REPORT

WASTE MANAGEMENT OF CANADA CORPORATION

WATFORD, ONTARIO

TWIN CREEKS ENVIRONMENTAL CENTRE: 2021 FOURTH QUARTER & ANNUAL MONITORING REPORT VOLUME 1 OF 5 – COMPLIANCE MONITORING

RWDI #2101781-1000

March 1, 2022

SUBMITTED TO

Angela McLachlan
Environmental Compliance Manager
amclachl@wm.com

Waste Management of Canada Corporation
Twin Creeks Environmental Centre
5768 Nauvoo Road (Watford)
Warwick Township, County of Lambton
N0M 2S0

T: 519.849.5810
F: 519.849.5811

SUBMITTED BY

Brent J. Langille, B.Sc., P.Geo.
Technical Director | Principal
Brent.Langille@rwdi.com | ext. 2618

Khalid Hussein, P.Eng.
Project Manager
Khalid Hussein@rwdi.com | ext. 2055

RWDI AIR Inc.
Consulting Engineers & Scientists
4510 Rhodes Drive | Suite 530
Windsor, Ontario
N8W 5K5

T: 519.974.7384
F: 519.823.1316

March 1, 2022

Ms. Angela McLachlan
Environmental Compliance Manager
Waste Management of Canada Corporation
Twin Creeks Environmental Centre
5678 Nauvoo Road (Watford)
Warwick Township, County of Lambton

Re: Waste Management of Canada Corporation
2021 Fourth Quarter and Annual Monitoring Report
Twin Creeks Environmental Centre, Warwick Township, County of Lambton, Ontario
Volumes 1 and 2 - Text, Figures, Tables, and Appendices

Dear Ms. McLachlan,

RWDI AIR Inc. (RWDI) is pleased to provide the 2021 Fourth Quarter and Annual Monitoring Report**, Volumes 1** and **2:** Compliance Monitoring and Operations Program, for the Twin Creeks Environmental Centre. **Volume 1** includes the text, figures, and tables. **Volume 2** includes the appendices, which contain the technical information and supporting documentation for the Compliance Monitoring and Operations Program and is provided in two (2) bound sections. **Volume 3** – Poplar System Monitoring Program, **Volume 4** – Ambient Air Quality Monitoring Program, and **Volume 5** – Noise Monitoring Program, are provided under separate covers

In November 2010, the Ministry of the Environment (MOE) issued the Technical Guidance Document entitled "*Monitoring and Reporting for Waste Disposal Sites, Groundwater and Surface Water*" (MOE, 2010). Appended to this report is a completed Monitoring and Screening Checklist from the above Technical Guidance Document, which provides certification of the Competent Environmental Practitioner (CEP). The Monitoring and Screening Checklist is provided in **Appendix S**.

Volumes 1 and 2 of the 2021 Fourth Quarter and Annual Monitoring Report have been prepared in consideration of Conditions 15.4 through 15.7 of amended Environmental Compliance Approval No. A032203, dated December 19, 2020 (Waste ECA), and provides a detailed interpretive analysis of the 2021 findings for the compliance monitoring at the Twin Creeks Environmental Centre and a summary of its operations in 2021.

We trust that this report satisfies your requirements. Please contact us if you have any questions.

Yours truly,

RWDI AIR Inc.

Khalid Hussein, P.Eng.
Project Manager

KAMH/kta

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1 INTRODUCTION

1.1 Purpose & Scope

The purpose of the 2021 Compliance Monitoring and Operations Program for Waste Management of Canada Corporation's (WM) Twin Creeks Environmental Centre (Site) is as follows.

- To report compliance with the terms and conditions of the relevant Environmental Compliance Approvals (ECAs) (waste, sewage, and air) and regulatory permits (PTTW) for the Site, the landfill gas flare systems, and stormwater management facilities for the reporting period of January 1 to December 31, 2021.
- To satisfy Conditions 5, 6, and 7 of the Environmental Assessment Act approval, dated January 15, 2007.
- To assess potential effects of the landfill on groundwater and surface water quality.
- To evaluate the monitoring program(s) on an annual basis and to recommend improvements as operations at the Site mature.
- To determine the need for the implementation of contingency measures.

Volumes 1 and 2 of the 2021 Fourth Quarter and Annual Monitoring Report (2021 Annual Report) satisfy the reporting requirements for both the fourth quarter (Q4) of 2021 (October 1 to December 31) and the 2021 compliance monitoring and operations calendar year monitoring period. Reporting involves a data collection component and a comprehensive analysis and interpretation component. The 2021 data were collected by WM and RWDI AIR Inc. (RWDI), while the data compiled for **Volumes 1 and 2** of the 2021 Annual Report were collated and analyzed by RWDI. The following presents a summary of the data collection responsibilities for the Compliance Monitoring Program in 2021.

Waste Management of Canada Corporation:

- Operations Logs (Dust and Litter)
- Leachate Volume Tracking
- Tonnage Tracking Information (Waste & Recyclables)
- Water Taking Information
- Complaint Logs
- Collection of Daily Liquid Levels from Expansion Site PDL Pumping Stations

RWDI AIR Inc.:

- Liquid Level Monitoring (Leachate and Groundwater)
- Groundwater Quality Monitoring
- Surface Water Quality Monitoring
- Contaminated Soil & ASR Quality Monitoring
- Leachate Quality Monitoring
- Monthly Collection of Liquid levels from Expansion Site SDL Pumping Stations
- Monthly Site Inspections
- Overall Data Collation and Reporting

Air quality, noise, total suspended particulate and Poplar System monitoring, and reporting were also completed by RWDI in 2021. The monitoring results, analysis, and interpretation for the Poplar System Monitoring Program are presented in **Volume 3** of the 2021 Annual Report. Approval to discontinue the monitoring of the Poplar Plantation was received on February 20, 2013, per Notice No. 1 of the Sewage ECA. Therefore, a relevant volume is not included in this Annual Report.

1.2 Site Regulatory Framework

The Site is owned and is operated by WM in conformance with the regulatory approvals noted below. Copies of the relevant ECAs and their amendments, as well as the PTTW, are provided in **Appendix A**.

- Amended Environmental Compliance Approval (ECA) No. A032203, dated December 19, 2020 (Waste ECA).
- Amended ECA for Industrial Sewage Works No. 2403-BE6LZ4, dated August 21, 2019 (Sewage ECA).
- ECA for Air No. 9488-AMPH4Y, dated July 6, 2017 (Air ECA).
- Amended Permit-To-Take-Water (PTTW) No. 4430-8PLMKV, dated January 17, 2012, for the removal of surface water from four (4) Sedimentation Ponds and the dewatering of the Secondary Drainage Layer (SDL) for the Expansion Site.
- PTTW No. 4682-BLJRYJ, dated November 8, 2021, for the removal of surface water from four (4) Sedimentation Ponds and the dewatering of the Secondary Drainage Layer (SDL) for the Expansion Site.
- MECP Letter entitled "Request for Modification to Surface Water Monitoring/Assessment Process at Twin Creeks Landfill", dated February 27, 2014 (2014 MECP Letter).

Throughout 2021, quarterly monitoring reports were submitted to relevant stakeholders in accordance with Condition 15.4 of the Waste ECA. **Volumes 1 and 2** of the 2021 Annual Report have been prepared in consideration of Conditions 15.4 through 15.7 of the Waste ECA and Condition 13(4) of the Sewage ECA. **Volumes 1 and 2** provide a detailed analysis of the 2021 findings for the compliance monitoring at the Site and its operation in 2021.

This 2021 Annual Report is also prepared in accordance with Conditions 5, 6, and 7 of the Notice of Approval to Proceed with the Undertaking, dated January 15, 2007, in regard to the Environmental Assessment Act (EAA) approval of the Warwick Landfill Expansion (renamed Twin Creeks Landfill and subsequently to Twin Creeks Environmental Centre).

1.3 Site Description & Background

The Site is a solid, non-hazardous waste landfill site that contains an old landfill (Existing Site) and an area approved for expansion (Expansion Site). The Site is located on Part of Lots 19 and 20, Concession 3, south of Egremont Road (SER), and part of Lots 20 to 22, Concession 4 SER, in the Township of Warwick, County of Lambton, Ontario. The Site occupies an area of 301 hectares (ha) with 101.8 ha permitted for landfilling. A Site Location Map is presented on **Figure 1**.

Landfill waste at the Site has two (2) distinct waste disposal areas: 1) the Existing Site; and 2) the Expansion Site. The Existing Site is divided into waste cells as presented on **Figure 2**. The progression of construction of the Expansion Site is summarized below and presented on **Figure 2**.

Expansion Site Cell	Date of First Waste Tonnage Deposited
Cell 1A Stage I	November 16, 2009
Cell 1A Stage II	September 21, 2010
Cell 1B Stage I	August 18, 2011
Cell 1B Stage II	June 20, 2012
Cell 2A	November 18, 2013
Cell 2B	September 25, 2014
Cell 2C	September 10, 2015
Cell 2D	August 19, 2016
Cell 2E	September 8, 2017
Cell 4A Stage 1	September 25, 2019
Cell 4A Stage 2	November 14, 2019
Cell 4B Stage 1	September 22, 2020
Cell 4B Stage 2	November 23, 2020
Cell 4C	August 10, 2021

During 2021, waste disposal occurred in Cell 4A, Cell 4B, and Cell 4C of the Expansion Site. Waste disposal in Cell 4C commenced on August 10, 2021, as the landfill liner system was approved to accept waste. Cell 6A pre-excavation activities related to the future construction of the Cell 6A landfill liner system of the Expansion Site were completed in 2021. Upon completion of the landfill liner system of Cell 6A, waste disposal is scheduled to also occur Cell 6A in 2022.

The South Cell (formerly South Fill Area) of the Existing Site consists of historical waste landfilled into trenches of various widths and depths excavated into the clayey soil. There are three (3) finger drains that transect through the trenches to provide gravity drainage toward the perimeter maintenance holes (MH16, MH17, and MH18) for leachate collection. The remainder of the waste footprint of the Existing Site also contains historical waste trenches but includes newer waste cells constructed with re-compacted clayey liners and, in some cells, waste underdrains.

Waste within the Expansion Site will extend to an average design depth of 15 m below existing grade. Leachate is managed with a liner system that directs leachate toward dedicated leachate pumping stations. The liner system consists of a primary drainage layer (PDL) below the waste to convey leachate, an underlying re-compacted clayey liner (primary liner), then a secondary drainage layer (SDL) for leak detection and contingency use, which is all underlain by a thick natural barrier of clayey soil. Design specifications are provided under Items 66 to 68 in Schedule A of the Waste ECA, namely, the report titled "*Development and Operations Plans – Warwick Landfill Expansion (Volumes 1 to 3)*", as prepared by Henderson Paddon & Associates and dated March 2008 (D&O Report).

Leachate generated at the Site can be managed either on-Site through irrigation for poplar trees to be treated by phytoremediation or by transport for off-Site treatment and disposal. The Poplar System was decommissioned in June 2014 as part of the construction activities to expand the footprint from the previous 3.3 ha to 9 ha. Leachate phytoremediation is approved for the expanded Poplar System located within the waste footprint of the Existing Site, as shown on **Figure 2**. In 2021, irrigation liquid was applied to the poplar trees intermittently from May 10 to September 30. It should be noted that the Poplar System pertains to a plot of poplar trees planted on the landfill cap of the Existing Site, whereas the Poplar Plantation refers to the plot of trees planted on native soil and is located south of the Existing Site. Details pertaining to the Poplar System Monitoring Program completed in 2021, including surface water monitoring in response to precipitation events of ≥ 10 millimetres (mm) in 24 hours, are provided in **Volume 3** of the 2021 Annual Report.

Surface water flow is ephemeral, with flow that typically occurs after snowmelt or prolonged periods of precipitation. Details on the surface water quality system are provided in **Section 2.4**. In summary, surface water is managed through a network of on-Site ditches, a Temporary Water Storage Area, and four (4) on-Site Sedimentation Ponds. Surface water runoff from the Site flows toward: 1) Kersey Drain (Brown Creek) to the east, and 2) to drains and ditches associated with Bear Creek to the west.

Assessments of local groundwater and surface water have continued to achieve acceptable quality at the Site compliance boundaries. A list of historical monitoring reports is provided in **Table B-1**, **Appendix B**.

For reference to the Site construction design details, **Appendix L** contains construction details of the Existing and Expansion Sites, with the breakdown as outlined below.

<u>Existing Site:</u>

The construction details: *"Laidlaw Waste Systems (Warwick) Limited, Warwick Township Landfill Site, Development and Operations Plan"* from the Development & Operations Report, Canadian Waste Services Inc., Warwick Landfill, Warwick Township (Henderson, Paddon Environmental Inc., October 1997), which is Item 37 of Schedule A of the Waste ECA (included as **Appendix L-1**, **Appendix L**).

<u>Expansion Site:</u>

The construction details: *"Drawings 111 – 120, 125, and 127"* from the Development & Operations Plans, Warwick Landfill Expansion, Volume 1 of 3, which is Item 66 of Schedule A of the Waste ECA (included as **Appendix L-2**, **Appendix L**).

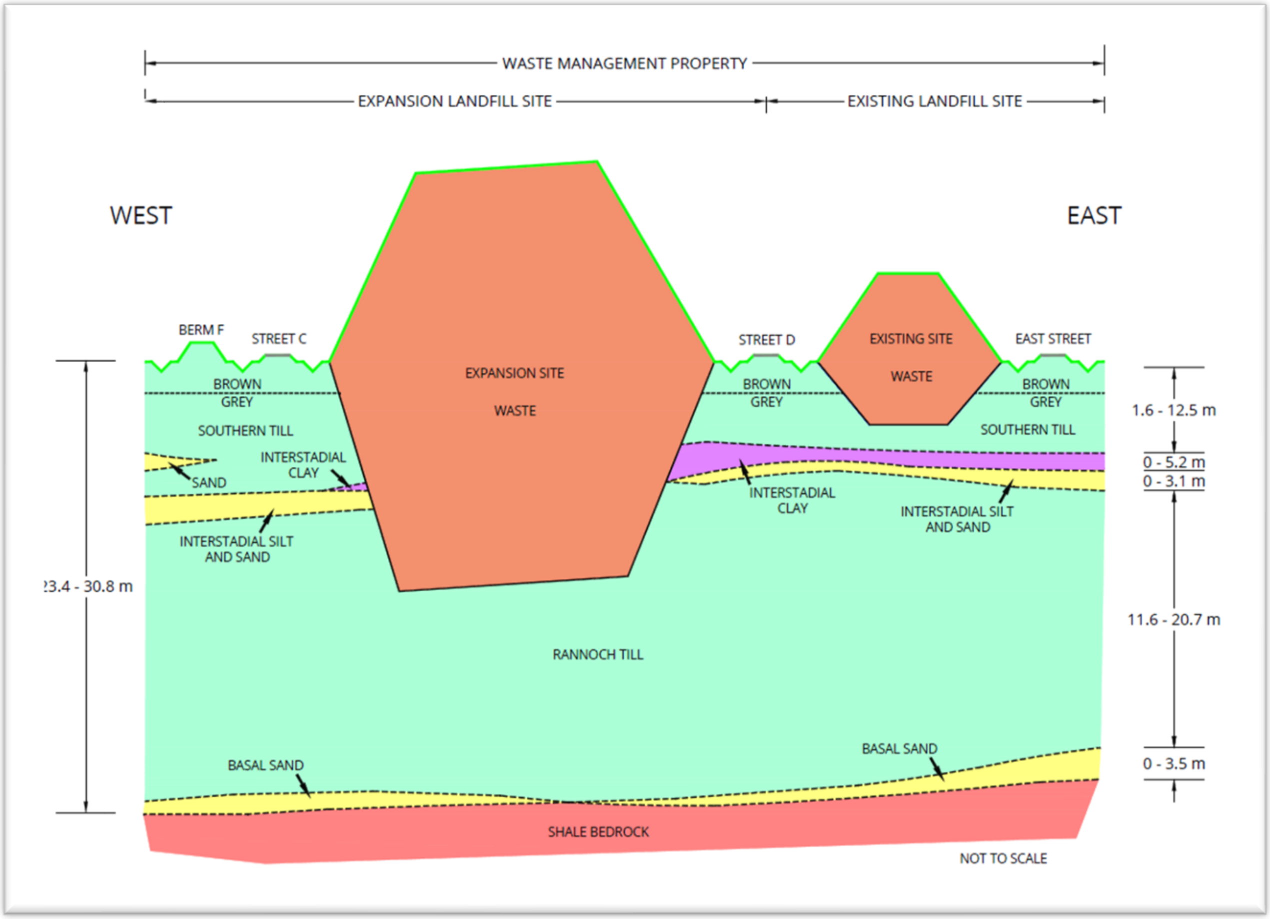
<u>As-built Information for Waste Cells Constructed in 2021:</u>

The CQA/CQC Liner System Summary Report (Cell 4C), as prepared by RWDI, dated August 4, 2021, respectively, can be found in **Appendix L-3, Appendix L**.

1.4 Site Hydrogeologic Setting

The landfill is located in southwestern Ontario within the southeastern portion of the Horseshoe Moraines physiographic region (Chapman and Putnam, 1984). The Horseshoe Moraines consist of a large horseshoe-shaped landform that includes a series of moraines aligned roughly parallel to the Lake Huron shoreline. Bear Creek to the west and Brown Creek to the east provide a slightly rolling topography around the Site. This rolling topography is further enhanced by the local tributaries and drainage swales.

For the purpose of this report, the local stratigraphy is subdivided into the following main units: 1) the Southern Till; 2) interstadial deposits; 3) the Rannoch Till; and 4) bedrock and the overlying basal sand. Each unit is shown in the following cross-section and is briefly discussed below.



The **Southern Till** unit consists of silty clay to clayey silt with trace amounts of disseminated sand and gravel. Occasional discontinuous layers or lenses of sand were observed within this unit. At the Site, this unit ranges in thickness from approximately 1.6 m to 12.5 m. The upper 1.6 m to 5.0 m of the Southern Till is weathered and is generally identified by a brown colour. Soil fractures are numerous near ground surface and decrease in frequency with depth. The underlying unweathered Southern Till is grey in colour and contains occasional fractures.

The **interstadial deposits** generally consist of two (2) distinct deposits: 1) an upper deposit of silt and clay, often varved, that is up to 5.2 m in thickness; and 2) a lower deposit of silt to sand that is up to 3.1 m in thickness. At some borehole locations, one or both deposits were not detected which indicates that these deposits are not continuous below the Site. Below the Site, the interstadial silt and sand ranges from 4.0 m to 10.7 m below ground surface where detected.

At about 4.0 m to 10.3 m below ground surface is the **Rannoch Till**. This till is a gritty to moderately stony clayey silt to silt till, although some textural variations occur. At some borehole locations, layers or lenses of silt to sand were detected within the till. The Rannoch Till was up to about 21.4 m thick below the Site.

Occasional discontinuous layers of sand and gravel between the Rannoch Till and underlying bedrock constitute the **basal sand**. The **bedrock** was encountered at a depth of between 23.4 m and 30.8 m below ground surface at the landfill and consists of the black bituminous shale of the Kettle Point Formation. The upper fractured portion of the bedrock and the overlying basal sand form the local bedrock aquifer.

The two (2) creeks that influence the physiography of the regional study area include Bear Creek to the west and Brown Creek to the east. The watershed for Bear Creek includes most of the Site and the area to the west. The Drainage Divide for the Bear Creek watershed cuts through the northeastern corner of the Site. Bear Creek is a tributary of the North Sydenham River and flows southwesterly to join the Sydenham River at Wallaceburg.

Surface water flow is ephemeral, with flow that typically occurs after snowmelt or prolonged periods of precipitation. Runoff from most of the east half of the Existing Site flows to Sedimentation Pond 1 (SP1), while runoff from the northern portion of Cell 11 and the west half of the Existing Site from north of approximately Cell 8/6 boundary flows to Sedimentation Pond 4 (SP4), drainage from most of Cell 6 flows into a Temporary Water Storage Area, while runoff from the remainder the west half of the Existing Site is directed to Sedimentation Pond 2 (SP2).

Sedimentation Ponds 1 through 4 are four (4) on-Site Sedimentation Ponds constructed in 2009 to manage surface water for the Site. Sedimentation Pond 2 discharges through culverts to the western Site boundary and into a tributary of Bear Creek on the east side of Lambton Road 79 (Nauvoo Road).

Upon completion of the Expansion Site, surface water runoff will be managed through Sedimentation Ponds 1, 2, 3, and 4. Surface water runoff originating from areas south of the Existing Site flows toward: 1) Kersey Drain (Brown Creek) to the east; and 2) to the west toward the Van Kessel Drain where it enters a municipal drainage tile at a catch basin (surface water monitoring station SS1), which is situated 60 m east of the western Site boundary. The municipal drainage tile subsequently drains into the discharge ditch of Sedimentation Pond 2, which ultimately flows westward to the Gilliand-Geerts Drain 'A', beneath Lambton Road 79.

The Brown Creek watershed drains the area east of the Site, including the northeast corner of the Existing Site. Brown Creek is a southwesterly flowing headwater of the Sydenham River, which it intersects about 1.3 kilometres (km) northeast of Alvinston.

Construction of the Sedimentation Pond network in the Expansion Site was completed by August 2009. The surface watercourse on the Expansion Site eventually discharges into a tributary of Bear Creek on the east side of Lambton Road 79 (Nauvoo Road). The surface water system around the Site is presented on **Figure 3**.

1.5 Water Budget

Water budgets are provided in **Tables C-1** through **C-7**, **Appendix C,** for the 30-year normal (1961-1990, 1971-2000, and 1981-2010) and the 2018 through 2021 climatic data for the area around the Site. The water budget information is based on the Thornthwaite Analytical Method (1957). A summary of precipitation data for the 30-Year Normal (1961-1990, 1971-2000, and 1981-2010) and the 1995 through 2021 annual climatic data for the area around the Site is provided in **Table C-9, Appendix C.** The 30-year normal and data to 1996 were collected at the Strathroy Climatological Station. Data from 1997 onward were collected from the Strathroy-Mullifarry Climatological Station, which is the nearest Environment Canada climatological station to the Site. As presented in **Table C-9, Appendix C**, a total of about 870.6 mm of precipitation was recorded from the on-Site climatological station during 2021, while the Strathroy-Mullifarry Climatological Station recorded about 1,028.4 mm of precipitation in 2021. Precipitation data collected from the on-Site climatological station from January 1 to December 31, 2021, is also provided in **Table C-8**, **Appendix C**.

Relative to the 30-Year Normal (1981-2010), 2021 was slightly wetter than normal as recorded at the climatological station. The 2002 to 2021 on-Site precipitation data from January 1 to December 31 indicates that the yearly precipitation received at the Site was consistently less than the regional total. For example, the precipitation recorded from the on-Site climatological in 2021 was approximately 15.3 % less than what was measured at the Strathroy-Mullifarry Climatological Station. This pattern of annually less precipitation recorded at the Site than recorded regionally, has typically been observed since on-Site precipitation monitoring began in 2003 (2003 was first full year of monitoring).

Based on the available historical data from the Environment Canada climatological stations, there is typically a water deficit (evapotranspiration exceeds precipitation) from May through September as expected during warmer climate. Therefore, there is a low potential for infiltration (lower accumulation of groundwater) or overland flow during this period. For January through April and from August through December in 2021, a water surplus (precipitation exceeds evapotranspiration) results in a greater potential for infiltration and overland flow.

1.6 Monitoring System & Schedule

Table 1 provides a schedule of the monitoring tasks completed in 2021. Also, provided in **Table 1** are rationales for monitoring requirements that were not completed in 2021. The annual monitoring program completed for the 2021 calendar year, including the relevant monitoring locations, parameters, and frequency, is outlined in **Table B-2**, **Appendix B**. **Table B-3**, **Appendix B**, provides a summary of changes to the Environmental Monitoring Plan (EMP) as approved by the Ministry of the Environment, Conservation and Parks (MECP). **Table B-4**, **Appendix B**, provides a summary of Compliance Point trigger concentration exceedances in 2021. Borehole logs and monitoring well information are provided in **Appendix D**. Monitoring well construction details are also summarized in tabular format as provided in **Table F-1**, **Appendix F**.

2 MONITORING METHODS

The 2021 Compliance Monitoring Program for groundwater, surface water, landfill gas, leachate, air quality and noise were completed by RWDI between January 1 and December 31, 2021. Liquid level monitoring of the primary drainage layer (PDL) and secondary drainage layer (SDL) of the Expansion Site was recorded automatically with pressure transducers and recorded by a SCADA system. Monitoring locations included in the annual monitoring program are listed in **Table 1** and presented on **Figure 2.**

Copies of the Chain of Custody Forms, as it relates to water, leachate, and soil, for samples submitted to the laboratory in 2021 are provided in **Table B-5**, **Appendix B**. A quality assurance and quality control (QA/QC) program was followed for each of the routine monitoring tasks completed. This program consists of procedures for the sampling of monitoring wells, the collection of samples, and ancillary tasks. A copy of the field sampling protocols is provided in **Appendix E**.

Monitoring well construction details are provided in **Table F-1**, **Appendix F**. Monitoring wells, which were included in the 2021 annual monitoring program, are designated as 'Active'. Other monitoring wells not included in the annual monitoring program are designated as 'Inactive'. Some historical monitoring wells that were recently removed and/or replaced from the monitoring program may be designated as 'Decommissioned'.

2.1 Liquid Level Measurements

Groundwater and leachate levels were manually measured at accessible monitoring wells, leachate wells, and maintenance holes located on the Site on May 17 and November 1, 2021.

Daily, during landfill operations, liquid levels for the leachate within the PDL at PS1, PS3, and PS5, as well as monthly groundwater levels for the water in the SDL at PS2, PS4, and PS6. Groundwater and leachate elevations are discussed in **Section 4**.

2.2 Leachate Sampling

Leachate samples were collected using dedicated disposable bailers for the relevant monitoring locations. Leachate samples were collected from select maintenance holes on May 18 and May 19, 2021.

Leachate from the Equalization Tank was conveyed into 20 litre (L) pails, which were rinsed with leachate prior to sample collection. The sampling point for the Equalization Tank is at the truck loading bay for PS10. The Equalization Tank is sampled on a quarterly basis. The leachate within the Equalization Tank represented leachate from: PS1 (Cell 1), PS3 (Cell 2), PS5 (Cell 4), most of the Existing Site, as well as partially derived from the condensate from the landfill gas collection systems installed in the Existing and Expansion Sites. During 2017, each cell with a leachate collection system within the Existing Site was automated for leachate transfer to the Equalization Tank, with the exception of the eastern portion of Cell 3S (MH3SA and MH3SB), and the northern portion of Cell 4 (MH4B). As such, leachate sampled from the Equalization Tank included leachate from the Existing Site throughout 2021.

Leachate was collected from PS1 (Cell 1), PS3 (Cell 2), and PS5 (Cell 4) via dedicated Waterra tubing equipped with a manual inertial-lift pump during the required annual sampling event in May. Leachate samples for soluble metals did not require field-filtering, but were preserved as required, while leachate samples for dissolved organic carbon (DOC) were field filtered and preserved. Leachate chemical results for the aforementioned various sampling locations are discussed in **Section 5.1**.

2.3 Monitoring Well Sampling

Groundwater samples were collected from May 18 to 21, 2021 for the spring semi-annual monitoring event. During the fall semi-annual monitoring event, groundwater sampling was completed from November 2 to 3, 2021.

Groundwater samples were collected using dedicated low flow bladder pumps.

The cemetery well is sampled annually in the spring by manually purging approximately 100 L using the existing old-water supply well manual inertial-lift pump. As the water from the cemetery well could be utilized as drinking water, metals sampling does not require field filtering.

As part of Site operations and to protect groundwater resources, some inactive monitoring wells were retained for potential future use as part of the monitoring program of the Expansion Site. This includes monitoring well OW59-10. Although monitoring well OW59-10 is considered an 'inactive' monitoring well, liquid levels are being assessed at OW59-10 to evaluate groundwater conditions near Cell 7 of the Existing Site. Idle monitoring wells OW39-6 and OW39-12 were decommissioned in 2017 during replacement activities related to damaged OW39-26. Monitoring locations OW61, OW62, OW75, OW76, OW77, OW78, and OW85 are currently inactive, as these monitoring wells are utilized to assess groundwater quality as it pertains to the operation of the Poplar Plantation. Since the Poplar Plantation has been inactive since its construction in 2009, groundwater quality assessment is not required to be completed in that location, which is also approved under Notice No.1 of the Sewage ECA.

In consultation with the Landfill Engineer and Hydrogeologist Reviewers of the Technical Review Team (TRT), WM had agreed post-2016 to supplement the existing leachate level monitoring. The supplemental leachate level monitoring locations (LW1 through LW6) were installed within the Existing Site in late 2017. The locations of the select landfill gas extraction wells from within the Expansion Site were determined in 2018 [EV229 in Cell 1A (Stage 1), EV268 in Cell 1A (Stage 2), EV022 in Cell 2B, and EV226 in Cell 2D], as shown on **Figure 2**. These supplemental leachate level monitoring wells are proposed to be monitored semi-annually together with the already established semi-annual spring and fall monitoring events for the Site to provide further insight toward leachate patterns within select waste cells of the Existing Site, as well as the Expansion Site.

2.4 Surface Water Sampling

2.4.1 Surface Water Flow

Surface water flow at the monitoring stations is precipitation dependent. Adequate flowing conditions to conduct surface water sampling were noted during Q1, Q2, Q3 and Q4 of 2021. After some precipitation events, some of the sampling stations did not produce the required flow for sampling. The observation of no flowing conditions after rain events ≥ 10mm/24hrs is expected and has been identified since precipitation monitoring began in 2003 at the Site. Verification surface water sampling events were also conducted, where required, in 2021.

As approval to discontinue monitoring the Poplar Plantation was received from the MECP on February 20, 2013, the surface water monitoring program for SS17A/B and SS18A/B remained inactive during the 2021 monitoring period.

2.4.2 Mechanism for Response Routine Monitoring

The surface water monitoring program adheres to the relevant Waste ECA, the Sewage ECA, as well as conditions stipulated within a MECP letter titled "RE: Request for Modification to Surface Water Monitoring/Assessment Process at Twin Creeks Landfill", dated February 27, 2014 (2014 MECP Letter). In general, the triggering mechanism for response monitoring is the receipt of ≥ 10 mm of precipitation in a 24-hour period from 08:00 to 08:00 hours. Flowing conditions permitting, the surface water stations are sampled within a 24-hour window following the receipt of ≥ 10 mm at the Site. Surface water is sampled once per quarter as part of the required routine monitoring for the Site. If a compliance monitoring station does not produce sufficient runoff to conduct sampling (or is dry), then the next precipitation event of ≥ 10 mm in a 24-hour period will trigger the assessment of those stations that were dry during the previous assessment. This response monitoring will continue throughout a quarterly monitoring period until the compliance stations have been sampled, or the quarter ends, in which monitoring of all the compliance stations will commence again for the next quarterly monitoring period.

2.4.3 Mechanism for Response Verification Monitoring

There are two (2) types of surface water monitoring stations at the Site. The first type of station consists of an open ditch where surface water flowing conditions heavily rely on precipitation. The second type of station consists of Sedimentation Ponds. When a Primary Leachate Indicator List (PLIL) parameter exceeds its trigger concentration at a surface water monitoring station, a verification monitoring response is triggered for that monitoring station.

For the 'ditch' type monitoring stations (e.g., SS1), verification monitoring can only occur after the receipt of ≥ 10 mm of precipitation in a 24-hour period where the precipitation was sufficient to generate flowing conditions to conduct sampling. Response monitoring continues throughout the quarter until a precipitation event is sufficient to conduct sampling. If insufficient flowing conditions continue at the ditch type station throughout a quarterly monitoring period, the verification event is postponed to the next quarterly monitoring period, and consequently, the postponed, monitoring event will consider both the routine quarterly monitoring event, as well as the verification monitoring event.

Similarly, for the Sedimentation Ponds, a verification monitoring event is triggered when one or more PLIL parameters exceed their relevant trigger concentrations following the routine quarterly sampling event. The verification monitoring for Sedimentation Ponds is completed within one (1) week of receipt of the routine monitoring event's chemical analytical results, independent of precipitation occurrences (Condition 5.4.) of the Sewage ECA).

Precipitation event monitoring, including biomonitoring testing is completed as outlined in the Waste and Sewage ECAs, as well as the conditions approved in the 2014 MECP Letter. An exceedance of a trigger concentration at one of the surface water monitoring compliance points would initiate verification monitoring, and if warranted, corrective action.

2.4.4 Precipitation Summary for Monitoring Events

Monitoring Station Locations and Sampling Details:

The surface water monitoring stations that formed part of the 2021 Compliance and Poplar System Monitoring Programs are summarized below.

Task	Monitoring Station Designations	Monitoring Station Description
Surface Water Environmental Monitoring Program	SS1	Downstream of landfill on WM property, 60 m east of Lambton Road 79 (Nauvoo Road) – Compliance Point
	SS10	Off-Site flow into East Ditch of the Existing Site – Background Surface Water Quality
	SS16	Flow onto expansion lands from Township land located south of the Site – Background Surface Water Quality
	SP1	Outlet Weir of Sedimentation Pond 1 – Internal assessment location
	SP2	Outlet Weir of Sedimentation Pond 2 – Compliance Point
	SP3	Outlet Weir of Sedimentation Pond 3 – Compliance Point
	SP4	Outlet Weir of Sedimentation Pond 4 – Compliance Point
Surface Water Poplar System Monitoring Program	SS14A (former SS14)	On-Site flow within East Ditch of the Existing Site, upstream of Poplar System
	SS14B (former SS15)	On-Site flow within West Ditch of the Existing Site, downstream of Poplar System as of June 2011.
	SS15A	South Ditch of the Existing Site and inlet point to Sedimentation Pond 1. Downstream of Poplar System.

Note: Former surface water monitoring stations SS14 and SS15, and revised/new surface water stations SS14A, SS14B, and SS15A as noted above, are required under the Waste and Sewage ECA's as part of the Poplar System Monitoring Program.

Details of the findings for the 2021 Poplar System surface water monitoring stations (SS14A, SS14B, and SS15A) can be found in **Volume 3** of the 2021 Annual Report.

A summary of the precipitation that triggered the surface water monitoring events is provided below. The precipitation amounts for the five days preceding the monitoring event are also provided. The data presented in the summary reflects that collected from the on-Site climatological station in 2021.

Quarter	Previous 5 Days of Precipitation (mm)	Sampling Events
1	0, 0, 0, 0.4, 28.0	March 26, 2021 – Routine monitoring event for the March 25, 2021 precipitation event
1	0, 3.0, 0, 0, 9.6	April 9, 2021 – Verification monitoring event for the March 26, 2021 routine precipitation monitoring event from Q1.
2	0, 0, 0, 0, 13.4	June 3, 2021 – Routine monitoring event for the June 2, 2021 precipitation event
2	0, 0, 0, 0, 19.2	June 26, 2021 – Routine monitoring event for June 25, 2021 precipitation event.
2	0, 0, 7.2, 8.0, 21.8	July 9, 2021 – Verification monitoring event for the June 26, 2021 routine precipitation monitoring event from Q2.
3	0, 0, 7.2, 8.0, 21.8	July 9, 2021 - Routine monitoring for July 8, 2021 precipitation event.
3	2.8, 0, 7.0, 0, 17.4	July 30, 2021 - Routine monitoring for July 29, 2021 precipitation event.
3	2.8, 0, 7.0, 0, 17.4	July 30, 2021 - Verification monitoring event for the July 9, 2021 routine precipitation monitoring event.
4	0, 0, 0, 6.2, 25.4	October 4, 2021 – Routine monitoring event for the October 3, 2021 precipitation event
4	9.8, 0.8, 0, 0, 15.6	October 15, 2021 – Verification monitoring event for the October 4, 2021 routine precipitation monitoring event.

Note: 1) N/A denotes verification monitoring event took place at a sedimentation pond and was therefore not precipitation event dependent.

Summary of Stations Monitored:

A summary of the surface water stations that were sampled in 2021, including a brief explanation as to why a station was not sampled, is provided below.

Surface Water Monitoring Station	Routine Monitoring	Verification Monitoring	Rationale for No Samples Being Collected
SS1	Q1, Q2, Q3, Q4	Q1, Q3, Q4	
SS10	Q1, Q3,		No flow in Q2 and Q4
SS16	Q1		No flow in Q2, Q3, and Q4
SP1	Q1, Q3, Q4		No flow in Q2
SP2	Q1, Q2, Q3, Q4	Q1, Q2, Q4	
SP3	Q1, Q2, Q3, Q4	Q4	
SP4	Q1, Q2, Q3, Q4		

For the first quarter (Q1), third quarter (Q3) and fourth quarter (Q4) monitoring periods, verification monitoring events were completed for compliance monitoring station SS1 on April 9, July 30, and October 15, 2021, respectively. For Q1, the second quarter (Q2), and Q4 monitoring periods, verification monitoring events were completed for compliance monitoring station SP2 on April 9, July 9, and October 15, 2021, respectively. For the Q4 monitoring period, a verification monitoring event was completed for compliance monitoring station SP3 on October 15, 2021.

Biological Monitoring:

The annual biomonitoring program was completed for the June 3 and June 26, 2021, spring surface water monitoring events per the EMP. Surface water samples were collected at stations SS1, SP2, SP3, and SP4 for the annual biomonitoring program. Surface water samples were not collected at stations SS10, SS16, and SP1 for the annual biomonitoring program due to no flow conditions.

Verification biomonitoring was also conducted at monitoring stations SS1 on April 9, July 30, and October 15, 2021, at SP2 on April 9, July 9 and October 15, 2021, and at SP3 on October 15, 2021 in accordance with conditions approved in 2014 MECP Letter. Details of the biological monitoring completed during the 2021 year are discussed in **Section 5.3.3 and 5.3.4**.

2.5 Landfill Gas Monitoring

Landfill gas monitoring was completed at gas probes GP1 to GP8 in January, February, March, April, July, November, and December 2021 per the EMP. Methane gas monitoring findings are discussed in **Section 5.4**.

2.6 Automobile Shredder Residue Monitoring

In accordance with Conditions 6.51 and 6.52 of the Waste ECA, automobile shredder residue (ASR) may be used at the Site as daily cover material on an ongoing basis. Samples of incoming ASR are collected on a semi-annual basis (when utilized) and submitted for analysis of the toxicity characteristic leachate procedure (TCLP) criteria in Schedule IV of Ontario Regulation 347. In 2021, ASR samples were collected on April 6 and October 1 in accordance with Conditions 6.51 and 6.52 of the Waste ECA. The ASR chemical analytical results satisfied the Schedule IV criteria within Ontario Regulation 347. Historical chemical analytical results are tabulated within **Table K-1**, **Appendix K**.

2.7 Contaminated Soil Monitoring

Per Conditions 6.53 to 6.61 of the amended Waste ECA, dated December 19, 2020, contaminated soil that meets the TCLP criteria in Schedule IV of Ontario Regulation 347 may be utilized as landfill cover material such that it is not placed on side slopes or above areas that are not underlain by waste (i.e., cannot store contaminated soil stockpiles on native soil). Contaminated soil for use as daily cover and/or intermediate cover was stockpiled in areas of the Site that have a leachate collection system installed below. Contaminated soil that meets the 10% TCLP criteria can be disposed within the monofill cells of the Existing Site (Cell 12 has available capacity). Contaminated soil was not disposed within the Existing Site monofill cells in 2021.

Samples of incoming contaminated soil are collected on a quarterly basis and submitted for analysis of the TCLP criteria in Schedule IV of Ontario Regulation 347. Contaminated soil samples were collected on March 16 (for Q1), May 5 (for Q2), August 12 (for Q3), and October 1 (for Q4) for laboratory analyses in 2021, with laboratory results verifying the samples satisfied Condition 6.57 of the Waste ECA. The relevant laboratory Certificates of Analysis, which detail the chemical analytical results, as well as a summary table of the chemical analytical results for the contaminated soil sampled in 2021, are included in **Table O-1** and **O-2**, **Appendix O**.

2.8 Field Sampling Parameters

Groundwater, leachate, and surface water field testing included the measurement of pH, electrical conductivity (EC), temperature, and turbidity (groundwater, surface water, and leachate), as well as dissolved oxygen (DO) (for surface water only). Surface water field parameters, including flow rates, were measured at each monitoring station, when water was present, during each monitoring event.

2.9 Laboratory Analytical Parameters

Analytical parameters are listed in **Table B-2**, **Appendix B**. In general, analyses were completed by Bureau Veritas Laboratories, previously known as Maxxam Analytics Inc., a Canadian Association of Laboratory Accreditation (CALA) accredited laboratory. Analyses for Automobile Shredder Residue and Contaminated Soil monitoring were completed by Eurofins Scientific, which is also a CALA accredited laboratory.

2.10 Field QA/QC Sampling

The field sampling QA/QC program is outlined in the following table. No equipment rinse blanks were collected due to the use of dedicated sampling equipment.

<table>
<tr><th>Media</th><th>Monitoring Event</th><th>Field-prepared Duplicate (Original Sample)</th></tr>
<tr><td>Leachate</td><td>May 18, 2021</td><td>LDUP (MH18)</td></tr>
<tr><td rowspan="7">Groundwater</td><td rowspan="4">May 18 to 21, 2021</td><td>GWDUP1 (OW54-10)</td></tr>
<tr><td>GWDUP2 (OW16-6)</td></tr>
<tr><td>GWDUP3 (OW57-4)</td></tr>
<tr><td>GWDUP4 (OW40A-7)</td></tr>
<tr><td rowspan="3">November 2 to 3, 2021</td><td>GWDUP1 (OW16-7)</td></tr>
<tr><td>GWDUP2 (OW16-6)</td></tr>
<tr><td>GWDUP3 (OW46-7)</td></tr>
<tr><td rowspan="8">Surface Water</td><td rowspan="2">March 26, 2021</td><td>SSDUP1 (SS1)</td></tr>
<tr><td>SPDUP (SP1)</td></tr>
<tr><td rowspan="2">June 3, 2021</td><td>SSDUP1 (SS1)</td></tr>
<tr><td>SPDUP (SP4)</td></tr>
<tr><td rowspan="2">July 9, 2021</td><td>SSDUP1 (SS1)</td></tr>
<tr><td>SPDUP (SP1)</td></tr>
<tr><td rowspan="2">October 4, 2021</td><td>SSDUP1 (SS1)</td></tr>
<tr><td>SPDUP (SP2)</td></tr>
</table>

Notes: 1) Field and trip blanks were analyzed as part of the groundwater monitoring events during May and November 2021. Parameters are outlined in **Table B-2**, **Appendix B**.
2) Field prepared duplicate samples are not required for verification monitoring events.

3 QUALITY ASSURANCE & QUALITY CONTROL EVALUATION

The QA/QC program included field-prepared duplicate samples, field-prepared blanks, trip blanks, comparisons with field-determined analytical results, laboratory-prepared blanks, matrix spikes, duplicates, percent recoveries of analyses, and data review. Additionally, the QA/QC program consists of verifying that the correct parameters were assessed by the laboratory for each sampling event, and that they were assessed within their respective hold times (not beyond the sample expiration date). During 2021 the correct parameters were assessed within the allotted hold times.

The laboratory analyzed several control samples to verify that the analytical equipment was functioning properly and reporting results accurately at the time of analysis for the samples collected at the Site. The control samples had an expected target value, which was compared against pre-determined data quality objectives. For the laboratory control samples, the results were within acceptable laboratory data quality criteria.

Analytical results for the field-prepared duplicate samples, completed as detailed in **Section 2.9**, were evaluated for the relative percent difference (RPD) of parameter concentrations using the USEPA National Functional Guidelines (US EPA 540-R-10-011) as a general QA/QC RPD screening mechanism. The RPD screening mechanism is such that for concentrations greater than five times the laboratory reportable detection limit (RDL), a concentration difference of less than or equal to 20% is deemed acceptable. For concentrations less than or equal to five times the RDL, a concentration difference of equal to or less than the RDL is deemed acceptable. Where an exceedance of the general QA/QC RPD screening mechanism is identified, the results for the required parameters of analysis are evaluated against the applicable performance standards for sample duplicates noted in Tables 5.1 to 5.15 of the *Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act*, as prepared by the Ministry of the Environment (MOE), dated March 9, 2004, and amended to July 1, 2011. For the results found to exceed the criteria of each QA/QC evaluations, a laboratory data quality review (DQR) of the results is requested to verify that the concentrations are accurate as presented and are within acceptable laboratory data quality criteria.

Laboratory chemical results for the leachate, groundwater, and surface water are provided in **Appendices G**, **H** and **I**, respectively.

3.1 Leachate

For leachate samples collected for the 2021 Compliance Monitoring Program, the RPD were acceptable between original and duplicate samples, with the exception of select parameters as summarized below.

Sampling Date	Original Sample (Duplicate)	Parameter with QA/QC Exception
May 18, 2021	MH18 (LDUP)	Total Suspended Solids

A laboratory DQR of the aforementioned results indicated that the concentrations for the above noted parameters were accurate as presented and within acceptable laboratory data quality criteria. Therefore, the results for the leachate samples collected during the 2021 monitoring event were considered representative of actual leachate quality at the time of sample collection and were acceptable for inclusion into the database for interpretation.

The leachate field analytical results for temperature, pH, EC, turbidity, and DO, are provided for the Existing Site (CFA-Comp, Sump, and MH18), as well as the Expansion Site (PS1, PS3, and Equalization Tank) in **Table G-1**, **Appendix G**. Field leachate temperatures showed some variability reflective of the location the leachate is being stored/generated and the time of year the leachate was assessed. For example, the quarterly field temperature results for the Equalization Tank showed expected variability based on the time of year sampled with relatively lower temperatures for January and November, and higher temperatures for May and August.

The field analytical values recorded for pH across the Site varied between 6.8 and 8.2 pH units. EC values also varied, with a range of 6,590 to 9,260 micro-Siemens per centimetre (µS/cm) at the Existing Site, and 12,780 to >20,000 µS/cm for the Expansion Site. Turbidity values also expectedly varied with values between 28.5 and >1000 nephelometric turbidity units (NTU) for the Existing Site, and values between 173 and >1,000 NTU for the Expansion Site.

Ion balances were also calculated as a QA/QC procedure for the leachate. Considering major anions and cations, an ion balance difference of greater than 10% would initiate a more thorough review of the chemical results and laboratory procedures. The leachate chemical results obtained during the 2021 annual monitoring program satisfied the 10% ion balance target, except as noted in the summary below. The cause of the ion balance exceedances summarized below are reasonable for the noted parameters and the respective concentrations detected in the relevant samples.

Media	Station/Monitoring Well ID	Ion Balance Percentage and Date	Comments
Leachate	SUMP	13.9 – May 2021	High anion concentrations
	MH18	26.7 – May 2021	High anion concentrations
	CFA-COMP	14.4 – May 2021	High anion concentrations
	Equalization Tank	25.9 - May 2021	High anion concentrations
		20.7 – November 2021	High anion concentrations
	PS1	13.4 – May 2021	High anion concentrations
	PS3	20.9 – May 2021	High anion concentrations
	PS5	18.8 – May 2021	High anion concentrations

3.2 Groundwater

For the groundwater samples collected for the 2021 Compliance Monitoring Program, the RPD were acceptable between original and duplicate samples, with the exception of select parameters as summarized below.

Sampling Date	Original Sample (Duplicate)	Parameter with QA/QC Exception
May 18 to 21, 2021	OW54-10 (GWDUP1)	Total Ammonia Conductivity Dissolved Sulphate Alkalinity Nitrate Dissolved Boron Dissolved Calcium Dissolved Iron
	OW16-6 (GWDUP2)	Conductivity Total Dissolved Solids Total Kjeldahl Nitrogen Total Organic Carbon Dissolved Sulphate Alkalinity Dissolved Chloride Dissolved Barium Dissolved Boron Dissolved Magnesium Dissolved Sodium
	OW57-4 (GWDUP3)	Dissolved Iron
	OW40A-7 (GWDUP4)	Dissolved Iron
November 2 to 3, 2021	OW16-6 (GWDUP1)	Dissolved Iron

A laboratory DQR for each of the aforementioned results indicated that the concentrations for the above noted parameters were accurate as presented and within acceptable laboratory data quality criteria. Therefore, the results for the leachate samples collected during the 2021 monitoring event were considered representative of actual leachate quality at the time of sample collection and were acceptable for inclusion into the database for interpretation.

The groundwater field analytical results for temperature, pH, EC, and turbidity are provided for the active aquitard, the interstadial silt and sand, as well as the interface aquifer in **Tables H-1** to **H-3**, **Appendix H**, respectively. Shallow groundwater generally showed greater temperatures than the deeper groundwater during May and cooler temperatures compared to the deeper groundwater during November, indicative of seasonal influences on the shallower groundwater. The field analytical values recorded for pH varied between 6.6 and 8.3 pH units. As expected in clayey soil, both conductivity and turbidity values varied, with a range of 475 to 5,930 µS/cm for conductivity and 0.95 to >1,000 NTU for turbidity.

Ion balances were also calculated as a QA/QC procedure for the groundwater. Considering major anions and cations, an ion balance difference of greater than 10% would initiate a more thorough review of the chemical results and laboratory procedures. The groundwater chemical results obtained during the 2021 annual monitoring program satisfied the 10% ion balance target, except as noted in the summary below. The cause of the ion balance exceedances summarized below are reasonable for the noted parameters and the respective concentrations detected in the relevant samples.

Media	Station/Monitoring Well ID	Ion Balance Percentage and Date	Comments
Groundwater	OW16-6	10.2 – May 2021	High cation concentrations
	OW17-4	20.7 – November 2021	High cation concentrations
	OW40D-4	26.6 – May 2021	High cation concentrations
	OW60-4	10.3 – May 2021	High cation concentrations
	OW67-4	19.0 – May 2021	High cation concentrations
	OW80-3	18.5 – May 2021	High cation concentrations
	Cemetery Well	10.5 – May 2021	High cation concentrations

3.3 Surface Water

For the surface water samples collected for the 2021 Compliance Monitoring Program, the RPD were acceptable between original and duplicate samples, with the exception of select parameters as summarized below.

Sampling Date	Original Sample (Duplicate)	Parameter with QA/QC Exception
June 3, 2021	SP4 (SPDUP)	Total Kjeldahl Nitrogen
October 4, 2021	SS1 (SSDUP1)	Total Suspended Solids

A laboratory DQR for each of the aforementioned results indicated that the concentrations for the above noted parameters with RPDs were accurate as presented and within acceptable laboratory data quality criteria. Therefore, results for the surface water samples collected during the 2021 monitoring events were considered representative of actual groundwater quality at the time of sample collection and were acceptable for inclusion into the database for interpretation.

Surface water field analytical results are provided in **Table I-1**, **Appendix I**. During the 2021 monitoring events, the surface water temperatures reflected the ambient air temperature during sampling. Field pH, EC, turbidity, and DO values fluctuated with no notable anomalies.

Ion balances were also calculated as a QA/QC procedure for surface water. Considering major anions and cations, an ion balance difference of greater than 10% would initiate a thorough review of the chemical results and laboratory procedures. The surface water chemical results obtained during the 2021 annual monitoring program satisfied the 10% ion balance target, except as noted in the summary below. The cause of the ion balance exceedances summarized below are reasonable for the noted parameters and the respective concentrations detected in the relevant samples.

Media	Surface Water Monitoring Station	Ion Balance Percentage and Date	Comments
Surface Water	SS1	47.5 – March 2021	High cation concentrations
	SP1	15.5 – March 2021	High cation concentrations

In summary, the 2021 field and laboratory QA/QC results indicated that the chemical results were representative of actual conditions at the time of sample collection.

4 GROUNDWATER & LEACHATE ELEVATION RESULTS

To define the local groundwater setting below the landfill, the stratigraphic sequence described in **Section 1.4** can be associated with hydrostratigraphic units, as summarized below.

Stratigraphic Unit	Hydrostratigraphic Unit	Approximate Depth to top of Unit (m)
Brown Zone in the Southern Till	Active Aquitard	0.0
Grey Zone in the Southern Till	Upper Aquitard	1.6 to 7.9
Interstadial Clay and Silt		
Interstadial Silt and Sand	Interstadial Sand	4.0 to 10.7
Rannoch Till	Lower Aquitard	4.5 to 12.5
Fractured Bedrock and Basal Sand	Interface Aquifer	22.8 to 29.3

Although each stratigraphic unit is identified as part of a hydrostratigraphic unit, each unit has a hydraulic influence on the others. Groundwater monitoring wells developed within each hydrostratigraphic unit are summarized below and monitoring well construction details provided in **Table F-1**, **Appendix F**.

Hydrostratigraphic Unit	Monitoring Wells
Active Aquitard	OW16-6, OW17-4, OW40D-4, OW54A-4, OW56-4, OW57-4, OW58-6, OW59-6, OW60-4, *OW61-4, OW62-5*, OW67-4, OW68-5, OW69-5, OW70B-5, OW71A-5, OW72-6, OW73-6, *OW75-3, OW76-5, OW77-4, OW78-4,* OW79-5, OW80-3, OW81-5, *OW85-5*
Interstadial Silt and Sand	OW16-7, OW40A-7, OW46-7, OW47-6, OW54-10, OW57-15, OW58-17, OW60-8, *OW61-6, OW62-7*, OW67-11, OW72-10, OW73-9, *OW75-7, OW78-6,* OW79-7, OW80-6, OW81-7, *OW85-8*
Interface Aquifer	OW17-30, OW19-29, OW39A-26, OW40A-28, OW49-29, OW60-25, *OW61-26, OW62-30*, OW79-26, OW80-27, OW81-27, Cemetery Well

Note: *Italicized* denotes monitoring well is inactive as the monitoring well is to be used to evaluate the Poplar Plantation two (2) months prior to activation of the system.
Monitoring well OW58-14 was decommissioned in early fall 2016 and was replaced with monitoring well OW58-17.
Monitoring well OW39-26 was observed to have been damaged during the fall semi-annual monitoring event and was replaced in spring 2017 with OW39A-26.
Monitoring well nest OW81 installed in June 2019.

4.1 Leachate Elevations

Leachate elevations measured at the Existing Site during the 2021 annual monitoring program are presented with historical data in **Tables F-2** and **F-3**, **Appendix F**. Leachate elevation data from the pumping stations of the Expansion Site are presented with historical data in **Table F-6**, **Appendix F**.

4.1.1 Leachate Elevation Assessment - Existing Site

Monitoring Details:

Leachate elevations are plotted on **Figure 4**. Flow valves between maintenance holes for each cell of the Existing Site are left in a normally open position to facilitate the automated pumping of leachate to the Equalization Tank, as necessary to keep leachate levels at an acceptable elevation.

Collection System(s) Background:

To provide background for the understanding of the design of the waste cells within the Existing Site, Cells 3S, 4, 5, 6, 7, 8, 9, 10, and 11, as well as Cell 12 (only the southern third is constructed) contain waste underdrains that direct leachate to a perimeter collector system. Cells 10 and 12 are hydraulically connected, with leachate extraction typically occurring from MH12. The South Cell is completed with finger drains that direct leachate to a perimeter collection system. The West Cell is completed with a collection “Sump” to collect leachate for extraction purposes. Cell 3 does not have a leachate collection system, however, based on historical liquid levels the leachate in this cell is understood to be managed by the adjacent cells. For cells with waste underdrains, when the valve is open and leachate flows freely between a cell’s maintenance holes, the leachate elevation in the maintenance holes of that cell is expected to be similar, typically within 0.15 m.

Two (2) exceptions to this pattern can occur for cells with waste underdrains, which are for Cells 3S and 4. For Cell 3S, the leachate levels can be notably different in each maintenance hole, by the design of the collection system MH3SA and MH3SB are not hydraulically connected with a pipe and are the upper end of the system, which drain to the low end at MH3SC. MW3SC is connected with a pipe to MH3SD but is constructed with a sump ~2m deeper than the base of MH3SD. For Cell 4, there are two distinct (north third and south two-thirds) waste underdrain systems, which independently gravitationally drain to their respective low ends, MH4A (south system) and MH4B (north system). MH4B gravity drains through a toe drain to MH4A.

By the fall of 2017 each of the downstream maintenance holes for the Existing Site were updated to be operated as pumping stations. This pumping station conversion enables the leachate level in the maintenance hole to be automatically managed, year-round, via pumping leachate to either the equalization tank or to the Poplar System irrigation tanks.

Leachate Management:

As a general leachate best management practice, the extraction of leachate within the Existing Site is prioritized based on the leachate elevations for each individual waste cell to facilitate inward hydraulic gradients (as calculated considering the previous year’s seasonally relevant groundwater elevations). Exceptions occur since 2019 for leachate management practices where leachate is stored in the waste during late winter to spring, for volume availability for irrigation application to the Poplar System in the subsequent growing season. From an environmental stewardship perspective, the leachate generated from within the waste mound of the Existing Site was determined to generally be of more suitable use as irrigation liquid during the growing season as opposed to dedicating efforts for off-Site disposal and treatment between late winter 2021 and spring 2021. It is noted that storing leachate in this manner is suitable as environmental compliance for the Existing Site relies on groundwater and surface water quality monitoring, which were acceptable.

Leachate Level Assessment Details:

The hydraulic assessment of leachate compared to nearby shallow groundwater is utilized as an additional guidance tool toward managing leachate volumes in the waste cells and preventing the potential for releases to local water resources, such as surface water and groundwater. The leachate target elevations updated in 2020 were used to assist in lowering the liquid elevation within the maintenance holes and Sump during 2021. Most of the waste cells of the Existing Site are completed with waste underdrains such that leachate will percolate vertically downward through the waste and into the collection lines and be directed gravitationally toward the perimeter maintenance holes. As the waste mound is not likely uniform in nature, some leachate could be perched within the waste mound. As such, the potential for leachate seeps exists. In 2021, RWDI did not observe any seeps on the landfill cap during their respective Site inspections.

4.1.1.1 Leachate Elevation Patterns – Existing Site

It is apparent that leachate elevations varied across the Site. A comparison of the May and November 2021 leachate elevations with ground surface and inferred groundwater elevations outside the waste footprint is provided in **Table 2**. Overall, leachate elevations generally increased from November 2020 to May 2021 and then decreased from May 2021 to November 2021. This generalized pattern was expected for 2021 as discussed in more detail in the following sections. Exceptions to the generalized pattern generally were noted in the western portion of Cell 3S, Cell 4, Cell 5 and Cell 6 were leachate elevations slightly increased from May 2021 to November 2021. This was a result of a reduction in the application of leachate in 2021 compared to 2019 and 2020, in part, as a result of precipitation events during the 2021 application period were significantly greater, especially in September and October, which reduced the ability for the Poplar System to be operated. More details regarding the operation of the Poplar System are discussed in Volume 3 of this document. Additionally, the precipitation events would have also generated more leachate during this time of year than equivalent to during 2019 and 2020.

Based on 2021 leachate elevations, the hydraulically connected maintenance holes in the Existing Site generally showed an elevation difference that was equal within the same cell or that differed by less than 0.15 m. Exceptions to this occurred for Cell 3S (at MH3SC and MH3SD) and Cell 8 in 2021. The below summary outlines the noted differences, which are not a concern as the differences are either based on design or generally consistent with historical observations.

- Within Cell 3S, the leachate elevation at MH3SC for the May monitoring event was greater than the elevation at MH3SD by 0.30 m on May 17, 2021, whereas the leachate elevation at MH3SC for the November monitoring event was less than the elevation at MH3SD by 1.15 m on November 1, 2021. The observations noted at MH3SC and MH3SD are generally consistent with historical observations.
- Within Cell 8 the leachate elevations at MH8A for the May and November monitoring events were less than the elevations at MH8B by 0.31 m and 0.18, respectively, which is generally consistent with historical observations.

4.1.1.2 Leachate Levels Assessed Against Ground Surface

Leachate elevations/pressures that would have the potential to affect the groundwater systems are reflected by the leachate elevations within the associated maintenance holes of a given waste cell. As presented in **Table 2**, leachate elevations within the eastern and western waste cells were generally lower than the surrounding ground surface in May and November 2021. One (1) exception occurred in the West Cell (Sump) both during the May and November 2021 monitoring event. Since the November 2015 monitoring event, the leachate elevation within the Sump has generally exhibited an increasing trend until November 2019, which showed a significant decrease of 2.6 m as a result of leachate extraction. The leachate elevation in within the Sump showed a further decrease from November 2019 to November 2020 of 1.51 m, also as a result of leachate extraction. In November 2021, the leachate elevation within the Sump showed an increase of 1.63 m since November 2020 as a result of a temporary decrease in leachate extraction as noted herein.

As discussed above, the short-term increase of leachate levels from November 2020 to May 2021 was a result preparing to utilize the leachate volumes within the waste for irrigation application to the Poplar System beginning in May 2021. The further short-term increase from May 2021 to November 2021 was a result of a greater number of precipitation events during the growing season of 2021 compared to 2019 and 2020, which would both reduce the leachate extracted for application to the Poplar System and increase the amount of leachate generated as a result of rain infiltration. Overall, however, acceptable groundwater and generally acceptable surface water quality was noted around the Existing Site in 2021. Additionally, leachate seeps were not observed along the waste side slopes of the Existing Site in 2021. Therefore, the noted leachate elevations within the West Cell and the South Cell do not represent an immediate concern. Continued leachate extraction from the West Cell and South Cell via automated pumping is expected to further reduce the leachate mound in these cells. Ongoing monitoring will evaluate these locations over time.

4.1.1.3 Leachate Levels Assessed Against the Shallow Groundwater Table

Spring 2021:

In May 2021, leachate elevations were lower than the local and inferred shallow groundwater table for Cells 3, 4, 5, 7, 9, 10, 12, as well as Cell 3S. This comparison shows that the groundwater was being induced toward the waste and that leachate was hydraulically contained within the waste at these locations.

- Within Cell 6 (at MH6A), the leachate elevation was higher than the historical (pre-2008) local shallow groundwater elevation by 1.16 m. However, the May 2021 leachate elevation within MH6A is 0.09 m lower than observed in May 2020.
- Within Cell 8 (at MH8B), the leachate elevation was higher than the historical local shallow groundwater elevation to the west by 0.64 m. It is noted that the May 2021 leachate elevation within MH8B is reflective of leachate storage practices for use onto the Poplar System.
- Within Cell 11 (at MH11A), the leachate elevation was higher than the historical local shallow groundwater elevation to the west by 2.26 m. It is noted that the May 2021 leachate elevation within MH11 is reflective of leachate storage practices for use onto the Poplar System.

- Within the West Cell (Sump), the leachate elevation was higher than the historical local shallow groundwater elevations by 4.78 m. However, the May 2021 leachate elevation within the SUMP is 3.22 m lower than the peak elevation observed in May 2019.
- Within the South Cell (at OW22A-10 and OW53-10), the leachate elevations were higher than the historical local shallow groundwater elevation to the west by 0.22 m, and 1.54 m, respectively. It is noted that the May 2021 leachate elevations within OW22A-10 and OW53-10 are within the historical ranges for these locations.

Fall 2021:

In November 2021, the leachate elevations throughout select cells of the Existing Site expectedly showed a decreased since May 2021 as a result of leachate extraction for irrigation onto the Poplar System. For a few waste cells, the leachate elevations remained elevated with respect to the historical shallow groundwater elevations to the west and south of the Existing Site. However, leachate elevations were lower than the local and inferred shallow groundwater table for Cells 3, 5, 7, 8, 9, 10, 11, and 12.

- Within Cell 4 (at MH4A and MH4B), the leachate elevations were higher than the historical shallow groundwater elevation by 0.63 m and 0.54 m, respectively. It is noted that the November 2021 leachate elevation within MH4B is within the historical range for this location. The elevated November 2021 leachate elevation within MH4A is a result of a greater number of precipitation events during the growing season of 2021 compared to 2019 and 2020, which would both reduce the leachate extracted for application to the Poplar System and increase the amount of leachate generated as a result of rain infiltration.
- The leachate elevation within Cell 6 (at MH6A) was higher than the historical shallow groundwater elevation by 3.10 m. The elevated November 2021 leachate elevation within MH6A is similar to observed at Cell 4 and is a result of increased precipitation events preventing leachate extraction for irrigation purposes and a corresponding increase in leachate generated during this timeframe.
- Within the West Cell (Sump), the leachate elevation was higher than the historical local shallow groundwater elevations by 5.52 m. However, the November 2021 leachate elevation within the SUMP is 2.48 m lower than observed in May 2019.
- Within the South Cell (OW53-10) the leachate elevation was higher than the local shallow groundwater elevation by 2.98 m. It is noted that the November 2021 leachate elevation within OW53-10 is within the historical range for this location.

Overall, as discussed herein, acceptable groundwater and surface water quality was demonstrated at the compliance points during 2021. Also, leachate seeps were not observed along the waste side slopes of the Existing Site in 2021. Therefore, the noted leachate elevations that were higher in 2021 than the local groundwater elevations within select leachate monitoring wells and maintenance holes of the Existing Site did not represent a concern.

4.1.1.4 Leachate Elevation Trends – Existing Site

Hydrographs of leachate elevations are presented on **Figures F-1** through **F-12**, **Appendix F**. Long-term trends are summarized in **Table 3**. For the purpose of assessing elevation trends, a constant elevation trend is defined as having 0.1 m or less of seasonal variation.

In the long-term, leachate elevations have mostly fluctuated with some exceptions, as noted in **Table 3**. The historically increasing leachate elevations trends that were noted in 2019 for Cell 3S (at MH3SC and MH3SD), Cell 6 (at MH6A and MH6B), and the West Cell (Sump) that were noted to have decreased in 2020 from their respective elevated leachate elevations, have generally become elevated again in 2021. As previously noted, the elevated leachate elevations were a result of a greater number of precipitation events during the growing season of 2021 compared to 2019 and 2020, which would both reduce the leachate extracted for application to the Poplar System and increase the amount of leachate generated as a result of rain infiltration.

Over the long-term, leachate elevations are expected to continue to decrease since the Existing Site is capped and leachate is extracted from cells within the Existing Site for the operation of the Poplar System and for off-Site disposal. It should be noted that over time, the amount of leachate removed from storage will likely increase with the operation of the expanded Poplar System, as the system matures. The volume of leachate managed from the Site in 2021 is summarized in Section **4.1.5.1**.

4.1.1.5 Supplemental Leachate Level Assessment

As discussed in **Section 2.3**, supplemental leachate level monitoring wells were installed in 2017 and were monitored semi-annually in 2021 together with the already established semi-annual spring and fall monitoring events at the Site. The leachate elevations for the leachate level monitoring wells (LW1 to LW6) are presented in **Table F-3**, **Appendix F.**

<u>Existing Site:</u>

The May and November 2021 data indicates that select waste cells have leachate stored within the waste that may not be directed to, or captured by, the leachate underdrain collection systems. As such, this leachate does not represent a hydraulic loading to the respective cell's floor/liner and therefore, does not have a direct influence on the groundwater system (i.e. potentiometric influences).

During 2021, the leachate elevations within select maintenance holes were generally drawn down throughout the majority of the application period and fluctuated significantly as a result of leachate extraction for irrigation to the Poplar System. As noted herein, the significant amount of precipitation that the Site received in September and October contributed to the elevated fall leachate elevations. With respect to draw down as a result of leachate extraction, the liquid elevations in leachate monitoring wells LW1 to LW6 did not definitively correlate to the elevations in their counterpart maintenance hole (within the same waste cell). This observation indicates that leachate within the waste mound that may not be directed to, or captured by the leachate underdrain collection system (i.e. perched, low hydraulic conductivity, or some other cause) is therefore, not having an effect to the groundwater system (i.e. potentiometric pressures). This effect is observed in waste cells that are both positioned under and not under the Poplar System, indicating that the operation of the Poplar System is not the cause of this leachate elevation differential effect.

There was no observable negative affect observed to the sideslope of the Existing Site, such as leachate seeps, soil staining, stress vegetation, soil slumping or erosion, as a result of this leachate elevation differential. At this time the exact cause of the leachate differential is unknown, but it is not causing a detrimental effect to the operation of the Poplar System, excluding limiting leachate volume availability from select waste cells, and is not casing visible stress to the landfill cap and as such does not represent an immediate concern. Ongoing leachate level monitoring will enable an evaluation if this leachate differential is a long-term (i.e. over 5 years) situation, or has the potential to represent a concern (i.e. increasing trends with time, or stress to the landfill cap, etc.).

In summary, the Existing Site requires the ongoing leachate level monitoring program to enable input such that the leachate is managed environmentally effective in consideration of the destination target (e.g. off-Site vs. on-Site treatment).

4.1.1.6 Leachate Storage Volume – Existing Site

Overall, between May 2020 and May 2021 there was a slight increase in the calculated theoretical total leachate volume stored above the local groundwater table (23,609 m^3) and within the waste (24,693 m^3) of the Existing Site, as summarized in **Table 5**. Between November 2020 and November 2021 there was also an increase in the calculated theoretical total leachate volume stored above the local groundwater table (97,275 m^3) and within the waste (136,557 m^3) of the Existing Site, as summarized in **Table 5**. It is noted that these volumes are only theoretical in nature, as the total Site leachate volume removed for treatment in 2021 was 50,687.86 m^3 of which 11,479.81 m^3 was removed from the Existing Site and there is routinely insufficient weaker strength leachate available for irrigation purposes during the growing season. For consistency comparison purposes of 2010 data to historical data, the calculation method used for leachate volume (refer to **Table 5**) has not been changed for this report.

As discussed, and as presented in **Table 2**, after the 2021 irrigation season in November 2021, the leachate elevations in some of the cells of the Existing Site were determined to be lower than the May 2021 elevations whereas, a number of the cells were determined to be slightly greater. As previously noted, the elevated leachate elevations in November 2021 were a result of a was a result of a greater number of precipitation events during the growing season of 2021 compared to 2019 and 2020, which would both reduce the leachate extracted for application to the Poplar System and increase the amount of leachate generated as a result of rain infiltration.

Over the long-term, leachate volumes within cells of the Existing Site are expected to continue to decrease as more leachate is extracted for the operation of the expanded Poplar System and off-Site disposal.

The calculation method or input variables for the theoretical leachate storage volume will be revisited in an effort to have more accurate theoretical values compared to actual values based on field data interpretations/expectations.

4.1.2 Leachate Elevation Assessment – Expansion Site

Leachate level monitoring within the Expansion Site is completed to assess leachate pressures on the liner and the effectiveness of the leachate management system. Leachate levels for PS1, PS3, and PS5 are tabulated in **Table F-6** and graphically represented on **Figure F-26 to F-28**.

Collection System Background:

Leachate within each cell is directed to a sump where it is managed by pumping stations PS1, PS3, and PS5 (Cell 1, Cell 2, and Cell 4A, respectfully) for conveyance to the Equalization Tank. The operation of the pumps in the aforementioned pumping stations is SCADA-controlled (automated) with liquid level sensors that control pump 'on' and 'off' depending on the leachate level within the relevant sump. Leachate retrieval from the Equalization Tank is controlled by pump station PS10. It is noted that pumping station PS7 is not yet installed.

Trigger Mechanism Assessment Process:

The trigger mechanism for implementation of groundwater contingency measures for the Expansion Site is the loss of hydraulic containment of the landfill waste footprint. The loss of hydraulic containment occurs when leachate levels within the PDL are higher than the surrounding groundwater elevation for the active aquitard and the groundwater pressures for the interface aquifer. Hydrogeological impact predictions indicated trigger leachate levels should be no more than 6 m above the base of the PDL. The leachate target level for each pumping station of the Expansion Site is noted in Condition 14.1 of the Waste ECA. For the installed pumping stations PS1, PS3, and PS5, the target elevations are 232.7 metres above sea level (m ASL), 232.6 m ASL, and 232.8 m ASL, respectively. Pumping station PS1 began operation on November 16, 2009. PS3 began operation on November 21, 2013. PS5 began operation on October 1, 2019.

In addition, Condition 7.18 of the Waste ECA requires that a hydraulic trap be maintained beneath the Expansion Area at a maximum leachate head of 300 mm (or 0.30 m) on the landfill liner, as measured from the leachate pumping stations.

During the 2021 monitoring period, the leachate elevations at PS1, PS3, and PS5 remained well below their respective trigger leachate elevations, as outlined in Condition 14.1 in the Waste ECA.

It is noted that periodic elevated leachate occurrences are described in the MECP-approved Development and Operations Report (D&O Report) (Henderson Paddon, 2008). A temporary increase of the leachate head under such circumstances is not considered a non-compliance issue with the Waste ECA. Notwithstanding this consideration, WM has implemented an Expansion Landfill Leachate Level Contingency Plan (RWDI, April 30, 2021). The aforementioned plan was implemented so that WM is aware of a leachate level elevation that could be indicative of a pending operating scenario that could cause the leachate head to exceed 300 mm. Notification process will enable WM to be aware of a level of possible concern and enable WM to evaluate if the leachate level is a concern or not. If the level is of concern, then WM will be able to evaluate the leachate level operational system to identify the cause of the leachate level of concern and implement the relevant remedial measures detailed in the D&O to address operational issues for leachate level management. The notifications are denoted below.

- Electronic issuance (email and/or text) to relevant WM operations personnel that a leachate level for a given waste cell of the Expansion Landfill is at 80% (240 mm) of the 300 mm leachate head limit.

- A visual notification (i.e., light) on the leachate pumping stations when the leachate level for the respective waste cell of the Expansion Landfill is at 80% (240 mm) of the 300 mm leachate head limit.

The leachate elevations within Cell 1, 2, and 4 of the Expansion Site were below the historical groundwater elevation in the active aquitard and the interstadial silt and sand groundwater flow systems.

Therefore, the leachate in Cells 1, 2, and 4 was hydraulically contained from the afore-mentioned groundwater flow systems.

Leachate levels within PS1, PS3, and PS5 satisfied the aforementioned Waste ECA conditions during 2021. The level sensor within PS3 was determined to be faulty in mid-October 2021 and is awaiting replacement. WM notified the Ministry of the Environment, Conservation and Parks (MECP) that the level sensor was faulty, and that WM set the pump in PS3 to run every 10 minutes until the level sensor is replaced. Every 10 minutes the pump will run until no flow is detected in the pump for a total of 10 seconds, thus triggering it to shut off until the start of the next cycle 10 minutes later. The frequent run cycles allow the pump to prevent any significant leachate build up on the cell liner, thus maintaining compliance with requirements of the Waste ECA. The leachate levels at PS3 throughout this time period are noted to be false sensor readings as the pump runs in frequent cycles and the leachate sensor readings would still remain elevated and fluctuating. Further details are included in **Appendix Q.**

4.1.2.1 Leachate Elevation trends – Expansion Site

Leachate levels for PS1, PS3, and PS5 are presented in **Table F-6** and on **Figure F-26 to F-28**, **Appendix F**. As expected, leachate levels vary with time as a result of the gradual accumulation of leachate and pumping activities to maintain acceptable leachate levels at each pumping station.

4.1.2.2 Supplemental Leachate Level Assessment

Expansion Site:

The leachate elevations for the Expansion Site were collected from landfill gas extraction wells, otherwise known as early vertical gas wells (EVGW) [EV229 in Cell 1A (Stage 1), EV268 in Cell 1A (Stage 2), EV022 in Cell 2B, and EV226 in Cell 2D] are presented in **Table F-8, Appendix F**.

Leachate elevations for the EV229, EV022, and EV226 were unable to be measured during 2021 semi-annual monitoring events. For the EVGW's that could not be assessed for liquid levels, similar to the 2020 semi-annual monitoring events, debris was encountered at elevations that were higher than the EVGW base, thus precluding access to deeper portions of the EVGW's. The obstructing debris could not be identified in the field. It is noted that in 2018 these same EVGWs were assessed to be dry to each of their respective bottom elevations (approximately 1.0 to 1.5 m above the liner floor). Accessible EVGW EV268 was determined to be dry to its depth extent, which is within 1 m above the liner floor.

4.1.3 Leachate Management

4.1.3.1 Leachate Volume

Leachate Generation:

The primary leachate source is from precipitation infiltrating into and percolating through the waste. The groundwater contribution is negligible. Between January 1 and December 31, 2021, a total of 44,284.83 m^3 of leachate was removed and transported off-Site for treatment and disposal at the Chatham Water Pollution Control Plant or Canflow Environmental Services, while 6,403.03 m^3 was irrigated onto the Poplar system during the 2021 growing season. Details regarding the 2021 Poplar System irrigation activities are discussed in **Volume 3** of the 2021 Annual Report.

A breakdown of the leachate volume treated in 2021 is presented below.

Area of Leachate Extraction	Treatment (m^3)
Off-Site Treatment Management	
Existing Site MHs	639.75
Pumping Station PS10	43,645.08
Sub-Total	***44,284.83***
On-Site Poplar System Management	
Existing Site MHs	6,338.53
Pumping Station PS10	64.50
Sub-Total	***6,403.03***
TOTAL	**50,687.86**

Note:
1) m^3 denotes cubic metre. 1 m^3 is equivalent to 1,000 L (litres).
2) Existing site denotes leachate extracted by tanker truck directly from one of, or a combination of, Cell 3S, 4, 5, 6, 7, 8, 9, 10/12, 11, South Cell, &/or West Cell (Sump).
3) The source cell leachate make-up in the Equalizations Tank, as sampled from PS10, changes over time, as outlined in Section 2.2.

Of the 50,687.86 m^3 noted above, the approximate breakdown of leachate source location between the Existing Site and the Expansion Site is 23% (11,479.81 m^3) and 77% (39,208.05 m^3), respectively. This breakdown is based on the leachate source distribution noted for the 2021 monitoring period which incorporates the separate approximate volumes of leachate extracted from the Existing Site (41% of area) and Expansion Site (59% of area) for either off-site or on-site treatment as discussed above.

4.1.4 Leachate Seeps & Stains

Leachate seeps or potentially ponded water within waste that were noted by WM during daily inspections were generally limited to areas adjacent to the active landfilling working area (e.g. waste mound, haul roads) of the Expansion Site in 2021. Although select observed occurrences may have been ponded water within waste, WM treated them as seeps and they were generally repaired the same day. No significant leachate seeps or stains were noted by the MECP, RWDI, or WM for the Expansion Site throughout the 2021 monitoring period. As discussed, no leachate seeps were observed for the Existing Site during 2021.

4.2 Secondary Drainage Layer Hydraulic Containment

Liquid levels were recorded monthly for the SDL of Cell 1, Cell 2, and Cell 4 in 2021. Liquid elevations from the SDL are provided in **Table F-7** and graphically represented on **Figure F-25**, **Appendix F**.

Hydraulic Containment Assessment:

Water levels within the SDL of Cell 1, Cell 2, and Cell 4A continued to be below surrounding groundwater levels and pressures and therefore, groundwater was induced to flow toward the SDL of Cell 1, Cell 2, and Cell 4. As the water elevations in the SDL for Cell 1, Cell 2, and Cell 4 (PS2, PS4, and PS6, respectively) are greater than the leachate elevations within the PDL of Cell 1, Cell 2, and Cell 4 the leachate in the PDLs are hydraulically contained within the PDLs from the SDLs. SDL pumping station PS8 has yet to be constructed.

Historical SDL Elevation Trends of Note:

The initial slow increase over time in the SDL elevation within Cell 1 since its installation is a result of the large pore volume for water to accumulate within the 0.3 m thick granular layer that comprises the SDL within the western half of Cell 1. The rapid increases in SDL elevation within Cell 2 and Cell 4 are reflective of the very small pore volume within the 0.01 m thick Geonet that is installed as the SDL for Cell 2 and Cell 4 (and the eastern portion of Cell 1). It is noted that the historical periodic short duration decreasing pattern in the SDL for Cell 1, Cell 2, and Cell 4 represents water taking activities for cell-to-cell connection activities and/or soil moisture conditioning of the clayey soil liner material used in the construction of the cell liner system. These periodic SDL level decreases are expected during the Expansion Site construction and as discussed, do not represent a concern as once a cell is excavated, groundwater movement is toward the cell excavation, thereby hydraulically containing any liquid (both in SDL and PDL) in the cell.

4.3 Active Aquitard Groundwater Movement

The active aquitard represents a shallow groundwater flow system whereby precipitation infiltrates into soil fractures, root casts, and other weathering features and moves in a dominantly lateral direction. The low permeability of the surrounding silty clay to clayey silt matrix reduces the volume of groundwater movement through the active aquitard. The low volume of water within the active aquitard is also evident by the slow recovery of monitoring wells after purging and sampling.

Groundwater elevations measured during the 2021 annual monitoring program are presented with historical data in **Table F-4**, **Appendix F**.

4.3.1 Groundwater Elevation Patterns

Groundwater elevations measured for the Active Aquitard on May 17, 2021, are presented on **Figure 4**. Considering the north-south flow divide through the Poplar Plantation and historical patterns of groundwater movement, an easterly and westerly direction of groundwater movement is inferred. Surficial features such as ditches, waste cells, excavations, ponds, berms, and the leachate management systems, as well as precipitation amounts, will locally influence the groundwater flow direction.

4.3.2 Groundwater Elevation Trends

Groundwater elevation hydrographs for the active aquitard are presented on **Figures F-13** through **F-18**, **Appendix F**. Long-term trends are summarized in **Table 4**. For the purpose of assessing elevation trends, a constant elevation trend is defined as having 0.1 m or less seasonal variation.

In the long-term within the active aquitard, groundwater elevations have continued to fluctuate. Overall, fluctuating patterns in groundwater elevation were noted across the Site in the Active Aquitard, which are attributed to seasonal effects from precipitation and snowmelt. Overall, groundwater elevations were generally noted to be within their historical ranges. The groundwater elevation at OW58-6 was noted to have increased to a new high in November 2021, likely as a result of significant precipitation totals in the fall of 2021.

4.4 Interstadial Silt & Sand Groundwater Movement

The interstadial silt and sand hydrostratigraphic unit consists of silt and sand layers or lenses within the interstadial deposit that overlies the Rannoch Till. Groundwater movement within the interstadial silt and sand will be controlled by hydraulic gradients and the soil texture. For the purpose of the landfill compliance assessment, it is assumed that the silt and sand layers or lenses are hydraulically connected and that groundwater movement is in the direction of the inferred hydraulic gradient.

Groundwater elevations measured during the 2021 annual monitoring program are presented with historical data in **Table F-4**, **Appendix F**. Hydrographs for the interstadial silt and sand are provided on **Figures F-19** through **F-22**, **Appendix F**.

4.4.1 Groundwater Elevation Patterns

Groundwater elevations measured for the Interstadial Silt and Sand on May 17, 2021, are presented on **Figure 5**. Groundwater pressures suggest a consistent pattern to the historical interpretation of an easterly and westerly groundwater flow direction from a north-south groundwater divide that extends from Confederation Line to Zion Line (Jagger Hims Limited, 2005). However, the excavation of Cell 1, Cell 2, and Cell 4 has reduced the groundwater potentiometric pressures within the interstadial silt in these areas and locally induces groundwater to move toward and into the SDL of the cells. These lowered groundwater pressures are expected to return to pre-existing conditions as the soil mass is replaced with waste mass. Higher groundwater pressure elevations relative to other areas may occur below the Central Fill Area (defined as waste cells: Cell 3S, Cell 3 through Cell 7, as well as Cell 9 and Cell 11) of the Existing Site due to the mass of the overlying waste and leachate, thereby hydraulic gradients are expected to be upward toward the waste.

4.4.2 Groundwater Elevation Trends

Long-term elevation trends are summarized in **Table 4**. For the purpose of assessing elevation trends, a constant elevation trend is defined as having 0.1 m or less seasonal variation.

Groundwater elevations within the interstadial silt and sand have generally fluctuated in the long-term, with the elevations at OW54-10, OW67-11, OW72-10, and OW73-9 exhibiting generally decreasing and fluctuating trends over time. It is noted that the groundwater elevations at the aforementioned monitoring wells appear to be stabilizing. Ongoing monitoring will evaluate the noted trends over time.

For the monitoring wells where seasonal fluctuations in the groundwater elevation have historically been observed, this trend generally continued in 2021. For these wells, the November 2021 groundwater elevations within the interstadial silt and sand were generally lower or similar compared to those observed in May 2021. It is noted that a relatively wet fall was observed in comparison to previous years which resulted in the November 2021 groundwater elevations being similar or slightly greater than those observed in May 2021 at a number of the monitoring wells. Within the interstadial silt and sand flow system, the overlying waste and leachate levels, as well as the Cell 1, Cell 2, and Cell 4 excavations, induced localized potentiometric pressure increases and decreases, which also resulted in variations in the local flow direction. Overall, with the exception of where decreasing trends continued to be observed in 2021, groundwater elevations were generally noted to be within their historical ranges.

4.4.3 Vertical Hydraulic Gradients

Vertical hydraulic gradients below the Site in the active aquitard to the interstadial silt and sand hydrostratigraphic unit were calculated for the May 17 and November 1, 2021, data.

The hydraulic gradients that were calculated are presented in **Table F-5**, **Appendix F**. In summary, vertical hydraulic gradients continued to be dominantly downward toward the interface aquifer around the waste footprints and below the Existing Site. However, localized upward hydraulic gradients occurred to the active aquitard from the interstadial silt and sand at the monitoring well locations summarized in the table below. Ongoing monitoring will continue to evaluate these trends over time.

May 2021	November 2021
OW40D-4 OW60-4 OW80-3	OW80-3

4.5 Interface Aquifer Groundwater Movement

Occasional discontinuous layers of sand and gravel between the Rannoch Till and underlying bedrock constitute the basal sand. For the purpose of the landfill compliance assessment, it is assumed that groundwater movement is in the direction of the inferred hydraulic gradient. The upper fractured portion of the bedrock and the overlying basal sand form the local bedrock aquifer and are generally referred to as the interface aquifer.

Groundwater elevations measured during the 2021 annual monitoring program are presented with historical data in **Table F-4**, **Appendix F**. Hydrographs are provided on **Figures F-23** to **F-24**, **Appendix F**.

4.5.1 Groundwater Elevation Patterns

Groundwater elevations measured for the Interface Aquifer on May 17, 2021, are presented on **Figure 6**. Overall, a southwesterly groundwater flow direction was apparent below the Existing Site and the Expansion Site. This flow direction is consistent with the historical inferred direction of groundwater movement within the interface aquifer (Jagger Hims Limited, 2005). Of note, as more overburden soil is removed during landfill cell construction, interface aquifer pressures are expected to decrease temporarily. As more waste is deposited within the waste cells of the Expansion Site, the increase in overlying mass will increase the groundwater pressures of the bedrock aquifer.

4.5.2 Groundwater Elevation Trends

Long-term elevation trends are summarized in **Table 4**. For the purpose of assessing elevation trends, a constant elevation trend is defined as having 0.1 m or less seasonal variation. Groundwater pressure elevation trends and patterns for the interface aquifer continue to be generally consistent with historical findings with a fluctuating trend with time. Additionally, the majority of monitoring wells in the interface aquifer have also been showing a fluctuating and decreasing trend since about 2010. This pattern at these locations was expected as it indicates a response to depressurization from the removal of overlying soil within the Expansion Site waste footprint. It is anticipated that these decreasing elevation trends will be temporary, and pressures will begin to increase once a sufficient waste mass is landfilled to replace the excavated clayey soil mass. As expected, monitoring wells OW39A-26, OW79-26, OW80-27, and OW81-27 are showing a fluctuating and increasing trend since about 2018 as a significant waste mass has been progressively landfilled into the southern half of the Expansion Site. Overall, with the exception of where a more dominant fluctuating trend continued to be observed in 2021, groundwater liquid levels were generally noted to be within their historical ranges.

4.5.3 Vertical Hydraulic Gradients

Vertical hydraulic gradients below the Site in the interstadial silt and sand to the interface aquifer hydrostratigraphic unit were calculated for the May 17 and November 1, 2021 data. The hydraulic gradients that were calculated are presented in **Table F-5**, **Appendix F**. In summary, vertical hydraulic gradients were noted to be downward during both the May and November 2021 monitoring events for the Interstadial Silt and Sand layer to the Interface Aquifer owing to the low leachate and groundwater levels within Cells 1 and 2. Ongoing monitoring will continue to evaluate these trends over time.

5 CHEMICAL & GAS MONITORING RESULTS

5.1 Leachate

In accordance with the landfill EMP, leachate sampling from within select maintenance holes across the Existing Site was completed on May 17, 2021, as part of the annual monitoring requirement. A leachate sample was obtained from the Sump that is located within the West Cell. A second leachate sample designated CFA-Comp consisted of the collection of a composite sample obtained from MH3SA-F, MH4B, MH5A, MH6A, MH7A, MH9A, and MH11A to represent leachate within the Central Fill Area. Leachate is also sampled from MH18 to represent leachate from the South Cell.

Samples were also collected from PS1, PS3, and PS5 during the spring monitoring event on May 18 and 19, 2021. PS1, PS3, and PS5 samples were collected directly from the pumping station sump. Chemical results are summarized in **Appendix G**.

Table 6 provides a chemical summary of the long-term leachate characteristics for the Existing Site and the Expansion Site to November 2021. The 2021 leachate chemical results were generally within the respective historical ranges for the parameters analyzed.

As shown on **Figure G-1**, **Appendix G**, the chloride concentrations in leachate from the Equalization Tank show a fluctuating trend since 2013. Concentration fluctuations over time are expected due to the nature of leachate, as well as to the variations in the relative contribution of weaker leachate from new waste (i.e., new waste in Cell 4C) or from the monofill cells (i.e., Cells 10/12) of the Existing Site to stronger leachate from the aging waste (i.e., waste in Cell 1) or from the West Cell (Sump) of the Existing Site. Chloride concentrations in leachate from the Equalization Tank will continue to be monitored during future sampling events.

5.1.1 Leachate Indicator List

In general, leachate concentrations vary across the Site, with stronger leachate within Cell 6 and the West Cell compared to other cells of the Existing Site. Leachate constituent concentrations for the Expansion Site are generally within the low range for concentrations detected in the Existing Site. This difference is attributed to the relatively young age of the waste (compared to waste in the Existing Site) and the onset of waste decomposition. The 2021 and historical ranges in chemical concentrations for the leachate, as well as the background groundwater and surface water, are presented in **Table 6**. Based on a comparison of the leachate concentrations to the background groundwater and surface water concentrations, the following parameters have had notably elevated concentrations within the leachate.

- EC
- Alkalinity
- Calcium
- Magnesium
- Sodium

- Potassium
- Chloride
- Dissolved Organic Carbon
- Ammonia
- Total Kjeldahl Nitrogen
- Boron
- BTEX Compounds (Benzene, Toluene, Ethylbenzene, and Xylenes)

A landfill leachate effect on groundwater or surface water quality is defined as leachate mixing with the water and migrating in the direction of water movement beyond the Site boundary. To differentiate landfill leachate effects from natural water quality variability, a group of parameters indicative of landfill leachate was selected based on the following items.

- Elevated concentrations in leachate.
- Mobility and stability in groundwater and surface water.
- Representative of a larger chemical group (e.g., boron for metals).
- Applicable Ontario Drinking Water Standard (ODWS) or PWQO.

A group of indicator parameters selected for this landfill, termed the Primary Leachate Indicator List (PLIL), are summarized below.

Primary Leachate Indicator List (PLIL)	
PLIL – Groundwater	**PLIL – Surface Water**
Chloride Nitrate (as N) Boron	Chloride Ammonia (unionized) Phenols Boron Nickel Chromium (total) Zinc

A supplemental group of parameters, termed the Secondary Leachate Indicator List (SLIL), is selected based on elevated concentrations within the leachate. The SLIL is used for quality assurance of the chemical database, for input to establish trigger concentrations, and for further data analyses in the event of trigger concentration exceedances. The SLIL parameters are summarized below.

Secondary Leachate Indicator List (SLIL)			
SLIL – Groundwater		**SLIL – Surface Water**	
Alkalinity Sulphate Calcium Magnesium Potassium Sodium Barium Iron DOC TDS	Ammonia (total) TKN pH Conductivity Cadmium Lead Benzene Toluene Ethylbenzene Xylenes	Alkalinity Sulphate Calcium Magnesium Potassium Sodium Iron Nitrate TKN Phosphorus (total)	TDS pH Conductivity Turbidity Dissolved Oxygen

The concentrations of leachate constituents will vary with time. Leachate quality monitoring will continue at the Existing Site and the Expansion Site to assess the changing leachate characteristics for a landfill impact assessment and for leachate management.

5.2 Groundwater

Field groundwater chemical results for the May, November, and supplemental monitoring events are presented in **Tables H-1** to **H-3**, **Appendix H**. The 2021 laboratory chemical results are presented in **Tables H-4** and **H-5**, **Appendix H**. Historical data are provided for comparison. Laboratory reports of analysis and QA/QC documentation are included as **Table H-6**, **Appendix H**.

Groundwater quality monitoring occurred at the required monitoring locations in consideration of the groundwater monitoring schedule within the approved landfill EMP. An updated monitoring schedule is presented within **Table B-2**, **Appendix B**, which shows the monitoring wells required for sampling, the sampling frequency, and the parameters for analytical testing. Monitoring well designations and locations are presented on **Figure 2**. Monitoring well nest OW81 was installed in June 2019; with monitoring beginning in November 2019. Future monitoring well nests OW82 to OW84 will be installed during their respective stages of landfill construction as presented in Table 2 of the landfill EMP.

5.2.1 General Chemical Trends

To assess long-term chemical trends with time, time-concentration graphs for chloride, nitrate, and boron were prepared. Based on the background concentrations presented in **Table 6**, concentrations were considered constant where results varied by less than 15 milligrams per litre (mg/L) for chloride, 0.5 mg/L for nitrate, and 0.2 mg/L for boron. Concentration trends that varied by greater than these concentration ranges were interpreted as increasing, decreasing, or fluctuating.

Concentration trends for the time-concentration graphs on **Figures H-1** to **H-13**, **Appendix H**, are summarized in **Table 7**. Typically, the long-term concentration trends indicate constant or fluctuating concentrations with time, with some exceptions, which are discussed below. It is noted that the below observations do not represent immediate concerns, but as a matter of diligence will be evaluated over time to verify that a trend of concern does not develop or corrective measures, if required can be implemented.

Active Aquitard:

- At monitoring well OW16-6, the chloride concentrations have been generally stable after the short-term historical high concentration of 77 mg/L noted in May 2015, which subsequently decreased to an approximate average of 45 mg/L since then. It is noted that the chloride concentrations discussed are notably less than the trigger concentration of 106 mg/L.
- At monitoring well OW17-4, the chloride concentrations have been generally stable after the short-term historical high concentration of 71 mg/L noted in May 2016, which subsequently decreased to an approximate average of 30 mg/L since then. It is noted that the chloride concentrations discussed are notably less than the trigger concentration of 106 mg/L.

- At monitoring well OW54A-4, chloride concentrations have been increasing and fluctuating since late 2014. It is noted that the aforementioned chloride concentrations have shown an approximate stabilization at 26 mg/L since 2018 and are notably less than the trigger concentration of 106 mg/L.
- At monitoring well OW56-4, nitrate concentrations have generally been low and constant, however, isolated elevated concentrations have been detected over time; with the most recent event occurring in 2018. It is likely that the nitrate concentrations are a result of effects resulting from fertilizer application to the adjacent field. Nitrate concentrations have continued to be low and constant since 2018.
- At monitoring well OW67-4, the concentrations of chloride, nitrate, and boron have exhibited generally decreasing and fluctuating trends over time. Periodic increases in concentrations for each parameter have occurred over time, however, the overall trend for each parameter has been decreasing and fluctuating since monitoring began at OW67-4. It is noted that the concentrations of chloride, nitrate, and boron were below their respective trigger concentrations in 2021.
- At monitoring well OW69-5, boron concentrations continue to show a generally constant but slightly fluctuating trend with concentrations hovering around the shallow groundwater trigger concentration of 1.1 mg/L. At this time the boron concentrations at OW69-5 are not a concern as it is expected the more mobile parameter chloride would be observed first if the source of the boron were leachate. It is likely that, similar to observations for monitoring well OW58-14, that was decommissioned in 2016, bentonite seal is moving into the filter screen material of the monitoring well, and as such may require decommissioning and replacement in the future depending on chemical results.
- At monitoring well OW71A-5, the chloride concentrations are showing an increasing trend to a historical high of 29 mg/L in May 2021. However, the chloride concentrations are notably less than the Active Aquitard trigger concentration of 106 mg/L. It is noted that monitoring well OW71A-5 is not a compliance monitoring well for the Site but was added to supplement historically dry conditions at OW67-4. The recent chloride concentrations at OW71A-5 and OW67-4 are generally similar and the concentrations of the other PLIL parameters are not showing a similar trend.

Interstadial Silt and Sand:

- At monitoring well OW46-7 the concentration of boron has been observed to have been fluctuating since November 2019, which is similar to the short-term increase in 2015. However, the boron concentrations are notably less than the historical concentrations prior to 2003. The boron concentrations remain below the trigger concentration of 2.1 mg/L. The other PLIL parameters are not elevated or showing an increasing trend. It is likely that the observed periodic increases in boron concentrations is an effect from the bentonite seal moving into the filter pack of the monitoring well. At historical monitoring well OW58-14, the observed boron concentrations were proven to be related to bentonite seal impacts from the monitoring well seal moving into the sand filter pack. Consequently, per MECP approval, OW58-14 was decommissioned and replaced as OW58-17, which has shown constant and acceptable concentrations of boron since its installation in 2014.

- At monitoring well OW67-11, chloride concentrations showed an increasing trend between about 2009 and 2013 and have since showed a generally fluctuating trend. Nitrate concentrations have continued to fluctuate since monitoring began. Boron concentrations have fluctuated and decreased since about 2011. The chloride concentrations are notably below the trigger concentration of 116 mg/L for the interstadial silt and sand hydrostratigraphic unit.
- At recently installed monitoring well OW81-7, chloride concentrations are elevated as a result of effects road salting along Nauvoo Road, similar to as observed at OW80-6. Per MECP approval OW80-6 is no longer used as part of the trigger assessment. Based on groundwater flow towards the landfill in this hydrostratigraphic unit and similar chemical results at similarly place monitoring well OW80-6, a request will be issued to the MECP to remove chloride from the trigger assessment at OW81-7.

5.2.2 Organic Chemistry

The 2021 and historical organic chemical results are provided in **Table H-5**, **Appendix H**. Tested organic chemical constituents at each monitoring location were not detected at concentrations greater than their respective laboratory RDL during 2021. Exceptions were noted during the May 2021 monitoring event for dichloromethane at monitoring wells OW60-8 (13 micrograms per litre (µg/L)), OW80-6 (6.3 µg/L), and OW81-7 (9 µg/L). It is noted that the May 2021 detected concentrations of dichloromethane at OW80-6 and OW81-7 were less than 5 times their respective RDL (2.0 µg/L), whereas OW60-8 was only slightly greater than 5 times its RDL (2.0 µg/L). The detected concentrations of dichloromethane were also below their respective ODWS (50 µg/L). Additionally, dichloromethane historically has been intermittently detected at other groundwater monitoring wells with no established pattern. Dichloromethane concentrations will continue to be evaluated over time for possible trends of concern. Organic constituents have historically been infrequently detected at low concentrations at various groundwater monitoring wells. No corrective measures are required to address the noted 2021 organic chemical results.

5.2.3 Trigger Mechanisms

Groundwater compliance is assessed based on criteria calculated with respect to the Ministry of the Environment and Energy's (MOEE) Guideline B-7 Reasonable Use Concept (Guideline B-7) and evaluated at the Site boundaries (Points of Compliance). Trigger concentrations are used to assess potential sources of concentration changes. The groundwater trigger concentrations are based on 80% of the calculated Guideline B-7 criteria for the reasonable use of groundwater (MOE, 1994), in accordance with Condition 14.2 of the ECA. When background groundwater quality satisfies the ODWS, background groundwater quality cannot be degraded by more than 25% of the ODWS for health-related parameters (e.g., nitrate) or by more than 50% of the ODWS for aesthetic-related parameters (e.g., sodium). Where background concentrations naturally exceed the ODWS, background groundwater quality becomes the criteria.

Historical background groundwater quality for local monitoring wells was used to calculate the trigger concentrations at the Site. As a screening process, trigger concentrations for the PLIL were calculated and assessed as provided in Table 3 of the landfill EMP.

5.2.3.1 Points of Compliance

An assessment of potential landfill leachate effects on groundwater quality is completed at the Site boundary to encompass the Expansion Site footprint and operations, as well as to consider potential effects of the Existing Site on groundwater quality. Monitoring wells are used at strategic locations around the Site to obtain an acceptable representation of groundwater quality moving beyond the Site boundary. These strategic locations are called the Points of Compliance and are assessed in accordance with Guideline B-7.

To account for the natural groundwater quality variability, the trigger concentrations consider the PLIL parameters discussed in **Section 5.1.1**. Exceedance of the trigger concentrations at the monitoring wells initiates the assessment process, which is detailed within Figure 3 of the landfill EMP. **Tables 8** to **10** provide the groundwater trigger concentration comparison and the 2021 chemical concentrations for the PLIL parameters.

Verification groundwater monitoring at the Site adheres to Condition 14.4 of the Waste ECA, which references the landfill EMP. Groundwater verification is required to be completed for two (2) subsequent events separated by six months with the first verification monitoring event taking place within one month of the initial sampling event.

5.2.3.2 Trigger Concentration Assessment

Primary Leachate Indicator List Comparison:

Based on the chemical analytical results for the 2021 monitoring events, the concentrations of the PLIL parameters at the groundwater monitoring wells, including the Points of Compliance, within the active aquitard, the interstadial silt and sand, as well as the interface aquifer satisfied the relevant trigger concentrations, with one (1) exception at OW81-7.

At monitoring well OW81-7, a concentration of chloride was detected that was greater than the respective trigger concentration during the spring monitoring event.

Shallow groundwater quality at the location of monitoring nests OW80 and OW81 are interpreted to be impacted by nearby road salting activities on Nauvoo Road. The MECP approved the discontinuation of utilizing the parameter chloride as a trigger mechanism OW80-3 and OW80-6 in 2010 following their installation in 2009. Given its similar construction and proximity to Nauvoo Road, the groundwater at interstadial silt and sand monitoring well OW81-7 is interpreted to also be influenced by road salting activities. As such, the chloride concentration of 220 mg/L in this monitoring well that was detected in May 2021 is not attributed to landfill leachate related impacts. This is also evidenced by the fact that the liquid level elevation noted at monitoring well OW81-7 was higher in elevation (234.90 mASL) than the secondary drainage layer (SDL) at pumping stations PS4 (229.59 mASL) and PS6 (226.63 mASL) in May 2021, indicating groundwater flow toward the landfill.

As noted in the 2021 Spring Groundwater Quality Monitoring Letter of Notification, prepared by RWDI and submitted to the MECP on June 17, 2021, a groundwater trigger concentration exceedance for chloride was identified within the newly installed (2019) groundwater monitoring well OW81-7. Based on this noted chloride groundwater trigger concentration exceedance, per the process outlined in the Environmental Monitoring

Program (Jagger Hims Limited, 2007) (EMP), a verification monitoring event for the primary and secondary leachate indicator list parameters was initiated on June 9, 2021. Verification monitoring confirmed the initial assessment findings that the groundwater quality at OW81-7 is being impacted by road salting effects along Nauvoo Road. A second verification sample was collected during the fall groundwater monitoring event in November 2021, which also confirmed the initial assessment findings.

Per Figure 3 of the EMP, the if the trigger concentration exceedance is confirmed, then an Alternate Source Evaluation is to be completed, which is outlined below along with the associated findings.

- **Confirm QAQC data** – Laboratory review of QAQC data confirms initial result reported.
- **Confirm chemical trends of primary and secondary leachate indicator list parameters** – Verification events were the second and third samples collected at this monitoring location. There is no identifiable chloride concentration trend of concern as the concentrations are fluctuating over time. The chloride concentration for initial spring routine sample was 220 mg/L (May 20, 2021) and the verification sample was 260 mg/L (June 9, 2021)
- **Inspect condition of monitoring well** – An assessment of the monitoring well denoted it is in good condition. Of note, OW81-7 is approximately 10 m east of Nauvoo Road at a lower elevation near the roadside ditch/toe of slope of screening berm.
- **Inspect Chain-of-Custody Form** – The field information form and chain of custody were reviewed, both of which are satisfactory and include all the required information.

Per Figure 3 of the EMP, a request will be submitted to the MECP to remove chloride as a PLIL parameter at monitoring location OW81-7.

Secondary Leachate Indicator List Assessment:

Based on the chemical analytical results for the 2021 monitoring events, the concentrations of the SLIL parameters at the groundwater monitoring wells, including the Points of Compliance, within the active aquitard, the interstadial silt and sand, as well as the interface aquifer satisfied the relevant trigger concentrations, with one (1) exception at OW60-8.

At monitoring well OW60-8, a concentration of dichloromethane was detected that was greater than the respective trigger concentration during the spring semi-annual monitoring event in May 2021. The detected dichloromethane concentration at monitoring well OW60-8 is not a concern as dichloromethane is a secondary leachate indicator list parameter, and the primary leachate indicator list parameters (chloride, boron, and ammonia) were not detected at elevated concentrations. Monitoring well OW60-8 is also distantly removed from the waste and groundwater quality that is closer to the waste was acceptable at monitoring well nests OW16 and OW69. Dichloromethane historically has been intermittently detected at other groundwater monitoring wells with no established pattern. The noted dichloromethane concentration is also less than its ODWS (0.050 mg/L). In consideration of the aforementioned discussion, the detected dichloromethane concentration at OW60-8 is not a concern and dichloromethane concentrations will continue to be evaluated over time for possible trends of concern.

With respect to the elevated lead concentration noted within the groundwater at monitoring well OW60-4 the past six (6) consecutive sampling events, the MECP approved to discontinue the use of lead as a SLIL parameter for groundwater at the location of OW60-4 per a letter dated October 2, 2020. Therefore, similar to chloride removal from the trigger concentration assessment process at a few monitoring wells, lead will be removed from the trigger concentration assessment at OW60-4 and the detected values will be documented for tracking purposes.

During the 2021 monitoring events, VOCs tested within the groundwater at the monitoring well locations satisfied their respective trigger concentrations.

In summary, based on the chemical analytical results for the 2021 monitoring events, the concentrations of the PLIL and SLIL parameters at the groundwater monitoring wells, including the Points of Compliance, within the active aquitard, the interstadial silt and sand, as well as the interface aquifer generally satisfied the relevant trigger concentrations.

5.3 Surface Water

Surface water chemical results are summarized in **Tables I-1** to **I-4**, **Appendix I**. Laboratory reports and documentation of quality control are provided in **Table I-5**, **Appendix I**.

5.3.1 General Chemical Trends

As discussed in **Section 5.1.1,** there are seven (7) surface water PLIL parameters that represent effective indicators of landfill leachate effects on surface water quality for the Site. To assess chemical trends with time, time-concentration graphs for chloride, un-ionized ammonia, boron, and zinc were prepared.

Data were analyzed for long-term trends, which considered the historical data. Concentrations were considered constant where results varied by less than 15 mg/L for chloride, 0.02 mg/L for un-ionized ammonia, 0.2 mg/L for boron, and 0.02 mg/L for zinc. Concentrations trends that varied by greater than these concentration ranges were interpreted as increasing, decreasing, or fluctuating. A minimum of three (3) to five (5) data points are required to determine a chemical trend with time. Concentration trends are summarized in **Table 11**. Time-concentration graphs are presented on **Figures I-1** to **I-4**, **Appendix I**.

Long-term concentration trends indicate both constant and fluctuating concentrations with time. Fluctuating concentrations generally showed a seasonal pattern for boron and chloride concentrations at stations SS1 and SP1. Chloride concentrations at SP2 and SP4 appear to have a fluctuating pattern in the long-term. Additionally, in the long-term, unionized ammonia concentrations continued a constant trend of being below their respective laboratory RDL and/or less than the respective PWQO (0.02 mg/L), with occasional historical exceedances at SS1, SP1, and SP2. Details pertaining to individual surface water monitoring events conducted in 2021 are provided in **Section 5.3.5**.

Concentrations of chloride, boron, unionized ammonia, and zinc in surface water within the Sedimentation Ponds and at compliance point SS1 were typically similar to each other, with some recent exceptions where elevated and fluctuating concentrations of boron have generally been noted at SS1 and SP2. The noted boron concentrations in 2021 at SS1 and SP2 are not a concern as they are not landfill leachate related but are a result of short-term effects from crushed glass (used as an aggregate bedding for landfill gas piping) being temporarily stored near the southeast corner of Sedimentation Pond 2, as well as the resurfacing and ditch regrading activities of Street C (from Street B to the southern high access ramp) from spring to fall of 2021.

5.3.2 Organic Chemistry

Organic chemical results are provided in **Table I-3**, **Appendix I**. Tested organic chemical constituents at the downstream compliance monitoring stations SS1, SP2, SP3, and SP4, as well as the internal compliance monitoring station SP1, were generally not detected at concentrations greater than their respective laboratory RDL. Two (2) exceptions were noted which occurred during the 2021 Q1 and Q2 monitoring periods.

Volatile organic compound (VOC) and semi-volatile organic compound (SVOC) concentrations for the Q1 and Q2 2021 surface water samples were generally below their respective laboratory reportable detection limits (RDLs).

- For the Q1 verification monitoring event on April 9, 2021, the SVOC phenol (0.63 µg/L) was detected at compliance surface water monitoring station SS1. The detected concentration of phenol was less than five (5) times the laboratory reportable detection limit (RDL) (0.5 µg/L). Additionally, phenol was detected at SS1 on one (1) prior occasion in 2008.
- For the Q2 monitoring event on June 3, 2021, the SVOC parameter phenol (3.7 µg/L) was detected at compliance surface water monitoring station SP4. The detected concentration of phenol was less than five (5) times the laboratory reportable detection limit (RDL) (2.0 µg/L). Additionally, phenol was detected at SP4 on one (1) prior occasion in 2013.

As there are not any concentration trends of concern occurring for phenol at SS1 and SP4, the above-noted SVOC concentrations are interpreted to be insignificant. The concentrations of phenol will continue to be evaluated to verify that concentration trends of concern are not occurring. There are no trigger concentrations for SVOC parameters.

5.3.3 Biomonitoring Program – Annual Spring Routine Event

The laboratory results for the biomonitoring monitoring events completed in 2021 are provided within **Table I-6, Appendix I**. The sample aliquots collected to assess biological conditions were assessed for surface water quality toxicity to *daphnia magna* and rainbow trout. The biological testing results showed that there was not a potential for detrimental effects to aquatic life in the discharge water.

5.3.4 Biomonitoring Program – Verification Events

Biomonitoring was also conducted in 2021 in accordance with conditions approved in the 2014 MECP Letter. Surface water verification sampling included the collection of a grab sample for analysis of the toxicity to rainbow trout and *daphnia magna* associated with verification surface water monitoring events for compliance monitoring discussed in **Section 2.4.4**.

During the verification sampling events, the verification biological results indicated that the surface water was of acceptable quality for continued discharge.

5.3.5 Trigger Concentration Assessment

Table 12 provides the Post 2020 trigger concentrations utilized to assess surface water quality during 2021, as well as the Post 2021 trigger concentrations that will be utilized in 2022 to assess the chemical quality of surface water.

A comparison of the 2021 surface water quality with the Post 2021 trigger concentrations is provided in **Table I–4**, **Appendix I**. Outlined below is a detailed discussion of the trigger concentration assessments for each surface water monitoring event, by calendar quarter for 2021. A quality comparison for background stations SS10 and SS16 is also provided where applicable.

First Quarter – January 1 to March 31, 2021

<u>March 26, 2021:</u>

Surface water samples were collected at compliance monitoring stations SS1, SP2, SP3, and SP4, as well as internal assessment monitoring location SP1 and background monitoring stations SS10 and SS16 on March 26, 2021, as part of the routine monitoring program following a precipitation event of greater than 10 mm in the 24-hour period from 8:00 AM March 25 to 8:00 AM March 26. The surface water quality at the required monitoring stations generally satisfied the relevant trigger concentrations, with two (2) exceptions.

- For the surface water sample collected at SS1, the concentrations of boron (0.7 mg/L), nickel (1.6 mg/L), total chromium (1.1 mg/L), and zinc (2.7 mg/L) were greater than their respective trigger concentrations (0.20 mg/L, 0.025 mg/L, 0.028 mg/L, and 0.060 mg/L, respectively).
- For the surface water sample collected at SP2, the concentration of boron (0.21 mg/L) exceeded the relevant trigger concentration (0.20 mg/L).

In consideration of the aforementioned, verification monitoring was required for SS1 and SP2, which details are discussed below for April 9, 2021.

The elevated boron, nickel, chromium, and zinc concentrations noted at the location of surface water monitoring station SS1 are interpreted to dominantly be as a result of erosional effects due to re-surfacing of the street directly west and south of Cell 1 and Cell 2 of the Expansion Site (Street C) that was on-going, which included the re-grading of the surface water drainage ditches along Street C. These construction works would result in temporary increased erosional effects as the work requires the removal of much of the established vegetation and straw-bale check dams that would normally provide erosion control in this area. As shown on **Figure 3**, the surface water drainage ditch on the south side of Street C leads directly to surface water monitoring station SS1. In addition to the Street C construction works, of the significant amount of precipitation (28.0 mm) that occurred prior to sampling, it is noted that the majority of the precipitation fell within 12 hours of sample collection and precipitation was also occurring during sample collection. The visually identifiable turbid waters for the streamflow at SS1 was confirmed as such through field measurements for turbidity. It is noted that the short-term temporary storage of crushed glass (used as an aggregate bedding for landfill gas piping) near the southwest corner of Sedimentation Pond 2 also likely contributed to the noted boron concentrations at this location.

The elevated total boron concentration at SP2 is also interpreted to be dominantly as a result of the aforementioned Street C reconstruction and lesser degree to the short-term storage of crushed glass based on the area of disturbed surface for reconstruction versus the area used for short-term storage of crushed glass. As shown on **Figure 3**, the surface water drainage ditch on the north side of Street C leads directly to Sedimentation Pond 2 and thus surface water monitoring station SP2.

Though elevated, the laboratory and field chemical constituent concentrations were noted to be within the historical range for surface water collected at monitoring stations SS1 and SP2, with the exception of nickel, chromium, and zinc at SS1. These historical high concentrations of nickel, chromium, and zinc at SS1 are interpreted to be a result of the non-routine Street C reconstruction activities. The elevated concentrations are expected to return to within historical ranges after the completion of the Street C reconstruction activities and associated remediation of the vegetation and re-installing straw-bale check dams in the surface water drainage ditches. Thus, it is interpreted that the elevated boron, nickel, chromium, and zinc concentrations at monitoring station SS1 and elevated boron concentration noted at monitoring station SP2 are not as a result of a landfill leachate effect, but dominantly from the Street C reconstruction activities and related soil erosional effects.

April 9, 2021:

To address the boron, nickel, total chromium, and zinc concentrations at SS1 and the boron concentration at SP2, a surface water verification monitoring event (including chemical and biological monitoring) was required. The verification monitoring event for surface water station SS1 indicated acceptable concentrations of nickel, total chromium, and zinc. The boron concentrations detected at SS1 and SP2 were again, greater than their respective trigger concentrations (0.20 mg/L). However, the verification monitoring event denoted acceptable biological results indicating that the surface water quality does not pose a detrimental effect to aquatic life and that the surface water was of acceptable quality for continued discharge and that no further verification monitoring was required (refer to Section 5.3.4).

Second Quarter – April 1 to June 30, 2021

June 3, 2021:

Surface water samples were collected at compliance monitoring stations SS1, SP3 and SP4, as part of the routine monitoring program following a precipitation event of greater than 10 mm in a 24-hour period from 8:00 AM June 2 to 8:00 AM June 3. Surface water samples were not collected at compliance monitoring station SP2 as well as internal assessment monitoring location SP1 and background monitoring stations SS10 and SS16 due to there not being flowing conditions to initiate sample collection. The surface water quality at the required monitoring stations satisfied the relevant trigger concentrations.

June 26, 2021:

A surface water sample was collected at compliance monitoring station SP2, as part of the routine monitoring program following a precipitation event of greater than 10 mm in a 24-hour period from 8:00 AM June 25 to 8:00 AM June 26. Surface water samples were not collected at internal assessment monitoring location SP1 and background monitoring stations SS10 and SS16 due to there not being flowing conditions to initiate sample collection. The surface water quality at the required monitoring stations generally satisfied the relevant trigger concentrations, with one (1) exception. For the surface water sample collected at SP2, the concentration of boron (0.31 mg/L) was greater than the trigger concentration (0.20 mg/L). As such verification monitoring was required for SP2 and is discussed below for July 9, 2021.

The elevated boron concertation noted at SP2 was dominantly a result of the aforementioned Street C reconstruction and lesser degree to the short-term storage of crushed glass based on the area of disturbed surface for reconstruction versus the area used for short-term storage of crushed glass.

July 9, 2021:

To address the boron concentration at SP2, a surface water verification monitoring event was completed for surface water station SP2. The verification monitoring event denoted acceptable chemical and biological results indicating that the surface water quality does not pose a detrimental effect to aquatic life and that the surface water was of acceptable quality for continued discharge and that no further verification monitoring was required (refer to **Section 5.3.4**).

Third Quarter – July 1 to September 30, 2021

July 9, 2021:

Surface water samples were collected at compliance monitoring stations SS10, SS1, SP3, and SP4, as well as internal assessment monitoring location SP1 on July 9, 2021, as part of the routine monitoring program following a precipitation event of greater than 10 mm in a 24-hour period from 8:00 AM July 8 to 8:00 AM July 9. A sample was not collected at surface water monitoring station SS16 due to there not being flowing conditions to initiate sample collection. A sample was also not collected at surface water monitoring station SP2 as a one (1) month period is required between quarterly samples at each monitoring location. As such, monitoring of SP2 remained required to be completed. The surface water quality at the required monitoring stations satisfied the relevant trigger concentrations with one (1) exception at compliance monitoring station SS1, where the concentration of boron (0.26 mg/L) was greater than its respective trigger concentration (0.20 mg/L). Therefore, verification monitoring was required for SS1 and as discussed below was completed on July 30, 2021.

Though elevated, the laboratory and field chemical constituent concentrations were noted to be within the historical range for surface water collected at monitoring station SS1. Thus, it is interpreted that the elevated boron concentration at monitoring station SS1 is attributable to the Street C reconstruction and lesser degree to the short-term storage of crushed glass based on the area of disturbed surface for reconstruction versus the area used for short-term storage of crushed glass.

July 30, 2021:

To address the boron concentration at SS1, a surface water verification monitoring event was completed for surface water station SS1, which again, indicated a boron concentration greater than its trigger concentration (0.20 mg/L). However, the verification monitoring event denoted acceptable biological results indicating that the surface water quality does not pose a detrimental effect to aquatic life and that the surface water was of acceptable quality for continued discharge and that no further verification monitoring was required (refer to **Section 5.3.4**).

In addition, on July 30, 2021, as part of the routine monitoring program following a precipitation event of greater than 10 mm in a 24-hour period from 8:00 AM July 29 to 8:00 AM July 30, a sample at surface water monitoring station SP2 was collected. A sample was again not collected at surface water monitoring station SS16 due to there not being flowing conditions to initiate sample collection. The surface water quality at monitoring station SP2 satisfied the relevant trigger concentrations.

Fourth Quarter – October 1 to December 31, 2021

October 4, 2021:

Surface water samples were collected at compliance monitoring stations SS1, SP2, SP3, and SP4, as well as internal assessment monitoring location SP1, on October 4, 2021, as part of the routine monitoring program following a precipitation event of greater than 10 mm in a 24-hour period from 8:00 AM October 3 to 8:00 AM October 4. Surface water samples were not collected at background monitoring stations SS10 and SS16 due to there not being flowing conditions to initiate sample collection. The surface water quality at the required monitoring stations generally satisfied the relevant trigger concentrations, with three (3) exceptions. For the surface water samples collected at SS1, SP2, and SP3, the concentrations of boron (0.26 mg/L, 0.22 mg/L, and 0.22mg/L), respectively, were greater than their respective trigger concentrations (0.20 mg/L). As such verification monitoring was required for SS1, SP2, and SP3 and is discussed below was completed on October 15, 2021.

Though elevated, the laboratory and field chemical constituent concentrations were noted to be within the historical range for surface water collected at monitoring stations SS1 and SP2. In addition, straw-bale check dams were re-installed upstream of monitoring stations SS1 and SP2 prior to this event. As a result, the surface water quality was observed to have generally improved indicating that once the vegetation for the surface water drainage ditches along Street C is re-established, water quality at these locations should return to the quality observed prior to the Street C reconstruction activities.

The elevated total boron concentration at SP3 is interpreted to be as a result of soil erosional effects related to earthworks to one of the inlet flow paths into the pond. Though elevated, the laboratory and field chemical constituent concentrations were noted to be within the historical range for surface water collected at monitoring station SP3. Thus, it is interpreted that the elevated boron concentration noted at monitoring station SP3 is not as a result of a landfill leachate effect, but rather from soil erosional effects.

October 15, 2021:

To address the boron parameter concentrations at SS1, SP2, and SP3 respectively, a surface water verification monitoring event was completed. The verification monitoring indicated an acceptable concentration of boron at SP3. The boron concentrations detected at SS1 and SP2 were again, greater than their respective trigger concentrations. However, the biological results for SS1, SP2, and SP3 indicated that the surface water quality does not pose a detrimental effect to aquatic life and that the surface water was of acceptable quality for continued discharge and that no further verification monitoring was required (refer to **Section 5.3.4**).

To address erosion effects related to Street C construction upstream of SS1 and SP2, and earthworks to one of the inlet flow paths into the SP3, efforts were completed throughout 2021 and will continue to be undertaken by WM to install additional straw-bale check dams at various locations within the surface water drainage network.

5.4 Landfill Gas Monitoring

Consistent with historical observations, methane gas was not detected within the gas probes in 2021. This observation indicates that landfill gas is not migrating in the subsurface beyond the waste footprint and is therefore, being effectively captured by the landfill gas collection system. Therefore, mitigation measures that would address a potential landfill gas migration in the shallow subsurface beyond the waste footprint are not required. The 2021 landfill gas monitoring results are presented in **Table J-1**, **Appendix J**.

6 SITE OPERATIONS SUPPLEMENTAL TESTING & MONITORING

6.1 Construction Activities

6.1.1 Existing Site

On June 25, 2021, a landfill cap repair was completed at the northeast corner of the Existing Site to address Total Hydrocarbon (THC) survey findings. This repair was completed with a geosynthetic bentonite composite layer placed approximately 0.3 m below final cap surface that was then hydrated, and subsequently the clayey soil cap material was replaced and re-compacted. Validation of the ground level THC (as methane) level was completed for the repair location on August 6, 2021. The ground level THC concentration was less than 500 ppm indicating that the repairs were successful. Refer to **Volume 4** of the 2021 Annual Report for details regarding the THC Survey monitoring.

6.1.2 Expansion Site

The Site was formally approved for expansion on August 5, 2008. During 2021, waste disposal occurred in Cell 4A, Cell 4B and Cell 4C of the Expansion Site. Waste disposal in Cell 4C commenced on August 10, 2021, as the landfill liner system was approved to accept waste. Cell 6A pre-excavation activities related to the future construction of the Cell 6A landfill liner system of the Expansion Site commenced in 2021 and are ongoing into 2022. Upon completion of the landfill liner system of Cell 6A, waste disposal is scheduled to also occur in Cell 6A in 2022.

Interim cover was placed on the southern, eastern and western side slopes of Cell 1, the eastern and western side sloped of Cell 2, and the northern and western side slopes of Cell 4A during 2021.

Additionally, the installation of the horizontal landfill gas collection system conveyance piping was completed in Cell 4A in January 2021.

6.1.3 Groundwater Monitoring Wells

In 2021, there were no new groundwater monitoring wells or gas probes installed at the Site. There were also no groundwater monitoring wells or gas probes decommissioned and/or replaced in 2021.

The 2021 monitoring well and gas probe installation/decommissioning status summary is provided in **Appendix M**.

6.1.4 On-Site Surface Water Management

Upon completion of cell construction and filling in the Expansion Site, surface water runoff will be managed through Sedimentation Ponds 1, 2, 3, and 4. Surface water runoff originating from areas south of the Existing Site flows toward: 1) Kersey Drain (Brown Creek) to the east; and 2) to the west toward the Van Kessel Drain and enters a municipal drainage tile at a catch basin (SS1), which is situated 60 m east of the western Site boundary. The municipal drainage tile subsequently drains into the discharge ditch for SP2, which ultimately flows to the Gilliand-Geerts Drain 'A', beneath Lambton Road 79.

During the 2021 operating period, maintenance to the on-Site surface water flow system was required, which is detailed in **Appendix R**.

Only water that satisfied the Criteria for On-Site Surface Water Management (D&O, 2008) was used on-Site for dust control and road cleaning purposes in 2021.

6.1.5 MECP Site Inspection Reports

A MECP Inspector provided inspection reports on a quarterly basis, at a minimum in 2021. The MECP inspection frequency was completed, at a minimum, in accordance with the Waste ECA, as well as in consideration of the MECP's policy regarding field inspections during the COVID Pandemic. The Site inspections were conducted to assess Site operation compliance with the applicable approval documentation. The 2021 quarterly MECP Inspection Reports, received by WM to date, are presented in **Appendix N**. Where action items were required, they were addressed by WM.

6.1.6 Contaminated Soil

Contaminated soil was received at the Site throughout 2021 and therefore, contaminated soil sampling was completed for each quarterly monitoring period.

Per Conditions 6.53 to 6.61 of the Waste ECA dated December 19, 2020, quarterly testing results for contaminated soil used as daily and/or intermediate cover, where applicable, are included in **Appendix O**. Confirmatory testing of the contaminated soil satisfied the TCLP criteria within Schedule IV of Ontario Regulation 347. Therefore, the contaminated soil was acceptable for disposal in the landfill. Contaminated soil that meets the 10% TCLP criteria can be disposed within the monofill cells of the Existing Site (Cell 12 has available capacity). Contaminated soil was not disposed within the Existing Site monofill cells in 2021.

6.1.7 Automobile Shredder Residue

ASR was received and used for daily cover at the Site in 2021 and was therefore, tested per the Waste ECA requirements. The ASR laboratory results satisfied the TCLP criteria within Schedule IV of Ontario Regulation 347 and was therefore acceptable for use as daily cover in 2021. The spring and fall laboratory test results are contained in **Appendix K**.

It is noted that on November 15, 2021, WM received its last load of ASR material onsite as they agreed to temporarily discontinue its use until they can evaluate other options.

7 AMBIENT AIR QUALITY MONITORING PLAN

7.1 Total Suspended Particulate (TSP) Monitoring

Monitoring of Total Suspended Particulate (TSP) for the 2021 monitoring period was completed as required. Findings of the TSP monitoring program is detailed within **Volume 4** of the 2021 Annual Report.

7.2 Volatile Organic Compounds (VOCs) Monitoring

The ambient air volatile organic compound (VOC) monitoring is to be completed during the summer period, which begins on June 21 and ends September 21 of every year. Findings of the VOC monitoring program, completed during the 2021 monitoring period, are detailed within **Volume 4** of the 2021 Annual Report.

7.3 Total Hydrocarbon (THC) Landfill Cap Surveys

The landfill final cap surface of the Existing Site is surveyed for Total Hydrocarbon (THC) vapour releases as part of the Ambient Air Quality Monitoring Plan twice annually in the spring and the fall. The landfill final cap surface of the Existing Site was surveyed by RWDI in the spring and fall of 2021 for Total Hydrocarbon (THC) vapour releases, as required. The THC Landfill Cap survey and associated details are presented within **Volume 4** of the 2021 Annual Report.

8 NOISE MONITORING PLAN

The Environmental Noise Monitoring Program (Aercoustics, 2007) was implemented in 2009. The survey is required under Condition 13.10 of the Waste ECA. The Noise Monitoring Plan (NMP) report as it relates to the 2021 monitoring period is presented within **Volume 5** of the 2021 Annual Report.

9 BEST MANAGEMENT PRACTICES

9.1 Dust

The Best Management Practices Plan (Dust) for the Twin Creeks Environmental Centre was utilized by WM for its operations during the 2021 monitoring period. The Dust Inspection and Dispatch Log for each event as filled out by WM are maintained on file.

Complaints related to dust were not received by WM during the 2021 monitoring period.

Details of the Ambient Air Quality Monitoring Program for the Site are presented within **Volume 4** of the 2021 Annual Report.

9.2 Litter

WM operated the Site in accordance with its Best Management Practices Plan (Litter) during the 2021 monitoring period. The Litter Inspection and Dispatch Logs for each event, as filled out by WM, are maintained on file.

Details related to litter complaints received and the associated response actions(s) by WM during the 2021 monitoring period are outlined in **Section 10**.

9.3 Odour

Odour control is achieved through the Best Management Practices Plan (Odour). The Odour Control Plan was implemented during the 2021 monitoring period. Additionally, an odour suppression system is available to manage refuse odours during normal operating procedures as identified by WM.

Details related to odour complaints received during the 2021 monitoring period are outlined in **Section 10**.

Further explanation of odour as it relates to the Ambient Air Quality Monitoring Program for the Site is presented within **Volume 4** of the 2021 Annual Report.

10 COMPLAINTS

Where complaints were received during the 2021 monitoring period, Waste Management completed the required steps in response, including notification to the MECP and other stakeholders as required. This included logging the complaint, completing the appropriate investigation into the potential source of the complaint, any required corrective action or mitigation and complainant follow up, as well as filing a formal complaint log (**Complaint Log**). The **Complaint Logs**, which detail the above-noted steps are summarized in **Table P-1, Appendix P**, as well as themselves included in **Appendix P**.

WM received a total of 36 complaints during the 2021 operating period (1 general, 9 litter, 26 odour). Of the complaints received, they represented a total of 29 complaint driven events which occurred on 26 separate days during 2021.

Noise:

No complaints related to noise were received by WM during 2021.

General/Litter:

WM received a total of ten (10) general/litter complaints (1 front gates, 9 litter) during the 2021 operating period.

For the complaint about the front gates, it is noted that authorized personnel were onsite at the time the gates were observed to be open.

For the noted litter complaints, WM either continued with ongoing road sweeping or reallocated personnel to clean up the litter that same day. It is noted that the majority of the litter complaints were related to ASR material being tracked out of the Site. WM implemented a number of abatement strategies to manage ASR material track out as outlined in the Automobile Shredder Residue Abatement Plan dated, August 4, 2021. On November 15, 2021, WM received its last load of ASR material onsite as they agreed to temporarily discontinue its use until they can evaluate other options.

Odour:

Of the 29 complaint driven events, 19 of the events were related to odour. Of these 19 odour events, 15 of the events were documented from 10 discrete physical locations such as a residence or commercial building. The other 4 events represent transient (drive-by) occurrences in which the complainant observed an odour while in transit along a road near to the Site. Transient (drive-by) complaints of this nature along roads are identified as not having a negative impact to sensitive receptor locations such as residential or commercial properties near the Site. A breakdown of the number of events where odour complaints were documented from a physical location and were received by WM on a quarterly basis during the 2021 operating period can be seen below.

Number of Odour Events per Quarter in 2021			
Q1	**Q2**	**Q3**	**Q4**
2	0	10	3

As presented in the summary above, the greatest number of events where odour complaints were received by WM in 2021 was during the third quarter operating period.

WM has reviewed the odour related complaints that were received during the 2021 operating period to assess for any trends and to identify corrective actions, as required. Of the odours that were identified as being related to Site operations, it was determined that the majority of the odours that were associated with the Site were related to temporary power outages to the landfill gas (LFG) collection system or a LFG well observed to be releasing LFG to the atmosphere. In response to each power outage, WM would promptly focus their efforts to regain power to the LFG collection system. In response to each instance where a LFG well observed to be releasing LFG to the atmosphere, WM would promptly have the LFG well repaired.

As shown in the above complaint summary for 2021, there was an increase in events where odour complaints were received in Q3 and Q4 compared to Q1 and Q2 of 2021. The portion of the LFG collection system that was extended beginning near the end of 2020 and was completed in January 2021, began to collect gas from Cell 4A in December 2020 which is evidenced by the low number of events where complaints were received in Q1 and Q2 of 2021. The increase in events where odour complaints were received in Q3 and Q4, may in part, be a result of the progression of landfilling of waste in Cell 4B and Cell 4C, which pending sufficient waste height achievement, have yet to have the early vertical gas collection wells fully connected to the landfill gas collection system.

It is expected that the number of events in which odour complaints are received will continue to decrease overall as upgrades and expansion of the LFG collection system, along with additional interim cover placement continue into the 2022 operating period.

11 WATER TAKINGS

Reporting of 2021 water takings is required to be completed for Sedimentation Ponds 1 to 4 and the SDL per Ontario Regulation 387/04: Water Taking and Transfer (O. Reg. 387/04), as well as Amended PTTW No. 4430-8PLMKV, dated January 17, 2012, and PTTW No. 4682-BLJRYJ, dated November 8, 2021. A report indicating water takings during 2021 from the Sedimentation Ponds and the SDL will be submitted to the MECP by March 31, 2022, in accordance with O. Reg. 387/04, and is provided under separate cover, and/or submitted using the online Water Taking Reporting System (WTRS).

In 2021, water was taken from Sedimentation Ponds 2 and 3, as well as pumping stations PS4 and PS6. Water that was taken from the aforementioned ponds was used mainly for dust control for landfill operations. Water was also taken from the aforementioned pumping stations for use as recompacted clayey liner soil conditioning. During 2021, the water taking activities were in compliance with the PTTW limits for the Site, as summarized below.

Pond 2		
PTTW Regulatory Components	**PTTW Value Limits**	**2021 Water Taking Values**
Max. Taken per Minute (L/min)	2,400	2,132
Max. Hours Taken per Day	10	1.86
Max. Litres Taken Per Day	246,700	238,000
Max. Days Taken per Year	105	46
Total Litres Taken in 2021	N/A	7,490,400
Pond 3		
PTTW Regulatory Components	**PTTW Value Limits**	**2021 Water Taking Values**
Max. Taken per Minute (L/min)	2,400	2,054
Max. Hours Taken per Day	10	0.86
Max. Litres Taken Per Day	110,100	105,994
Max. Days Taken per Year	105	62
Total Litres Taken in 2021	N/A	3,902,068
PS4		
PTTW Regulatory Components	**PTTW Value Limits**	**2021 Water Taking Values**
Max. Taken per Minute (L/min)	1,325	234
Max. Hours Taken per Day	24	14.5
Max. Litres Taken Per Day	1,907,640	203,580
Max. Days Taken per Year	365	10
Total Litres Taken in 2021	N/A	840,996
PS6		
PTTW Regulatory Components	**PTTW Value Limits**	**2021 Water Taking Values**
Max. Taken per Minute (L/min)	1,325	234
Max. Hours Taken per Day	24	17.3
Max. Litres Taken Per Day	1,907,640	242,892
Max. Days Taken per Year	365	14
Total Litres Taken in 2021	N/A	1,382,940

12 WASTE DISPOSAL INFORMATION

Waste disposal area Cell 4C was constructed in 2021. For reference, design drawings for the Existing and Expansion Sites are presented in **Appendix L**. Details of the 2021 landfill operations are summarized in the relevant sections of **Appendix Q**. **Appendix R** provides the 2021 performance report for the sewage works.

13 EAA MONITORING & ANNUAL REPORTING

13.1 Mitigation Measures

No mitigation measures related to hydrogeology were required beyond the mitigation built into the Site design.

13.2 Monitoring Measures

Monitoring requirements at the landfill evolved in accordance with the EMP as construction progressed in 2021. No changes occurred in 2021 from the previous monitoring period.

13.3 Contingency Measures

Based on the groundwater and surface water quality results presented in **Sections 5.2** and **5.3**, the detailed development and implementation of contingency plans is not required.

13.4 Annual Reporting

Reporting requirements for the Site are addressed and detailed in **Appendix Q**, per the Waste and Sewage ECAs, as well as the amended PTTW.

14 2022 MONITORING PROGRAM

The 2022 Monitoring Program reflects the EMP approved for the Site and incorporates the requirements of the Waste ECA, Sewage ECA, Air ECA, as well as the PTTW. Details of the proposed 2022 Monitoring Program are presented in **Table 13**.

15 CONCLUSIONS

Based on the findings presented in this report, the following conclusions are provided.

- Overall, generally leachate elevations increased from November 2020 into May 2021 and then decreased from May 2021 to November 2021. This generalized pattern was expected for 2021 with the short-term increase of leachate levels in May 2021 resulting from utilizing the leachate volumes within the waste for irrigation application to the Poplar System beginning in May. From an environmental stewardship perspective, the leachate generated from within the waste mound of the Existing Site was determined to be of more suitable use as irrigation liquid during the growing season as opposed to dedicating efforts for off-Site disposal and treatment between late winter and spring. This storage practice began in 2019 and will continue into the future such that there is sufficient weak-strength leachate volume for irrigation purposes during the growing season. There was a short-term increase in leachate elevation noted at a number of the leachate maintenance holes from May 2021 to November 2021 which was a result of a greater number of precipitation events during the growing season of 2021 compared to 2019 and 2020, which would both reduce the leachate extracted for application to the Poplar System and increase the amount of leachate generated as a result of rain infiltration.

- Environmental compliance at the Site as it relates to the Existing Site relies on groundwater and surface water quality monitoring, which once again verified at the Site in 2021. As an additional guidance tool toward managing leachate volumes in the waste cells a hydraulic gradient assessment of leachate compared to nearby shallow groundwater is utilized to further protect local water resources. May 2021 leachate levels were reflective of leachate storage for utilization onto the Poplar. However, by November 2021, the leachate elevation data within the waste of the Existing Site indicated that groundwater flow was inward toward the waste at Cells 3, 5, 7, 8, 9, 10, 11, 12, as well as the southern and eastern portions of the South Cell.
- In 2021, leachate elevations within the eastern portion of Cell 3S (at MH3SA and MH3SB), Cell 6, Cell 8, Cell 11, the western portion of the South Cell (at OW22A-10 and OW53-10), and the West Cell (Sump) were higher in elevation compared to groundwater during the May monitoring event. Leachate elevations within Cell3S (at MH3SA, MH3SB and at MH3SD), Cell 4 (at MH4A and MH4B), Cell 6, the western portion of the South Cell (at OW53-10), and the West Cell (Sump) were higher in elevation compared to groundwater during the November monitoring event. However, acceptable water quality was demonstrated at the Site during 2021 and therefore, the elevated leachate elevations that showed the potential for outward migration were not negatively affecting the water resources at the Site. Also, leachate seeps were not observed along the waste side slopes of the Existing Site in 2021. Continued leachate management of the leachate via automated pumping is expected to continue to reduce the leachate mound in these cells overtime.
- During November 2021, leachate elevation in the West Cell (Sump) was greater than the surrounding natural ground surface elevation. However, the leachate elevation in the West Cell (Sump) was lowered by approximately 2.48 m between its historical high in May 2019 through leachate transfer to the Expansion Site Leachate Equalization Tank. The noted leachate elevation within the Sump does not represent a concern based on acceptable surface water quality at compliance stations and no visible leachate seeps on the sideslope. Continued leachate extraction from the West Cell over time is expected to further reduce the potential for outward leachate seepage in this area.
- For the Existing Site in May 2021, the total theoretical leachate volume stored above the local groundwater table was approximately 166,024 m^3 and within the waste was approximately 400,084 m^3, which both represent a slight increase from May 2020 and a significant decrease from May 2019. For the Existing Site in November 2021, the total theoretical leachate volume stored above the local groundwater table was approximately 209,083 m^3 and within the waste was approximately 421,707 m^3, which both represent an increase from November 2020 and a slight decrease from November 2018. Over the long-term, leachate volumes within cells of the Existing Site are expected to further decrease as more leachate is extracted for the operation of the expanded Poplar System and for off-Site disposal. It is noted that these theoretical values are not representative of actual conditions as many maintenance holes are pumped to a near-dry state during the growing season and a fraction of the calculated theoretical leachate volume available in a given cell is actually able to be extracted for irrigation purposes. The use of theoretical leachate volume calculations is to track patterns of leachate volume from year to year and does not represent a compliance assessment.
- The trigger mechanism for implementation of groundwater contingency measures for the Expansion Site is the loss of hydraulic containment of the landfill waste footprint. During 2021, the leachate target level for each pumping station of the Expansion Site as noted in Condition 14.1 of the Waste ECA was satisfied.

- The operation of the primary leachate collection system is designed to maintain a liquid level of no more than 300 mm (or 0.30 m) above the primary clay liner (bottom of the landfill). Occasionally, after major storm events when a part of the active waste disposal area within the Expansion Site is not final capped, a large percentage of precipitation will move to the cell floor and the leachate pumping rates for PS1, PS3, and PS5 would be less than the incoming volume of liquid. There were no periods of time during 2021, as outlined in **Appendix Q** where there were occurrences of this nature, which are understood to normally occur and are described in the D&O Report.
- Between January 1 and December 31, 2021, a total of 44,284.83 m^3 of leachate was removed and transported off-Site for treatment and disposal at the Chatham Water Pollution Control Plant or Canflow Environmental Services, while 6,403.03 m^3 was irrigated onto the Poplar system during the 2021 growing season.
- Of the 50,687.86 m^3 of leachate managed for treatment during 2021, the approximate breakdown of leachate source location between the Existing Site and the Expansion Site is 23% (11,479.81 m^3) and 77% (39,208.05 m^3), respectively. This breakdown is based on the leachate source distribution noted for the 2021 monitoring period, which incorporates the separate approximate volumes of leachate extracted from the Existing Site (41% of area) and Expansion Site (59% of area) for either off-site or on-site treatment as discussed above.
- Considering a north-south groundwater drainage divide at the Site, shallow groundwater movement within the active aquitard was in an easterly and westerly direction away from the divide with local variations as a result of surficial feature influences, such as ditches, waste cells, excavations, ponds, berms, and the leachate management systems. Groundwater movement within the interstadial silt and sand also typically moves toward the east and west, away from the drainage divide. Influences from the excavation of the Expansion Site as well as landfilling of waste in the Expansion Site were noted to the south (at monitoring well OW79) where the groundwater in the active aquitard, as well as the interstadial silt and sand was induced toward the north. The groundwater pressures within the interface aquifer have also appeared to be affected by the removal of the overlying soil mass, whereby pressures were observed to be slightly decreasing recent years, which are expected to return to pre-existing conditions as the soil mass is replaced with waste mass. As expected, monitoring wells OW39A-26, OW79-26, OW80-27, and OW81-27 are showing a fluctuating and increasing trend since about 2018 as a significant waste mass has been progressively landfilled into the southern half of the Expansion Site. Groundwater movement within the interface aquifer is in a southwesterly direction.
- The groundwater monitoring results for the active aquitard, the interstadial silt and sand, as well as the interface aquifer satisfied the relevant PLIL and SLIL trigger concentrations. One (1) exception occurred for the PLIL parameter chloride at OW81-7, which as discussed in **Section 5.2.3.2** is not landfill related. Overall, groundwater quality did not show an unacceptable landfill leachate or operations effect in 2021.
- At monitoring wells OW69-5 (Active Aquitard) and OW46-7 (Interstadial Silt and Sand), the concentrations of boron show infrequent spikes, but concentrations are less than the respective trigger concentration at each location. At this time the boron concentrations are not a concern as it is expected the more mobile parameter chloride would be observed first if the source of the boron were leachate. It is likely that, similar to observations for monitoring well OW58-14, the bentonite seal for these locations is likely moving into the filter screen material of the monitoring well, and as such may require decommissioning and replacement in the future depending on chemical results.

- The routine quarterly surface water monitoring results satisfied the relevant trigger concentrations, with seven (7) exceptions. The exceptions are discussed in detail **in Section 5.3.5**, with verification results indicating acceptable chemical and biological results and no further verification monitoring was required. Overall, surface water quality did not show an unacceptable landfill leachate or operations effect in 2021.
- The annual spring biomonitoring showed that there was not a potential for detrimental effects to aquatic life in the discharge water and was acceptable for continued discharge.
- Water takings at the Site from the Sedimentation Ponds were used as a dust suppressant related to landfill operations. The water taking activities in 2021 satisfied the requirements of the Site's PTTW. Documentation will be submitted to the MECP, as required by the PTTW, under separate cover.
- No methane gas was detected within the gas probes in 2021. Therefore, mitigation measures that would address a potential landfill gas migration in the shallow subsurface beyond the waste footprint are not required.
- WM received a total of 36 complaints during the 2021 operating period (1 general, 9 litter, and 26 odour). Of the complaints received, they represented a total of 29 complaint driven events which occurred on 26 separate days during 2021. Of the 29 complaint driven events, 19 of the events were related to odour. Of these 19 odour events, 15 of the events were documented from 10 discrete physical locations such as a residence or commercial building. The other 4 events represent transient (drive-by) occurrences in which the complainant observed an odour while in transit along a road near to the Site. \

16 CLOSURE

We trust that this 2021 Fourth Quarter and Annual Monitoring Report for the Twin Creeks Environmental Centre is satisfactory. Should there be any questions or comments, please contact us.

Yours very truly,

RWDI AIR Inc.

Jeff Cleland, B.Eng., EIT
Scientist | Geoscience

Brent J. Langille, B.Sc., P.Geo.
Technical Director | Principal

JCL/BJL/kta

Attach.

TABLES

Table 1
Monitoring Schedule - 2021
Twin Creeks Environmental Centre - 2021 Annual Monitoring Report

Task	Monitoring Locations	Monitoring Dates	Notes
First Quarter Monitoring Period (January 1 to March 31, 2021)			
Precipitation Event Surface Water Monitoring/Sampling	SS1, SS10, SS16, SS19 (new), SP1, SP2, SP3, SP4	March 26, 2021 - Routine monitoring for March 25, 2021 precipitation event.	SS19 not monitored since the compost facility is not yet constructed.
	SS1, SP2	April 9, 2021 - Verification monitoring event based on the results for the March 26, 2021 routine monitoring event.	
Biomonitoring	SS1, SP2	April 9, 2021 - Verification monitoring event based on the results for the March 26, 2021 routine monitoring event.	
Secondary Drainage Layer (SDL) Liquid Levels	PS2, PS4, PS6, and PS8(new)		PS8 was not monitored as it is not yet constructed.
Leachate Sampling	Equalization Tank	Quarterly, and Semi-Annually in May and November. A quarterly sample was collected on January 12, 2021.	
Gas Monitoring	GP1A, GP2, GP3, GP4, GP5, GP6, GP7, GP8, GP9 (new), GP10 (new)	Monthly gas monitoring from November to April and in July. Perimeter gas probes were monitored on January 7, February 4, and March 5, 2021.	Gas probes GP9, and GP10 are not yet installed.
Poplar System Monitoring Program			
Precipitation Event Surface Water Monitoring/Sampling	SS14A, SS14B, and SS15A	March 26, 2021 - Routine monitoring for March 25, 2021, precipitation event.	
Ambient Air Quality Monitoring Program			
Total Suspended Particulate - Dust	Stations West, Northeast, and Southeast	Every sixth day - NAPS Schedule (October 1 to May 31) Every third day - NAPS Schedule (June 1 to September 30)	
Noise Monitoring System			
Noise monitoring	Stations - M1, M2, M3, and M4	Ongoing - Quarterly Reporting	
Operational Monitoring			
Contaminated Soil	Landfill Daily Cover/Disposed Material	Quarterly, if utilized: March 16, 2021	
Automobile Shredder Residue (ASR)	Landfill Daily Cover/Disposed Material	Semi-Annually (Spring and Fall), if utilized.	Monitoring not required as ASR was not utilized during the Q1 monitoring period.
Second Quarter Monitoring Period (April 1 to June 30, 2021)			
Precipitation Event Surface Water Monitoring/Sampling	SS1, SS10, SS16, SS19 (new), SP1, SP2, SP3, SP4	June 3, 2021 - Routine monitoring for June 2, 2021 precipitation event.	SS19 not monitored since the compost facility is not yet constructed. SS10, SS16, SP1 and SP2 not monitored due to no flow conditions.
	SS10, SS16, SS19 (new), SP1, SP2	June 26, 2021 - Routine monitoring for June 25, 2021 precipitation event.	SS19 not monitored since the compost facility is not yet constructed. SS10, SS16 and SP1 not monitored due to no flow conditions.
	SP2	July 9, 2021 - Verification monitoring event based on the results for the June 26, 2021 routine monitoring event.	
Biomonitoring	SS1, SS10, SS16, SS19 (new), SP1, SP2, SP3, SP4	June 3, 2021 - Routine monitoring for June 2, 2021 precipitation event.	SS19 not monitored since the compost facility is not yet constructed. SS10, SS16, SP1 and SP2 not monitored due to no flow conditions.
	SS10, SS16, SS19 (new), SP1, SP2	June 26, 2021 - Routine monitoring for June 25, 2021 precipitation event.	SS19 not monitored since the compost facility is not yet constructed. SS10, SS16, and SP1 not monitored due to no flow conditions.
	SP2	July 9, 2021 - Verification monitoring event based on the results for the June 26, 2021 routine monitoring event.	
Leachate Liquid Level Measurements	PS1, PS3, PS5, PS7(new), MH3S, MH4, MH5, MH6, MH7, MH8, MH9, MH10, MH11, MH12, MH16, MH17, MH18, OW22A-10, OW51A-15, OW53-10, Sump	Semi-annually in May and November: May 17, 2021. Daily during operation for PS1, PS3, and PS5.	PS7 was not monitored as it is not yet constructed.
Leachate Sampling	PS1, PS3, PS5, PS7(new), South Fill Area (MH18), West Central Fill Area (Sump), Central Fill Area (Composite of MH3S, MH4, MH5, MH6, MH7, MH8, MH9, MH10, MH11, MH12)	Annually in May: May 18 and 19, 2021.	PS7 was not monitored as it is not yet constructed.
	Equalization Tank	Semi-Annually sampled in May and November: May 19, 2021.	
Secondary Drainage Layer (SDL) Liquid Levels	PS2, PS4, PS6, and PS8(new)	Monthly - April 7, May 5, June 16, 2021 - PS2, PS4, and PS6	PS8 was not monitored as it is not yet constructed.
Groundwater Liquid Level Measurements	ACTIVE AQUITARD OW16-6, OW17-4, OW40B-4r, OW54A-4, OW56-4, OW57-4, OW58-6, OW59-6, OW60-4, OW67-4, OW68-5, OW69-5, OW70B-5, OW71A-5*, OW72-6, OW73-6, OW79-5, OW80-3, OW81-5, OW82(new), OW83(new), OW84(new) INTERSTADIAL SILT AND SAND OW16-7, OW40A-7, OW46-7, OW47-6, OW54-10, OW57-15, OW58-17, OW60-8, OW67-11, OW72-10, OW73-9, OW79-7, OW80-6, OW81-7, OW82(new), OW83(new), OW84(new) INTERFACE AQUIFER OW17-30, OW19-29, OW39-26, OW40A-28, OW49-29, OW60-25, OW79-26, OW80-27,	Semi-annually in May and November: May 17, 2021.	Monitoring well nests OW82, OW83, and OW84 are not yet constructed.
Piezometer Liquid Level Measurements	PS1, PS2, PS3	Semi-annually in May and November: May 17, 2021.	
Groundwater Sampling	ACTIVE AQUITARD OW16-6, OW17-4, OW40B-4r, OW54A-4, OW56-4, OW57-4, OW58-6, OW59-6, OW60-4, OW67-4, OW68-5, OW69-5, OW70B-5, OW71A-5*, OW72-6, OW73-6, OW79-5, OW80-3, OW81-5, OW82(new), OW83(new), OW84(new) INTERSTADIAL SILT AND SAND OW16-7, OW40A-7, OW46-7, OW47-6, OW54-10, OW57-15, OW58-14, OW60-8, OW67-11, OW72-10, OW73-9, OW79-7, OW80-6, OW81-7, OW82(new), OW83(new), OW84(new) INTERFACE AQUIFER OW19-29, OW39-26, OW49-29, OW79-26, OW80-27, OW81-27, OW82(new), OW83(new), OW84(new), Cemetery Well	Semi-annually in May and November: May 18, 19, 20 and 21, 2021. June 9, 2021 - OW81-7 verification monitoring	Monitoring well nests OW82, OW83, and OW84 are not yet constructed.
Gas Monitoring	GP1A, GP2, GP3, GP4, GP5, GP6, GP7, GP8, GP9 (new), GP10 (new)	Monthly gas monitoring from November to April and in July. Perimeter gas probes were monitored on April 6, 2021.	Gas probes GP9, and GP10 are not yet installed. .
Poplar System Monitoring Program			
Precipitation Event Surface Water Monitoring/Sampling	SS14A, SS14B, and SS15A	June 3, 2021 - Routine monitoring for June 2, 2021 precipitation event.	SS14A and SS15A not sampled due to no flow conditions.
Ambient Air Quality Monitoring Program			
Total Suspended Particulate - Dust	Stations West, Northeast, and Southeast	Every sixth day - NAPS Schedule (October 1 to May 31) Every third day - NAPS Schedule (June 1 to September 30)	
Total Hydrocarbon Landfill Cap Survey	Final Capped Areas	Between the Spring and Fall: June 1, 2021	
Noise Monitoring Program			
Noise Monitoring	Stations - M1, M2, M3, and M4	Ongoing - Quarterly Reporting	
Operational Monitoring			
Contaminated Soil	Landfill Daily Cover/Disposed Material	Quarterly, if utilized: May 5, 2021.	
Automobile Shredder Residue	Landfill Daily Cover/Disposed Material	Semi-Annually (Spring and Fall), if utilized: April 6, 2021.	
Third Quarter Monitoring Period (July 1 to September 30, 2021)			
Compliance Monitoring System			
Precipitation Event Surface Water Monitoring/Sampling	SS1, SS10, SS16, SS19(new), SP1, SP2, SP3, SP4	July 9, 2021 - Routine monitoring for July 8, 2021 precipitation event.	SS19 not monitored since the compost facility is not yet constructed. SS16 not monitored due to no flow conditions. SP2 not monitored as a 1 month period is required between quarterly samples at each monitoring location.
	SP2	July 30, 2021 - Routine monitoring for July 29, 2021 precipitation event.	SS19 not monitored since the compost facility is not yet constructed.

Table 1
Monitoring Schedule - 2021
Twin Creeks Environmental Centre - 2021 Annual Monitoring Report

Task	Monitoring Locations	Monitoring Dates	Notes
	SS1	July 30, 2021 - Verification monitoring event based on the results for the July 9, 2021 routine monitoring event.	
Biomonitoring	SS1	July 30, 2021 - Verification monitoring event based on the results for the July 9, 2021 routine monitoring event.	
Leachate Sampling	Equalization Tank	Quarterly, and semi-annually in May and November. A quarterly sample was collected on August 11, 2021.	
Secondary Drainage Layer (SDL) Liquid Levels	PS2, PS4, PS6, and PS8(new)	Monthly - July 12, August 6, September 3, 2021 - PS2, PS4, and PS6	PS8 was not monitored as it is not yet constructed.
Gas Monitoring	GP1A, GP2, GP3, GP4, GP5, GP6, GP7, GP8, GP9 (new), GP10 (new)	Monthly gas monitoring from November to April and in July. Perimeter gas probes were monitored on July 21, 2021.	Gas probes GP9, and GP10 were not installed during this time period.
Poplar System Monitoring Program			
Precipitation Event Surface Water Monitoring/Sampling	SS14A, SS14B, and SS15A	July 9, 2021 - Routine monitoring for July 8, 2021 precipitation event.	SS14A not monitored due to no flow conditions.
	SS14A	September 23, 2021 - Routine monitoring for September 22, 2021 precipitation event.	
Storm Event Surface Water Monitoring	SS14A, SS14B, and SS15A	Two (2) events during the irrigation season and after a storm event (>25 mm in 24 hrs): September 8, 2021 - Storm event monitoring for September 7, 2021 precipitation event.	SS14A and SS15A not monitored due to no flow conditions.
	SS14A, SS14B, and SS15A	September 23, 2021 - Storm event monitoring for September 22, 2021 precipitation event.	
Ambient Air Quality Monitoring Program			
Total Suspended Particulate - Dust	Stations West, Northeast, and Southeast	Every sixth day - NAPS Schedule (October 1 to May 31) Every third day - NAPS Schedule (June 1 to September 30)	
Volatile Organic Compounds	Upwind/downwind Monitoring	June 21 to September (5 sets): July 20, July 23, August 4, August 5, and September 3, 2021.	
Total Hydrocarbon Landfill Cap Survey	Final Capped Areas	Between the Spring and Fall: October 20, 2021.	
Noise Monitoring System			
Noise Monitoring	Stations - M1, M2, M3, and M4	Ongoing - Quarterly Reporting	
Operational Monitoring			
Contaminated Soil	Landfill Daily Cover/Disposed Material	Quarterly, if utilized: August 12, 2021.	
Automobile Shredder Residue	Landfill Daily Cover/Disposed Material	Semi-Annually (Spring and Fall), if utilized:	Monitoring not completed during the 2021 third quarter monitoring period.
Fourth Quarter Monitoring Period (October 1 to December 31, 2021)			
Precipitation Event Surface Water Monitoring/Sampling	SS1, SS10, SS16, SS19(new), SP1, SP2, SP3, SP4	October 4, 2021 - Routine monitoring for October 3, 2021 precipitation event.	SS19 not monitored since the compost facility is not yet constructed. SS10 and SS16 not monitored due to no flow conditions.
	SS1, SP2, SP3	October 15, 2021 - Verification monitoring event based on the results for the October 4, 2021 routine monitoring event.	
Biomonitoring	SS1, SP2, SP3	October 15, 2021 - Verification monitoring event based on the results for the October 4, 2021 routine monitoring event.	
Leachate Liquid Level Measurements	PS1, PS3, PS5, PS7(new), MH3S, MH4, MH5, MH6, MH7, MH8, MH9, MH10, MH11, MH12, MH16, MH17, MH18, OW22A-10, OW51A-15, OW53-10, Sump	Semi-annually in May and November: November 1, 2021. Daily during operation for PS1, PS3, and PS5.	PS7 was not monitored as it is not yet constructed.
Leachate Sampling	Equalization Tank	Quarterly, and semi-annually in May and November. A quarterly sample was collected on November 4, 2021.	
Secondary Drainage Layer (SDL) Liquid Levels	PS2, PS4, PS6, and PS8(new)	Monthly - July 12, August 6, September 3, 2021 - PS2, PS4, and PS6	PS8 was not monitored as it is not yet constructed.
Groundwater Liquid Level Measurements	ACTIVE AQUITARD OW16-6, OW17-4, OW40D-4, OW54A-4, OW56-4, OW57-4, OW58-6, OW59-6, OW60-4, OW67-4, OW68-5, OW69-5, OW70B-5, OW71A-5*, OW72-6, OW73-6,OW79-5, OW80-3, OW81-5, OW82(new), OW83(new), OW84(new) INTERSTADIAL SILT AND SAND OW16-7, OW40A-7, OW46-7, OW47-6, OW54-10, OW57-15, OW58-14, OW58-17, OW60-8, OW67-11, OW72-10, OW73-9, OW79-7, OW80-6, OW81-7, OW82(new), OW83(new), OW84(new)	Semi-annually in May and November: November 1, 2021.	Monitoring well nests OW82, OW83, and OW84 are not yet constructed.
Piezometer Liquid Level Measurements	PS1, PS2, PS3	Semi-annually in May and November: November 1, 2021.	
Groundwater Sampling	ACTIVE AQUITARD OW16-6, OW17-4, OW40B-4r, OW54A-4, OW56-4, OW57-4, OW58-6, OW59-6, OW60-4, OW67-4, OW68-5, OW69-5, OW70B-5, OW71A-5*, OW72-6, OW73-6, OW79-5, OW80-3, OW81-5, OW82(new), OW83(new), OW84(new) INTERSTADIAL SILT AND SAND OW16-7, OW40A-7, OW46-7, OW47-6, OW54-10, OW57-15, OW58-14, OW60-8, OW67-11, OW72-10, OW73-9, OW79-7, OW80-6, OW81-7, OW82(new), OW83(new), OW84(new) INTERFACE AQUIFER OW19-29, OW39-26, OW49-29, OW79-26, OW80-27, OW81-27, OW82(new), OW83(new), OW84(new), Cemetery Well	Semi-annually in May and November: November 2 and 3, 2021. November 2, 2021 - OW81-7 verification monitoring	Monitoring well nests OW82, OW83, and OW84 are not yet constructed.
Gas Monitoring	GP1A, GP2, GP3, GP4, GP5, GP6, GP7, GP8, GP9(new), GP10(new)	Perimeter gas probes monitored on November 17 and December 8, 2021	Gas probes GP9, and GP10 are not yet installed.
Poplar System Monitoring Program			
Precipitation Event Surface Water Monitoring/Sampling	SS15A	October 4, 2021 - Routine monitoring for October 3, 2021 precipitation event.	
	SS14A, SS14B	October 26, 2021 - Routine monitoring for October 25, 2021 precipitation event.	
Ambient Air Quality Monitoring Program			
Total Suspended Particulate - Dust	Stations West, Northeast, and Southeast	Every sixth day - NAPS Schedule (October 1 to May 31) Every third day - NAPS Schedule (June 1 to September 30)	
Noise Monitoring Program			
Noise Monitoring	Stations - M1, M2, M3, and M4	Ongoing - Quarterly Reporting	
Operational Monitoring			
Contaminated Soil	Landfill Daily Cover/Disposed Material	Quarterly (if utilized), October 1, 2021	
Automobile Shredder Residue	Landfill Daily Cover/Disposed Material	Semi-Annually (Spring and Fall), if utilized: October 1, 2021	

NOTES:
1) (new) denotes monitoring station/wells to be installed per the Environmental Monitoring Plan (EMP) dated December 20, 2007.
2) OW71A-5* denotes groundwater well monitored at the request of the Public Liaison Committee.

Table 2
Leachate Elevation Comparison
Twin Creeks Environmental Centre - 2021 Annual Monitoring Report

Monitoring Location	Groundwater Monitoring Wells Compared	Existing Ground Surface Elevation (m ASL)	Exisiting Bottom of Ditch Elevation (m ASL)	Current Local Groundwater Elevation (m ASL)	Leachate Elevation (m ASL)	Leachate Elevation Compared to Ground Surface Elevation	Leachate Elevation Compared to Groundwater Elevation
May 17, 2021							
Cell 3S							
MH3SA	OW17-4 and OW56-4	240.71	240.68	239.23	239.43	LOWER	HIGHER
MH3SB	OW17-4 and OW56-4	240.46	240.31	239.23	239.51	LOWER	HIGHER
MH3SC	*OW7-5*	239.66	239.42	*236.85*	236.79	LOWER	LOWER
MH3SD	*OW7-5*	239.87	239.93	*236.85*	236.49	LOWER	LOWER
Central Fill Area							
Sump	*OW7-5 and OW8-5*	240.81	240.28	*237.14*	241.92	HIGHER	HIGHER
OW51A-15	OW17-4	240.24	239.68	239.36	236.47	LOWER	LOWER
MH4A	OW17-4 and OW69-5	240.33	239.71	239.22	238.59	LOWER	LOWER
MH4B	OW57-4	240.95	240.17	240.04	239.44	LOWER	LOWER
MH5A	OW58-6	241.51	240.78	240.01	238.50	LOWER	LOWER
MH6A	*OW65-4/OW65A-4*	241.90	241.20	*237.34*	238.50	LOWER	HIGHER
MH7A	OW73-6	242.07	241.34	240.71	237.92	LOWER	LOWER
MH8B	*OW74-6*	242.54	242.46	*239.33*	239.97	LOWER	HIGHER
MH9A	OW72-6	242.33	241.89	240.50	239.17	LOWER	LOWER
MH10	*OW74-6*	241.80	241.43	*239.33*	237.13	LOWER	LOWER
MH11A	OW54A-4	242.34	241.94	237.89	240.15	LOWER	HIGHER
MH12A	*OW66-4*	241.90	241.37	*241.79*	237.12	LOWER	LOWER
MH12B	*OW66-4*	241.90	241.37	*241.79*	237.12	LOWER	LOWER
South Cell							
MH16	*OW63A-6*	239.77	238.38	*238.12*	237.82	LOWER	LOWER
MH17	*OW63A-6*	238.07	238.05	*238.12*	237.83	LOWER	LOWER
MH18	*OW63A-6*	238.86	238.79	*238.12*	237.81	LOWER	LOWER
OW22A-10	*OW6-4*	239.38	238.76	*238.11*	238.33	LOWER	HIGHER
OW53-10	*OW44-5 and OW64-4/OW64A-4*	239.47	238.45	*236.77*	238.31	LOWER	HIGHER
Expansion Site Cell 1							
PS1	*OW38-6*	240.88		*236.73*	226.86	LOWER	LOWER
Expansion Site Cell 2							
PS3	*OW38-6*	240.18		*236.73*	226.62	LOWER	LOWER
Expansion Site Cell 4							
PS5	*OW38-6*	240.73		*236.73*	226.91	LOWER	LOWER

Notes: 1) Leachate elevations from May 17, 2021.
2) m ASL denotes meters above sea level.
3) *Italics* denotes historic information used to calculate data.
4) ***Bold and italics*** denotes elevation presented is the maintenance hole bottom elevation as it was dry at the time of monitoring.
5) For waste cells with two maintenance holes, the maintenance hole farthest into the waste cell was utilized for comparison.
6) Revised measuring point elevations for Existing Site manholes and leachate wells, as well as updated ground surface elevations reflect the findings of an updated survey (2016).

Table 2
Leachate Elevation Comparison
Twin Creeks Environmental Centre - 2021 Annual Monitoring Report

Monitoring Location	Groundwater Monitoring Wells Compared	Existing Ground Surface Elevation (m ASL)	Exisiting Bottom of Ditch Elevation (m ASL)	Current Local Groundwater Elevation (m ASL)	Leachate Elevation (m ASL)	Leachate Elevation Compared to Ground Surface Elevation	Leachate Elevation Compared to Groundwater Elevation
November 1, 2021							
Cell 3S							
MH3SA	OW17-4 and OW56-4	240.71	240.68	239.17	239.74	LOWER	HIGHER
MH3SB	OW17-4 and OW56-4	240.46	240.31	239.17	239.58	LOWER	HIGHER
MH3SC	*OW7-5*	239.66	239.42	*236.85*	236.82	LOWER	LOWER
MH3SD	*OW7-5*	239.87	239.93	*236.85*	237.97	LOWER	HIGHER
Central Fill Area							
Sump	*OW7-5 and OW8-5*	240.81	240.28	*237.14*	242.66	HIGHER	HIGHER
OW51A-15	OW17-4	240.24	239.68	239.50	236.29	LOWER	LOWER
MH4A	OW17-4 and OW69-5	240.33	239.71	239.29	239.92	LOWER	HIGHER
MH4B	OW57-4	240.95	240.17	239.42	239.95	LOWER	HIGHER
MH5A	OW58-6	241.51	240.78	240.92	239.95	LOWER	LOWER
MH6A	*OW65-4/OW65A-4*	241.90	241.20	*237.34*	240.44	LOWER	HIGHER
MH7A	OW73-6	242.07	241.34	240.17	237.08	LOWER	LOWER
MH8B	*OW74-6*	242.54	242.46	*239.33*	239.05	LOWER	LOWER
MH9A	OW72-6	242.33	241.89	240.46	238.78	LOWER	LOWER
MH10	*OW74-6*	241.80	241.43	*239.33*	236.75	LOWER	LOWER
MH11A	OW54A-4	242.34	241.94	241.34	238.77	LOWER	LOWER
MH12A	*OW66-4*	241.90	241.37	*241.79*	236.74	LOWER	LOWER
MH12B	*OW66-4*	241.90	241.37	*241.79*	236.75	LOWER	LOWER
South Cell							
MH16	*OW63A-6*	239.77	238.38	*238.12*	238.01	LOWER	LOWER
MH17	*OW63A-6*	238.07	238.05	*238.12*	238.00	LOWER	LOWER
MH18	*OW63A-6*	238.86	238.79	*238.12*	237.99	LOWER	LOWER
OW22A-10	*OW6-4*	239.38	238.76	*238.24*	238.23	LOWER	LOWER
OW53-10	*OW44-5 and OW64-4/OW64A-4*	239.47	238.45	*235.30*	238.28	LOWER	HIGHER
Expansion Site Cell 1							
PS1	*OW38-6*	240.88		*236.73*	226.88	LOWER	LOWER
Expansion Site Cell 2							
PS3	*OW38-6*	240.18		*236.73*	232.99	LOWER	LOWER
Expansion Site Cell 4							
PS5	*OW38-6*	240.73		*236.73*	227.41	LOWER	LOWER

Notes: 1) Leachate elevations from November 1, 2021.
2) m ASL denotes meters above sea level.
3) *Italics* denotes historic information used to calculate data.
4) ***Bold and italics*** denotes elevation presented is the maintenance hole bottom elevation as it was dry at the time of utilized for monitoring.
5) For waste cells with two maintenance holes, the maintenance hole farthest into the waste cell was monitored.
6) Revised measuring point elevations for Existing Site manholes and leachate wells, as well as updated ground surface elevations reflect the findings of an updated survey (2016).

Table 3
Leachate Elevation Trends
Twin Creeks Environmenal Centre - 2021 Annual Monitoring Report

Monitor Designation	Long-Term Trend (Includes Historical Data)				
	Constant	Decreasing	Increasing	Fluctuating	Comments
Cell 3S					
MH3SA				X	Increasing to 2018 and since fluctuating
MH3SB				X	Decreasing to 2017 and since fluctuating.
MH3SC			X	X	Decreasing to 2010 and since increasing to fluctuating.
MH3SD			X	X	Decreasing to 2012 and since increasing to fluctuating.
MH3SE	X			X	Increasing to 2017 and since constant to fluctuating.
MH3SF	X			X	Decreasing to 2017 and since constant to fluctuating.
Central Fill Area					
OW51A-15	X			X	Constant to fluctuating since 2005.
MH4A				X	Fluctuating since 2004.
MH4B				X	Fluctuating since 2015.
MH5				X	Fluctuating since 2007.
MH6			X	X	Decreasing to 2017 and since increasing to fluctuating.
MH7		X		X	Fluctuating to decreasing since 2009.
MH8				X	Fluctuating since 2005.
MH9				X	Decreasing to 2012 and since fluctuating.
MH10		X		X	Fluctuating to 2018 and since decreasing.
MH11				X	Decreasing to 2011 and since fluctuating.
MH12		X		X	Fluctuating to 2018 and since decreasing.
SUMP			X	X	Fluctuating to 2016 and since increasing to fluctuating
South Fill Area					
OW22A-10				X	Fluctuating since 2005.
OW53-10				X	Increasing to 2014 and since fluctuating.
MH16				X	Increasing to 2010 and since fluctuating.
MH17				X	Increasing to 2010 and since fluctuating.
MH18				X	Increasing to 2010 and since fluctuating.

NOTES:

1) Elevations can show more than one trend.
2) For waste cells with two maintenance holes, the maintenance hole furthest within the waste was utilized for comparison.

Table 4
Groundwater Elevation Trends
Twin Creeks Environmental Centre - 2021 Annual Monitoring Report

Monitor Designation	Long-Term Trend (Includes Historical Data)				
	Constant	Decreasing	Increasing	Fluctuating	Comments
Active Aquitard					
OW16-6*				X	Seasonal
OW17-4				X	Seasonal
OW40D-4*				X	Seasonal
OW54A-4*			X	X	Seasonal
OW56-4			X	X	Seasonal
OW57-4			X	X	Seasonal
OW58-6*			X	X	Seasonal
OW59-6*				X	Seasonal
OW60-4				X	Seasonal
OW67-4				X	
OW68-5				X	Seasonal
OW69-5				X	
OW70B-5*				X	Seasonal
OW71A-5*				X	Seasonal
OW72-6				X	Seasonal
OW73-6				X	Seasonal
OW79-5				X	Seasonal
OW80-3				X	
OW81-5				X	
Interstadial Silt and Sand					
OW16-7				X	Seasonal
OW40A-7*				X	Seasonal
OW46-7			X	X	
OW47-6				X	
OW54-10		X		X	Decreasing since 2009
OW57-15				X	
OW58-14				X	Decommissioned 2016
OW58-17				X	Installed April 2014
OW60-8				X	Seasonal
OW67-11				X	Fluctuating since 2018
OW72-10				X	Fluctuating since 2018
OW73-9				X	Fluctuating since 2018
OW79-7				X	Seasonal
OW80-6				X	Seasonal
OW81-7				X	
Interface Aquifier					
OW17-30				X	
OW19-29				X	
OW39-26				X	Well damaged in 2016
OW39A-26			X	X	Seasonal
OW40A-28*		X		X	Decreasing since 2015
OW49-29		X		X	Decreasing since 2009
OW60-25		X		X	
OW79-26			X	X	Increasing since 2018
OW80-27			X	X	Increasing since 2018
OW81-27				X	

Notes:

1) Seasonal - denotes a seasonal trend with elevated elevations during prolonged periods of precipitation, typically in the spring and summer months, and lower elevations during drier periods, typically the fall and winter months.
2) Water elevations can show more than one trend.
3) Ins - denotes insufficient data. At least three data points are required to establish a trend.
4) * denotes trends consider historical data from former monitoring wells at that location.
5) Monitoring well OW58-14 was decomissioned prior to the fall 2016 monitoring event.
6) Monitoring well OW39-26 was noted to have been damaged during the fall 2016 monitoring event and decomissioned April 2017.
7) OW81-5, OW81-7 and OW81-27 installed in June 2019. Insufficient data collected yet to track trend.

Table 5
Estimated Leachate Storage Volumes
Twin Creeks Environmental Centre - 2021 Annual Monitoring Report

Fill Area	Approximate Area (ha)	Approximate Original Ground Surface Elevation (m asl)	Groundwater Reference Elevation (m asl)	Estimated Average Base of Waste (m asl)	May 2021 Average Leachate Elevation (m asl)	Estimated Volume in Waste Cells (Measured from Cell Base) (m^3)												Change in Volume Within the Waste Cells From May 2020 to May 2021 (m^3)	Volume Above Groundwater Reference Level (m^3)												Change in Volume Above Groundwater Reference Level From May 2020 to May 2021 (m^3)
						MAY 2010	MAY 2011	MAY 2012	MAY 2013	MAY 2014	MAY 2015	MAY 2016	MAY 2017	MAY 2018	MAY 2019	MAY 2020	MAY 2021		MAY 2010	MAY 2011	MAY 2012	MAY 2013	MAY 2014	MAY 2015	MAY 2016	MAY 2017	MAY 2018	MAY 2019	MAY 2020	MAY 2021	
West Cell (Sump)	6.3	238.3	237.1	235.5	241.9	103,320	118,440	110,628	136,332	87,948	71,568	148,680	164,052	195,552	242,928	122,724	161,784	39,060	63,000	78,120	70,308	96,012	47,628	31,248	108,360	123,732	155,232	202,608	82,404	121,464	39,060
Cell 3 (OW51A-15)	1.5	239.9	239.2	235.2	236.5	4,200	4,980	5,220	5,100	7,800	6,180	4,800	4,920	5,100	6,360	5,640	7,620	1,980	0	0	0	0	0	0	0	0	0	0	0	0	0
Cell 4 (MH4B)	2.1	240.8	238.5	234.1	239.4	52,080	62,664	29,148	36,120	30,492	37,212	46,200	46,452	40,404	46,368	43,848	44,856	1,008	11,760	25,704	0	0	0	252	9,240	9,492	3,444	9,408	6,888	7,896	1,008
Cell 5 (MH5A)	2.2	241.2	237.0	236.5	238.5	7,040	0	7,832	28,776	22,264	0	14,520	28,160	0	28,512	27,984	17,600	-10,384	0	0	3,432	24,376	17,864	0	10,120	23,760	0	24,112	23,584	13,200	-10,384
Cell 6 (MH6A)	2.0	240.0	237.3	236.5	238.5	4,000	8,080	5,280	9,680	10,880	1,600	0	0	3,840	28,880	16,720	16,000	-720	0	1,680	0	3,280	4,480	0	0	0	0	22,480	10,320	9,600	-720
Cell 7 (MH7A)	1.9	240.7	238.8	236.5	237.9	15,960	10,564	19,076	2,736	5,548	17,784	9,576	18,848	12,920	23,484	13,984	10,792	-3,192	1,520	0	1,596	0	0	304	0	1,368	0	6,004	0	0	0
Cell 8 (MH8B)	1.9	240.0	239.3	237.0	240.0	760	10,108	19,380	17,480	3,496	1,672	9,880	18,392	17,252	27,968	29,868	22,572	-7,296	0	0	1,900	0	0	0	0	912	0	10,488	12,388	5,092	-7,296
Cell 9 (MH9A)	1.9	241.2	239.0	237.5	239.2	15,200	17,936	8,816	7,296	7,296	8,968	5,700	13,072	1,064	19,456	14,440	12,692	-1,748	6,080	6,536	0	0	0	0	0	1,672	0	8,056	3,040	1,292	-1,748
Cell 10 (MH10)	1.9	241.5	239.3	236.5	237.1	7,600	22,496	21,280	5,320	5,092	8,588	28,500	34,200	28,120	34,276	4,636	4,788	152	0	1,216	0	0	0	0	7,220	12,920	6,840	12,996	0	0	0
Cell 11 (MH11A)	1.9	244.3	240.8	237.8	240.2	20,520	7,068	15,884	14,516	15,352	19,076	23,560	21,584	20,292	25,156	11,324	17,860	6,536	9,120	0	0	0	0	0	760	0	0	2,356	0	0	0
Cell 12 (MH12A)	0.6	242.5	241.8	236.5	237.1	2,400	7,152	6,768	4,008	1,512	2,640	8,880	10,800	8,856	11,016	1,488	1,488	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cell 3S (MH3SA/B/C/D/E/F)	1.1	238.6	238.3	235.2	240.0	7,964	16,060	13,640	16,588	5,412	10,340	14,520	4,752	16,368	21,831	17,431	21,120	3,689	0	2,420	0	2,948	0	0	880	0	2,728	8,191	3,791	7,480	3,689
South Cell (MH16/17/18)	5.4	239.4	238.1	235.0	237.8	54,000	62,640	62,640	67,176	55,296	60,912	49,680	46,224	55,296	70,992	65,304	60,912	-4,392	0	0	0	0	0	0	0	0	0	4,032	0	0	0
					Total	**295,044**	**348,188**	**325,592**	**351,128**	**258,388**	**246,540**	**364,496**	**411,456**	**405,064**	**587,227**	**375,391**	**400,084**	24,693	**91,480**	**115,676**	**77,236**	**126,616**	**69,972**	**31,804**	**136,580**	**173,856**	**168,244**	**310,731**	**142,415**	**166,024**	23,609

Notes:

1) Average leachate elevations are from May 17, 2021.
2) Assumes a waste porosity of 40%.
3) NA indicates data not available, owing to date of manhole installation.
4) Revised original ground surface elevations reflect the findings of an updated survey in 2016.
5) Estimated Leachate Storage Volume (m^3) for Total in Waste Cell = Average Leachate Elevation (m) - (Estimated Average Base of Waste (ha) * 10,000 (m^2)) * 0.4 (assumed porosity).
6) Groundwater Reference Elevation is a fixed value as of 2011 based on historic (2003-2007) data.
7) Volume Above Groundwater Reference Level based on similar reference level for post-2010 volumes. Pre-2010 volumes based on spring average level.

Table 5
Estimated Leachate Storage Volumes
Twin Creeks Environmental Centre - 2021 Annual Monitoring Report

Fill Area	Approximate Area (ha)	Approximate Original Ground Surface Elevation (m asl)	Groundwater Reference Elevation (m asl)	Estimated Average Base of Waste (m asl)	Nov 2021 Average Leachate Elevation (m asl)	Estimated Volume in Waste Cells (Measured from Cell Base) (m3)				Change in Volume Within the Waste Cells From Nov 2020 to Nov 2021 (m^3)	Volume Above Groundwater Reference Level (m3)				Change in Volume Above Groundwater Reference Level From Nov 2020 to Nov 2021 (m^3)
						NOV 2018	NOV 2019	NOV 2020	NOV 2021		NOV 2018	NOV 2019	NOV 2020	NOV 2021	
West Cell (Sump)	6.3	238.3	237.1	235.5	242.7	217,224	177,408	139,356	180,432	41,076	176,904	137,088	99,036	140,112	41,076
Cell 3 (OW51A-15)	1.5	239.9	239.2	235.2	236.3	5,040	6,000	6,840	6,540	-300	0	0	0	0	0
Cell 4 (MH4B)	2.1	240.8	238.5	234.1	240.0	47,376	40,572	44,772	49,140	4,368	10,416	3,612	7,812	12,180	4,368
Cell 5 (MH5A)	2.2	241.2	237.0	236.5	240.0	26,136	0	0	30,360	30,360	21,736	0	0	25,960	25,960
Cell 6 (MH6A)	2.0	240.0	237.3	236.5	240.4	2,560	30,640	11,360	31,520	20,160	0	24,240	4,960	25,120	20,160
Cell 7 (MH7A)	1.9	240.7	238.8	236.5	237.1	10,412	3,952	456	4,408	3,952	0	0	0	0	0
Cell 8 (MH8B)	1.9	240.0	239.3	237.0	239.1	17,556	6,992	6,308	15,580	9,272	76	0	0	0	0
Cell 9 (MH9A)	1.9	241.2	239.0	237.5	238.8	4,712	7,752	1,596	9,728	8,132	0	0	0	0	0
Cell 10 (MH10)	1.9	241.5	239.3	236.5	236.8	33,668	0	0	1,900	1,900	12,388	0	0	0	0
Cell 11 (MH11A)	1.9	244.3	240.8	237.8	238.8	22,952	7,296	4,484	7,372	2,888	152	0	0	0	0
Cell 12 (MH12A)	0.6	242.5	241.8	236.5	236.7	10,632	0	0	576	576	0	0	0	0	0
Cell 3S (MH3SA/B/C/D/E/F)	1.1	238.6	238.3	235.2	239.6	19,323	21,685	11,730	19,351	7,621	5,683	8,045	0	5,711	5,711
South Cell (MH16/17/18)	5.4	239.4	238.1	235.0	238.0	59,760	58,608	58,248	64,800	6,552	0	0	0	0	0
					Total	**477,351**	**360,905**	**285,150**	**421,707**	136,557	**227,355**	**172,985**	**111,808**	**209,083**	97,275

Notes:

1) Average leachate elevations are from Nov 1, 2021.

2) Assumes a waste porosity of 40%.

3) NA indicates data not available, owing to date of manhole installation.

4) Revised original ground surface elevations reflect the findings of an updated survey in 2016.

5) Estimated Leachate Storage Volume (m^3) for Total in Waste Cell = Average Leachate Elevation (m) - (Estimated Average Base of Waste (ha) * 10,000 (m^2)) * 0.4 (assumed porosity).

6) Groundwater Reference Elevation is a fixed value as of 2011 based on historic (2003-2007) data.

7) Volume Above Groundwater Reference Level based on similar reference level for post-2010 volumes. Pre-2010 volumes based on spring average level.

Table 6
Leachate Chemical Summary
Twin Creeks Environmental Centre – 2021 Annual Monitoring Report

Parameter	Leachate Concentrations			Background Concentrations		
	West Central Fill Area (Existing Site) (2008-2021)	Typical Waste Areas (Existing Site) (2008-2021)	Equalization Tank (Expansion Site) (2010-2021)	Groundwater (1984-2001)	Surface Water (2001-2021) SS10	Surface Water (2008-2021) SS16
pH (pH units)	**7.3 - 8.0**	**7.4 - 8.2**	**7.0 - 8.1**	7.0 – 8.3	6.7 - 8.7	7.4 - 8.4
Conductivity (µS/cm)	**880 - 16,400**	**501 – 31,100**	**2,000 - 26,000**	443 – 2,550	62 - 1200	109 - 620
Alkalinity	**290 - 7,060**	**160 - 18,300**	**1,820 - 10,000**	100 - 581	22 - 203	45 - 228
Calcium	**76 - 150**	**19 - 380**	**79- 1,400**	19 - 250	5.4 - 170	15 - 1300
Magnesium	**22 - 390**	**19 - 450**	**130 - 530**	9 - 261	1.6 - 33	3.3 - 85
Sodium	**57 - 2,100**	**19 - 6,300**	**270 - 2,700**	48 - 199	0.49 - 20	1.4 - 18
Potassium	**12 - 620**	**6.7 - 1,100**	**81 - 900**	1 - 9	1 - 17	3.1 - 60
Chloride	**68 - 2,600**	**11 - 1,000**	**330 - 3,400**	1 - 15	1 - 46	1.2 - 20
Sulphate	**0.5 - 81**	**10 - 410**	**10 - 220**	100 – 1,330	0.5 - 220	<1 - 220
Iron	**2.2 - 54**	**<0.05 - 33**	**1.6 - 120**	<0.1 - 3.3	0.25 - 79	0.3 - 540
DOC	**25 - 462**	**8.3 - 1,480**	**234 - 4,500**	0.7 - 9.8	<0.02 - 0.26	
Ammonia (total)	**11.1 - 857**	**8 - 3,540**	**57 - 2,000**	<0.05 – 7.1	<0.02 - 18.4	0.05 - 0.3
TKN	**11 - 930**	**11 - 3,500**	**26 - 2,700**	<0.1 – 10.9	0.41 - 33	<0.7 - 7.2
Nitrate	**<0.1 - <2.0**	**<0.1 - 6.7**	**<0.1 - <5.0**	<0.1 – 2.7	<0.01 - 102	<0.01 - 1.5
Boron	**1.3 - 70**	**0.67 - 560**	**1.3 - 24**	0.09 – 0.99	0.02 - 0.48	<0.02 - 0.4
Benzene (µg/L)	**<0.2 - 361**	**<0.1 - 12.0**	**<1 - <10**	<1.3		
Toluene (µg/L)	**<0.2 - 782**	**<0.2 - 550**	**20 - 2400**	<1.5		
Ethylbenzene (µg/L)	**<0.2 - 318**	**<0.1 - 891**	**<0.5 - 21**	<1.6		
m/p - xylenes (µg/L)	**<0.2 - 1,990**	**<0.1 - 200**	**7.5 - 48**	<3.4		
o - xylene (µg/L)	**<0.2 - 1140**	**<0.1 - 97.4**	**<0.5 - 22**	<2.7		

Notes:

1) Background concentrations for groundwater are established from 1984 to 2001 for monitoring wells 250 metres or greater to the west of the Existing Site: OW1-5, OW5-6, OW38-6, OW38-10, OW39-6, OW39-12, OW42-6, OW42-9.

2) Background concentrations for surface water (SS10 and SS16) are established for 2001-2021 data, where available.

3) All data are mg/L unless otherwise specified.

4) Blank denotes parameter not tested.

Table 7
Indicator Parameter Concentration Trend Summary - Groundwater
Twin Creeks Environmental Centre - 2021 Annual Monitoring Report

Monitor Designation	Long-Term Trend (Includes Historic Data)		
	Chloride	Nitrate	Boron
Active Aquitard			
OW16-6*	C	C	C
OW17-4	F	C	C
OW40D-4	C	C	D/F
OW54A-4*	I/F	C	C
OW56-4	C	F	F
OW57-4	C	C	C
OW58-6	C	C	C
OW59-6	C	C	F
OW60-4	C	C	C
OW67-4	D/F	F	D/F
OW68-5	C	C	C
OW69-5	C	C	F
OW70B-5*	C	C	C
OW71A-5*	I	C	C
OW72-6	C	C	C
OW73-6	C	C	F
OW79-5	F	C	C
OW80-3	F	C	C
OW81-5	ID	ID	ID
Interstadial Silt and Sand			
OW16-7	C	C	C
OW40A-7	C	C	C
OW46-7	C	C	F
OW47-6	C	F	F
OW54-10	C	C	C
OW57-15	C	C	C
OW58-17*	C	C	F
OW60-8	C	C	F
OW67-11	F	F	F
OW72-10	C	C	C
OW73-9	C	C	F
OW79-7	F	C	C
OW80-6	F	C	C
OW81-7	ID	ID	ID
Interface Aquifer			
OW19-29	C	C	F
OW39A-26*	F	C	F
OW49-29	C	C	F
OW79-26	C	F	C
OW80-27	C	C	F
OW81-27	ID	ID	ID
Cemetery Well	C	F	C

Notes:
1) C denotes constant trend.
2) D denotes decreasing trend.
3) I denotes increasing trend.
4) F denotes fluctuating trend.
5) S denotes seasonal pattern.
6) ID denotes insufficient data for interpretation.
7) Data are presented in Table H-4 Appendix H .
8) Historic data trends assume nitrate+nitrite represents nitrate.
9) Concentrations can show more than one trend.
10) * denotes considers historic data from decommissioned monitoring well.

Table 8
Groundwater Trigger Concentration / Comparison Summary - Active Aquitard
Twin Creeks Environmental Centre - 2021 Annual Monitoring Report

Monitor Designation		Chloride	Nitrate	Boron
Active Aquitard				
	Trigger Concentration (mg/L)	**106**	**2.3**	**1.1**
OW16-6	May 2021	48	<0.10	0.18
	November 2021	45	<0.10	0.16
OW17-4	May 2021	35	<0.10	0.23
	November 2021	32	0.29	0.26
OW40D-4	May 2021	4.6	0.34	0.4
OW54A-4	May 2021	24	<0.10	0.23
	November 2021	23	<0.10	0.23
OW56-4	May 2021	8.6	0.31	0.4
	November 2021	7.6	0.11	0.49
OW57-4	May 2021	6.6	<0.10	0.37
	November 2021	6.4	<0.10	0.39
OW58-6	May 2021	6.1	<0.10	0.62
	November 2021	5.3	<0.10	0.59
OW59-6	May 2021	7.0	<0.10	0.8
	November 2021	6.5	<0.10	0.72
OW60-4	May 2021	6.5	<0.10	0.03
OW67-4	May 2021	12	1.21	0.17
	November 2021	18	0.78	0.21
OW68-5	May 2021	9.1	<0.10	0.08
	November 2021	8.5	<0.10	0.09
OW69-5	May 2021	11	<0.10	1.0
	November 2021	11	<0.10	0.94
OW70B-5	May 2021	7.0	<0.10	0.43
	November 2021	6.4	<0.10	0.46
OW71A-5	May 2021	29	<0.10	0.12
	November 2021	29	<0.10	0.14
OW72-6	May 2021	5.1	<0.10	0.62
	November 2021	4.7	<0.10	0.67
OW73-6	May 2021	7.3	<0.10	0.9
	November 2021	8.6	<0.10	0.84
OW79-5	May 2021	26	<0.10	0.09
OW80-3	May 2021	*160*	0.12	0.04
OW81-5	May 2021	20	<0.10	0.54

NOTES:

1) Trigger Concentrations based on Table 4 of the 2007 Landfill EMP.

2) Bolded text and shading denotes concentration exceeds trigger concentration.

3) Italics denotes that per MECP approval the parameter's concentration is not evaluated against the trigger concertation.

4) Monitoring well nests OW82, OW83, and OW84 have yet to be constructed.

5) Monitoring well nest OW81 installed in June 2019.

6) N/A denotes not applicable as chloride is not used as part of the trigger assessment process at this location.

Table 9
Groundwater Trigger Concentration Comparison Summary - Interstadial Silt and Sand
Twin Creeks Environmental Centre - 2021 Annual Monitoring Report

Monitor Designation		Chloride	Nitrate	Boron
Interstadial Silt and Sand				
	Trigger Concentration (mg/L)	**116**	**2.3**	**2.1**
OW16-7	May 2021	7.1	0.12	0.28
	November 2021	5.3	<0.10	0.27
OW40A-7	May 2021	6.7	0.20	0.59
OW46-7	May 2021	14	<0.10	0.34
	November 2021	13	0.15	0.7
OW47-6	May 2021	6.4	0.37	0.91
	November 2021	5.4	0.38	0.96
OW54-10	May 2021	8.9	0.18	0.96
	November 2021	8.5	0.35	0.95
OW57-15	May 2021	8.8	0.44	1.1
	November 2021	8.4	<0.10	1.1
OW58-17	May 2021	9.5	<0.10	1.3
	November 2021	8.4	<0.10	1.3
OW60-8	May 2021	8.8	<0.10	0.85
OW67-11	May 2021	24	0.14	0.51
	November 2021	31	<0.10	0.53
OW72-10	May 2021	6.3	0.34	1.1
	November 2021	5.3	<0.10	1.1
OW73-9	May 2021	8.9	0.45	1.1
	November 2021	8.1	0.60	1.2
OW79-7	May 2021	*140*	<0.10	0.22
OW80-6	May 2021	*190*	<0.10	0.21
OW81-7	May 2021	**220**	0.10	0.53

Notes:

1) Trigger Concentrations based on Table 4 of the 2007 Landfill EMP.

2) Bolded text and shading denotes concentration exceeds trigger concentration.

3) Italics denotes that per MECP approval the parameter's concentration is not evaluated against the trigger concertation.

4) Chloride trigger concentration of 116mg/L is not applicable to OW79-7 and OW80-6

5) Monitoring well nests OW82, OW83, and OW84 have yet to be constructed.

6) Monitoring well nest OW81 installed in June 2019.

Table 10
Groundwater Trigger Concentration Comparison Summary - Interface Aquifer
Twin Creeks Environmental Centre - 2021 Annual Monitoring Report

Monitor Designation		Chloride	Nitrate	Boron
Interface Aquifer				
	Trigger Concentration (mg/L)	**134**	**2.3**	**2.6**
OW19-29	May 2021	28	<0.10	2.2
OW39A-26	May 2021	57	<0.10	1.8
OW49-29	May 2021	29	<0.10	1.5
OW79-26	May 2021	28	<0.10	1.7
OW80-27	May 2021	47	<0.10	1.8
OW81-27	May 2021	48	<0.10	1.9
Cemetery Well	May 2021	4.4	0.98	0.03

Notes:

1) Trigger Concentrations based on Table 4 of the 2007 Landfill EMP.

2) Bolded text and shading denotes concentration exceeds trigger concentration.

3) Monitoring well nests OW82, OW83, and OW84 have yet to be constructed.

4) Monitoring well nest OW81 installed in June 2019.

Table 11
Indicator Parameter Concentration Trend Summary - Surface Water
Twin Creeks Environmental Centre - 2021 Annual Monitoring Report

Monitoring Station	Long-Term Trend (Includes Historic Data)			
	Chloride	Ammonia	Boron	Zinc
SS1	F	C	F	F
SS10	F	C	F	F
SS16	C	C	C	C
SP1	F	C	F	C
SP2	F	F	F	F
SP3	F	F	C	C
SP4	F	F	C	C

Notes:

1) C denotes constant trend.
2) D denotes decreasing trend.
3) I denotes increasing trend.
4) F denotes fluctuating trend.
5) S denotes seasonal pattern.
6) Data are presented in Table I-2, Appendix I.
7) INS - denotes there is insufficient data available for interpretation.
8) NC denotes sampling station not yet constructed.

Table 12
Surface Water Trigger Concentrations
Twin Creeks Environmental Centre - 2021 Annual Monitoring Report

Parameter	Units	PWQO	Background Station SS10 and SS16 90% Trigger Concentration	Number of Samples for Background Station SS10	Number of Samples for Background Station SS16	Post 2020 Trigger Concentration	Post 2021 Trigger Concentration
Trigger Concentrations/Levels for Compliance Points							
Chloride	mg/L	210*	20.3	63	45	210	210
Ammonia (unionized)	mg/L	0.020	0.010	63	45	0.020	0.020
Phenols	mg/L	0.001	0.004	63	45	0.004	0.004
Boron	mg/L	0.20	0.17	63	45	0.20**	0.20**
Nickel	mg/L	0.025	0.027	63	45	0.028	0.027
Chromium (total)	mg/L	0.0089	0.024	63	45	0.025	0.024
Zinc	mg/L	0.02	0.06	63	45	0.06	0.06

Notes:

1) PWQO denotes Provincial Water Quality Objectives (1994) with updates.

2) * denotes recommended concentration by Environment Canada.

3) ** It is noted that the boron trigger concentration for SP1 is 0.39 mg/L, per the MOECC letter dated May 18, 2012.

4) Trigger concentrations are calculated annually from SS10 and SS16, per MOECC letter dated February 27, 2014.

Table 13
2022 Monitoring Program
Twin Creeks Environmental Centre - 2021 Annual Monitoring Report

Monitoring Locations	Parameters	Frequency
Leachate		
PS1, PS3, PS5, PS7*, MH3S, MH4, MH5, MH6, MH7, MH8, MH9, MH10, MH11, MH12, MH16, MH17, MH18, OW22A-10, OW51A-15, OW53-10, Sump, LW1, LW2, LW3, LW4, LW5, LW6	Leachate Levels	May and November
PS1, PS3, PS5, PS7*	Leachate Levels	Daily
PS1, PS3, PS5, PS7*, South Fill Area (MH18), West Central Fill Area (Sump), Central Fill Area (Composite of MH3, MH4, MH5, MH6, MH7, MH9, MH11)	PLIL-GW, SLIL-GW, PLIL-SW, SLIL-SW, LS	May
Equalization Tank	BOD_5, DOC, phosphorus (total), TKN, BTEX, pH	Quarterly
	PLIL-SW, SLIL-SW, LS	May and November
Treated Leachate Effluent		
Treatment Plant Effluent	Discharge Rates, COD, pH, turbidity	Daily
	Chloride, $CBOD_5$, BOD_5, DOC, BTEX, ammonia, pH	Weekly
	PLIL-GW, SLIL-GW, PLIL-SW, SLIL-SW, LS	Monthly
	PCB, organochlorines	May and November
Treated Leachate Temporary Storage Cells : Cells 1 and 2	Discharge Rates	Daily
Cell 1 Inlet, Cells 1 and 2	Chloride, $CBOD_5$, BOD_5, DOC, BTEX, ammonia, pH	Weekly
Cells 1 and 2	DO, pH, alkalinity, DOC	Weekly
Cells 1 and 2	PLIL-GW, SLIL-GW, PLIL-SW, SLIL-SW, LS	Monthly
Cell 1	Biomonitoring	May and November
Secondary Drainage Layer		
PS2, PS4, PS6, PS8*	Groundwater Levels	Monthly
Active Aquitard		
OW16-6, OW17-4, OW40D-4, OW54A-4, OW56-4, OW57-4, OW58-6, OW59-6, OW60-4, **OW61-4, OW62-5**, OW67-4, OW68-5, OW69-5, OW70B-5, OW71A-5†, OW72-6, OW73-6, **OW75-3, OW76-5, OW77-4, OW78-4**, OW79-5, OW80-3, OW81-5, OW82(new), OW83(new), OW84(new), **OW85-5,** P1, P2, P3	Groundwater Levels	May and November
OW16-6, OW17-4, OW54A-4, OW56-4, OW57-4, OW58-6, OW59-6, **OW61-4, OW62-5**, OW67-4, OW68-5, OW69-5, OW70B-5, OW71A-5*, OW72-6, OW73-6, **OW75-3, OW76-5, OW77-4, OW78-4**	PLIL-GW, SLIL-GW	May and November
OW40D-4, OW60-4, OW79-5, OW80-3, OW81-5, OW82(new), OW83(new), OW84(new), **OW85-5**	PLIL-GW, SLIL-GW	May
OW16-6, **OW61-4, OW62-5, OW75-3, OW78-4**	Volatiles	May and November
OW17-4, OW40D-4, OW54A-4, OW56-4, OW57-4, OW58-6, OW59-6, OW60-4, OW67-4, OW68-5, OW69-5, OW70B-5, OW71A-5*, OW72-6, OW73-6, **OW76-5, OW77-4**, OW79-5, OW80-3, OW81-5, OW82(new), OW83(new), OW84(new), **OW85-5**	Volatiles	May
Interstadial Silt and Sand		
OW16-7, OW40A-7, OW46-7, OW47-6, OW54-10, OW57-15, OW58-17, OW60-8, **OW61-6, OW62-7**, OW67-11, OW72-10, OW73-9, **OW75-7, OW78-6**, OW79-7, OW80-6, OW81-7, OW82(new), OW83(new), OW84(new), **OW85-8**	Groundwater Levels	May and November
OW46-7, OW47-6, OW54-10, OW57-15, OW58-17, OW67-11, OW72-10, OW73-9	PLIL-GW, SLIL-GW	May and November
OW16-7, **OW61-6, OW62-7, OW75-7, OW78-6**	PLIL-GW, SLIL-GW, volatiles	May and November
OW40A-7 OW60-8, OW79-7, OW80-6, OW81-7, OW82(new), OW83(new), OW84(new), **OW85-8**	PLIL-GW, SLIL-GW	May
OW40A-7, OW46-7, OW47-6, OW54-10, OW57-15, OW58-17, OW60-8, OW67-11, OW72-10, OW73-9, OW79-7, OW80-6, OW81-7, OW82(new), OW83(new), OW84(new), **OW85-8**	Volatiles	May
Interface Aquifer		
OW17-30, OW19-29, OW39A-26, OW40A-28, OW49-29, OW60-25, **OW61-26, OW62-30**, OW79-26, OW80-27, OW81-27, OW82(new), OW83(new), OW84(new)	Groundwater Levels	May and November
OW19-29, OW39A-26, OW49-29, OW79-26, OW80-27, OW81-27, OW82(new), OW83(new), OW84(new), Cemetery Well	PLIL-GW, SLIL-GW	May
OW19-29, OW39A-26, OW49-29, OW79-26, OW80-27, OW81-27, OW82(new), OW83(new), OW84(new), Cemetery Well	Volatiles	Biennial - May 2022
Background Station		
SS10, SS16	Flow Rates	Quarterly after 10 mm precipitation events. Greater than 1 month intervals between sampling.
	PLIL-SW, SLIL-SW, nitrite	
	LS-SW	Spring Precipitation Event
	Biomonitoring	Spring Precipitation Event
Sedimentation Ponds (Discharge Points)		
SP1, SP2, SP3, SP4	Flow Rates	Quarterly after 10 mm precipitation events. Greater than 1 month intervals between sampling.
	PLIL-SW, SLIL-SW, nitrite	
	LS-SW, volatiles, semi-volatiles	Quarterly after 10 mm precipitation events. Greater than 1 month intervals between sampling.
	Biomonitoring	Spring Precipitation Event
Western Site Boundary Compliance Point		
SS1	Flow Rates	Quarterly after 10 mm precipitation events. Greater than 1 month intervals between sampling.
	PLIL-SW, SLIL-SW, nitrite	
	LS-SW, volatiles, semi-volatiles	Quarterly after 10 mm precipitation events. Greater than 1 month intervals between sampling.
	Biomonitoring	Spring Precipitation Event
Poplar Tree Plantation Land Application Area		
SS17A, SS17B, SS18A, SS18B	Flow Rates	Quarterly after 10 mm precipitation events. Greater than 1 month intervals between sampling.
	PLIL-SW, SLIL-SW, nitrite	
	LS-SW, volatiles, semi-volatiles	Quarterly after 10 mm precipitation events. Greater than 1 month intervals between sampling.
	Biomonitoring	Spring Precipitation Event
Compost Facility (if constructed)		
SS19	PLIL-SW, SLIL-SW, nitrite, BOD_5, TSS, Total Coliform, Fecal Coliform, E. Coli	Prior to water use
Landfill Gas Monitoring		
Landfill Cap	Inspections	Monthly (April to November)
GP1A, GP2, GP3, GP4, GP5, GP6, GP7, GP8, GP9(new), GP10(new)	Methane Gas	January, February, March, April, July, November, December

Notes:

1) PLIL-GW indicates: chloride, nitrate, boron.

2) SLIL-GW indicates: alkalinity, sulphate, calcium, magnesium, potassium, sodium, barium, cadmium, iron, lead, DOC, TDS, ammonia (total), TKN, pH, conductivity. Field parameters of pH, conductivity, temperature, turbidity.

3) PLIL-SW indicates: chloride, ammonia (total and unionized), phenols, boron, nickel, chromium (total), zinc.

4) SLIL-SW indicates: alkalinity, sulphate, calcium, magnesium, potassium, sodium, total phosphorus, iron, nitrate, TKN, TDS, pH, conductivity. Field parameters of temperature, pH, conductivity, turbidity, DO.

5) LS indicates: arsenic, barium, cadmium, copper, lead, manganese, mercury, nitrite, TSS, volatiles, semi-volatiles, BOD_5, COD.

6) LS-SW indicates: arsenic, barium, cadmium, copper, lead, mercury, nitrite, TSS, BOD_5, COD.

7) Volatiles should include the following at a minimum: benzene, 1,4-dichlorobenzene, dichloromethane, toluene, ethylbenzene, xylenes, and vinyl chloride.

8) Semi-volatiles should include the following at a minimum: 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, hexachlorobenzene, diethylphthalate, dimethylphthalate, di-n-butyl phthalate, phenol, benzo(a)pyrene, 2,4,6-trichlorophenol, 2,4-dichlorophenol, pentachlorophenol.

9) Organochlorines include herbicide and pesticide scan.

10) Biomonitoring indicates toxicity testing for Rainbow Trout and Daphnia Magna.

11) Biennial indicates every second year.

12) QA/QC includes one (1) blind duplicate for each 15 samples or once per event, whichever is greater.

13) Surface water samples shall be collected in a downstream to upstream sequence.

14) OW84(new) denotes monitoring wells to be installed per EMP dated December 20, 2007.

15) Spring denotes: April, May, and June.

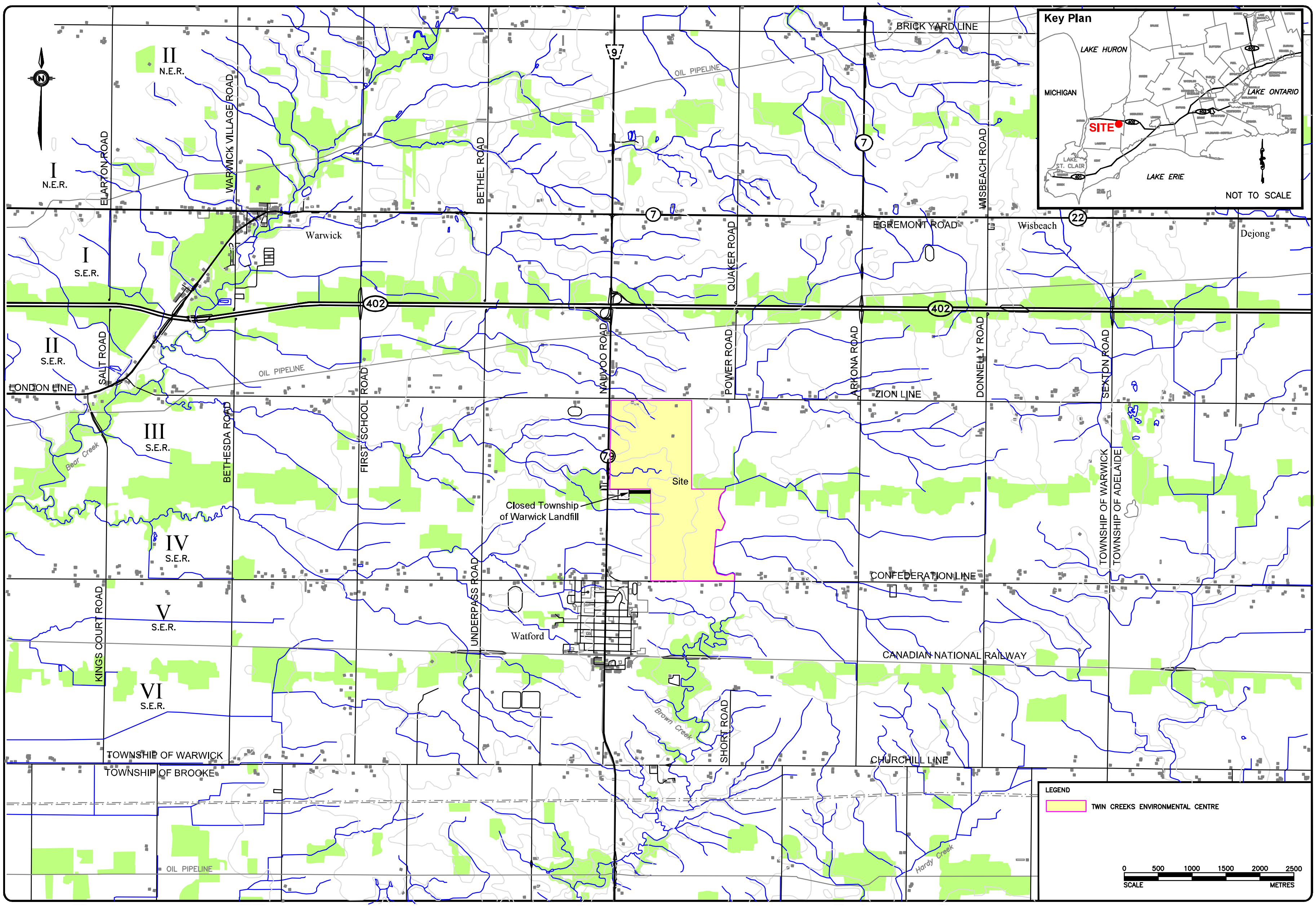
16) † indicates that OW71A-5 is not required as part of the monitoring program, however, obtained data is interpolated for the monitoring well OW67-4, which used to show dry conditions.

17) Since the Poplar Plantation is not required to be utilized until a few months prior to the initiation of the treatment plant as operational, monitoring per the EMP and ECA, as well as the Waste and Sewage ECA's that is completed to evaluate the vigour of the Poplar Plantation, is not required. It is recognized that once the Poplar Plantation is initialized, then the required monitoring to evaluate the Poplar Plantation would be reinitiated.

18) Monitoring stations that are currently idle until 2 months prior to the leachate treatment plant being operational, include the following: 1) Surface water stations **SS17A, SS17B, SS18A, SS18B**; and 2) Groundwater monitoring locations **OW61, OW62, OW75, OW76, OW77, OW78, AND OW85.**

19) * PS7, and PS8 not yet constructed.

FIGURES



MAP SOURCE:
FIGURE PROVIDED BY GENIVAR INC., FIGURE 1, FILE REF NO. 111-53111-00-F1-LM 12CM Q4, DATED FEBRUARY 2013.

WASTE MANAGEMENT

SITE LOCATION MAP

2021 COMPLIANCE MONITORING PROGRAM

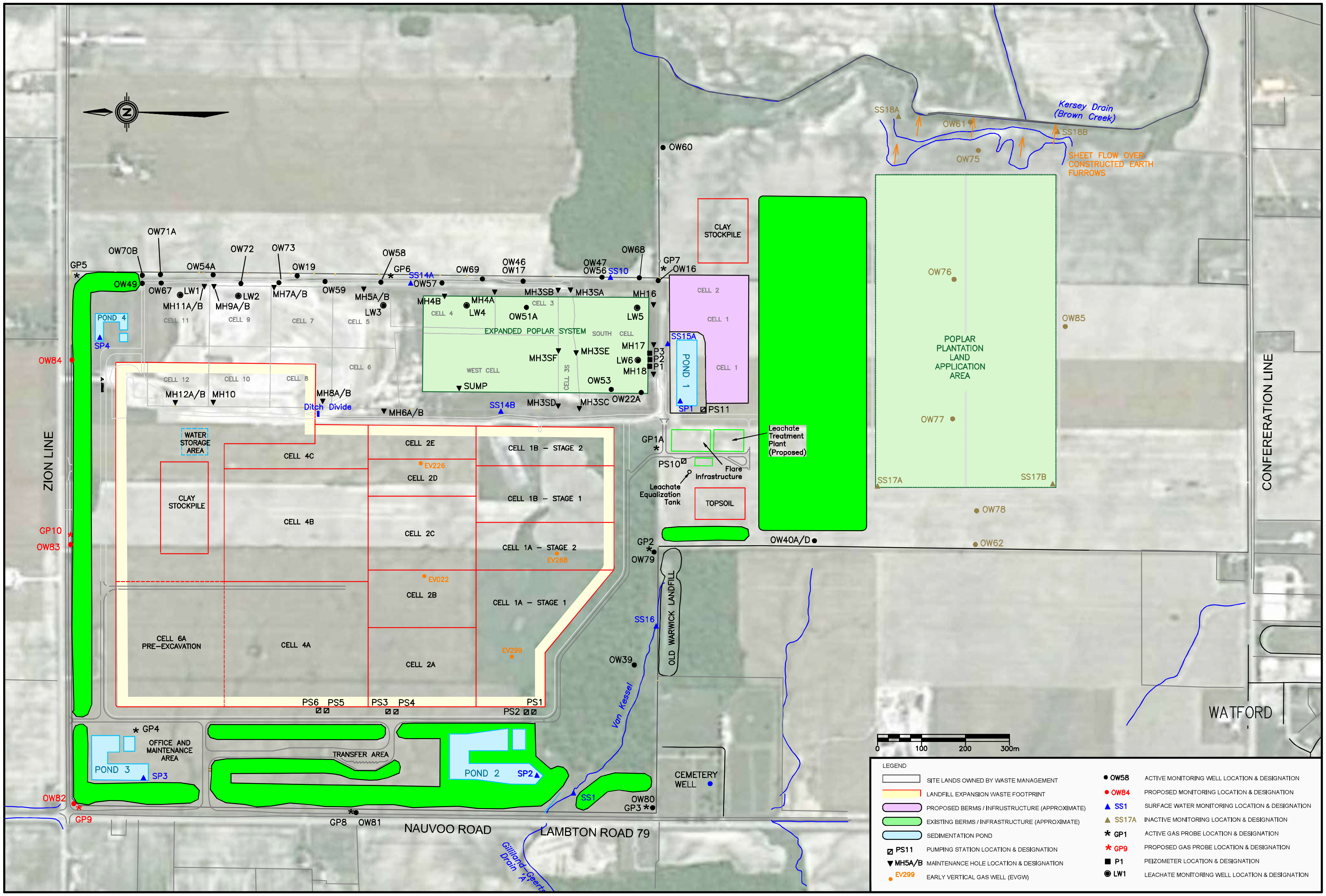
TWIN CREEKS ENVIRONMENTAL CENTRE
TOWNSHIP OF WARWICK, ONTARIO

DWN BY: AJV
CHK BY: PEJ
DATE: MAY 2021
SCALE: 1:50,000

WASTE MANAGEMENT OF CANADA CORP.

PROJECT FILE REF. NO. 2101781

FIGURE 1



MAP SOURCE:
AERIAL PHOTO PROVIDED BY GOOGLE EARTH (2011), ACCESSED ON JANUARY 2014.
FIGURE PROVIDED BY GENIVAR INC., FIGURE 2, FILE REF NO. 111-53111-00-F2-SP 12CM Q4, DATED FEBRUARY 2013.

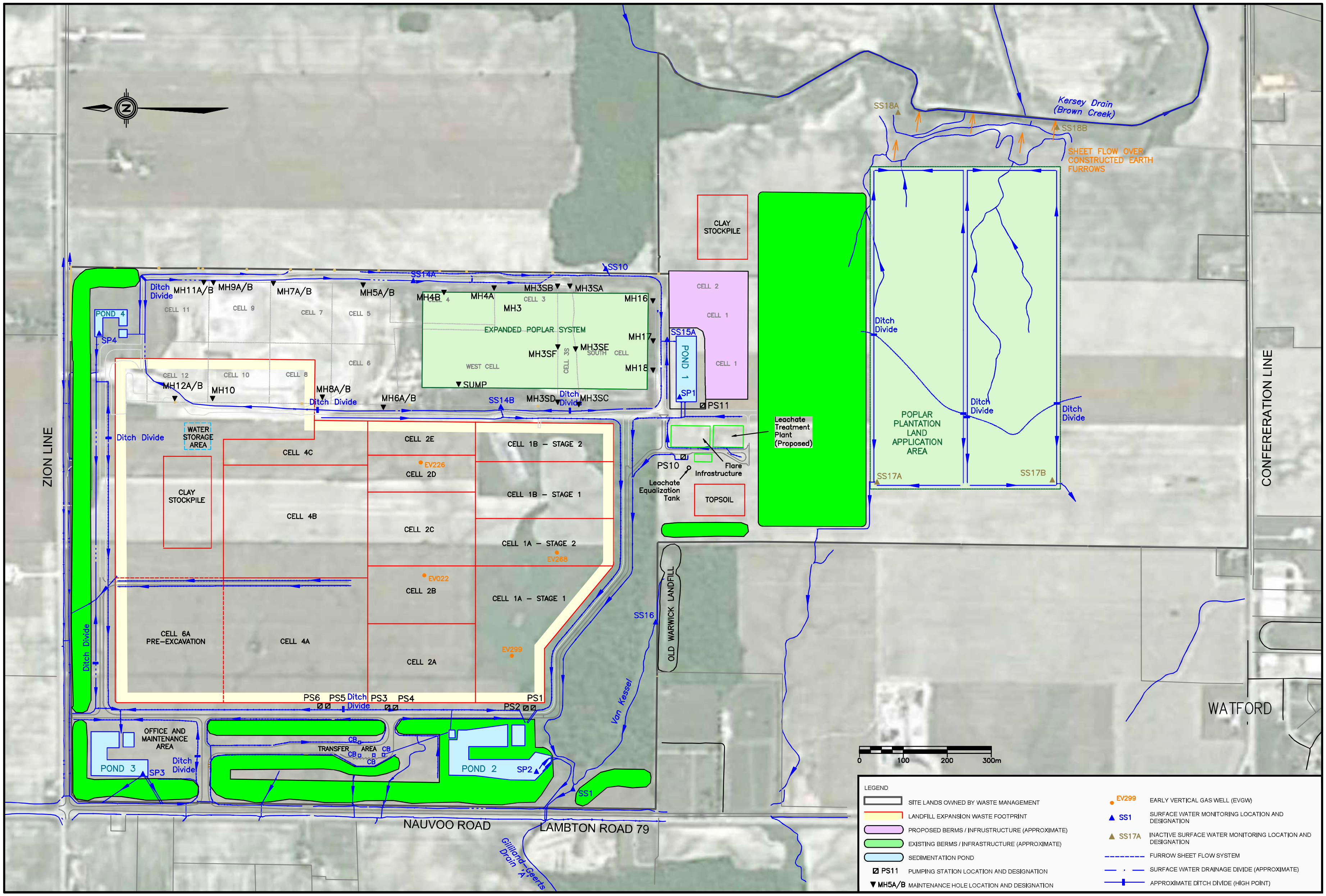
NOTE: LOCATION OF CONSTRUCTION SEDIMENTATION PONDS, BERMS, POPLAR PLANTATION, TREATMENT PLANT, & EFFLUENT LAGOONS FROM NOVEMBER 2010 SURVEY PLAN.

WASTE MANAGEMENT

SITE PLAN
2021 COMPLIANCE MONITORING PROGRAM
TWIN CREEKS ENVIRONMENTAL CENTRE
TOWNSHIP OF WARWICK, ONTARIO

DWN BY: AJV
CHK BY: JCL
DATE: FEBRUARY 2022
SCALE: 1:8,000
WASTE MANAGEMENT OF CANADA CORP.
PROJECT FILE REF. NO.
2101781

FIGURE
2



MAP SOURCE:
AERIAL PHOTO PROVIDED BY GOOGLE EARTH (2011), ACCESSED ON JANUARY 2014.
FIGURE PROVIDED BY GENIVAR INC., FIGURE 3, FILE REF NO. 111–53111–00–F3–SP 12CM Q4, DATED JANUARY 2013.

NOTE:
LOCATION OF CONSTRUCTION SEDIMENTATION PONDS, BERMS, POPLAR PLANTATION, TREATMENT PLANT, & EFFLUENT LAGOONS FROM NOVEMBER 2010 SURVEY PLAN.

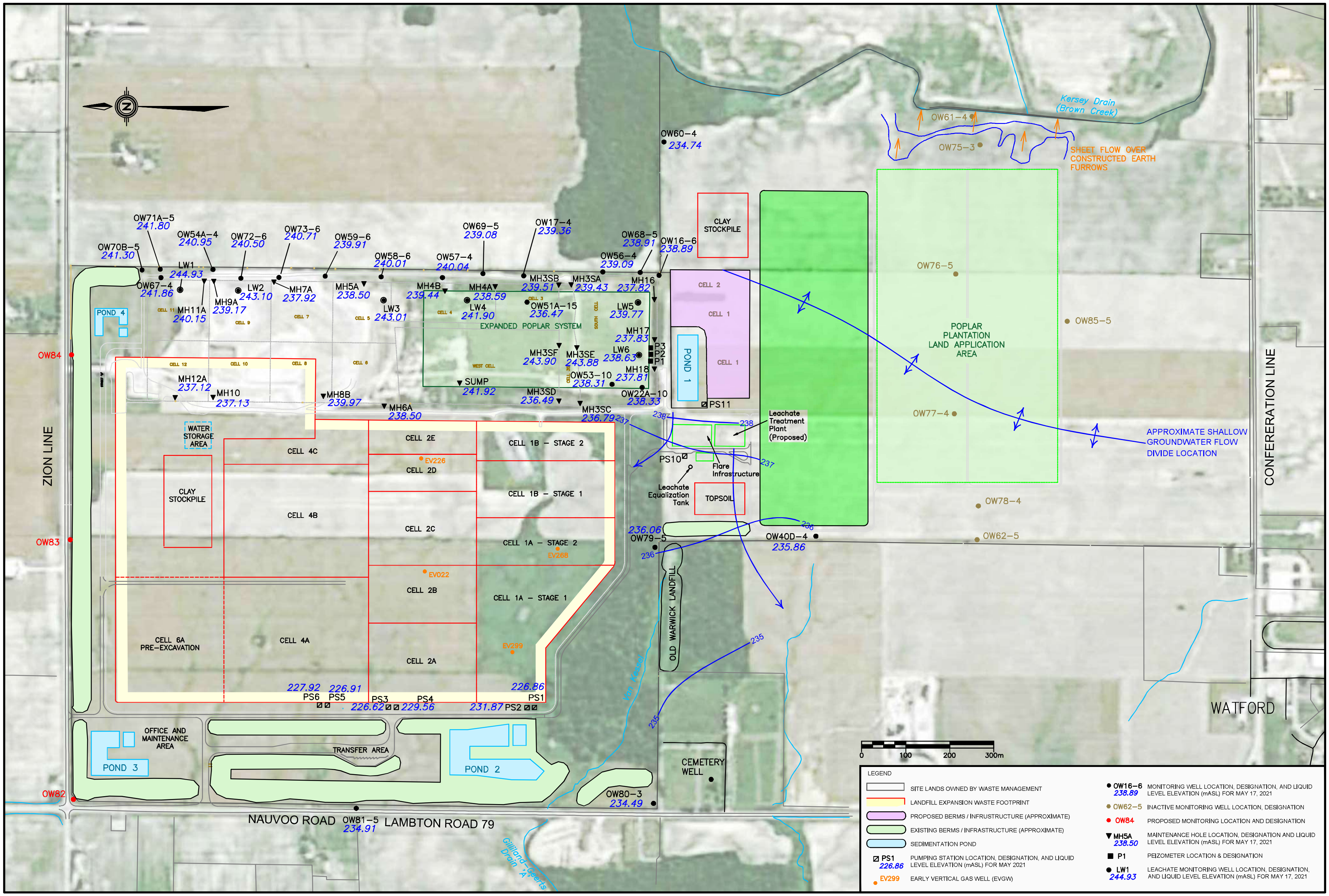
RWDI

WM WASTE MANAGEMENT

SURFACE WATER SYSTEM
2021 COMPLIANCE MONITORING PROGRAM
TWIN CREEKS ENVIRONMENTAL CENTRE
TOWNSHIP OF WARWICK, ONTARIO

DWN BY: AJV
CHK BY: JCL
DATE: FEBRUARY 2022
SCALE: 1:8,000
WASTE MANAGEMENT OF CANADA CORP.
PROJECT FILE REF. NO. 2101781

FIGURE
3



MAP SOURCE:
AERIAL PHOTO PROVIDED BY GOOGLE EARTH (2011), ACCESSED ON JANUARY 2014.
FIGURE PROVIDED BY GENIVAR INC., FIGURE 3, FILE REF NO. 111-53111-00-F4-GW 12CM Q4, DATED FEBUARY 2013.

NOTE:
LOCATION OF CONSTRUCTION SEDIMENTATION PONDS, BERMS, POPLAR PLANTATION, TREATMENT PLANT, & EFFLUENT LAGOONS FROM DECEMBER 2010 SURVEY PLAN.

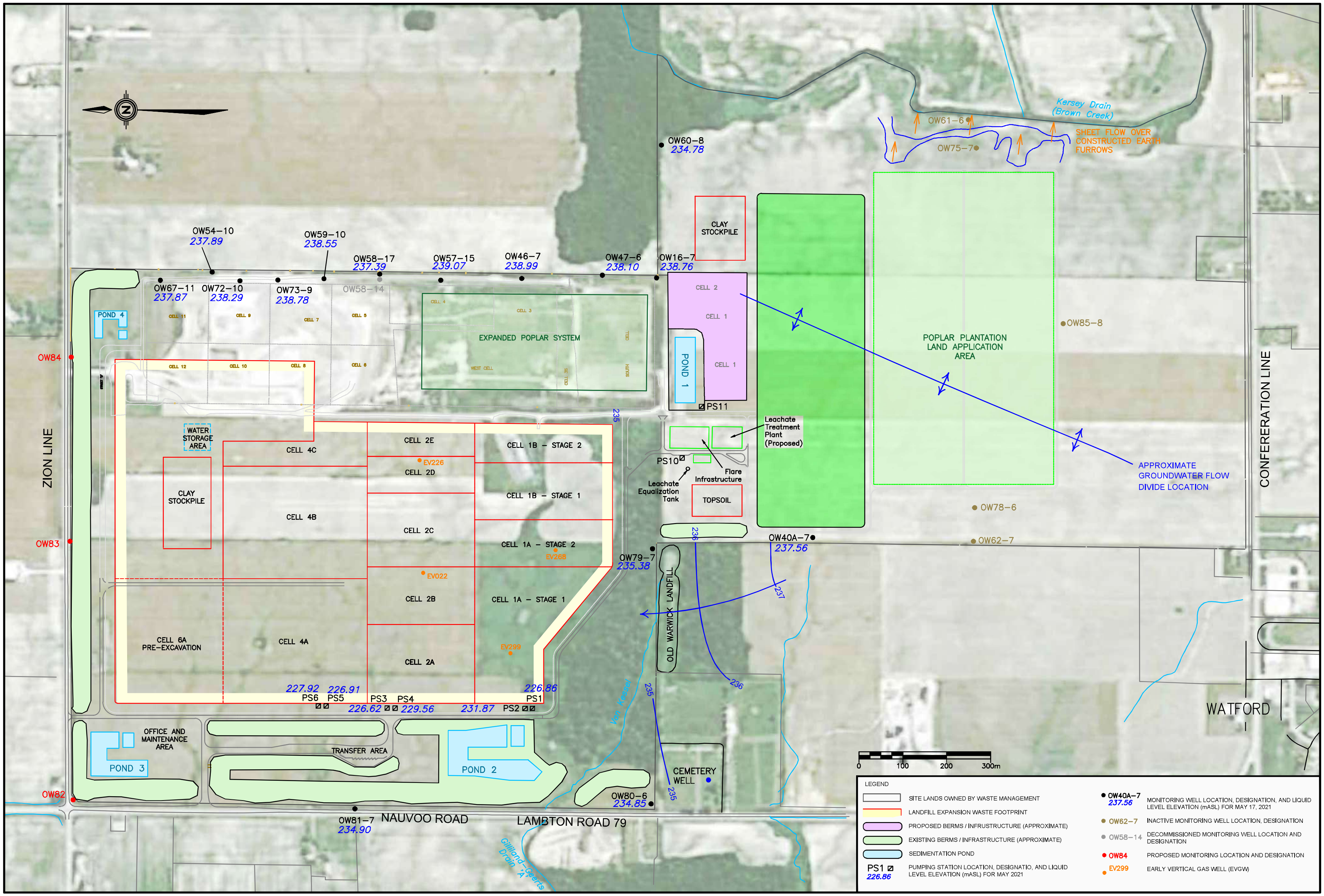
RWDI

WM WASTE MANAGEMENT

LEACHATE & SHALLOW GROUNDWATER ELEVATIONS
2021 COMPLIANCE MONITORING PROGRAM
TWIN CREEKS ENVIRONMENTAL CENTRE
TOWNSHIP OF WARWICK, ONTARIO

DWN BY: AJV
CHK BY: JCL
DATE: FEBRUARY 2022
SCALE: 1:8,000
WASTE MANAGEMENT OF CANADA CORP.
PROJECT FILE REF. NO. 2101781

FIGURE
4



MAP SOURCE:
AERIAL PHOTO PROVIDED BY GOOGLE EARTH (2011), ACCESSED ON JANUARY 2014.
FIGURE PROVIDED BY GENIVAR INC., FIGURE 3, FILE REF NO. 111–53111–00–F5–GW 12CM Q4, DATED FEBUARY 2013.

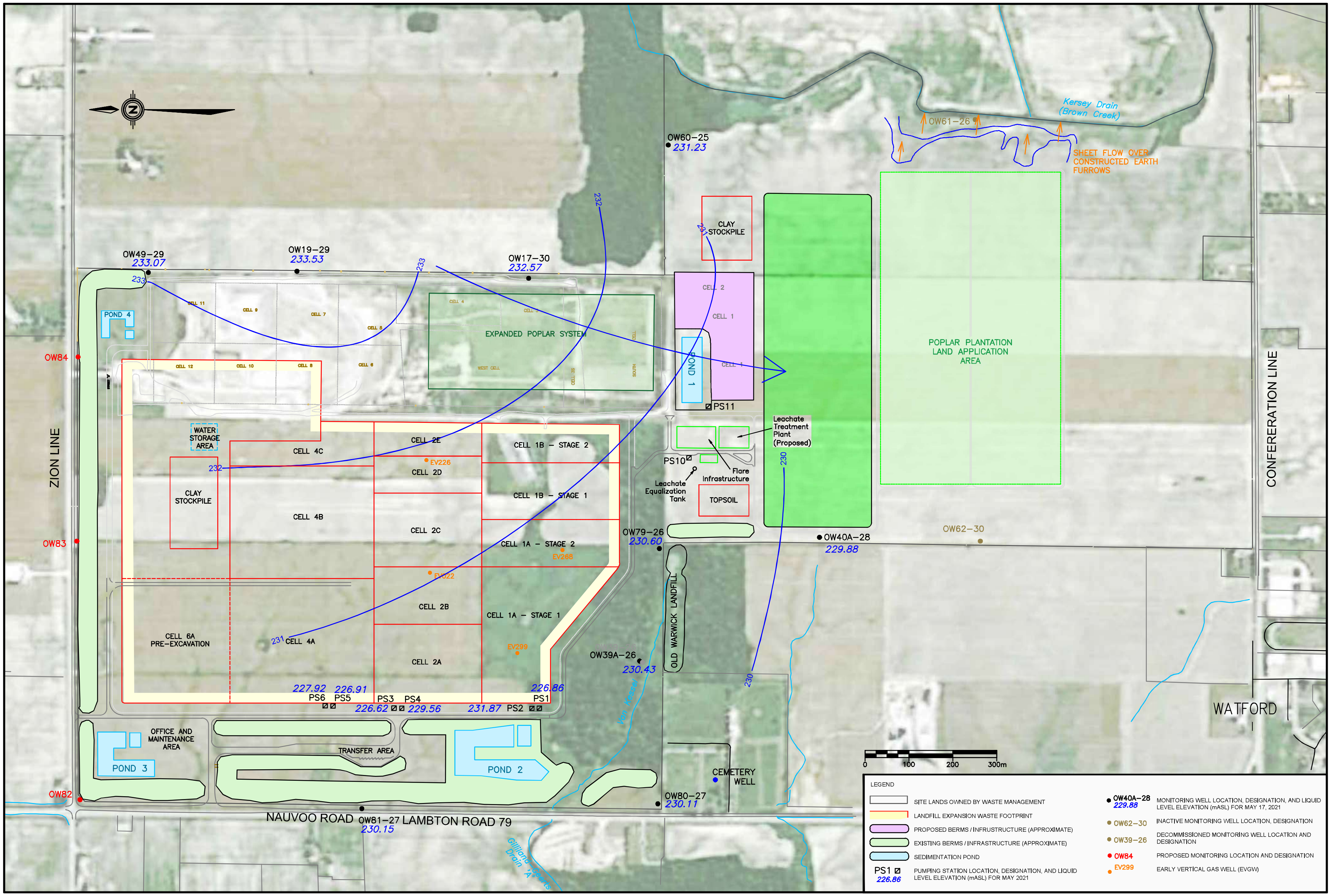
NOTE:
LOCATION OF CONSTRUCTION SEDIMENTATION PONDS, BERMS, POPLAR PLANTATION, TREATMENT PLANT, & EFFLUENT LAGOONS FROM DECEMBER 2010 SURVEY PLAN.

WM WASTE MANAGEMENT

INTERSTADIAL SILT AND SAND GROUNDWATER ELEVATIONS
2021 COMPLIANCE MONITORING PROGRAM
TWIN CREEKS ENVIRONMENTAL CENTRE
TOWNSHIP OF WARWICK, ONTARIO

DWN BY: AJV
CHK BY: JCL
DATE: FEBRUARY 2022
SCALE: 1:8,000
WASTE MANAGEMENT OF CANADA CORP.
PROJECT FILE REF. NO. 2101781

FIGURE
5



MAP SOURCE:
AERIAL PHOTO PROVIDED BY GOOGLE EARTH (2011), ACCESSED ON JANUARY 2014.
FIGURE PROVIDED BY GENIVAR INC., FIGURE 3, FILE REF NO. 111-53111-00-F6-GW 12CM Q4, DATED FEBUARY 2013.

NOTE:
LOCATION OF CONSTRUCTION SEDIMENTATION PONDS, BERMS, POPLAR PLANTATION, TREATMENT PLANT, & EFFLUENT LAGOONS FROM DECEMBER 2010 SURVEY PLAN.

WASTE MANAGEMENT

INTERFACE AQUIFER GROUNDWATER ELEVATIONS

2021 COMPLIANCE MONITORING PROGRAM

TWIN CREEKS ENVIRONMENTAL CENTRE
TOWNSHIP OF WARWICK, ONTARIO

DWN BY: AUV
CHK BY: JCL
DATE: FEBRUARY 2022
SCALE: 1:8,000

WASTE MANAGEMENT OF CANADA CORP.

PROJECT FILE REF. NO. 2101781

FIGURE 6