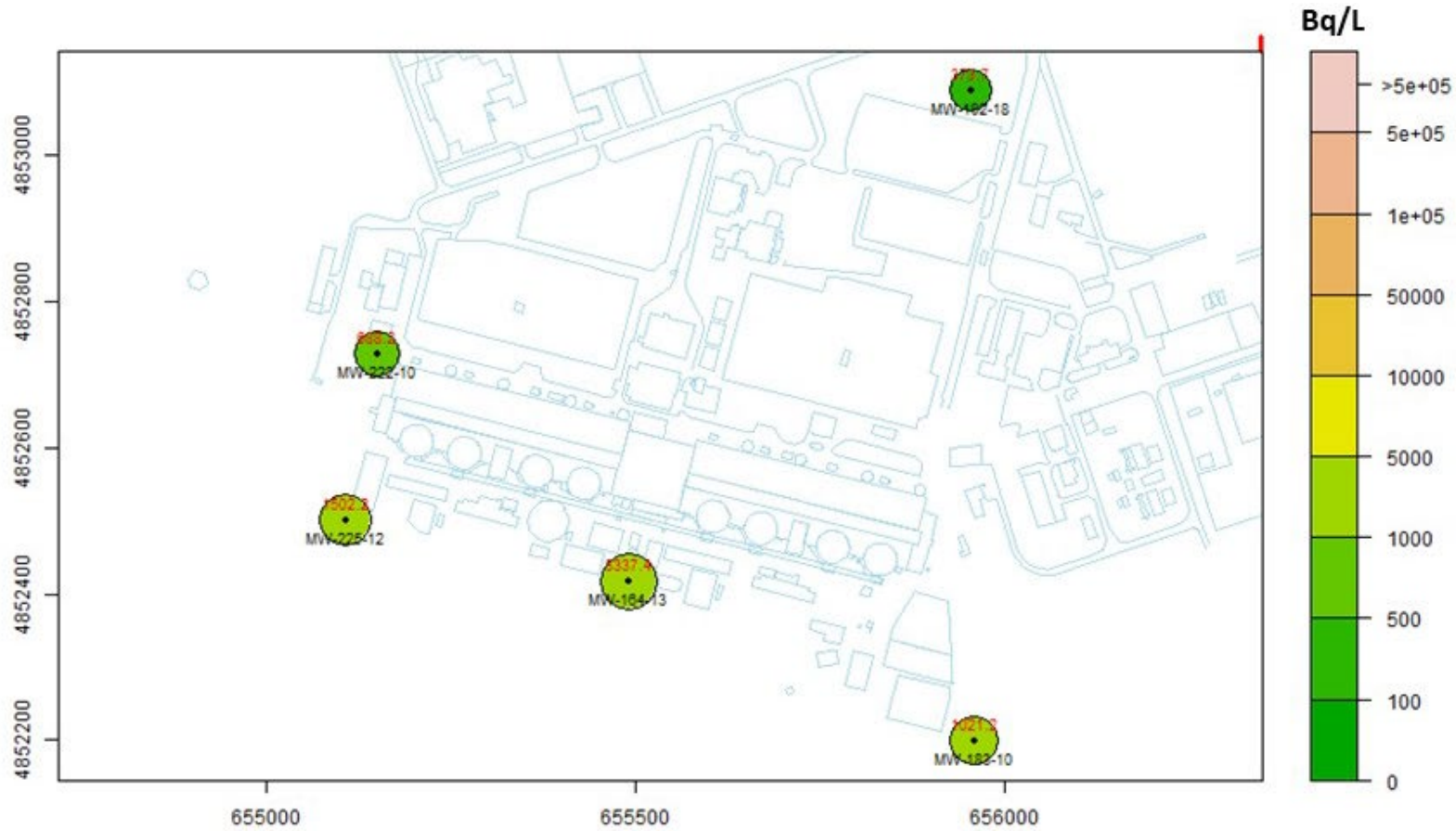


Figure 13: 2021 Annual Maximum Tritium in HU 1-3, Site Perimeter

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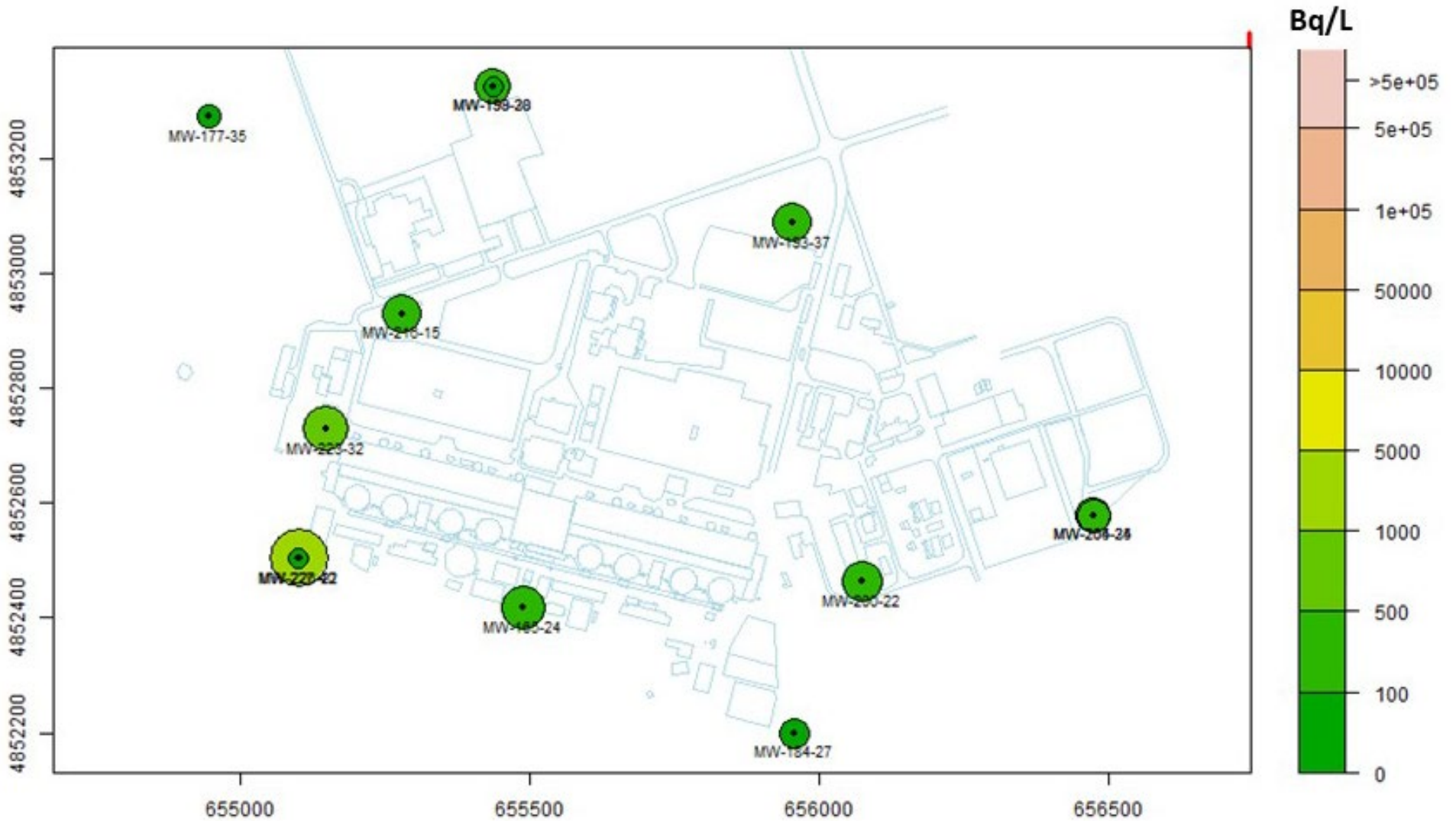


Figure 14: 2021 Annual Maximum Tritium in HU 6, Site Perimeter

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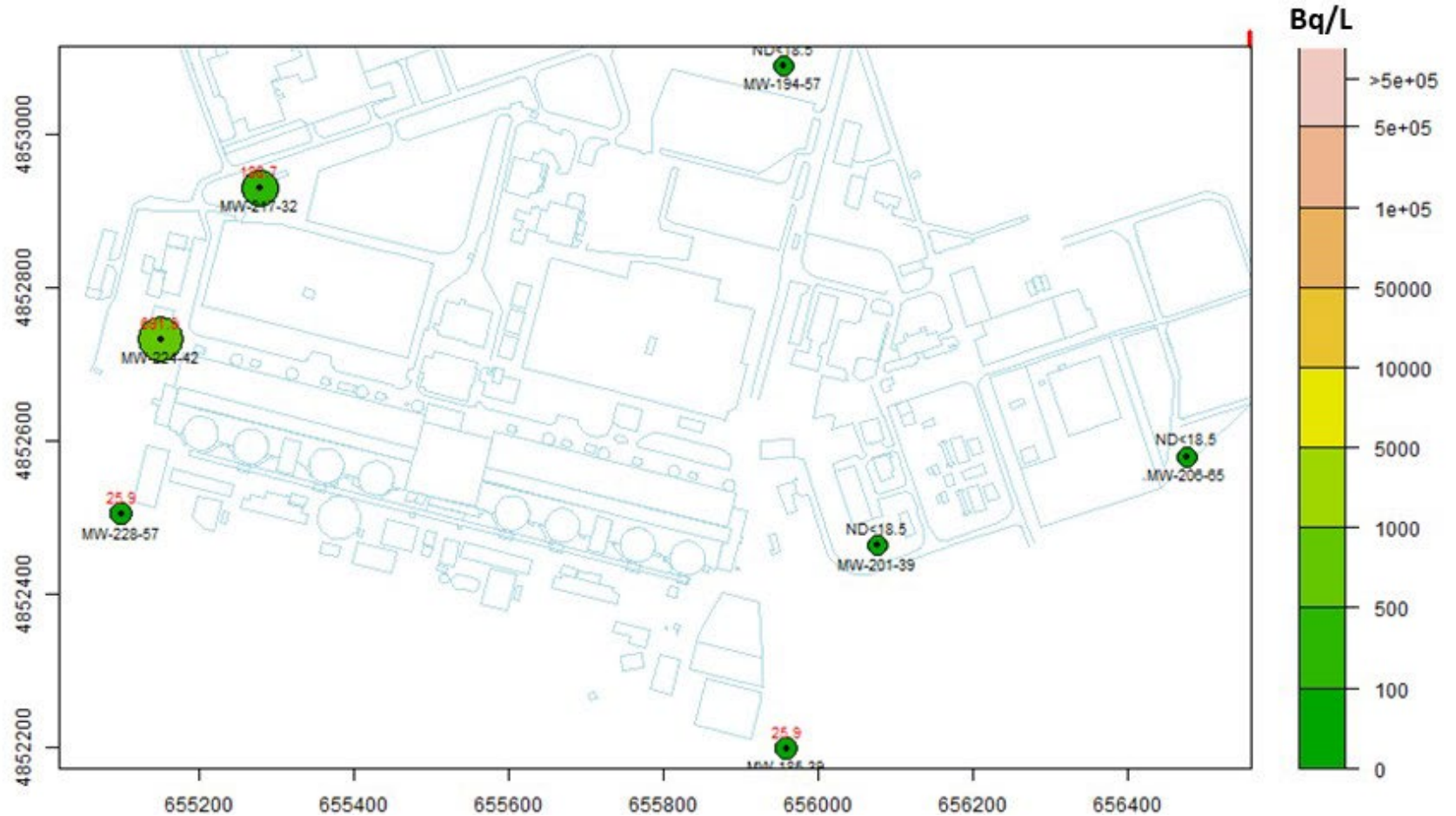


Figure 15: 2021 Annual Maximum Tritium in HU 7, Site Perimeter

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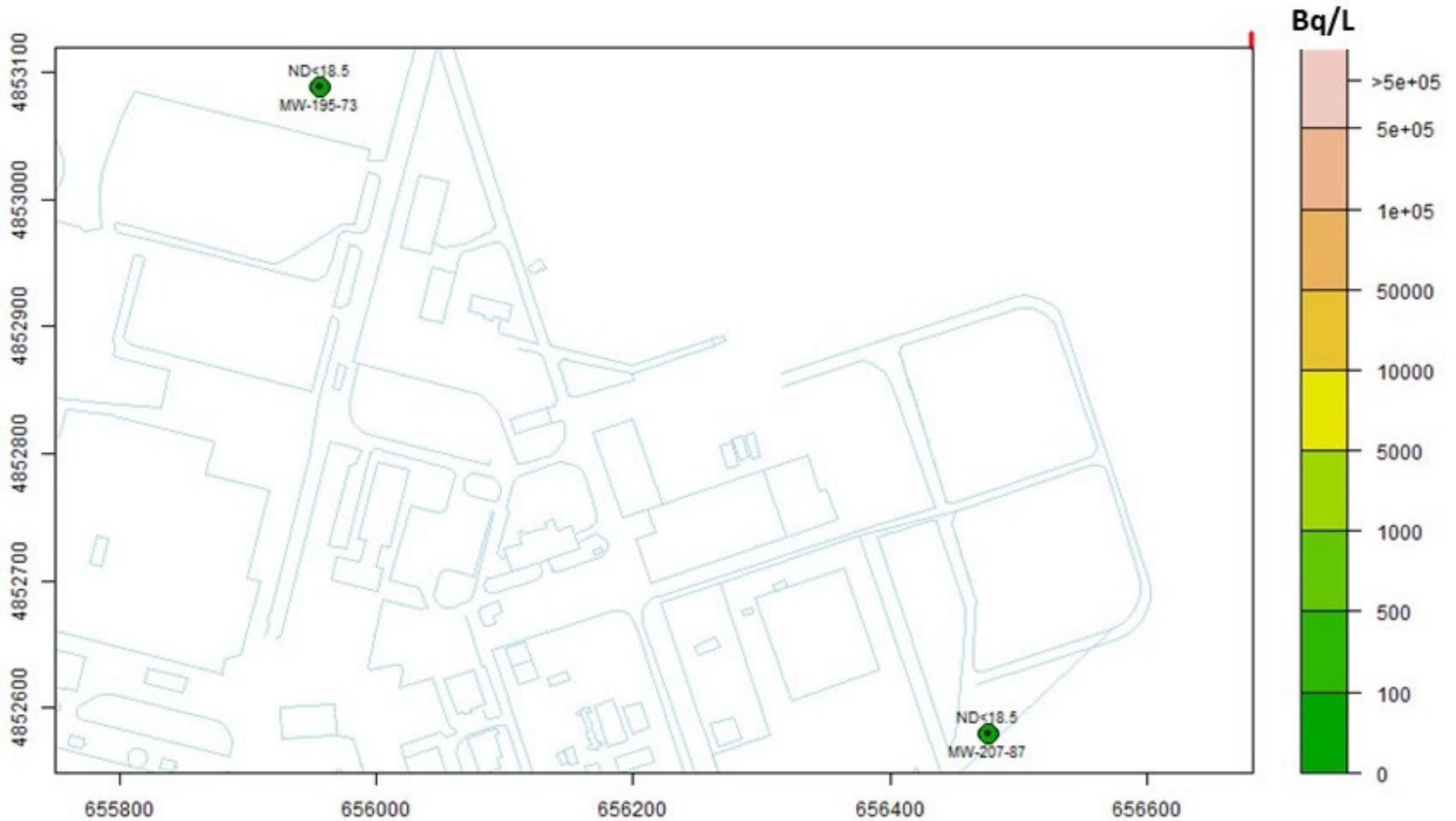


Figure 16: 2021 Annual Maximum Tritium in HU 8, Site Perimeter

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### 3.4 Objective 3 Results

#### 3.2.1 Overview of Groundwater Flow Direction

The ground water flow directions inferred for HUs beneath the PNGS from hydraulic head data collected in 2021 are consistent with historical interpretations.

In the shallower groundwater table (HU 1-3; Figure 17), the East Landfill (northeast of the PNGS) remains the major local recharge area with groundwater flowing generally from the landfill towards the station buildings to the southwest, and towards the lake in the south.

Closer to the reactor units, groundwater flows are more complicated due to subsurface structures and active pumping in the TAB foundation drains and VBRS. The general groundwater flow direction is interpreted to be south towards the lake, with influence from the pumping activities in the area of the reactors. The direction of the arrows in Figure 17 shows the inferred direction of groundwater flow at specific well locations and the length of the arrows represent the steepness of the hydraulic gradient. Groundwater within the vicinity of Units 1 to 4 is inferred to migrate towards the Turbine Auxiliary Bay (TAB) and IFB-A. In the Units 5 to 8 area, groundwater is generally inferred to migrate towards the TAB. 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.

Groundwater within the area of Units 1 and 2 in HU 1-3 are interpreted to migrate towards the VBRS. As mentioned above, the VBRS 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 (Ecometrix 2020a; CSM).

Water levels collected from wells installed within HU 6, HU 7 and HU 8 are generally consistent with historical values. Thus, no change in the historically inferred groundwater flow directions in these units, towards Lake Ontario, are suggested.

Overall, the groundwater monitoring completed in 2021 was sufficient to determine groundwater flow conditions at the site and support the understanding of migration of constituents in groundwater throughout the site.

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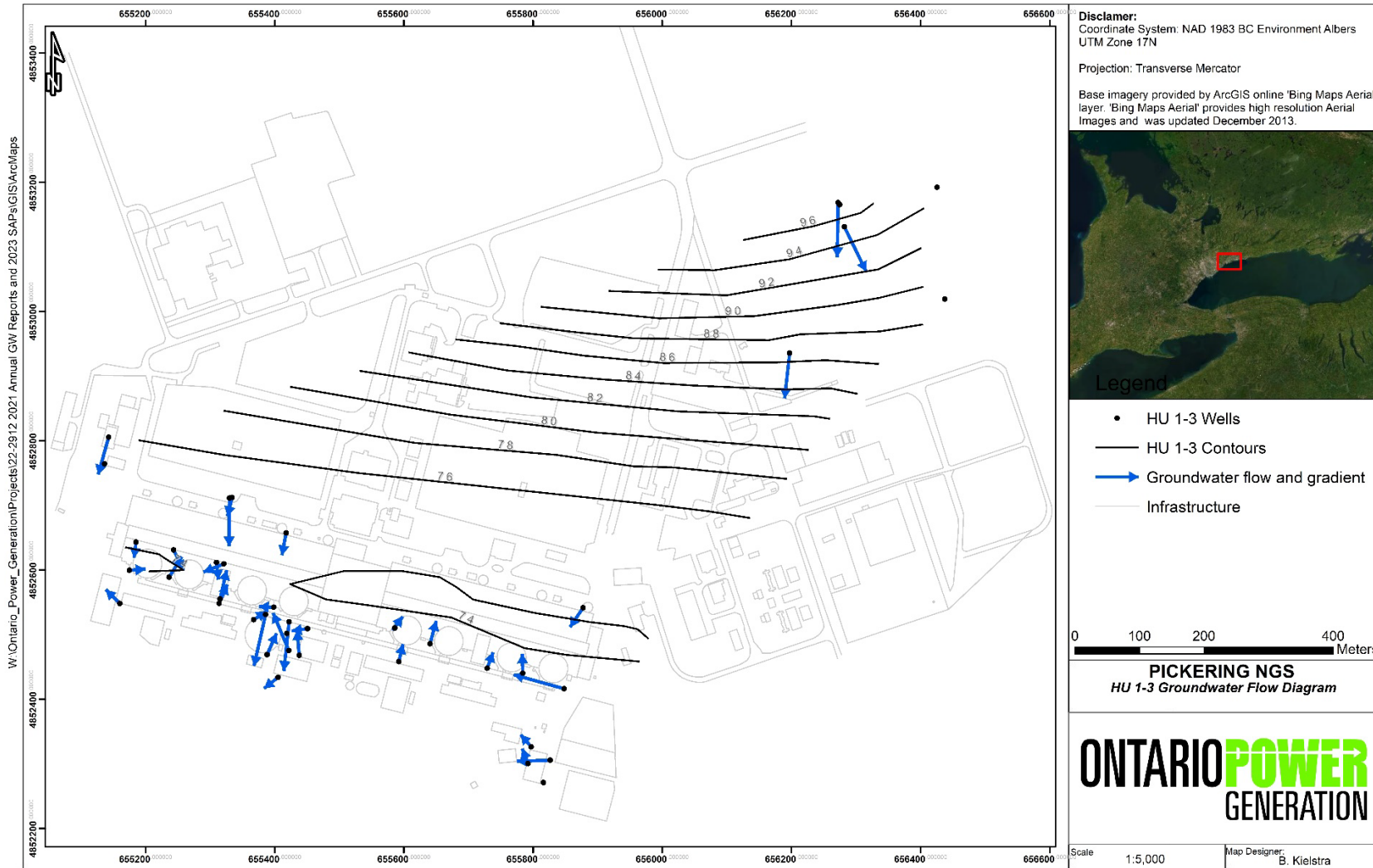


Figure 17: 2021 Q4 Shallow (HU 1-3) Groundwater Contours

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**4.0 2021 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**

In 2021, samples from MW-287-15 were submitted to Bureau Veritas (BV), which is accredited to ISO 17025 by the Standards Council of Canada for environmental tests. Many of the conventional contaminants are governed by criteria established in MECP’s (formerly Ministry of Environment or MOE) ‘Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario’ (MOE, 2009). Bureau Veritas has developed their analytical protocols to meet the recommended analytical protocols documented in this publication.

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 2021, 40 field duplicate samples were collected. The results and calculated relative percent differences (RPD), to understand the sampling precision, are presented in Table A-7a (Appendix A). All calculated RPDs were below 20 percent as recommended in the PNGS GWMP. All duplicate samples were deemed of acceptable quality, the field techniques and the laboratory’s analytical methods employed were determined to be reproducible and reliable. Quality Control results are presented in Table A-7b (Appendix A).

**5.0 SUPPLEMENTARY STUDIES AND AUDITS**

There were no supplementary studies initiated or completed in 2021.

**6.0 NOMENCLATURE OF SAMPLING LOCATIONS**

<b>Sampling Location Type</b>	<b>Identifier</b>	<b>Explanation of Nomenclature</b>
Monitoring Well	MW-XXX-YY	XXX represents a unique identifier YY represents the depth of the monitoring well in feet

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Reactor Building Foundation Drainage Groundtube	RBUX-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	UX MK YY	X represents the unit associated with the sump Y is a unique identifier
Irradiated Fuel Bay Groundtube	IFBA-GT-XA IFBB-GT-XB	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

7.0 ACRONYMS

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
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
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

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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

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Ecometrix (Ecometrix Incorporated), 2020b. Conceptual Site Model – CSA N288.7 Implementation at Pickering Nuclear. Report No. P-REP-07294-00001. December.

MOE (Ministry of Environment), 2009. Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario. March.

OPG (Ontario Power Generation), 2020. Pickering Nuclear Groundwater Sampling and Analysis Plan. Report No. P-PLAN-10120-00001-R009. November.

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**Appendix A: Tables A-1 to A-7**

**Table A-1: Units 1 to 4, Vacuum Building Areas and Units 1 to 4 Turbine Auxillary Bays**

Monitoring Location	Frequency	Analysis Parameter	HU <sup>a</sup>	Q1 (Bq/L)	Q2 (Bq/L)	Q3 (Bq/L)	Q4 (Bq/L)
IAD-SU-1	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-1-1	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-1-2	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-2	Quarterly	Tritium	HU 7	43660	31820	33670	76220
IAD-SU-2-1	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-2-2	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-3	Quarterly	Tritium	HU 7	N/A	N/A	N/A	71780
IAD-SU-3-1	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-3-2	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-4	Quarterly	Tritium	HU 7	11470	10730	6660	N/A
IAD-SU-4-1	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-4-2	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
MW-064-21	Annual	Tritium	HU 1-3	--	N/A	--	--
MW-157-12	Annual	Tritium	HU 6	5550	5920	--	--
MW-158-34	Annual	Tritium	HU 1-3	125.8	229.4	--	--
MW-161-48	Quarterly	Tritium	HU 6	79180	82140	76590	74370
MW-209-13	Annually	Tritium	HU 1-3	2778.7	--	--	--
MW-210-30	Annually	Tritium	HU 1-3	77.7	--	--	--
MW-215-12	Quarterly	Tritium	HU 1-3	9250	8880	9250	5920
MW-230-30	Quarterly	Tritium	HU 6	832500	888000	817700	817700
MW-234-30	Quarterly	Tritium	HU 6	3196800	2752800	3774000	3585300
MW-237-30	Quarterly	Tritium	HU 6	4625000	4551000	4329000	4255000
MW-239-30	Quarterly	Tritium	HU 6	11174000	11285000	10582000	9768000
MW-240-26	Annual	Tritium	HU 1-3	2960	--	--	--
MW-242-25	Quarterly	Tritium	HU 1-3	274910	227550	116920	105820
MW-243-29	Quarterly	Tritium	HU 1-3	45140	43660	39590	34780
MW-246-30	Quarterly	Tritium	HU 6	2268100	2297700	2075700	2038700
MW-247-35	Annual	Tritium	HU 6	632.7	--	--	--
MW-251-5	Quarterly	Tritium	HU 1-3	N/A	N/A	N/A	N/A
MW-257-5	Quarterly	Tritium	HU 1-3	N/A	N/A	N/A	N/A
MW-260-25	Quarterly	Tritium	HU 1-3	1591000	1605800	2149700	1846300
MW-261-25	Quarterly	Tritium	HU 1-3	112480	131720	67710	66970
MW-269-20	Quarterly	Tritium	HU 1-3	4847	5180	5550	4070
MW-270-20	Quarterly	Tritium	HU 1-3	38850000	44030000	30007000	17279000
MW-273-20	Quarterly	Tritium	HU 1-3	15207000	12728000	N/A	8473000
MW-301-15	Quarterly	Tritium	HU 1-3	19610	14060	N/A	14060
MW-302-40	Annual	Tritium	HU 6	55.5	--	--	--
MW-313-40	Semi-Annual	Tritium	HU 6	21830	--	139120	120250
MW-315-15	Quarterly	Tritium	HU 1-3	2416100	2009100	220520	135790
MW-318-40	Quarterly	Tritium	HU 6	3959	4884	4070	4810
MW-320-20	Quarterly	Tritium	HU 1-3	6327	7030	N/A	5180
MW-321-15	Quarterly	Tritium	HU 1-3	N/A	113960	N/A	58090
RBU2-GT-1 or GT-2	Quarterly	Tritium	HU 1-3	N/A	12432000	4736000	4662000
RBU2-GT-3 or GT-4	Quarterly	Tritium	HU 1-3	5587000	N/A	N/A	N/A
RBU3-GT-1 or GT-2	Quarterly	Tritium	HU 1-3	3996000	17390	12210	11100
RBU3-GT-3 or GT-4	Quarterly	Tritium	HU 1-3	N/A	N/A	N/A	N/A
RBU4-GT-1 or GT-2	Quarterly	Tritium	HU 1-3	N/A	N/A	N/A	N/A
RBU4-GT-3 or GT-4	Quarterly	Tritium	HU 1-3	N/A	N/A	N/A	N/A
U1-RBFD-1	Quarterly	Tritium	HU 1-3	117660000	69560000	36815000	26603000
U1-RBFD-2	Quarterly	Tritium	HU 1-3	112480000	72890000	27380000	19684000
U1-RBFD-3	Quarterly	Tritium	HU 1-3	19869000	8584000	5032000	4995000
U1-RBFD-4	Quarterly	Tritium	HU 1-3	N/A	N/A	N/A	N/A
VB Ramp Sump	Quarterly	Tritium	HU 1-3	3848000	4366000	2242200	1838900

Note:

Where multiple samples were collected, the maximum value was chosen to represent the value for that quarter.

**Table A-2: Units 5 to 8 and Units 5 to 8 Turbine Auxillary Bays**

Monitoring Location	Frequency	Analysis Parameters	HU <sup>a</sup>	Q1 (Bq/L)	Q2 (Bq/L)	Q3 (Bq/L)	Q4 (Bq/L)
IAD-SU-5	Quarterly	Tritium	HU 7	N/A	N/A	N/A	3330
IAD-SU-5-1	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-5-2	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-6	Quarterly	Tritium	HU 7	6660	3330	2590	3330
IAD-SU-6-1	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-6-2	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-7	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-7-1	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-7-2	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-8	Quarterly	Tritium	HU 7	36630	38110	34410	30340
IAD-SU-8-1	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
IAD-SU-8-2	Quarterly	Tritium	HU 7	N/A	N/A	N/A	N/A
MW-102-15	Annual	Tritium	HU 1-3	N/A	--	--	--
MW-170-25	Annual	Tritium	HU 1-3	1391.2	--	--	--
MW-180-40	Annual	Tritium	HU 6	<18.5	--	--	--
MW-181-57	Annual	Tritium	HU 7	196.1	--	--	--
MW-186-12	Annual	Tritium	HU 1-3	1332	--	--	--
MW-264-10	Annual	Tritium	HU 1-3	N/A	--	--	--
MW-265-12	Annual	Tritium	HU 1-3	4625	--	--	--
MW-266-19	Quarterly	Tritium	HU 1-3	N/A	59200	14800	18130
MW-267-17	Quarterly	Tritium	HU 1-3	29822	36260	8510	4440
MW-325-15	Annual	Tritium	HU 1-3	2475.3	2245.9	--	--
RBU5-GT-1	Quarterly	Tritium	HU 1-3	3811000	1938800	1709400	N/A
RBU5-GT-2	Quarterly	Tritium	HU 1-3	N/A	N/A	N/A	N/A
RBU5-GT-3	Quarterly	Tritium	HU 1-3	1842600	1724200	1653900	899100
RBU5-GT-4	Quarterly	Tritium	HU 1-3	1361600	4181000	1901800	N/A
RBU6-GT-1	Quarterly	Tritium	HU 1-3	N/A	N/A	N/A	N/A
RBU6-GT-2	Quarterly	Tritium	HU 1-3	19499000	13357000	20165000	N/A
RBU6-GT-3	Quarterly	Tritium	HU 1-3	24457000	7659000	N/A	N/A
RBU6-GT-4	Quarterly	Tritium	HU 1-3	30858000	9953000	22570000	3996000
RBU7-GT1 or GT-2	Quarterly	Tritium	HU 1-3	N/A	N/A	N/A	61420
RBU7-GT3 or GT-4	Quarterly	Tritium	HU 1-3	N/A	34040	721500	195360
RBU8-GT1 or GT-2	Quarterly	Tritium	HU 1-3	732600	1587300	925000	312650
RBU8-GT3 or GT-4	Quarterly	Tritium	HU 1-3	274170	788100	51800	N/A
U5 MK 26	Quarterly	Tritium	HU 1-3	N/A	4662000	2926700	N/A
U6 MK 30	Quarterly	Tritium	HU 1-3	9435000	5772000	3481700	N/A
U7 MK 36	Quarterly	Tritium	HU 1-3	86950	444000	19240	N/A
U8 MK 42	Quarterly	Tritium	HU 1-3	255670	267510	311540	N/A

Note:

Where multiple samples were collected, the maximum value was chosen to represent the value for that quarter.

**Table A-3: Units 1 to 8 Irradiated Fuel Bays**

Monitoring Location	Frequency	Analysis Parameters	HU <sup>a</sup>	Q1 (Bq/L)	Q2 (Bq/L)	Q3 (Bq/L)	Q4 (Bq/L)
<b>Unit 1-4 IFB</b>							
MW-056-18	Semi-Annual	Tritium	HU 1-3	5180	--	6660	--
MW-057-30	Quarterly	Tritium	HU 1-3	6660	6660	24790	6660
MW-062-42	Annual	Tritium	HU 7	1579.9	--	--	--
MW-244-18	Annual	Tritium	HU 1-3	588300	--	--	--
IFBA-GT-1A	Quarterly	Tritium	HU 6	3996000	4070000	4107000	4514000
IFBA-GT-2A	Quarterly	Tritium	HU 6	1935100	1986900	7511000	66970
IFBA-GT-4A	Quarterly	Tritium	HU 6	N/A	178710	53280	201650
IFBA-GT-5A	Quarterly	Tritium	HU 6	47730	63640	87320	562400
<b>Unit 5-8 IFB</b>							
MW-171-15	Quarterly	Tritium	HU 1-3	8510	7400	7400	8880
MW-172-25	Semi-Annually	Tritium	HU 1-3	12210	--	6660	--
IFBB-GT-1B	Quarterly	Tritium	HU 6	925000	1472600	1628000	1291300
IFBB-GT-2B	Quarterly	Tritium	HU 6	858400	1091500	3563100	4699000
IFBB-GT-3B	Quarterly	Tritium	HU 6	925000	1450400	3026600	8695000
IFBB-GT-4B	Quarterly	Tritium	HU 6	62900	55130	51060	66970
IFBB-GT-5B	Quarterly	Tritium	HU 6	207200	187960	183150	165760
IFBB-GT-6B	Quarterly	Tritium	HU 6	130980	144670	78440	87690

Note:

Where multiple samples were collected, the maximum value was chosen to represent the value for that quarter.

**Table A-4: Upgrading Plant Pickering**

Monitoring Well	Frequency	Analysis Parameters	HU <sup>a</sup>	Q1 (Bq/L)	Q2 (Bq/L)	Q3 (Bq/L)	Q4 (Bq/L)
MW-066-20	Annual	Tritium	HU 5/HU 6	185	--	--	--
MW-075-10	Annual	Tritium	HU 1-3	58460	--	--	--
MW-076-20	Annual	Tritium	HU 6	63270	--	--	--
MW-089-10	Annual	Tritium	HU 1-3	56610	--	--	--
MW-090-20	Quarterly	Tritium	HU 6	212380	202020	196840	200540
MW-091-35	Annual	Tritium	HU6/HU 7	21090	--	--	--
MW-093-20	Annual	Tritium	HU 5	847.3	--	--	--
MW-096-20	Annual	Tritium	HU 6	20646	--	--	--

Note:

Where multiple samples were collected, the maximum value was chosen to represent the value for that quarter.

**Table A-5a: Units 1 to 4 Standby Generators Analytical Results**

<b>Location</b>	<b>Quarter</b>	<b>Benzene</b>	<b>Toluene</b>	<b>Ethylbenzene</b>	<b>Xylene Total</b>	<b>PHC F1-BTEX</b>	<b>PHC F2</b>	<b>PHC F3</b>	<b>PHC F4</b>	<b>Dissolved Iron</b>
MW-287-15	Q2	<0.2	0.38	<0.2	<0.4	25	1700	570	<200	2900
	Q4	0.23	0.22	<0.2	<0.4	<25	2100	780	<200	3800

**Table A-5b: Units 1 to 4 Standby Generators Product Thicknesses**

Year	Quarter	MW-137-15	MW-138-15	MW-286-15	MW-287-15	MW-340-28	MW-344-17
2011	Q1	ND	ND	ND	--	ND	ND
	Q2	ND	ND	ND	--	ND	ND
	Q3	ND	0.051	ND	--	ND	ND
	Q4	0.082	0.002	0.120	--	0.0280	0.019
2012	Q1	0.003	ND	0.001	--	0.0350	ND
	Q2	0.180	0.005	0.105	--	0.0100	0.07
	Q3	0.100	0.030	0.002	--	0.0210	ND
	Q4	0.005	0.050	0.033	--	0.0220	ND
2013	Q1	0.002	0.001	0.037	--	0.0020	ND
	Q2	0.004	ND	0.068	--	ND	ND
	Q3	ND	ND	0.225	--	ND	ND
2014	Q2	0.130	0.007	0.095	--	ND	0.002
	Q3	0.100	0.001	0.100	--	0.001	0.001
	Q4	0.145	0.020	0.103	--	ND	0.008
2015	Q2	0.135	ND	0.023	--	ND	0.012
	Q3	ND	ND	ND	--	ND	ND
	Q4	0.200	ND	0.137	--	ND	0.047
2016	Q2	0.193	ND	0.194	--	ND	ND
2018	Q2	0.249	0.053	0.372	--	0.492	0.009
	Q3	0.311	ND	ND	--	0.404	ND
	Q4	0.001	0.807	ND	--	0.190	ND
2020	Q3	ND	0.078	ND	--	ND	ND
	Q4	0.195	0.38	ND	--	0.060	ND
2021	Q1	0.256	0.086	0.208	0.084	0.114	0.080
	Q2	0.168	0.268	0.082	ND	0.012	0.058
	Q3	0.028	0.001	0.084	0.001	0.102	0.005
	Q4	0.104	0.017	0.18	ND	0.002	0.002

Notes:

"--": product thickness was not measured

"ND" : No detectable product

**Table A-6: Site Perimeter Wells**

Monitoring Well	Frequency	Analysis Parameters	HU	Q1 (Bq/L)	Q2 (Bq/L)	Q3 (Bq/L)	Q4 (Bq/L)
<b>Boundary Wells</b>							
MW-156-20	Annual	Tritium	HU 4-6	--	N/A	--	--
MW-176-23	Annual	Tritium	HU 5	33.3	<18.5	--	--
MW-177-35	Annual	Tritium	HU 6	33.3	<18.5	--	--
MW-185-39	Annual	Tritium	HU 7	25.9	<18.5	--	--
MW-192-18	Annual	Tritium	HU 5	373.7	329.3	--	--
MW-193-37	Annual	Tritium	HU 6	259	259	--	--
MW-194-57	Annual	Tritium	HU 7	<18.5	<18.5	--	--
MW-195-73	Annual	Tritium	HU 8	<18.5	N/A	--	--
MW-197-15	Annual	Tritium	HU 5 / HU 6	--	N/A	--	--
MW-198-20	Annual	Tritium	HU 5 / HU 6	181.3	133.2	--	--
MW-199-38	Annual	Tritium	HU 6	<18.5	<18.5	--	--
MW-200-22	Annual	Tritium	HU 6	325.6	329.3	--	--
MW-201-39	Annual	Tritium	HU 7	<18.5	<18.5	--	--
MW-204-24	Annual	Tritium	HU 6	125.8	114.7	--	--
MW-205-35	Annual	Tritium	HU 6	148	88.8	--	--
MW-206-65	Annual	Tritium	HU 7	<18.5	<18.5	--	--
MW-207-87	Annual	Tritium	HU 8	<18.5	<18.5	--	--
MW-216-15	Annual	Tritium	HU 5 / HU 6	251.6	188.7	--	--
MW-217-32	Annual	Tritium	HU 7	<18.5	188.7	--	--
MW-224-42	Annual	Tritium	HU 7	691.9	651.2	--	--
MW-227-40	Annual	Tritium	HU 6	<18.5	<18.5	--	--
MW-228-57	Annual	Tritium	HU 7	<18.5	25.9	--	--
MW-229-70	Annual	Tritium	HU 8	--	N/A	--	--
<b>Shoreline Wells</b>							
MW-164-13*	Annual	Tritium	HU 1-3	3337.4	3330	--	--
MW-165-24*	Annual	Tritium	HU 6	473.6	421.8	--	--
MW-225-12*	Annual	Tritium	HU 1-3	1154.4	1502.2	--	--
MW-226-22*	Quarterly	Tritium	HU 6	3700	3922	4070	4070
MW-183-10*	Annual	Tritium	HU 1-3	1021.2	1013.8	--	--
MW-184-27*	Annual	Tritium	HU 5 / HU 6	81.4	<18.5	--	--
MW-222-10*	Annual	Tritium	HU 1-3	688.2	651.2	--	--
MW-223-32*	Annual	Tritium	HU 6 / HU 7	714.1	717.8	--	--

**Table A-7a: Quality Control Results, Duplicate Samples and Relative Percent Differences (RPD)**

Location	Sample Date	Tritium Sample Values (Bq/L)		RPD (%)
		Duplicate	Primary	
IFBB-GT-1B	13-Mar-2021	943500	925000	0.5
	13-Jun-2021	1491100	1472600	0.3
	23-Sep-2021	1291300	1628000	5.8
	23-Sep-2021	1609500	1628000	0.3
MW-057-30	22-Mar-2021	7030	6660	1.4
	06-Apr-2021	6290	6660	1.4
	19-Sep-2021	24050	24790	0.8
	05-Oct-2021	6660	6660	0.0
MW-076-20	09-Mar-2021	64010	63270	0.3
MW-157-12	06-Apr-2021	0.16	0.139	3.5
MW-161-48	08-Mar-2021	79180	79180	0.0
	17-May-2021	82140	82140	0.0
	20-Sep-2021	72150	76590	1.5
	05-Oct-2021	75110	74370	0.2
MW-170-25	09-Mar-2021	1224.7	1391.2	3.2
MW-192-18	23-Feb-2021	373.7	373.7	0.0
	25-May-2021	358.9	329.3	2.2
MW-222-10	10-Feb-2021	669.7	688.2	0.7
	05-Apr-2021	625.3	651.2	1.0
MW-242-25	23-Mar-2021	270470	274910	0.4
	24-May-2021	229030	227550	0.2
	22-Sep-2021	118400	116920	0.3
	18-Oct-2021	102120	105820	0.9
MW-267-17	07-Mar-2021	29563	29822	0.2
	17-May-2021	28120	36260	6.3
	20-Sep-2021	7770	8510	2.3
	06-Oct-2021	3330	4440	7.1
MW-301-15	08-Mar-2021	25160	19610	6.2
	06-Apr-2021	15540	14060	2.5
	06-Oct-2021	14060	14060	0.0
MW-325-15	09-03-2021	2246	2475	2.4
U7 MK 36	15-Mar-2021	96940	86950	2.7
	18-May-2021	440300	444000	0.2
	21-Sep-2021	19240	19240	0.0
VB Ramp Sump	28-Mar-2021	3848000	3848000	0.0
	17-May-2021	3385500	3441000	0.4
	06-Sep-2021	2201500	2242200	0.5
	21-Dec-2021	1546600	1539200	0.1
MW-287-15 (Benzene)	10-May-2021	0.21	<0.2	N/A
	02-Nov-2021	0.24	0.23	1.1
MW-287-15 (Toluene)	10-May-2021	0.38	0.38	0.0
	02-Nov-2021	0.24	0.22	2.2
MW-287-15 (Ethylbenzene)	10-May-2021	0.2	<0.2	N/A
	02-Nov-2021	<0.2	<0.2	N/A
MW-287-15 (Total Xylenes)	10-May-2021	<0.4	<0.4	N/A
	02-Nov-2021	<0.4	<0.4	N/A
MW-287-15 (PHC F1)	10-May-2021	<25	25	N/A
	02-Nov-2021	<25	<25	N/A
MW-287-15 (PHC F2)	10-May-2021	1800	1700	1.4
	02-Nov-2021	1900	2100	2.5
MW-287-15 (PHC F3)	10-May-2021	630	570	2.5
	02-Nov-2021	850	780	2.1
MW-287-15 (PHC F4)	10-May-2021	<200	<200	N/A
	02-Nov-2021	<200	<200	N/A
MW-287-15 (Dissolved Iron)	10-May-2021	2700	2900	1.8
	02-Nov-2021	3800	3800	0.0

Notes:

Samples were analyzed for Tritium unless otherwise specified  
N/A : RPDs could not be calculated as at least one sample value was below detection

**Table A-7b: Quality Control Results, Trip and Field Blank Sample Results**

Sample Type	Parameter	Sample Result ( $\mu\text{g/L}$ )	
		Q2 (10-May-21)	Q4 (02-Nov-21)
Field Blank	Benzene	<0.2	<0.2
	Toluene	<0.2	<0.2
	Ethylbenzene	<0.2	<0.2
	Xylene Total	<0.4	<0.4
	PHC F1-BTEX	<25	<25
	PHC F2	<100	<100
	PHC F3	<200	<200
	PHC F4	<200	<200
Trip Blank	Benzene	<0.2	<0.2
	Toluene	<0.2	<0.2
	Ethylbenzene	<0.2	<0.2
	Xylene Total	<0.4	<0.4
	PHC F1-BTEX	<25	<25
	PHC F2	<100	<100
	PHC F3	<200	<200
	PHC F4	<200	<200