ONTARIO POWER GENERATION | **Report**

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2023 Darlington Nuclear Groundwater Monitoring Program Results

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Table of Contents

Page

List of Figures, Graphs and Table

Page

Revision Summary

Revision Number	Date	Comments
000	2024-08-06	Initial issue.

Land Acknowledgement

The lands and waters on which the Darlington Nuclear Generating Station (DNGS) is situated are within the traditional and treaty territory of the Williams Treaties First Nations, which includes Curve Lake First Nation, Hiawatha First Nation, Alderville First Nation, Chippewas of Beausoleil First Nation, Chippewas of Georgina Island First Nation, Chippewas of Rama First Nation, and the Mississaugas of Scugog Island First Nation.

The DNGS is within the territory of the Gunshot Treaty and the Williams Treaties of 1923. The Gunshot Treaty Rights were reaffirmed in 2018 in a settlement with Canada and the Province of Ontario.

To acknowledge the treaty and traditional territory, is to recognize the rights of the First Nations. It is to recognize the history of the land, predating the establishment of the earliest European colonies. It is also to acknowledge the significance for the Indigenous peoples who lived and continue to live upon it, to acknowledge the people whose practices and spiritualties are tied to the land and water and continue to develop in relation to the territory and its other inhabitants today.

ALDERVILLE FIRST NATION · BEAUSOLEIL FIRST NATION · CURVE LAKE FIRST NATION · GEORGINA ISLAND FIRST NATION · HIAWATHA FIRST NATION · SCUGOG ISLAND FIRST NATION · RAMA FIRST NATION

Executive Summary

Darlington Nuclear (DN), comprised of the Darlington Nuclear Generating Station (DNGS) and Darlington New Nuclear Project (DNNP) has a mature and robust groundwater monitoring program in place to address the following primary objectives:

- Objective 1: Monitor changes to on-site groundwater quality to ensure timely detection of inadvertent releases to groundwater;
- Objective 2: Ensure that there are no adverse off-site impacts from DNGS groundwater;
- Objective 3: Monitor groundwater flow conditions and groundwater quality during site preparation at the DNNP; and
- Objective 4: Confirm predominant on-site groundwater flow characteristics at the DNGS site.

The findings in 2023 with respect to the above objectives are:

- Objective 1: Groundwater data collected from the system structures and components indicate tritium, petroleum hydrocarbons (PHCs), benzene, toluene, ethylbenzene and total xylene (BTEX) concentrations are consistent with historical results.
- Objective 2: Tritium, PHC and BTEX concentrations within the upgradient and downgradient site perimeter wells are generally within historical ranges. No off-site effects of tritium in groundwater are observed.
- Objective 3: Groundwater flow conditions in Q2 and Q4 2023 at the DNNP are consistent with historical interpretations.
- Objective 4: The predominant groundwater flow patterns remain unchanged in 2023 from the recent years' interpretations.

1.0 INTRODUCTION

Ontario Power Generation (OPG), Darlington Nuclear (DN) site, comprised of Darlington Nuclear Generating Station (DNGS) and Darlington New Nuclear Project (DNNP), 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 four primary objectives are addressed by specific objectives detailed in the Canadian Standards Association (CSA) N288.7 (CSA, 2015) compliant DN Groundwater Protection and Monitoring Program (GWPMP) (Ecometrix, 2023a):

- **Objective 1:** Monitor changes to on-site groundwater quality to ensure timely detection of inadvertent releases to groundwater;
  - Tritium concentrations in groundwater near systems structures and components (SSCs)
  - Petroleum Hydrocarbons (PHCs) in groundwater near SSCs
- **Objective 2:** Ensure that there are no adverse off-site impacts from DNGS groundwater.
  - Tritium and PHC concentrations in groundwater in perimeter wells – monitor tritium and PHCs in site perimeter wells to establish tritium concentrations at the DN site boundaries and to confirm no adverse off-site impacts
- **Objective 3:** Monitor groundwater flow conditions and groundwater quality during site preparation at the DNNP
  - Hydraulic Head Measurements – provide head measurements in selected monitoring wells to confirm the groundwater flow conditions across the DNNP site
  - Monitor indicator parameters to understand changes in groundwater quality
- **Objective 4:** Confirm predominant on-site groundwater flow characteristics across the DN site;
  - Hydraulic Head Measurements – provide head measurements in selected monitoring wells to confirm the groundwater flow conditions across the DN site and to support the interpretation of constituent migration in groundwater.

The groundwater sampling and monitoring program conducted in 2023 followed the DN Sampling and Analysis Plan (SAP) for 2023 (OPG, 2023). This report presents groundwater data collected at DN for the period from January 1st to December 31st, 2023.

1.1 Summary of Hydrogeological Characteristics at the DN Site

Six hydrostratigraphic units (HUs) have been identified beneath DN through historical assessments. Of the 6 HUs, 3 main groundwater flow systems have been identified for the site:

- Shallow overburden groundwater system
  - Within the Protected Area of the DNGS this is referred to as HU PA, comprised primarily of fill materials
  - Outside the Protected Area, this is referred to as HU 1
- Deep overburden groundwater system (HU 2 as well as HU 3 to a limited extent)
- Shallow bedrock groundwater system (HU 5)

HU 3 and HU 4 are not always observed, and where they are observed, are generally thin and grouped into the intermediate overburden groundwater system. The deep overburden groundwater system (HU 2) likely represents aquifer conditions (SENES, 2009). In addition, more permeable conditions representing aquifers are thought to be present in the fill materials (HU 1) and upper bedrock surface (HU 5) which is weathered and fractured.

2.0 2023 PROGRAM DESIGN

The groundwater monitoring program design is detailed in the DN GWPMP (Ecometrix, 2023a). The N288.7-compliant 2023 SAP was developed to meet the relevant components of the objectives listed above.

Groundwater quality results are provided in Appendix A

2.1 Objective 1 Methodology: Constituents near SSCs

The methodology for the objective to monitor changes to on-site groundwater quality to ensure timely detection of inadvertent releases to groundwater is described in this section.

2.1.1 Tritium Concentrations in Groundwater Near SSCs

In 2023, as per the SAP, groundwater samples were collected from 16 monitoring wells near the vicinity of the Powerhouse, the Heavy Water Management Building (HWMB), Tritium Removal Facility (TRF) and Active Liquid Waste (ALW) collection and treatment system. Figure 1 shows the locations that were monitored.

Additionally, as per the SAP, groundwater samples were collected from 3 monitoring wells near the building effluent lagoon. Figure 2 shows the locations that were monitored.

The 2023 SAP specified the sampling locations and frequency (e.g., quarterly, annually) of sampling tritium concentrations in groundwater at each location.

Water levels were measured in each monitoring well prior to the collection of samples by OPG technicians. Following measurement of the water level and prior to sample collection, each monitoring well was purged to remove standing water or sampled using low flow methodology, ensuring that the groundwater collected had a quality representative of subsurface conditions. Collected samples were analyzed for tritium concentrations by Bureau Veritas.

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

2.1.2 PHC concentrations in Groundwater Near SSCs

In 2023, as per the SAP, groundwater samples were collected from 13 monitoring wells near the Emergency Power Supply (EPS) Fuel Management system, Standby Generators (SGs) and Auxiliary Steam Heating Facility (ASHF). Figure 3 shows the locations that were monitored. The 2023 SAP specified the sampling locations and frequency (e.g., quarterly, annually) of sampling for PHCs and benzene, toluene, ethylbenzene, and total xylenes (BTEX) in groundwater at each location.

The methodology for groundwater collection was the same as what is described above for tritium. Collected samples were analyzed for PHC and BTEX concentrations by Bureau Veritas.

Sample results of groundwater PHC and BTEX concentrations for Objective 1 are presented in Appendix A (Table A-3).

2.2 Objective 2 Methodology: Perimeter Wells

The methodology for objective 2 to ensure that there are no adverse off-site impacts from DNGS groundwater is described in this section.

The 2023 SAP included the sampling of monitoring wells at the site boundary to confirm that there are no adverse off-site impacts from DN groundwater as well as to confirm upgradient groundwater quality near the site boundary. 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. Wells downgradient to the SSCs are also monitored to assess off-site impacts to groundwater quality. Figure 4 shows the locations of the site perimeter wells. Analytical results for monitoring wells sampled at the upgradient perimeter monitoring wells are presented in Table A-4 (Appendix A), and analytical results for monitoring wells sampled at downgradient monitoring wells are presented in Table A-5a and Table A-5b (Appendix A).

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: DNNP

The methodology to monitor groundwater flow conditions and groundwater quality during site preparation at the DNNP is described in this section.

The 2023 SAP included collecting water level measurements and collecting groundwater samples from 25 monitoring wells to confirm groundwater flow interpretations and groundwater quality. Groundwater samples were analyzed for indicator parameters: sodium (Na), calcium (Ca), magnesium (Mg), potassium (K), bicarbonate (HCO_3^-), carbonate (CO_3^{2-}), chloride (Cl), sulphate (SO_4^{2-}), iron (Fe) and general parameters: pH, electrical conductivity (EC) and total dissolved solids (TDS). The locations monitored for Objective 3 are shown in Figure 5. The analytical results are provided in Table A-6 (Appendix A).

2.4 Objective 4 Methodology: Groundwater Flow

The methodology for the objective to confirm predominant on-site groundwater flow characteristics across the DN site is described in this section.

Detailed interpretation of groundwater flow conditions beneath the DNGS was first carried out in 2010 and flow conditions are summarized in the GWPMP. On an annual basis, the GWPMP requires a set of water levels be collected from several 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 the second quarter (Q2) of 2023, water level readings were collected from monitoring well locations across the site over a period of 7 days (May 4 to 10, 2023). The data was subsequently used to calculate the groundwater elevation at each monitoring well. The resulting groundwater elevations and the average daily mean Lake Ontario water levels collected between May 4 and May 10, 2023 (IJC, 2023) were used to generate groundwater elevation contours, from which groundwater flow directions are inferred.

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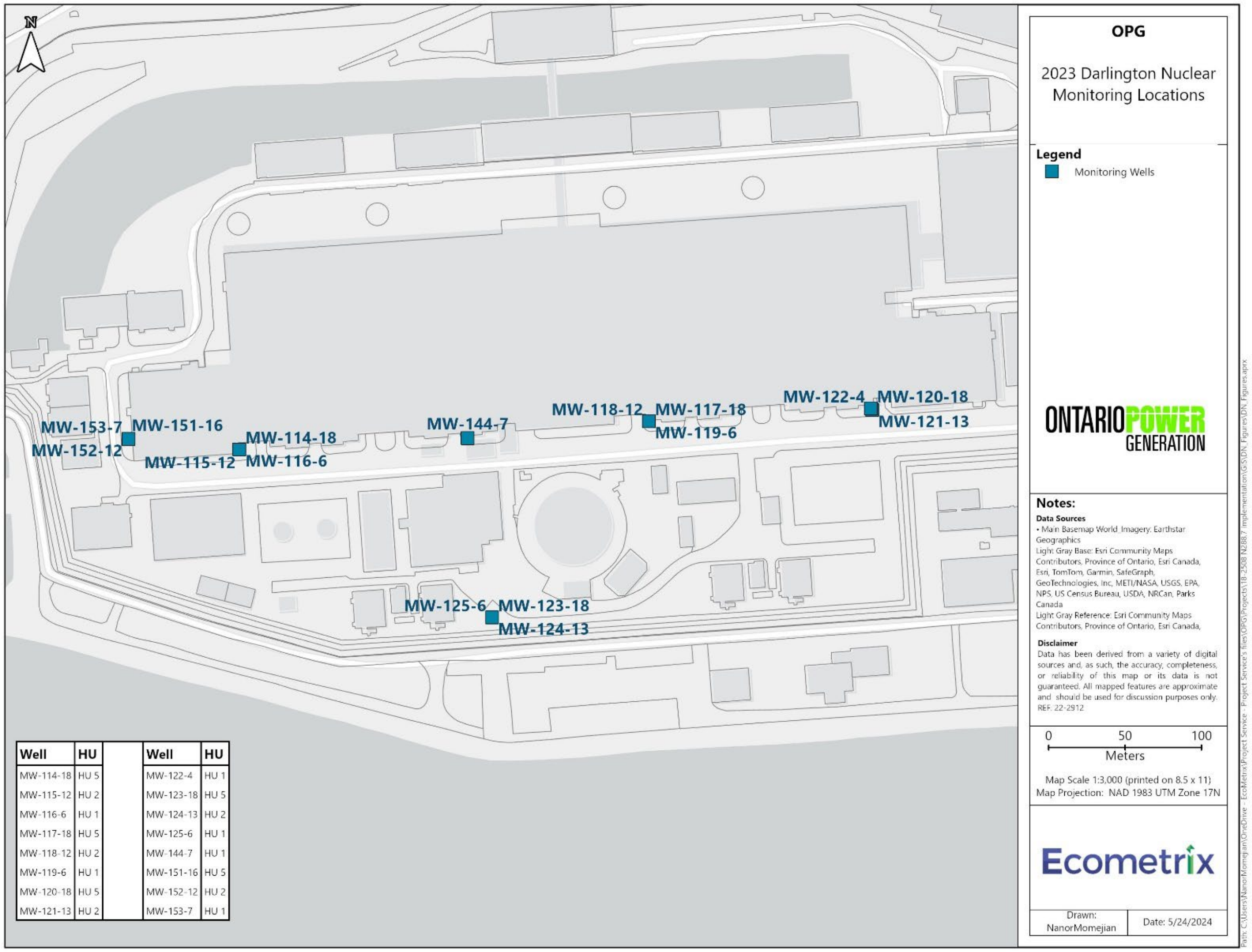


Figure 1: 2023 Monitoring Locations – Tritium in groundwater near HWMB, TRF, ALW Collection system, ALW Treatment system

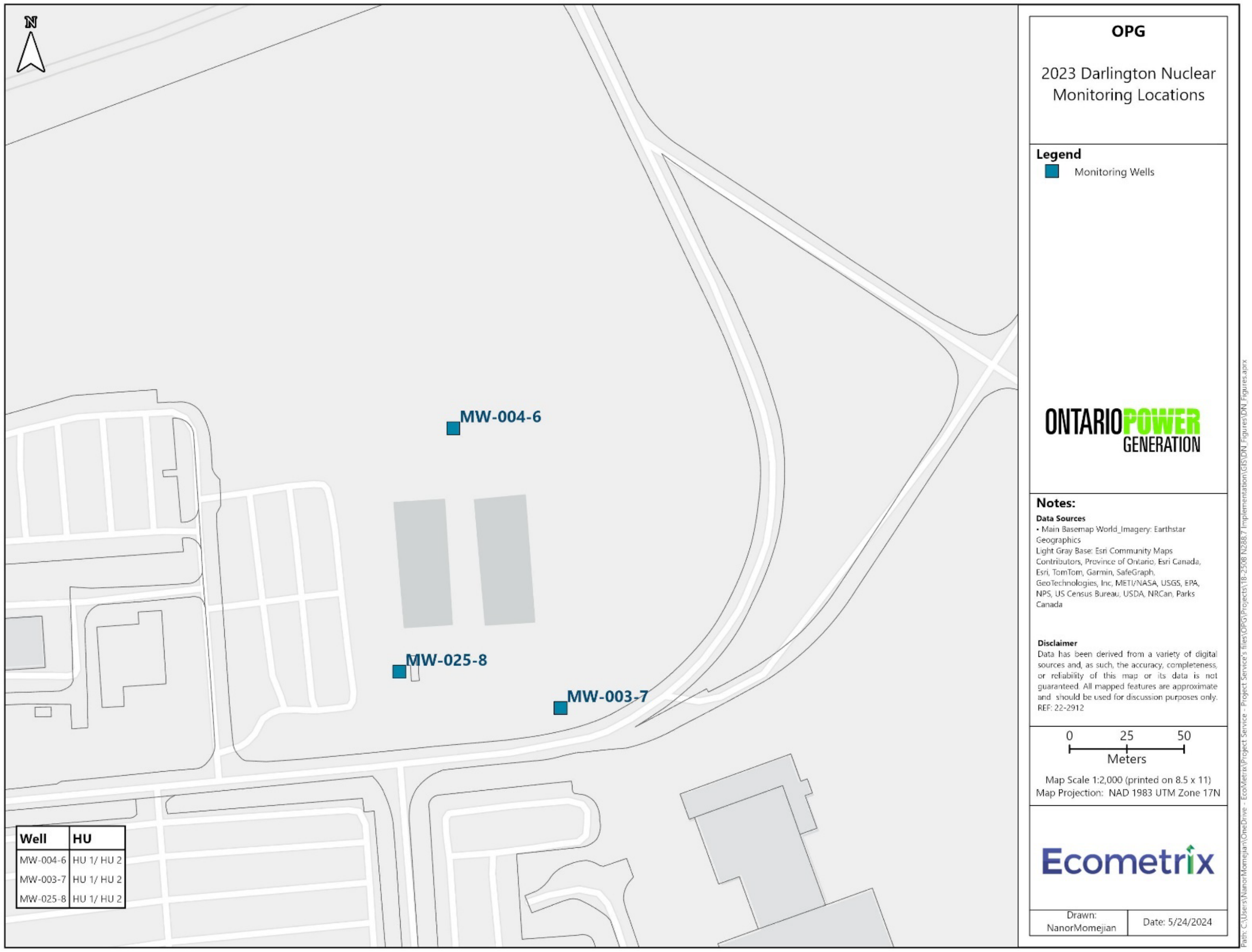


Figure 2: 2023 Monitoring Locations – Tritium in groundwater near Building Effluent Lagoons

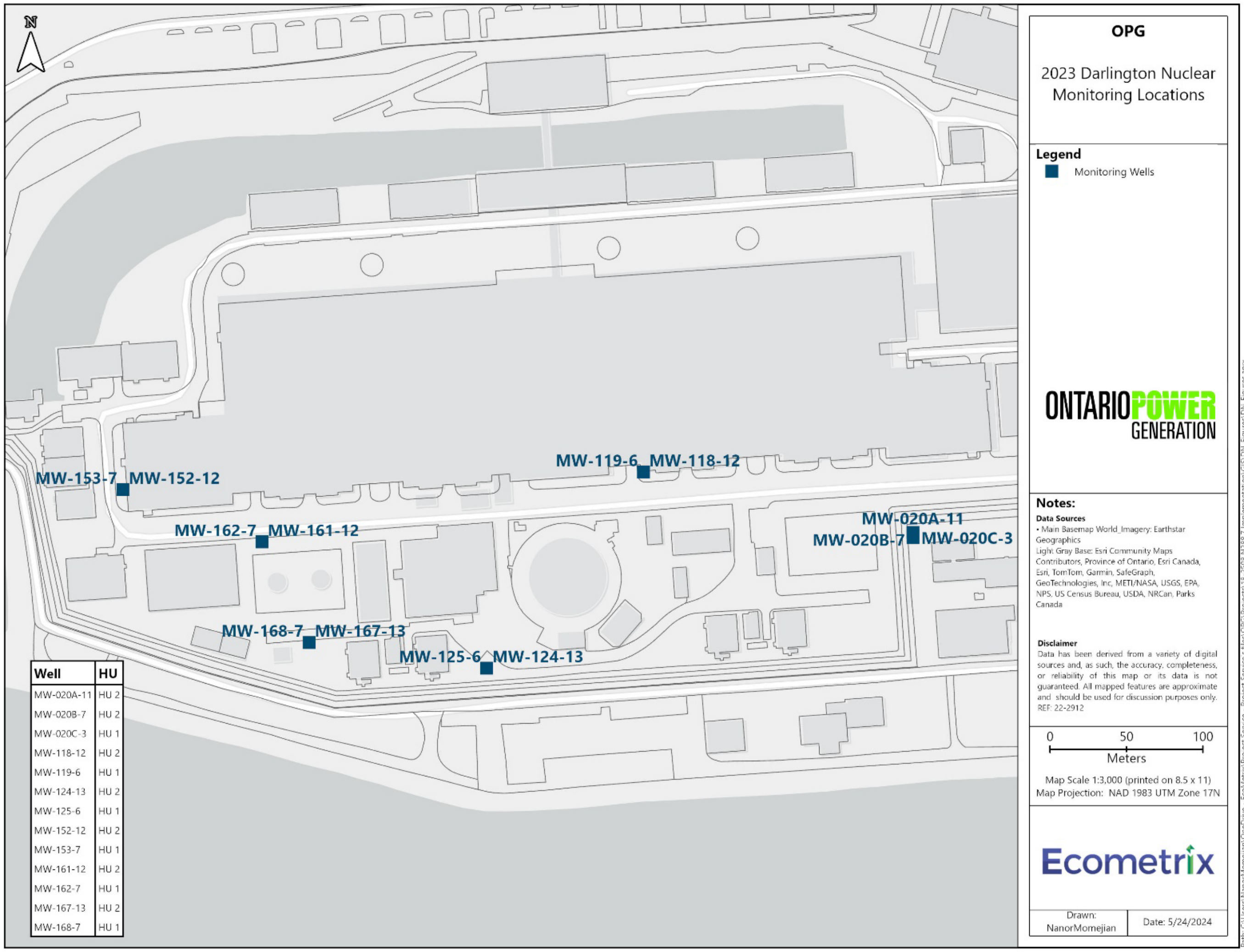
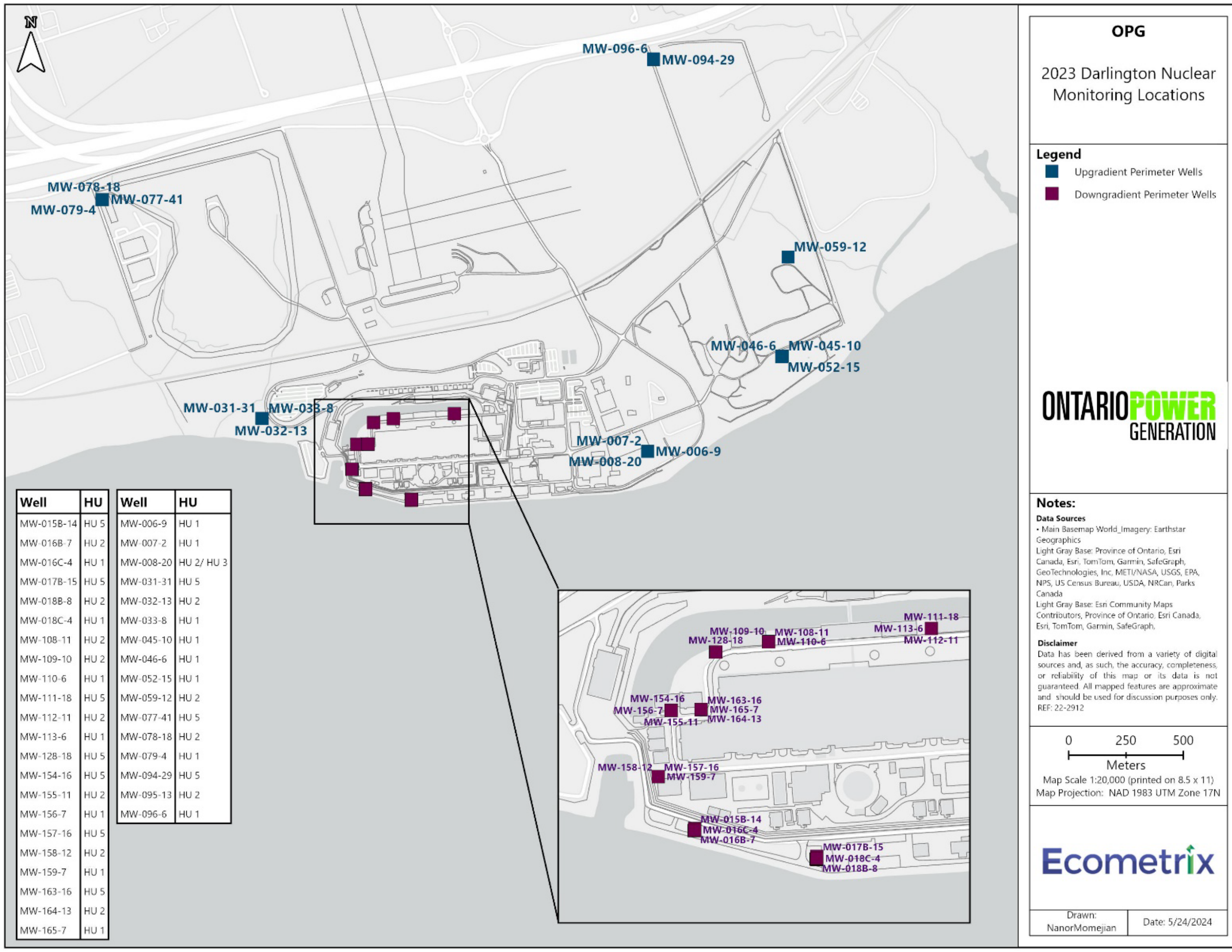


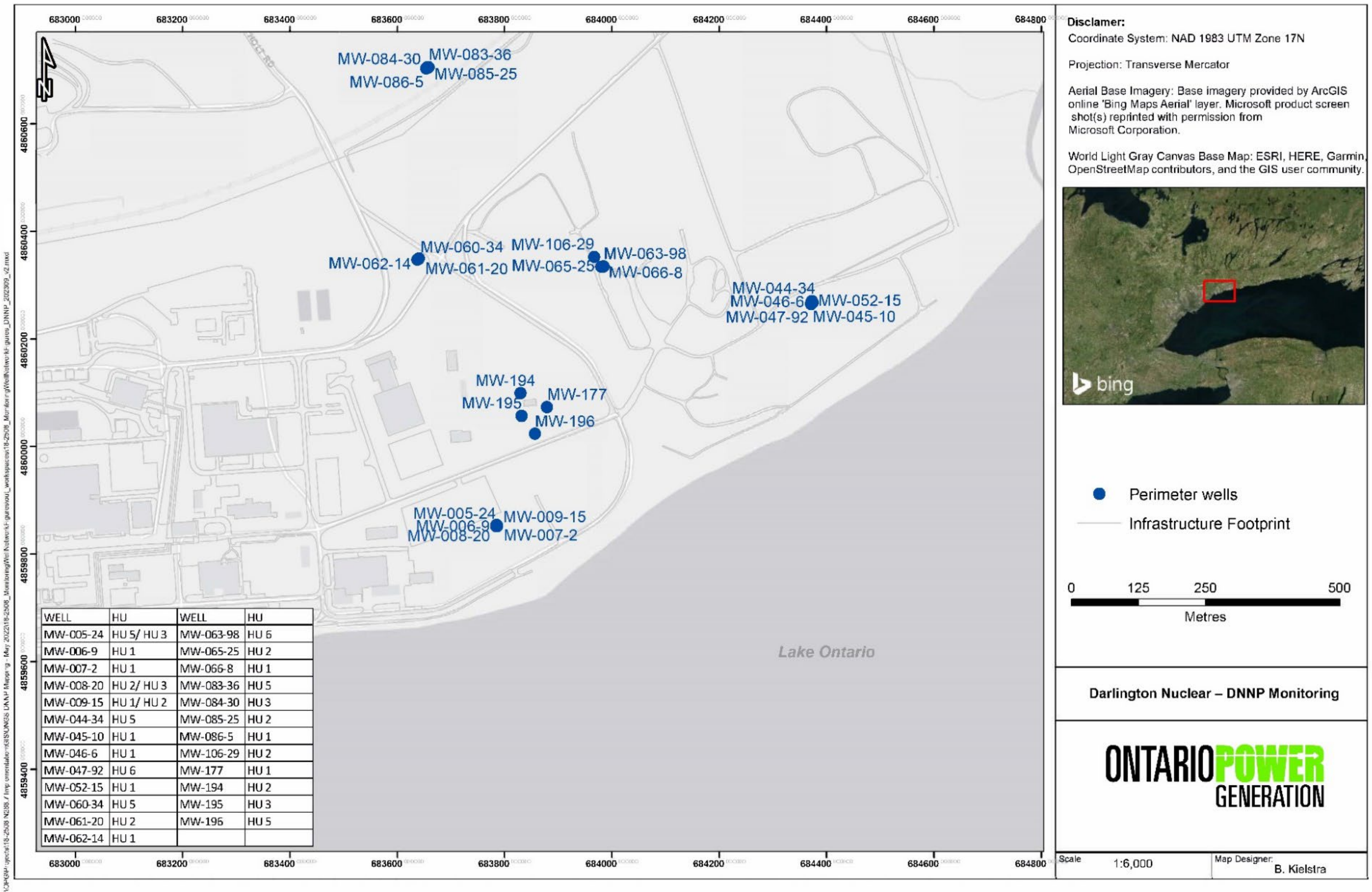
Figure 3: 2023 Monitoring Locations – PHCs in groundwater near the EPS Fuel Management system, SGs, and ASHF



Well	HU
MW-015B-14	HU 5
MW-016B-7	HU 2
MW-016C-4	HU 1
MW-017B-15	HU 5
MW-018B-8	HU 2
MW-018C-4	HU 1
MW-108-11	HU 2
MW-109-10	HU 2
MW-110-6	HU 1
MW-111-18	HU 5
MW-112-11	HU 2
MW-113-6	HU 1
MW-128-18	HU 5
MW-154-16	HU 5
MW-155-11	HU 2
MW-156-7	HU 1
MW-157-16	HU 5
MW-158-12	HU 2
MW-159-7	HU 1
MW-163-16	HU 5
MW-164-13	HU 2
MW-165-7	HU 1

Well	HU
MW-006-9	HU 1
MW-007-2	HU 1
MW-008-20	HU 2/ HU 3
MW-031-31	HU 5
MW-032-13	HU 2
MW-033-8	HU 1
MW-045-10	HU 1
MW-046-6	HU 1
MW-052-15	HU 1
MW-059-12	HU 2
MW-077-41	HU 5
MW-078-18	HU 2
MW-079-4	HU 1
MW-094-29	HU 5
MW-095-13	HU 2
MW-096-6	HU 1

Figure 4: 2023 Monitoring Locations – Tritium and PHCs in groundwater near DN perimeter



WELL	HU	WELL	HU
MW-005-24	HU 5/ HU 3	MW-063-98	HU 6
MW-006-9	HU 1	MW-065-25	HU 2
MW-007-2	HU 1	MW-066-8	HU 1
MW-008-20	HU 2/ HU 3	MW-083-36	HU 5
MW-009-15	HU 1/ HU 2	MW-084-30	HU 3
MW-044-34	HU 5	MW-085-25	HU 2
MW-045-10	HU 1	MW-086-5	HU 1
MW-046-6	HU 1	MW-106-29	HU 2
MW-047-92	HU 6	MW-177	HU 1
MW-052-15	HU 1	MW-194	HU 2
MW-060-34	HU 5	MW-195	HU 3
MW-061-20	HU 2	MW-196	HU 5
MW-062-14	HU 1		

Figure 5: 2023 Monitoring Locations – DNNP

3.0 2023 PROGRAM RESULTS

3.1 Objective 1 Results: Constituents near SSCs

The results for the objective to monitor changes to on-site groundwater quality to ensure timely detection of inadvertent releases to groundwater are described in this section.

3.1.1 Tritium in Groundwater Near SSCs

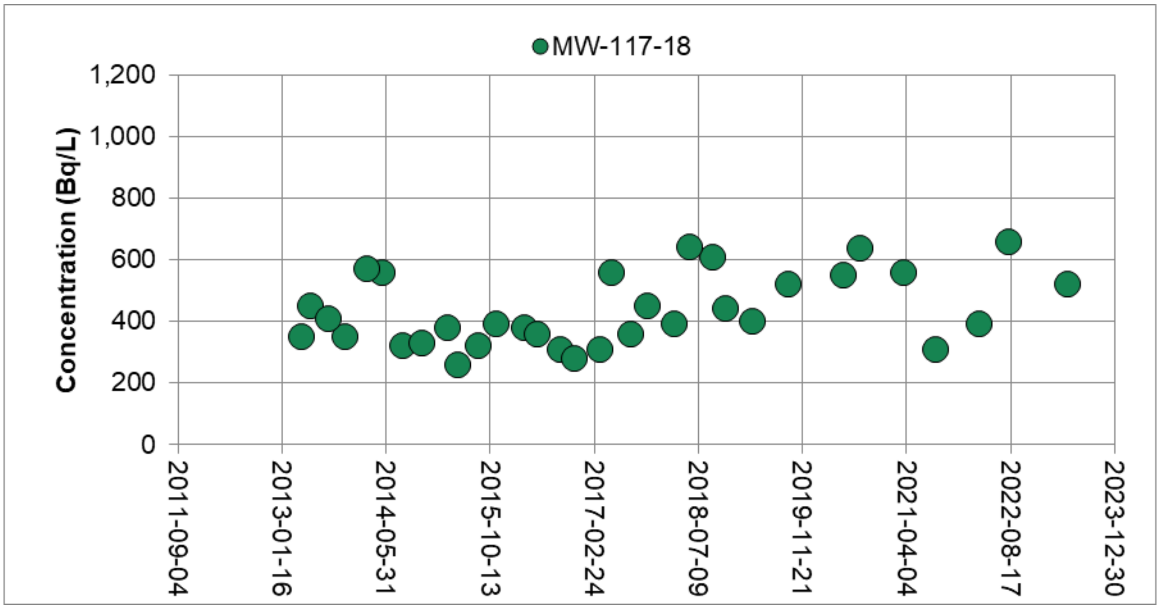
Within the protected area, and to a lesser extent outside of that, tritium concentrations in groundwater will have a background contribution from tritium air emissions associated with DNGS operations. Tritium in air emissions enter groundwater through the infiltration of wet deposition/precipitation. OPG carried out a precipitation sampling program that spanned two years (February 2009 to March 2011) in which tritium was sampled in the collected rainwater at twelve (12) locations within the protected area (CH2M Hill, 2011). Tritium concentrations in precipitation showed variability over time and space, as would be expected with changing seasonal weather conditions. The maximum concentration measured in precipitation was 1,924 Bq/L (CH2M Hill, 2011). This value is considered to appropriately bound expected background water quality conditions concerning tritium in groundwater within the protected area.

The groundwater data collected near SSCs indicate that tritium concentrations in groundwater have remained, consistent with results for previous years, and are otherwise within the range of expected fluctuations resulting from ongoing operations or represent the expected movement of historical tritium in groundwater.

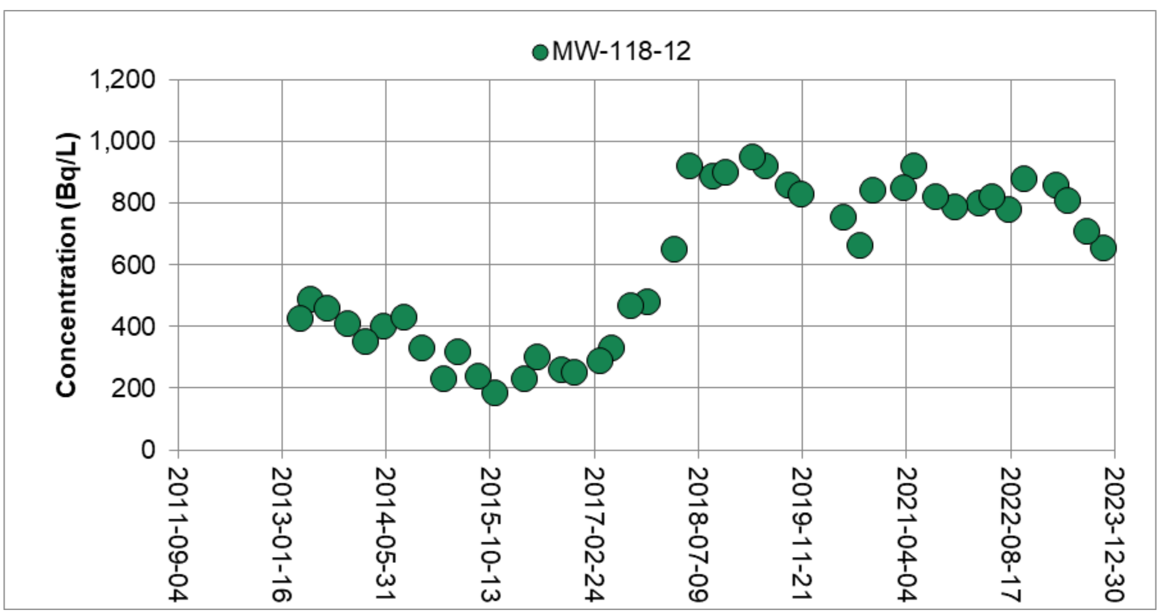
3.1.1.1 Tritium in Groundwater near the Powerhouse, HWMF, TRF and ALW collection and treatment system

In 2023, 16 monitoring wells were sampled for the analysis of tritium within the vicinity of the Powerhouse, HWMF, TRF and ALW collection and treatment system, located within the Protected Area. Analytical results for all wells sampled are provided in Appendix A and tritium concentrations are summarized in Figure 6 for HU 1, HU 2 and HU 5. For Figure 6, to simplify the presentation of data, and as a conservative approach, the annual maximum tritium concentration at each well is presented.

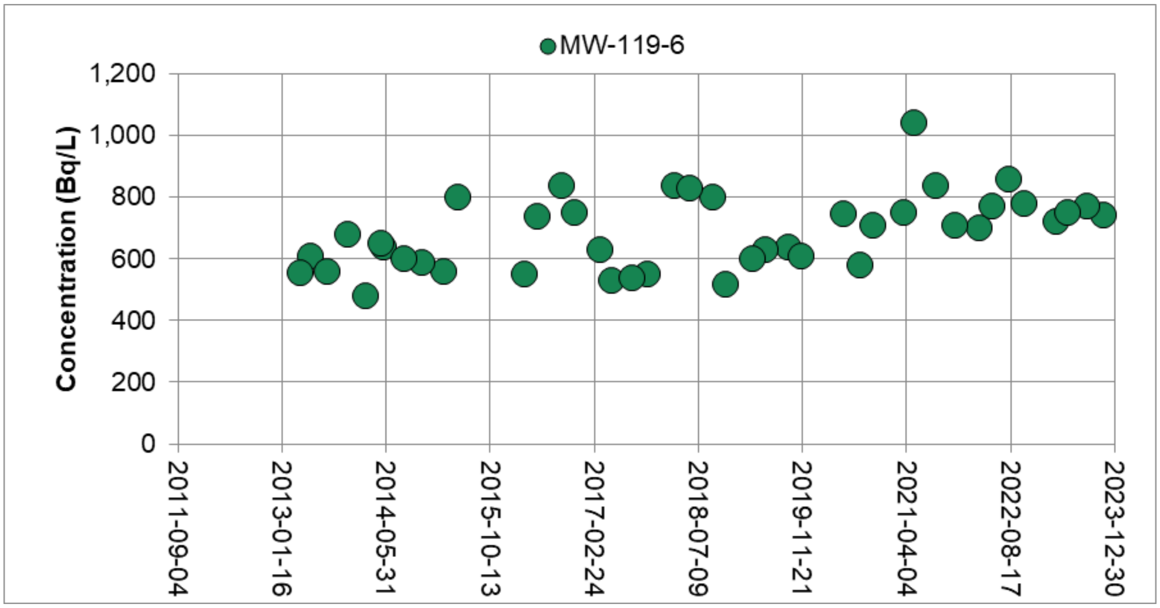
In general, 2023 groundwater results near the Powerhouse, HWMF, TRF and ALW collection and treatment system remained within historical ranges reflective of routine operations. Graphs 1 to 7 display tritium concentrations over time at MW-117-18, MW-118-12, MW-119-6, MW-120-18, MW-121-13, MW-122-4 and MW-123-18.



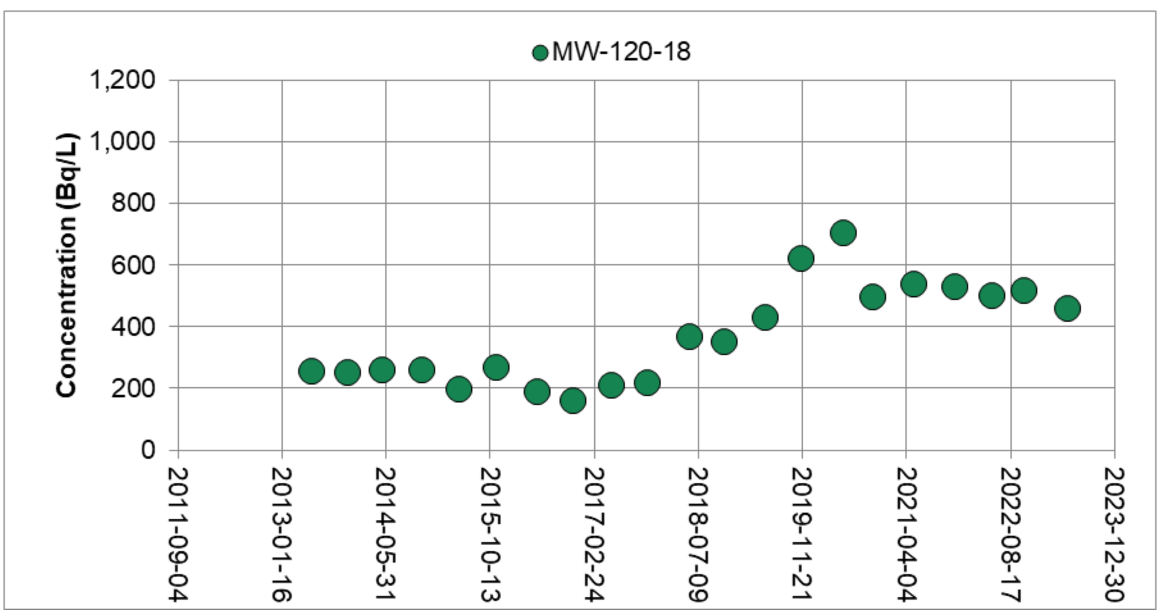
Graph 1: MW-117-18 Tritium Data



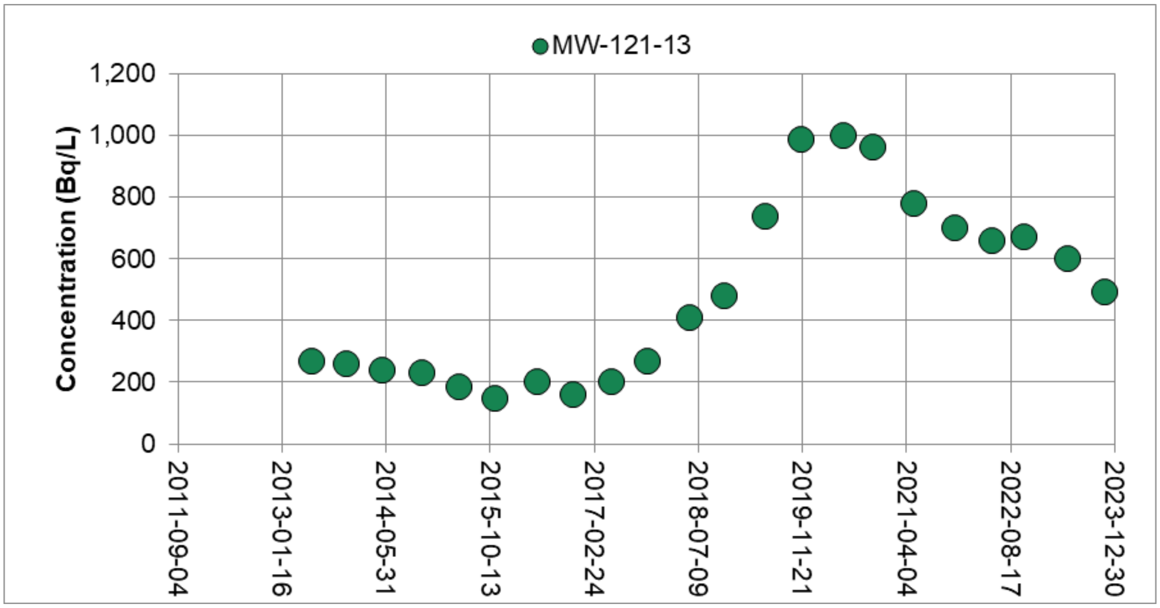
Graph 2: MW-118-12 Tritium Data



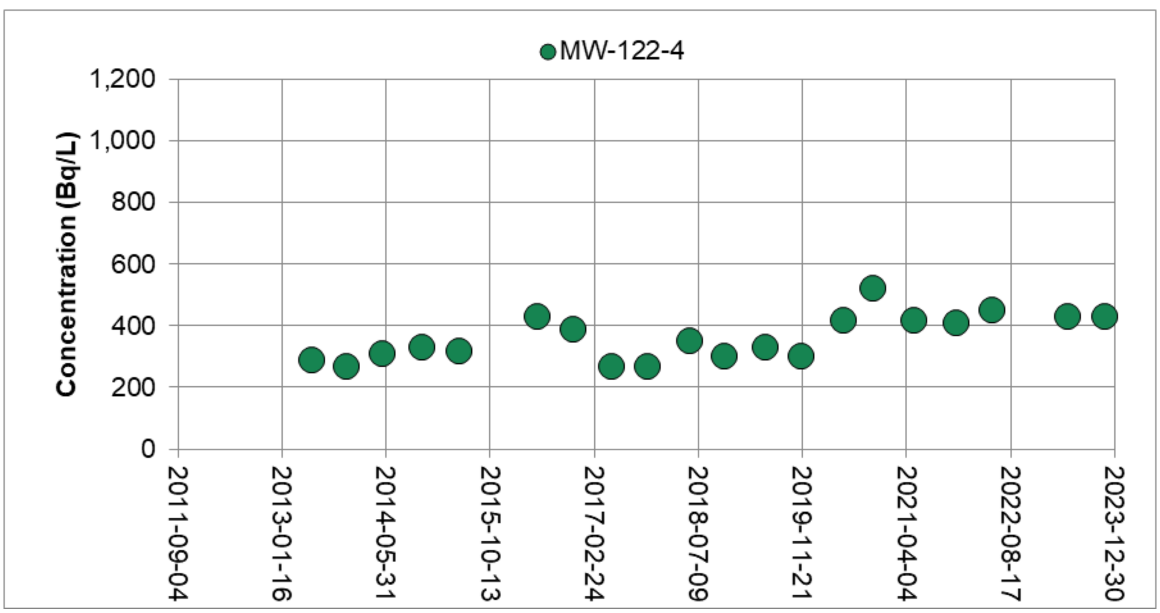
Graph 3: MW-119-6 Tritium Data



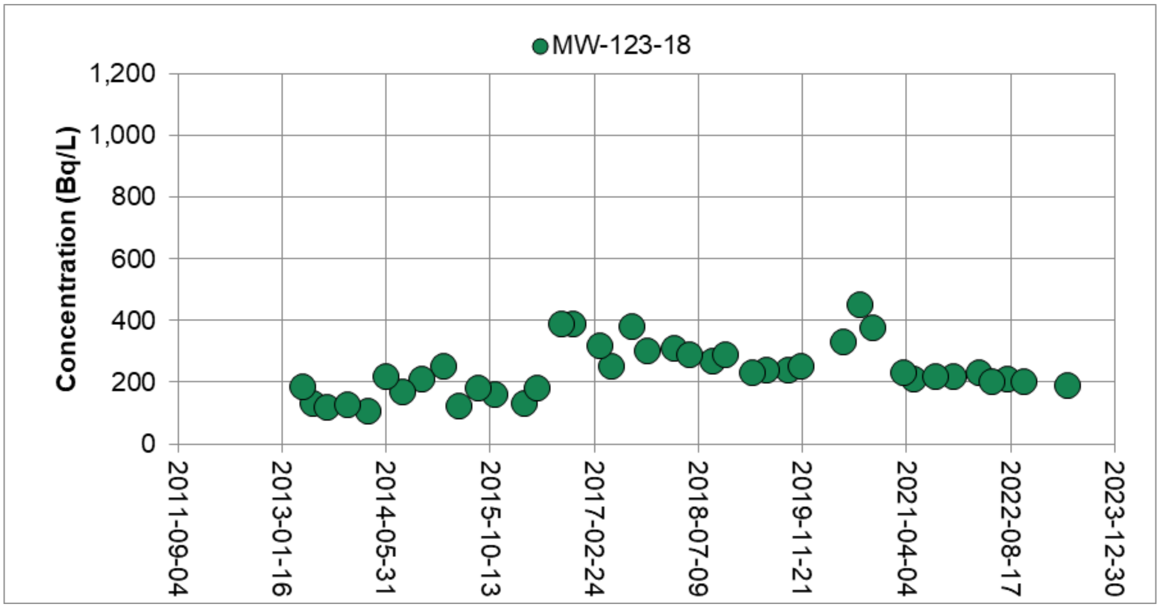
Graph 4: MW-120-18 Tritium Data



Graph 5: MW-121-13 Tritium Data



Graph 6: MW-122-4 Tritium Data

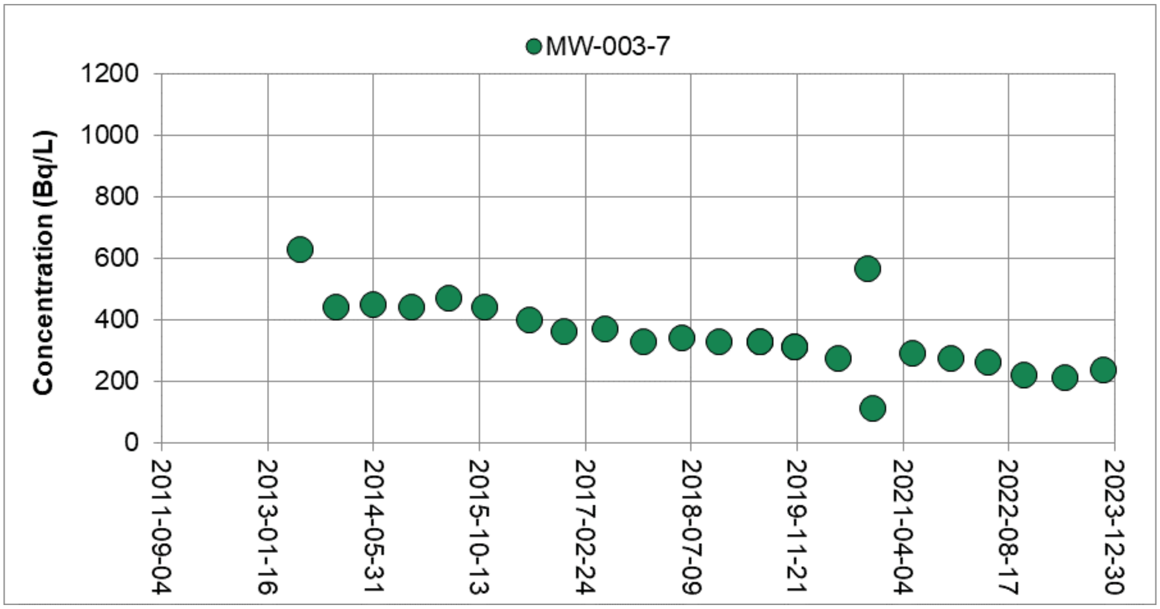


Graph 7: MW-123-18 Tritium Data

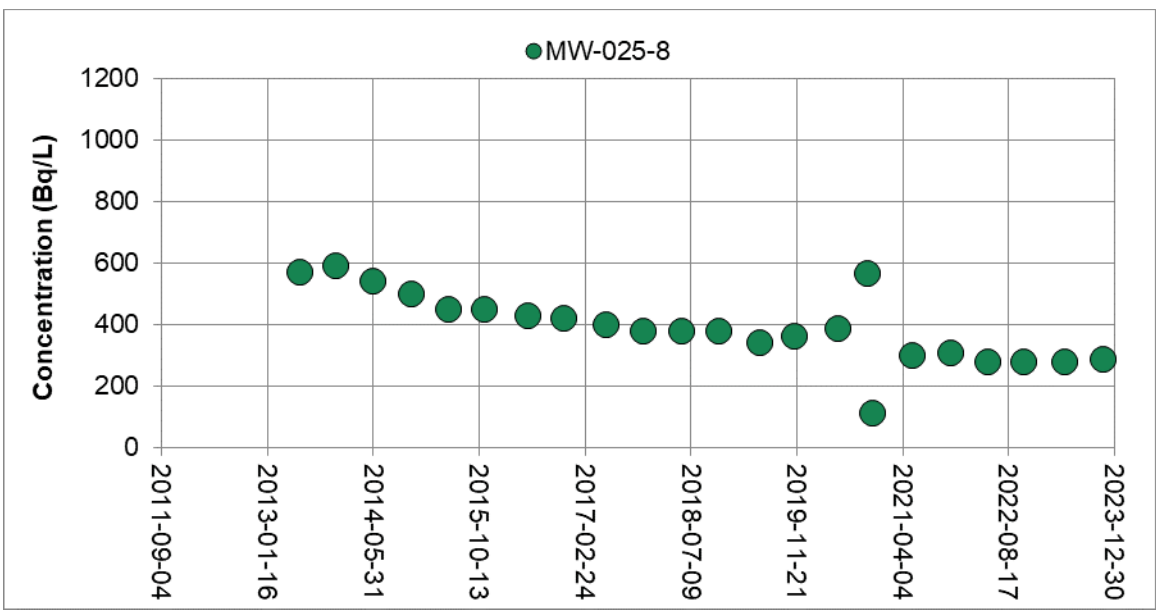
3.1.1.2 Building Effluent Lagoon

Analytical results for wells sampled within the vicinity of the building effluent lagoon are provided in Appendix A: Table A-2 and maximum tritium concentrations are summarized in Figure 6.

The presence of tritium at MW-003-7 and MW-025-8 (HU 1/ HU 2), is mainly attributed to a past identified leak from the building effluent lagoon in 2012. The lagoon liner was replaced and groundwater quality monitoring results indicate that tritium concentrations have been declining since. Groundwater monitoring at MW-004-6, located upgradient of the building effluent lagoons are included to establish background groundwater quality within vicinity of the building effluent lagoons. The 2023 tritium concentration in groundwater is 150 Bq/L at this well, and below the concentration at MW-003-7 and MW-025-8. Graphs 8 and 9 display tritium concentrations over time at MW-003-7, MW-004-6 and MW-025-8.



Graph 8: MW-003-7 Tritium Data



Graph 9: MW-025-8 Tritium Data

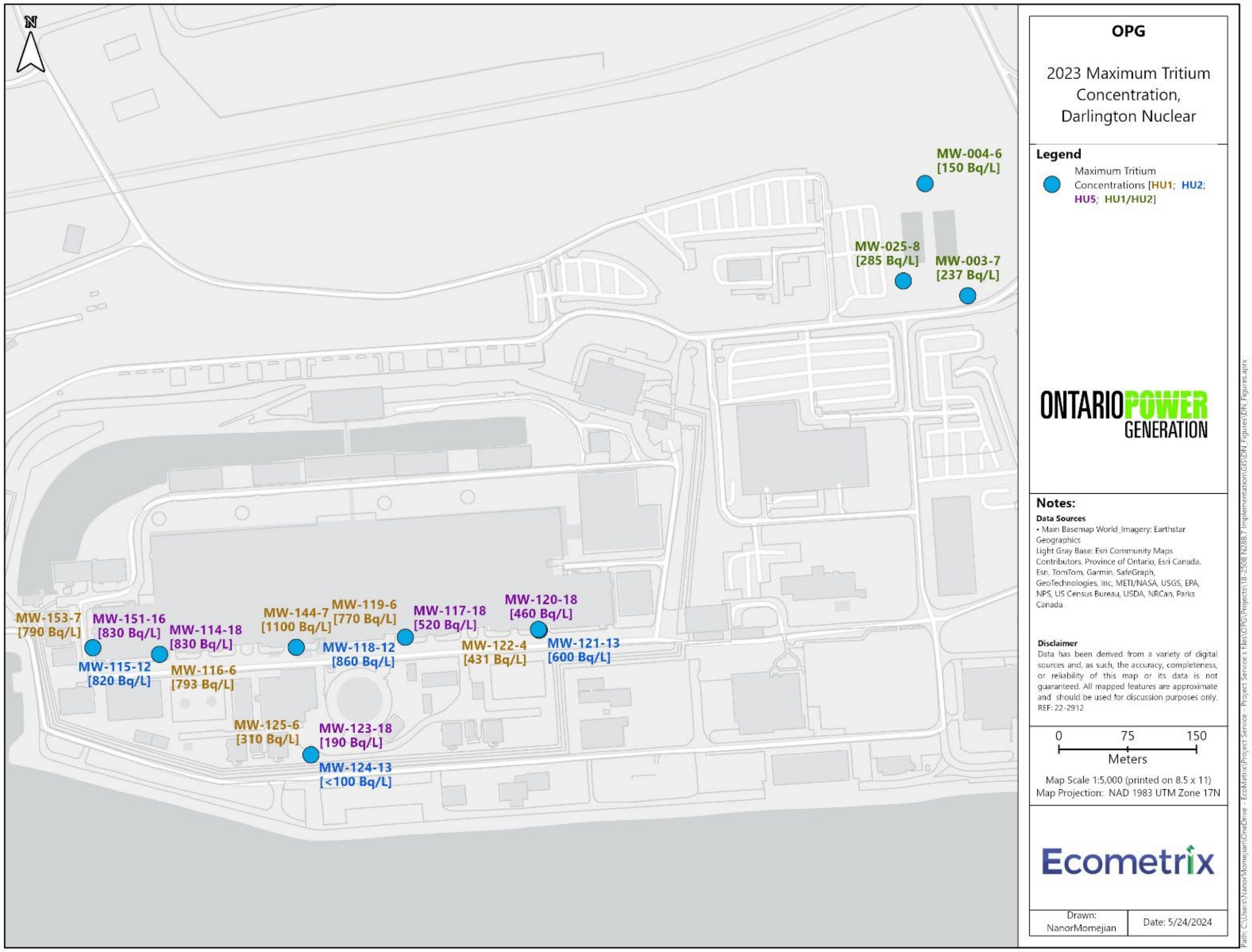


Figure 6: 2023 Maximum Tritium Concentrations in Protected Area – HU 1, HU 2 and HU 5

3.1.2 PHCs in Groundwater near SSCs

In 2023, groundwater quality monitoring was conducted in the vicinity or downgradient of the EPG, SGs and the ASHF, to detect fuel oil leaks associated with these areas.

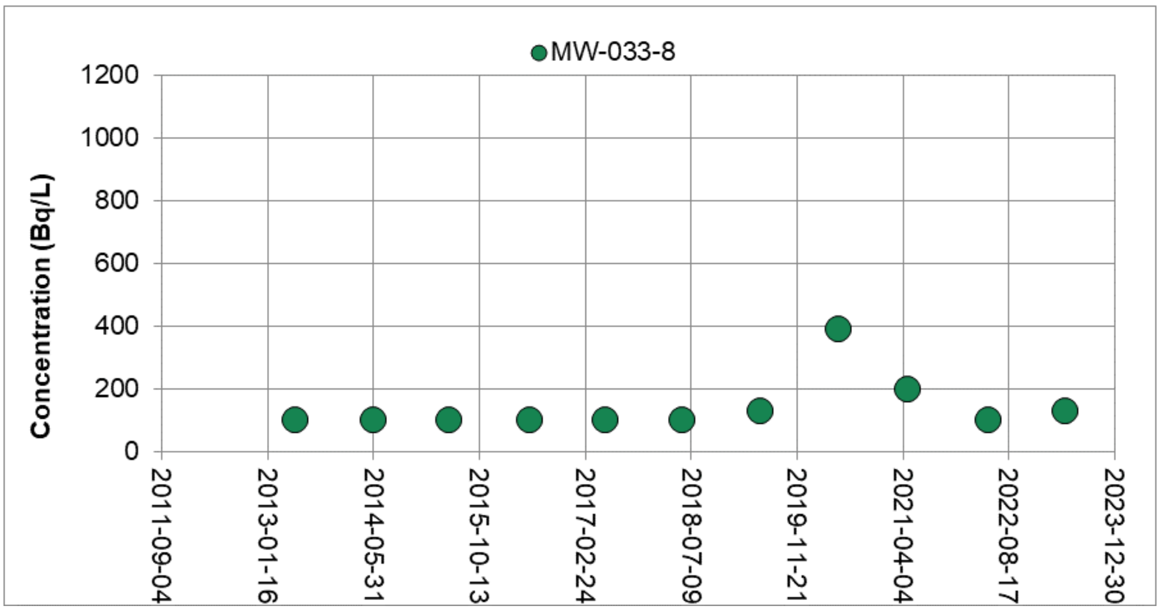
Thirteen monitoring wells were sampled for PHCs and BTEX. In 2023, all groundwater quality results were non-detect with respect to PHCs and ethylbenzene and most groundwater quality results were non-detect with respect to benzene, toluene and total xylenes. Where detected, concentrations of benzene, toluene and total xylenes were marginally above the detection limit, are within the expected range of background concentrations and are orders of magnitude below the risk-based evaluation criteria for the site.

The analytical results for PHCs and BTEX are presented in Appendix A, Table A-3.

3.2 Objective 2 Results: Perimeter Wells

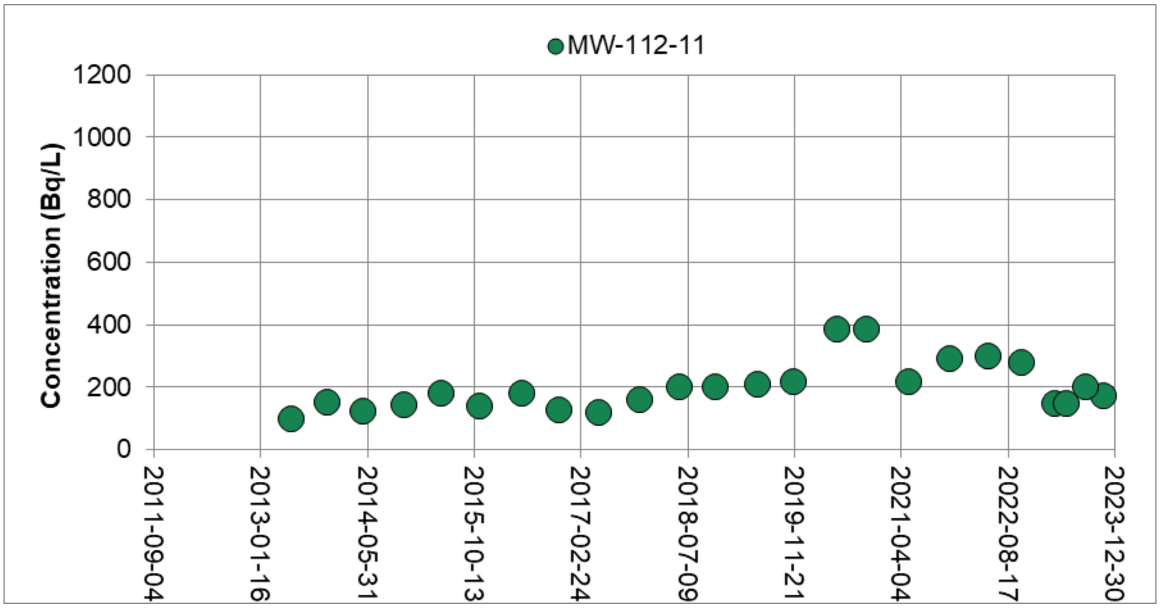
In 2023, 38 monitoring wells located at the property boundary were sampled. The results are summarized in Appendix A, Table A-5a and Table A-5b and the maximum tritium concentrations are summarized in Figure 7 for HU 1, HU 2 and HU 5.

Sixteen monitoring wells located upgradient of the SSCs were sampled for tritium. All concentrations measured were below detection with the exception of MW-033-8, where the tritium concentration was marginally above detection limit at 130 Bq/L, which is consistent with historical concentrations of tritium at this location. The observed concentration of tritium can likely be attributed to atmospheric deposition, and is several orders of magnitude below the risk-based criterion for the site. Graph 10 displays the tritium concentration at MW-033-8.

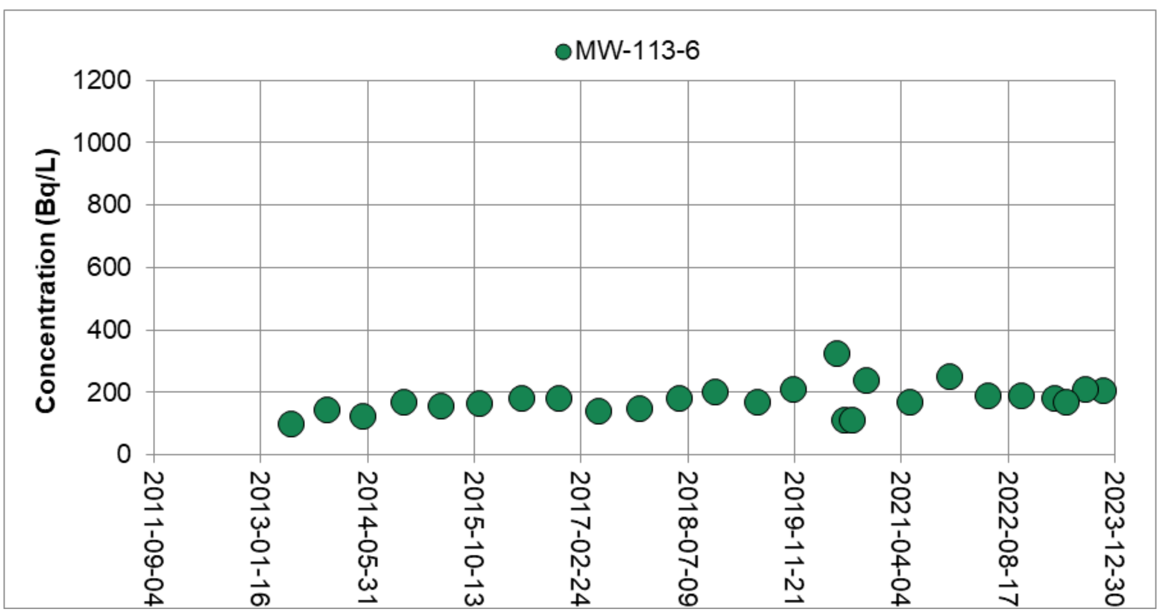


Graph 10: MW-033-8 Tritium Data

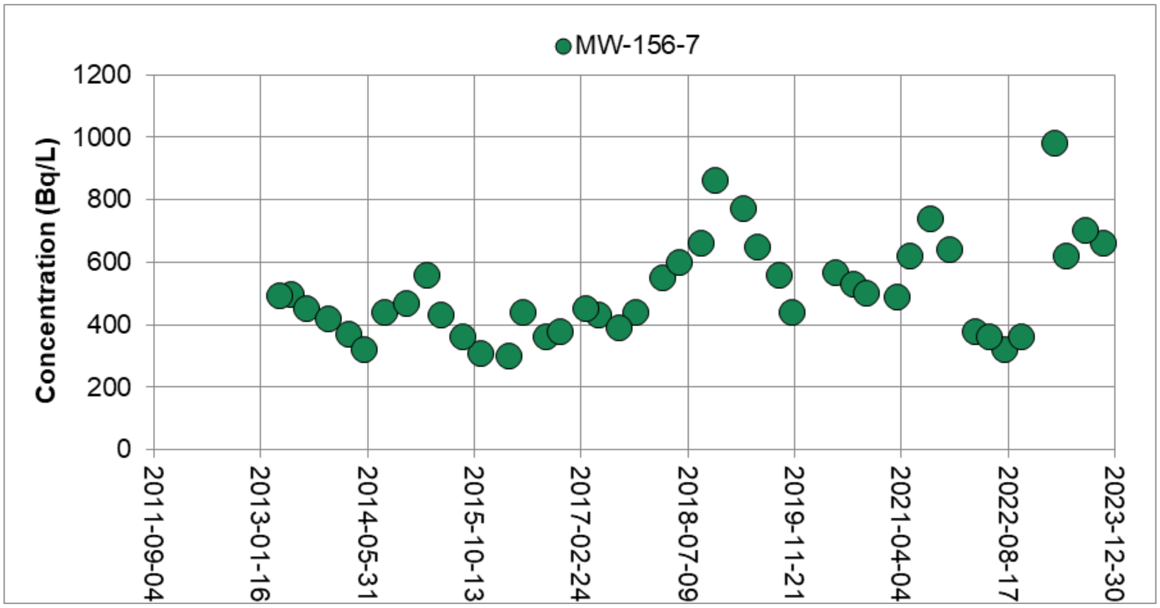
Twenty-two monitoring wells, located downgradient of the SSCs were sampled for the analysis of tritium. Tritium concentrations of these monitoring wells remained within historical ranges. Graphs 11 to 13 display the tritium concentrations at MW-112-11, MW-113-6 and MW-156-7.



Graph 11: MW-112-11 Tritium Data



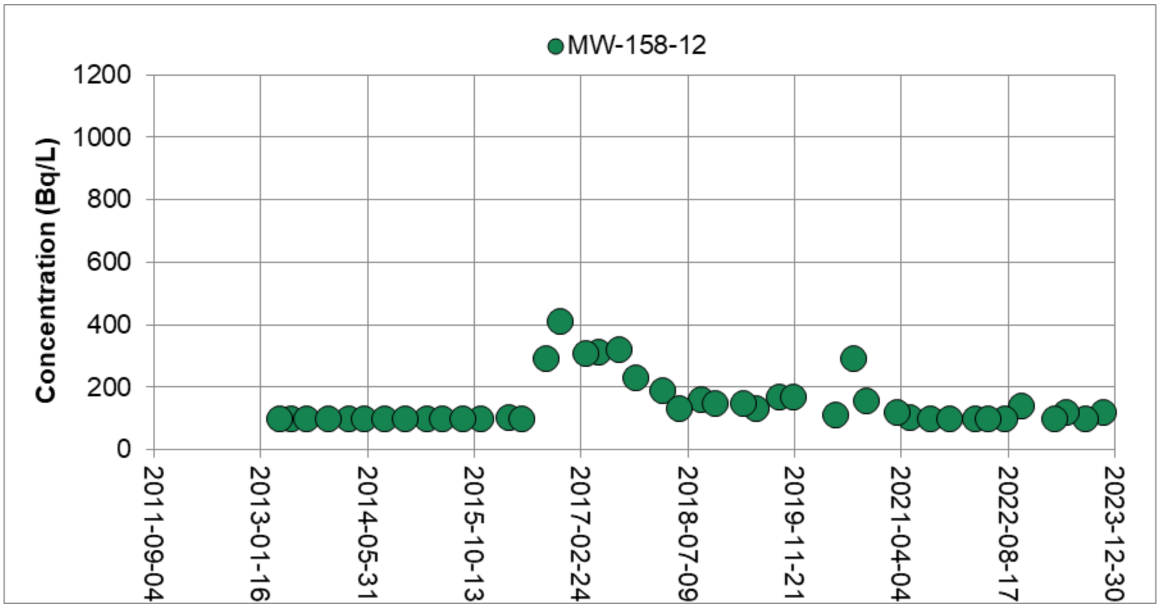
Graph 12: MW-113-6 Tritium Data



Graph 13: MW-156-7 Tritium Data

Nine monitoring wells, located downgradient of the SSCs were sampled for the analysis of PHCs and BTEX. In 2023, all groundwater quality results were non-detect with respect to PHCs and BTEX, with the exception of MW-158-12 (HU 3). The concentration of benzene was marginally above the detection limit, however remained well below the risk-based evaluation criterion, and is consistent with historical concentrations of benzene within this monitoring well. Graph 14 displays the benzene concentrations at MW-158-12.

Overall, low tritium, PHC and BTEX concentrations at site-perimeter locations indicate that the potential for adverse impacts to off-site groundwater quality from groundwater quality beneath the DNGS is low to negligible.



Graph 14: MW-158-12 Benzene Data

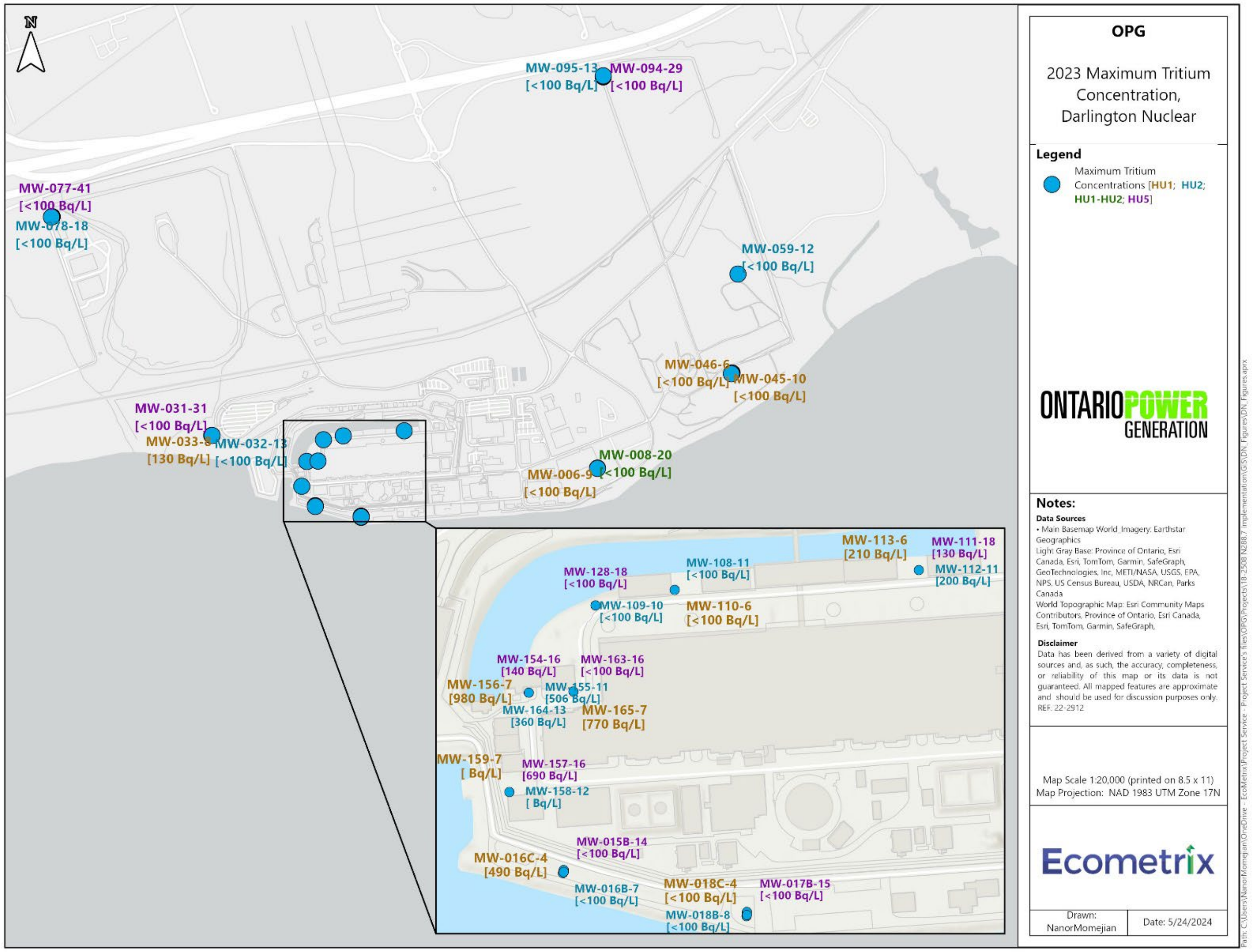


Figure 7: 2023 Maximum Tritium Concentrations in Protected Area - HU 1, HU 2 and HU 5

3.3 Objective 3 Results: DNNP

The results for the objective to monitor groundwater flow conditions and groundwater quality during site preparation at the DNNP is described in this section.

3.3.1 Groundwater Flow

Groundwater flow directions beneath the DNNP have been included within DN Site-wide investigations and are verified annually. The contouring of hydraulic head and interpretation of flow directions have not changed significantly over time. Inferred groundwater flow directions in each of the groundwater flow systems between Q2 and Q4 2023 within shallow overburden intermediate overburden and shallow bedrock groundwater flow systems are shown in Figure 8 to Figure 13. The basis for the inferred groundwater flow directions are hydraulic head measurements collected on May 4,2023 for Q2 and October 25, 2023 for Q4 (with the exception of MW-060-34, which was collected November 1, 2023). Average daily lake elevations from May 4, 2023 and October 24, 2023 were used in the HU 1 contour development for Q2 and Q4, respectively.

Groundwater flow directions within HU 1, HU 2 and HU 5 are generally south toward Lake Ontario. These groundwater flow conditions are consistent with the historical interpretations of beneath the DNNP (Ecometrix, 2022b) and between both Q2 and Q4 events in 2023.

Based on the groundwater flow interpretations in 2023, there is no adverse impacts to groundwater flow during site preparation activities in 2023 .

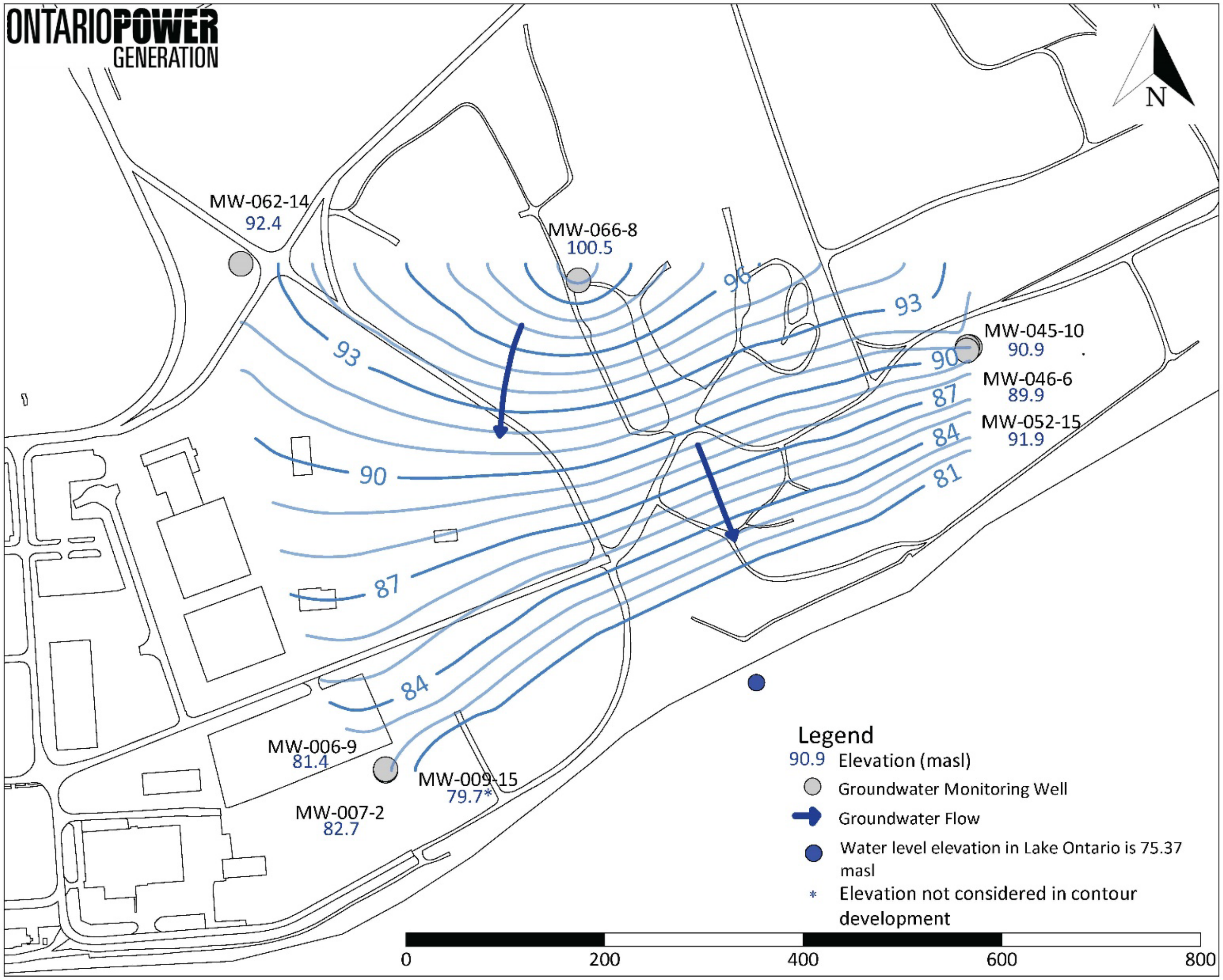


Figure 8: Q2 2023 Water Level Contour Map – Shallow Overburden (HU1)

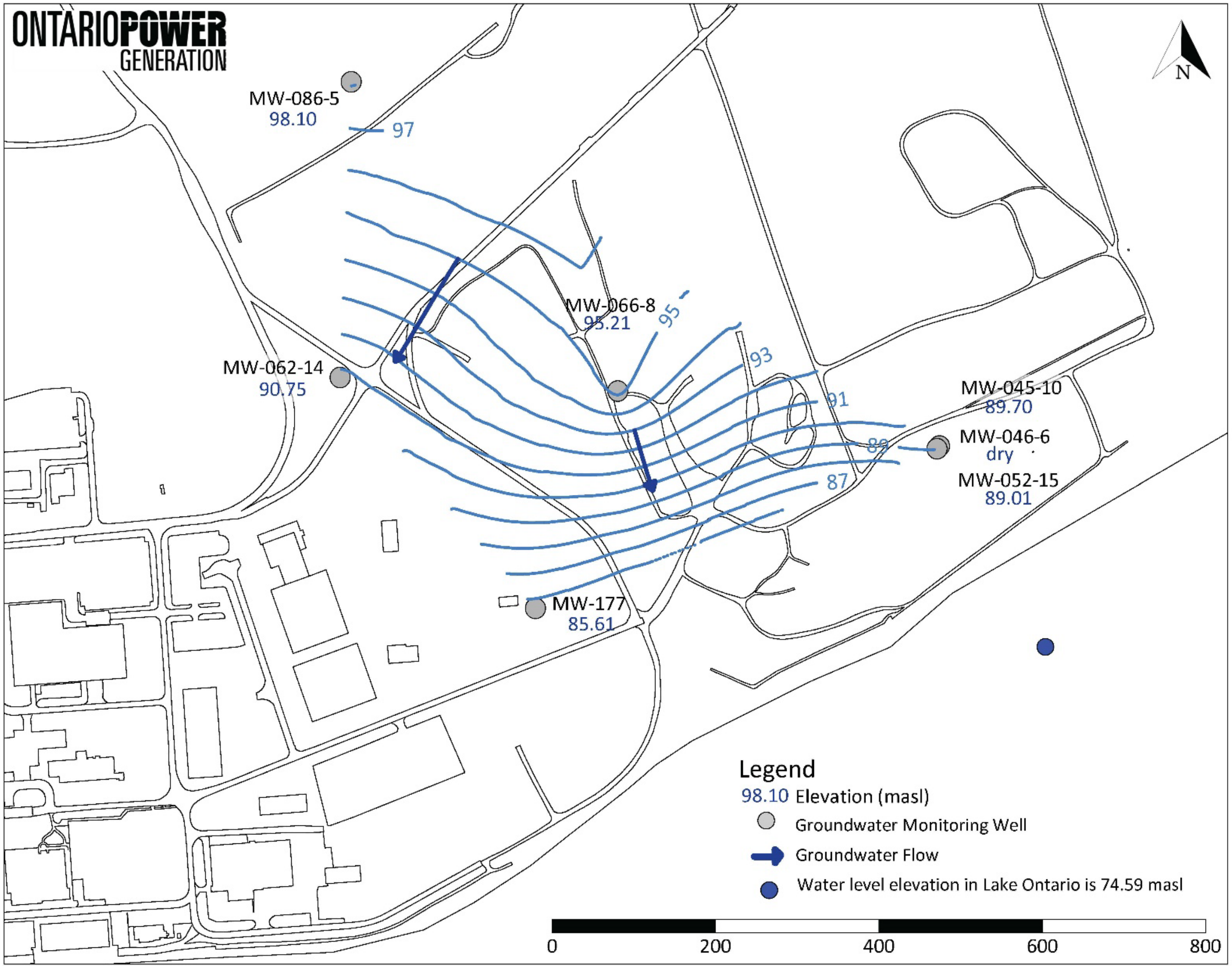


Figure 9: Q4 2023 Water Level Contour Map – Shallow Overburden (HU1)

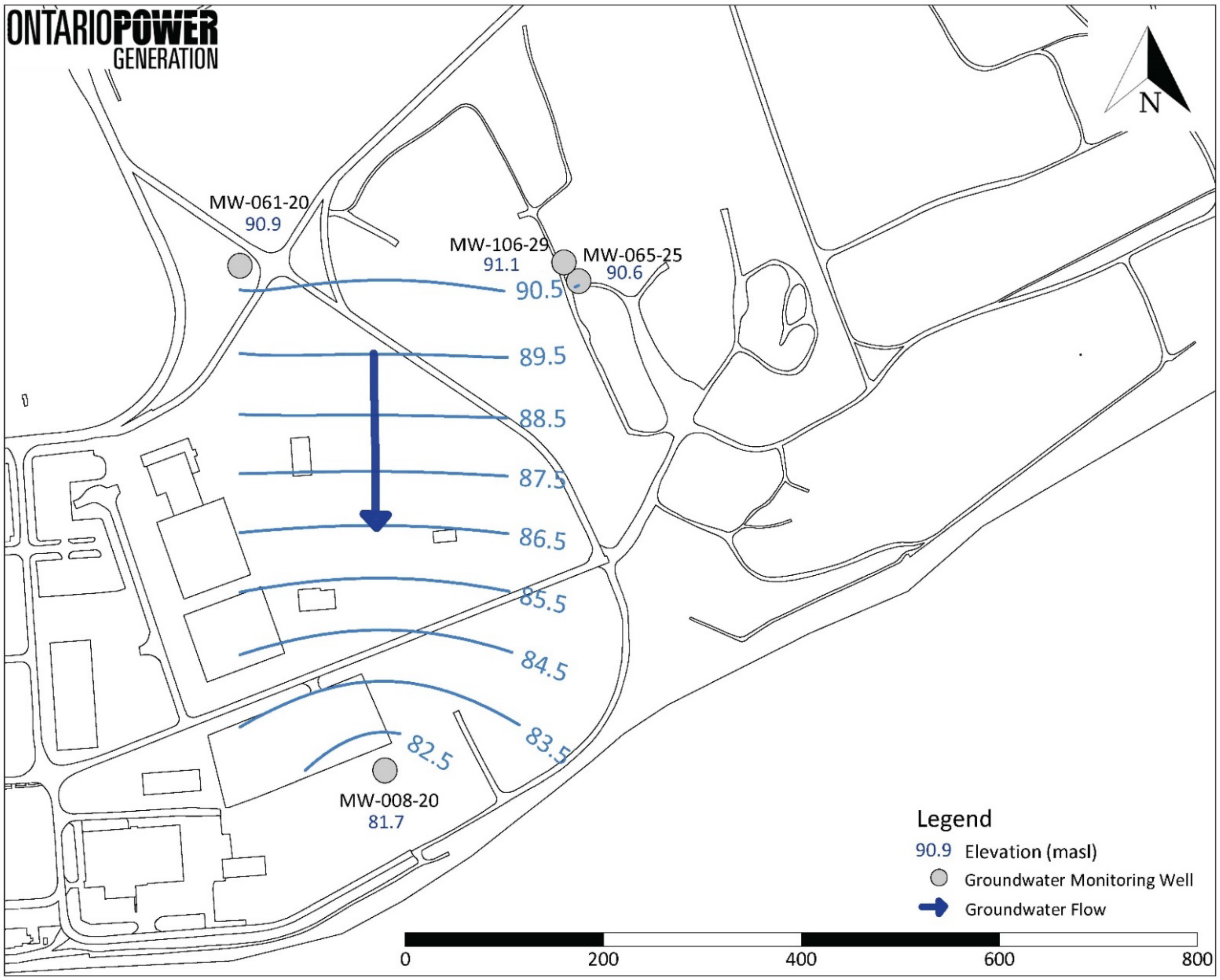


Figure 10: Q2 2023 Water Level Contour Map – Shallow Overburden (HU 2)

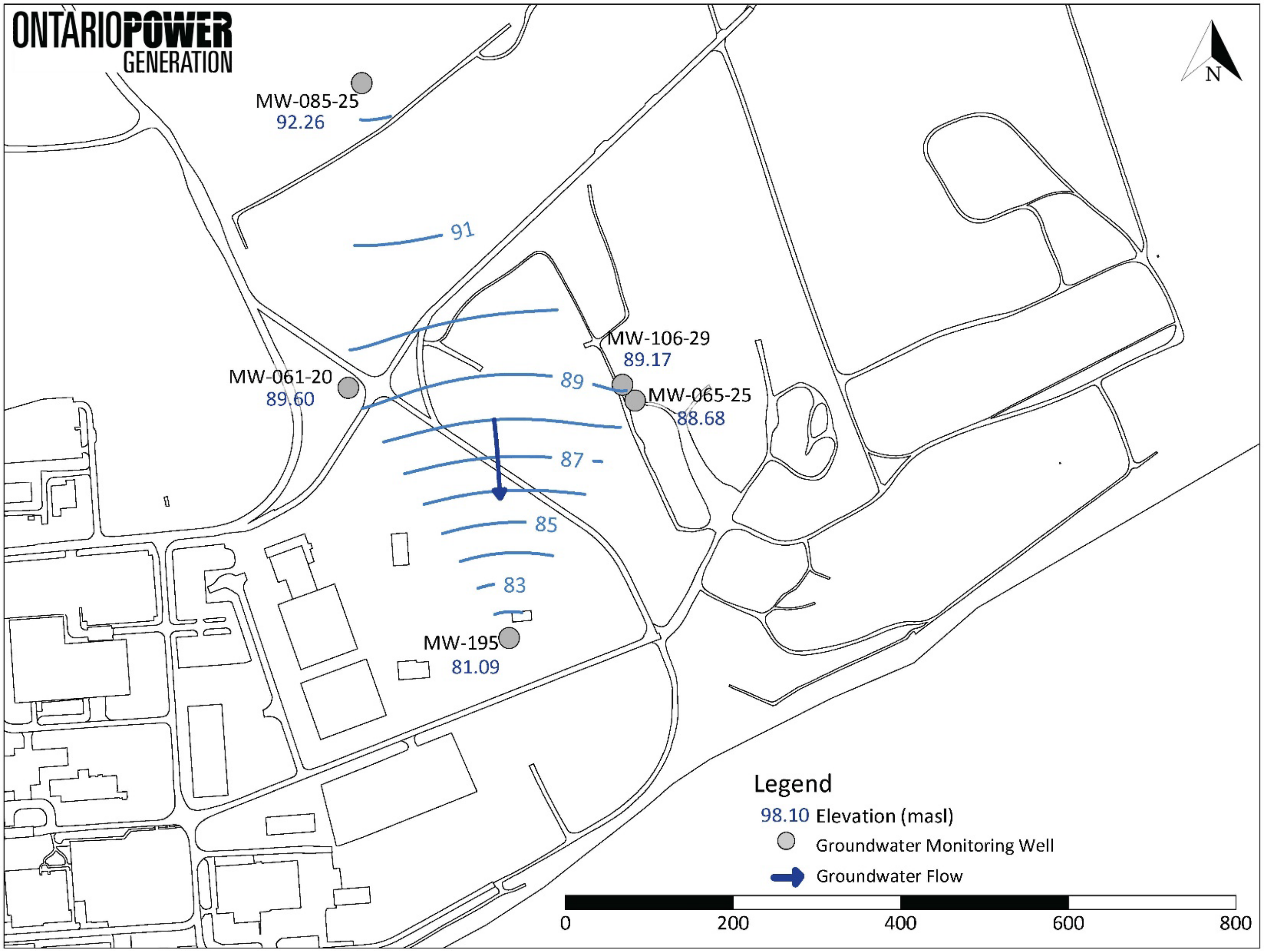


Figure 11: Q4 2023 Water Level Contour Map – Shallow Overburden (HU 2)

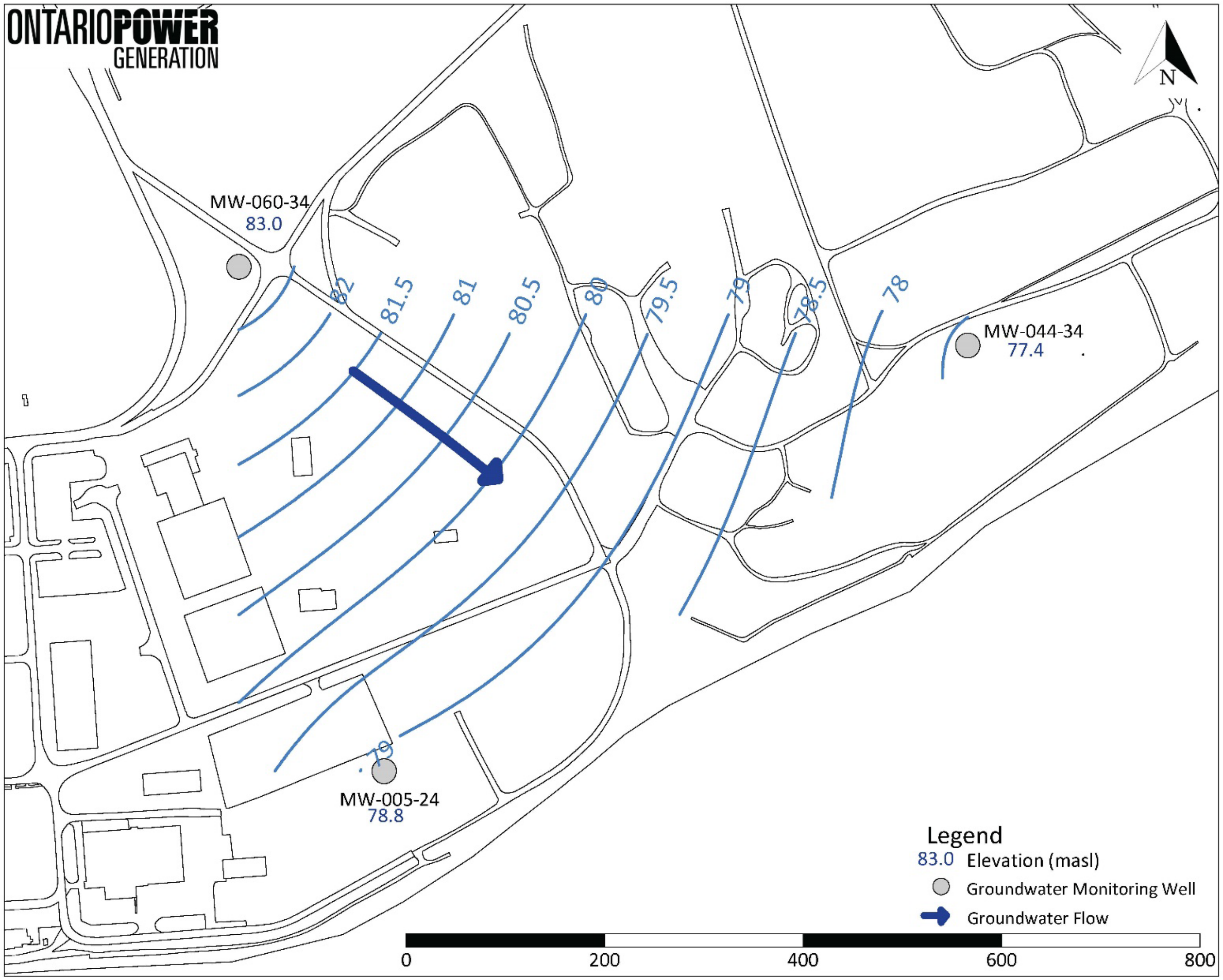


Figure 12: Q2 2023 Water Level Contour Map – Shallow Overburden (HU 5)

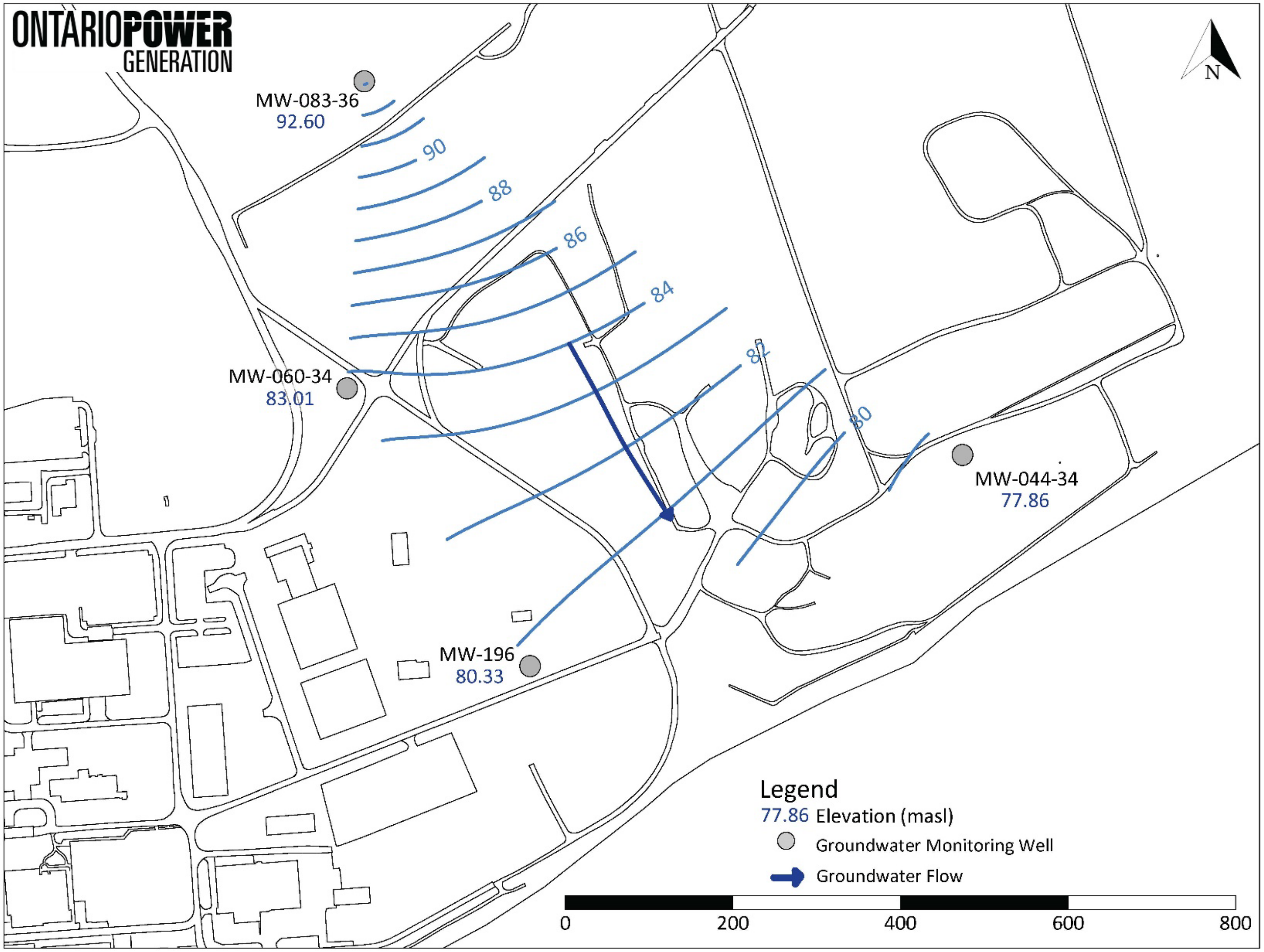


Figure 13: Q4 2023 Water Level Contour Map – Shallow Overburden (HU 5)

3.3.2 Groundwater Quality

In 2023, 23 monitoring wells were sampled for the analysis of indicator parameters ions (Na, Ca, Mg, K, HCO^{3-}, CO_3^{2-}, Cl, SO_4^{2-}, and dissolved Fe) and general parameters (pH, EC, TDS).

Historical hydrochemical types within HU 1, HU 2 and HU 5 prior to site preparation have been described by Ecometrix (2023b). The groundwater chemistry results from samples collected in DNNP monitoring wells in 2023 were plotted along with historical chemistry results, where available, to compare hydrochemical types.

The sample results for monitoring wells installed within HU 1 in the DNNP are shown in Figure 14. Groundwater hydrochemistry is generally described as Ca/Mg-Cl or Ca/Mg-HCO_3 type waters, which reflect freshwater recharge and interaction with the natural geologic materials in the overburden units. In general, the hydrochemical typing within the groundwater monitoring wells appear to be consistent in general over time with the available sample results. An exception to this pattern is MW-062-14, the sample collected in Q4 2023 is considered to be Na-HCO_3-type water, which is a shift from the samples collected in Q2 2023 and Dec 2021 which appear to be Ca/Mg-HCO_3-type water. Additionally, the hydrochemical type at MW-007-2 appears to have shifted from Ca/Mg-Cl to Na-Cl type waters from 2008 to 2023, this is expected as MW-007 is located within a paved area within the DNNP and is now situated in the middle of a roadway due to road realignment. Continual road salting is expected to occur and the hydrochemical type is expected to remain Na-Cl-type water.

The sample results for monitoring wells installed within HU 2 in the DNNP are shown in Figure 15. Groundwater hydrochemistry is generally described to be Ca/Mg-Cl or Ca/Mg-HCO_3 type waters as well, which also reflect freshwater recharge and interaction with the natural geologic materials in the overburden units. In general, the hydrochemical typing within the groundwater monitoring wells appear to be consistent in general over time with the available sample results with some exceptions. Available sample results from 2008 and 2022 in MW-009-15 were classified as Ca/Mg-Cl and Ca/Mg-HCO_3-type waters. Sample results from 2023 were also classified as Ca/Mg-Cl and Ca/Mg-HCO_3 types in different sampling events. Additionally, the hydrochemical type at MW-008-20 appears to have shifted from Ca/Mg-Cl-type water in 2009 and Q2 2023 to Na-HCO_3-type water in Q4 2023.

The sample results for monitoring wells installed within HU 5 in the DNNP are shown in Figure 16. Groundwater hydrochemistry is generally described as Na-HCO_3-type water. In general, the hydrochemical typing within a groundwater monitoring well appears to be consistent over time with the available sample results.

Overall, there have not been any major shifts in hydrochemical typing in the three major groundwater flow systems at the DNNP, and the hydrochemical typing alone does not indicate a potential for changing groundwater quality conditions.

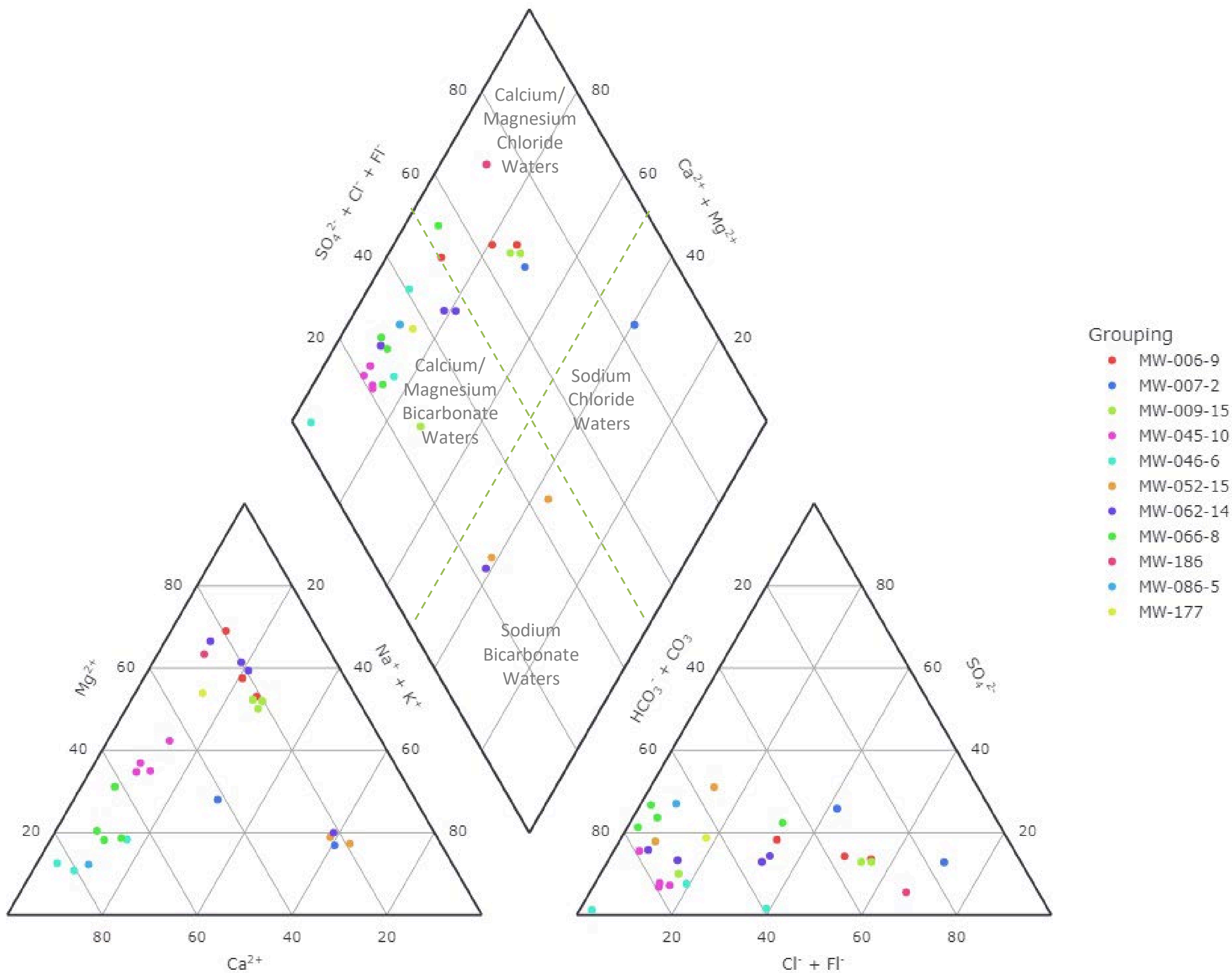


Figure 14: Piper Diagram – Available Sample Results from HU 1 Wells in DNNP

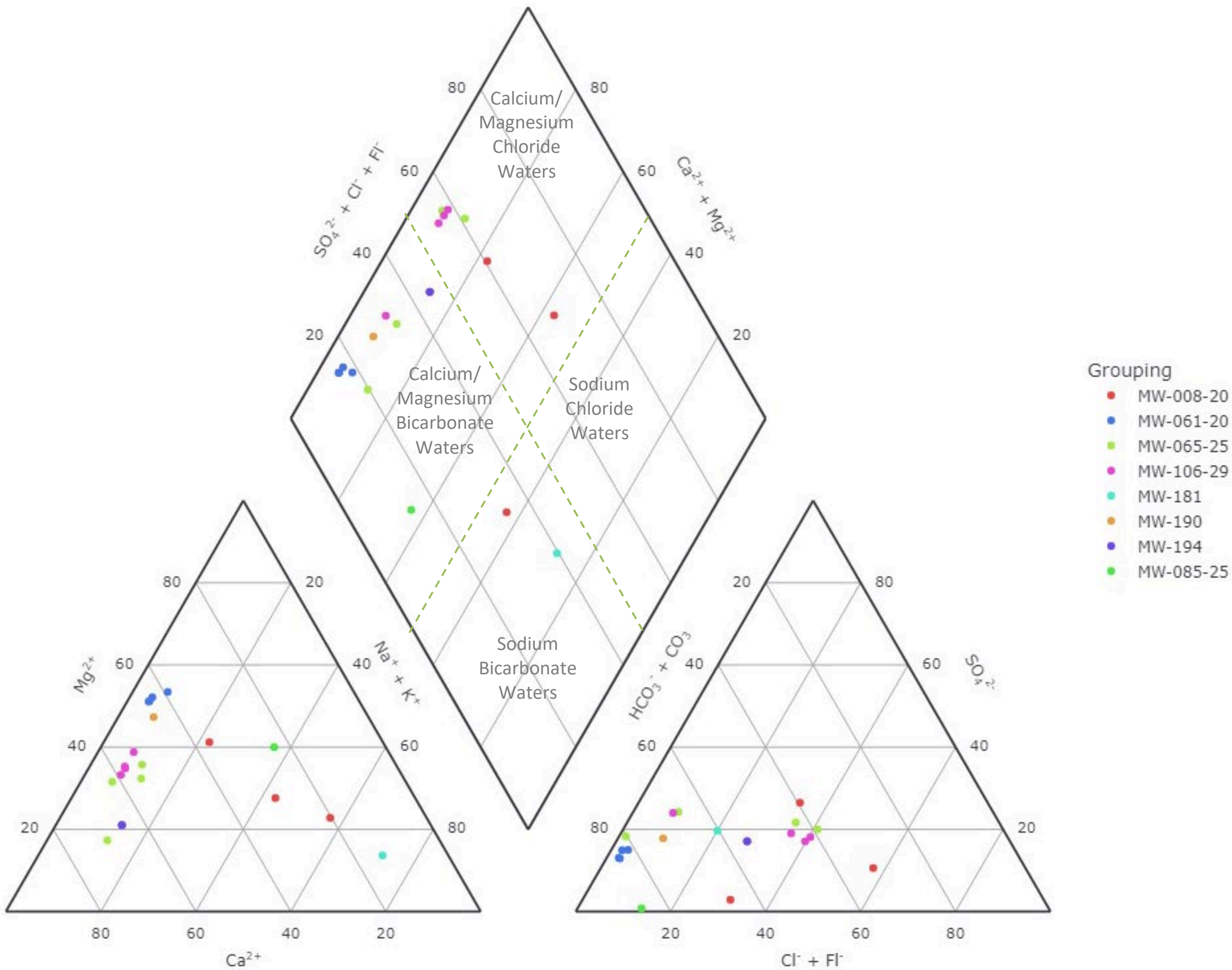


Figure 15: Piper Diagram – Available Sample Results from HU 2 Wells in DNNP

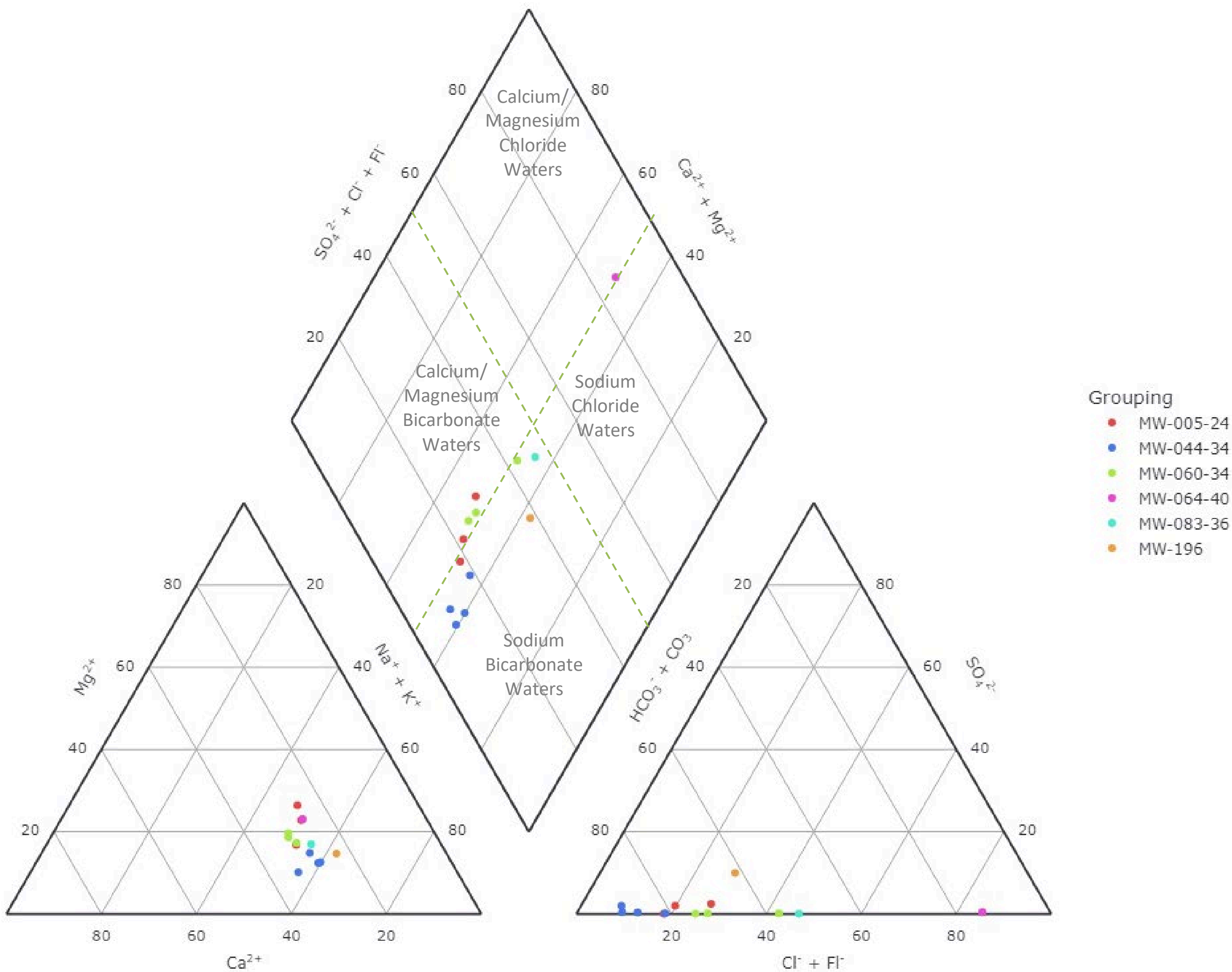


Figure 16: Piper Diagram – Available Sample Results from HU 5 Wells in DNNP

3.4 Objective 4 Results: Groundwater Flow

The results for the objective to confirm predominant on-site groundwater flow characteristics across the DN site is described in this section.

The predominant groundwater flow patterns in 2023 remain consistent with the historical interpretations of groundwater flow conditions and are summarized as follows:

- In general, groundwater in HU 1 flows from north to south and is inferred to discharge to Lake Ontario.

- The northeastern portion of the DNGS site has a component of groundwater flow directed to the east, and then southeast towards Lake Ontario and is interpreted to be influenced by the dewatering activities at the St. Mary's Cement property bounding the east of the DN Site.

- General flow in the interglacial deposits (HU 2) and the shallow bedrock (HU 5) are similar to that of the water table in the fill/upper till (HU 1) described above.

- Groundwater flow direction is complex within the protected area in HU PA, and HU 5 due to site infrastructure as detailed below:

    - The powerhouse extends to the bedrock and acts as a barrier to groundwater flow; therefore, groundwater flow at the water table on the north side of the powerhouse may not be connected to or may be poorly connected to groundwater flow at the water table on the south side of the powerhouse.

    - Groundwater on the west side of the powerhouse is interpreted to discharge into the Forebay Channel as the Condenser Cooling Water pumps lower the Forebay Channel water level, creating a hydraulic gradient directed to the Forebay Channel.

    - Based on the groundwater elevations measured in Q2 2023, groundwater flow direction interpretations cannot be inferred clearly. However, it is historically understood that groundwater generally flows west along the south of the powerhouse and north into the Forebay Channel. A component of groundwater flow is also directed south to Lake Ontario.

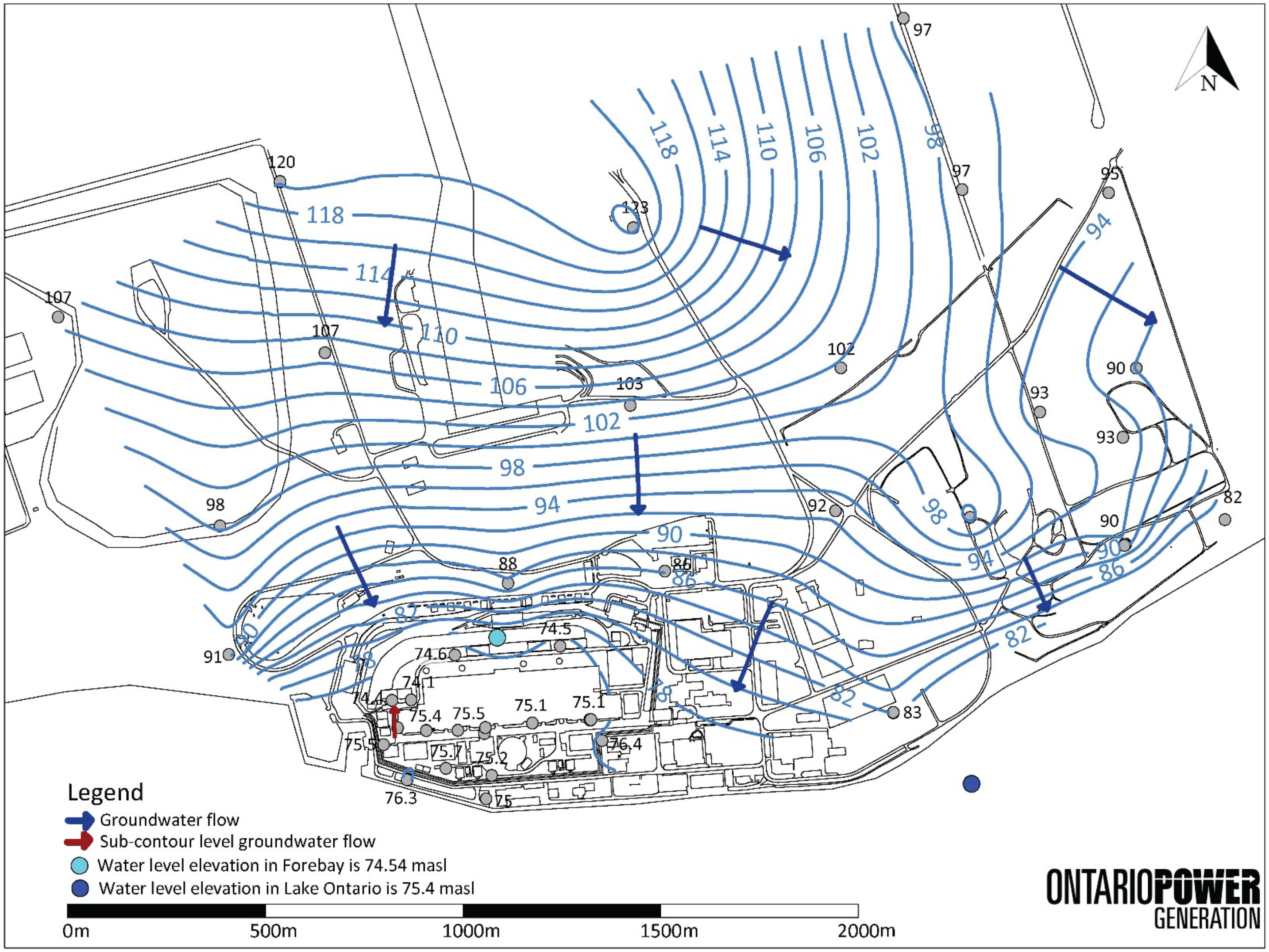


Figure 17: 2023 Inferred Shallow Groundwater (HU 1 and HU PA) Flow Direction

4.0 2023 QUALITY ASSURANCE AND QUALITY CONTROL

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

4.1 Quality Assurance Program for Laboratories

Bureau Veritas is accredited with ISO 17025 by the Standards Council of Canada for environmental tests. The methodology for analysis including detection limits for many conventional parameters in groundwater is governed by criteria established in the MECP's "Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act". Bureau Veritas has a Quality Assurance Department, which routinely monitors procedures and processes by way of compliance audits, quality system audits and method audits to ensure compliance with accreditation and regulatory requirements. Bureau Veritas is also accredited by the Standards Council of Canada for radiological tests, including analysis of tritium concentrations in water.

4.2 Quality Control Results

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

In 2023, 30 field duplicate samples were collected from 14 monitoring wells. The analytical results and calculated relative percentage differences (RPD) are presented in Table A-7a (Appendix A). All RPDs calculated were below 20% with the exception of one pairing for tritium (collected at MW-113-6 in Q3), sulphate (MW-046-6 in Q2) and chloride (MW-085-25 in Q4), which marginally exceeded the RPD of 20%. In general, the duplicate samples were deemed of acceptable quality, demonstrating that the field techniques and the analytical methods employed by the laboratories were reproducible and reliable.

Field blanks and trip blanks were part of the quality program where PHCs and BTEX were measured. All field blank results were non-detect for those parameters. Therefore, no significant contamination of samples by those parameters occurred during the sample collection process. Similarly, PHCs and BTEX were at non-detect levels in all trip blank samples analyzed indicating that there was no contamination of the samples by those parameters during handling and transportation.

The QA/QC calculations and results discussed above are presented in Appendix A: Table A-7a and Table A-7b.

5.0 SUPPLEMENTARY STUDIES

A DNNP baseline groundwater report was initiated in 2023 and the main conclusions from this report are summarized in this section.

Physical Hydrogeology

This report summarized the physical hydrogeological characteristics and groundwater quality representative of the baseline and establishes the appropriate groundwater evaluation criteria for groundwater quality and flow conditions following baseline.

The physical hydrogeological properties across the DN Site are generally summarized in the Conceptual Site Model (CSM) for CSA N288.7 Implementation (Ecometrix, 2023b). The baseline groundwater report summarizes these characteristics and considers the hydrogeological characteristics in the DNNP Environmental Impact Statement Technical Support Document (EIS TSD) (CH2M Hill and Kinectrics, 2009) along with the 2022 DNNP geotechnical investigation (Golder, 2022). Overall, the lithologies encountered, horizontal and vertical groundwater flow interpretations as well as the hydraulic conductivities reported were consistent with those described in the 2009 EIS TSD, the 2022 DNNP geotechnical investigation and the CSM. In general, the available calculated hydraulic gradients using the 2022 geotechnical investigation are within range of the available hydraulic gradients reported for the same HUs in the 2009 EIS TSD and CSM.

Additionally, available water level elevations collected from DNNP monitoring wells between October 2021 and February 2022 were reviewed to understand seasonal fluctuations in hydraulic head with depth. In general, minimal groundwater fluctuations, particularly in HU 1, HU 2 and select wells in HU 5 were observed, which reflect the relatively moderate climatic conditions regionally.

Groundwater Quality

The hydrochemical types were also evaluated for all baseline groundwater quality data available. Groundwater samples collected in the 2022 DNNP geotechnical investigation from wells installed within HU 1 and HU 2 were consistent with interpretation of overburden hydrochemistry by Kinectrics (2004). These samples were rich in magnesium and bicarbonate and reflect fresh water being recharged in the overburden aquifers. The upper bedrock (HU 5) in the 2022 DNNP geotechnical investigation was rich in sodium and potassium, which is consistent with Kinectrics (2004), however instead of just being rich in chloride and sulphate, this water was found to be rich in bicarbonate as well.

Groundwater sample results were available for a suite of parameters including radionuclides, metals and inorganic parameters, PHCs, BTEX, volatile organic compounds, polyaromatic hydrocarbons, semi-volatiles, and polychlorinated biphenyls between 2008 and 2023. Available maximum groundwater sample results were then screened against the selected screening criteria to confirm baseline groundwater quality:

1. All available sample results were first screened against the Ministry of the Environment, Conservation and Parks (MECP), Table 3 Full Depth Generic Site Condition Standards (SCS) in a Non-Potable Ground Water Condition and Table 9 Generic SCS for Use within 30 m of a Water Body in a Non-Potable Ground Water Condition) for MW-107-7, which is located within 30 m of Darlington Creek.

2. The maximum tritium sample results were compared to the numerical groundwater evaluation criterion for Tritium selected for the DN Site, which is 1 x 10^7 Bq/L (Ecometrix, 2023b).

3. As MECP SCS are not available for radiological parameters, the provincial water quality objectives (PWQO) were selected for screening against these parameters as a method to contextualize the maximum radiological concentrations on site, and for ease of comparison against future radiological sample results during future phases of the DNNP, where relevant. Since the PWQO values are applicable for screening against surface water quality or groundwater quality, a dilution factor of 10 is applied to account for groundwater discharge into a surface water body. This dilution factor is consistent with the MECP's (2011) derivation of the groundwater to surface water pathway component values (GW3), which assumes at least a 10-fold dilution of groundwater in surface water.

Overall the maximum groundwater sample results met the applicable criteria with the following exceptions:

- The maximum groundwater sample results for MW-057-27 (HU 5) and MW-094-29 (HU 5) exceeded the MECP Table 3 SCS for selenium, which is inferred to be attributed to the sampling methodology and is not suggested to be reflective of groundwater quality within these wells.

- The maximum concentrations of lead, selenium, sodium, and zinc also exceeded the MECP Table 3 SCS at MW-047-92 over several years and the maximum concentration of nickel, selenium and sodium exceeded the MECP Table 3 SCS at MW-013A-24. These monitoring wells are installed within the deep bedrock which is expected to be saline and elevated in metal concentrations as deep groundwater is inferred to migrate further distances from the recharge location. Along this longer migration path, soluble constituents in bedrock are expected to dissolve into groundwater.

- The maximum PHC F3 concentration at MW-053-31 (HU 5) exceeds the applicable MECP Table 3 SCS marginally, and is inferred to be attributed to the sampling and laboratory analysis methodology, and is not suggested to be reflective of groundwater quality within this well.

6.0 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 metres

7.0 ACRONYMS AND UNITS

ASHF	Auxiliary Steam Heating Facility

Bq/L	Becquerel per Litre
BTEX	Benzene, Toluene, Ethylbenzene, and total Xylenes
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
DNGS	Darlington Nuclear Generating Station
DNNP	Darlington New Nuclear Project
EPS	Emergency Power Service
HU	Hydrostratigraphic Unit
MECP	Ministry of Environment, Conservation and Parks
MW	Monitoring Well
OPG	Ontario Power Generation Inc.
PHC	Petroleum Hydrocarbon
QA/QC	Quality Assurance/Quality Control
RPD	Relative Percentage Difference
SAP	Sampling and Analysis Plan
SG	Standby Generator

8.0 REFERENCES

CH2M Hill, 2011. Geological and Hydrogeological Environment Technical Support Document Darlington Nuclear Generating Station Refurbishment and Continued Operation Environmental Assessment. Report No. NK38- REP- 07730–10003. December.

CH2M Hill, Kinectrics, 2009. Geological and Hydrogeological Environment Existing Environmental Conditions TSD. Report No. NK054- REP- 07730- 00005- R000. September.

CSA (Canadian Standards Association), 2015. Groundwater protection programs at Class I nuclear facilities and uranium mines and mills. Report No. CSA N288.7-15 (Reaffirmed 2020). June.

Ecometrix (Ecometrix Incorporated), 2020. Groundwater Protection and Monitoring Programs for Pickering Nuclear - CSA N288.7 Implementation. Report No. P-REP-07294-00002. December.

Ecometrix (Ecometrix Incorporated), 2023a. Groundwater Protection and Monitoring Programs for Darlington Nuclear Generating Station and Darlington New Nuclear Project - CSA N288.7 Implementation. October.

Ecometrix (Ecometrix Incorporated), 2023b. Conceptual Site Model - CSA N288.7 Implementation at Darlington Nuclear Generating Station and Darlington New Nuclear Project. October.

Golder (Golder Associates), 2022. Phase I Geotechnical Investigation (Power Block) Darlington New Nuclear Report, Volume 1 of 2. Report No. NK054- REP- 01210– 00175_00001. December.

IJC, 2023. International Lake Ontario-St. Lawrence River Board- Lake Ontario Daily Mean Water Levels 2022-2024 [WWW Document]. Int. Jt. Comm. Int. Lake Ont.-St Lawrence River Board. May. URL https://ijc.org/en/loslrb/watershed/water-levels

Kinectrics (Kinectrics Inc.), 2004. Darlington Nuclear Phase II Part 2 – Investigation of Five Sites. Report No. NK38- REP- 07010-10003- R000. July.

MECP (Ontario Ministry of the Environment, Conservation and Parks), 2011. Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario. Standards Development Branch. April.

OPG (Ontario Power Generation), 2023. 2023 Darlington Nuclear Groundwater Sampling and Analysis Plan. January.

SENES (SENES Consultants Limited), 2009. Environmental Impact Statement New Nuclear – Darlington Environmental Assessment. Report No. NK054- REP- 07730– 00029. September.

Appendix A: Tables A-1 to A-7

Table A-1: 2023 Powerhouse, ALW collection and treatment system, HWMV and TRF Tritium Results

Sample Location Name	Frequency	Analysis Parameter	HU	Q1 (Bq/L)	Q2 (Bq/L)	Q3 (Bq/L)	Q4 (Bq/L)
MW-114-18	Annual	Tritium	HU 5	--	830	--	--
MW-115-12	Quarterly	Tritium	HU PA	810	780	820	792
MW-116-6	Quarterly	Tritium	HU PA	740	760	760	793
MW-117-18	Annual	Tritium	HU 5	--	520	--	--
MW-118-12	Quarterly	Tritium	HU PA	860	810	710	656
MW-119-6	Quarterly	Tritium	HU PA	720	750	770	743
MW-120-18	Annual	Tritium	HU 5	--	460	--	--
MW-121-13	Semi-Annual	Tritium	HU PA	--	600	--	491
MW-122-4	Semi-Annual	Tritium	HU PA	--	430	--	431
MW-123-18	Annual	Tritium	HU 5	--	190	--	--
MW-124-13	Quarterly	Tritium	HU 2	<100	<100	100	50
MW-125-6	Quarterly	Tritium	HU PA	200	310	120	254
MW-144-7	Quarterly	Tritium	HU PA	1100	940	820	852
MW-151-16	Annual	Tritium	HU 5	--	830	--	--
MW-152-12	Quarterly	Tritium	HU PA	830	800	770	782
MW-153-7	Quarterly	Tritium	HU PA	590	630	790	686

Notes:

--- denotes that samples were not required

< denotes that result is below the laboratory method detection limit

Table A-2: 2023 Building Effluent Lagoon

Sample Location Name	Frequency	Analysis Parameter	HU	Q1 (Bq/L)	Q2 (Bq/L)	Q3 (Bq/L)	Q4 (Bq/L)
MW-003-7	Semi-Annual	Tritium	HU 1/ HU 2	--	210	--	237
MW-004-6	Annual	Tritium	HU 1/ HU 2	--	150	--	--
MW-025-8	Semi-Annual	Tritium	HU 1/ HU 2	--	280	--	285

Notes:
--- denotes that samples were not required
< denotes that result is below the laboratory method detection limit

Table A-3: 2023 EPS/EPG, SG and AHSF BTEX and Petroleum Hydrocarbon Results

Parameter	**MW-020C-3**	**MW-118-12**	**MW-119-6**	**MW-124-13**	**MW-125-6**
HU	**HU 1**	**HU PA**	**HU PA**	**HU 2**	**HU PA**
Benzene	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	<0.2	<0.2	<0.2	0.45	<0.2
Ethylbenzene	<0.2	<0.2	<0.2	<0.2	<0.2
Total Xylenes	<0.4	<0.4	<0.4	0.45	<0.4
F1 (C6-C10) - BTEX	<25	<25	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	<200	<200	<200	<200	<200
F4 (C34-C50 Hydrocarbons)	<200	<200	<200	<200	<200

Parameter	**MW-161-12**	**MW-162-7**	**MW-167-13**	**MW-168-7**
HU	**HU 3**	**HU 3**	**HU PA**	**HU PA**
Benzene	<0.2	<0.2	0.25	<0.2
Toluene	<0.2	<0.2	0.33	<0.2
Ethylbenzene	<0.2	<0.2	<0.2	<0.2
Total Xylenes	<0.4	<0.4	<0.4	<0.4
F1 (C6-C10) - BTEX	<25	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	<200	<200	<200	<200
F4 (C34-C50 Hydrocarbons)	<200	<200	<200	<200

Notes:
Units are in µg/L
--- denotes that samples were not required
< denotes that result is below the laboratory method detection limit

Table A-4: 2023 Upgradient Perimeter Wells Tritium Results

Sample Location Name	Frequency	Analysis Parameter	HU	Q1 (Bq/L)	Q2 (Bq/L)	Q3 (Bq/L)	Q4 (Bq/L)
MW-006-9	Annual	Tritium	HU 1	--	<100	--	--
MW-007-2	Annual	Tritium	HU 1	--	<100	--	--
MW-008-20	Annual	Tritium	HU 2/ HU 3	--	<100	--	--
MW-031-31	Annual	Tritium	HU 5	--	<100	--	--
MW-032-13	Annual	Tritium	HU 2	--	<100	--	--
MW-033-8	Annual	Tritium	HU 1	--	130	--	--
MW-045-10	Annual	Tritium	HU 1	--	<100	--	--
MW-046-6	Annual	Tritium	HU 1	--	<100	--	--
MW-052-15	Annual	Tritium	HU 1	--	<100	--	--
MW-059-12	Annual	Tritium	HU 2	--	<100	--	--
MW-077-41	Annual	Tritium	HU 5	--	<100	--	--
MW-078-18	Annual	Tritium	HU 2	--	<100	--	--
MW-079-4	Annual	Tritium	HU 1	--	<100	--	--
MW-094-29	Annual	Tritium	HU 5	--	<100	--	--
MW-095-13	Annual	Tritium	HU 2	--	<100	--	--
MW-096-6	Annual	Tritium	HU 1	--	<100	--	--

Notes:

--- denotes that samples were not required

< denotes that result is below the laboratory method detection limit

Table A-5a: 2023 Downgradient Perimeter Wells Tritium Results

Sample Location Name	Frequency	Analysis Parameter	HU	Q1 (Bq/L)	Q2(Bq/L)	Q3(Bq/L)	Q4(Bq/L)
MW-015B-14	Annual	Tritium	HU 5	--	<100	--	--
MW-016B-7	Annual	Tritium	HU 2	--	<100	--	--
MW-016C-4	Annual	Tritium	HU 1	--	490	--	--
MW-017B-15	Annual	Tritium	HU 5	--	<100	--	--
MW-018B-8	Annual	Tritium	HU 2	--	<100	--	--
MW-018C-4	Annual	Tritium	HU 1	--	<100	--	--
MW-108-11	Quarterly	Tritium	HU PA	<100	<100	100	<15
MW-109-10	Quarterly	Tritium	HU PA	<100	<100	100	<15
MW-110-6	Quarterly	Tritium	HU PA	<100	<100	100	<15
MW-111-18	Annual	Tritium	HU 5	--	130	--	--
MW-112-11	Quarterly	Tritium	HU PA	147	150	200	173
MW-113-6	Quarterly	Tritium	HU PA	180	170	210	204
MW-128-18	Annual	Tritium	HU 5	--	<100	--	--
MW-154-16	Annual	Tritium	HU 5	--	140	--	--
MW-155-11	Quarterly	Tritium	HU PA	420	420	480	506
MW-156-7	Quarterly	Tritium	HU PA	980	620	700	661
MW-157-16	Annual	Tritium	HU 5	--	690	--	--
MW-158-12	Quarterly	Tritium	HU 3	<100	120	100	121
MW-159-7	Quarterly	Tritium	HU PA	710	910	890	797
MW-163-16	Annual	Tritium	HU 5	<100	--	--	--
MW-164-13	Quarterly	Tritium	HU PA	310	360	280	224
MW-165-7	Quarterly	Tritium	HU PA	730	770	720	765

Notes:

NA denotes that sample could not be collected and the result is not available

--- denotes that samples were not required

< denotes that result is below the laboratory method detection limit

Table A-5b: 2023 Downgradient Perimeter Wells PHC and BTEX Results

Parameter	MW-016B-7	MW-016C-4	MW-018B-8	MW-018C-4
Benzene	<0.2	<0.2	<0.2	<0.2
Toluene	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	<0.2	<0.2	<0.2	<0.2
Total Xylenes	<0.4	<0.4	<0.4	<0.4
F1 (C6-C10) - BTEX	<25	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	<200	<200	<200	<200
F4 (C34-C50 Hydrocarbons)	<200	<200	<200	<200

Parameter	MW-155-11	MW-156-7	MW-158-12	MW-159-7	MW-165-7
Benzene	<0.2	<0.2	0.58	<0.2	<0.2
Toluene	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	<0.2	<0.2	<0.2	<0.2	<0.2
Total Xylenes	<0.4	<0.4	<0.4	<0.4	<0.4
F1 (C6-C10) - BTEX	<25	<25	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	<200	<200	<200	<200	<200
F4 (C34-C50 Hydrocarbons)	<200	<200	<200	<200	<200

Notes:
Units are in µg/L
--- denotes that samples were not required
< denotes that result is below the laboratory method detection limit

Table A-6: 2023 DNNP Groundwater Indicator Parameter Results

Parameter	Units	MW-005-24		MW-006-9		MW-007-2		MW-008-20	
Date									
Dissolved Metals									
Calcium	µg/L	34,200	33,700	55,800	46,000	121,000	NA	61,500	17,000
Iron	µg/L	21	168	<25	108	<25	NA	34	612
Magnesium	µg/L	21,500	17,500	85,900	73,900	55,200	NA	35,000	11,600
Potassium	µg/L	1,960	1,970	1,660	1,790	4,010	NA	1,560	861
Sodium	µg/L	72,800	72,500	78,600	49,500	370,000	NA	102,000	54,200
General Parameters									
Alkalinity (Total as CaCO3)	µg/L	250,000	250,000	200	200,000	230,000	NA	170,000	150,000
Bicarbonate Alkalinity (as CaCO3)	µg/L	240,000	240,000	200,000	200,000	220,000	NA	170,000	140,000
Carbonate Alkalinity (as CaCO3)	µg/L	2,700	2,300	2,100	1,800	1,800	NA	1,500	1,100
Chloride	µg/L	55,000	36,000	210,000	160,000	570,000	NA	180,000	39,000
Conductivity	µmho/cm	660	620	1,300	1,100	2,600	NA	1,100	440
pH	Unitless	8	8	8	8	8	NA	8	8
Sulphate (SO4)	mg/L	7	5	70	63	140	NA	45	4,9
Total Dissolved Solids	mg/L	325	320	715	615	1,400	NA	580	200

Notes:
Units are in µg/L
--- denotes that samples were not required

< denotes that result is below the laboratory method detection limit

NA denotes that sample could not be collected and the result is not available

Table A-6: 2023 DNNP Groundwater Indicator Parameter Results

Parameter	Units	MW-009-15		MW-044-34		MW-045-10		MW-046-6	
Date									
Dissolved Metals									
Calcium	µg/L	56,900	46,500	36,400	33,000	109,000	104,000	103,000	NA
Iron	µg/L	118	83	31	38	82	139	<5	NA
Magnesium	µg/L	78,300	66,700	10,100	8,820	41,500	43,500	9,470	NA
Potassium	µg/L	1,720	1,570	3,120	2,690	2,600	2,720	464	NA
Sodium	µg/L	81,100	60,900	88,900	78,500	20,600	19,800	5,670	NA
General Parameters									
Alkalinity (Total as CaCO3)	µg/L	210,000	190,000	290,000	270,000	400,000	380,000	320,000	NA
Bicarbonate Alkalinity (as CaCO3)	µg/L	210,000	190,000	290,000	260,000	400,000	380,000	310,000	NA
Carbonate Alkalinity (as CaCO3)	µg/L	2,300	2,300	2,100	2,200	2,800	1,900	2,500	NA
Chloride	µg/L	220,000	180,000	25,000	16,000	49,000	39,000	4,900	NA
Conductivity	µmho/cm	1,300	1,100	620	550	880	870	580	NA
pH	Unitless	8	8	8	8	8	8	8	NA
Sulphate (SO4)	mg/L	69	59	<1	<1	30	26	3	NA
Total Dissolved Solids	mg/L	710	620	435	305	505	505	305	NA

Notes:
Units are in µg/L
--- denotes that samples were not required

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NA denotes that sample could not be collected and the result is not available

Table A-6: 2023 DNNP Groundwater Indicator Parameter Results

Parameter	**Units**	**MW-047-92**	**MW-052-15**		**MW-060-34**		**MW-061-20**	
Date								
Dissolved Metals								
Calcium	µg/L	38,400,000	20,600	20,000	112,000	156,000	91,500	90,200
Iron	µg/L	10,500	10	<25	311	548	1,010	1,720
Magnesium	µg/L	11,300,000	10,500	11,400	40,400	54,000	63,900	63,600
Potassium	µg/L	556,000	1,650	1,540	4,160	6,520	2,130	2,060
Sodium	µg/L	52,600,000	60,600	62,500	203,000	306,000	9,440	9,670
General Parameters								
Alkalinity (Total as CaCO3)	µg/L	34,000	180,000	180,000	630,000	770,000	420,000	450,000
Bicarbonate Alkalinity (as CaCO3)	µg/L	34,000	180,000	180,000	630,000	760,000	410,000	440,000
Carbonate Alkalinity (as CaCO3)	µg/L	<1	2,600	2,800	1,200	2,200	4,200	3,700
Chloride	µg/L	160,000,000	11,000	10,000	140,000	330,000	7,300	8,800
Conductivity	µmho/cm	>100,000 *	440	450	1,600	2,400	830	890
pH	Unitless	6	8	8	7	7	8	8
Sulphate (SO4)	mg/L	110	35	30	<1	<1	51	54
Total Dissolved Solids	mg/L	278,000	235	235	820	1,280	470	503

Notes:
Units are in µg/L
--- denotes that samples were not required

< denotes that result is below the laboratory method detection limit

NA denotes that sample could not be collected and the result is not available

Table A-6: 2023 DNNP Groundwater Indicator Parameter Results

Parameter	Units	MW-062-14		MW-063-98	MW-065-25		MW-066-8	
Date								
Dissolved Metals								
Calcium	µg/L	33,600	29,800	NA	95,400	110,000	111,000	99,500
Iron	µg/L	<5	<25	NA	<5	575	142	<5
Magnesium	µg/L	61,900	54,600	NA	14,300	34,000	33,900	16,900
Potassium	µg/L	2,330	2,030	NA	859	1,960	1,910	983
Sodium	µg/L	40,300	32,700	NA	19,400	12,400	13,500	24,600
General Parameters								
Alkalinity (Total as CaCO3)	µg/L	230,000	210,000	NA	290,000	210,000	210,000	290,000
Bicarbonate Alkalinity (as CaCO3)	µg/L	230,000	210,000	NA	290,000	200,000	210,000	290,000
Carbonate Alkalinity (as CaCO3)	µg/L	2,900	2,400	NA	2,600	1,700	2,000	2,500
Chloride	µg/L	88,000	84,000	NA	3,000	98,000	88,000	4,900
Conductivity	µmho/cm	790	750	NA	640	900	850	680
pH	Unitless	8	8	NA	8	8	8	8
Sulphate (SO4)	mg/L	37	32	NA	53	81	83	65
Total Dissolved Solids	mg/L	435	370	NA	350	510	530	410

Notes:
Units are in µg/L
--- denotes that samples were not required

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NA denotes that sample could not be collected and the result is not available

Table A-6: 2023 DNNP Groundwater Indicator Parameter Results

Parameter	**Units**	**MW-106-29**		**MW-083-36**	**MW-084-30**	**MW-085-25**	**MW-086-5**	**MW-177**	**MW-194**
Date									
Dissolved Metals									
Calcium	µg/L	120,000	106,000	183,000	11,200	15,700	127,000	62,100	140,000
Iron	µg/L	1,150	1,190	8,030	25	51	5	409	<5
Magnesium	µg/L	40,900	39,000	68,600	3,970	16,200	12,300	63,600	27,500
Potassium	µg/L	1,930	1,860	9,030	474	643	986	1,900	1,730
Sodium	µg/L	16,500	15,200	422,000	59,400	27,600	20,300	30,700	33,300
General Parameters									
Alkalinity (Total as CaCO3)	µg/L	220,000	210,000	940,000	150,000	140,000	280,000	310,000	280,000
Bicarbonate Alkalinity (as CaCO3)	µg/L	220,000	210,000	930,000	150,000	140,000	270,000	310,000	280,000
Carbonate Alkalinity (as CaCO3)	µg/L	1,900	1,200	3,700	1,200	1,200	1,900	3,500	1,700
Chloride	µg/L	120,000	120,000	480,000	27,000	13,000	18,000	52,000	82,000
Conductivity	µmho/cm	950	930	3,100	360	320	730	910	980
pH	Unitless	8	8	8	8	8	8	8	8
Sulphate (SO4)	mg/L	70	73	<1	1	<1	89	74	69
Total Dissolved Solids	mg/L	570	590	1,640	185	155	450,000	475	580

Notes:
Units are in µg/L
--- denotes that samples were not required

< denotes that result is below the laboratory method detection limit

NA denotes that sample could not be collected and the result is not available

Table A-6: 2023 DNNP Groundwater Indicator Parameter Results

Parameter	Units	MW-195	MW-196
Date			
Dissolved Metals			
Calcium	µg/L	14,300	23,900
Iron	µg/L	9	240
Magnesium	µg/L	286	9,180
Potassium	µg/L	4,060	3,570
Sodium	µg/L	73,100	71,500
General Parameters			
Alkalinity (Total as CaCO3)	µg/L	44,000	160,000
Bicarbonate Alkalinity (as CaCO3)	µg/L	25,000	160,000
Carbonate Alkalinity (as CaCO3)	µg/L	16,000	2,000
Chloride	µg/L	87,000	44,000
Conductivity	µmho/cm	490	540
pH	Unitless	10	8
Sulphate (SO4)	mg/L	28	21
Total Dissolved Solids	mg/L	225	265

Notes:
Units are in µg/L
--- denotes that samples were not required

< denotes that result is below the laboratory method detection limit

NA denotes that sample could not be collected and the result is not available

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

Location	Sample Date	Parameter Analysed	Units	Sample Values		RPD (%)
				Duplicate	Primary	
MW-003-7	11-May-2023	Tritium	Bq/L	240	210	13.3
	06-Nov-2023	Tritium	Bq/L	234	237	1.3
MW-005-24	27-Oct-2023	Alkalinity (Total as CaCO3)	mg/L	240	250	4.1
		Bicarbonate Alkalinity (calc as CaCO3)	mg/L	240	240	0.0
		Calcium	µg/L	34400	33700	2.1
		Carbonate Alkalinity (calc as CaCO3)	mg/L	3	2	8.3
		Chloride	µg/L	41000	36000	13.0
		Conductivity	µmho/cm	620	620	0.0
		Iron	µg/L	178	168	5.8
		Magnesium	µg/L	18100	17500	3.4
		pH	pH units	8	8	0.6
		Potassium	µg/L	1960	1970	0.5
		Sodium	µg/L	72700	72500	0.3
		Sulphate (SO4)	mg/L	5	5	0.0
		Total Dissolved Solids	mg/L	320	320	0.0
MW-007-2	05-May-2023	Alkalinity (Total as CaCO3)	mg/L	220	230	4.4
		Bicarbonate Alkalinity (calc as CaCO3)	mg/L	220	220	0.0
		Calcium	µg/L	119000	121000	1.7
		Carbonate Alkalinity (calc as CaCO3)	mg/L	2	2	5.4
		Chloride	µg/L	570000	570000	0.0
		Conductivity	µmho/cm	2600	2600	0.0
		Iron	µg/L	<25	<25	NC
		Magnesium	µg/L	53000	55200	4.1
		pH	pH units	8	8	0.5
		Potassium	µg/L	3800	4010	5.4
		Sodium	µg/L	355000	370000	4.1
		Sulphate (SO4)	mg/L	140	140	0.0
		Total Dissolved Solids	mg/L	1440	1400	2.8
		Tritium	Bq/L	<100	<100	NC
MW-033-8	11-May-2023	Tritium	Bq/L	130	130	0.0
MW-046-6	04-May-2023	Alkalinity (Total as CaCO3)	mg/L	320	320	0.0
		Bicarbonate Alkalinity (calc as CaCO3)	mg/L	310	310	0.0
		Calcium	µg/L	106000	103000	2.9
		Carbonate Alkalinity (calc as CaCO3)	mg/L	3	3	0.0
		Chloride	µg/L	5600	4900	13.3
		Conductivity	µmho/cm	590	580	1.7
		Iron	µg/L	5	5	0.0
		Magnesium	µg/L	9140	9470	3.5
		pH	pH units	8	8	0.1
		Potassium	µg/L	454	464	2.2
		Sodium	µg/L	5550	5670	2.1
		Sulphate (SO4)	mg/L	4	3	22.2
		Total Dissolved Solids	mg/L	320	305	4.8
MW-065-25	20-Nov-2023	Alkalinity (Total as CaCO3)	mg/L	210	210	0.0
		Bicarbonate Alkalinity (calc as CaCO3)	mg/L	200	200	0.0
		Calcium	µg/L	107000	110000	2.8
		Carbonate Alkalinity (calc as CaCO3)	mg/L	2	2	6.1
		Chloride	µg/L	100000	98000	2.0
		Conductivity	µmho/cm	890	900	1.1
		Iron	µg/L	580	575	0.9
		Magnesium	µg/L	34000	34000	0.0
		pH	pH units	8	8	0.5
		Potassium	µg/L	1940	1960	1.0
		Sodium	µg/L	12400	12400	0.0
		Sulphate (SO4)	mg/L	82	81	1.2
		Total Dissolved Solids	mg/L	545	510	6.6
MW-085-25	30-Oct-2023	Alkalinity (Total as CaCO3)	mg/L	140	140	0.0
		Bicarbonate Alkalinity (calc as CaCO3)	mg/L	140	140	0.0
		Calcium	µg/L	15500	15700	1.3
		Carbonate Alkalinity (calc as CaCO3)	mg/L	1	1	0.0
		Chloride	µg/L	16000	13000	20.7
		Conductivity	µmho/cm	310	320	3.2
		Iron	µg/L	50	51	2.0
		Magnesium	µg/L	16200	16200	0.0
		pH	pH units	8	8	0.3
		Potassium	µg/L	639	643	0.6
		Sodium	µg/L	27000	27600	2.2
		Sulphate (SO4)	mg/L	1	1	0.0
		Total Dissolved Solids	mg/L	150	155	3.3
MW-110-6	21-Mar-2023	Tritium	Bq/L	<100	<100	NC
	15-May-2023	Tritium	Bq/L	<100	<100	NC
	14-Aug-2023	Tritium	Bq/L	100	100	0.0
	07-Nov-2023	Tritium	Bq/L	<15	<15	NC
MW-113-6	21-Mar-2023	Tritium	Bq/L	160	180	11.8
	15-May-2023	Tritium	Bq/L	200	170	16.2
	14-Aug-2023	Tritium	Bq/L	170	210	21.1
	07-Nov-2023	Tritium	Bq/L	196	204	4.0
	22-Mar-2023	Tritium	Bq/L	760	720	5.4
		Benzene	µg/L	<0.2	<0.2	NC
		Ethylbenzene	µg/L	<0.2	<0.2	NC

Location	Sample Date	Parameter Analysed	Units	Sample Values		RPD (%)
				Duplicate	Primary	
MW-119-6	18-May-2023	F1 (C6-C10)	µg/L	<25	<25	NC
		F1 (C6-C10) - BTEX	µg/L	<25	<25	NC
		F2 (C10-C16 Hydrocarbons)	µg/L	<100	<100	NC
		F3 (C16-C34 Hydrocarbons)	µg/L	<200	<200	NC
		F4 (C34-C50 Hydrocarbons)	µg/L	<200	<200	NC
		Toluene	µg/L	<0.2	<0.2	NC
		Total Xylenes	µg/L	<0.4	<0.4	NC
		Tritium	Bq/L	790	750	5.2
	15-Aug-2023	Tritium	Bq/L	750	770	2.6
	07-Nov-2023	Tritium	Bq/L	733	743	1.4
MW-153-7	21-Mar-2023	Tritium	Bq/L	620	590	5.0
	17-May-2023	Benzene	µg/L	<0.2	<0.2	NC
		Ethylbenzene	µg/L	<0.2	<0.2	NC
		F1 (C6-C10)	µg/L	<25	<25	NC
		F1 (C6-C10) - BTEX	µg/L	<25	<25	NC
		F2 (C10-C16 Hydrocarbons)	µg/L	<100	<100	NC
		F3 (C16-C34 Hydrocarbons)	µg/L	<200	<200	NC
		F4 (C34-C50 Hydrocarbons)	µg/L	<200	<200	NC
		Toluene	µg/L	<0.2	<0.2	NC
		Total Xylenes	µg/L	<0.4	<0.4	NC
		Tritium	Bq/L	630	630	0.0
	15-Aug-2023	Tritium	Bq/L	750	790	5.2
	08-Nov-2023	Tritium	Bq/L	706	686	2.9
MW-155-11	22-Mar-2023	Tritium	Bq/L	440	420	4.7
	18-May-2023	Tritium	Bq/L	450	420	6.9
	17-Aug-2023	Tritium	Bq/L	500	480	4.1
	09-Nov-2023	Tritium	Bq/L	531	506	4.8
MW-165-7	16-May-2023	Benzene	µg/L	<0.2	<0.2	NC
		Ethylbenzene	µg/L	<0.2	<0.2	NC
		F1 (C6-C10)	µg/L	<25	<25	NC
		F1 (C6-C10) - BTEX	µg/L	<25	<25	NC
		F2 (C10-C16 Hydrocarbons)	µg/L	<100	<100	NC
		F3 (C16-C34 Hydrocarbons)	µg/L	<200	<200	NC
		F4 (C34-C50 Hydrocarbons)	µg/L	<200	<200	NC
		Toluene	µg/L	<0.2	<0.2	NC
		Total Xylenes	µg/L	<0.4	<0.4	NC
MW-194	31-Oct-2023	Alkalinity (Total as CaCO3)	mg/L	290	280	3.5
		Bicarbonate Alkalinity (calc as CaCO3)	mg/L	280	280	0.0
		Calcium	µg/L	142000	140000	1.4
		Carbonate Alkalinity (calc as CaCO3)	mg/L	2	2	0.0
		Chloride	µg/L	82000	82000	0.0
		Conductivity	µmho/cm	980	980	0.0
		Iron	µg/L	<5	<5	NC
		Magnesium	µg/L	28200	27500	2.5
		pH	pH units	8	8	0.4
		Potassium	µg/L	1820	1730	5.1
		Sodium	µg/L	33100	33300	0.6
		Sulphate (SO4)	mg/L	69	69	0.0
		Total Dissolved Solids	mg/L	545	580	6.2

Notes:

< denotes that result is below the laboratory method detection limit

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

Sample Type	Parameter	Units	Sample Result (µg/L)	
			Q2 (12-May-23)	Q2 (18-May-23)
Field Blank	Benzene	µg/L	<0.2	<0.2
	Ethylbenzene	µg/L	<0.2	<0.2
	F1 (C6-C10) - BTEX	µg/L	<25	<25
	Toluene	µg/L	<0.2	<0.2
	Total Xylenes	µg/L	<0.4	<0.4
			Q2 (18-May-23)	Q2 (23-May-23)
Trip Blank	Benzene	µg/L	<0.2	<0.2
	Ethylbenzene	µg/L	<0.2	<0.2
	F1 (C6-C10) - BTEX	µg/L	<25	<25
	Toluene	µg/L	<0.2	<0.2
	Total Xylenes	µg/L	<0.4	<0.4

Notes:

< denotes that result is below the laboratory method detection limit