CLOSED OAKVILLE NINTH LINE LANDFILL SITE

2018 ENVIRONMENTAL MANAGEMENT PLAN

REGIONAL MUNICIPALITY OF HALTON

PROJECT NO.: 181-30000-00-106-1001

DATE: APRIL 12, 2019

WSP
UNIT 2
126 DON HILLOCK DRIVE
AURORA, ON, CANADA L4G 0G9

T: +1 905 750-3080
F: +1 905 727-0463
WSP.COM

April 12, 2019

REGIONAL MUNICIPALITY OF HALTON
Public Works
1151 Bronte Road
Oakville, Ontario
L6M 3L1

Attention: Ms. Nicole Levie, Supervisor of Waste Processing

Dear Ms. Levie:

Subject: Closed Oakville Ninth Line Landfill Site
2018 Environmental Management Plan

We are pleased to forward the 2018 Environmental Management Plan for the Closed Oakville Ninth Line Landfill Site. This report presents the results of the impact assessment of leachate produced at the landfill site on local groundwater and surface water, and gas emissions. Comments provided by the Region have been incorporated into the report.

The environmental management plan was completed in accordance with direction from the Regional Municipality of Halton. This report combines historical data collected during previous monitoring programs and the supplemental field monitoring results. Findings are summarized in the conclusions and recommendations section, and technical information is appended.

In summary, leachate is produced at this landfill site primarily from the infiltration of precipitation and snow melt on the site. The shallow groundwater and leachate flow is towards Joshua's Creek, adjacent to the landfill. The surface water chemistry results indicate that the water quality within the creek is influenced by discharge from the nearby tributary, and likely from overland runoff from the adjacent areas. There are no groundwater users in the area that are affected by this site. Gas emissions and migration are not a significant concern.

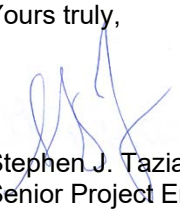
It is recommended that the biennial surface water sampling events be continued to provide a continued assessment of the influence of the landfill on surface water quality. Further monitoring is also recommended.

UNIT 2
126 DON HILLOCK DRIVE
AURORA, ON, CANADA L4G 0G9

T: +1 905 750-3080
F: +1 905 727-0463
wsp.com

Thank you for the opportunity to work on this study. If there are any questions, please contact us.

Yours truly,



Stephen J. Taziar, P.Eng., DCE
Senior Project Engineer

SJT/nah

WSP ref.: 181-30000-00-106-1001

SIGNATURES

APPROVED[1] BY

Stephen J. Taziar, P.Eng., DCE
Senior Project Engineer

April 12, 2019
Date

WSP Canada Inc. prepared this report solely for the use of the intended recipient, REGIONAL MUNICIPALITY OF HALTON, in accordance with the professional services agreement. The intended recipient is solely responsible for the disclosure of any information contained in this report. The content and opinions contained in the present report are based on the observations and/or information available to WSP Canada Inc. at the time of preparation. If a third party makes use of, relies on, or makes decisions in accordance with this report, said third party is solely responsible for such use, reliance or decisions. WSP Canada Inc. does not accept responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken by said third party based on this report. This limitations statement is considered an integral part of this report.

The original of this digital file will be conserved by WSP Canada Inc. for a period of not less than 10 years. As the digital file transmitted to the intended recipient is no longer under the control of WSP Canada Inc., its integrity cannot be assured. As such, WSP Canada Inc. does not guarantee any modifications made to this digital file subsequent to its transmission to the intended recipient.

[1] Approval of this document is an administrative function indicating readiness for release and does not impart legal liability on to the Approver for any technical content contained herein. Technical accuracy and fit-for-purpose of this content is obtained through the review process. The Approver shall ensure the applicable review process has occurred prior to signing the document.

FORWARD

Halton Region manages eleven closed landfill sites on behalf of the local municipalities, or the Region itself. Environmental Management Plans (EMPs) were developed for each site. All of the Plans have a similar format that includes:

- Outline of the site history
- Physical setting
- Monitoring results
- Study results
- Asset condition assessment
- Discussion of the results
- Conclusions, recommendation, and cost analysis for future works

The principle objective for the EMPs is to ensure that the environmental impacts of the closed landfill sites are minimized. The research for the EMPs includes historical monitoring documents and subsequent monitoring programs and/or events. These additional findings are also included in the final Environmental Management Plans.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

1.1 BACKGROUND

1.1.1 LOCAL SETTING

The Closed Oakville Ninth Line Landfill Site is located on the west side of Ninth line, approximately 1 kilometre south of Dundas Street. See Figure 1, Location Map, for location details. The legal description is Part of Lot 6, Concession 1 SDS, Town of Oakville.

The landfill site is bounded by the Crusaders Rugby Club to the south, and the Ontario Hydro corridor to the north. The western portion of the site is also bounded by Joshua's Creek, as shown in Figure 2. A tributary also discharges to Joshua's Creek near the northwest corner of the landfill site. This tributary, which receives water from two stormwater ponds located northwest of the landfill site, discharges to Joshua's Creek on the opposite side of the stream from the refuse area.

It appears that the refuse was placed to fill part of the depression between Joshua's Creek and the Ninth Line, thus, the northern and western slopes of the landfill area are steep. The upper part of the landfill is relatively flat, with a general slight slope to the west. The eastern portion of the landfill has been adapted for a rugby pitch, as shown in Figure 2. The thickness of the refuse extends up to 9 metres, based on boreholes 99-1 and 99-2.

This site, which has a landfilled area of approximately 2.7 ha, predates the current licensing system. According to MECP records, the closed landfill site was in operation for approximately six years. The landfill does not have an Environmental Compliance Approval (ECA) as operations concluded around 1962-1963, prior to the initialization of the approval system. The Town of Oakville continues to own the site, however, the Regional Municipality of Halton is currently responsible for the environmental management of the landfill.

The southern portion of the site, which does not contain refuse, currently consists of a rugby playing field (pitch) and a club house. The eastern portion of the landfilled area has been converted to a practice playing field for the rugby players. The remaining portion of the landfilled area consists of shrubs and grasses.

1.1.2 PREVIOUS STUDIES

1987 HYDROGEOLOGICAL STUDY

A hydrogeologic study was carried out at the site by Morrison Beatty Limited for the Town of Oakville in 1987 which involved a test pitting program and a surface water sampling program.

Fifteen test pits were excavated across the site in order to: i) define the limits and depths of the refuse, ii) determine the type of refuse material, iii) determine the depth to water table, and iv) install gas monitoring probes. The gas probes were identified as GP1 to GP13, and GP15. Currently, only gas probes GP6, GP8 to GP11, and GP15, are included in the monthly monitoring program. The remaining gas probes were removed/decommissioned and/or replaced since 1987, as some of these monitors became damaged, inoperable, or redundant. As additional gas probes were installed at the site in subsequent years, the monitoring network was deemed to be sufficient for assessing potential landfill gas migration from the refuse area, and older gas probes that were redundant would have been decommissioned.

Surface water samples were obtained at SW1, SW3, and SW4 on June 11, 1986 and November 19, 1986, and analysed for general chemistry and metals. The locations are shown in Figure 2. There had been no prior sampling of Joshua's Creek before these events. The chemical results for these sampling events are included in the database of this report.

1994 GAS PROBE INSTALLATIONS AND SURFACE WATER MONITORING

Additional gas probes were installed within the landfill area on August 8, 1994. The gas probes were installed with a soils drill rig, and are identified as GP101 to GP106. These monitors were incorporated into a monthly gas monitoring program which was carried out by G.K. Bell & Associates. These monitors are included in the current monthly gas monitoring program, with the exception of GP104, which has been destroyed.

Surface water sampling was also completed on June 24, 1994 at the same surface water stations sampled by Morrison Beatty Limited during the 1986 sampling events. These samples were analysed for general chemistry, metals, bacteriological parameters, volatile organic compounds, polycyclic aromatic hydrocarbons, herbicides, and pesticides. The general chemistry, metals, and volatile organic compounds are included in the database of this report.

The 1994 report suggested that the landfill had a moderately negative effect on the water quality of Joshua's Creek immediately adjacent to the landfill, however this interpretation was based on a simple comparison of surface water quality between the upstream station SW1, and the downstream station SW4. Sampling events completed since these events, which incorporated additional surface water stations along Joshua's Creek and the tributary, have confirmed that other off-site sources are influencing the water quality along Joshua's Creek, which are not associated with the landfill site.

1998 SURFICIAL GAS EMISSION ASSESSMENT REPORT

Comcor Environmental Limited was retained in December 1998 by the Region to assess the surficial emission of landfill gas from the closed landfill site. This work plan included the following.

- Determination of the average vinyl chloride and benzene surficial concentration across the site
- Identification of an area of maximum instantaneous emission, or "hot spot" of landfill gas emitting through the landfill cap, and collection of a sample for VOC analysis
- Collection of a landfill gas sample from the subsurface and analyses for VOCs

The surficial emission survey completed by Comcor Environmental indicated that the average benzene and vinyl chloride concentrations across the site were 17.7 µg/m^3 and 1.8 µg/m^3, respectively. The average concentration of vinyl chloride was below the Ontario Ministry of the Environment's Point of Impingement (POI) Standards. The average concentration of benzene was approximately five times higher than the average 1994 annual concentration in 20 Canadian cities. The elevated levels, compared to other closed landfills in the Regional Municipality of Halton is attributed to a combination of greater landfill gas emission through the landfill cap and the close proximity of the site to Highway 403 and Dundas Street. Benzene is a carcinogen and has no POI standard. Emission of benzene to the atmosphere is to be prevented or limited to the greatest extent possible. Details of their work program and results were included in the 2002 Environmental Management Plan.

2002 ENVIRONMENTAL MANAGEMENT PLAN

The original Environmental Management Plan for the site was completed in 2002 by Jagger Hims Ltd. (now WSP Canada Inc.), for the Regional Municipality of Halton. The plan consisted of reviewing existing reports, leachate monitoring for levels and chemistry, surface water sampling for chemistry, and an assessment of potential user risks and the need for remedial measures at the site. Surface water and leachate sampling events were carried out previously as part of the original environmental management plan.

The report concluded that “there are no measurable impacts on the surface water quality within Sixteen Mile Creek”. Recommendations included that a surface water sampling event be conducted on a biennial basis, and the monthly gas monitoring event should be continued, incorporating all of the accessible on-site monitors.

2012 ENVIRONMENTAL MANAGEMENT PLAN

The 2012 Environmental Management Plan for the site was completed in 2014 by WSP Canada Inc. (WSP) for the Regional Municipality of Halton. The plan consisted of reviewing existing reports, leachate monitoring for levels and chemistry, surface water sampling for chemistry, and an assessment of potential user risks and the need for remedial measures at the site. Surface water and leachate sampling events were carried out previously as part of the original environmental management plan.

The report concluded that there are no measurable landfill influences on the surface water quality within Joshua’s Creek; but water quality within the creek exhibited notable influences from the northern tributary. Recommendations included that a surface water sampling event be conducted on a biennial basis, and the monthly gas monitoring event should be continued, incorporating all of the accessible on-site monitors.

The Region subsequently incorporated the recommendations of the 2012 Environmental Management Plan and have completed the periodic surface water sampling events, and routine gas monitoring events, since that time.

1.2 OBJECTIVES AND SCOPE

The principal objectives of the environmental management plan are as follows:

- To assess the effects of the closed landfill site on local groundwater and surface water resources.
- To assess the effects of gas produced from the refuse.
- To assess the potential user risks.
- Provide an assessment of assets
- To assess the need for remedial measures.
- Provide a cost analysis of recommendations

The assessment involves a data collection component, collation, and an analysis and interpretation component.

1.3 METHODOLOGY

The environmental management plan for the Closed Oakville Ninth Line Landfill Site was comprised of several tasks, which are summarized below.

- Review of existing reports.
- Updating groundwater monitoring for chemistry.
- Updating surface water sampling for chemistry.
- Updating combustible gas monitoring data.
- Interpretation and reporting.

A quality assurance and quality control (QA/QC) program was followed for each of the monitoring tasks carried out by WSP. This program consisted of protocols and procedures for the purging of monitors, and the collection of groundwater, surface water, and leachate samples.

1.3.1 GROUNDWATER MONITORING

The collection of a groundwater sample was attempted from gas probe GP106 in October 2018, however, following the purging of a small amount of water from the probe, the monitor did not recover sufficiently during the subsequent weeks to permit sample collection. Since the water levels within the monitor are likely influenced by climatic conditions, it is recommended that the sampling of this monitor be attempting during the spring period, when water levels, and recovery times, are more suited to obtaining a sample.

The Clubhouse well was sampled for treated and un-treated groundwater quality on October 19, 2018. The samples were submitted to Maxxam Analytics for analysis of inorganics, volatile organic compounds (VOCs), and metal parameters.

1.3.2 LEACHATE MONITORING

To assess the leachate chemistry within the refuse, two boreholes were drilled within the refuse on October 28, 1999 using a soils drilling rig. The boreholes were advanced to the base of the refuse prior to the installation of the leachate monitors. The monitors are designated as 99-1 and 99-2, as shown in Figure 2. The most recent leachate samples were obtained from monitor 99-1 on October 5, and from monitor 99-2 on October 4, 2018. The samples were submitted to Maxxam Analytics for analysis of inorganics, volatile organic compounds (VOCs), and metal parameters.

1.3.3 SURFACE WATER SAMPLING

The surface water sampling carried out by Morrison Beatty was completed on June 11, 1986 and November 19, 1986, and analysed for general chemistry and metals. G.K. Bell & Associates completed the sampling on June 24, 1994, and analysed for general chemistry, metals, bacteriological parameters, volatile organic compounds, polycyclic aromatic hydrocarbons, herbicides, and pesticides. It is noted that a portion of the June 1994 samples were filtered during sampling due to excessive solids after a rain event. The study report does not indicate which bottles were filtered, or what filtration method was used. The proper protocol for surface water sampling requires that no filtering be carried out during sampling. As a result, the June, 1994 sample results have been interpreted with caution.

Water samples were obtained from surface water stations by WSP (formerly GENIVAR/Jagger Hims Ltd) on the following dates.

- September 15, 1999 SW2
- June 7, 2000 SW1, SW2, SW3, SW4, SW5, SW6
- September 30, 2000 SW1, SW2, SW4, SW5, SW6
- November 20, 2001 SW1, SW2, SW5, SW7, SW8, SW9, SW10
- November 1, 2011 SW1 – SW10
- August 14, 2014 SW1, SW2, SW3, SW4, SW5, SW7, SW8, SW9, SW10
- November 18, 2016 SW1 – SW10
- October 5, 2018 SW1 – SW13

Stations SW1, SW2, SW4-SW9, and SW11 are established along the length of Joshua's Creek, adjacent to the landfilled area. Station SW10 is established along the north tributary, prior to the tributary discharging to Joshua's Creek; and station SW3 and SW13 are established along the ditch on the south side of the refuse area. The locations of the stations are shown in Figure 2. The samples were collected by placing the sample bottle beneath the water surface. Samples from the 2001 sampling event and earlier were submitted to Maxxam Analytics for analysis of inorganics and metal parameters.

1.3.4 LANDFILL GAS MONITORING

Combustible gas measurements are obtained from each of the accessible gas probes on a monthly basis using a handheld Bacharach Model H combustible gas meter, or similar device, with summary reports prepared and submitted to the Region on a monthly basis.

1.3.5 ASSET ASSESSMENT

As part of the asset assessment for the site, an inventory of the existing gas probes and leachate monitors was completed in 2018. The conditions of the monitors are observed during each monthly gas monitoring event, and deficiencies are noted in the field book and communicated to the Region. This inventory considers various aspects of the monitor condition, including the condition of the riser, protective casing, cap, and lock (if applicable). The results in 2018 indicate that the monitors are generally in good condition, although locks periodically require replacement, and the leachate monitors 99-1 and 99-2 are susceptible to being buried or flooded during spring conditions, as these monitors are flush mounted because they are installed within, and adjacent to, the practice rugby field.

There is no other infrastructure at this site, associated with the landfill site.

1.3.6 INTERPRETATION AND REPORTING

Following the collation of the landfill database, analysis and interpretation of the data was completed. This component included the following items.

- Compliance assessment
- Requirement for remedial measures
- Consideration of future monitoring
- Financial Considerations

Results of the environmental management plan, with conclusions and recommendations, are presented in this report.

2 PHYSICAL SETTING

2.1 LOCAL GEOLOGY

The interpreted on-site geological conditions are shown in the Schematic Sections, Figure 3. Sections A and B present the geological conditions along the length of the landfilled area, and a typical section through central portion of the site. As shown in the figure, the landfilled area extends to the edge of Joshua's Creek.

The landfill is situated on a deposit of low bulk hydraulic conductivity clayey silt till, known as Halton Till. The clayey silt till overlies shale bedrock of the Queenston Formation.

The thickness of the refuse over the clayey silt ranges from about 7 m at 99-2, to 9 m at 99-1. It is expected that the thickness of the refuse will decrease in an easterly direction from Monitor 99-2, and in a westerly direction from Monitor 99-1. The depth to the bedrock was not determined during this investigation, however, since bedrock is present within the Joshua's Creek bed, the thickness of the clayey silt unit overlying the bedrock would be in the range of two to three metres.

2.2 SHALLOW GROUNDWATER FLOW

An interpretation of the shallow groundwater configuration, based on the September and October water level data, is presented in Figure 2. The leachate and groundwater levels are presented in Table B-3, Appendix B. The groundwater table, which is a reflection of the local topography, slopes towards the west and towards Joshua's Creek. The rate of groundwater movement through the refuse is estimated to be in the range of 0.7 m/a to 1.7 m/a, based on horizontal gradients of 0.013 and 0.033, respectively, a porosity of 0.3, and a hydraulic conductivity of $5x10^{-7}$ m/s. The till, which has a lower hydraulic conductivity than the refuse, acts as a barrier to the downward flow. Thus, there is a potential for leachate seeps to form at the contact of these two units, which would coincide with the edge of Joshua's Creek.

The Region currently completes a spring inspection at this site on an annual basis, which includes the identification of potential seeps at the site. The inspections occur during the spring to permit easier identification of seeps while the vegetative growth is minimal, and when the wetter seasonal conditions are more likely to promote the occurrence of seeps. The Region intends to continue this protocol in the future.

2.3 SURFACE WATER FLOW SYSTEM

Joshua's Creek is situated around the western portion of the refuse, as shown in Figure 2. A drainage ditch is located along the south property boundary line, just north of the pipeline easement. This drainage ditch slopes toward the west and discharges surface runoff to Joshua's Creek. On the north side of the landfill, surface drainage is also to the west, towards Joshua's Creek. A tributary also discharges to Joshua's Creek near the northwest corner of the landfill site. This tributary, which receives water from two stormwater ponds located northwest of the landfill site, discharges to Joshua's Creek on the opposite side of the stream from the refuse area.

Figure 2 shows the location of the surface water monitoring stations used for this study. SW1 is located upstream of the landfill site and SW4 is located downstream of the site. SW2 is located along the gabion wall at the location of a spring, and SW3 is located along the drainage ditch located along the southern side of the refuse, just prior to discharging into Joshua's Creek.

Surface water stations SW11 to SW13 were established and incorporated into the sampling program in 2018 at the recommendation of the MECP, in their letter dated January 16, 2017. Station SW11 was established midway between SW9 and SW6, along the west side of the landfill site, and stations SW12 and SW13 were established near the confluence of the perimeter ditch and Joshua's Creek, at the south end of the site.

A seep was identified approximately 20-25 metres upstream of station SW2 during the sampling event in November 2016, which had not previously been identified for this site. This location was approximately 10 m east (upstream) of the gabion wall, and the size of the seep was relatively small and localized. An additional inspection within this area was completed by WSP and Regional staff in early December 2016, and the seep was not present during this inspection. Inspections of the area will be continued during future spring inspection events.

3 STUDY RESULTS

3.1 LEACHATE QUALITY

The laboratory chemistry results for the inorganic and organic parameters at Monitors 99-1 and 99-2 are presented in Tables A-1 and A-2, of Appendix A, respectively. In general, the leachate general chemistry concentrations within the refuse are relatively low compared to typical landfill leachate. The low concentrations are attributed to the extended age of refuse within the landfilled area. A summary of the concentration values for the inorganic indicator parameters is presented below. All units are in mg/L.

		LEACHATE CONCENTRATIONS (2018)	
PARAMETER	**ODWQS STANDARDS**	**99-1**	**99-2**
Chloride	250	110	83
Hardness	80 - 100	590	740
DOC/TOC	5	56	44
Iron	0.30	37	45
Manganese	0.05	0.13	6.8
TDS	500	1200	1000

In general, the concentrations of the inorganic and metals for the sampling event in 2018 were similar to, or lower than, the concentrations exhibited in 1999, with the exception of iron, which was noticeably higher in 2018 compared to the results in 1999. The organic parameter concentrations for the 1999 sampling event were generally elevated, but the concentrations for these parameters were lower for the sampling event completed in 2018. A summary of the detected concentration values for the organic parameters in 2018 is presented below. All units are in µg/L.

		LEACHATE CONCENTRATIONS (2018)	
PARAMETER	**ODWQS STANDARDS**	**99-1**	**99-2**
1,4-Dichlorobenzene	1	3.6	0.68
Acetone		16	15
Benzene	5	12	83
Chlorobenzene	30	3.1	1.3
Ethyl benzene	2.4	0.87	0.85
m/p-Xylenes	300**	0.37	130
o-Xylene	300**	0.60	<0.20
Toluene	24	0.21	0.34
Xylenes: total	300	0.97	130

Note: ** - Standard is for total concentration of all xylenes

The differences in the leachate characteristics between these monitors are attributed to the variability of the refuse.

There are no downgradient groundwater users, as groundwater flow is towards Joshua's Creek. The surrounding area, with the exception of the clubhouse, is serviced by a municipal water supply, and the adjoining properties (including the clubhouse) are generally upgradient or laterally gradient of the landfilled area.

3.2 GROUNDWATER QUALITY

The laboratory chemistry results for the inorganic and organic parameters at gas probe GP106 and the Clubhouse Well (CW) are presented in Tables A-3 and A-4, in Appendix A, respectively. In general, the parameter concentrations of the groundwater during the sampling event in 2018 satisfied the Ontario Drinking Water Quality Standards (ODWQS) except for the following:

- Sulphate: CW-untreated, CW-treated
- Hardness: CW-untreated, CW-treated
- Uranium: CW-untreated, CW-treated
- Total dissolved solids: CW-untreated, CW-treated:

The parameters listed are not health related and only affect the aesthetic quality of the water, with the exception of uranium. The detection of uranium is not uncommon within the Oakville area, and the presence of uranium within the samples collected at the Clubhouse is not attributed to the landfill site. The elevated concentrations for sulphate, hardness, and total dissolved solids, compared to the ODWQS, are attributed to the naturally poor water quality within the area and are not attributed to the landfill site.

The organic parameter concentrations were generally below the estimated quantitation limit with the exception of 1,1-dichloroethane in the treated and untreated groundwater, and chloroform in the untreated groundwater, at the Clubhouse well. The concentrations of these parameters, however, are near the estimated quantitation limit, and satisfy the Ontario Drinking Water Quality Standards. The detected parameters in 2018 is similar to the pattern exhibited for the Clubhouse samples in 2011/2012.

3.3 SURFACE WATER QUALITY

The surface water laboratory results for inorganic parameters are summarized in Table A-5, Appendix A. The concentration vs distance graphs of selected parameters for the August 2014, November 2016, and October 2018 sampling events are included in Figures A-1 to A-5, Appendix A. The concentration vs distance graphs include chloride, sulphate, alkalinity, un-ionized ammonia, TOC, barium, boron, TDS, iron, and sodium.

Based on the three sampling events, there were some distinguishable trends between adjacent surface water stations from the upstream location, SW1, through to the downstream location, SW4. These trends included:

- Water quality along the north side of the refuse area, between stations SW2 and SW7 and/or SW8, is generally comparable to the concentrations at upstream station SW1 for chloride, sulphate, sodium, boron, alkalinity, un-ionized ammonia, TOC, barium, and TDS for a majority of the sampling events, although some variations are exhibited on the graphs.
- Concentrations of some parameters varied noticeably between stations SW8 and SW5, where the north tributary discharges to Joshua's Creek, during select events, including:
  - 2016: chloride, sodium, sulphate, alkalinity, barium, and boron (all increasing between stations)
  - 2018: chloride, sodium, alkalinity, TOC, and TDS decreasing, but boron increasing

- Concentrations for chloride, sodium, sulphate, alkalinity, TOC, and TDS during the August 2014 event were generally elevated between stations SW1 and SW7, compared to the remaining stations along Joshua's Creek.
- Concentrations for chloride, sodium, TOC, and TDS during the October 2018 event were generally elevated between stations SW1 and SW7, compared to the remaining stations along Joshua's Creek; which is similar to the pattern exhibited in August 2014.
- Parameter concentrations along the west side of the refuse area are relatively constant, or decrease slightly, between stations SW5 and SW4.
- Concentrations for several parameters during the October 2018 event exhibited noticeable concentration changes at station SW12, compared to station SW6. Station SW12 is established downstream of the ditch located along the south side of the refuse area. It is noted that the stations near the confluence of the ditch and Joshua's Creek (SW12 and SW13) were initially established in 2018, so only one event is available for comparison.

The patterns indicate that water quality within Joshua's Creek is noticeably influenced by discharge from the north tributary on occasion, and to a lesser extent, from the ditch located along the south side of the refuse area. Water quality along the north side of the refuse area, between SW2 and SW7 and/or SW8, is generally comparable to water quality at the upstream station SW1, with some variations; and water quality along the west side of the refuse area tends to be relatively similar between stations SW5 and SW4. Although there is likely a landfill influence on the surface water quality within Joshua's Creek, this influence is not as significant as other off-site sources and surficial run off, including the north tributary, at this time.

The surface water quality based on the August 2014 to October 2018 sampling results generally comply with the Provincial Water Quality Objectives (PWQOs) with the exception of those parameters listed in Table 1. As shown in the table, aluminum, boron, iron, and phosphorus exceeded the PWQO at a majority of the stations during at least one sampling event, between 2014 and 2018, including the upstream station, SW1, and the north tributary station SW10. It is noted that a majority of the PWQO exceedances for phosphorus occurred during the October 2018 event, and a majority of the PWQO exceedances for boron occurred during the August 2014 event. It is also noted that the concentrations for iron and phosphorus are also significantly influenced by sediment content within the collected sample. Since PWQO exceedances occurred at reference locations SW1 and SW10, the PWQO exceedances along Joshua's Creek are due to the natural variability of the surface water quality, including upstream and off-site sources, and are not solely attributed to the landfill site.

3.4 GAS MONITORING

Results of the recent routine combustible gas monitoring at the on-site monitors up until December 2018, are presented in Table C-1. In general, the combustible gas was not detected, with the exception of leachate gas monitors 99-1 and 99-2. Combustible gas concentrations at monitors 99-1 and 99-2 ranged up to 8% and 54% gas by volume in air, respectively, in 2018. A time-concentration graph for the gas concentrations within monitors 99-1 and 99-2 is presented in Figure C-1. Overall these readings indicate that there is no significant migration of methane gas beyond the landfilled area. The overall long-term trends for combustible gas are decreasing until mostly non-detectable in mid-2008.

4 ASSET CONDITION ASSESSMENT

The infrastructure (assets) that is present on-site is limited to the gas monitoring and leachate monitoring network.

The condition of the monitors was maintained in a satisfactory condition in 2018, based on observations made during the monthly gas monitoring events; with the main issues being associated with seized locks, which were replaced as needed.

5 DISCUSSION

5.1 WATER QUALITY

Leachate is produced at this site primarily from the percolation of precipitation through the refuse. The chemistry of the leachate depends on factors such as refuse composition and age, residence time, amount of infiltration, and flow pathways. Since 1995, a practice rugby field has been constructed within the eastern portion of the landfilled area. This area is relatively flat, which reduces surface water runoff, and promotes infiltration into the refuse. Some evaporation losses will occur during the summer.

In general, the general chemistry concentrations within the leachate produced at this site is relatively low compared to typical leachate, with most parameters satisfying the Ontario Drinking Water Standards. Several aesthetic guidelines are exceeded, including hardness, DOC, iron, manganese, and total dissolved solids. These parameters are not health related. The organic chemistry parameter concentrations were relatively elevated, with 1,4-dichlorobenzene and benzene being above the Ontario Drinking Water Standards. The significant chemical differences between the leachate samples at Monitors 99-1 and 99-2 is attributed to the varying composition of the refuse.

The on-site shallow groundwater flow is towards Joshua's Creek. Groundwater flow through the clayey silt till is slow, compared to the flow in the refuse, due to a lower hydraulic conductivity in the till. It is this difference in the hydraulic conductivity that would result in the breakout of leachate to the surface in the form of leachate seeps or springs along the base of the slope. A seep was observed approximately 20 m upstream of station SW2 during the November 2016 event but no additional seeps or springs were noted during the other site visits in 2014 and 2018. During extended periods of normal precipitation amounts, it is expected that the shallow groundwater flow through the refuse will intercept the base of Joshua's Creek. The seeps would likely occur during this wetter time period. It is expected, however, that the discharge from these seeps would be relatively low.

The Region currently completes a spring inspection at this site on an annual basis, which includes the identification of potential seeps at the site. The inspections occur during the spring to permit easier identification of seeps while the vegetative growth is minimal, and when the wetter seasonal conditions are more likely to promote the occurrence of seeps. The Region intends to continue this protocol in the future.

The water sampling results indicate that there is an influence on the surface water quality within Joshua's Creek by the north tributary discharge and other off-site sources. There is likely an additional influence from the landfill site, however this influence is considered to be negligible compared to the north tributary at this time, based on the minor variances in water quality along Joshua's Creek. It is noted that the tributary catchment area is off site towards the north, and the sources are unrelated to the landfill site.

It is recommended that the current surface water stations, leachate monitors, and groundwater sampling locations be sampled in 2020 to continue assessing the potential influence of the landfill on the creek at different locations along the stream during different flow periods. The requirement for future monitoring beyond 2020 should be based on the results of the monitoring event in 2020. If future monitoring results indicate that Joshua's Creek is being measurable influenced by sources other than the tributary, an additional three groundwater monitors could be installed and sampled at the locations shown in Figure 2 to better assess the potential for a leachate influence on surface water quality.

5.2 LANDFILL GAS

The principal combustible gas is methane, which has a lower explosive limit of 5% volume in air, and an upper explosive limit of 15%. Since methane is lighter than air, it typically moves upwards from the refuse into the soil cover, and dissipates by venting to the atmosphere. During periods of frost, venting is reduced or inhibited by frozen soils. As lateral movement of gas is naturally restricted by the low hydraulic conductivity soils, the relatively high groundwater table, and the configuration of the site, gas concentrations tend to increase in the refuse during these periods. The methane concentrations within the refuse are generally higher than the upper explosive limit for methane, but the gas monitors around the periphery of the landfilled area indicate that there is no significant lateral migration of methane gas.

There is no gas collection or venting system on the site. The lack of lateral migration of combustible gas, along with the current uses for the site, indicates that additional landfill gas controls are not required at the present time. Based on the age of the waste, the peak rate of landfill gas generation at the site has passed, and gas controls will likely not be required in the future. If future gas monitoring indicates a change in the migration of combustible gases and/or there is a change in land use(s) on the property, consideration of landfill gas control may be required. The implementation of gas controls would be required if the monitoring results suggest that there is a potential hazard for structures or users of the property. Due to the relative age of the waste, and relatively low rate of gas generation, the gas control would likely take the form of passive gas vents.

5.3 ASSET CONDITION ASSESSMENT

The infrastructure (assets) that is present on-site is limited to the gas monitoring and leachate monitoring network. The condition of the monitors was maintained in a satisfactory condition in 2018, based on observations made during the monthly gas monitoring events; with the main issues being associated with seized locks, which were replaced as needed. Observations of the monitor conditions, and implementation of suitable repairs, will be continued by the Region as part of the future monthly gas monitoring program.

5.4 REMEDIAL MEASURES

Based on the surface water sampling results obtained between 2014 and 2018, the surface water quality adjacent to the landfill site is not adversely influenced by the landfill site and, therefore, a benthic study is not required at the present time.

The requirement for remedial measures will be dependent on future monitoring results at the site. If future monitoring results indicate that the landfill site is having a measurable influence on the water quality within Joshua's Creek, a benthic study may be undertaken for Joshua's Creek to determine the actual extent of the water quality impacts on the flora and fauna of the creek. Options to address measurable negative influences from the landfill site will be considered at such time, if required.

If the results from the benthic study indicate that there is an impact on the creek, a cost-benefit analysis should be done for the possible remedial alternatives. Remedial measures which can be considered for landfill impacts could include the following:

- Installation of a leachate collector system along the creek side of the refuse.
- Installation of sumps within the refuse to reduce leachate levels.

An outline of the strategy is presented in Figure 4.

5.4.1 LANDFILL CAPPING

Reduction of infiltration into the refuse can be accomplished by increasing the quality of the cover (cap) material, and promoting surface water runoff. Currently, the cover material over the landfilled area is approximately 3 metres in the areas of the refuse monitors and consists of a silty clay. The clayey silt material is adequate for reducing infiltration into the refuse, however, the eastern portion of the landfilled area is relatively flat, which does not promote surface water runoff. If the infiltration into the refuse needs to be further reduced, the site should be graded to promote surface water runoff. These soils would then be covered with topsoil, and seeded with grass, to promote evapotranspiration. Alternate vegetation, such as hybrid poplar, will further reduce infiltration through increased evapotranspiration. These site alterations, however, would not permit a rugby field to remain on this portion of the landfill property.

5.4.2 LEACHATE COLLECTOR SYSTEM

There is no leachate collection system installed at this site. With the exception of select sampling events in 2000 and 2016, leachate seeps have not been detected at the site. If site conditions were to change in the future, or future supplemental monitoring revealed an adverse landfill influence on adjacent water resources, additional remediation measures will be considered and recommended.

5.4.3 PURGE WELLS

If site conditions were to change in the future, or future supplemental monitoring revealed an adverse landfill influence on adjacent water resources, purge wells may be one option that is considered to reduce the negative landfill influence on the adjacent surface water quality. The installation of purge wells within the refuse will reduce leachate levels within the landfill. The purge wells can be placed along the northern and western portion of the landfill site, and extended to the base of the refuse. Sump pumps can be placed within the wells to remove the leachate once pre-determined levels are reached. The leachate collected in the wells can be: i) pumped to a holding tank, which is then trucked off site on a routine basis, or ii) pumped directly to a sanitary sewer.

It is noted, however, that purge wells will only be one of various options that would be considered, if remedial measures were required in the future; and the actual selection of the purge well options would only occur if the in-situ characteristics of the site are suited efficient purge well operation.

5.5 COST ANALYSIS OF RECOMMENDATIONS

Based on the recommendations provided in this Environmental Management Plan, the following costing would be incurred:

- Monthly gas monitoring events: $4,000/year
- Maintenance of gas probes and leachate monitors (repairs, replacement): $500/year
- Biennial water sampling event (including surface water, leachate, and clubhouse water samples): $6,000/event (includes laboratory fees of approximately $3,000/event)

5.6 MECP COMMENTS

The Ministry of the Environment, Conservation, and Parks provided several recommendations following their review of the 2012 Environmental Management Plan, and outlined in their letter dated January 16, 2017. A copy of the Response to MECP Comments is provided in Appendix D.

In general, based on the Ministry comments and recommendations in the letter, two additional surface water stations were established along Joshua's Creek, and an additional station was established along the perimeter ditch along the south side of the refuse area, as part of the 2018 surface water sampling program. The existing upstream station, SW1, is considered suitable as an upstream station for this site. The resulting surface water monitoring network is considered sufficient for the assessment of potential influences on surface water quality within Joshua's Creek, including potential influences from the landfill site and other off-site and/or upstream sources.

Based on the results of the biennial surface water sampling, and the results obtained from the existing leachate monitors, installation of additional monitors (A, B, C) is not required at the present time. The results of the surface water quality monitoring also indicate that a benthic study is not required at the present time.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The following conclusions are based on the findings presented in this report.

- Local groundwater flow is in a westerly direction towards Joshua's Creek.
- Leachate within the refuse is produced from the infiltration of precipitation and snowmelt. The general chemistry concentrations within the leachate are generally low, with most values satisfying the Ontario Drinking Water Standards, whereas several organic parameters are elevated above the Ontario Drinking Water Standards. These parameters do, however, satisfy the Guidelines for Use At Contaminated Sites in Ontario.
- There were no seeps present along the slope of the landfill with the exception of single seeps being detected during the June 2000 and November 2016 sampling events. Generally dry conditions would aid in reducing any seeps.
- The landfill site has no measurable adverse influence on the water quality within Joshua's Creek.
- Surface water quality in Joshua's Creek is affected by the tributary discharge in the area of SW5. There is likely an additional influence from the landfill site, however, this influence is considered to be negligible, compared to the tributary, at this time. The pathways for the surface water influence may also include overland runoff.
- There are no groundwater users in the area which are affected by this site.
- Combustible gas levels within the surrounding subsurface were generally low during the 2018 monitoring period. These results indicate that there was no hazard potential for surrounding structures or users during the monitoring program.
- The existing surface water monitoring network and sampling program is sufficient for identifying influences on the water quality within Joshua's Creek, adjacent to the landfill site; which includes potential influences from the landfill site, the western tributary, or other off-site sources not associated with the landfill site.

6.2 RECOMMENDATIONS

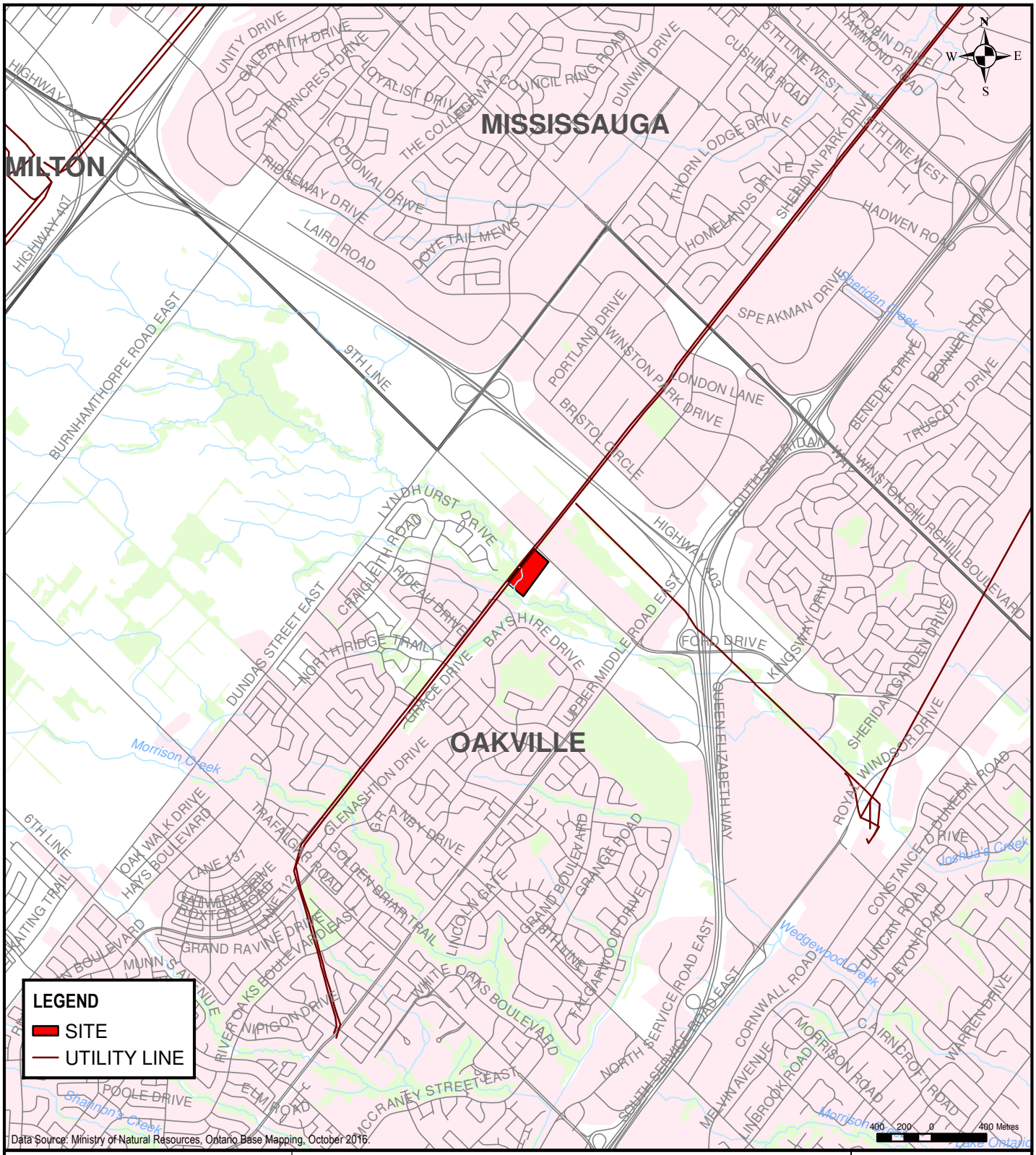
We respectfully submit the following recommendations based on the study findings for your consideration.

- A groundwater, leachate, and surface water sampling event is suggested for 2020, as part of the perpetual care of the site. Details are contained in Section 4.1.
- The monthly gas monitoring program should be continued for the site, as part of the perpetual care of the site. Monitor deficiencies should also be noted during these events, with repairs implemented as required.
- Additional surficial monitoring should be completed within the landfilled area, and on adjacent properties, if subsurface gas monitoring indicates a future change in landfill gas migration at the site. The surficial monitoring would confirm the concentrations of benzene and vinyl chloride concentrations on the subject property, and better assess the influence of the nearby highway traffic on the benzene levels.
- The results of the sampling and remedial monitoring should be reviewed and assessed to determine if additional measures are required.
- The existing gas and surface water monitoring network, and the established monitoring program should be maintained for the future monitoring programs, as part of the perpetual care of the site, unless additional monitoring results indicate that revisions are required.

7 REFERENCES

- Landfill Gas Surface Emission Study, Ninth Line Landfill, Comcor Environmental Limited, February 10, 1999.
- Leachate Sampling and Comparison – Final Report, Ninth Line Landfill, Oakville, Ontario, G.K. Bell & Associates Ltd., April 18, 1995.
- Gas Probe Installation, Ninth Line Landfill, Oakville, Ontario, G.K. Bell & Associates Ltd., September 8, 1994.
- Hydrogeologic Impact Study, Ninth Line Landfill, Town of Oakville, Morrison Beatty Limited, January 30, 1987.
- Closed Oakville Ninth Line Landfill Site Environmental Management Plan, Jagger Hims Limited, October 2002.
- Closed Oakville Ninth Line Landfill Site 2012 Environmental Management Plan, WSP Canada Inc., February 2014.

FIGURES



Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2016.

wsp

126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

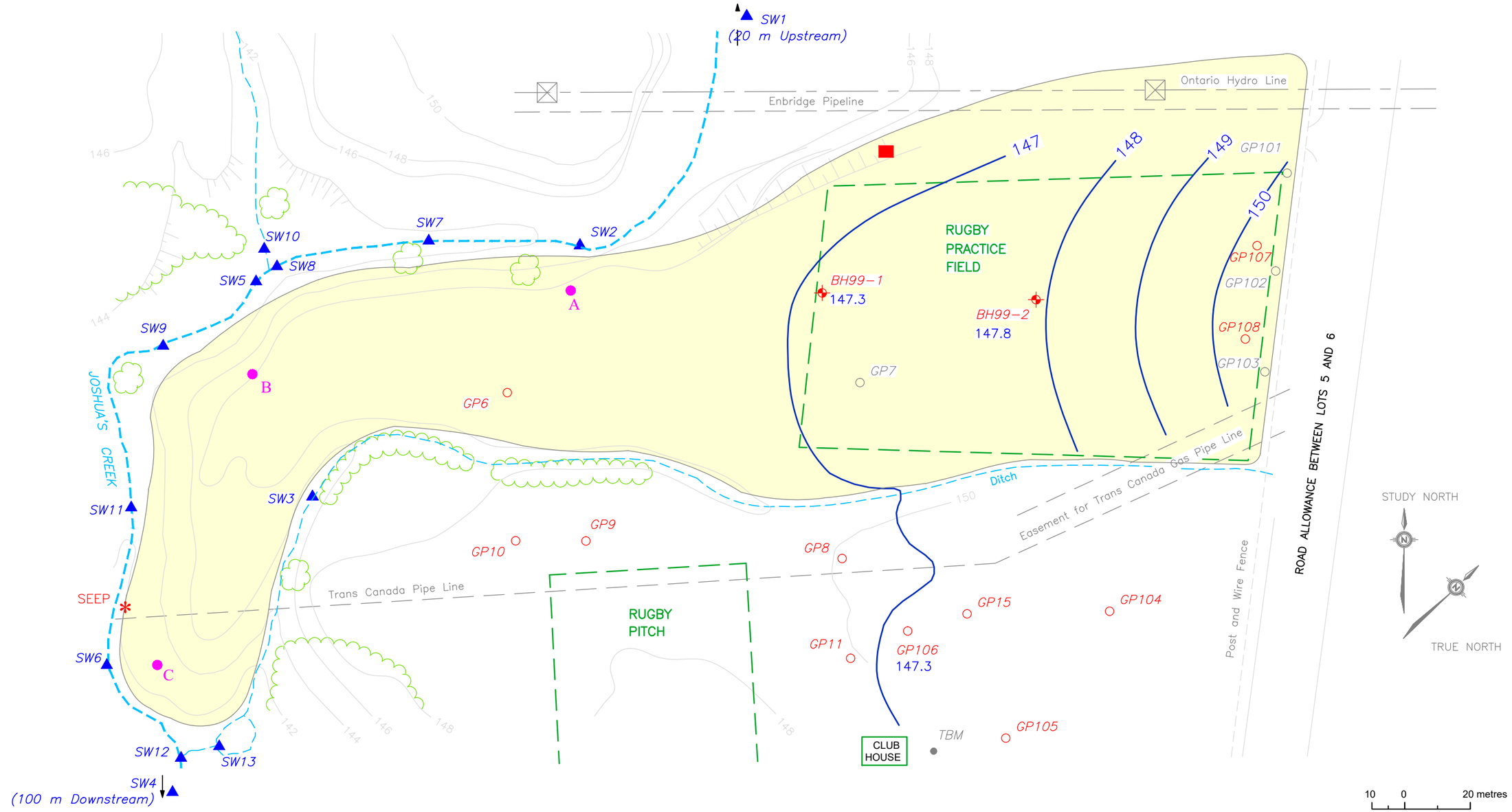
PROJECT:
CLOSED OAKVILLE NINTH LINE LANDFILL SITE
ENVIRONMENTAL MANAGEMENT PLAN

TITLE:
LOCATION MAP

CLIENT:
REGIONAL MUNICIPALITY OF HALTON

SCALE:	1:40,000
DRAWN BY:	PLB
CHECKED BY:	SJT
PROJECT NO:	181-30000-00 106
DATE:	FEBRUARY 2019
FIGURE NO:	1
REV.:	-

Document Path: T:\181-30000-00106\MXD\181-30000-00 106 F1 Location Map.mxd



126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

LEGEND

- APPROXIMATE EXTENT OF RUGBY PRACTICE FIELD
- GP101 150.3 — EXISTING GAS PROBE LOCATION, DESIGNATION, AND WATER LEVEL ELEVATION
- GP104 — PREVIOUS GAS PROBE LOCATION AND DESIGNATION
- BH99-1 147.3 — LEACHATE MONITOR LOCATION, DESIGNATION, AND LEACHATE ELEVATION
- TBM — TEMPORARY BENCH MARK LOCATION (Top of green hydro box, approx. 150.3 m)
- SW1 — SURFACE WATER SAMPLING LOCATION AND DESIGNATION
- LOCATION OF MAXIMUM INSTANTANEOUS GAS EMISSION "HOT SPOT" (Comcor, 1998)
- APPROXIMATE EXTENT OF REFUSE
- A — PROPOSED LEACHATE MONITOR
- SEEP — INTERMITTENT SEEP (Detected only during the June 2000 surface water monitoring event)

CLIENT: REGIONAL MUNICIPALITY OF HALTON	PROJECT NO: 181-30000-00 106	DATE: FEB. 2019	TITLE: SITE PLAN
CLIENT REF. #:	DESIGNED BY: SJT		
PROJECT: CLOSED OAKVILLE NINTH LINE LANDFILL SITE ENVIRONMENTAL MANAGEMENT PLAN	DRAWN BY: PLB		DISCIPLINE: ENVIRONMENT
	CHECKED BY: SJT		ISSUE:
	FIGURE NO: 2	SCALE: 1:1250	DATE OF:

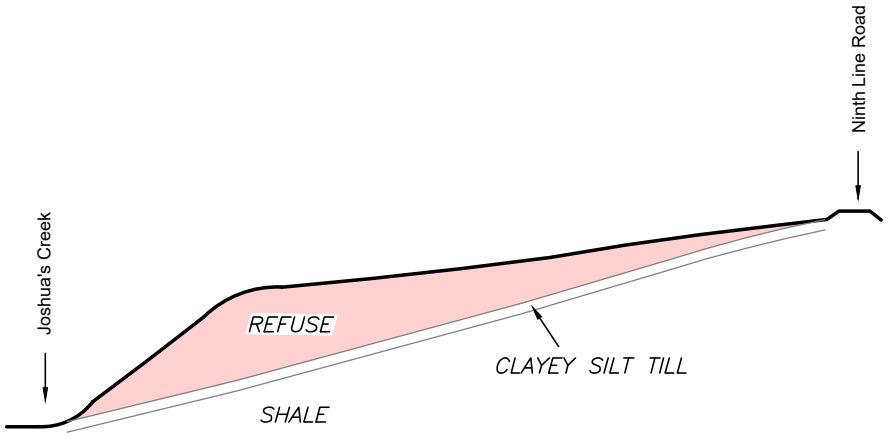
Ansi B-SCE, H:\Proj\18\30000-00\106 Oakville Ninth Line\1001\Grph\Env Management Plan\181-30000-00 106 F2.dwg , 2/11/2019 4:49:49 PM

West

East

A

A'

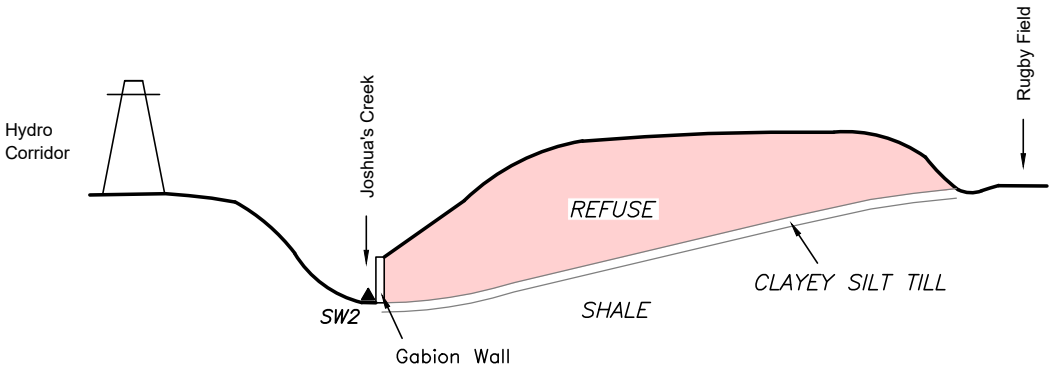


North

South

B

B'



Legend

REFUSE

SW2 ▲ SURFACE WATER STATION

GEOLOGIC CONTACT

126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

PROJECT:
CLOSED OAKVILLE NINTH LINE LANDFILL SITE ENVIRONMENTAL MANAGEMENT PLAN

TITLE:
SCHEMATIC SECTIONS

CLIENT:
REGIONAL MUNICIPALITY OF HALTON

SCALE: NOT TO SCALE

DRAWN BY: PLB

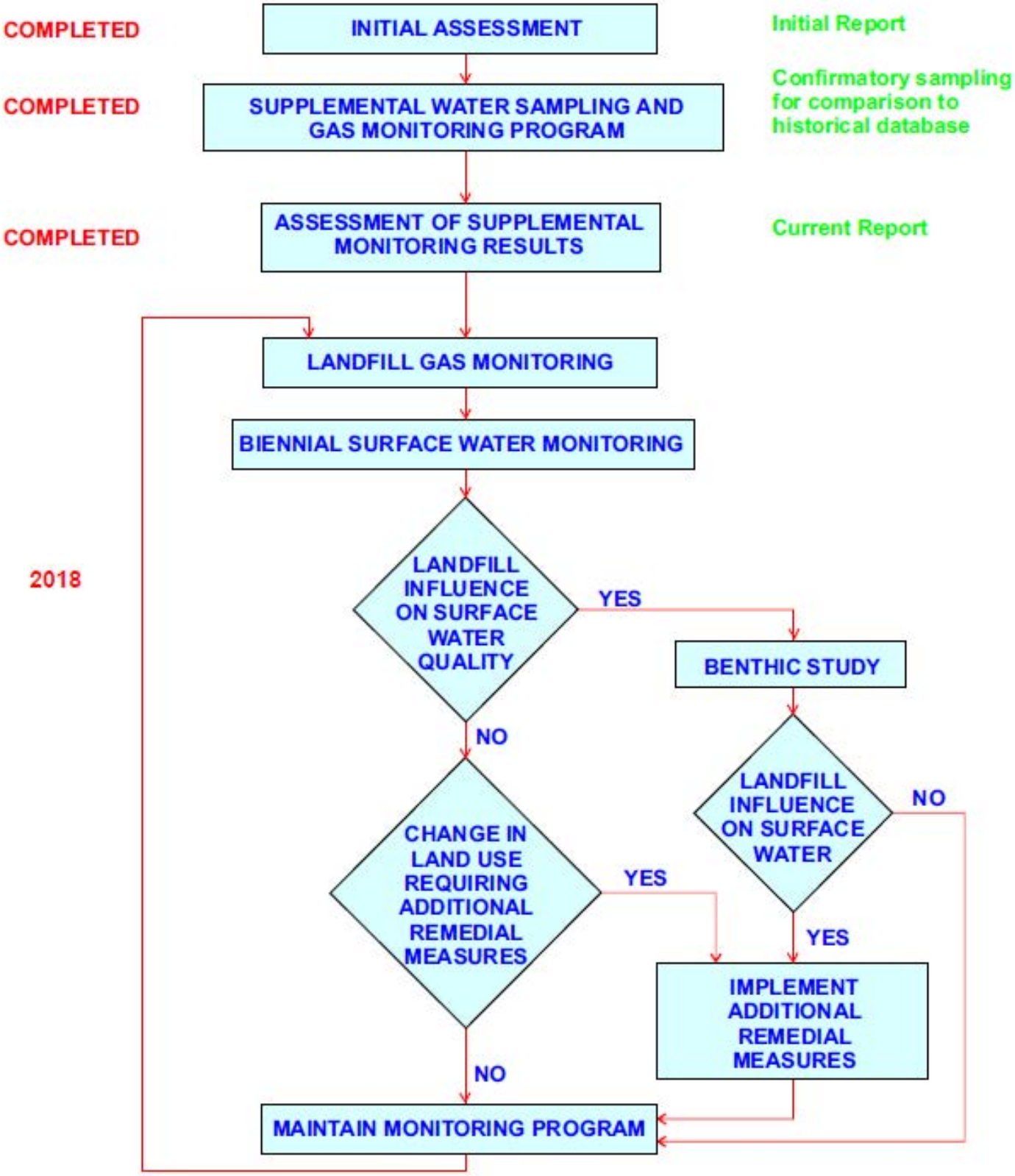
PROJECT NO: 181-30000-00 106

DATE: FEBRUARY 2019

FIGURE NO: 3

REV. #.

Figure 4
CLOSED NINTH LINE LANDFILL SITE
RECOMMENDED ENVIRONMENTAL MANAGEMENT PLAN



TABLES

TABLE 1
SURFACE WATER PWQO EXCEEDANCES
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

			PARAMETER and PWQO				
LOCATION	**STATION**	**SAMPLING EVENT**	**ALUMINUM** (0.075 mg/L)	**BORON** (0.200 mg/L)	**IRON** (0.300 mg/L)	**PHOSPHORUS** (0.030 mg/L)	**ZINC** (0.030 mg/L)
UPSTREAM	**SW1**	Aug-14	0.10				
		Nov-16					
		Oct-18	0.76		1.20	0.090	
ADJACENT TO REFUSE AREA	**SW2**	Aug-14	0.50	0.23	0.86	0.100	
		Nov-16					
		Oct-18	0.23		0.40	0.092	
	SW7	Aug-14	0.20	0.24			
		Nov-16					
		Oct-18	0.23		0.38	0.094	
	SW8	Aug-14	0.20	0.20	0.32		
		Nov-16					
		Oct-18	0.23		0.39	0.090	
	SW5	Aug-14	0.30	0.21	0.37		
		Nov-16					
		Oct-18	0.22		0.36	0.070	
	SW9	Aug-14	0.20	0.21	0.33		
		Nov-16		0.22			
		Oct-18	0.23		0.39	0.082	
	SW11	Aug-14	-	-	-	-	-
		Nov-16	-	-	-	-	-
		Oct-18	0.23		0.37	0.077	
	SW6	Aug-14	-	-	-	-	-
		Nov-16		0.23			
		Oct-18	0.39		0.67	0.097	
DOWNSTREAM	**SW12**	Aug-14	-	-	-	-	-
		Nov-16	-	-	-	-	-
		Oct-18	0.16		0.71	0.034	
	SW4	Aug-14	0.20	0.20			
		Nov-16	0.22	0.21	0.44	0.038	
		Oct-18	0.34		0.57	0.082	
NORTH TRIBUTARY	**SW10**	Aug-14	0.30	0.21	0.37		
		Nov-16		0.23		0.036	
		Oct-18	0.13	0.23		0.048	
SOUTH DITCH	**SW3**	Aug-14	0.60	0.26	1.10		0.210
		Nov-16			2.10		
		Oct-18	0.14		2.10		
	SW13	Aug-14	-	-	-	-	-
		Nov-16	-	-	-	-	-
		Oct-18	0.28		0.47	0.086	

NOTES: 1) PWQO - Provicial Water Quality Objectives (1999)
2) Blank indicates parameter concentration was within the PWQO.
3) "-" - Indicates parameter not analysed during the sampling event presented.

APPENDIX

A CHEMISTRY RESULTS

TABLE A-1
LEACHATE GENERAL CHEMISTRY RESULTS
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

PARAMETER	UNITS	ODWS	99-1		99-2	
			Nov-99	Oct-18	Nov-99	Oct-18
pH	**units**	**6.5-8.5**	6.84	7.03	7.03	7.37
Conductivity	**µS/cm**		2920	360	2010	1500
Chloride	**mg/L**	**250**	188	110	187	83
Phosphate-ortho	**mg/L**		<0.3	<0.20	<0.3	<0.20
Sulphate	**mg/L**	**500**	9.2	<20	354.0	<20
Alkalinity	**mg/L**		1540	1000	620	830
Bicarbonate	**mg/L**		1540	1000	619	830
Carbonate	**mg/L**		1.0	1.0	<1	1.8
Hardness	**mg/L**	**80-100**	770	590	949	740
Nitrate	**mg/L**	**10.0 ***	<0.2	<0.50	<0.2	<0.10
Nitrite	**mg/L**	**1.0 ***	<0.2	<0.05	<0.2	0.06
Ammonia	**mg/L**		154	94	0.16	17
Dissolved Organic Carbon	**mg/L**	**5**	98	56	52	44
Aluminum	**mg/L**		<0.03	0.01	<0.03	0.02
Antimony	**mg/L**	**0.006**		0.0014		<0.0005
Arsenic	**mg/L**	**0.025**		0.0190		0.0083
Barium	**mg/L**	**1.0 ***	1.06	0.74	0.13	0.35
Beryllium	**mg/L**		<0.0005	<0.0005	<0.0005	<0.0005
Bismuth	**mg/L**		<0.1		<0.1	
Boron	**mg/L**	**5.0 ***	2.88	1.30	1.10	0.75
Cadmium	**mg/L**	**0.005 ***	<0.005	<0.0001	<0.005	<0.0001
Calcium	**mg/L**		133	120	230	220
Chromium	**mg/L**	**0.05 ***	<0.005	<0.005	<0.005	<0.005
Cobalt	**mg/L**		0.010	0.004	<0.005	0.002
Copper	**mg/L**	**1**	<0.003	<0.001	<0.003	0.002
Iron	**mg/L**	**0.3**	0.19	37	0.01	45
Lead	**mg/L**	**0.01 ***	0.3000	<0.0005	0.0030	<0.0005
Magnesium	**mg/L**		107.0	71.0	91.3	49.0
Manganese	**mg/L**	**0.05**	0.30	0.13	1.73	6.80
Molybdenum	**mg/L**		0.11	<0.0005	<0.02	<0.0005
Nickel	**mg/L**		0.04	0.004	<0.02	0.003
Phosphorus	**mg/L**		<0.1	0.7	<0.1	0.2
Potassium	**mg/L**		77	42	12	18
Selenium	**mg/L**	**0.01**		<0.002		<0.002
Silica	**mg/L**		20.6	13.0	22.3	9.5
Silver	**mg/L**		<0.003	<0.0001	<0.003	<0.0001
Sodium	**mg/L**	**200**	183	69	150	55
Strontium	**mg/L**		1.74	0.90	0.65	0.86
Thallium	**mg/L**			<0.00005		<0.00005
Tin	**mg/L**		<0.05		<0.05	
Titanium	**mg/L**		<0.005	<0.005	<0.005	<0.005
Uranium	**mg/L**			<0.0001		0.001
Vanadium	**mg/L**		0.007	0.002	0.005	0.003
Zinc	**mg/L**	**5**	<0.005	<0.005	<0.005	<0.005
Total Dissolved Solids	**mg/L**	**500**	1840	1200	1420	1000

NOTES: 1) ODWS - Ontario Drinking Water Standards, Objectives and Guidelines, 2006
2) * - Indicates health related Drinking Water Standard.

TABLE A-2
LEACHATE ORGANIC CHEMISTRY RESULTS
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

PARAMETER	ODWS	99-1		99-2	
		Oct-99	Oct-18	Oct-99	Oct-18
1,1,1,2-Tetrachloroethane		<8.0	<0.50	<200	<0.50
1,1,1-Trichloroethane		<8.0	<0.20	<200	<0.20
1,1,2,2-Tetrachloroethane		<8.0	<0.50	<200	<0.50
1,1,2-Trichloroethane		<8.0	<0.50	<200	<0.50
1,1-Dichloroethane		<8.0	<0.20	<200	<0.20
1,1-Dichloroethylene		<8.0	<0.20	<200	<0.20
1,2-Dichlorobenzene	**3**	<8.0	0.96	<200	<0.50
1,2-Dichloroethane	**5 ****	<8.0	<0.50	<200	<0.50
1,2-Dichloropropane		<8.0	<0.20	<200	<0.20
1,3-Dichlorobenzene		<8.0	<0.50	<200	<0.50
1,3-Dichloropropylene			<0.50		<0.50
1,4-Dichlorobenzene	**1**	<8.0	3.6	<200	0.68
Acetone		<400	16	<10000	15
Benzene	**5 ****	27.5	12	<100	83
Bromodichloromethane		<8.0	<0.50	<200	<0.50
Bromoform		<8.0	<1.0	<200	<1.0
Bromomethane		<20.0	<0.50	<500	<0.50
Carbon tetrachloride	**5 ****	<8.0	<0.20	<200	<0.20
Chlorobenzene	**30**	<8.0	3.1	<200	1.3
Chloroethane		<20.0		<500	
Chloroform		<8.0	<0.20	<200	<0.20
Chloromethane		<40.0		<1000	
cis-1,2-Dichloroethylene		<8.0	<0.50	<200	<0.50
cis-1,3-Dichloropropylene		<8.0	<0.30	<200	<0.30
Dibromochloromethane		<8.0	<0.50	<200	<0.50
Dichlorodifluoromethane			<1.0		<1.0
Dichloromethane	**50 ****	<40.0	<2.0	<1000	<2.0
Ethyl benzene	**2.4**	* 5.4	0.87	668	0.85
Ethylene dibromide		<8.0	<0.20	<200	<0.20
Hexane			<1.0		<1.0
m/p-Xylenes	**300 *****	29.0	0.37	1950	130
Methyl butyl ketone		<200		<5000	
Methyl ethyl ketone		<200	<10	<5000	<10
Methyl isobutyl ketone		<200	<5.0	* 4480	<5.0
Methyl t-butyl ether		<8.0	<0.50	<200	<0.50
o-Xylene	**300 *****	* 6.2	0.60	453	<0.20
Styrene		<8.0	<0.50	<200	<0.50
Tetrachloroethylene		<8.0	<0.20	<200	<0.20
Toluene	**24**	<8.0	0.21	5470	0.34
trans-1,2-Dichloroethylene		<8.0	<0.50	<200	<0.50
trans-1,3-Dichloropropylene		<8.0	<0.40	<200	<0.40
Trichloroethylene	**50 ****	<8.0	<0.20	<200	<0.20
Trichlorofluoromethane		<20.0	<0.50	<500	<0.50
Vinyl chloride	**2 ****	<20.0	<0.20	<500	<0.20
Xylenes: total	**300**	35.2	0.97	2403	130

NOTES: 1) ODWS - Ontario Drinking Water Standards, Objectives and Guidelines, 2006
2) Blank indicates parameter not analysed.
3) * - Indicates trace concentration detected below the Limit of Quantitation.
** - Indicates health related drinking water standard.
*** - Standard is total concentration of all xylenes.
4) Concentrations in µg/L.

TABLE A-3
GROUND WATER GENERAL CHEMISTRY RESULTS
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

PARAMETER	UNITS	ODWQS	GP106	CLUBHOUSE Treated		CLUBHOUSE Untreated	
			Sep-99	Nov-11	Oct-18	Jun-12	Oct-18
pH	**units**	**6.5-8.5**	8.06	8.07	7.54	7.01	7.83
Conductivity	**µS/cm**		1490	2800	2800	830	2800
Colour	**TCU**	**5**	8				
Chloride	**mg/L**	**250**	6	180	230	160	240
Phosphate-ortho	**mg/L**		<0.3	0.02	<0.010	<0.010	<0.010
Sulphate	**mg/L**	**500**	646	720	560	800	570
Alkalinity	**mg/L**		235	528	600	530	590
Bicarbonate	**mg/L**		232	522	600	530	590
Carbonate	**mg/L**		3	6	1.9	<1.0	3.7
Hardness	**mg/L**	**80-100**	893	880	1200	1200	980
Nitrate	**mg/L**	**10.0 ***	<0.2	0.2	<0.10	<0.10	<0.10
Nitrite	**mg/L**	**1.0 ***	<0.2	<0.01	<0.010	<0.010	<0.010
Ammonia - total	**mg/L**		0.06	<0.05	<0.050	<0.050	<0.050
Dissolved Organic Carbon	**mg/L**	**5.0**	4.9	2.6	2.5	2.2	2.5
Aluminum	**mg/L**		<0.05	<0.005	0.0065	<0.005	0.012
Antimony	**mg/L**	**0.006**			<0.00050		<0.00050
Arsenic	**mg/L**	**0.025**			<0.0010		<0.0010
Barium	**mg/L**	**1.0 ***	0.039	0.003	0.0093	0.0073	0.011
Beryllium	**mg/L**		<0.005	<0.0005	<0.00050	<0.0005	<0.00050
Bismuth	**mg/L**		<0.1				
Boron	**mg/L**	**5.0 ***	0.240	1.9	1.7	1.7	1.6
Cadmium	**mg/L**	**0.005 ***	<0.005	<0.0001	<0.00010	<0.0001	<0.00010
Calcium	**mg/L**		151	76	130	130	110
Chromium	**mg/L**	**0.05 ***	<0.01	<0.005	<0.0050	<0.005	<0.0050
Cobalt	**mg/L**		<0.01	<0.0005	<0.00050	<0.0005	<0.00050
Copper	**mg/L**	**1.0**	<0.01	0.06	0.085	0.0022	0.10
Iron	**mg/L**	**0.30**	<0.01	<0.1	<0.10	<0.1	<0.10
Lead	**mg/L**	**0.01 ***	<0.001	0.0006	<0.00050	<0.0005	0.0095
Magnesium	**mg/L**		125	170	200	210	170
Manganese	**mg/L**	**0.05**	0.090	0.004	0.0030	0.0025	0.0039
Mercury	**mg/L**	**0.001**					
Molybdenum	**mg/L**		<0.05	0.0072	0.0060	0.0067	0.0051
Nickel	**mg/L**		<0.05	<0.001	0.0010	<0.001	0.11
Phosphorus	**mg/L**		<0.1	<0.1	<0.10	<0.1	<0.10
Potassium	**mg/L**		9.7	32	36	33	29
Selenium	**mg/L**	**0.01**			<0.0020		<0.0020
Silica	**mg/L**		10.7	3.6	4.0	3.6	3.3
Silver	**mg/L**		<0.005	<0.0001	<0.00010	<0.0001	<0.00010
Sodium	**mg/L**	**200**	36.8	340	160	170	130
Strontium	**mg/L**		1.1	2.8	6.3	5.7	5.1
Thallium	**mg/L**				<0.000050		<0.000050
Tin	**mg/L**		<0.10				
Titanium	**mg/L**		<0.005	<0.005	<0.0050	<0.005	<0.0050
Tungsten	**mg/L**				<0.0010		<0.0010
Uranium	**mg/L**	**0.02**		0.045	0.039	0.043	0.031
Vanadium	**mg/L**		0.006	<0.0005	<0.00050	<0.0005	<0.00050
Zinc	**mg/L**	**5.0**	<0.01	0.019	0.015	0.008	0.43
Total Dissolved Solids	**mg/L**	**500**	1130	1840	1700	1830	1600

NOTES: 1) ODWS - Ontario Drinking Water Standards, Objectives and Guidelines, 2006
2) * - Indicates health related Drinking Water Standard.

TABLE A-4
GROUND WATER ORGANIC CHEMISTRY RESULTS
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

PARAMETER	ODWS	GP106	CLUBHOUSE Treated		CLUBHOUSE Untreated	
		Sep-99	Nov-11	Oct-18	Jun-12	Oct-18
1,1,1,2-Tetrachloroethane		<0.2	<0.1	<0.50	<0.2	<0.50
1,1,1-Trichloroethane		<0.2	<0.1	<0.20	<0.1	<0.20
1,1,2,2-Tetrachloroethane		<0.2	<0.2	<0.50	<0.2	<0.50
1,1,2-Trichloroethane		<0.2	<0.2	<0.50	<0.2	<0.50
1,1-Dichloroethane		<0.2	0.4	0.30	0.39	0.22
1,1-Dichloroethylene		<0.2	<0.1	<0.20	<0.1	<0.20
1,2-Dichlorobenzene	**3**	<0.2	<0.2	<0.50	<0.2	<0.50
1,2-Dichloroethane	**5 ****	<0.2	<0.2	<0.50	<0.2	<0.50
1,2-Dichloropropane		<0.2	<0.1	<0.20	<0.1	<0.20
1,3-Dichlorobenzene		<0.2	<0.2	<0.50	<0.2	<0.50
1,4-Dichlorobenzene	**1**	<0.2	<0.2	<0.50	<0.2	<0.50
Acetone		<10.0	<10	<10	<10	<10
Benzene	**5 ****	0.2	<0.1	<0.20	<0.1	<0.20
Bromodichloromethane		<0.2	<0.1	<0.50	<0.1	<0.50
Bromoform		<0.2	<0.2	<1.0	<0.2	<1.0
Bromomethane		<0.5	<0.5	<0.50	<0.5	<0.50
Carbon tetrachloride	**5 ****	<0.2	<0.1	<0.20	<0.1	<0.20
Chlorobenzene		<0.2	<0.1	<0.20	<0.1	<0.20
Chloroethane		<0.5				
Chloroform		<0.2	<0.1	<0.20	<0.1	0.40
Chloromethane		<1.0				
cis-1,2-Dichloroethylene		<0.2	<0.1	<0.50	<0.1	<0.50
cis-1,3-Dichloropropylene		<0.2	<0.2	<0.30	<0.2	<0.30
Dibromochloromethane		<0.2	<0.2	<0.50	<0.2	<0.50
Dichlorodifluoromethane				<1.0		<1.0
Dichloromethane	**50 ****	<1.0	<0.5	<2.0	<0.5	<2.0
Ethyl benzene	**2.4**	<0.2	<0.1	<0.20	<0.1	<0.20
Ethylene dibromide		<0.2	<0.2	<0.20	<0.2	<0.20
Hexane				<1.0		<1.0
m/p-Xylene	**300 *****	<0.2	<0.1	<0.20	<0.1	<0.20
Methyl butyl ketone		<5.0				
Methyl ethyl ketone		<5.0	<5	<10	<5	<10
Methyl isobutyl ketone		<5.0	<5	<5.0	<5	<5.0
Methyl t-butyl ether		<0.2	<0.2	<0.50	<0.2	<0.50
o-Xylene	**300 *****	<0.2	<0.1	<0.20	<0.1	<0.20
Styrene		<0.2	<0.2	<0.50	<0.2	<0.50
Tetrachloroethylene		<0.2	<0.1	<0.20	<0.1	<0.20
Toluene	**24**	* 0.1	<0.2	<0.20	<0.2	<0.20
trans-1,2-Dichloroethylene		<0.2	<0.1	<0.50	<0.1	<0.50
trans-1,3-Dichloropropylene		<0.2	<0.2	<0.40	<0.2	<0.40
Trichloroethylene	**50 ****	<0.2	<0.1	<0.20	<0.1	<0.20
Trichlorofluoromethane		<0.5	<0.2	<0.50		<0.50
Vinyl chloride	**2 ****	<0.5	<0.2	<0.20	<0.2	<0.20
Xylenes - total	**300**			<0.20		<0.20
F1 (C6-C10)				<25		<25
F1 (C6-C10) - BTEX				<25		<25

NOTES: 1) ODWS - Ontario Drinking Water Standards, 2001
2) Blank indicates parameter not analysed.
3) * - Indicates trace concentration detected below the Limit of Quantitation.
** - Indicates health related drinking water standard.
*** - Standard is total concentration of all xylenes.
4) Concentrations in µg/L.

TABLE A-5
SURFACE WATER GENERAL CHEMISTRY RESULTS
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

PARAMETER	UNITS	PWQO	UPSTREAM									
			SW1									
		Objectives	Jun-86	Nov-86	Jun-94	Jun-00	Sep-00	Nov-01	Nov-11	Aug-14	Nov-16	Oct-18
pH	**units**	**6.5-8.5**	8.00	8.52	5.90	8.08	7.86	8.09	8.27	7.90	8.03	8.21
Conductivity	**µS/cm**		1191	840	1690	1051	1190	1051	939	1900	870	1600
Turbidity	**NTU**				2	1	1	41.0		5.0	1.9	19
Chloride	**mg/L**		157	69	325	173	223	167	130	340	100	320
Phosphate-ortho	**mg/L**		<0.01	0.02	0.06	<1	<0.3	<1	0.01	0.01	<0.010	0.054
Sulphate	**mg/L**		115.0	78.0	166.0	86.7	110.0	138	73	140	43	65
Alkalinity	**mg/L**		341	269	29	285	277	157	192	280	150	230
Bicarbonate	**mg/L**					345	275	189	188			230
Carbonate	**mg/L**					1	2	1	3			3.5
Hardness	**mg/L**		411	322	221	332	403	287	250	530	260	290
Nitrate	**mg/L**		<0.05	0.10	0.20	0.2	<0.2	0.7	0.7	<0.001	<0.10	<0.10
Nitrite	**mg/L**					<0.2	<0.2	<0.2	<0.01	<0.001	<0.01	<0.010
Total Kjeldahl Nitrogen	**mg/L**				0.93							
Ammonia: total	**mg/L**		0.05	<0.05	<0.05	<0.03	<0.03	<0.03	<0.05	<0.001	<0.05	0.062
Ammonia: un-ionized	**µg/L**	**20**	1	<1	<1	<1	<1	<1	<0.97	<1	<2	2
Total Organic Carbon	**mg/L**		5.2	6.3	8.5	6.2	7.9	8.7	7.8	4.8	3.4	11
Phenols	**µg/L**									<0.001		
Aluminum	**mg/L**	**0.075 ****	0.130	<0.001	0.025	0.024	<0.03	1.090	0.270	0.100	0.057	0.76
Antimony	**mg/L**				0.004	<0.0005		<0.0005	<0.0005	<0.001	<0.0005	<0.0005
Arsenic	**mg/L**				0.002	<0.002		<0.002	<0.001	<0.001	<0.001	0.0012
Barium	**mg/L**				0.045	0.051	0.047	0.050	0.036	0.087	0.033	0.051
Beryllium	**mg/L**	**1.100 *****			<0.005	<0.001	<0.0005	<0.001	<0.0005	<0.005	<0.0005	<0.0005
Bismuth	**mg/L**					<0.001	<0.1	<0.001		<0.001		
Boron	**mg/L**	**0.200**			0.094	0.112	0.090	0.06	0.05	0.19	0.06	0.067
Cadmium	**mg/L**	**0.0002**	<0.003	<0.010	<0.0002	<0.0001	<0.005	<0.0001	<0.0001	<0.002	<0.0001	<0.0001
Calcium	**mg/L**		116.0	86.2	64.6	97.2	115.0	80	75	140	64	80
Chromium	**mg/L**	**1.100**	<0.010	<0.010	0.005	<0.005	<0.005	<0.005	<0.005	<0.003	<0.005	<0.005
Cobalt	**mg/L**	**0.0009**			<0.001	<0.0001	<0.005	0.0004	<0.0005	<0.01	<0.0005	0.00061
Copper	**mg/L**	**0.005**	<0.010	<0.010	0.0100	0.0018	<0.003	0.0044	0.0030	<0.003	<0.001	0.0048
Iron	**mg/L**	**0.300**			0.02	0.04	0.04	1.16	0.25	0.20	<0.1	1.2
Lead	**mg/L**	**0.025 ******			0.0002	<0.0005	<0.001	0.0009	<0.0005	<0.002	<0.0005	0.0012
Magnesium	**mg/L**		29.3	25.9	14.5	21.5	28.3	21.4	18.0	39.0	17.0	21
Manganese	**mg/L**		0.052	0.130	0.029	0.033	0.045	0.022	0.030	0.760	0.150	0.13
Molybdenum	**mg/L**				0.002	0.001	<0.02	0.001	0.001	<0.001	0.001	0.0012
Nickel	**mg/L**	**0.025**	<0.030	<0.010	0.003	<0.001	<0.02	0.001	<0.001	<0.0005	<0.001	0.0023
Phosphorus	**mg/L**	**0.030**				<0.05	<0.1	0.08	0.05	<0.1	0.015	0.09
Potassium	**mg/L**		5.7	4.0	4.2	4.4	5.0	5.4	3.6	6.0	2.8	5.1
Selenium	**mg/L**				<0.001	<0.002		<0.002	<0.002	<0.004	<0.002	<0.002
Silicon	**mg/L**				3.8	1.39	3.30	3.93	3.10	2.90	1.10	4
Silver	**mg/L**	**0.0001**			<0.0001	<0.0001	<0.003	<0.0001	<0.0001	<0.5	<0.0001	<0.0001
Sodium	**mg/L**		99.2	45.8	215.0	104.0	115.0	100	97	200	74	210
Strontium	**mg/L**				0.540	0.692	0.730	0.630	0.560	1.300	0.580	0.69
Thallium	**mg/L**	**0.0003**									<0.00005	<0.00005
Tin	**mg/L**				<0.002	<0.001	<0.05	0.001		<0.002		
Titanium	**mg/L**					<0.005	<0.005	0.016	0.010	<0.005	<0.005	0.016
Vanadium	**mg/L**	**0.007**			0.003	<0.0005	<0.005	0.0018	0.0006	<0.001	<0.0005	0.0019
Zinc	**mg/L**	**0.030**	<0.020	<0.010	0.010	<0.005	<0.005	0.009	<0.005	<0.004	<0.005	0.01
Total Dissolved Solids	**mg/L**				872	659	765	606	508	1100		860

NOTES: 1) PWQO - Provincial Water Quality Objectives
2) ** - PWQO value based on pH range of 6.5 to 9.0.
*** - PWQO value based on hardness >75 mg/L.
**** - PWQO value based on alkalinity >80 mg/L.
3) Free ammonia concentration based on a surface water temperature of 12 ºC for November, 18 ºC for June, prior to 2000.

TABLE A-5
SURFACE WATER GENERAL CHEMISTRY RESULTS
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

PARAMETER	UNITS	PWQO	ADJACENT TO REFUSE AREA							
			SW2							
		Objectives	Sep-99	Jun-00	Sep-00	Nov-01	Nov-11	Aug-14	Nov-16	Oct-18
pH	**units**	**6.5-8.5**	8.28	8.15	8.03	8.02	8.27	8.10	7.98	8.19
Conductivity	**µS/cm**		1860	1053	1200	1067	937	2000	850	1500
Turbidity	**NTU**		12	1	2	39.0		5.5	1.9	8.5
Chloride	**mg/L**		180	170	224	167	130	370	130	300
Phosphate-ortho	**mg/L**		<0.3	<1	<0.3	<1	0.02	<0.001	0.014	0.055
Sulphate	**mg/L**		185.0	87.8	111.0	138	74	180	59	63
Alkalinity	**mg/L**		563	288	289	159	192	270	160	220
Bicarbonate	**mg/L**		553	349	286	191	189			220
Carbonate	**mg/L**		10.0	1	3	1	3			3.1
Hardness	**mg/L**		520	343	403	288	250	520	270	280
Nitrate	**mg/L**		0.60	0.2	<0.2	0.7	0.7	0.5	<0.10	0.12
Nitrite	**mg/L**		<0.2	<0.2	<0.2	<0.2	<0.01	0.02	<0.01	<0.010
Total Kjeldahl Nitrogen	**mg/L**									
Ammonia: total	**mg/L**		1.48	0.24	0.45	<0.03	<0.05	0.09	0.55	<0.050
Ammonia: un-ionized	**µg/L**	**20**	59	11	11	<1	<2	1	5	<1
Total Organic Carbon	**mg/L**		20.7	6.8	8.6	8.4	7.8	7.7	4	10
Phenols	**µg/L**							0.0		
Aluminum	**mg/L**	**0.075 ****	0.070	0.032	<0.03	1.240	0.260	0.500	0.045	0.23
Antimony	**mg/L**			<0.0005		<0.0005	<0.0005	<0.001	<0.0005	<0.0005
Arsenic	**mg/L**			<0.002		<0.002	<0.001	<0.001	<0.001	<0.001
Barium	**mg/L**		0.099	0.054	0.056	0.050	0.035	0.096	0.039	0.046
Beryllium	**mg/L**	**1.100 *****	<0.005	<0.001	<0.0005	<0.001	<0.0005	<0.005	<0.0005	<0.0005
Bismuth	**mg/L**		<0.1	<0.001	<0.1	<0.001		<0.001		
Boron	**mg/L**	**0.200**	1.390	0.122	0.120	0.07	0.06	0.23	0.08	0.067
Cadmium	**mg/L**	**0.0002**	<0.005	<0.0001	<0.005	<0.0001	<0.0001	<0.002	<0.0001	<0.0001
Calcium	**mg/L**		98.2	99.8	113.0	80	75	130	64	79
Chromium	**mg/L**	**1.100**	<0.01	<0.005	<0.005	<0.005	<0.005	<0.003	<0.005	<0.005
Cobalt	**mg/L**	**0.0009**	<0.01	<0.0001	<0.005	0.0005	<0.0005	<0.01	<0.0005	<0.0005
Copper	**mg/L**	**0.005**	<0.01	0.0018	<0.003	0.0047	0.0030	<0.003	<0.001	0.0035
Iron	**mg/L**	**0.300**	0.22	0.11	0.37	1.30	0.24	0.86	0.27	0.4
Lead	**mg/L**	**0.025 ******	<0.001	<0.0005	<0.001	0.0010	<0.0005	<0.002	<0.0005	<0.0005
Magnesium	**mg/L**		66.8	22.7	29.2	21.3	18.0	42.0	17.0	19
Manganese	**mg/L**		0.900	0.052	0.102	0.028	0.028	0.410	0.200	0.06
Molybdenum	**mg/L**		<0.05	0.001	<0.02	0.001	0.001	<0.001	0.001	0.0012
Nickel	**mg/L**	**0.025**	<0.05	<0.001	<0.02	0.002	<0.001	<0.0005	<0.001	0.0013
Phosphorus	**mg/L**	**0.030**	<0.1	<0.05	<0.1	0.09	0.05	0.10	0.016	0.092
Potassium	**mg/L**		22.4	4.8	5.0	5.4	3.6	8.0	3.2	4.9
Selenium	**mg/L**			<0.002		<0.002	<0.002	<0.004	<0.002	<0.002
Silicon	**mg/L**		0.7	1.24	2.40	4.23	3.00	1.90	1.20	3.3
Silver	**mg/L**	**0.0001**	<0.005	<0.0001	<0.003	<0.0001	<0.0001	<0.5	<0.0001	<0.0001
Sodium	**mg/L**		236.0	104.0	116.0	99	95	220	68	210
Strontium	**mg/L**		1.410	0.695	0.743	0.649	0.550	1.400	0.550	0.65
Thallium	**mg/L**	**0.0003**							<0.00005	<0.00005
Tin	**mg/L**		<0.10	<0.001	<0.05	0.003		<0.002		
Titanium	**mg/L**		<0.005	<0.005	<0.005	0.017	0.009	0.010	<0.005	0.0076
Vanadium	**mg/L**	**0.007**	<0.005	<0.0005	<0.005	0.0021	0.0007	<0.001	<0.0005	0.00085
Zinc	**mg/L**	**0.030**	<0.01	0.007	<0.005	0.009	<0.005	<0.004	<0.005	<0.005
Total Dissolved Solids	**mg/L**		1130	662	775	606	509	1100		820

NOTES: 1) PWQO - Provincial Water Quality Objectives
2) ** - PWQO value based on pH range of 6.5 to 9.0.
*** - PWQO value based on hardness >75 mg/L.
**** - PWQO value based on alkalinity >80 mg/L.
3) Free ammonia concentration based on a surface water temperature of 12 ºC for November, 18 ºC for June, prior to 2000.

TABLE A-5
SURFACE WATER GENERAL CHEMISTRY RESULTS
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

PARAMETER	UNITS	PWQO	ADJACENT TO REFUSE AREA							
			SW3							
		Objectives	Jun-86	Nov-86	Jun-94	Jun-00	Nov-11	Aug-14	Nov-16	Oct-18
pH	**units**	**6.5-8.5**	8.50	8.50	7.50	8.18	8.23	8.02	7.81	8
Conductivity	**µS/cm**		836	790	740	811	843	1800	1100	970
Turbidity	**NTU**				33	7		8	23	20
Chloride	**mg/L**		122	72	68	57	46	220	110	98
Phosphate-ortho	**mg/L**		0.01	0.03	0.05	<1	ND	<0.001	<0.010	<0.010
Sulphate	**mg/L**		64.0	66.5	69.0	67.9	75.0	260.0	30	82
Alkalinity	**mg/L**		192	264	154	353	291	380	370	300
Bicarbonate	**mg/L**					428	286			300
Carbonate	**mg/L**					1	5			2.8
Hardness	**mg/L**		371	311	217	358	340	710	400	350
Nitrate	**mg/L**		<0.05	0.50	0.67	2.0	0.5	0.5	<0.10	0.17
Nitrite	**mg/L**					<0.2	0.01	0.08	0.012	0.016
Total Kjeldahl Nitrogen	**mg/L**				1.24					
Ammonia: total	**mg/L**		0.05	<0.05	0.11	0.10	<0.05	0.17	0.49	0.18
Ammonia: un-ionized	**µg/L**	**20**	5	<3	1	4	<2	3	4	3
Total Organic Carbon	**mg/L**		5.2	5.7	6.6	5.7	7.2	6.8	6.2	6.7
Phenols	**µg/L**							<0.001		
Aluminum	**mg/L**	**0.075 ****	0.066	0.100	1.200	0.063	0.093	0.600	0.042	0.14
Antimony	**mg/L**				<0.002	<0.0005	<0.0005	<0.001	0.001	0.00056
Arsenic	**mg/L**				0.002	<0.002	<0.001	<0.001	<0.001	<0.001
Barium	**mg/L**				0.050	0.078	0.110	0.210	0.110	0.09
Beryllium	**mg/L**	**1.100 *****			<0.005	<0.001	<0.0005	<0.005	<0.0005	<0.0005
Bismuth	**mg/L**					<0.001		<0.001		
Boron	**mg/L**	**0.200**			0.140	0.224	0.150	0.260	0.120	0.11
Cadmium	**mg/L**	**0.0002**	0.003	0.001	<0.0002	<0.0001	0.000	<0.002	<0.0001	<0.0001
Calcium	**mg/L**		108.0	79.3	61.7	83.5	82.0	180.0	98.0	90
Chromium	**mg/L**	**1.100**	0.010	0.010	0.003	<0.005	<0.005	<0.003	<0.005	<0.005
Cobalt	**mg/L**	**0.0009**			0.001	<0.0001	<0.0005	<0.01	0.001	<0.0005
Copper	**mg/L**	**0.005**	0.0100	0.0100	0.0100	0.0030	0.0030	<0.003	0.0011	0.0023
Iron	**mg/L**	**0.300**			1.30	0.69	0.43	1.10	2.10	2.1
Lead	**mg/L**	**0.025 ******			0.0070	0.0023	0.0024	<0.002	0.0010	0.0029
Magnesium	**mg/L**		24.9	27.4	15.2	36.1	39.0	68.0	28.0	31
Manganese	**mg/L**		0.220	0.120	0.056	0.093	0.100	0.450	1.100	0.22
Molybdenum	**mg/L**				<0.002	0.003	0.003	<0.001	0.001	0.0018
Nickel	**mg/L**	**0.025**	0.030	0.010	0.004	0.002	0.001	<0.0005	0.003	0.0019
Phosphorus	**mg/L**	**0.030**				<0.05	0.02	<0.1	0.014	0.025
Potassium	**mg/L**		5.7	4.4	7.4	9.7	15.0	18.0	6.3	5.4
Selenium	**mg/L**				<0.001	<0.002	<0.002	<0.004	<0.002	<0.002
Silicon	**mg/L**				3.7	2.00	2.50	5.90	3.40	3.7
Silver	**mg/L**	**0.0001**			<0.0001	<0.0001	<0.0001	<0.5	<0.0001	<0.0001
Sodium	**mg/L**		70.1	42.4	53.5	37.4	36.0	140.0	79.0	72
Strontium	**mg/L**				0.033	1.520	1.500	2.200	1.000	2.1
Thallium	**mg/L**	**0.0003**							<0.00005	<0.00005
Tin	**mg/L**				<0.002	<0.001		<0.002		
Titanium	**mg/L**					<0.005	<0.005	0.010	<0.005	0.0057
Vanadium	**mg/L**	**0.007**			0.00	<0.0005	<0.0005	<0.001	<0.0005	0.00055
Zinc	**mg/L**	**0.030**	0.020	0.010	0.033	0.015	0.012	0.210	0.009	0.01
Total Dissolved Solids	**mg/L**				375	503	465	1100		580

NOTES: 1) PWQO - Provincial Water Quality Objectives
2) ** - PWQO value based on pH range of 6.5 to 9.0.
*** - PWQO value based on hardness >75 mg/L.
**** - PWQO value based on alkalinity >80 mg/L.
3) Free ammonia concentration based on a surface water temperature of 12 ºC for November, 18 ºC for June, prior to 2000.

TABLE A-5
SURFACE WATER GENERAL CHEMISTRY RESULTS
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

PARAMETER	UNITS	PWQO	DOWNSTREAM								
			SW4								
		Objectives	Jun-86	Nov-86	Jun-94	Jun-00	Sep-00	Nov-11	Aug-14	Nov-16	Oct-18
pH	**units**	**6.5-8.5**	8.54	8.48	7.80	8.26	8.10	8.27	8.18	8	8.11
Conductivity	**µS/cm**		856	775	1160	1011	1180	919	1100	1200	1300
Turbidity	**NTU**				1	2	1.2		3.9	8.2	12
Chloride	**mg/L**		124	72	160	170	226	120	170	170	250
Phosphate-ortho	**mg/L**		0.01	0.05	0.05	<1	<0.3	0.02	0.02	<0.01	0.048
Sulphate	**mg/L**		61.0	66.2	78.0	65.5	83.2	71.0	88.0	87	61
Alkalinity	**mg/L**		208	179	177	287	307	198	200	220	210
Bicarbonate	**mg/L**					348	303	195			210
Carbonate	**mg/L**					1	4	3			2.5
Hardness	**mg/L**		401	311	267	380	448	260	390	410	270
Nitrate	**mg/L**		<0.05	0.45	0.56	0.5	0.3	1.2	0.4	0.8	0.49
Nitrite	**mg/L**					<0.2	<0.2	<0.01	<0.001	0.012	<0.010
Total Kjeldahl Nitrogen	**mg/L**				1.14						
Ammonia: total	**mg/L**		<0.05	0.05	0.05	0.18	<0.03	<0.05	<0.001	0.061	<0.050
Ammonia: un-ionized	**µg/L**	**20**	<5	3	1	10	<1	<2	<1	1	<1
Total Organic Carbon	**mg/L**		5.6	5.7	9.6	6.1	7.4	7.2	4.3	3.7	8.8
Phenols	**µg/L**								<0.001		
Aluminum	**mg/L**	**0.075 ****	0.072	<0.100	1.300	0.065	<0.03	0.210	0.200	0.220	0.34
Antimony	**mg/L**				0.005	<0.0005		<0.0005	<0.001	<0.0005	<0.0005
Arsenic	**mg/L**				0.002	<0.002		<0.001	<0.001	<0.001	<0.001
Barium	**mg/L**				0.073	0.082	0.073	0.044	0.083	0.069	0.047
Beryllium	**mg/L**	**1.100 *****			<0.005	<0.001	<0.0005	<0.0005	<0.005	<0.0005	<0.0005
Bismuth	**mg/L**					<0.001	<0.1		<0.001		
Boron	**mg/L**	**0.200**			0.190	0.171	0.16	0.07	0.20	0.21	0.099
Cadmium	**mg/L**	**0.0002**	<0.003	<0.001	<0.0002	<0.0001	<0.005	<0.0001	<0.002	<0.0001	<0.0001
Calcium	**mg/L**		112.0	80.7	71.9	104.0	121	78	94	90	73
Chromium	**mg/L**	**1.100**	<0.010	<0.010	0.004	<0.005	<0.005	<0.005	<0.003	<0.005	<0.005
Cobalt	**mg/L**	**0.0009**			0.001	<0.0001	<0.005	<0.0005	<0.01	<0.0005	<0.0005
Copper	**mg/L**	**0.005**	<0.010	<0.010	0.0100	0.0026	<0.003	0.0030	<0.003	0.0022	0.0038
Iron	**mg/L**	**0.300**			1.20	0.25	0.14	0.21	0.22	0.44	0.57
Lead	**mg/L**	**0.025 ******			0.0010	<0.0005	<0.001	<0.0005	<0.002	0.0008	0.0006
Magnesium	**mg/L**		29.5	26.6	21.3	28.9	35.7	20.0	37.0	29.0	19
Manganese	**mg/L**		0.081	0.012	0.055	0.058	0.039	0.034	0.080	0.220	0.068
Molybdenum	**mg/L**				0.003	0.001	<0.02	0.001	<0.001	0.002	0.0016
Nickel	**mg/L**	**0.025**	<0.030	<0.010	0.004	0.001	<0.02	<0.001	<0.0005	0.001	0.0015
Phosphorus	**mg/L**	**0.030**				0.05	<0.1	0.0	<0.1	0.038	0.082
Potassium	**mg/L**		6.5	4.1	7.5	5.8	6	4	8	6	5
Selenium	**mg/L**				0.002	<0.002		<0.002	<0.004	<0.002	<0.002
Silicon	**mg/L**				4.9	1.12	2.4	3.1	2.4	2.3	3.2
Silver	**mg/L**	**0.0001**			<0.0001	<0.0001	<0.003	<0.0001	<0.5	<0.0001	<0.0001
Sodium	**mg/L**		76.6	42.8	108.0	91.4	109.0	88.0	85.0	93.0	160
Strontium	**mg/L**				0.860	1.200	1.290	0.760	2.000	1.600	0.77
Thallium	**mg/L**	**0.0003**								<0.00005	<0.00005
Tin	**mg/L**				<0.002	<0.001	<0.05		<0.002		
Titanium	**mg/L**					<0.005	<0.005	0.010	<0.005	0.008	0.0083
Vanadium	**mg/L**	**0.007**			0.00	<0.0005	<0.005	0.001	<0.001	0.001	0.0013
Zinc	**mg/L**	**0.030**	<0.020	<0.010	0.009	0.109	<0.005	<0.005	<0.004	0.005	0.0066
Total Dissolved Solids	**mg/L**				617	638	768	497	610		730

NOTES: 1) PWQO - Provincial Water Quality Objectives
2) ** - PWQO value based on pH range of 6.5 to 9.0.
*** - PWQO value based on hardness >75 mg/L.
**** - PWQO value based on alkalinity >80 mg/L.
3) Free ammonia concentration based on a surface water temperature of 12 ºC for November, 18 ºC for June, prior to 2000.

TABLE A-5
SURFACE WATER GENERAL CHEMISTRY RESULTS
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

PARAMETER	UNITS	PWQO	ADJACENT TO REFUSE AREA											
			SW5							SW6				
		Objectives	Jun-00	Sep-00	Nov-01	Nov-11	Aug-14	Nov-16	Oct-18	Jun-00	Sep-00	Nov-11	Nov-16	Oct-18
pH	**units**	**6.5-8.5**	8.19	8.21	8.05	8.23	8.09	7.99	8.09	8.08	8.00	8.28	8.15	8.21
Conductivity	**µS/cm**		1098	1240	1073	902	1100	1200	1100	1045	1180	926	1200	1300
Turbidity	**NTU**		1	1	40.0		4.9	2	6.3	2	2.2		1.1	12
Chloride	**mg/L**		200	256	168	120	160	190	180	178	219	120	180	250
Phosphate-ortho	**mg/L**		<1	<0.3	<1	0.02	0.02	0.013	0.033	<1	<0.3	0.01	0.02	0.046
Sulphate	**mg/L**		72.8	84.5	139	73	85	92	64	65.2	81.2	71.0	89	65
Alkalinity	**mg/L**		285	316	162	194	190	190	200	296	318	197	230	210
Bicarbonate	**mg/L**		345	311	195	191			200	359	315	193		210
Carbonate	**mg/L**		1	5	1	3			2.3	1	3	3		3.1
Hardness	**mg/L**		390	464	308	270	380	380	270	362	447	260	430	270
Nitrate	**mg/L**		0.2	0.2	0.7	1.6	0.3	0.22	1.26	0.4	0.3	1.2	0.99	0.53
Nitrite	**mg/L**		<0.2	<0.2	<0.2	<0.01	<0.001	0.015	0.026	<0.2	<0.2	<0.01	0.013	<0.010
Total Kjeldahl Nitrogen	**mg/L**													
Ammonia: total	**mg/L**		0.08	<0.03	<0.03	<0.05	0.06	0.1	0.06	0.31	0.16	<0.05	0.075	<0.050
Ammonia: un-ionized	**µg/L**	**20**	4	<1	<1	<2	1	2	<1	11	4	<1	1	<1
Total Organic Carbon	**mg/L**		5.6	7.4	8.2	5.2	4.5	4.3	6.6	6.1	7.2	7.3	3.5	8.5
Phenols	**µg/L**						<0.001							
Aluminum	**mg/L**	**0.075 ****	0.030	<0.03	1.190	0.310	0.300	0.044	0.22	0.022	<0.03	0.230	0.063	0.39
Antimony	**mg/L**		<0.0005		<0.0005	<0.0005	<0.001	<0.0005	<0.0005	<0.0005		<0.0005	<0.0005	<0.0005
Arsenic	**mg/L**		<0.002		<0.002	<0.001	<0.001	<0.001	<0.001	<0.002		<0.001	<0.001	<0.001
Barium	**mg/L**		0.076	0.068	0.053	0.060	0.088	0.053	0.052	0.081	0.079	0.043	0.074	0.049
Beryllium	**mg/L**	**1.100 *****	<0.001	<0.0005	<0.001	<0.0005	<0.005	<0.0005	<0.0005	<0.001	<0.0005	<0.0005	<0.0005	<0.0005
Bismuth	**mg/L**		<0.001	<0.1	<0.001		<0.001			<0.001	<0.1			
Boron	**mg/L**	**0.200**	0.159	0.170	0.08	0.13	0.21	0.12	0.18	0.166	0.17	0.08	0.23	0.11
Cadmium	**mg/L**	**0.0002**	<0.0001	<0.005	<0.0001	<0.0001	<0.002	<0.0001	<0.0001	<0.0001	<0.005	<0.0001	<0.0001	<0.0001
Calcium	**mg/L**		108.0	123.0	85	83	91	87	73	99.6	119	80	98	74
Chromium	**mg/L**	**1.100**	<0.005	<0.005	<0.005	<0.005	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	**mg/L**	**0.0009**	<0.0001	<0.005	0.0005	<0.0005	<0.01	<0.0005	<0.0005	<0.0001	<0.005	<0.0005	<0.0005	<0.0005
Copper	**mg/L**	**0.005**	0.0023	<0.003	0.0046	0.0040	<0.003	0.0013	0.0035	0.0023	<0.003	0.0040	0.0016	0.004
Iron	**mg/L**	**0.300**	0.09	0.10	1.26	0.34	0.37	0.11	0.36	0.22	0.32	0.23	0.22	0.67
Lead	**mg/L**	**0.025 ******	<0.0005	<0.001	0.0010	<0.0005	<0.002	<0.0005	<0.0005	<0.0005	<0.001	<0.0005	<0.0005	0.00069
Magnesium	**mg/L**		29.0	38.3	23.1	23.0	37.0	26.0	20	27.4	36.4	21.0	32.0	19
Manganese	**mg/L**		0.027	0.028	0.027	0.046	0.080	0.070	0.047	0.082	0.170	0.030	0.082	0.075
Molybdenum	**mg/L**		0.001	<0.02	0.001	0.003	<0.001	0.001	0.0023	0.001	<0.02	0.001	0.002	0.0
Nickel	**mg/L**	**0.025**	0.001	<0.02	0.002	<0.001	<0.0005	<0.001	0.0013	<0.001	<0.02	0.001	0.001	0.0017
Phosphorus	**mg/L**	**0.030**	<0.05	<0.1	0.07	0.05	<0.1	0.02	0.07	<0.05	<0.1	0.0	0.018	0.097
Potassium	**mg/L**		4.9	6.0	5.8	6.0	8.0	4.7	5.4	5.1	6	4	6	5
Selenium	**mg/L**		<0.002		<0.002	<0.002	<0.004	<0.002	<0.002	<0.002		<0.002	<0.002	<0.002
Silicon	**mg/L**		1.00	3.10	4.19	3.30	2.70	1.70	3.1	0.90	2.7	3.1	2.3	3.3
Silver	**mg/L**	**0.0001**	<0.0001	<0.003	<0.0001	<0.0001	<0.5	<0.0001	<0.0001	<0.0001	<0.003	<0.0001	<0.0001	<0.0001
Sodium	**mg/L**		106.0	114.0	106	74	80	110	130	90.7	105	92	100	160
Strontium	**mg/L**		1.270	1.540	0.687	1.300	2.200	1.100	1	1.170	1.330	0.780	1.800	0.78
Thallium	**mg/L**	**0.0003**						<0.00005	<0.00005				<0.00005	<0.00005
Tin	**mg/L**		<0.001	<0.05	0.001		<0.002			<0.001	<0.05			
Titanium	**mg/L**		<0.005	<0.005	0.017	0.018	<0.005	<0.005	0.0068	<0.005	<0.005	0.006	0.005	0.011
Vanadium	**mg/L**	**0.007**	<0.0005	<0.005	0.0022	0.0011	<0.001	<0.0005	0.0011	<0.0005	<0.005	0.001	0.001	0.0015
Zinc	**mg/L**	**0.030**	0.015	<0.005	0.025	0.010	<0.004	<0.005	0.0097	<0.005	<0.005	0.013	<0.005	0.0083
Total Dissolved Solids	**mg/L**		692	815	624	490	600		610	644	762	499		720

NOTES: 1) PWQO - Provincial Water Quality Objectives
2) ** - PWQO value based on pH range of 6.5 to 9.0.
*** - PWQO value based on hardness >75 mg/L.
**** - PWQO value based on alkalinity >80 mg/L.
3) Free ammonia concentration based on a surface water temperature of 12 ºC for November, 18 ºC for June, prior to 2000.

TABLE A-5
SURFACE WATER GENERAL CHEMISTRY RESULTS
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

PARAMETER	UNITS	PWQO	ADJACENT TO REFUSE AREA									
			SW7					SW8				
		Objectives	Nov-01	Nov-11	Aug-14	Nov-16	Oct-18	Nov-01	Nov-11	Aug-14	Nov-16	Oct-18
pH	**units**	**6.5-8.5**	8.05	8.27	8.19	8.02	8.22	8.08	8.28	8.09	8.06	8.22
Conductivity	**µS/cm**		1061	943	1900	840	1500	1070	925	1100	800	1500
Turbidity	**NTU**		38.0		7.6	1.7	8.2	41.0		6.0	2.2	8.4
Chloride	**mg/L**		164	130	330	130	310	168	120	170	110	310
Phosphate-ortho	**mg/L**		<1	0.02	0.04	<0.01	0.055	<1	0.02	0.02	<0.01	0.055
Sulphate	**mg/L**		139	73.0	180.0	58	63	137	72.0	89.0	55	64
Alkalinity	**mg/L**		159	193	250	160	220	160	197	190	150	220
Bicarbonate	**mg/L**		191	190			220	193	194			220
Carbonate	**mg/L**		1	3			3.4	1	3			3.4
Hardness	**mg/L**		308	250	580	260	280	298	260	380	250	280
Nitrate	**mg/L**		0.6	0.7	0.9	0.19	0.2	0.7	1.1	0.4	0.2	0.2
Nitrite	**mg/L**		<0.2	<0.01	<0.001	0.024	<0.010	<0.2	<0.01	<0.001	0.024	<0.010
Total Kjeldahl Nitrogen	**mg/L**											
Ammonia: total	**mg/L**		<0.03	<0.05	<0.001	0.31	0.063	<0.03	<0.05	0.07	0.15	<0.050
Ammonia: un-ionized	**µg/L**	**20**	<1	<2	<1	3	1	<1	<1	2	2	<1
Total Organic Carbon	**mg/L**		9.8	7.8	5.1	3.9	10	8.5	7.5	4.7	3.8	9.5
Phenols	**µg/L**				<0.001					<0.001		
Aluminum	**mg/L**	**0.075 ****	1.200	0.290	0.200	0.047	0.23	1.150	0.260	0.200	0.051	0.23
Antimony	**mg/L**		<0.0005	<0.0005	<0.001	<0.0005	<0.0005	<0.0005	0.001	<0.001	<0.0005	<0.0005
Arsenic	**mg/L**		<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	0.001
Barium	**mg/L**		0.052	0.036	0.110	0.040	0.046	0.051	0.041	0.087	0.034	0.045
Beryllium	**mg/L**	**1.100 *****	<0.001	<0.0005	<0.005	<0.0005	<0.0005	<0.001	<0.0005	<0.005	<0.0005	<0.0005
Bismuth	**mg/L**		<0.001		<0.001			<0.001		<0.001		
Boron	**mg/L**	**0.200**	0.07	0.06	0.24	0.08	0.068	0.07	0.06	0.20	0.08	0.07
Cadmium	**mg/L**	**0.0002**	<0.0001	<0.0001	<0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.002	<0.0001	<0.0001
Calcium	**mg/L**		85	79	140	64	77	83	78	92	58	77
Chromium	**mg/L**	**1.100**	<0.005	<0.005	<0.003	<0.005	<0.005	<0.005	<0.005	<0.003	<0.005	<0.005
Cobalt	**mg/L**	**0.0009**	0.0005	<0.0005	<0.01	<0.0005	<0.0005	0.0005	<0.0005	<0.01	<0.0005	<0.0005
Copper	**mg/L**	**0.005**	0.0047	0.0030	<0.003	<0.001	0.0035	0.0046	0.0030	<0.003	<0.001	0.0034
Iron	**mg/L**	**0.300**	1.24	0.26	0.24	0.17	0.38	1.20	0.27	0.32	0.13	0.39
Lead	**mg/L**	**0.025 ******	0.0010	<0.0005	<0.002	<0.0005	<0.0005	0.0010	<0.0005	<0.002	<0.0005	<0.0005
Magnesium	**mg/L**		23.3	19.0	52.0	17.0	19	21.8	20.0	37.0	16.0	19
Manganese	**mg/L**		0.024	0.030	0.030	0.150	0.053	0.026	0.029	0.070	0.074	0.057
Molybdenum	**mg/L**		0.001	0.001	<0.001	0.001	0.0012	0.001	0.001	<0.001	0.001	0.0
Nickel	**mg/L**	**0.025**	0.002	<0.001	<0.0005	<0.001	0.0013	0.002	<0.001	<0.0005	<0.001	0.0015
Phosphorus	**mg/L**	**0.030**	0.10	0.0	<0.1	0.013	0.094	0.09	0.0	<0.1	0.015	0.09
Potassium	**mg/L**		5.7	4	9	3	5	5.5	4	8	3	5
Selenium	**mg/L**		<0.002	<0.002	<0.004	<0.002	<0.002	<0.002	<0.002	<0.004	<0.002	<0.002
Silicon	**mg/L**		4.26	3.2	3.7	1.1	3.2	4.10	3.1	2.6	1.0	3.2
Silver	**mg/L**	**0.0001**	<0.0001	<0.0001	<0.5	0.0001	<0.0001	<0.0001	<0.0001	<0.5	<0.0001	<0.0001
Sodium	**mg/L**		107	100	180	71	200	97	92	82	66	200
Strontium	**mg/L**		0.683	0.580	2.400	0.580	0.69	0.657	0.670	2.100	0.550	0.69
Thallium	**mg/L**	**0.0003**				<0.00005	<0.00005				<0.00005	<0.00005
Tin	**mg/L**		<0.001		<0.002			0.001		<0.002		
Titanium	**mg/L**		0.017	0.007	<0.005	<0.005	0.0076	0.016	0.008	<0.005	<0.005	0.009
Vanadium	**mg/L**	**0.007**	0.0021	0.001	<0.001	<0.0005	0.001	0.0021	0.001	<0.001	<0.0005	0.00094
Zinc	**mg/L**	**0.030**	0.012	<0.005	<0.004	<0.005	<0.005	0.053	<0.005	<0.004	<0.005	<0.005
Total Dissolved Solids	**mg/L**		620	508	1100		830	609	503	610		830

NOTES: 1) PWQO - Provincial Water Quality Objectives
2) ** - PWQO value based on pH range of 6.5 to 9.0.
*** - PWQO value based on hardness >75 mg/L.
**** - PWQO value based on alkalinity >80 mg/L.
3) Free ammonia concentration based on a surface water temperature of 12 ºC for November, 18 ºC for June, prior to 2000.

TABLE A-5
SURFACE WATER GENERAL CHEMISTRY RESULTS
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

PARAMETER	UNITS	PWQO	ADJACENT TO REFUSE AREA					TRIBUTARY				
			SW9					SW10				
		Objectives	Nov-01	Nov-11	Aug-14	Nov-16	Oct-18	Nov-01	Nov-11	Aug-14	Nov-16	Oct-18
pH	**units**	**6.5-8.5**	8.11	8.28	8.10	8.14	8.19	8.20	8.23	8.06	8.15	8.03
Conductivity	**µS/cm**		1084	925	1100	1200	1300	1348	890	1100	2300	1100
Turbidity	**NTU**		37.0		5.5	1.2	7.5	3.5		8.4	1.4	2.5
Chloride	**mg/L**		174	120	170	180	240	266	110	150	430	170
Phosphate-ortho	**mg/L**		<1	0.01	0.02	0.017	0.045	<1	0.02	0.02	0.027	0.027
Sulphate	**mg/L**		135	72.0	85.0	91	64	95	72.0	77.0	180	68
Alkalinity	**mg/L**		169	193	200	230	210	229	196	190	300	200
Bicarbonate	**mg/L**		204	190			200	277	193			200
Carbonate	**mg/L**		1	3			3	1	3			2
Hardness	**mg/L**		293	260	380	410	270	396	290	380	690	290
Nitrate	**mg/L**		0.7	1.1	0.4	1.02	0.63	0.5	1.8	0.3	0.33	1.82
Nitrite	**mg/L**		<0.2	<0.01	<0.001	<0.01	0.014	<0.2	0.02	<0.001	<0.01	0.031
Total Kjeldahl Nitrogen	**mg/L**											
Ammonia: total	**mg/L**		<0.03	<0.05	0.08	0.077	0.053	<0.03	<0.05	<0.001	<0.05	0.073
Ammonia: un-ionized	**µg/L**	**20**	<1	<1	1	1	1	<1	<2	<1	<2	1
Total Organic Carbon	**mg/L**		8.0	7.6	4.6	3.3	8	6.0	4.5	4.5	5.7	4.5
Phenols	**µg/L**				<0.001					<0.001		
Aluminum	**mg/L**	**0.075 ****	1.060	0.220	0.200	0.035	0.23	0.074	0.150	0.300	0.056	0.13
Antimony	**mg/L**		<0.0005	<0.0005	<0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	<0.0005	<0.0005
Arsenic	**mg/L**		<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001
Barium	**mg/L**		0.052	0.038	0.085	0.070	0.046	0.089	0.068	0.087	0.096	0.06
Beryllium	**mg/L**	**1.100 *****	<0.001	<0.0005	<0.005	<0.0005	<0.0005	<0.001	<0.0005	<0.005	<0.0005	<0.0005
Bismuth	**mg/L**		<0.001		<0.001			<0.001		<0.001		
Boron	**mg/L**	**0.200**	0.08	0.06	0.21	0.22	0.12	0.20	0.16	0.21	0.23	0.23
Cadmium	**mg/L**	**0.0002**	<0.0001	<0.0001	<0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.002	<0.0001	<0.0001
Calcium	**mg/L**		81	74	91	93	72	103	82	87	150	75
Chromium	**mg/L**	**1.100**	<0.005	<0.005	<0.003	<0.005	<0.005	<0.005	<0.005	<0.003	<0.005	<0.005
Cobalt	**mg/L**	**0.0009**	0.0005	<0.0005	<0.01	<0.0005	<0.0005	<0.0001	<0.0005	<0.01	<0.0005	<0.0005
Copper	**mg/L**	**0.005**	0.0043	0.0020	<0.003	0.0012	0.004	0.0030	0.0030	<0.003	0.0018	0.004
Iron	**mg/L**	**0.300**	1.17	0.25	0.33	0.12	0.39	0.05	0.15	0.37	<0.1	0.21
Lead	**mg/L**	**0.025 ******	0.0009	<0.0005	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.002	<0.0005	<0.0005
Magnesium	**mg/L**		22.3	19.0	37.0	31.0	18	33.5	25.0	35.0	50.0	20
Manganese	**mg/L**		0.024	0.025	0.080	0.053	0.05	<0.005	0.036	0.060	0.045	0.03
Molybdenum	**mg/L**		0.001	0.001	<0.001	0.002	0.0017	0.001	0.004	<0.001	0.002	0.0026
Nickel	**mg/L**	**0.025**	0.002	<0.001	<0.0005	<0.001	0.0013	<0.001	<0.001	<0.0005	0.002	0.0013
Phosphorus	**mg/L**	**0.030**	0.07	0.0	<0.1	0.026	0.082	<0.05	0.0	<0.1	0.036	0.048
Potassium	**mg/L**		5.4	4	8	6	4.9	4.8	7	8	8	5.5
Selenium	**mg/L**		<0.002	<0.002	<0.004	<0.002	<0.002	<0.002	<0.002	<0.004	<0.002	<0.002
Silicon	**mg/L**		3.89	2.9	2.6	2.4	3	2.58	3.1	2.6	3.1	3
Silver	**mg/L**	**0.0001**	<0.0001	<0.0001	<0.5	<0.0001	<0.0001	<0.0001	<0.0001	<0.5	<0.0001	<0.0001
Sodium	**mg/L**		99	87	78	96	160	123	66	73	220	100
Strontium	**mg/L**		0.739	0.640	2.100	1.900	0.79	1.810	1.700	2.200	2.700	1.3
Thallium	**mg/L**	**0.0003**				<0.00005	<0.00005				<0.00005	<0.00005
Tin	**mg/L**		<0.001		<0.002			0.002		<0.002		
Titanium	**mg/L**		0.017	0.006	<0.005	<0.005	0.0055	<0.005	<0.005	<0.005	<0.005	0.0055
Vanadium	**mg/L**	**0.007**	0.0019	<0.0005	<0.001	<0.0005	0.00094	<0.0005	0.001	<0.001	<0.0005	0.00094
Zinc	**mg/L**	**0.030**	0.008	<0.005	<0.004	<0.005	0.0063	<0.005	0.013	<0.004	<0.005	0.01
Total Dissolved Solids	**mg/L**		617	507	590		710	763	487	570		590

NOTES: 1) PWQO - Provincial Water Quality Objectives
2) ** - PWQO value based on pH range of 6.5 to 9.0.
*** - PWQO value based on hardness >75 mg/L.
**** - PWQO value based on alkalinity >80 mg/L.
3) Free ammonia concentration based on a surface water temperature of 12 ºC for November, 18 ºC for June, prior to 2000.

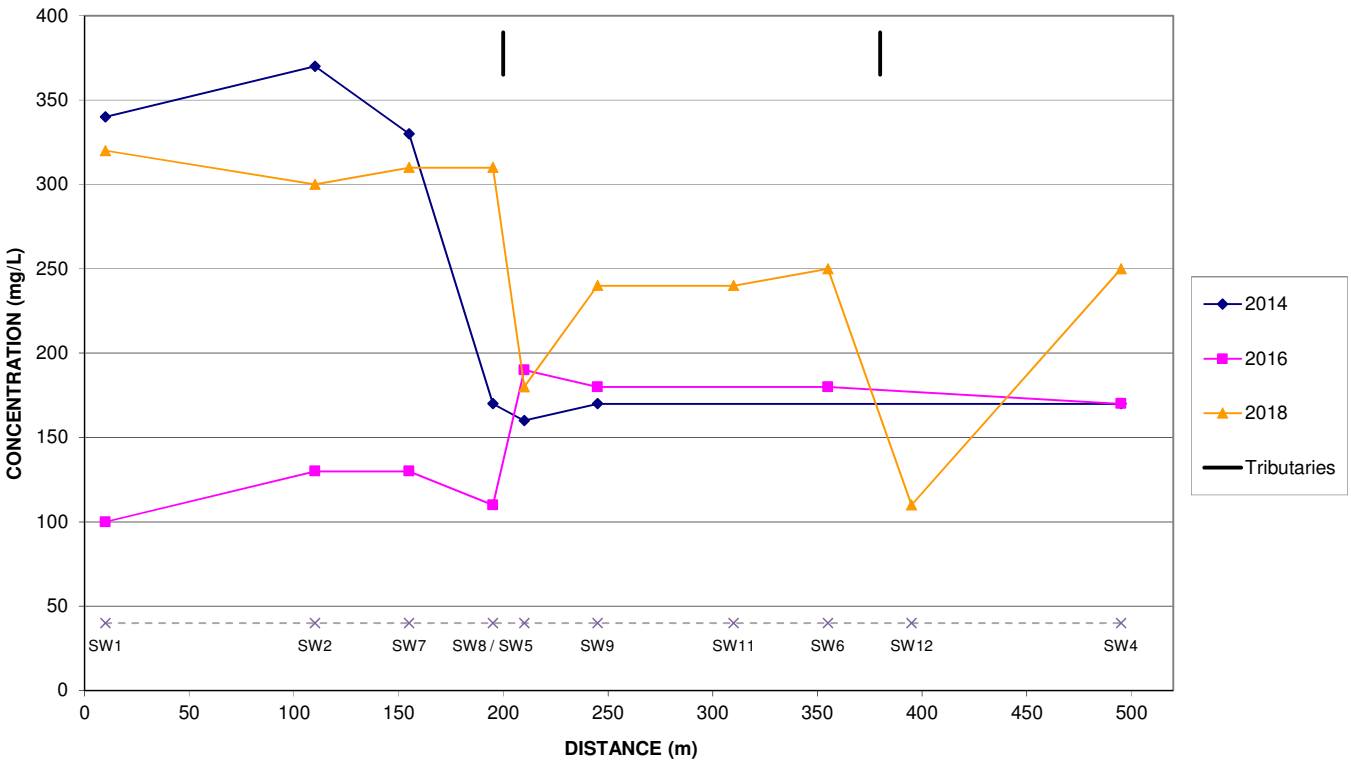
TABLE A-5
SURFACE WATER GENERAL CHEMISTRY RESULTS
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

			ADJACENT TO REFUSE AREA		DOWNSTREAM
PARAMETER	**UNITS**	**PWQO**	**SW11**	**SW12**	**SW13**
		Objectives	Oct-18	Oct-18	Oct-18
pH	**units**	**6.5-8.5**	8.21	8.15	8.22
Conductivity	**µS/cm**		1300	1000	1300
Turbidity	**NTU**		7.4	4.8	8.4
Chloride	**mg/L**		240	110	250
Phosphate-ortho	**mg/L**		0.05	<0.010	0.048
Sulphate	**mg/L**		63	74	61
Alkalinity	**mg/L**		210	330	210
Bicarbonate	**mg/L**		210	320	210
Carbonate	**mg/L**		3.1	4.3	3.3
Hardness	**mg/L**		270	380	280
Nitrate	**mg/L**		0.54	0.23	0.5
Nitrite	**mg/L**		0.015	<0.010	<0.010
Total Kjeldahl Nitrogen	**mg/L**				
Ammonia: total	**mg/L**		<0.050	<0.050	<0.050
Ammonia: un-ionized	**µg/L**	**20**	<1	<1	<1
Total Organic Carbon	**mg/L**		8.5	6.6	8.6
Phenols	**µg/L**				
Aluminum	**mg/L**	**0.075 ****	0.230	0.160	0.28
Antimony	**mg/L**		<0.0005	<0.0005	<0.0005
Arsenic	**mg/L**		<0.001	<0.001	<0.001
Barium	**mg/L**		0.046	0.082	0.047
Beryllium	**mg/L**	**1.100 *****	<0.0005	<0.0005	<0.0005
Bismuth	**mg/L**				
Boron	**mg/L**	**0.200**	0.11	0.13	0.11
Cadmium	**mg/L**	**0.0002**	<0.0001	<0.0001	<0.0001
Calcium	**mg/L**		72	96	77
Chromium	**mg/L**	**1.100**	<0.005	<0.005	<0.005
Cobalt	**mg/L**	**0.0009**	<0.0005	<0.0005	<0.0005
Copper	**mg/L**	**0.005**	0.0033	0.0023	0.0037
Iron	**mg/L**	**0.300**	0.37	0.71	0.47
Lead	**mg/L**	**0.025 ******	<0.0005	0.0024	0.0005
Magnesium	**mg/L**		18.0	31.0	19
Manganese	**mg/L**		0.049	0.610	0.054
Molybdenum	**mg/L**		0.002	0.002	0.0016
Nickel	**mg/L**	**0.025**	0.002	0.002	0.0017
Phosphorus	**mg/L**	**0.030**	0.077	0.034	0.086
Potassium	**mg/L**		4.9	6	5
Selenium	**mg/L**		<0.002	<0.002	<0.002
Silicon	**mg/L**		3.10	3.5	3.3
Silver	**mg/L**	**0.0001**	<0.0001	<0.0001	<0.0001
Sodium	**mg/L**		160	78	170
Strontium	**mg/L**		0.770	1.800	0.8
Thallium	**mg/L**	**0.0003**	<0.00005	<0.00005	<0.00005
Tin	**mg/L**				
Titanium	**mg/L**		0.006	<0.005	0.0079
Vanadium	**mg/L**	**0.007**	0.0010	0.001	0.0011
Zinc	**mg/L**	**0.030**	0.006	0.005	0.006
Total Dissolved Solids	**mg/L**		710	620	730

NOTES: 1) PWQO - Provincial Water Quality Objectives
2) ** - PWQO value based on pH range of 6.5 to 9.0.
*** - PWQO value based on hardness >75 mg/L.
**** - PWQO value based on alkalinity >80 mg/L.
3) Free ammonia concentration based on a surface water temperature of 12 ºC for November, 18 ºC for June, prior to 2000.

FIGURE A-1
SURFACE WATER STATIONS - CONCENTRATION vs DISTANCE GRAPHS

CHLORIDE



SULPHATE

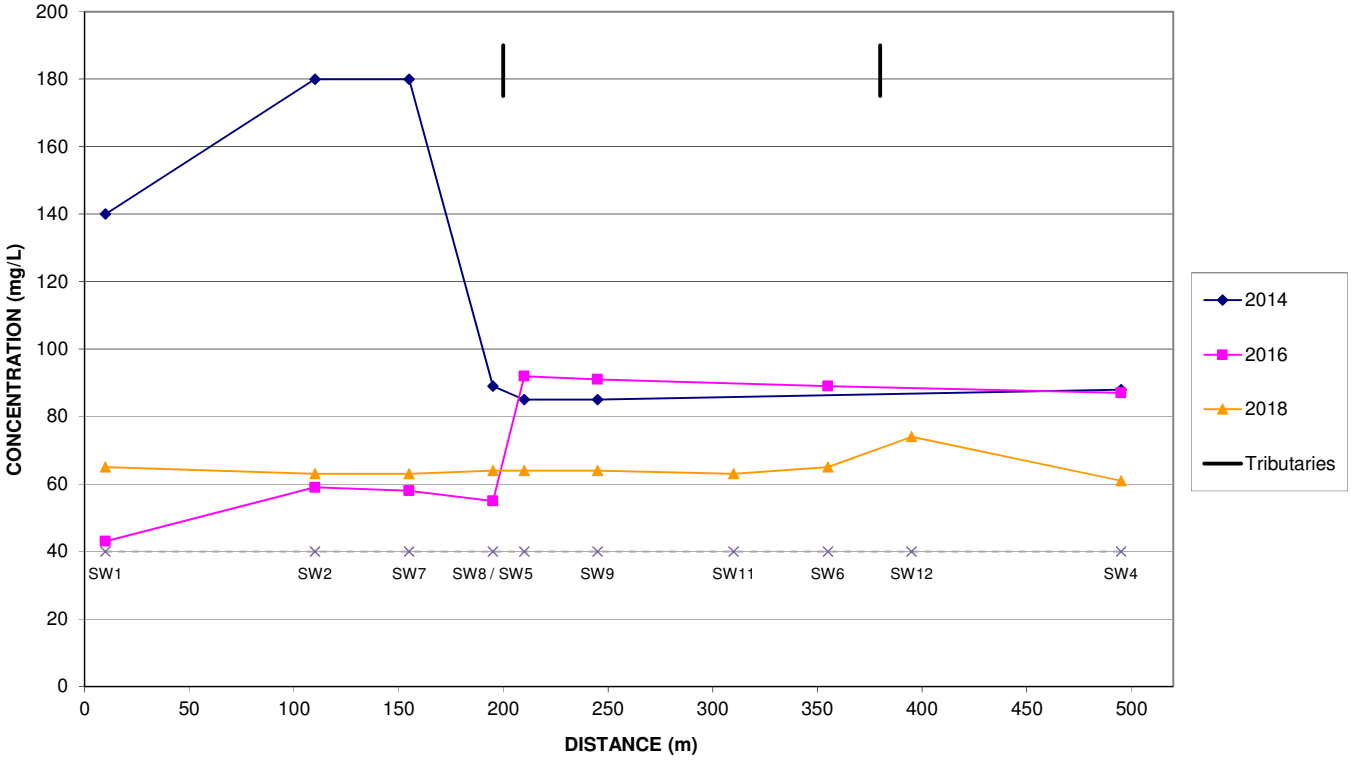
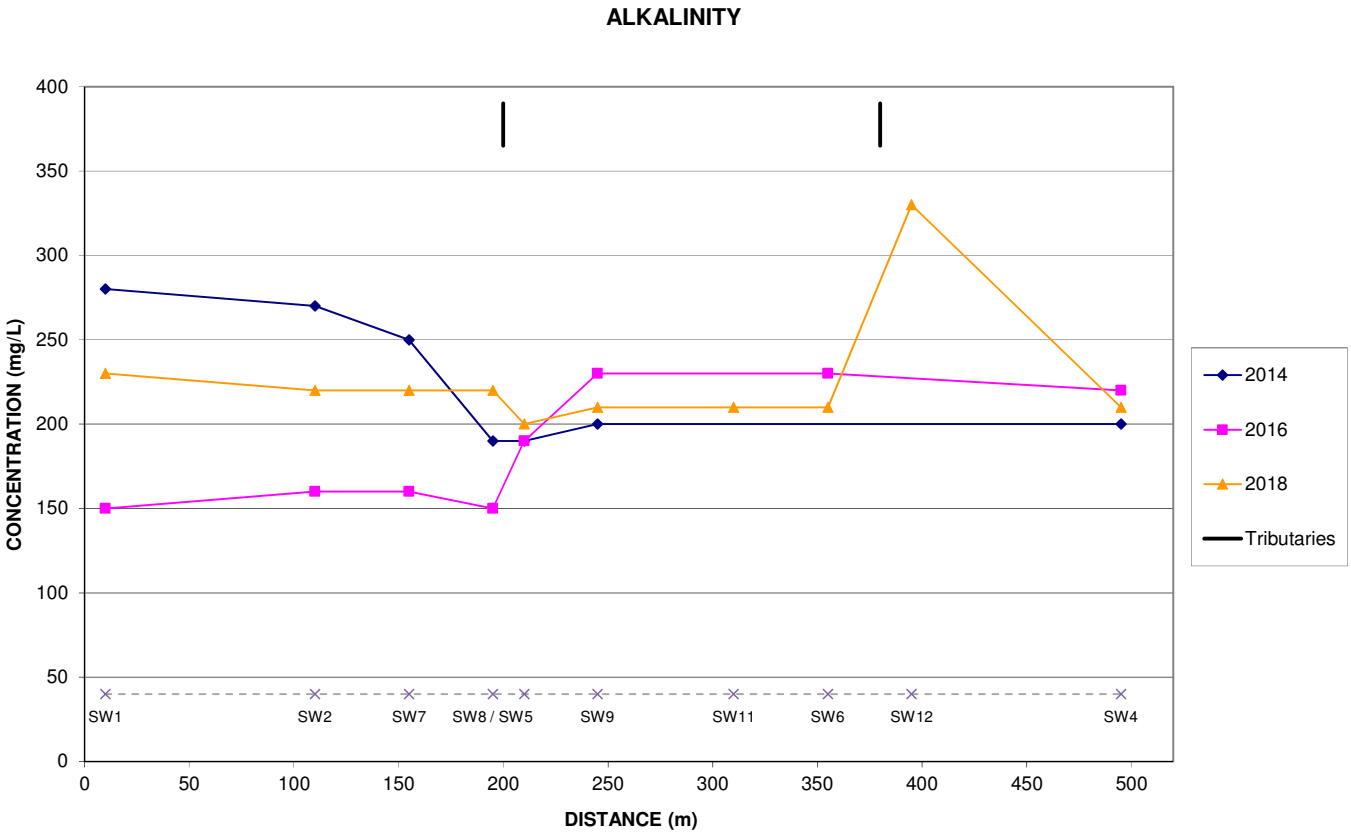


FIGURE A-2
SURFACE WATER STATIONS - CONCENTRATION vs DISTANCE GRAPHS



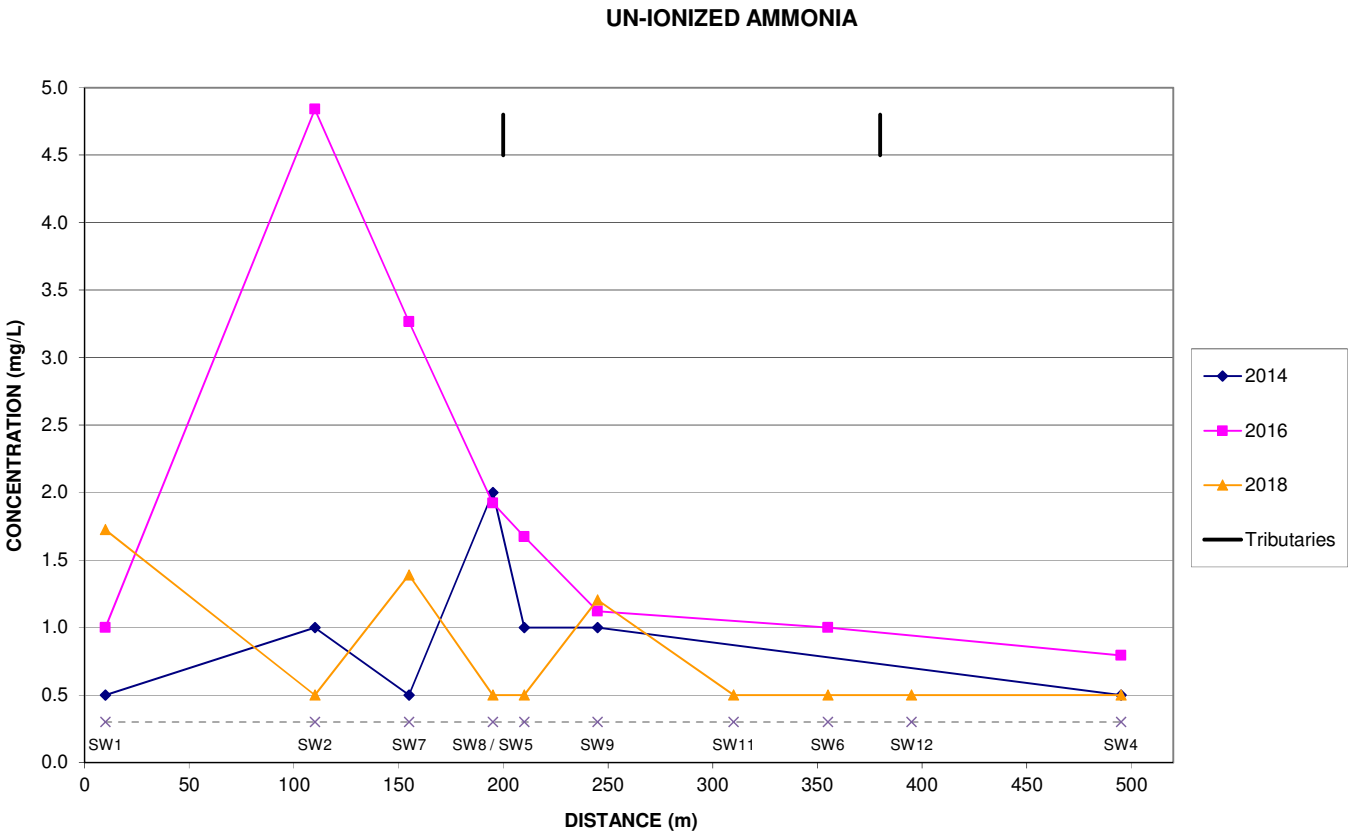
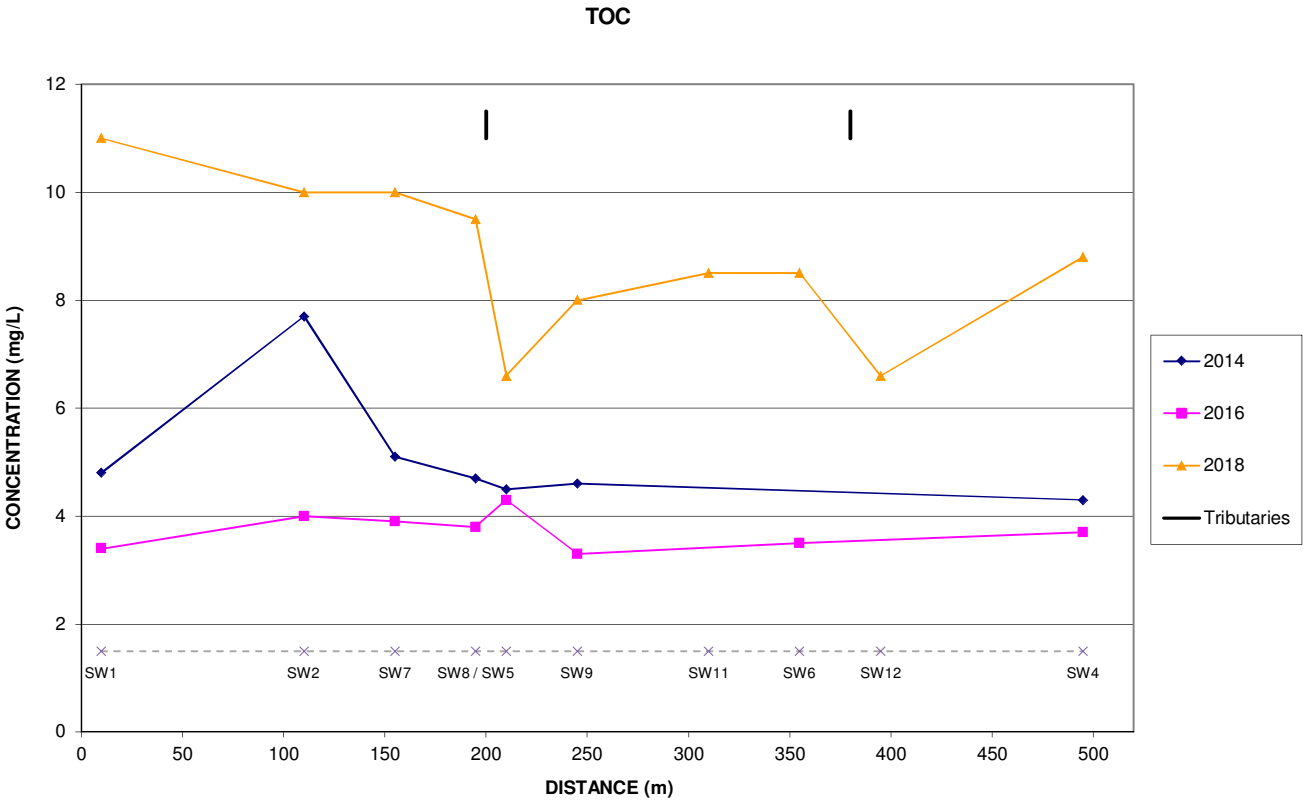


FIGURE A-3
SURFACE WATER STATIONS - CONCENTRATION vs DISTANCE GRAPHS



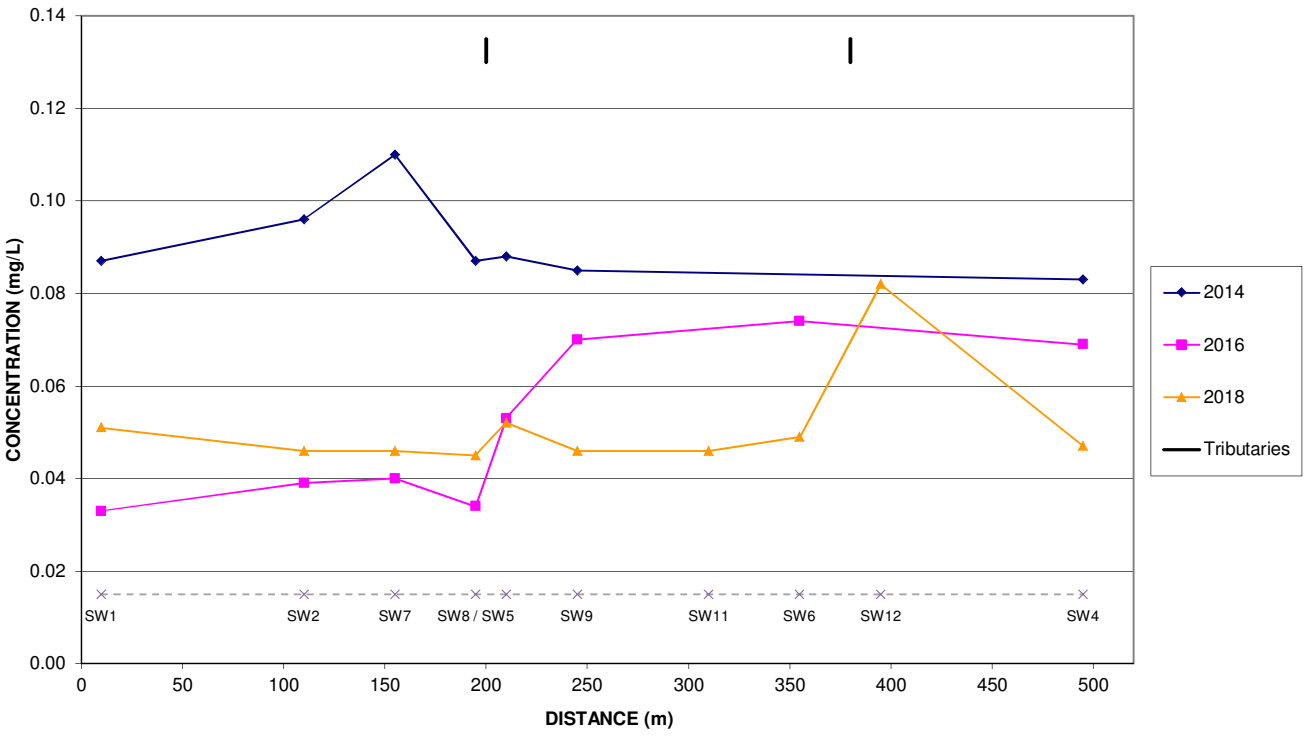
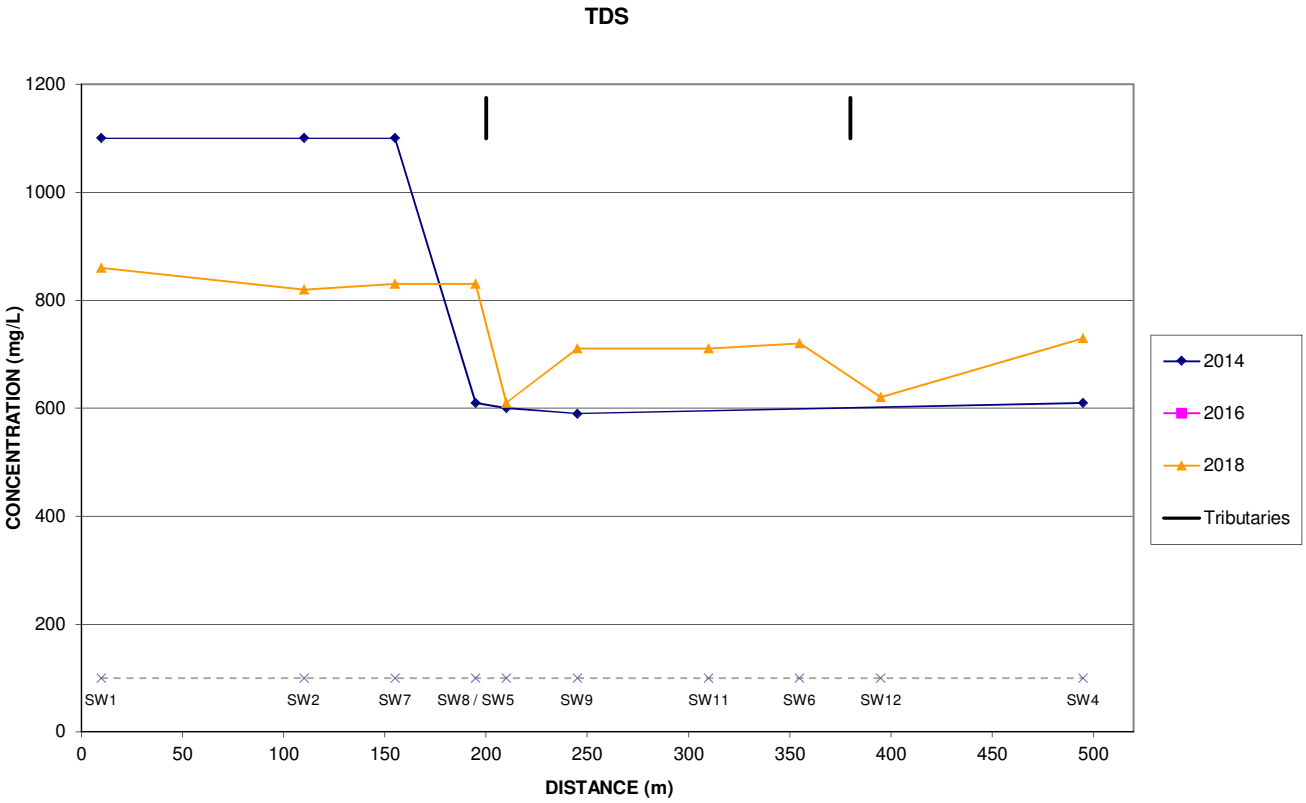


FIGURE A-4
SURFACE WATER STATIONS - CONCENTRATION vs DISTANCE GRAPHS



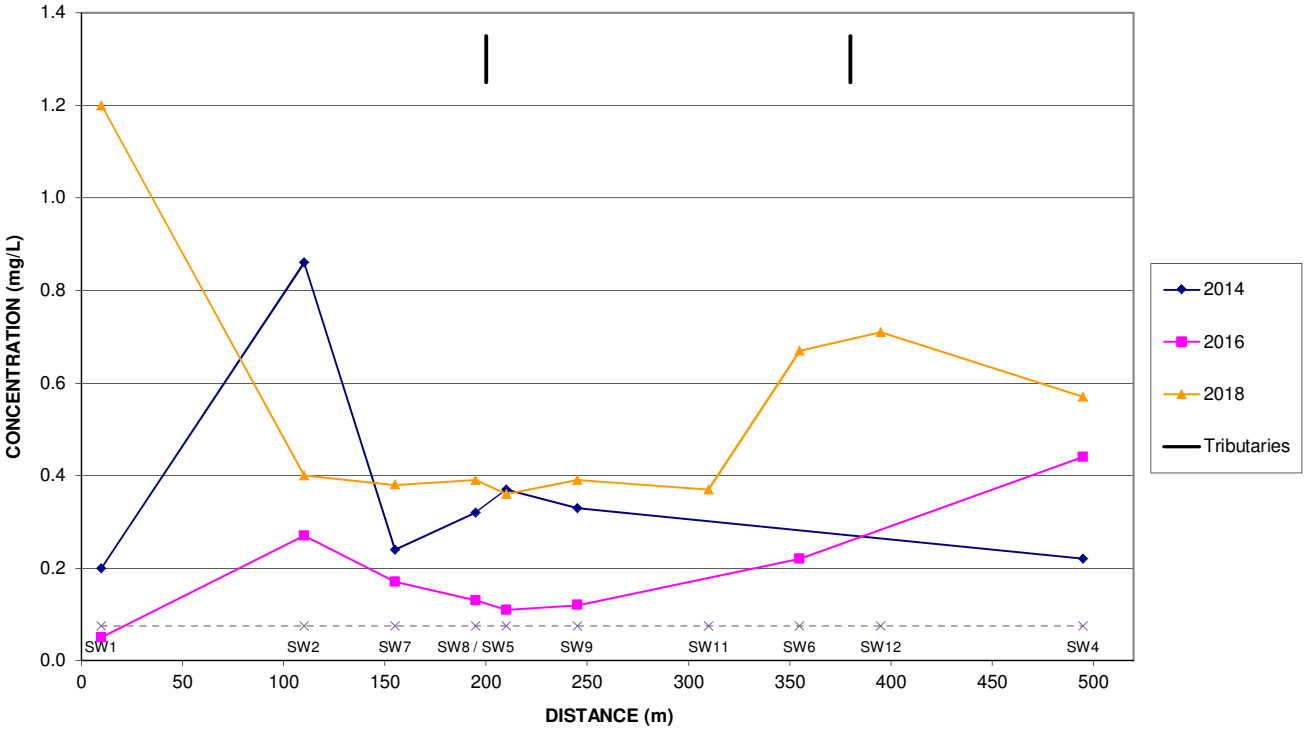
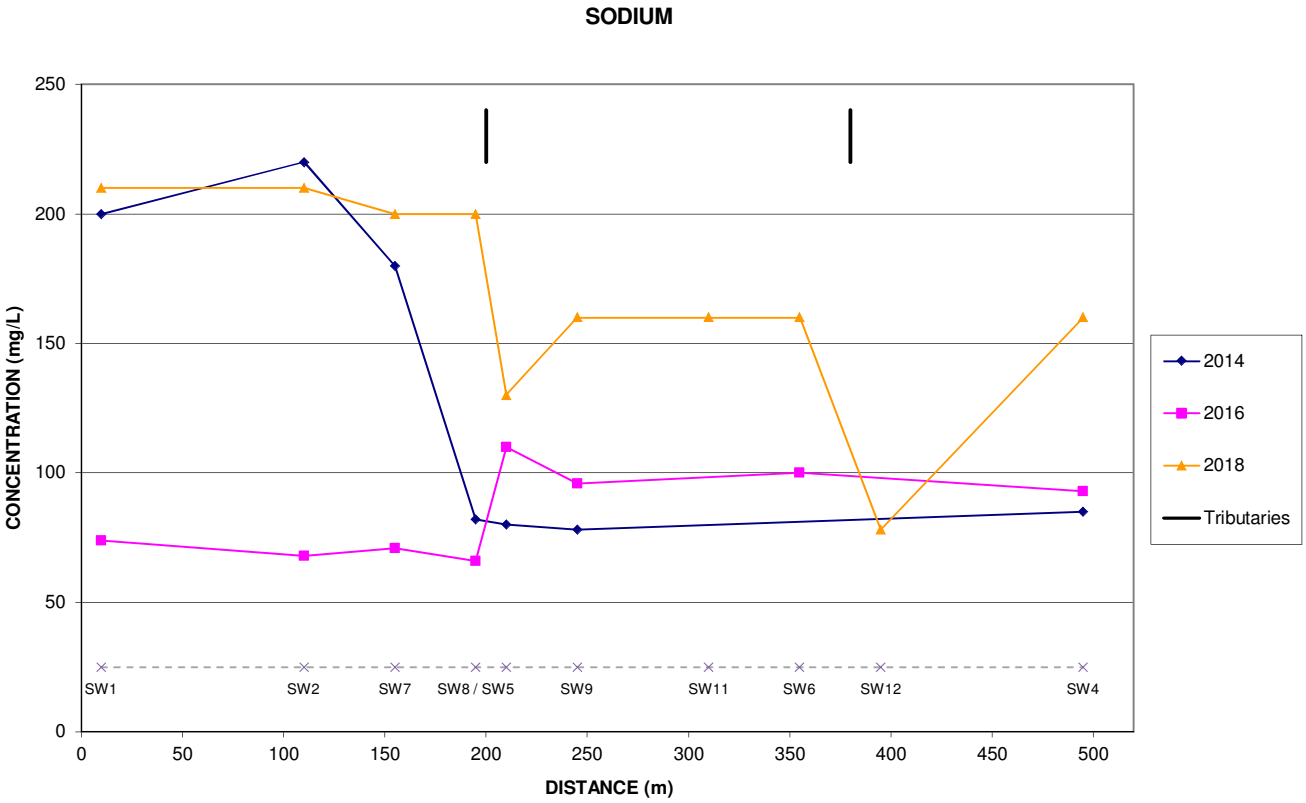
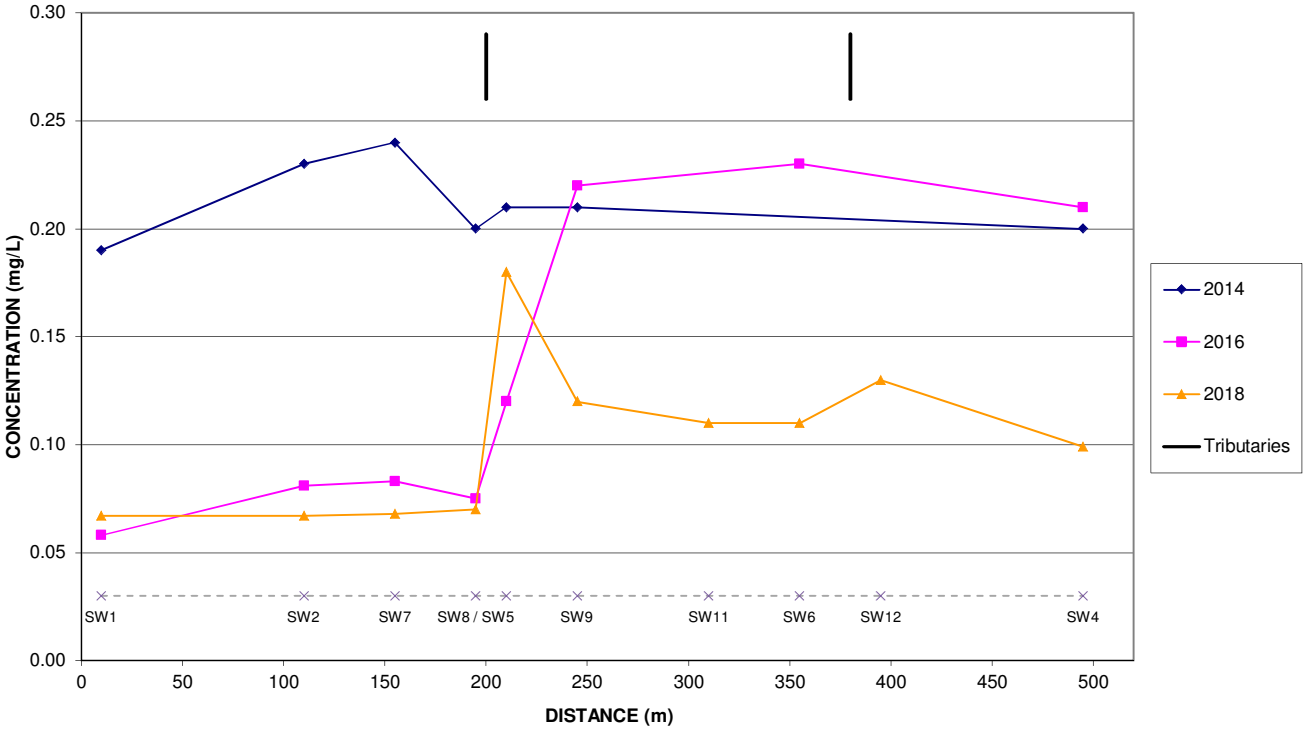


FIGURE A-5
SURFACE WATER STATIONS - CONCENTRATION vs DISTANCE GRAPHS





APPENDIX

B HYDROGEOLOGICAL DATA

TABLE B-1
WATER LEVEL ELEVATIONS
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

MONITOR	T.O.P. ELEVATION (m)	WATER LEVEL ELEVATION (m)	
		Sep-99	Oct-18
GP101	153.57	150.32	-
GP102	153.04	150.83	-
GP103	153.29	150.91	-
GP106	150.32	147.30	147.15
99-1	154.15	147.26	149.01
99-2	154.62	147.83	150.04

NOTES: 1) Elevations based on an original assumed T.O.P. elevation of 153.57 m for GP101.
2) m - Metres
T.O.P - Top of Pipe

Table A-1

Borehole Logs – G.K. Bell & Associates

G.K. Bell & Associates Ltd.
CONSULTING GEOTECHNICAL ENGINEERS

GAS PROBE 101

Figure: 2
Ref. No: 9262.12

Project: NINTH LINE LANDFILL
Location: OAKVILLE, ONTARIO
Date: August 9, 1994
Boring Method: CME 55 (Track) SSA
Engineer: GB
Technician: JH

SOIL PROFILE					SAMPLES			Shear Strength—kPa ■ 50 100 150 200 250 / SPT N Index ● 20 40 60 80 100 / Water Content ○ 10 20 30 40 50
Depth—m	DESCRIPTION **Elevation:** 152.48 m.	Legend	Elevation	Ground Water Conditions	Number	Type	N-Index	
1	Brown silty CLAY, (FILL), (CL—ML), with rootlets, hard and moist.		152		1		6	
1.67			151					
2	Brown silty CLAY, (TILL), (CL—ML), very hard and moist.				2		26	
	Grading reddish brown and dry at 2.29 m.		150		3		51	
3	Grading moist at 3.05 m.							
			149		4		67	
4					5		254 mm / 50 Blows	
4.21	Borehole terminated at 4.21 m. Gas probe installed to 1.09 m above ground. Borehole dry on completion.		148					
5			147					
6			146					
7			145					
8			144					
9								
10								

G.K. Bell & Associates Ltd.
CONSULTING GEOTECHNICAL ENGINEERS

GAS PROBE 102

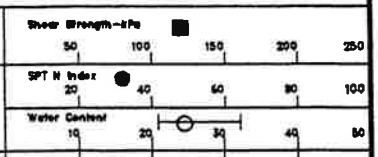
Figure: 3
Ref. No: 9262.12

Project: NINTH LINE LANDFILL
Location: OAKVILLE, ONTARIO

Date: August 9, 1994
Boring Method: CME 55 (Track) SSA

Engineer: GB
Technician: JH

Depth-m	DESCRIPTION Elevation: 151.89 m.	Legend	Elevation	Ground Water Conditions	SAMPLES Number	Type	N-Index
1	Reddish brown silty CLAY, (FILL), (CL–ML), very hard and moist.		151		1		30
0.91	Reddish brown silty CLAY, (TILL), (CL–ML), very hard and moist. Grading dry at 1.52 m.		150		2		44
2	Grading greyish brown at 2.29 m.		149		3		53
3	Grading reddish brown at 3.05 m.				4		69
3.50	Borehole terminated at 3.50 m. Gas probe installed to 0.30 m above ground. Borehole dry on completion.		148				
4							
5			147				
6			146				
7			145				
8			144				
9			143				
10							



G.K. Bell & Associates Ltd.
CONSULTING GEOTECHNICAL ENGINEERS

GAS PROBE 103

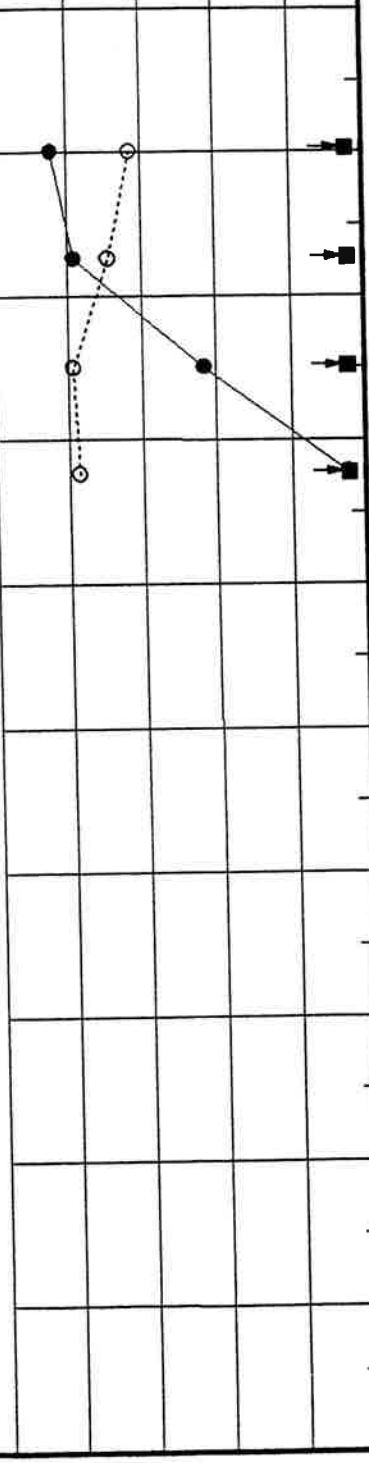
Project: NINTH LINE LANDFILL
Location: OAKVILLE, ONTARIO
Date: August 9, 1994
Boring Method: CME 55 (Track) SSA

Figure: 4
Ref. No: 9262.12
Engineer: GB
Technician: JH

Depth-m	DESCRIPTION **Elevation:** 151.91 m.	Legend	Elevation	Ground Water Conditions	Sample Number	Sample Type	N-Index
0	Reddish brown silty CLAY, (FILL), black cinder, very hard and moist.		151		1		16
1							
2	Grading possible till at 1.67 m.		150		2		22
2.13	Reddish brown silty CLAY, (TILL), (CL–ML), very hard and dry.				3		58
3			149				
	Grading greyish brown and moist at 3.05 m.				4		125 mm 50 Blows
3.33	Borehole terminated at 3.33 m. Gas probe installed to 0.55 m above ground. Borehole dry on completion.		148				
4							
			147				
5							
			146				
6							
			145				
7							
			144				
8							
			143				
9							
10							

SOIL PROFILE | SAMPLES

Shear Strength–kPa ■ 50 100 150 200 250
SPT N Index ● 20 40 60 80 100
Water Content ○ 10 20 30 40 50



G.K. Bell & Associates Ltd.
CONSULTING GEOTECHNICAL ENGINEERS

GAS PROBE 104

Figure: 5
Ref. No: 9262.12

Project: NINTH LINE LANDFILL
Date: August 9, 1994
Engineer: GB

Location: OAKVILLE, ONTARIO
Boring Method: CME 55 (Track) SSA
Technician: JH

SOIL PROFILE					SAMPLES			Shear Strength—kPa ■ 50 100 150 200 250 / SPT N Index ● 20 40 60 80 100 / Water Content ○ 10 20 30 40 50
Depth-m	DESCRIPTION Elevation: 150.52 m.	Legend	Elevation	Ground Water Conditions	Number	Type	N-Index	
1	Reddish brown silty CLAY, (FILL), (CL–ML), with rootlets and wood, very hard and moist.		150		1		25	
1.67			149					
2	Reddish brown silty CLAY, (TILL), (CL–ML), with cobbles, hard and moist.				2		57	
			148		3		72	
3	Grading no cobbles at 3.05 m.				4		75 mm / 50 Blows	
3.28	Borehole terminated at 3.28 m. Gas probe installed to 0.22 m above ground. Borehole dry on completion.		147					
4			146					
5			145					
6			144					
7			143					
8			142					
9								
10								

G.K. Bell & Associates Ltd.
CONSULTING GEOTECHNICAL ENGINEERS

GAS PROBE 105

Figure: 6
Ref. No: 9262.12

Project: NINTH LINE LANDFILL
Location: OAKVILLE, ONTARIO
Date: August 9, 1994
Boring Method: CME 55 (Track) SSA
Engineer: GB
Technician: JH

SOIL PROFILE					SAMPLES			Shear Strength-kPa 50 100 150 200 250
Depth-m	DESCRIPTION **Elevation:** 149.45 m.	Legend	Elevation	Ground Water Conditions	Number	Type	N-Index	SPT N Index 20 40 60 80 100 Water Content 10 20 30 40 50
1	Reddish brown silty CLAY, (FILL), (CL–ML), very hard and moist.		149		1		23	
1.67			148		2		45	
2	Reddish brown silty CLAY, (TILL), (CL–ML), very hard and moist.		147		3		125 mm / 50 Blows	
3					4		100 mm / 50 Blows	
3.30	Borehole terminated at 3.30 m. Gas probe installed to 0.48 m above ground. Borehole dry on completion.		146					
4			145					
5			144					
6			143					
7			142					
8			141					
9								
10								

G.K. Bell & Associates Ltd.
CONSULTING GEOTECHNICAL ENGINEERS

GAS PROBE 106

Figure: 7
Ref. No: 9262.12

Project: NINTH LINE LANDFILL
Location: OAKVILLE, ONTARIO

Date: August 9, 1994
Boring Method: CME 55 (Track) SSA

Engineer: GB
Technician: JH

SOIL PROFILE					SAMPLES			
Depth-m	DESCRIPTION Elevation: 149.89 m.	Legend	Elevation	Ground Water Conditions	Number	Type	N-Index	Shear Strength-kPa ■ 50 100 150 200 250 SPT N Index ● 20 40 60 80 100 Water Content ○ 10 20 30 40 50
1	Reddish brown silty CLAY, (FILL), (CL–ML), with rootlets very hard and moist.		149		1		37	
1.37								
2	Reddish brown silty CLAY, (TILL), (CL–ML), very hard and moist.		148		2		43	
3			147		3		44	
3.46	Grading greyish brown at 3.20 m.				4		254 mm / 50 Blows	
4	Borehole terminated at 3.46 m. Gas probe installed to 0.43 m above ground. Borehole dry on completion.		146					
5			145					
6			144					
7			143					
8			142					
9			141					
10								

Table A-2

Borehole Logs – Jagger Hims Limited

BOREHOLE NO. 99-1

PROJECT NAME: CLOSED OAKVILLE NINTH LINE LANDFILL SITE
PROJECT NO.: 980950.02
CLIENT: REGIONAL MUNICIPALITY OF HALTON
DATE: OCTOBER 28, 1999
BOREHOLE TYPE: 108 mm ID HOLLOW STEM AUGERS
GEOLOGIST: SJT
GROUND ELEVATION: N/A
REVIEWER: DEJ

DEPTH (m)	STRATIGRAPHIC DESCRIPTION	STRATIGRAPHY	MONITOR DETAILS	SAMPLE TYPE	SAMPLE 'N' VALUE	SAMPLE % WATER	SAMPLE % RECOVERY	SAMPLE RQD (%)	CONE PENETRATION "N" VALUE 10 20 30 / SHEAR STRENGTH	WATER CONTENT % 10 20 30 / W_P W_L	REMARKS
0											
	FILL: BROWN, CLAYEY SILT TO SILT, SOME CLAY										STRAIGHT AUGERING TO 8.53 m
2											
3.00											
	REFUSE: SOIL, NEWSPAPERS, CLOTHING, METAL										
4											
6											
8											
8.53	SILT: BLACK, SOME FINE SAND, SOME TO TRACE CLAY, MOIST, SOFT			1SS	-	-	80				STRONG HYDROCARBON ODOUR IN 1SS
9.14											
9.75	CLAYEY SILT: BROWN, DTPL, FIRM			2SS	-	-	80				
10	BOREHOLE TERMINATED AT 9.75 m IN CLAYEY SILT										
12											
14											
16											
18											
20											

BOREHOLE NO. 99-2

PROJECT NAME: CLOSED OAKVILLE NINTH LINE LANDFILL SITE
PROJECT NO.: 980950.02
CLIENT: REGIONAL MUNICIPALITY OF HALTON
DATE: OCTOBER 28, 1999
BOREHOLE TYPE: 108 mm ID HOLLOW STEM AUGERS
GEOLOGIST: SJT
GROUND ELEVATION: N/A
REVIEWER: DEJ

DEPTH (m)	STRATIGRAPHIC DESCRIPTION	STRATIGRAPHY	MONITOR DETAILS	SAMPLE TYPE	SAMPLE 'N' VALUE	SAMPLE % WATER	SAMPLE % RECOVERY	SAMPLE RQD (%)	CONE PENETRATION "N" VALUE 10 20 30 / SHEAR STRENGTH	WATER CONTENT % 10 20 30 / W_P W_L	REMARKS
0	FILL: BROWN, CLAYEY SILT TO SILT, SOME CLAY										STRAIGHT AUGERING TO 7.62 m
3.00	REFUSE: SOIL, NEWSPAPERS, RAGS, CLOTHING, METAL										
7.62	CLAYEY SILT: BROWN, SOME GRAVEL, DTPL, STIFF			1SS	87	-	75				
8.23	BOREHOLE TERMINATED AT 8.23 m IN CLAYEY SILT										

APPENDIX

C GAS MONITORING RESULTS

TABLE C-1
COMBUSTIBLE GAS READINGS
CLOSED OAKVILLE NINTH LINE LANDFILL SITE - ENVIRONMENTAL MANAGEMENT PLAN

LOCATION	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18
GP6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GP8R	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GP9R	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GP10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GP11	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0
GP15R	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GP105	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GP106	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GP107	0.0	0.0	0.0	flooded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GP108	0.0	0.0	0.0	flooded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99-1	54	40	30	34	45	3	4	0.0	36	37	23	19
99-2	0.0	8	2.4	2.0	1.6	0.0	0.0	0.0	0.9	1.5	0.0	0.0
CLUB HOUSE	-	-	-	-	-	-	-	-	-	-	-	-

NOTES: 1) All values are percent methane.

2) "-" - Indicates no measurement obtained.

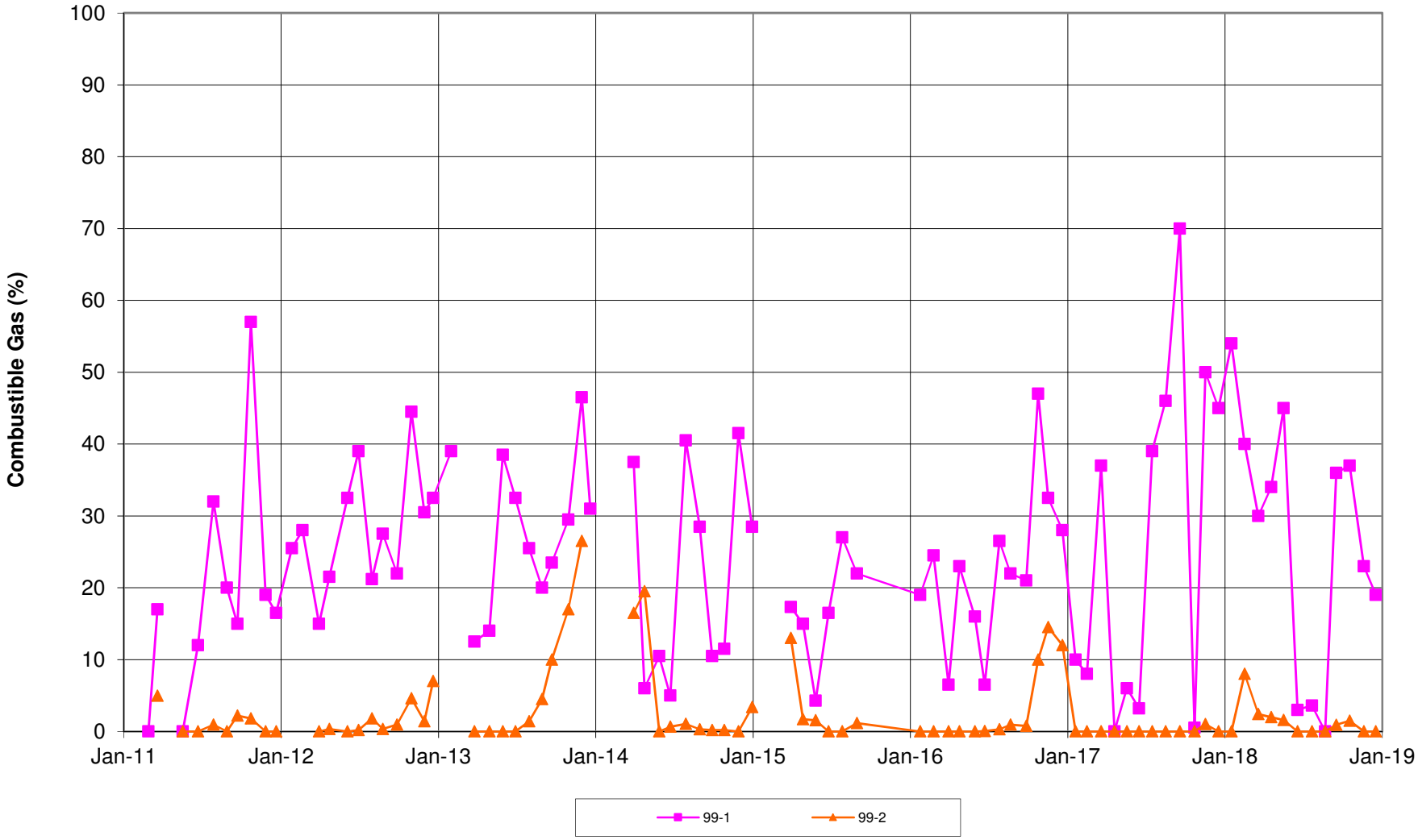
3) Gas probes GP1, GP2, GP3, GP4, GP5, GP7, GP12, GP13, GP14, and GP104 have been reported as destroyed.

4) Gas probes GP101, GP102, and GP103 were decommissioned in spring 2014 due to the roadwork expansion, and were replaced by gas probes GP107 and GP108 in June 2015.

5) Gas probes GP8, GP9 and GP15 were decommissioned and replaced with GP8R, GP9R, and GP15R in early September 2016.

FIGURE C-1

COMBUSTIBLE GAS CONCENTRATIONS : Ninth Line Landfill



APPENDIX

D RESPONSE TO MECP COMMENTS

2019-04-12

Denise Plourde, Environmental Officer
Ministry of the Environment and Climate Change
Halton-Peel District Office
4145 North Service Road
Suite 300
Burlington, Ontario
L7L 6A3

Subject: Oakville Ninth Line Landfill Site
Response to MOE Comments –
Review of 2012 Environmental Management Plan

Dear Ms. Plourde:

On behalf of the Region of Halton, we are pleased to forward our response to your comments on the 2012 Environmental Management Plan for the Closed Ninth Line Landfill Site, in the City of the Oakville. The comments and recommendations provided by the Ministry are contained in the memorandum dated January 13, 2017.

The response to these Ministry comments are provided in the following sections.

1. PREVIOUS STUDIES

Statement, Page 2 of 8: (For the 1994 G.K. Bell & Associates Report) It was concluded that the landfill leachate has a moderate negative effect on the water quality of Joshua's Creek immediately adjacent to the landfill.

Response: The interpretation that was provided in the 1994 report was based on a simple comparison of surface water quality between the upstream station SW1, and the downstream station SW4, as no other samples were obtained along Joshua's Creek between these stations. Sampling events completed since the events in 1994, which incorporated additional surface water stations along Joshua's Creek and the tributary, have confirmed that other off-site sources are influencing the water quality along Joshua's Creek, which are not associated with the landfill site.

Unit 2
126 Don Hillock Drive
Aurora, ON, Canada L4G 0G9

T: +1 905 750-3080
F: +1 905 727-0463
wsp.com

2. GROUNDWATER REVIEW - MONITORING

(a) Recommendation, Page 4 of 8: Additional monitoring locations including but not limited to the proposed leachate monitors …. may be required to obtain sufficient information about the leachate level and groundwater level throughout the entire refuse site.

Response: Although the installation of additional monitors at the landfill site is always an option, and under routine consideration by the Region, the existing monitoring network is sufficient for providing adequate data for interpretation of on-site conditions; and the installation of additional monitors would not provide additional useful information at the present time. As a result, no additional monitors are required at this time.

(b) Recommendation, Page 4 of 8: It would be beneficial to measure the leachate level and groundwater level annually at the site …. This monitoring would provide information on the leachate level fluctuation during wet and dry periods and assist in understanding the potential locations for seepage.

Response: Water levels will be obtained at the existing leachate monitors on a quarterly basis until the end of 2020, to assess the magnitude of the seasonal fluctuations.

3. GROUNDWATER REVIEW - LEACHATE/GROUNDWATER

(a) Recommendation, Page 4 of 8: Include proposed leachate monitors A, B, C as recommended in WSP 2014 report for the leachate sampling and other locations as required and recommended above.

Response: The installation of the additional leachate monitors was recommended if water sampling results indicated that the landfill site was having an adverse influence on the surface water quality within the adjacent Joshua's Creek. Based on a review of the chemical results, following the completion of the sampling events in 2014, 2016, and 2018, no additional leachate monitors were deemed to be necessary or required. The recommendation for additional leachate monitors will be considered in the future, as water monitoring data becomes available.

(b) Recommendation, Page 4 of 8: Take samples from leachate for chemical analysis concurrent to additional groundwater quality sampling.

Response: Leachate samples will be obtained from the two existing refuse monitors during future groundwater sampling events at the site.

(c) *Recommendation, Page 4 of 8: Install a background monitor for groundwater to obtain information upgradient in each hydrostratigraphic unit since it is difficult to ascertain that the groundwater samples from GP106 and Clubhouse are not impacted by leachate.*

Response: The presence of a clayey soil overburden will limit potential downward migration of leachate influenced groundwater, such that the primary mechanism for groundwater movement will be lateral; therefore, the potential of a landfill influence within an underlying aquifer is minimal. Since the natural groundwater quality in the Town of Oakville area is frequently naturally poor, as confirmed by reference groundwater monitors at the Fourth Line Landfill Site, parameter concentrations are often elevated compared to the Ontario Drinking Water Standards (ODWS). As shown in Table A-3 of

the 2018 EMP, the concentrations for several leachate diagnostic parameters, including chloride, barium, boron, and iron, are low and/or satisfy the ODWS within the samples obtained from the clubhouse well and gas probe GP106. This indicates that the landfill site is not having an adverse influence on the water quality within these sampled locations, and additional reference monitors are not required at the present time.

4. SURFACE WATER - MONITORING

(a) Statement, Page 6 of 8: The WSP 2014 report concludes that the landfill's impact on Joshua's Creek … recommended additional sampling take place to better understand the effect the landfill is having on the environment.

Response: The surface water monitoring network was expanded for the sampling event in 2018, to better refine potential water quality variances along Joshua's Creek. The results from the results in 2014 and 2016, along with the results in 2018, continue to indicate that the tributary discharge has a noticeable influence on surface water quality within Joshua's Creek. Water quality within Joshua's Creek is also likely influenced by overland flow from non-landfill areas. Based on the current monitoring results, the Region intends to continue the biennial water sampling program in the future, subject to future changes in the monitoring results and interpretation.

(b) Statement, Page 6 of 8: To ensure that the quality of the creek Is maintained, I suggest …conducting at least two years of seasonal monitoring….to better understand the impact the landfill is having on Joshua's Creek.

Response: The Region intends to complete the next surface water sampling event in 2020, as part of the long term environmental management plan for the site.

5. SURFACE WATER – CONCLUSIONS / RECOMMENDATIONS

(a) Recommendation, Page 6 of 8: Installation of a new surface water quality monitoring station at the upstream end of the ditch that runs along the southern side of the landfill … to better determine background conditions in the ditch.

Response: Future surface water sampling events will include attempts to sample at the recommended new station along the referenced ditch, however, given the configuration and intermittent nature of the ditch, the presence of sufficient water for sampling will be sporadic.

(b) Recommendation, Page 6 of 8: Installation of a new surface water quality monitoring station further upstream to better represent background conditions (closer to Dundas Street East).

Response: The location of the current upstream surface water station, SW1, is sufficient for the surface water quality assessments at this site. The station is located at a suitable distance from the refuse area, so that water quality at the station is not influenced by the refuse area; but the station is located close enough to the landfill site to negate other potential off-site sources that may be present upstream of the landfill site boundary.

(c) Recommendation, Page 6 of 8: More strategic placement of stations along Joshua's Creek …and more stations further south towards the area of the seep observed in 2000.

Response: Additional surface water stations were incorporated into the monitoring network for the surface water sampling event in 2018. The additional stations included the following:

- SW11: located midway between current stations SW6 and SW9, along Joshua's Creek
- SW12: located along the south ditch, prior to discharge into Joshua's Creek
- SW13: located along Joshua's Creek, downstream of the south ditch discharge point

(d) Recommendation, Page 7 of 8: As per the groundwater review, I also recommend that groundwater quality should occur during the field program…to determine any changes that have occurred since the last sample was taken in 1999.

Response: The groundwater locations were included in the water sampling event that was completed in 2018. These locations will be sampled in conjunction with the subsequent biennial surface water sampling events in the future.

(e) Recommendation, Page 7 of 8: Further inspections during wetter periods to aid in the assessment of seeps along the bank of Joshua's Creek.

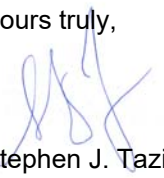
Response: The Region undertakes a comprehensive spring inspection on an annual basis, as part of its standard protocols, to identify potential seeps during the wetter seasonal period. The Region intends to continue this practise as part of its standard protocols for the site.

(f) Recommendation, Page 7 of 8: Conducting a benthic study for Joshua's Creek if water quality results indicate that the landfill is having a measurable impact on the water quality of Joshua's Creek.

Response: The recommendation for a benthic survey is included as part of the environmental management plan for the site, and will be implemented if the landfill is having a measurable impact on the water quality of Joshua's Creek.

We trust that this is satisfactory for your needs at the present time. If there are any questions, please contact us.

Yours truly,



Stephen J. Taziar, P.Eng., DCE
Senior Project Engineer

SJT/nah

c: Region of Halton, Nicole Levie

Encl.
WSP ref.: 181-30000-00-106-1001
H:\Proj\18\30000-00\106 Oakville Ninth Line\1001\Wp\Oakville Ninth Line Landfill Site - Response to MOE Comments.docx