CanNorth

Canada North Environmental Services Limited Partnership

A First Nation Environmental Services Company

MIDLAND BAY LANDING
RISK ASSESSMENT

420 Bayshore Drive, Midland, Ontario

Prepared by:

Canada North Environmental Services
Markham, Ontario

Prepared for:

Cambium Inc.
843 King Street West, Unit 8
Oshawa, Ontario
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Project No. 2960

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Term	**Description**
APEC	Area of Potential Environmental Concern
APV	Aquatic Receptor Protection Values
EBC	Effect-Based Concentration
EC	Electrical Conductivity
ERA	Ecological Risk Assessment
ESA	Environmental Site Assessment
CCME	Canadian Council of Ministers of the Environment
COC	Contaminant of Concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSM	Conceptual Site Model
HASP	Health and Safety Plan
HBIAC	Health-Based Indoor Air Quality Criteria
HDPE	High-Density Polyethylene
HHERA	Human Health and Ecological Risk Assessment
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
ILCR	Incremental Lifetime Cancer Risk
IRIS	Integrated Risk Information System
LEL	Lowest Effect Level
MASL	Meters Above Sea Level
MDL	Method Detection Limit
MECP	Ministry of the Environment, Conservation and Parks
MGRA	Modified Generic Risk Assessment
NHIC	Natural Heritage Information Centre
O.Reg.	Ontario Regulation
PAH	Polycyclic Aromatic Hydrocarbon
PCA	Potentially Contaminating Activity

PCB	Polychlorinated Biphenyl
PIN	Property Identification Number
PHC	Petroleum Hydrocarbon
PSF	Pre-Submission Form
PSS	Property Specific Standard
PWQO	Provincial Water Quality Objective
QP	Qualified Person
RA	Risk Assessment
REMC	Reasonable Estimate of Maximum Concentration
RfC	Reference Concentration
RfD	Reference Dose
RMM	Risk Management Measure
RMP	Risk Management Plan
RSC	Record of Site Condition
SAR	Sodium Adsorption Ratio
SI	Screening Index
SCS	Site Condition Standards
SEL	Severe Effect Level
SF	Slope Factor
SGMP	Soil and Groundwater Management Plan
SVIMS	Soil Vapour Intrusion Mitigation System
TEF	Toxicity Equivalency Factor
TRV	Toxicological Reference Value
UR	Unit Risk
VEC	Valued Ecosystem Component
VOC	Volatile Organic Compound

1.0 SUMMARY OF RECOMMENDATIONS AND FINDINGS

1.1 Introduction

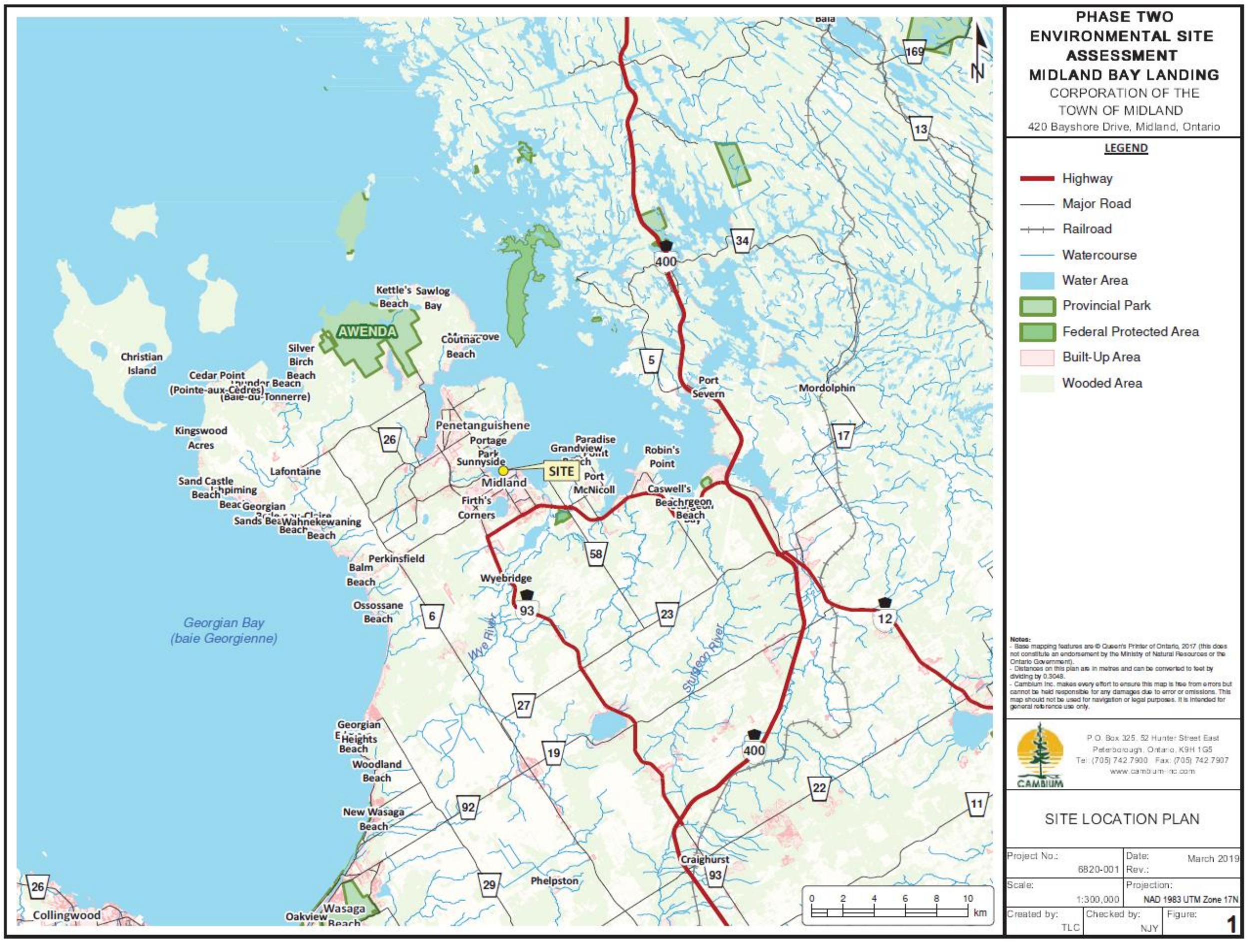
Canada North Environmental Services (CanNorth) worked with Cambium Inc. (Cambium) to prepare a Risk Assessment (RA) for a site located at 420 Bayshore Drive, Midland, Ontario (Site or Property) for the Town of Midland. The site is currently vacant and is planned to be redeveloped with mixed parkland, residential and commercial land use. The location of the site is presented on Figure 1.1.

This report has been prepared by CanNorth and Cambium, based on fieldwork conducted by Cambium and others, for the sole benefit and use by the Town of Midland. In performing this work, CanNorth/Cambium has relied in good faith on information provided by others and has assumed that the information provided is both complete and accurate. This work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work; further, they are considered valid only at the time the report was produced.

The RA was undertaken to determine whether soil and groundwater exhibiting contaminants at concentrations above the Table 9 Site Condition Standards in the "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act" (MOE 2011) for potable groundwater and Residential/Parkland/ Institutional land use are safe for the identified receptors at the Site, with or without some form of protective engineered, institutional, or administrative control. The RA was completed for residents, indoor workers, visitors, long-term outdoor workers, short-term subsurface workers, as well as ecological receptors that may be exposed to Contaminants of Concern (COCs) in the soil and groundwater at the Site.

As it the Town of Midland's intent to file a Record of Site Condition (RSC) under Ontario Regulation (O.Reg.) 153/04 of the Environmental Protection Act, this report has been structured to include the relevant sections, headings, and subheadings as laid out in Table 1 – Mandatory Requirements for Risk Assessment Reports from Schedule C of O.Reg. 153/04.

Figure 1.1 Site Location



1.2 Risk Assessment Objectives and Approach

The purpose of this RA is to evaluate the potential for human and ecological risks at the Site for the proposed land use and to develop Property-Specific Standards (PSSs) for the soil and groundwater COCs that are protective of human health and the environment. The specific objectives of this RA for the Site are as follows:

- Evaluate all potential pathways for human and ecological exposure to COCs in Site media
- Assess human health risk/hazard levels for potentially complete exposure pathways using both quantitative and qualitative methods
- Assess the potential risks to valued ecosystem components (VECs) posed by the COCs

- Develop PSSs for each COC identified in soil and groundwater to be protective of the more sensitive of the human and ecological receptors at the Site
- Develop a Risk Management Plan (RMP) discussing proposed Risk Management Measures (RMMs) if it is deemed that risks to human health and the environment are unacceptable

This RA has been conducted using a standard full depth quantitative approach, a risk assessment other than those identified in O. Reg. 153/04, Schedule C, Part II.

CanNorth has prepared this RA in accordance with O.Reg. 153/04 made under the Environmental Protection Act entitled, "Records of Site Condition - Part XV.1 of the Act" (MOE 2004). The RA was conducted based on the identification of COCs through a comparison of analytical data to generic standards presented in "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act" (MOE 2011) (MECP Standards). CanNorth used several other risk assessment guidance documents published by the Ministry of the Environment, Conservation and Parks (MECP) and other regulatory agencies in the completion of the RA, as referenced herein. MECP's "Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario" dated April 15, 2011 (MOE 2011), which is the basis of the MECP Standards, was used in the preparation of this RA.

As per Schedule C, Part I, Section 5 of O.Reg. 153/04, the Mandatory Certifications made by the Qualified Person (Risk Assessment) conducting and supervising the RA are presented in Appendix D.

Cambium completed a Phase One Environmental Site Assessment (ESA) and Phase Two ESA for the Site in accordance with O.Reg. 153/04. These ESA reports were used to support the RA and are summarized in Appendix F. A list of Site related documents relied upon in support of the RA is provided in Appendix E.

CanNorth submitted the RA Pre-Submission Form (PSF) to the MECP on May 15, 2019 (Appendix A). Based on MECP's comments on the PSF, received July 8, 2019, the Site is not considered to be part of a wider area of abatement; therefore, a communication plan was not required as part of the RA.

MECP comments on the Phase Two Conceptual Site Model (CSM) were received on August 23, 2019. A copy of the MECP comments and the responses are provided in Appendix B. The responses to the MECP comments have been incorporated into the RA and the current Phase Two CSM is provided in Appendix G.

1.3 Deviations from Pre-submission Form

The following are changes made in the Risk Assessment that deviate from the information provided in the pre-submission form including:

- The property boundary was revised, the updated boundaries show that there are no aquatic environments on the Site, only the terrestrial parcel. This has implications for the relevant receptors and pathways and thus the CSMs have been modified.
- The theoretical maximum concentration of vinyl chloride was re-evaluated and determined to be 0.62 µg/L, which equates to a Reasonable Estimate of the Maximum Concentration (REMC) of 0.74 µg/L. This was updated from the value identified in the PSF.
- Additional data was collected from the site and all COC have been delineated.
- The CSM was updated based on the comments received and includes exposure to groundwater for a wider range of receptors and indirect exposure of residents through the consumption of biota (garden produce) that could uptake contaminants in groundwater.
- The potential for offsite exceedance of soil SCS was changed to "No" (Table 1.1) because soil is not expected to migrate off the site once RMM are in place.
- The most recent groundwater sampling results indicated that there is no potential for offsite exceedance of groundwater SCS, and therefore this was updated to "No" in Table 1.2.

The type of risk assessment is the same as identified in the PSF and no additional computer models were used.

1.4 Risk Assessment Standards

Table 1.1 and Table 1.2 and provide the proposed PSSs in soil and groundwater for each COC. The PSS selected are protective of human and ecological health at the Site. The consideration of RMMs to be implemented will mitigate exposure pathways and reduce risks/hazards to below acceptable levels. The selection of the proposed PSSs for COCs in soil and groundwater are outlined in Section 6. The RMMs to be implemented at the Site are described in the RMP presented in Section 7.

Table 1.1 Property Specific Standards in Soil

Parameter	Units	Soil Maximum	Soil REMC	Table 9 SCS	Recommended PSS	Dominant Exposure Pathway	Risk Management Requirement	Potential for Offsite Exceedance of SCS
Metals								
Antimony	µg/g	88	105.6	1.3	105.6	Direct contact by residents, sediment migration	RMM-1, RMM-3	No
Arsenic	µg/g	110	132	18	132	Direct contact by residents	RMM-1, RMM-3	No
Barium	µg/g	1470	1,764	220	1,764	Mammals and birds (short-tail shrew), sediment migration	RMM-1	No
Beryllium	µg/g	3.2	3.84	2.5	3.84	Plants and soil organisms	None	No
Cadmium	µg/g	1.8	2.16	1.2	2.16	Sediment migration	RMM-1	No
Cobalt	µg/g	48	57.6	22	57.6	Direct contact by residents	RMM-1	No
Copper	µg/g	280	336	92	336	Sediment migration	RMM-1	No
Cyanide (CN-)	µg/g	0.07	0.084	0.051	0.084	Sediment migration	None	No
Lead	µg/g	6800	8160	120	8160	Mammals and birds (American woodcock), sediment migration	RMM-1, RMM-3	No
Mercury	µg/g	1.4	1.68	0.27	1.68	Sediment migration	None	No
Molybdenum	µg/g	6.8	8.16	2	8.16	Sediment migration	RMM-1	No
Nickel	µg/g	84	100.8	82	100.8	Sediment migration	RMM-1	No
Selenium	µg/g	9.2	11.04	1.5	11.04	Mammals and birds (short-tail shrew)	RMM-1	No
Silver	µg/g	1.2	1.44	0.5	1.44	Sediment migration	~~None~~RMM-1	No
Uranium	µg/g	3.1	3.72	2.5	3.72	Sediment migration	None	No
Zinc	µg/g	1300	1,560	290	1,560	Sediment migration	RMM-1	No
Polycyclic Aromatic Hydrocarbons								
Acenaphthene	µg/g	1.4	1.68	0.072	1.68	Sediment migration	RMM-1	No
Acenaphthylene	µg/g	2.2	2.64	0.093	2.64	Sediment migration	RMM-1, RMM-2	No
Anthracene	µg/g	8.7	10.44	0.22	10.44	Sediment migration	RMM-1	No
Benz[a]anthracene	µg/g	5.5	6.6	0.36	6.6	Sediment migration	RMM-1	No
Benzo[a]pyrene	µg/g	8.6	10.32	0.3	10.32	Sediment migration	RMM-1	No
Benzo[b]fluoranthene	µg/g	14	16.8	0.47	16.8	Sediment migration	RMM-1	No

Parameter	Units	Soil Maximum	Soil REMC	Table 9 SCS	Recommended PSS	Dominant Exposure Pathway	Risk Management Requirement	Potential for Offsite Exceedance of SCS
Benzo[ghi]perylene	µg/g	8.4	10.08	0.68	10.08	Sediment migration	RMM-1	No
Benzo[k]fluoranthene	µg/g	5.1	6.12	0.48	6.12	Sediment migration	RMM-1	No
Chrysene	µg/g	5.5	6.6	2.8	6.6	Sediment migration	RMM-1	No
Dibenz[a,h]anthracene	µg/g	2	2.4	0.1	2.4	Sediment migration	RMM-1	No
Fluoranthene	µg/g	12	14.4	0.69	14.4	Mammals and birds (short-tailed shrew)	RMM-1	No
Fluorene	µg/g	1.4	1.68	0.19	1.68	Sediment migration	RMM-1	No
Indeno[1,2,3-cd]pyrene	µg/g	8.3	9.96	0.23	9.96	Sediment migration	RMM-1	No
Methylnaphthalene, 2-(1-)	µg/g	12	14.4	0.59	14.4	Plants and soil organisms	RMM-1	No
Naphthalene	µg/g	4.7	5.64	0.09	5.64	Sediment migration	RMM-1	No
Phenanthrene	µg/g	6.4	7.68	0.69	7.68	Sediment migration	RMM-1	No
Pyrene	µg/g	8	9.6	1	9.6	Plants and soil organisms	RMM-1	No
Volatile Organic Compounds								
Trichloroethylene	µg/g	0.38	0.456	0.05	0.456	Indoor air	RMM-2	No
BTEX								
Benzene	µg/g	8.4	10.08	0.02	10.08	Direct contact by residents, Indoor air	RMM-1 RMM-2	No
Toluene	µg/g	25	30	0.2	30	Indoor air	RMM-1, RMM-2	No
Ethylbenzene	µg/g	4.8	5.76	0.05	5.76	Indoor air	RMM-1, RMM-2	No
Xylene Mixture	µg/g	43	51.6	0.05	51.6	Indoor air	RMM-1, RMM-2	No
Petroleum Hydrocarbons								
PHC F1	µg/g	400	480	25	480	Indoor air	RMM-2	No
PHC F2	µg/g	1,700	2,040	10	2,040	Indoor air	RMM-2	No
PHC F3	µg/g	38,000	45,600	240	45,600	Plants and soil organisms	RMM-1	No
PHC F4	µg/g	22,000	26,400	120	26,400	Sediment migration	RMM-1	No

Notes:
PSS Property Specific Standards REMC Reasonable Estimate Maximum Concentration: see Section 3.3.4.
SCS Site Condition Standard from MOE (2011): *Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act.*
NA Not applicable
Risk Management Measures:

- RMM-1: A cover (soil or hard cap) to be placed across the site
- RMM-2: Soil vapour management for buildings at the site Future building construction on the east portion of the Site (Area 1~~2~~ on Figure 7.1) will include either i) an at or below grade storage/parking garage or ii) SVIMS. On the west portion (Area 2~~1~~ on Figure 7.1) of the site buildings will include a SVIMS.
- RMM-3: Health and Safety Plan for workers involved in sub-surface activities.

Table 1.2 Property Specific Standards in Groundwater

Parameter	Units	Groundwater Maximum	Groundwater REMC	Table 9 SCS	Recommended PSS	Dominant Exposure Pathway	Risk Management Requirement	Potential for Offsite Exceedance of SCS
Volatile Organic Compounds								
Trichloroethylene	µg/L	2.2	2.64	1.6	2.64	Indoor air	RMM-2	No
Vinyl Chloride	µg/L	<0.2	0.74	0.5	0.74	Indoor air	RMM-2	No
BTEX								
Benzene	µg/L	2.4	2.88	44	2.88	Indoor air	RMM-2	No
Petroleum Hydrocarbons								
PHC F2	µg/L	1,000	1,200	150	1,200	Indoor air	RMM-2	No
PHC F3	µg/L	580	696	500	696	NA	None	No

Notes:
PSS Property Specific Standards
REMC Reasonable Estimate Maximum Concentration: see Section 3.3.4.
SCS Site Condition Standard from MOE (2011): *Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act.*
NA Not applicable
Risk Management Measures:

- RMM-2: Soil vapour management for buildings at the site

1.5 Risk Assessment Assumptions

The soil and groundwater analytical data were compared to the MECP Table 9 Generic Site Condition Standards for Use within 30 m of a Water Body in a Non-Potable Groundwater Condition for coarse-textured soil and Residential/Parkland/Institutional Property Use to identify the Site-related COCs. Additionally, the GW2 component of the Table 7: Generic SCS for Shallow Soils in a Non-Potable Ground Water Condition, Industrial/Commercial/Community Property Use, and coarse-textured soils are also applicable to protect against the migration of volatile vapours to indoor air. The Phase Two CSM (Appendix G) provides a detailed discussion on the applicability of the MECP Table 9 and Table 7 Standards to the Site. As further outlined in Section 3.3.4, a compound was identified as a COC if the screening concentration was greater than its respective MECP Table 9 Standard. The RA was conducted based on the following assumptions:

- the current land use is industrial and parkland; the proposed land use is commercial, parkland, and residential
- The Site will be redeveloped for mixed residential, commercial, and parkland use with low-rise and mid-rise commercial/residential condominium units.
- Seventy-five soil samples were submitted for laboratory analysis by Pinchin (2014) and Stantec (2014) to assess soil pH at the Site. Except for one surface soil sample, soil pH results were within the allowable ranges for surface and sub-surface soil. Five additional soil samples collected by Cambium within 2 m of the original sample, including one sample collected at the original location and depth, were within the acceptable range for surface soil. Therefore, the single low pH sample result in the Stantec data was considered spurious and was removed from the dataset. Accordingly, the MECP's assumptions regarding the mobility and bioavailability for chemicals used in the Rationale for the Development and Application of Generic Soil, Ground Water and Sediment Criteria for Use at Contaminated Sites in Ontario (MOE 2011) are applicable
- the Site is within 30 m of a body of water; Midland Bay is directly adjacent
- the Site is municipally serviced such that groundwater is not potable
- groundwater was measured at less than 2.0 m below ground surface and thus groundwater at the Site is considered shallow
- soil texture was determined to be coarse as defined by O.Reg. 153/04 and soil and groundwater standards were selected as appropriate

- ecological receptors will be present and receptors selected by the MECP in the development of the generic standards are appropriate for the Site
- regular users of the Site would include long-term indoor workers, outdoor maintenance workers, subsurface workers and residents
- based on subsurface investigations, groundwater flow direction in both the shallow and deeper wells was northerly toward Midland Bay
- a combination of a qualitative and quantitative assessment was undertaken based on the estimates of reasonable maximum concentrations

Assumptions in this RA are consistent with the generic assumptions contained in MOE (2011) with the exception of Site characteristics specified in Section 3 and any modifications to ecological habitat specified in Section 5.

1.6 Risk Management Requirements

Section 7.0 presents the RMP that has been developed for the Site based on the findings of the RA. The following RMMs are recommended for the Site:

- Hard cap / fill cap that will:
  - protect residents, outdoor workers, and terrestrial ecological receptors (terrestrial community and wildlife) from direct contact with impacted soils.
  - protect migration of soil from the site into the adjacent aquatic environment.
  - include landscape restriction to prohibit the installation of vegetable gardens, other than those planted in above ground containers isolated from subsurface conditions, to protect residents from the consumption of foods grown directly in impacted soils.
- Mitigate soil vapour intrusion in buildings at the site. Future building construction on the east portion of the Site (Area 1~~2~~ on Figure 7.1) will include either i) an at or below grade storage/parking garage or ii) SVIMS. On the west portion (Area 2~~1~~ on Figure 7.1) of the site buildings will include a SVIMS.
- Health and Safety Plan to protect construction/utility sub-surface workers from direct contact with impacted soil.

In addition, a soil and groundwater management plan (SGMP) will be implemented to control the manner in which soils are excavated and or groundwater removed and/or managed during future ground intrusive activities at the Site to ensure that the health of construction/utility workers and the public are protected. There will be a restriction on any future use of on-site groundwater for potable purposes.

2.0 RISK ASSESSMENT TEAM MEMBERSHIP

The RA team includes Stacey Fernandes, Nicole Thackeray, and Leah Leon along with the ESA and risk management support from Nick Young, Bernie Taylor and Natalie Wright Cambium. The RA team encompassed expertise in human health toxicity, ecotoxicity, hydrogeology, soil science/soil chemistry, environmental science, environmental chemistry, analytical chemistry, and engineering. Appendix C of the RA presents the curriculum vitae of all RA team members. Brief descriptions regarding the expertise of each team member, and the disciplines to which they contribute, are presented below.

Stacey Fernandes, M.Sc., P.Eng., QP_{RA}

Stacey has over 20 years of experience in human health and ecological risk assessment (HHERA). Stacey has conducted a number of RAs for contaminated sites and assisted in the development of risk management plans. She has extensive experience in the assessment of human health and ecological risk due to exposure to metals, inorganics, PHCs, PCBs, PAHs, BTEX compounds, chlorinated organic compounds, perfluoroalkyl substances and radiation. She is a Qualified Person – Risk Assessment (QPRA) in Ontario under O.Reg. 153/04 and has considerable experience in conducting and reviewing RAs (human health and ecological) under the regulation.

Nicole Thackeray, M.Env.Sc.

Nicole has over 6 years of experience in human health and has been involved in the preparation of several risk assessments compliant with O.Reg 153/04. She has been involved with each aspect of human health and ecological risk assessments, including assessing human health and ecological components for residential, institutional, commercial, community, and industrial property use. Nicole has completed exposure modelling for: vapour infiltration, swimming, trench working, fate and transport in aquatic environments. Additionally, Nicole has participated in the selection of RMM to address vapour infiltration, direct exposure to soil and groundwater, and surface runoff to the aquatic environment.

Leah Leon, M.A.Sc.

Leah Leon has ten years of experience in completing HHERAs for contaminated residential, parkland, commercial, and industrial sites throughout Ontario and northern Canada. She has prepared PSFs, screening-level RAs, and detailed RAs. She is experienced in site characterization, selection of COC, development of RA CSMs, receptor selection and characterization, exposure estimation, hazard assessment, risk analysis, and consideration of RMMs and PSS. In addition to completing RAs that are compliant with or in the spirit of O.Reg. 153/04, she has also participated in the review of PSFs and RAs on behalf of the MECP.

Nick Young, M.Eng, P.Geo.

Nick is a Senior Environmental Scientist with Cambium and an environmental consultant specializing in identifying and implementing environmental risk management strategies for brownfield properties and ongoing management of industrial/commercial and municipal properties. Nick has over 25 years' experience in assessment, remediation, and risk assessment/management at contaminated sites, and is recognized by the Ministry as a QP for ESAs and RA. He has successfully submitted numerous RSCs, based on Phase I and II ESAs and Risk Assessments, to the MECP for filing.

Bernie Taylor, P.Eng.

Bernie is a Project Manager and Environmental Engineer with Cambium, holding a Master's in Environmental Studies from York University and a Bachelor of Engineering in Environmental Engineering from Dalhousie University. He is a licenced Professional Engineer in the Province of Ontario with over 10 years' experience in the environmental field. Mr. Taylor's work experience includes conducting ESAs, contaminated site remediation, drinking water treatment evaluations, and Certificate of Approval applications for water, biosolid spreading and landfill operations. Bernie is recognized by the MECP as a QP for ESAs, and has submitted numerous RSCs to the Ministry for filing.

Natalie Wright, BESc, PMP, P.Eng,

Natalie is an Environmental Specialist with Cambium and holds a Bachelor of Engineering degree from Western University and a Post-Graduate Certificate in Environmental Engineering Applications from Conestoga College. Ms. Wright is a Professional Engineer in the Province of Ontario and certified as a Project Management Professional (PMP) with the Project Management Institute. Ms. Wright's professional experience includes six years in the environmental consulting industry, during which time she has developed extensive experience completing Phase One and Two ESAs, remediation projects, and monitoring of Brownfield sites.

3.0 PROPERTY INFORMATION, SITE PLAN AND GEOLOGICAL INFORMATION

Site details (including the past and current uses of the Site and adjacent properties), the physical characteristics of the Site, and COCs are discussed in the following sections.

3.1 Property Information

The Site is on the north side of Bayshore Drive and extends from William Street to Queen Street in Midland, Ontario in the County of Simcoe. The site location is shown on Figure -1 from the Phase Two ~~ESA~~CSM (Appendix G). Site information and property owner information are summarized below.

The Site was historically three separate municipal addresses: 288 Bayshore Drive (east parcel) and 420 Bayshore Drive (west parcel), each with a property identification number (PIN); and 475 Bayshore Drive (south parcel) that was included in the PINs for the other two parcels. The parcels were combined under a single PIN in 2015.

The Phase One and Two property included water lots that extend into Midland Bay. The risk assessment is for only the terrestrial portion of the property.

Site Identification Information

Municipal Address	420 Bayshore Drive, Ontario
Historical Land Use	Mixed industrial and parkland
Current Land Use	Vacant former industrial and parkland
Future Land Use	Mixed commercial and residential/parkland
PIN	58452-0553 (LT)
Roll No.	437402000227500
Universal Transverse Mercator Coordinates*	Zone 17T 588386 m E, 4956586 m N
Legal Description	**420 Bayshore Drive – PIN 58452-0553 (LT)** Part Lots 107 & 108, Part Lots 1 to 12 N/S Frank Street, Part Charles Street, Part George Street & Part Lindsay Street Plan 349; Part Charles Street, Part George Street & Part Lindsay Street, Closed North of CNR Plan 724 Being Part 1 51R40291; Town of Midland.
Site Area	≈14.6 ha (36 acres)

* The Universal Transverse Mercator measurements were obtained from Google Earth Pro.

Property Owner Information

Property Owner	Contact Information
The Corporation of the Town of Midland 575 Dominion Avenue,	Wes Crown

Midland, Ontario L4R 1R2	Director of Planning and Building Services Phone: (705) 526-4275 x2216 Email: wcrown@midland.ca

3.1.1 Past and Current Use of the Property

To summarize current and historical property use the Site was divided into the following four areas as shown on Figure 2 from the Phase Two ~~ESA~~ CSM (Appendix G)~~(Cambium 2019a)~~.

Area 1

- Former Unimin Canada Ltd. (Unimin) plant property
- Fenced and secured
- Unimin operated an aggregate processing plant (silica sand products)
- Plant closed in 2012; plant removed in 2013
- The Town of Midland purchased this land in 2014

Area 2

- Vacant lands used as informal/impromptu open space area with multiple trails and pedestrian access to waterfront/water's edge
- Lands are not fenced and have never been signed as private
- Last known industrial use was coal docks and coal storage, which were removed 30 or more years ago. Unimin's (as Indusmin) previous owner purchased these vacant lands so that they would not have immediate neighbours.
- Area 2 had industrial uses prior to the coal docks that included rail spur lines, and lumber and gristmills.
- The Town of Midland purchased this land in 2014

Area 3

- Area 3 is a small portion of Area 2 where passenger boats (Miss Midland and Serendipity Princess) are dry docked over the winter.
- Dry docking for +/- 15 years through lease with previous owner (Unimin)
- Leases have continued under Town of Midland ownership

Area 4

- Area 4 is a roughly 1.21 ha (3 acre) portion of Area 2 that Town previously leased (since 2002) from Unimin for use as a parking lot, park, boat launch (summer), and snow mobile access to the lake (winter).
- These uses have continued since the purchase of Area 2 in 2014. The park was renamed Midland Bay Landing Park in 2014.

Detail regarding the historical and current uses of these areas was provided to the MECP (Midland 2017a) for comment on interim temporary uses prior to redevelopment. The MECP (MOECC 2017) responded that:

- Areas 1 and 3 would be deemed industrial use and would require an RSC before utilization for a more sensitive use.
- The Area 2 lands have been used as parkland for more than 30 years, and as such, an RSC would not be required to continue this use or change the use to residential.
- The Area 4 lands have been and are continuing to be used as parkland, and as such, an RSC would not be required to continue this use or change the use to residential.

3.1.2 Proposed Use of the Property

The proposed future use of the Site is mixed commercial, residential and parkland. A conceptual land use plan is provided as Figure 3 from the Phase Two ~~ESA~~ CSM (Appendix G)~~(Midland 2013)~~.

3.1.3 Adjacent Property Use

Property use surrounding the Site is as follows:

North: Midland Bay

South: Bayshore Drive, beyond which is parkland and residential properties

East: Residential (Mundy's Harbour Condominiums – 155 William Street)

West: Commercial/Industrial (Central Marine – 171 Midland Avenue)

3.1.4 Description of On-Site Sources of COCs and Potential Receptors

Cambium completed a Phase One ESA (Cambium 2019b) and a Phase Two ESA (Cambium 2019a). A summary of significant findings is presented below:

- Cambium identified 25 potentially contaminating activities (PCAs), 15 on-site and 10 off-site, within the Phase One study area.

- Cambium assessed the PCAs for their risk of contamination to the Site. This assessment resulted in 20 PCAs that contribute to areas of potential environmental concern (APECs).
- The COCs related to the environmental concerns identified by the Phase One ESA were petroleum hydrocarbons (PHCs), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and metals.
- The results of the Phase Two ESA sampling program are outlined in Section 6 of the Phase Two CSM, and presented on Figures 11 to 22 from the Phase Two ~~ESA~~CSM (Appendix G). Investigation locations are shown on Figure 9 from the Phase Two ~~ESA~~ CSM (Appendix G)~~(Cambium 2019a)~~.

3.1.4.1 On-Site Receptors

Based on a review of site characteristics (e.g., soil profile, depth to groundwater, contaminant type and distribution, etc.), Cambium identified potential exposure pathways and receptors for human health and ecological receptors.

The following exposure pathways are considered applicable for one or more of the current and future on-site receptors:

- Direct contact with soil or groundwater
- Incidental ingestion of soil or groundwater
- Ingestion of impacted food from possible community garden
- Inhalation of soil particulate
- Inhalation of volatiles from groundwater in outdoor air
- Inhalation of volatiles from groundwater in indoor air (future use only)
- inhalation of volatiles from soil to indoor air,
- inhalation of volatiles from soil and groundwater to trench air

Based on the future commercial/residential/parkland land use for the Site, possible receptors at the Site are:

- Resident (all age groups)
- Site visitor/trespasser (all age groups)

- Adult indoor worker (long-term adult/teen employee)
- Adult outdoor worker (long-term adult/teen employee)
- Subsurface worker (adult/teen construction worker)
- Maintenance worker (short-term adult/teen)

3.1.4.2 Ecological

Ecological receptors at the Site are assumed to have direct contact with surface soil and shallow groundwater. In the absence of risk management measures, the following exposure pathways are considered applicable for one or more of the potential on-site ecological receptors:

- Direct contact with soil and groundwater
- Uptake of groundwater
- Ingestion of soil or groundwater
- Ingestion of impacted food

Based on the current and future commercial/residential/parkland land use for the Site, possible ecological receptors at the Site are:

- Terrestrial soil invertebrates and plants
- Birds, mammals, and reptiles

3.1.5 Description of Off-Site Sources of COCs and Potential Receptors

3.1.5.1 Off-Site Sources

Ten off-site PCAs were identified by the ESAs, as shown on Figure 4 from the Phase Two CSM (Appendix G). Five of the off-site PCAs contribute to APECs. The COCs associated with these PCAs are PHCs, VOCs, and metals.

3.1.5.2 Off-Site Receptors

Based on the adjacent and neighbouring land uses, the following off-site human health and ecological receptors are possible.

Human Health

- Visitor/trespasser (all age groups)
- Resident (all age groups)

- Construction/utility worker (outdoor worker - adult)
- Commercial worker (indoor worker - adult)
- Maintenance worker (short term - adult)

Subsurface utility workers may be present on any of the surrounding properties. Construction workers may be present at any location should redevelopment occur. Maintenance workers and site visitors/trespassers may be present on any of the adjacent or neighbouring properties. Commercial workers may be present on any property with a commercial building. A Resident may be present on any property with a residential building.

Ecological

Given the naturalized areas on-site and the adjacent water body, use by ecological receptors is expected. Soil invertebrates and plants are possible in areas where hard caps are not present. Terrestrial birds, small mammals, and reptiles are possible; however, these will likely be limited to urban adapted species since limited habitat is present in the area surrounding the Site. Down-gradient aquatic receptors are present adjacent to the Site, in Midland Bay.

3.2 Site Plan and Hydrogeological Interpretation of RA Property

A site plan showing the surrounding property use is provided as Figure 4 from the Phase Two ~~ESA~~ CSM (Appendix G)~~(Cambium 2019a)~~. Investigation locations are shown on Figure 9 from the Phase Two ~~ESA~~ CSM (Appendix G)~~(Cambium 2019a)~~.

3.2.1 Topography and Hydrology

Dearden and Stanton Ltd. (DLS 2015) prepared a topographic survey of the Site. Review of the survey indicated that the Site slopes down to the north toward Midland Bay. Midland Bay is adjacent to the north of the Site. Surface elevation at the water's edge is about 176 m increasing to about 180 m along most of Bayshore Drive. A steep slope is present in the area from George Street to Edgehill Drive where the elevation increases to a maximum of about 185 m. The topography increases regionally to the south and west with contours generally following the shoreline of Midland Bay (Simcoe 2018).

3.2.2 Stratigraphy

The following soil profile was encountered, with increasing depth, during subsurface investigations completed from 2014 to 2017, and during the Phase Two ESA:

- A 0.6 to 8.5 m thick layer of fill was encountered across the Site. The fill consisted of:
  - A 0.3 m to 2 m thick layer of topsoil was present in the central and western parts of the Site. Quartzite aggregate was encountered at surface on the western portion of the Site to about 1.5 m below ground surface (mbgs).
  - Brown sand, sand and gravel or silty sand fill was encountered in all boreholes at surface or below the discontinuous topsoil or quartzite aggregate. Trace organics, wood pieces, brick pieces, and peat inclusions were noted in some areas. The fill was deepest toward the northern part of the Site along Midland Bay and typically ranged from 4 m to 5.5 mbgs with local areas as shallow as 2.1 mbgs and as deep as 8.5 mbgs. The fill was shallower toward Bayshore Drive ranging from 0.6 m to 4.0 mbgs.
  - A discontinuous woody (peat) layer was encountered beneath the fill generally in the central part of the Site. The fill/peat ranged in thickness from approximately 0.5 m to 3.2 m. Coal was encountered below ground surface in some locations in the middle area of the Site.
- Silty clay was encountered predominantly in the western half of the Site below the fill. The unit extended to 2.1 to 8.0 mbgs. Locally in the eastern part of the Site, the layer extended to 9.3 mbgs.
- Brown to grey sand and gravel to sand was encountered in all the boreholes and test pits. Varying amounts of silt were present. The sand and gravel or sand was observed at varying depths across the Site to the full depths of the boreholes or test pits.
- A brown to grey silty sand to sandy silt was encountered below the sand and gravel unit. Varying amounts of gravel were present. This unit extended to the maximum sampling depth of the investigation (7.5 mbgs).
- A geotechnical investigation (PML 2017) noted that auger refusal was encountered across the site resulting in multiple attempts for several of the boreholes. During Cambium's subsurface investigations, refusal using direct push was also encountered across the Site. It is likely that refusal was the result of boulders within the fill, till, sand and/or in the sand and gravel deposits, since follow-up attempts at nearby locations typically did not encounter refusal at the same depth.

Bedrock was not encountered during subsurface investigations. A review of Ministry water well records (MOECC 2018) indicated that limestone bedrock was encountered at about 30 mbgs in a well to the west of Midland Bay.

3.2.3 Water levels and Flow Direction

Water level data was collected from monitoring wells installed in 2013 by Pinchin and in 2018/2019 by Cambium. To evaluate groundwater-flow direction and hydrogeological characteristics, the monitoring wells were classified as shallow or deep based on installation depth of the well screen.

- Shallow Wells: BH101, BH102, BH103, BH105, BH107, BH111, BH113, BH114, BH117, BH120, BH123, BH18-01, BH18-05, BH18-06, BH18-07, BH18-11, BH18-12, BH18-13, BH18-16, BH18-18
- Deep Wells: BH18-15, BH18-17, BH18-19

Water levels data was available for select wells for May 28, 2018, August 28, 2018, December 13, 2018, and February 15, 2019. Minimum, maximum, and average water depth to the water table are summarized below.

Table 3.1 Summary of Water Depths to the Water Table

	Shallow Wells	Deep Wells
Minimum (mbgs)	0.34	1.62
Maximum (mbgs)	4.41	4.40
Average (mbgs)	1.91	2.71

The water level (WL) data was used to calculate groundwater elevations. Elevation data is summarized below. Groundwater elevations (GWE) were calculated as follows.

$$GWE = Top\ of\ Casing\ Elevation - WL\ Depth\ below\ Top\ of\ Casing$$

Table 3.2 Summary of Groundwater Elevations

	Shallow	Deep
Highest (masl)	179.74	177.77
Lowest (masl)	176.54	176.81
Average (masl)	177.76	177.28

masl – metres above sea level

February 2019 elevation data was used to generate flow direction figures for shallow groundwater and deep groundwater. Groundwater flow direction in both the shallow and deeper wells was northerly toward Midland Bay.

Pinchin (2014) calculated an estimated horizontal hydraulic gradient of 0.0066. Hydraulic conductivity values measured using rising head conductivity tests ranged from

7.9×10^{-7} m/s to 1.4×10^{-6} m/s with a geometric mean of 1.13×10^{-6} m/s. Using a porosity range of 20% to 25%, Pinchin calculated an average groundwater flow velocity ranging from 0.98 m to 1.17 m/yr.

3.2.4 Vertical Gradient

Vertical hydraulic gradients were assessed using the December 2018 and February 2019 water level data for clustered monitoring wells BH18-07/BH18-17, BH18-01/BH18-19, and BH18-11/BH18-15. The average vertical hydraulic gradient was 0.037 m/m at BH18-07/BH18-17, 0.311 m/m at BH18-01/BH18-19, and 0.207 m/m at BH18-11/BH18-15. The gradient was downward at all three well clusters.

3.2.5 Hydraulic Conductivity and Flow

Cambium conducted rising and falling head slug tests at four monitoring wells. The slug test results are summarized below. Assuming a porosity range of 20% to 25%, hydraulic gradient of 0.02, and a mean hydraulic conductivity of 6.9x10-6, the average groundwater flow velocity ranges from 17 m to 22 m per year.

Table 3.3 Summary of Hydraulic Conductivities

Well ID	Description	Hydraulic Conductivity - K (m/s)
MW18-05	Screened in clay	1.8×10^{-6}
MW18-07	Screened in silt and sand	5.9×10^{-6}
MW18-12	Screened across silt and sand layers	2.8×10^{-6}
MW113	Screened across silty sand, sand and gravel, and sandy clay layers	7.7×10^{-5}
	Geometric Mean	6.9×10^{-6}

3.3 Contaminants of Concern

To identify COCs for assessment in the risk assessment, maximum concentrations identified on-site were compared to the applicable site condition standards (SCS). Parameters with maximum concentrations exceeding the SCS were carried forward as COCs for evaluation in the RA.

3.3.1 Applicable Site Condition Standards

O.Reg. 153/04, Records of Site Condition – Part XV.1 under the Environmental Protection Act specifies acceptable limits of contaminants in soil, groundwater, and sediment in the Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act (MOECC 2011). These standards are presented in tables (Tables 1 to 9) defined by groundwater use (potable or non-potable) and type of remediation (full depth or stratified). Each table presents chemical-specific SCS based on property use (agricultural, residential/parkland/ institutional, or industrial/community/ commercial), grain-texture (medium/fine-textured or coarse-textured).

Selection of the applicable SCS considered the following site-specific characteristics:

- Intended property use
- Soil characteristics
- Environmental sensitivity, including:
  - Soil pH
  - Proximity to areas of natural significance
- Proximity to water bodies
- Groundwater use

3.3.1.1 Intended Property-Use

The proposed future use of the Site is mixed commercial, residential and parkland. Therefore, the applicable land use category is residential/parkland/institutional (RPI).

3.3.1.2 Soil Characteristics

Investigations completed at the Site have identified a complex overburden stratigraphic profile that includes fill (crushed rock, and silty sand and sand with variable gravel content, and cobble and boulders), discontinuous localized peat and organic silt layers, clay, till (sand and sand and gravel), sand, and sand and gravel.

Based on grain size distribution testing completed by Pinchin (2014), Stantec (Stantec 2014), and PML (2017) coarse-textured soil was considered applicable since the unconfined aquifer at the Site is present within both the fine and coarse-textured soil.

3.3.1.3 Environmentally Sensitive Areas

The generic SCS cannot be used at properties that are within, include, or are proximate (i.e., within 30 m) to an area of natural significance, when soil pH is not within the allowable ranges for surface (5 to 9) and/or sub-surface soils (5 to 11), or if a QP is of the opinion that it is appropriate to apply Section 41 of the regulation.

Areas of Natural and Scientific Interest

Based on a site sensitivity search completed as per the requirements of Section 41 of O.Reg.153/04, no areas of natural significance as defined by the regulation, were identified on or within 30 m of the Site. Therefore, the Site was not considered an environmentally sensitive area and the generic SCS were applicable.

Soil pH

Seventy-five soil samples were submitted for laboratory analysis by Pinchin (2014) and Stantec (Stantec 2014) to assess soil pH at the Site. Except for one surface soil sample, soil pH results were within the allowable ranges for surface and sub-surface soil. Five additional soil samples collected by Cambium (2019a) within 2 m of the original sample, including one sample collected at the original location and depth were within the acceptable range for surface soil. Therefore, the single low pH sample result in the Pinchin/Stantec data was considered spurious and was removed from the dataset.

Qualified Person Opinion

Geologic and hydrogeological parameters that influence the derivation of the O.Reg.153/04 generic SCS were compared to site-specific data and the generic values used in the derivation of the SCS. The site-specific parameters were consistent with the defaults; therefore, it was the QP's opinion that the generic SCS were applicable.

3.3.1.4 Proximity of Water Bodies and Shallow Bedrock

SCS are defined for properties that are within 30 m of a water body and at which bedrock is less than 2 mbgs.

The risk assessment property is adjacent to Midland Bay to the north and is therefore considered within 30 m of a water body. The generic SCS established for properties within 30 m of a water body (i.e., Tables 8 or 9) were considered applicable for the Site.

Subsurface investigations completed at the Site by PML (2017) and Cambium did not encounter bedrock to a maximum depth of about 22 mbgs. While Pinchin (2014) indicated that bedrock was encountered at depths ranging from 2.9 to 7.5 mbgs, Stantec (Stantec 2014) speculated that the inferred bedrock reported by Pinchin was refusal on boulders or cobbles. Cambium concurs with this opinion; therefore, the generic SCS established for properties with shallow soil (i.e., Tables 6 and 7) are not applicable.

3.3.1.5 Shallow Groundwater and Groundwater Use

Groundwater levels measured by Cambium in 2018 and 2019 ranged from 0.34 to 4.41 mbgs. Generally, the depth to groundwater is less than 2 mbgs except for the west side of the Site and close to the south property line on the eastern side of the Site. The shallow groundwater condition will be considered in the risk assessment and the applicable GW2 (groundwater to indoor air vapor migration pathway) criteria will be used to identify volatile parameters to be retained as COCs in the risk assessment.

For groundwater at a property to be considered non-potable, all properties within 250 m of the property must be supplied by a municipal drinking water system that does not obtain its water from a groundwater source.

The Town of Midland municipal system obtains drinking water from a series of 10 operational groundwater wells. The nearest to the Site is Well #17, which is about 1,200 m west of the Site, west of Midland Bay. This well, along with five others, is within the Vinden Flume well field, which is under the direct influence of surface water sources (Midland 2017b).

Cambium contracted ERIS to provide a database report for the Phase One study area (ERIS 2018). The ERIS report did not identify drinking water wells on or within 250 m of the Site.

A review of the mapping provided by the Source Protection Information Atlas (MOECC 2018) indicated the Site is within an area categorized as Highly Vulnerable Aquifer (score 6) and Significant Groundwater Recharge Area (score 6). In addition, land at the northwest corner of the Site is within an area mapped as Wellhead Protection Area D (score 4), which represents a 25 year travel time for groundwater migration to a well.

The Town of Midland and the County of Simcoe were notified by letters dated June 15, 2018 of the intention to apply non-potable groundwater standards at the Site. Neither the Town nor the County responded with an objection within 30 days; therefore, in accordance with Section 35(3)(e), non-potable SCS are considered acceptable by both. These letters were resent on March 20, 2019 with no response received from either party.

3.3.1.6 Applicable Generic Site Condition Standards

Based on the foregoing, the Table 9: Generic Site Condition Standards for Use within 30 m of a Water Body in a Non-Potable Groundwater Condition were considered applicable.

In addition, the groundwater results were screened against the Table 7 GW2 criteria for consideration of the groundwater to indoor air pathway due to the shallow groundwater condition.

3.3.2 Contaminants of Concern (COCs)

The Site analytical data were compared to the applicable standards to identify the COCs in soil and groundwater. As discussed in Section 3.3.1, the applicable SCS for this site is Table 9. In addition, the groundwater results were screened against the Table 7 GW2 criteria for consideration of the groundwater to indoor air pathway due to the shallow groundwater condition.

3.3.2.1 Selection of Contaminants of Concern in Soil

The screening for COCs in soil relied upon maximum concentrations from soil samples collected in June and December 2013, April 2014, May and June 2015, June, July, August, November, December 2019. The screening is summarized in Table 3.4. Based on the screening, metals, PAHs, VOCs, BTEX and PHCs exceeded the Table 9 SCS.

The Electrical Conductivity (EC) and SAR exceedances in the soil have been attributed to off-Site application of road de-icing salt, for safety purposes. They have been horizontally delineated to the property boundaries and vertically delineated to approximately 3.5 mbgs. Some deeper SAR exceedances were noted at deeper depths at various locations; however, these exceedances are believed to be a reflection of concentrations of the components used to calculate SAR and not actual SAR exceedances, as detailed in the Phase Two ESA (Appendix F). An exemption under Section 48(3) of O.Reg. 153/04 exists if exceedances of generic standards are due to the application of a substance to a public highway for safety reasons under conditions of snow or ice. Since the EC and SAR exceedances are attributed to the use of de-icing agents, which have been applied for the safety of vehicular and pedestrian traffic, they are not considered COCs at the Site.

Based on the screening (Table 3.4), the following contaminants are identified as COCs in soil at the Site:

- Metals: antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, cyanide, lead, mercury, molybdenum, nickel, selenium, silver, uranium, zinc.
- PAHs: acenaphthene, acenaphthylene, anthracene, benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[ghi]perylene, benzo[k]fluoranthene, chrysene, dibenz[a, h]anthracene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene, 2-(1-)methylnaphthalene, naphthalene, phenanthrene, and pyrene.

- VOCs: trichloroethylene
- BTEX: benzene, toluene, ethylbenzene, and xylene mixture
- PHCs: F1, F2. F3, and F4

Table 3.4 Screening for Contaminants of Concern in Soil

Parameter	Units	Maximum Concentration	Table 9 SCS	COC?	Rationale
Metals					
Antimony	**µg/g**	**88**	**1.3**	**Y**	**Max > SCS**
Arsenic	**µg/g**	**110**	**18**	**Y**	**Max > SCS**
Barium	**µg/g**	**1,470**	**220**	**Y**	**Max > SCS**
Beryllium	**µg/g**	**3.2**	**2.5**	**Y**	**Max > SCS**
Boron (total)	µg/g	21	36	N	Max < SCS
Boron (Hot Water Soluble)	µg/g	0.75	1.5	N	Max < SCS
Cadmium	**µg/g**	**1.8**	**1.2**	**Y**	**Max > SCS**
Chromium (Total)	µg/g	68	70	N	Max < SCS
Chromium (VI)	µg/g	0.4	0.66	N	Max < SCS
Cobalt	**µg/g**	**48**	**22**	**Y**	**Max > SCS**
Copper	**µg/g**	**280**	**92**	**Y**	**Max > SCS**
Cyanide	**µg/g**	**0.07**	**0.051**	**Y**	**Max > SCS**
Lead	**µg/g**	**6,800**	**120**	**Y**	**Max > SCS**
Mercury	**µg/g**	**1.4**	**0.27**	**Y**	**Max > SCS**
Molybdenum	**µg/g**	**6.8**	**2**	**Y**	**Max > SCS**
Nickel	**µg/g**	**84**	**82**	**Y**	**Max > SCS**
Selenium	**µg/g**	**9.2**	**1.5**	**Y**	**Max > SCS**
Silver	**µg/g**	**1.2**	**0.5**	**Y**	**Max > SCS**
Thallium	µg/g	0.6	1	N	Max < SCS
Uranium	**µg/g**	**3.1**	**2.5**	**Y**	**Max > SCS**
Vanadium	µg/g	69	86	N	Max < SCS
Zinc	**µg/g**	**1,300**	**290**	**Y**	**Max > SCS**
Polychlorinated Biphenyls					
PCBs	µg/g	<0.1	0.3	N	Max < SCS
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	**µg/g**	**1.4**	**0.072**	**Y**	**Max > SCS**
Acenaphthylene	**µg/g**	**2.2**	**0.093**	**Y**	**Max > SCS**
Anthracene	**µg/g**	**8.7**	**0.22**	**Y**	**Max > SCS**
Benz[a]anthracene	**µg/g**	**5.5**	**0.36**	**Y**	**Max > SCS**
Benzo[a]pyrene	**µg/g**	**8.6**	**0.3**	**Y**	**Max > SCS**
Benzo[b]fluoranthene	**µg/g**	**14**	**0.47**	**Y**	**Max > SCS**
Benzo[ghi]perylene	**µg/g**	**8.4**	**0.68**	**Y**	**Max > SCS**
Benzo[k]fluoranthene	**µg/g**	**5.1**	**0.48**	**Y**	**Max > SCS**
Chrysene	**µg/g**	**5.5**	**2.8**	**Y**	**Max > SCS**
Dibenz[a,h]anthracene	**µg/g**	**2**	**0.1**	**Y**	**Max > SCS**
Fluoranthene	**µg/g**	**12**	**0.69**	**Y**	**Max > SCS**
Fluorene	**µg/g**	**1.4**	**0.19**	**Y**	**Max > SCS**
Indeno[1,2,3-cd]pyrene	**µg/g**	**8.3**	**0.23**	**Y**	**Max > SCS**
Methylnaphthalene, 2-(1-)	**µg/g**	**12**	**0.59**	**Y**	**Max > SCS**
Naphthalene	**µg/g**	**4.7**	**0.09**	**Y**	**Max > SCS**
Phenanthrene	**µg/g**	**6.4**	**0.69**	**Y**	**Max > SCS**
Pyrene	**µg/g**	**8**	**1**	**Y**	**Max > SCS**
Volatile Organic Compounds					

Parameter	Units	Maximum Concentration	Table 9 SCS	COC?	Rationale
Bromodichloromethane	µg/g	<0.05	0.05	N	Max < SCS
Bromoform	µg/g	<0.05	0.05	N	Max < SCS
Bromomethane	µg/g	<0.05	0.05	N	Max < SCS
Carbon Tetrachloride	µg/g	<0.05	0.05	N	Max < SCS
Chlorobenzene	µg/g	<0.05	0.05	N	Max < SCS
Chloroform	µg/g	<0.04	0.05	N	Max < SCS
Dibromochloromethane	µg/g	<0.05	0.05	N	Max < SCS
Dichlorobenzene, 1,2-	µg/g	<0.05	0.05	N	Max < SCS
Dichlorobenzene, 1,3-	µg/g	<0.05	0.05	N	Max < SCS
Dichlorobenzene, 1,4-	µg/g	<0.05	0.05	N	Max < SCS
Dichlorodifluoromethane	µg/g	<0.05	0.05	N	Max < SCS
Dichloroethane, 1,1-	µg/g	<0.02	0.05	N	Max < SCS
Dichloroethane, 1,2-	µg/g	<0.03	0.05	N	Max < SCS
Dichloroethylene, 1,1-	µg/g	<0.02	0.05	N	Max < SCS
Dichloroethylene, 1,2-cis-	µg/g	<0.02	0.05	N	Max < SCS
Dichloroethylene, 1,2-trans-	µg/g	<0.05	0.05	N	Max < SCS
Dichloropropane, 1,2-	µg/g	<0.03	0.05	N	Max < SCS
Dichloropropene, 1,3-	µg/g	<0.04	0.05	N	Max < SCS
Ethylene dibromide	µg/g	<0.04	0.05	N	Max < SCS
Methyl Ethyl Ketone	µg/g	<0.5	0.5	N	Max < SCS
Methyl Isobutyl Ketone	µg/g	<0.5	0.5	N	Max < SCS
Methyl tert-Butyl Ether (MTBE)	µg/g	<0.05	0.05	N	Max < SCS
Methylene Chloride	µg/g	<0.05	0.05	N	Max < SCS
Styrene	µg/g	<0.05	0.05	N	Max < SCS
Tetrachloroethane, 1,1,1,2-	µg/g	<0.04	0.05	N	Max < SCS
Tetrachloroethane, 1,1,2,2-	µg/g	<0.05	0.05	N	Max < SCS
Tetrachloroethylene	µg/g	<0.05	0.05	N	Max < SCS
Trichloroethane, 1,1,1-	µg/g	<0.05	0.05	N	Max < SCS
Trichloroethane, 1,1,2-	µg/g	<0.04	0.05	N	Max < SCS
Trichloroethylene	**µg/g**	**0.38**	**0.05**	**Y**	**Max > SCS**
Trichlorofluoromethane	µg/g	<0.05	0.25	N	Max < SCS
Vinyl chloride	µg/g	<0.02	0.02	N	Max < SCS
BTEX					
Benzene	**µg/g**	**8.4**	**0.02**	**Y**	**Max > SCS**
Toluene	**µg/g**	**25**	**0.2**	**Y**	**Max > SCS**
Ethylbenzene	**µg/g**	**4.8**	**0.05**	**Y**	**Max > SCS**
Xylene Mixture	**µg/g**	**43**	**0.05**	**Y**	**Max > SCS**
Petroleum Hydrocarbons					
PHC F1	**µg/g**	**400**	**25**	**Y**	**Max > SCS**
PHC F2	**µg/g**	**1,700**	**10**	**Y**	**Max > SCS**
PHC F3	**µg/g**	**38,000**	**240**	**Y**	**Max > SCS**
PHC F4	**µg/g**	**22,000**	**120**	**Y**	**Max > SCS**

Note: Concentrations are on a dry weight basis; Table 9 Site Condition Standards (SCS) for coarse textured soils and non-potable groundwater from the Ontario Ministry of Environment, Conservation and Parks (MOE 2011); **bold shading** indicates exceedance of Table 9 SCS.

3.3.2.2 Selection of Contaminants of Concern in Groundwater

The screening for COCs in groundwater relied upon maximum concentrations from groundwater samples collected in July 2013, May, August and December 2018, and January and February 2019. The screening is summarized in Table 3.5.

Based on the screening (Table 3.5), the following contaminants are identified as COCs in groundwater at the Site. In addition, to account for potential degradation of chlorinated aliphatic compounds, vinyl chloride was also considered a COC:

- PHCs: F2, and F3 fractions
- BTEX: Benzene
- VOCs: Trichloroethylene and vinyl chloride

Table 3.5 Screening for Contaminants of Concern in Groundwater

Parameter	Units	Maximum Concentration	Table 7 GW2[a]	Table 9 SCS	COC?	Rationale
Inorganics						
Sodium	µg/L	330,000	--	1,800,000	N	Max < SCS
Chloride	µg/L	230,000	--	1,800,000	N	Max < SCS
Metals						
Antimony	µg/L	3.4	--	16,000	N	Max < SCS
Arsenic	µg/L	31.1	--	1,500	N	Max < SCS
Barium	µg/L	830	--	23,000	N	Max < SCS
Beryllium	µg/L	<0.5	--	53	N	Max < SCS
Boron (total)	µg/L	214	--	36,000	N	Max < SCS
Cadmium	µg/L	0.64	--	2.1	N	Max < SCS
Chromium (Total)	µg/L	10.9	--	640	N	Max < SCS
Chromium (VI)	µg/L	<5	--	110	N	Max < SCS
Cobalt	µg/L	9.6	--	52	N	Max < SCS
Copper	µg/L	4.6	--	69	N	Max < SCS
Cyanide (CN-)	µg/L	2	--	52	N	Max < SCS
Lead	µg/L	<0.5	--	20	N	Max < SCS
Mercury	µg/L	<0.1	0.1[a]	0.29	N	Max < SCS
Molybdenum	µg/L	54.3	--	7,300	N	Max < SCS
Nickel	µg/L	55.7	--	390	N	Max < SCS
Selenium	µg/L	4.8	--	50	N	Max < SCS
Silver	µg/L	<0.2	--	1.2	N	Max < SCS
Thallium	µg/L	<0.3	--	400	N	Max < SCS
Uranium	µg/L	13.1	--	330	N	Max < SCS
Vanadium	µg/L	2.7	--	200	N	Max < SCS
Zinc	µg/L	460	--	890	N	Max < SCS
Polychlorinated Biphenyls						
PCBs	µg/L	<0.1	0.11	0.2	N	Max < SCS
Polycyclic Aromatic Hydrocarbons						
Acenaphthene	µg/L	0.43	31	600	N	Max < SCS
Acenaphthylene	µg/L	<0.2	1.8	1.4	N	Max < SCS
Anthracene	µg/L	0.15	12	1	N	Max < SCS

Parameter	Units	Maximum Concentration	Table 7 GW2[a]	Table 9 SCS	COC?	Rationale
Benz[a]anthracene	µg/L	<0.2	7	1.8	N	Max < SCS
Benzo[a]pyrene	µg/L	<0.01	5.7	0.81	N	Max < SCS
Benzo[b]fluoranthene	µg/L	<0.1	150	0.75	N	Max < SCS
Benzo[ghi]perylene	µg/L	<0.2	--	0.2	N	Max < SCS
Benzo[k]fluoranthene	µg/L	<0.1	180	0.4	N	Max < SCS
Chrysene	µg/L	<0.1	170	0.7	N	Max < SCS
Dibenz[a,h]anthracene	µg/L	<0.2	260	0.4	N	Max < SCS
Fluoranthene	µg/L	<0.2	80	73	N	Max < SCS
Fluorene	µg/L	0.51	--	290	N	Max < SCS
Indeno[1,2,3-cd]pyrene	µg/L	<0.2	360	0.2	N	Max < SCS
Methylnaphthalene, 2-(1-)	µg/L	<0.2	--	1,500	N	Max < SCS
Naphthalene	µg/L	0.37	7[a]	1,400	N	Max < SCS
Phenanthrene	µg/L	0.3	--	380	N	Max < SCS
Pyrene	µg/L	0.15	620	5.7	N	Max < SCS
Volatile Organic Compounds						
Acetone	µg/L	25	120,000	100,000	N	Max < SCS
Bromodichloromethane	µg/L	<0.5	--	67,000	N	Max < SCS
Bromoform	µg/L	<1	--	380	N	Max < SCS
Bromomethane	µg/L	<0.5	0.89[a]	5.6	N	Max < SCS
Carbon Tetrachloride	µg/L	<0.2	0.2[a]	0.79	N	Max < SCS
Chlorobenzene	µg/L	<0.2	140	500	N	Max < SCS
Chloroform	µg/L	<0.2	10	2.4	N	Max < SCS
Dibromochloromethane	µg/L	<0.5	--	65,000	N	Max < SCS
Dichlorobenzene, 1,2-	µg/L	<0.5	150	4,600	N	Max < SCS
Dichlorobenzene, 1,3-	µg/L	<0.5	--	7,600	N	Max < SCS
Dichlorobenzene, 1,4-	µg/L	<0.5	0.5[a]	8	N	Max < SCS
Dichlorodifluoromethane	µg/L	<1	--	3,500	N	Max < SCS
Dichloroethane, 1,1-	µg/L	<0.3	11	320	N	Max < SCS
Dichloroethane, 1,2-	µg/L	<0.5	0.5[a]	1.6	N	Max < SCS
Dichloroethylene, 1,1-	µg/L	<0.2	0.5[a]	1.6	Y	Max < SCS
Dichloroethylene, 1,2-cis-	µg/L	1.3	1.6[a]	1.6	Y	Max < SCS
Dichloroethylene, 1,2-trans-	µg/L	<0.5	1.6[a]	1.6	Y	Max < SCS
Dichloropropane, 1,2-	µg/L	<0.2	0.58	16	N	Max < SCS
Dichloropropene, 1,3-	µg/L	<0.5	0.5[a]	5.2	N	Max < SCS
Ethylene dibromide	µg/L	<0.2	0.2[a]	0.25	N	Max < SCS
Hexane (n)	µg/L	<1	5[a]	51	N	Max < SCS
Methyl Ethyl Ketone	µg/L	74	21,000	470,000	N	Max < SCS
Methyl Isobutyl Ketone	µg/L	<10	5,200	140,000	N	Max < SCS
Methyl tert-Butyl Ether (MTBE)	µg/L	1.9	15[a]	190	N	Max < SCS
Methylene Chloride	µg/L	<2	61	610	N	Max < SCS
Styrene	µg/L	<0.5	43	1,300	N	Max < SCS
Tetrachloroethane, 1,1,1,2-	µg/L	<0.5	1.1[a]	3.3	N	Max < SCS
Tetrachloroethane, 1,1,2,2-	µg/L	<0.5	0.5[a]	3.2	N	Max < SCS
Tetrachloroethylene	µg/L	<0.2	0.5[a]	1.6	N	Max < SCS
Trichloroethane, 1,1,1-	µg/L	<0.3	23	640	N	Max < SCS
Trichloroethane, 1,1,2-	µg/L	<0.5	0.5[a]	4.7	N	Max < SCS
Trichloroethylene	**µg/L**	**2.2**	**0.5[a]**	**1.6**	**Y**	**Max > SCS**
Trichlorofluoromethane	µg/L	<0.5	--	2,000	N	Max < SCS
Vinyl chloride	**µg/L**	**<0.2**	**0.5[a]**	**0.5**	**Y**	**Degradation of TCE**
BTEX						

Parameter	Units	Maximum Concentration	Table 7 GW2[a]	Table 9 SCS	COC?	Rationale
Benzene	**µg/L**	**2.4**	**0.5[a]**	**44**	**Y**	**Max > SCS**
Toluene	µg/L	2.5	320	14,000	N	Max < SCS
Ethylbenzene	µg/L	<0.2	110	1,800	N	Max < SCS
Xylene Mixture	µg/L	<0.4	72[a]	3,300	N	Max < SCS
Petroleum Hydrocarbons						
PHC F1	µg/L	<25	420[a]	420	N	Max < SCS
PHC F2	**µg/L**	**1,000**	**150[a]**	**150**	**Y**	**Max > SCS**
PHC F3	**µg/L**	**580**	--	**500**	**Y**	**Max > SCS**
PHC F4	µg/L	<200	--	500	N	Max < SCS

Note: Table 9 Generic Site Condition Standards (SCS) for coarse textured soils and non-potable groundwater from the Ontario Ministry of Environment, Conservation and Parks (MOE 2011), and Residential GW2 component from Table 7; **bold shading** indicates exceedance of Table 7 and/or Table 9 SCS.
[a] The Ontario Background concentration was greater than the residential GW2 component value and was thus selected

3.3.2.3 Sampling Programs

This risk assessment relied upon the information in ESA reports (Cambium 2019b, 2019a). It is the QPESA's opinion that the Phase Two ESA sampling program/intrusive investigations were sufficient for identifying COCs, maximum concentrations, and characterizing the distribution of the COCs for the purpose of the risk assessment. The QPRA considers the data presented in the Phase Two ESA sufficient to characterize risk/hazard to applicable receptors.

Sampling locations were selected to identify maximum concentrations on the Site and assess lateral and vertical distribution of the COCs. Borehole and monitoring well locations were placed to provide general coverage of the Site. Soil samples that were selected for analysis were chosen based on field observations (visual staining and/or olfactory indications), vapour readings, and soil type. All soil and groundwater samples were collected using appropriate sampling methods, which included appropriate cleaning of sampling tools, proper well development, and purging and sampling using dedicated sampling equipment. Further, as part of the quality control program that was completed for the Phase Two ESA, analysis of blind field duplicates was completed, and the laboratory completed duplicate and method spikes as required by their certification.

The soil and groundwater analytical data that was collected in 2013 until 2019 are presented in the Phase Two CSM (Appendix G)

Soil (Surface and Subsurface)

The soil samples included in the RA were collected from 2013 until 2019. The total number of samples analyzed for parameters in soil and included in the RA is presented in the table below:

Table 3.6 Number of Soil Samples

Parameter Group	Number of Samples
Metals	140
Inorganics	134
VOCs	137
PAHs	142
PHCs	175
PCBs	22

Groundwater

The groundwater samples included in the RA were collected in 2013, 2018, and 2019. The total number of samples analyzed for parameters in groundwater and included in the RA is presented in the table below:

Table 3.7 Number of Groundwater Samples

Parameter Group	Number of Samples
Metals and Inorganics	33
VOCs	39
PAHs	26
PHCs	46
PCBs	5

Off-Site Sediment

Although the risk assessment is for only the terrestrial portion of the property, sediment samples obtained in support of the RA were collected in April 2014. The total number of samples analyzed inclusive of duplicate samples for parameters in sediment and included in the RA is presented in the table below:

Table 3.8 Number of Sediment Samples

Parameter Group	Number of Samples
Metals and Inorganics	11
PAHs	11
BTEX and PHCs	11

Off-Site Surface Water

Although the risk assessment is for only the terrestrial portion of the property, surface water samples obtained in support of the RA were collected in April 2014. The total number of samples analyzed for parameters in groundwater and included in the RA is presented in the table below:

Table 3.9 Number of Surface Water Samples

Parameter Group	Number of Samples
Metals and Inorganics	6
PHCs	7
PAHs	5

3.3.2.4 Reasonable Estimate of the Maximum Concentration

There is uncertainty associated with the measurements of contaminants in environmental media, and it is therefore always a possibility that the real maximum concentration has not been captured in the sampling programs. As such, Reasonable Estimates of the Maximum Concentrations (REMCs) are derived from the maximum measured concentrations of COCs to account for this uncertainty and capture the likely maximum concentrations in the area.

The REMC is taken to be 20% above the maximum measured concentration, except where noted. This is an approach that is accepted by the MECP and is applied in the Modified Generic Risk Assessment (MGRA) (MOECC 2016a) model. Table 3.10 provides a summary of the REMCs for each COC.

Degradation of TCE

Consideration was given to the potential for increasing concentrations of 1,1-dichloroethylene, cis- and trans-1,2-dichloroethylene, and vinyl chloride in groundwater from the anaerobic degradation of trichloroethylene. Biodegradation produces almost purely cis-1,2-dichloroethylene (MOE 2011), as evidenced by concentrations of cis-1,2-dichloroethylene in groundwater at the Site being much higher than either of the other two isomers. The concentrations of trichloroethylene and cis-1,2-dichloroethylene are all below the detection limit across the Site except for at BH18-11, where the maximum concentrations were found.

To account for future degradation of trichloroethylene, 1,1-dichloroethylene, cis-and trans-1,2-dichloroethylene, a theoretical “worst case” vinyl chloride concentration was calculated based on the maximum concentrations of those parent compounds. The “worst case” concentration of vinyl chloride is estimated to be its current concentration plus 10% of the sum of the concentrations of each parent compound. The 10% assumption is taken from MECP’s rationale (MOE 2011). For parent compounds not detected in the monitoring wells, the detection limits were used in the estimation. Through this approach, the theoretical "worst case" maximum concentration of vinyl chloride was 0.62 µg/L, and it was carried forward in the RA.

Table 3.10 Reasonable Estimates of the Maximum Concentration (REMC) for each Contaminant of Concern (COC) in Soil and Groundwater

Parameter	Soil REMC (µg/g)	Groundwater REMC (µg/L)
Metals		
Antimony	105.6	-
Arsenic	132	-
Barium	1,764	-
Beryllium	3.84	-
Cadmium	2.16	-
Cobalt	57.6	-
Copper	336	-
Cyanide (CN-)	0.084	-
Lead	8160	-
Mercury	1.68	-
Molybdenum	8.16	-
Nickel	100.8	-
Selenium	11.04	-
Silver	1.44	-
Uranium	3.72	-
Zinc	1,560	-
Polycyclic Aromatic Hydrocarbons		
Acenaphthene	1.68	-
Acenaphthylene	2.64	-
Anthracene	10.44	-
Benz[a]anthracene	6.6	-
Benzo[a]pyrene	10.32	-
Benzo[b]fluoranthene	16.8	-
Benzo[ghi]perylene	10.08	-
Benzo[k]fluoranthene	6.12	-
Chrysene	6.6	-
Dibenz[a,h]anthracene	2.4	-
Fluoranthene	14.4	-
Fluorene	1.68	-
Indeno[1,2,3-cd]pyrene	9.96	-
Methylnaphthalene, 2-(1-)	14.4	-
Naphthalene	5.64	-
Phenanthrene	7.68	-
Pyrene	9.6	-
Volatile Organic Compounds		
Trichloroethylene	0.456	2.64
Vinyl Chloride	-	0.74
BTEX		
Benzene	10.08	2.88
Ethylbenzene	5.76	-
Toluene	30	-
Xylene Mixture	51.6	-

Parameter	Soil REMC (µg/g)	Groundwater REMC (µg/L)
Petroleum Hydrocarbons		
PHC F1	480	-
PHC F2	2,040	1,200
PHC F3	45,600	696
PHC F4	26,400	-

Note: '-' Not a Contaminant of Concern (COC) in this media.

4.0 HUMAN HEALTH RISK ASSESSMENT (HHRA)

A Human Health Risk Assessment (HHRA) is a scientific process used to describe and estimate the likelihood of potential risks (i.e., adverse health effects) to humans resulting from exposure to COCs, taking receptor characteristics, exposure pathways, toxicity data, and mitigating circumstances into consideration. The four principal elements of an HHRA comprise of the following:

- problem formulation
- exposure assessment
- toxicity assessment
- risk characterization

Each element is discussed in more detail in the following subsections of the HHRA conducted for the Site.

4.1 Problem Formulation

The completion of an HHRA requires a good understanding of Site conditions, including the nature, extent, and distribution of the contaminants as described in Section 3.0. A detailed understanding of the COCs, potential exposure pathways and human receptors present at the Site is also required. Three (3) components must be present for risks to human and ecological health to exist at contaminated sites impacted by chemicals:

- The contaminant must be present at concentrations sufficient to cause a potential adverse effect
- A human receptor must be present
- There must be a complete exposure pathway by which the receptor can come into contact with the chemical

Without all three elements described above, there can be no risk. Simply put, if there is no possible exposure to a chemical, regardless of inherent toxicity or potency or environmental concentration, there is no potential for the development of an adverse human health effect. These components are integrated into a conceptual site model for the Site.

4.1.1 Human Health Conceptual Site Model

The first step in the development of the conceptual site model for the HHRA is to determine who (or what class or classes of individuals) may be exposed to COCs encountered at the Site. As discussed in Section 3.1.2, the proposed future use of the Site is mixed commercial/residential and parkland.

Regular users of the Site include residents (all ages), long-term indoor workers (adults), short-term subsurface workers (adults), long-term outdoor maintenance workers (adults), Site visitors (all ages), and trespassers (teenagers and adults). Since the resident and workers at the site will have greater exposure than receptors with casual access (visitors, trespassers) these selected receptors are used as a surrogate and the casual access receptors are not considered further.

The second step is to examine how the selected receptors may be exposed through a determination of potential pathways of exposure. These pathways are described below.

4.1.1.1 Resident

The resident may be exposed to COCs through inhalation of indoor vapours as a result of volatile COCs migrating from soil and groundwater to the indoor environment as well as direct contact with the soil. Since groundwater at the Site is not potable, there is no exposure from ingestion of groundwater as a drinking water source and therefore this pathway was not evaluated. The potential exposure pathways for the resident are summarized in Table 4.2, with rationale for inclusion or exclusion of each pathway. The CSM for the resident is presented in Figure 4.1.

Table 4.1 Potential Pathways of Exposure for the Resident and Property Visitor

Potential Pathway of Exposure	Relevant	Comment
Soil ingestion	Yes	This receptor spends most of their time indoors but could be exposed to soil during activities outdoors at the Site.
Soil inhalation	Yes	This receptor spends most of their time indoors but could be exposed to soil during activities outdoors at the Site.
Soil skin contact	Yes	This receptor spends most of their time indoors but could be exposed to soil during activities outdoors at the Site.
Groundwater ingestion	No	Groundwater is not potable. Potential incidental ingestion during gardening expected to be negligible and is addressed by sub-surface worker.
Groundwater skin contact	No	Groundwater is not potable. Potential dermal contact during gardening expected to be negligible and is addressed by sub-surface worker.
Surface water ingestion	No	There is no surface water at the Site.
Surface water skin contact	No	There is no surface water at the Site.
Vapour inhalation	Yes	There is the potential for inhalation of volatile contaminant vapours migrating into indoor air following vapour migration.
Vapour skin contact	Yes	There is the potential for contact of volatile contaminant with skin in indoor air following vapour migration. The dose from this route of exposure is expected to be insignificant compared to other exposure and is not included in the quantitative assessment.
Garden produce ingestion	Yes	As this is proposed residential property there is the potential for gardens. This pathway is not included in the quantitative assessment as there is a high degree of uncertainty with respect to numerous assumptions required (e.g. uptake factors, amounts of garden produce consumed from a site, size of contaminated area, food preparation methods) but is assessed qualitatively.
Livestock ingestion	No	There is no livestock are present.
Other pathways	No	There are no other exposure pathways available.

The resident may have exposure pathways related to the aquatic environment that is directly adjacent to the Site, including fishing and swimming. The aquatic environment may be affected by the Site. These pathways are assessed qualitatively.

4.1.1.2 Indoor Worker

The indoor worker may be exposed to COCs through inhalation of indoor vapours as a result of volatile COCs migrating from soil and groundwater to the indoor environment. Groundwater at the Site is non-potable; potable water is provided by municipal services. Thus, there would be no exposure from ingestion of groundwater as a drinking water source. With the exception of brief outdoor exposure as a result of, for example, walking to and from the parking lot, these receptors remain indoors. As such, direct contact with soil and groundwater and inhalation of outdoor vapours and soil particulates is not expected. The potential exposure pathways for the indoor worker are summarized in Table 4.2, with rationale for inclusion or exclusion of each pathway.

Table 4.2 Potential Pathways of Exposure for Indoor Worker

Potential Pathway of Exposure	Relevant for This Receptor	Comment
Soil ingestion	Negligible	This receptor is assumed to spend time indoors; negligible exposure to soil while walking to and from parking lot.
Soil inhalation	Negligible	This receptor is assumed to spend time indoors; negligible exposure to soil while walking to and from parking lot.
Soil skin contact	Negligible	This receptor is assumed to spend time indoors; negligible exposure to soil while walking to and from parking lot.
Groundwater ingestion	No	Groundwater is not potable.
Groundwater skin contact	No	Groundwater is not potable.
Surface water ingestion	No	There is no surface water at the Site.
Surface water skin contact	No	There is no surface water at the Site.
Vapour inhalation	Yes	There is the potential for inhalation of volatile contaminant vapours migrating into indoor air following vapour migration.
Vapour skin contact	Yes	There is the potential for contact of volatile contaminant with skin in indoor air following vapour migration. The dose from this route of exposure is expected to be insignificant compared to other exposure and is not included in the quantitative assessment.
Garden produce ingestion	No	Not an applicable pathway for the indoor worker.
Livestock ingestion	No	The Site is used for residential/commercial purposes and therefore no livestock will be present under the proposed Site development.
Other pathways	No	There are no other exposure pathways available.

4.1.1.3 Outdoor Maintenance Worker

Without risk management measures, the outdoor maintenance worker has potential exposure to COCs through direct contact with and incidental ingestion of soil, as well as inhalation of soil particulates and volatile vapours migrating from soil and groundwater to the outdoor air. Ingestion of groundwater was not considered as the Site is municipally serviced and it is unlikely that this receptor would have direct contact with groundwater while performing above-ground maintenance activities. However, with the shallow depth to groundwater (0.34 mbgs) it is possible that outdoor workers will occasionally have direct contact with groundwater. It is not expected that this would be a regular occurrence, only when more intensive activities such as planting of trees would occur. The potential exposure pathways for this receptor and rationale for inclusion or exclusion are summarized in Table 4.3.

Table 4.3 Potential Pathways of Exposure for Outdoor Worker

Potential Pathway of Exposure	Relevant for This Receptor	Comment
Soil ingestion	Yes	This receptor may come in contact with contaminated soil when undertaking maintenance activities at the Site.
Soil inhalation	Yes	This receptor may inhale dust from contaminated soil when undertaking maintenance activities at the Site.
Soil skin contact	Yes	This receptor may come in contact with contaminated soil when undertaking maintenance activities at the Site.
Groundwater ingestion	No	Groundwater is not potable. Potential incidental ingestion during landscaping expected to be negligible and is addressed by sub-surface worker.
Groundwater skin contact	No	Groundwater is not potable. Potential dermal contact during landscaping expected to be negligible and is addressed by sub-surface worker.
Surface water ingestion	No	There is no surface water at the Site.
Surface water skin contact	No	There is no surface water at the Site.
Vapour inhalation	Yes	There is the potential for inhalation of volatile contaminant vapours migrating into outdoor air following vapour migration.
Vapour skin contact	Yes	There is the potential for contact of volatile contaminant with skin in outdoor air following vapour migration. The dose from this route of exposure is expected to be insignificant compared to other exposure and is not included in the quantitative assessment.
Garden produce ingestion	No	Not an applicable pathway for the outdoor worker.
Livestock ingestion	No	The Site is used for residential/commercial purposes and therefore no livestock will be present under the proposed Site development.
Other pathways	No	There are no other exposure pathways available.

4.1.1.4 Subsurface Worker

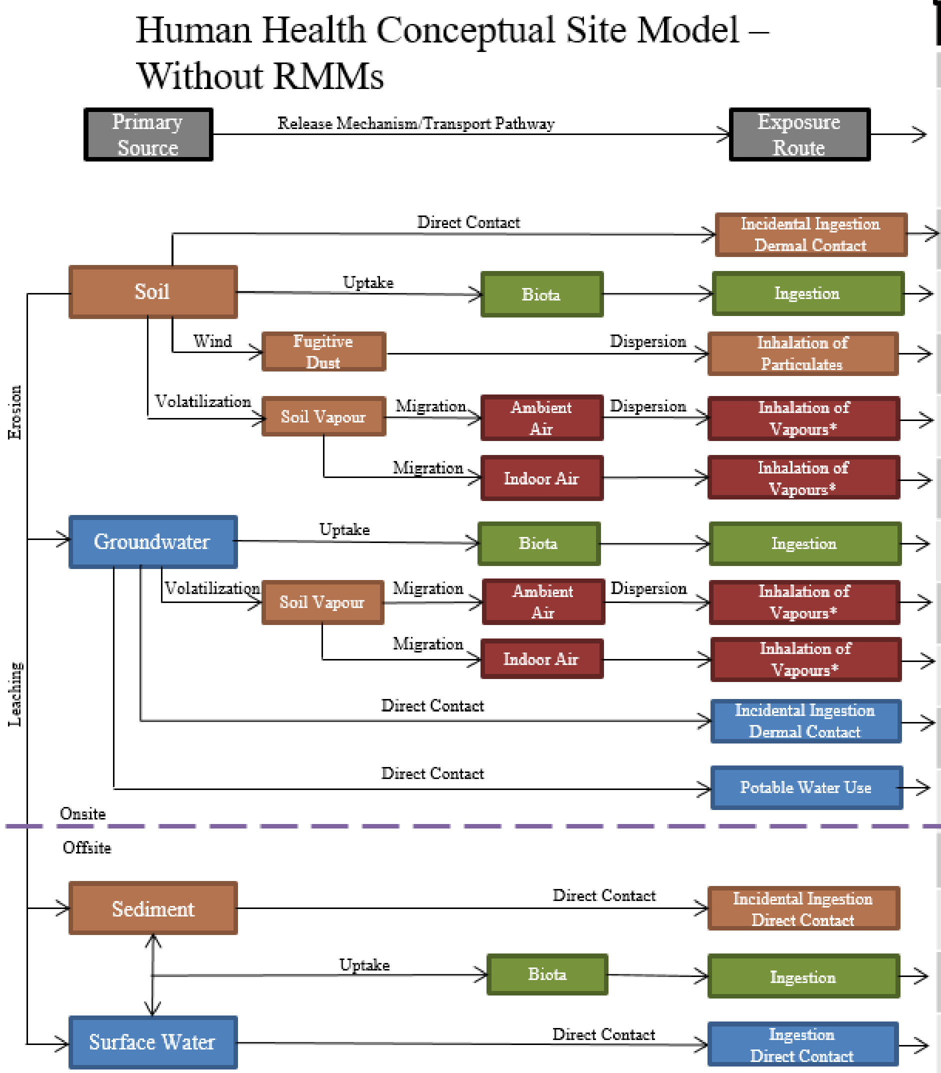
The subsurface worker may be exposed to COCs through the same pathways as the outdoor worker; however, this worker may also be exposed through incidental ingestion of and dermal contact with groundwater while digging below ground. The potential exposure pathways for this receptor and rationale for inclusion or exclusion are summarized in Table 4.4.

Table 4.4 Potential Pathways of Exposure for Subsurface Worker

Potential Pathway of Exposure	Relevant for This Receptor	Comment
Soil ingestion	Yes	This receptor may come in contact with contaminated soil when undertaking subsurface activities at the Site.
Soil inhalation	Yes	This receptor may inhale dust from contaminated soil when undertaking subsurface activities at the Site.
Soil skin contact	Yes	This receptor may come in contact with contaminated soil when undertaking subsurface activities at the Site.
Groundwater ingestion	Yes	Groundwater is not potable. However, this receptor may accidentally ingest groundwater while undertaking subsurface activities.
Groundwater skin contact	Yes	Groundwater is not potable. However, this receptor may come into contact with groundwater while undertaking subsurface activities.
Surface water ingestion	No	There is no surface water at the Site.
Surface water skin contact	No	There is no surface water at the Site.
Vapour inhalation	Yes	There is the potential for inhalation of volatile contaminant vapours migrating into outdoor air following vapour migration.
Vapour skin contact	Yes	There is the potential for contact of volatile contaminant with skin in outdoor air following vapour migration. The dose from this route of exposure is expected to be insignificant compared to other exposure and is not included in the quantitative assessment.
Garden produce ingestion	No	Not an applicable pathway for the subsurface worker.
Livestock ingestion	No	The Site is used for residential/commercial purposes and therefore no livestock will be present under the proposed Site development.
Other pathways	No	There are no other exposure pathways available.

The conceptual models for the receptors without and with the implementation of RMMs are presented in Figure 4.1 and Figure 4.2, respectively.

Figure 4.1 Human Health Conceptual Site Model – Without Risk Management (Revised)

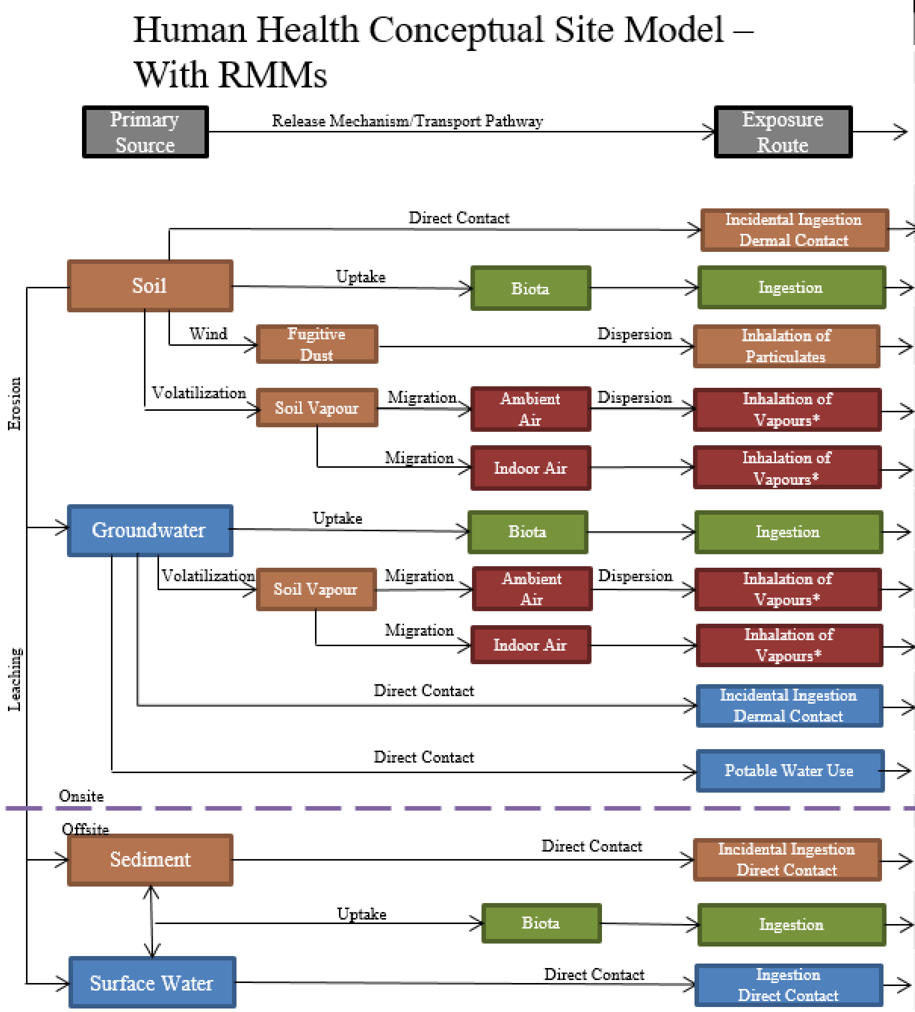


Receptor Characterization – Potentially Exposed Receptors	On-Site					Off-site		
Exposure Route	Resident	Indoor Worker	Outdoor Worker	Subsurface Worker	Visitor/ Trespasser	Resident	Outdoor Worker	Subsurface Worker
Incidental Ingestion Dermal Contact	✓	O	✓	✓	✓	--	--	--
Ingestion	✓	--	--	--	✓	--	--	--
Inhalation of Particulates	O	O	O	✓	O	O	O	O
Inhalation of Vapours*	✓	O	✓	✓	✓	✓	✓	✓
Inhalation of Vapours*	✓	✓	--	--	✓	--	--	--
Ingestion	✓	--	--	--	✓	O	--	--
Inhalation of Vapours*	✓	O	✓	✓	✓	✓	✓	✓
Inhalation of Vapours*	✓	✓	--	--	✓	O	--	--
Incidental Ingestion Dermal Contact	--	--	✓	✓	--	--	--	✓
Potable Water Use	--	--	--	--	--	--	--	--
Incidental Ingestion Direct Contact	O	--	--	--	O	O	--	--
Ingestion	O	--	--	--	O	O	--	--
Ingestion Direct Contact	O	--	--	--	O	O	--	--

✓ : Potential pathway of exposure (included in the HHRA)
O : Potential pathway of exposure but expected to be negligible
-- : Not a potential exposure pathway for this receptor/receptor not considered in the HHRA

* Dermal contact with vapours is a potential pathway of exposure but expected to be negligible; not considered further in the HHRA

Figure 4.2 Human Health Conceptual Site Model – With Risk Management (Revised)



Receptor Characterization
Potentially Exposed Receptors

Exposure Route	On-Site Resident	On-Site Indoor Worker	On-Site Outdoor Worker	On-Site Subsurface Worker	On-Site Visitor/ Trespasser	Off-site Resident	Off-site Outdoor Worker	Off-site Subsurface Worker
Incidental Ingestion Dermal Contact	RMM-1	RMM-1	RMM-1	RMM-3	RMM-1	--	--	--
Ingestion	RMM-1	--	--	--	RMM-1	--	--	--
Inhalation of Particulates	RMM-1	RMM-1	RMM-1	✓	RMM-1	RMM-1	RMM-1	RMM-1
Inhalation of Vapours*	✓	O	✓	✓	✓	✓	✓	✓
Inhalation of Vapours*	RMM-2	RMM-2	--	--	RMM-2	--	--	--
Ingestion	RMM-1	--	--	--	RMM-1	O	--	--
Inhalation of Vapours*	✓	O	✓	✓	✓	✓	✓	✓
Inhalation of Vapours*	RMM-2	RMM-2	--	--	RMM-2	O	--	--
Incidental Ingestion Dermal Contact	--	--	✓	✓	--	--	--	✓
Potable Water Use	--	--	--	--	--	--	--	--
Incidental Ingestion Direct Contact	O	--	--	--	O	O	--	--
Ingestion	O	--	--	--	O	O	--	--
Ingestion Direct Contact	O	--	--	--	O	O	--	--

✓	: Potential pathway of exposure (included in the HHRA)
O	: Potential pathway of exposure but expected to be negligible
--	: Not a potential exposure pathway for this receptor/receptor not considered in the HHRA

* Dermal contact with vapours is a potential pathway of exposure but expected to be negligible; not considered further in the HHRA

Risk Management Measures:
RMM-1: A cover (soil or hard cap) to be placed across the site
RMM-2: Soil vapour management for buildings at the site
RMM-3: Health and Safety Plan for workers involved in sub-surface activities

4.1.2 Risk Assessment Objectives

4.1.2.1 Objectives

The objective of the HHRA is to quantify the health risks/hazards to the human receptors within the Site associated with the presence of the COCs in soil and groundwater in the absence of RMMs.

The land use of the Site is mixed commercial, parkland, and residential and thus, the identified receptors for this land use include residents, long-term workers (i.e., indoor workers and outdoor workers), construction/utility workers, trespassers, and casual visitors. The primary pathways include direct contact with soil, inhalation of vapours migrating from soil and groundwater and direct contact with groundwater. The receptors and pathways are discussed in more detail in Section 4.1.1. Both quantitative and qualitative risk assessment approaches were used in the HHRA for the purpose of developing PSS. Human health risks/hazards are calculated for the Site following O.Reg. 153/04 in Schedule C, and the approach is a risk assessment other than those identified in O.Reg. 153/04 Schedule C, Part II.

Table 4.5 Summary of Human Health Exposure Pathways

Exposure pathway	Receptor	Quantitative or Qualitative Evaluation?
On-Site		
Soil incidental ingestion and dermal contact	Resident	Quantitative and Qualitative
	Outdoor Worker	Quantitative and Qualitative
	Subsurface Worker	Quantitative and Qualitative
Inhalation of soil particulates	Subsurface Worker	Qualitative
Inhalation of soil vapours in ambient air	Resident	Qualitative
	Outdoor Worker	Qualitative
	Subsurface Worker	Quantitative
Inhalation of soil vapours in indoor air	Resident	Quantitative and Qualitative
	Indoor Worker	Quantitative and Qualitative
Inhalation of groundwater vapours in ambient air	Resident	Qualitative
	Outdoor Worker	Quantitative
	Subsurface Worker	Quantitative
Inhalation of groundwater vapours in indoor air	Resident	Quantitative and Qualitative
	Indoor Worker	Quantitative and Qualitative
Groundwater incidental ingestion and dermal contact	Resident	Qualitative
	Outdoor Worker	Qualitative
	Subsurface Worker	Quantitative

Exposure pathway	Receptor	Quantitative or Qualitative Evaluation?
Garden produce ingestion (uptake from soil)	Resident	Qualitative
Garden produce ingestion (uptake from groundwater)	Resident	Qualitative
Off-Site		
Inhalation of soil vapours in ambient air	Off-Site Resident	Qualitative
	Off-Site Outdoor Worker	
	Off-Site Subsurface Worker	
Inhalation of groundwater vapours in ambient air	Off-Site Resident	Qualitative
	Off-Site Outdoor Worker	
	Off-Site Subsurface Worker	
Groundwater incidental ingestion and dermal contact	Subsurface Worker	Qualitative

4.1.2.2 Data Quality

Cambium implemented a QA/QC program during the investigative activities at the Site to ensure that quality data were generated. As part of the quality control program, analysis of blind field duplicates and trip blanks was completed, and the laboratory completed duplicate and method spikes as required by their certification.

The evaluation of the analytical data was based on QA/QC information provided by Maxxam Analytics, including laboratory blank data (spiked and method), laboratory duplicate data, and laboratory surrogate, matrix spike, and check recovery data.

Additional discussion on the sampling programs is included in Section 3.3.2.3. Based on the results of the data quality assessment and validation, the analytical data are suitable for use in the RA.

4.1.2.3 Uncertainty Analysis

As described in Section 3, multiple sampling programs have been conducted, and through these sampling programs, the presence of PHCs, VOCs, SVOCs, PAHs, PCBs, metals, and general chemistry parameters has been thoroughly characterized and no significant data gaps remain. QA/QC programs were implemented during the sampling programs, and the quality assessment of the data collected demonstrate that the analytical results are consistent, of high quality, and are suitable for use in the RA. To account for analytical variability, the REMC was used in the assessment. There were no significant identified issues related to poor data quality or gaps in data. Overall, the data are suitable for setting and meeting the objectives of the HHRA.

4.1.3 Contaminants of Concern for Human Receptors

In order to identify those COCs that need to be carried through the quantitative HHRA, REMCs of COCs (Table 3.10) were compared to human health components of the generic standards that are provided by the MECP. The component values were obtained from the MGRA excel spreadsheet (MOECC 2016a) after updating select Toxicological Reference Values (TRVs) to reflect current acceptable values. The toxicity data are discussed in Section 4.3.

Determination of volatility was based on MECP guidance, a screening process as to whether (or not) a chemical is of potential concern for vapour intrusion includes an evaluation of both volatility and toxicity, using the following steps:

Step 1: If either one of the following conditions is met, then the chemical is considered sufficiently volatile and screened in, to be further assessed as part of Step 2:

- Henry's Law constant is greater than $1x10^{-5}$ atm-m^3/mol; or,
- Vapour pressure is greater than1.0 millimeter of mercury (equivalent to 1.0 Torr).

Components for S-IA and GW2 for COPCs that were determined to not be volatile were not included in the secondary screening tables for soil (Table 4.6) and groundwater (Table 4.7).

Step 2: If the maximum theoretical indoor air concentration based on conservative assumptions (Cair) exceeds applicable health based indoor air concentration (HBIAC) or odour thresholds (if available), then the chemical should be retained in the vapour intrusion assessment, as follows:

- If Cair > HBIAC (or odour thresholds), then the chemical is considered a COPC for the vapour intrusion assessment; or,
- If Cair ≤ HBIAC (or odour thresholds), then the chemical is not considered a COPC for the vapour intrusion assessment.

Step 3, the comparison of air concentrations to HBIACs is investigated in Section 4.2.

4.1.3.1 Soil

The REMC soil concentrations of the COC identified previously were compared to the relevant components of the applicable SCS. According to the Rationale (MOE 2011) Table 9 components are stated as being the same as Table 2 Full Depth Generic Site Condition Standards in a Potable Ground Water Condition for residential, parkland and institutional use (with additional consideration of the potential for soil to physically migrate into an adjacent waterbody and form sediment). This is primarily a concern from an ecological perspective, so this component is not included in the screening. The potential for any exposure to the off-site aquatic environment is discussed in Section 4.4.3.

The applicable human health components include S1 (soil contact – resident), S2 (soil contact – outdoor worker), S3 (soil contact – subsurface worker), S-IA (soil to indoor air – resident and commercial), Indoor Air Odour, and Outdoor Air (soil to outdoor air).

The comparison of the REMCs for COCs to the component values is presented in Table 3.4. As seen from the table, the following COCs will be carried forward to be evaluated quantitatively for the following pathways:

Soil Contact

Residents (S1):

- Metals: antimony, arsenic, cadmium, cobalt, copper, lead
- PAHs: benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, indeno[1,2,3-cd]pyrene
- BTEX: Benzene
- PHCs: F3 and F4

Outdoor Maintenance Worker (S2):

- Metals: antimony, arsenic, lead
- PAHs: benzo[a]pyrene, benzo[b]fluoranthene, dibenz[a,h]anthracene, indeno[1,2,3-cd]pyrene
- PHCs: F3 fraction

Subsurface Worker (S3):

- Metals: antimony, arsenic, lead

Inhalation

Residential Indoor Air (S-IA):

- PAHs: acenaphthylene, naphthalene
- VOCs: trichloroethylene

- BTEX: benzene, toluene, ethylbenzene, xylene mixture
- PHCs: F1 and F2

Commercial Indoor Air (S-IA):

- VOCs: trichloroethylene
- BTEX: benzene, xylene mixture
- PHCs: F2

Indoor Air Odour: none

Outdoor Air: none

Soil Odour (S-Nose):

- PAHs: 2-(1-)methylnaphthalene, naphthalene
- BTEX: toluene, ethylbenzene, and xylene mixture

There are some missing component values. For COC that are not volatile there is no need to consider inhalation components (e.g. S-IA or S-OA).

Based on the MECP volatility check, the following chemical parameters would be considered volatile but are not considered for vapour migration.

Metals: arsenic, mercury, and selenium

PHCs: F3 and F4 fractions.

The Phase 2 ESA makes no mention of metals in a form that would be gaseous (such as elemental mercury or arsine gas). The Phase 2 ESA outlines the potential contaminating activities that occurred at the site. These metals (arsenic, mercury, selenium) were found within APEC A (rail yards, tracks and spurs), APEC B (coal storage) and APEC N (importation of fill material of unknown quality).

Arsenic

- Exceeds the standard at BH14-07, MOUND 2, BH20, BH34, SS18-06, SS18-13
- Known to be associated with coal
- Volatile form of arsenic (arsine) used in semiconductor and microelectronic applications, which is not relevant for this site

Mercury

- The only location where mercury was above the standard was BH18-07
- Known to be associated with coal
- Volatile form of mercury (elemental mercury) is susceptible to oxidation and typically only present in the atmosphere. Elemental mercury found in soil when heavily polluted by anthropogenic activities (i.e., spillages) involving this form of mercury (O'Connor et al. 2019).

Selenium

- Exceeds the standard at BH14-07, MOUND 2, SS3, SS18-06, SS18-13
- Known to be associated with coal
- Volatile selenium compounds can be formed naturally by microbial activities; however, this is a minor process. Humans are normally not exposed to large amounts of selenium in the air, unless selenium dust or volatile selenium compounds are formed in their workplace (ATSDR 2003).

The information in the Phase 2 ESA does not support the presence of volatile metals. Therefore, metals were not retained for the assessment of vapours.

Although the Henry's Law constant for some of the components of F3 and F4 are above the MECP guidance, the solubility of these compounds are so low that there would not be any present in the liquid phase to be able to be released (therefore Henry's Law constant cannot be applied). The vapour pressure is much less than 1.0 millimeter of mercury. Therefore, it was determined that these compounds do not need to be retained for vapour migration calculations.

Otherwise, if no component was available, then the COC was assessed qualitatively. This includes: phenanthrene (direct contact), and 2-(1-)methylnaphthalene (inhalation).

Table 4.6 Comparison of Soil REMCs to Human Health Component Values

Parameter	Units	REMC	Human Health Component									Carried Forward for Quantitative Assessment?
			Soil Contact (S1 Risk)	Soil Contact (S2 Risk)	Soil Contact (S3 Risk)	RPI Indoor Air (S-IA)	RPI Indoor Air Odour	ICC Indoor Air (S-IA)	ICC Indoor Air Odour	Outdoor Air	Soil Odour (S-Nose)	
Metals												
Antimony	µg/g	105.6	**7.5**	**63**	**63**							**Yes**
Arsenic	µg/g	132	**0.79**	**1**	**39**							**Yes**
Barium	µg/g	1,764	3,800	32,000	8,600							No
Beryllium	µg/g	3.84	38	320	60							No
Cadmium	µg/g	2.16	**0.69**	7.9	7.9							**Yes**
Cobalt	µg/g	57.6	**22**	250	2,500							**Yes**
Copper	µg/g	336	**200**	1,900	1,900							**Yes**
Cyanide (CN-)	µg/g	0.084	38	320	950							No
Lead	µg/g	8,160	**120**[a]	**120**[a]	**120**[a]							**Yes**
Mercury	µg/g	1.68	9.8	67	670	-[b]		-[b]		-[b]		No
Molybdenum	µg/g	8.16	110	1,200	1,200							No
Nickel	µg/g	100.8	180	1,200	510							No
Selenium	µg/g	11.04	110	1,200	1,200							No
Silver	µg/g	1.44	77	490	490							No
Uranium	µg/g	3.72	23	300	300							No
Zinc	µg/g	1,560	5,600	47,000	47,000							No
Polycyclic Aromatic Hydrocarbons												
Acenaphthene	µg/g	1.68	570	700	26,000	14	3,900	210	18,000	2,400	100	No
Acenaphthylene	µg/g	2.64	57	70	2,600	**0.82**		12		180		**Yes**
Anthracene	µg/g	10.44	57	70	2,600	19		270		950		No
Benz[a]anthracene	µg/g	6.6	**5.7**	7	260	120		1,800		600		**Yes**
Benzo[a]pyrene	µg/g	10.32	**0.57**	**0.7**	17	-[b]		-[b]		-[b]		**Yes**
Benzo[b]fluoranthene	µg/g	16.8	**5.7**	**7**	260	-[b]		-[b]		-[b]		**Yes**
Benzo[ghi]perylene	µg/g	10.08	57	70	2,600							No

Parameter	**Units**	**REMC**	**Human Health Component**									**Carried Forward for Quantitative Assessment?**
			Soil Contact (S1 Risk)	**Soil Contact (S2 Risk)**	**Soil Contact (S3 Risk)**	**RPI Indoor Air (S-IA)**	**RPI Indoor Air Odour**	**ICC Indoor Air (S-IA)**	**ICC Indoor Air Odour**	**Outdoor Air**	**Soil Odour (S-Nose)**	
Benzo[k]fluoranthene	µg/g	6.12	**5.7**	7	260	- [b]		- [b]		- [b]		**Yes**
Chrysene	µg/g	6.6	57	70	2,600	- [b]		- [b]		- [b]		No
Dibenz[a,h]anthracene	µg/g	2.4	**0.57**	**0.7**	26	- [b]		- [b]		- [b]		**Yes**
Fluoranthene	µg/g	14.4	57	70	2,600	- [b]		- [b]		- [b]		No
Fluorene	µg/g	1.68	720	5,600	56,000							No
Indeno[1,2,3-cd]pyrene	µg/g	9.96	**5.7**	**7**	260	- [b]		- [b]		- [b]		**Yes**
Methylnaphthalene, 2-(1-)	µg/g	14.4	72	560	560		34		160		**0.99**	**Yes**
Naphthalene	µg/g	5.64	360	2,800	28,000	**0.65**	150	9.6	710	270	**4.5**	**Yes**
Phenanthrene	µg/g	7.68										No
Pyrene	µg/g	9.6	540	700	26,000	3500		51,000		41,000		No
Volatile Organic Compounds												
Trichloroethylene	µg/g	0.456	10	24	53	**0.0011**	480	**0.0051**	2,200	12	91	**Yes**
BTEX												
Benzene	µg/g	10.08	**9.3**	13	480	**0.21**	820	**0.32**	3,800	17	63	**Yes**
Toluene	µg/g	30	1,700	18,000	180,000	**6.2**	35	99	170	34,000	**2.3**	**Yes**
Ethylbenzene	µg/g	5.76	2,100	22,000	88,000	**2.1**	100	34	470	15,000	**5.2**	**Yes**
Xylene Mixture	µg/g	51.6	4,200	44,000	88,000	**3.1**	580	**50**	2,700	4,900	**35**	**Yes**
Petroleum Hydrocarbons												
PHC F1	µg/g	480	6,900	47,000	100,000	**130**		580		26,000		**Yes**
PHC F2	µg/g	2,040	3,100	22,000	48,000	**98**		**380**		25,000		**Yes**
PHC F3	µg/g	45,600	**5,800**	**40,000**	260,000							**Yes**
PHC F4	µg/g	26,400	**6,100**	42,000	400,000							**Yes**

Note: Concentrations are on a dry weight basis; ecological and human health components of Table 9 Site Condition Standards (SCS) for coarse textured soils and non-potable groundwater from the Ontario Ministry of Environment, Conservation and Parks (MOE 2011).
[a] MECP currently re-evaluating the TRV for lead; background value of 120 µg/g was substituted for S2 and S3.
[b] The S-IA component was not included because it was determined to be not volatile.

4.1.3.2 Groundwater

The maximum groundwater concentrations of the COC identified previously were compared to Table 7 and Table 9 SCS.

The applicable components include Residential and Commercial/Industrial GW2 (groundwater to indoor air) and Residential and Commercial/Industrial GW2 Odour. Although the Site is not potable, the GW1 component was used to estimate for direct contact of a subsurface worker with groundwater in a trench based on an assumed incidental ingestion.

The comparison of the REMCs to the component values is presented in Table 4.7. Trichloroethylene, vinyl chloride (future worst case), benzene and PHC F2 exceeded the Residential GW2 and Commercial/ Industrial GW2. PHC F2 exceeded the GW1 component. PHC F3 did not exceed any of the applicable groundwater components and was therefore eliminated from further assessment in the HHRA. The COCs exceeding the Residential GW2 and/or GW2 odour were also carried through to estimate the risk of exposure for the outdoor maintenance worker and the subsurface worker.

There are some missing component values. For COC that are not volatile there is no need to consider inhalation components (e.g. GW2). The only other missing components are related to odour, which are thus considered not applicable.

Table 4.7 Comparison of Groundwater REMCs to Human Health Component Values

Parameter	Units	REMC	Human Health Component					Carried Forward for Quantitative Assessment?
			GW1[a]	Residential GW2	Industrial GW2	Residential GW2 Odour	Industrial GW2 Odour	
Volatile Organic Compounds								
Trichloroethylene	µg/L	2.64	5	**0.053**	**0.86**	2,400,000	14,000,000	**Yes**
Vinyl Chloride (future worst case)	µg/L	0.744	2	**0.0072**	**0.12**	7,600,000	4,400,000	**Yes**
BTEX								
Benzene	µg/L	2.88	5	**0.17**	**2.8**	17,000,000	100,000,000	**Yes**
Petroleum Hydrocarbons								
PHC F2	µg/L	1,200	**300**	**5.7**	**97**			**Yes**
PHC F3	µg/L	696	1000					No

Note: Concentrations are on a dry weight basis; human health components of Table 9 Site Condition Standards (SCS) for coarse textured soils and non-potable groundwater from the Ontario Ministry of the Environment, Conservation and Parks (MOE 2011).
[a] The Site is non-potable; however, the GW1 component was used to estimate the direct contact pathway for a subsurface worker.

4.2 Exposure Assessment

The exposure assessment involves an estimation of the intakes of the COCs by the human receptors via the various exposure pathways discussed previously using receptor-specific characteristics such as body weight and frequency of exposure, which are discussed below. Appendix H includes sample calculations in support of the HHRA.

4.2.1 Receptor Characteristics

The human receptors selected for quantitative evaluation in this HHRA are residents, indoor workers, outdoor maintenance workers, and subsurface workers. The residents and the three types of workers are believed to encompass the exposures that may be experienced by other receptors such as visitors and off-Site receptors and it was thus considered unnecessary to quantitatively evaluate visitors and off-Site receptors.

The receptor characteristics for the residents of all age groups and the three types of workers are summarized in Table 4.8, which for the most part are the default values provided by the MECP (MOE 2011), with the exception of time being spent outside, which MECP does not provide guidance. Time spent outdoors was assumed to be 1.5 hours per day for adults, 2.2 hours per day for teens and 1.8 hours per day for children. The MECP does not provide an intake value for accidental ingestion of groundwater by a subsurface worker while in a trench. To be conservative, an incidental groundwater ingestion rate of 0.1 L/d was used to account for ingestion from splashing and hand-to-mouth contact for the subsurface worker.

To assess the potential exposure of developmental toxicants, an adult female (pregnant) receptor was assessed without time adjustments to the exposure. A pregnant female was assumed be exposed continuously during subsurface activities, outdoor maintenance, indoor worker, and residential scenarios for trichloroethylene.

Table 4.8 Human Receptor Characteristics

Characteristic	Label	Units	Resident					Indoor Worker[d]	Long-Term Outdoor Worker[d]	Short-Term Subsurface Worker[d]
			Infant	Toddler	Child	Teen	Adult			
Body weight	BW	kg	8.2	16.5	32.9	59.7	70.7	70.7	70.7	70.7
Soil ingestion rate	IR_s	kg/d	0.00003	0.0002	0.00005	0.00005	0.00005	0.00005	0.0001	0.0001
Groundwater ingestion rate	IR_{gw}	L/d	NE	NE	NE	NE	NE	NE	0.1	0.1
Inhalation rate adjustment factor	IRA	-	1	1	1	1	1	1	1.8[a]	1.8[a]
Exposed skin surface area for groundwater contact	SA	cm^2	NE	NE	NE	NE	NE	NE	3400[b]	3400[b]
Exposed skin surface area for soil contact		cm^2	1105	1745	2822	3858	4343	4343	3400[b]	3400[b]
Soil loading	SL	mg/cm^2 /event	0.07	0.2	0.2	0.07	0.07	0.07	0.2	0.2
Duration of groundwater contact event	t_{ev}	h/event	NE	NE	NE	NE	NE	NE	1	1
Groundwater dermal event	EF_{gw}	event/d	NE	NE	NE	NE	NE	NE	1	1
Soil dermal event	EF_s	event/d	1	1	1	1	1	1	1	1
Hours exposed per day - indoor	ET_h	h/d	24	24	22.2	21.8	22.5	9.8	NE	NE
Hours exposed per day - outdoor		h/d	NE	1.5	1.8	2.2	1.5	NE	9.8	9.8[c]
Days exposed per week - indoor	ET_d	d/wk	7	7	7	7	7	5	NE	NE
Days exposed per week - outdoor		d/wk	7	7	7	7	7	NE	5	5
Weeks exposed per year - indoor	ET_{wk}	wk/yr	50	50	50	50	50	50	NE	NE
Weeks exposed per year - outdoor		wk/yr	39	39	39	39	39	NE	39	39
Exposure duration	ED	yr	0.5	4.5	7	8	56	56	56	1.5
Averaging time - cancer	AT	yr	76	76	76	76	76	56	56	56

NE – not evaluated (exposure pathway incomplete).

[a] Hourly inhalation rate (1.5 m^3/hr) times 24 hr/d divided by 20 m^3/d (daily inhalation rate assumed in the development of inhalation TRVs by the MECP (MOE 2011)).

[b] Head, forearms, and hands.[c] Half the time spent on site by the sub-surface worker was assumed to be in the trench

[d] for developmental toxicants a pregnant worker was included. This receptor has the same characteristics as other workers, with the exception of a body weight of 63.1 kg, exposed skin surface for soil and groundwater contact of 3400 and 3090cm^2.In addition, pro-rating for less than continuous exposure was not applied.

4.2.2 Pathways Analysis

Based on the secondary screening completed in Section 4.1.3, the exposure pathways requiring further assessment for each combination of receptor and COC are summarized in Table 4.9. The residential soil-to-indoor air component (S-IA) was used as a surrogate for trench air quality. Any COC exceeding the S-IA component was retained in the evaluation of a subsurface worker in a trench. Also, the residential groundwater-to-indoor air (GW2) component was used as a conservative indication for outdoor air quality. Similarly, any COC that exceeded the Residential GW2 component was retained as a COC for the evaluation of an outdoor maintenance worker and a subsurface worker.

Table 4.9 Exposure Pathways Evaluated for Human Receptors

Parameter	Resident	Indoor Worker	Outdoor Maintenance Worker	Subsurface Worker
Metals				
Antimony	✓ (Soil Contact)	-	✓ (Soil Contact)	✓ (Soil Contact)
Arsenic	✓ (Soil Contact)	-	✓ (Soil Contact)	✓ (Soil Contact)
Cadmium	✓ (Soil Contact)	-	-	-
Cobalt	✓ (Soil Contact)	-	-	-
Copper	✓ (Soil Contact)			
Lead	✓ (Soil Contact)	-	✓ (Soil Contact)	✓ (Soil Contact)
Polycyclic Aromatic Hydrocarbons				
Acenaphthylene	✓ (Soil - Indoor Air)	-	-	✓ (Soil - Trench Air)
Benz[a]anthracene	✓ (Soil Contact)	-	-	-
Benzo[a]pyrene	✓ (Soil Contact)	-	✓ (Soil Contact)	
Benzo[b]fluoranthene	✓ (Soil Contact)	-	✓ (Soil Contact)	-
Benzo[k]fluoranthene	✓ (Soil Contact)	-	-	-
Dibenz[a,h]anthracene	✓ (Soil Contact)	-	✓ (Soil Contact)	-
Indeno[1,2,3-cd]pyrene	✓ (Soil Contact)	-	✓ (Soil Contact)	-
Methylnaphthalene, 2-(1-)	-	-	✓ (Soil Odour)	✓ (Soil Odour)
Naphthalene	✓	-	✓ (Soil Odour)	✓

Parameter	Resident	Indoor Worker	Outdoor Maintenance Worker	Subsurface Worker
	(Soil - Indoor Air)			(Soil Odour; Soil – Trench Air)
Volatile Organic Compounds				
Trichloroethylene	✓ (Soil - Indoor Air; Groundwater – Indoor Air)	✓ (Soil - Indoor Air; Groundwater – Indoor Air)	✓ (Groundwater – Outdoor Air)	✓ (Soil - Trench Air; Groundwater – Trench Air)
Vinyl Chloride	✓ (Groundwater – Indoor Air)	✓ (Groundwater – Indoor Air)	✓ (Groundwater – Outdoor Air)	✓ (Groundwater – Trench Air)
BTEX				
Benzene	✓ (Soil Contact; Soil - Indoor Air; Groundwater – Indoor Air)	✓ (Soil - Indoor Air; Groundwater – Indoor Air)	✓ (Groundwater – Outdoor Air)	✓ (Soil - Trench Air; Groundwater – Trench Air)
Ethylbenzene	✓ (Soil - Indoor Air)	-	✓ (Soil Odour)	✓ (Soil - Trench Air; Soil Odour)
Toluene	✓ (Soil - Indoor Air)	-	✓ (Soil Odour)	✓ (Soil – Trench Air; Soil Odour)
Xylene Mixture	✓ (Soil - Indoor Air)	✓ (Soil - Indoor Air)	✓ (Soil Odour)	✓ (Soil - Trench Air; Soil Odour)
Petroleum Hydrocarbons				
PHC F1	✓ (Soil - Indoor Air)	-	-	✓ (Soil - Trench Air)
PHC F2	✓ (Soil - Indoor Air; Groundwater – Indoor Air)	✓ (Soil - Indoor Air; Groundwater – Indoor Air)	✓ (Groundwater – Outdoor Air)	✓ (Soil - Trench Air; Groundwater – Direct Contact; Groundwater – Trench Air)
PHC F3	✓ (Soil Contact)	-	✓ (Soil Contact)	-
PHC F4	✓ (Soil Contact)	-	-	-

4.2.3 Exposure Estimates

As discussed previously, the pathways of exposure relevant to this assessment exist as a result of inhalation of volatile vapours in indoor air (resident, indoor worker) and outdoor air (outdoor and subsurface workers), and direct contact (incidental ingestion, dermal contact) with groundwater (subsurface worker) and soil (resident, outdoor and subsurface workers). Potential exposures were calculated using the REMCs discussed in Section 3.3.2.4 and receptor characteristics discussed in Section 4.2.1.

The equations and assumptions used to calculate the intakes are provided in this section. Only the pathways highlighted in Table 4.9 are discussed. Exposures to COCs with developmental endpoints were not modified by the exposure times presented in the following sections (i.e., assumed exposure 24 hours a day, 7 days a week, 52 weeks a year).

4.2.3.1 Petroleum Hydrocarbons

PHC fractions comprise both aliphatic and aromatic sub-fractions which are considered in the exposure calculations. The concentrations of each aliphatic and aromatic sub-fraction in soil were estimated from the PHC F1 and PHC F2 REMCs and groundwater was estimated from PHC F2 REMC using recommended compositions (based on equivalent carbon number) from the Canadian Council of Ministers of the Environment (CCME) (CCME 2008) and supported by the MECP. The concentrations are summarized in Table 4.10 for soil and Table 4.11 for groundwater.

Table 4.10 REMC of Individual PHC F1 and F2 Sub-fractions in Soil

PHC F1			PHC F2		
Sub-fraction	**Composition (%)**	**Concentration (µg/g)**	**Sub-fraction**	**Composition (%)**	**Concentration (µg/g)**
PHC F1	100	480	**PHC F2**	100	2,040
Aliphatic C_6-C_8	55	264	Aliphatic $C_{>10}$-C_{12}	36	734
Aliphatic $C_{>8}$-C_{10}	36	173	Aliphatic $C_{>12}$-C_{16}	44	898
Aromatic $C_{>8}$-C_{10}	9	43	Aromatic $C_{>10}$-C_{12}	9	184
-	-	-	Aromatic $C_{>12}$-C_{16}	11	224
PHC F3			**PHC F4**		
Sub-fraction	**Composition (%)**	**Concentration (µg/g)**	**Sub-fraction**	**Composition (%)**	**Concentration (µg/g)**
PHC F3	100	45,600	**PHC F4**	100	26,400
Aliphatic $C_{>16}$-C_{21}	56	25,536	Aliphatic $C_{>34}$	80	21,120
Aliphatic $C_{>21}$-C_{34}	24	10,944	Aromatic $C_{>34}$	20	5,280
Aromatic $C_{>16}$-C_{21}	14	6,384	-	-	-
Aromatic $C_{>21}$-C_{34}	6	2,736	-	-	-

Table 4.11 Concentrations of Individual PHC F2 Sub-fractions in Groundwater

Sub-fraction	Composition (%)	Concentration (µg/L)
PHC F2	100	1,200
Aliphatic $C_{>10}$-C_{12}	2.4	29
Aliphatic $C_{>12}$-C_{16}	0.2	2.4
Aromatic $C_{>10}$-C_{12}	60.3	724
Aromatic $C_{>12}$-C_{16}	37.1	445

4.2.3.2 Carcinogenic PAHs

Acenaphthene, acenaphthylene, anthracene, benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[ghi]perylene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluoranthene, indeno[1,2,3-cd]pyrene, and pyrene, which are all carcinogenic PAHs, were identified as COCs in soil in Section 3.3. Although acenaphthene, anthracene, benzo[ghi]perylene, chrysene, fluoranthene, and pyrene were not identified as COCs for human receptors in Section 4.1.3.1, they were carried forward in the assessment in order to evaluate total risk from exposure to all carcinogenic PAHs. No carcinogenic PAHs were identified in groundwater.

To assess the total risk caused by exposure to the carcinogenic PAHs, the Toxicity Equivalency Factor (TEF) approach was adopted. It provides a TEF value for each carcinogenic PAH, which ties its toxicity to benzo[a]pyrene. The total risk of all carcinogenic PAHs was calculated by summing the products of the REMCs of individual PAHs and their TEFs according to CCME (2010). The TEFs of all the carcinogenic PAHs were taken from the most recent Ministry recommendations (MECP 2019a) and are summarized in Table 4.12, along with the REMCs.

Table 4.12 Summary of TEFs of the Carcinogenic PAHs in Soil

Carcinogenic PAH	TEF	Concentration (µg/g)
Acenaphthene	0.001	1.68
Acenaphthylene	0.01	2.64
Anthracene	0.01	10.44
Benz[a]anthracene	0.1	6.6
Benzo[a]pyrene	1	10.32
Benzo[b]fluoranthene	0.1	16.8
Benzo[ghi]perylene	0.01	10.08
Benzo[k]fluoranthene	0.1	6.12
Chrysene	0.01	6.6
Dibenz[a,h]anthracene	1	2.4
Fluoranthene	0.01	14.4

Carcinogenic PAH	TEF	Concentration (µg/g)
Indeno[1,2,3-cd]pyrene	0.1	9.96
Pyrene	0.001	9.6
Total Carcinogenic PAHs:		17.05

Note: The Ministry (MECP 2019a) provides TEF values of 0 for fluorene, 2-(1-)methylnaphthalene, naphthalene, and phenanthrene and thus they were not considered in the evaluation of total risk from exposure to all carcinogenic PAHs.

4.2.4 Inhalation Pathway

Inhalation intake by human receptors of COC vapours and dust was calculated using equation 4-1 for the air pathway:

$$I_{inh} = C_a \times AF_{inh} \frac{ET_h \times ET_d \times ET_{wk}}{24 \times 365} \times IRA \times \frac{ED}{AT} \qquad (4\text{-}1)$$

Where:

I_{inh}	=	Intake of COC through the inhalation pathway [mg/m^3]
C_a	=	Concentration of COC in dust, indoor air, or outdoor air [mg/m^3] {see below}
AF_{inh}	=	Inhalation absorption factor [-] {assumed to be 1}
ET_h	=	Hours per day exposed indoors or outdoors [h/d] {Table 4.8}
ET_d	=	Days per week exposed indoors or outdoors [d/wk] {Table 4.8}
ET_{wk}	=	Weeks per year exposed indoors or outdoors [wk/yr] {Table 4.8}
24	=	Total hours in a day [h]
365	=	Total days in a year [d]
IRA	=	Inhalation rate adjustment factor for to account for higher breathing rate during physical labour [-] {Table 4.8}
ED	=	Total exposure duration [y] {for carcinogenic COC only} {Table 4.8}
AT	=	Averaging time [y] {for carcinogenic COC only} {Table 4.8}

4.2.4.1 Estimation of Dust Concentrations

In general, this pathway of exposure is insignificant relative to direct ingestion of soil and to dermal absorption (Health Canada 2012); however, it is included in the risk assessment as a conservative measure. In the absence of measured air concentrations, concentrations of COC associated with particulate in ambient air can be estimated from soil data using an assumed respirable (≤ 10 µm aerodynamic diameter) particulate concentration. For the outdoor maintenance worker, a respirable particulate concentration (Pa) of 0.76 µg/m^3 (or 7.6×10^{-10} kg/m^3) was used as provided by Health Canada (2012) for areas with no construction activities. For the subsurface workers who may be exposed to a higher concentration of particulates as a result of soil resuspension during typical activities, a value of 60 µg/m^3 (or 6.0x10^{-8} kg/m^3) was used (MOE 2011). The estimated particulate in air concentration is calculated as follows:

$$C_{a,p} = C_s \times P_a \qquad (4\text{-}2)$$

Where:

$C_{a,p}$ = Particulate air concentration of COC [mg/m^3]

C_s = Concentration of COC in soil [mg/kg]

P_a = Particulate concentration in air [kg/m^3]

4.2.4.2 Estimation of Indoor Air Concentrations

Site-specific soil vapour and sub-slab vapour data were not available at the Site; therefore, indoor air concentrations of volatile vapours originating from soil and groundwater were estimated by multiplying the source vapour concentration (C_{source}) below a future building by an indoor attenuation coefficient (α) as shown in equation 4-3:

$$C_a = C_{source} \times \alpha \qquad (4\text{-}3)$$

Where:

C_a = Concentration of volatile COC in indoor air [mg/m^3]

C_{source} = Concentration of volatile COC below building foundation [mg/m^3]

α = Indoor air attenuation coefficient [-]

Determination of volatility was based on the methodology outlined in Section 4.1.3 by the MECP (2019b). This approach states that either the Henry's Law constant has to be greater than 1x10^{-5} atm-m^3/mol or the vapour pressure greater than 1 mm Hg (equivalent to 1.0 Torr) to be considered a volatile COPC.

Indoor Air Concentrations from Soil

The source vapour concentrations originating from soil were estimated using the Johnson & Ettinger (J&E) Model for Soil Contamination for evaluating subsurface vapour intrusion into buildings, available for download as an Excel spreadsheet from the U.S. EPA (SL-ADV, Version 3.1, February). The input and intercalculation sheets are provided in Appendix H.

The volatile COC concentrations below the future building foundation originating from soil were estimated according to equation 4-4:

$$C_{source} = \frac{C_s \times H'_{TS} \times \rho_b}{\theta_w + (K_d \times \rho_b) + (H'_{TS} \times \theta_a)} \times 1000 \qquad (4\text{-}4)$$

Where:

C_{source}	=	Concentration of volatile COC below building foundation [mg/m^3]
C_s	=	Concentration of COC in soil [mg/kg]
H'_{TS}	=	Dimensionless Henry's law constant of COC at average soil/groundwater temperature (noted in Table 4.13) [-] {Table 4.14}
ρ_b	=	Dry bulk density of soil below building foundation [g/cm^3] {Table 4.13}
$\theta_{a/w}$	=	Air- ('a') or water ('w')-filled porosity of soil below building foundation [cm^3/cm^3] {Table 4.13}
K_d	=	Soil-water partition coefficient of COC [cm^3/g] {Table 4.14}
1000	=	Unit conversion for dry bulk density (to kg/m^3)

The dimensionless Henry's Law constants corrected for the soil temperature of 15°C were obtained from the MGRA spreadsheets (MOECC 2016a).

If the soil concentration (C_s) of a COC based on measured data was above the soil saturation concentration (calculated within the J&E model), then the saturation concentration was used in the above equation.

The site-specific indoor air attenuation coefficient for soil was also estimated using the J&E Model, which accounts for vapour migration from the source through up to three soil layers and through the building foundation. For this assessment, the depth below grade to the top of the contamination (L_t) was conservatively assumed to be immediately beneath the gravel crush layer below the building foundation (i.e., 188 cm for a residential building and 41.25 cm for a commercial building). For a residential building, the 188 cm comprises a 150 cm basement, an 8 cm floor foundation, and a 30 cm gravel crush layer, consistent with the MECP default residential building. For a commercial building, the 41.25 cm comprises an 11.25 cm floor foundation and a 30 cm gravel crush layer, consistent with the MECP default commercial building.

The Phase 2 CSM shows that the soil at the site is coarse-textured lacustrine deposits of sand and gravel with minor silt and clay. As a conservative representation of this soil texture, the parameters for coarse-textured soil were used in the modelling.

The attenuation factor, α, is calculated according to equation 4-5:

$$\alpha = \frac{\left(\frac{D_{eff,T}\times A_b}{Q_b\times L_t}\right)exp\left(\frac{Q_{soil}\times L_{crack}}{D_{crack}\times A_{crack}}\right)}{exp\left(\frac{Q_{soil}\times L_{crack}}{D_{crack}\times A_{crack}}\right)+\left(\frac{D_{eff,T}\times A_b}{Q_b\times L_t}\right)+\left(\frac{D_{eff,T}\times A_b}{Q_{soil}\times L_t}\right)\left[exp\left(\frac{Q_{soil}\times L_{crack}}{D_{crack}\times A_{crack}}\right)-1\right]} \quad (4\text{-}5)$$

Where:

α	=	Indoor air attenuation coefficient [-]
$D_{eff,T}$	=	Overall effective diffusion coefficient in soil [cm^2/s]
A_b	=	Area of enclosed space below grade [cm^2] {Table 4.13}
Q_b	=	Building ventilation rate [cm^3/s] {Table 4.13}
L_t	=	Depth below grade to top of contamination (i.e., sum of individual soil layer thicknesses) [cm] {Table 4.13}
Q_{soil}	=	Volumetric flow rate of soil gas into the building [cm^3/s] {Table 4.13}
L_{crack}	=	Thickness of building foundation [cm] {Table 4.13}
D_{crack}	=	Effective diffusion coefficient through the foundation; assumed to be equal to the effective diffusion coefficient through upper soil layer [cm^2/s]
A_{crack}	=	Total area of cracks through which vapours enter building [cm^2] {Table 4.13}

The overall effective diffusion coefficient in soil, $D_{eff,T}$, is calculated as follows:

$$D_{eff,T} = \frac{L_t}{\sum \frac{h_i}{D_{eff,i}}} \quad (4\text{-}6)$$

Where:

$D_{eff,T}$	=	Overall effective diffusion coefficient in soil [cm^2/s]
L_t	=	Depth below grade to top of contamination (i.e., sum of individual soil layer thicknesses) [cm] {Table 4.13}
h_i	=	Thickness of soil layer 'i' [cm] {Table 4.13}
$D_{eff,i}$	=	Effective diffusion coefficient through soil layer 'i' [cm^2/s]

The effective diffusion coefficient through each soil layer 'i' ($D_{eff,i}$) is calculated according to the following equation:

$$D_{eff,i} = D_a \frac{(\theta_{a,i})^{10/3}}{(n_i)^2} + \frac{D_w}{H'_{TS}} \frac{(\theta_{w,i})^{10/3}}{(n_i)^2} \quad (4\text{-}7)$$

Where:

$D_{eff,i}$	=	Effective diffusion coefficient through soil layer 'i' [cm^2/s]
$D_{a/w}$	=	Diffusivity of COC in air ('a') or water ('w') [cm^2/s] {Table 4.14}

$\theta_{a/w,i}$ = Air- ('a') or water ('w')-filled porosity of soil layer 'i' [cm^3/cm^3] {Table 4.13}

n_i = Total effective porosity of soil layer 'i' [cm^3/cm^3] {Table 4.13}

H'_{TS} = Dimensionless Henry's law constant of COC at average soil/groundwater temperature (noted in Table 4.13) [-] {Table 4.14}

The variables used in the above-detailed equations were obtained from the approved MGRA model (MOECC 2016a) and are summarized in Table 4.13. Values for chemical-specific variables were also obtained from the MGRA model (MOECC 2016a). The estimated source vapour concentrations from soil are presented in Table 4.14 and Table 4.15 along with other variables used to determine the indoor air concentrations associated with volatile COC in soil.

Table 4.13 Variables Used to Estimate Indoor Air Concentrations from Soil

<table>
<tr><th>Variable</th><th>Description</th><th>Units</th><th>Industrial Value</th><th>Residential Value</th><th colspan="2">Comment</th></tr>
<tr><td>Q_b</td><td>Building ventilation rate</td><td>cm^3/s</td><td>$2.5x10^5$</td><td>$4.6x10^4$</td><td colspan="2">Calculated within J&E Model; default MECP building specifications</td></tr>
<tr><td>Q_{soil}</td><td>Average vapour flow rate into building</td><td>cm^3/s</td><td>163</td><td>141</td><td colspan="2">Default for industrial/residential building, coarse soil</td></tr>
<tr><td>L_{crack}</td><td>Thickness of building foundation</td><td>cm</td><td>11.25</td><td>8</td><td colspan="2">Default for industrial/residential building</td></tr>
<tr><td>A_{crack}</td><td>Total area of cracks</td><td>cm^2</td><td>700</td><td>490</td><td colspan="2">Calculated within J&E model; default</td></tr>
<tr><td>L_t</td><td>Depth below grade to top of contamination</td><td>cm</td><td>41.25</td><td>188</td><td colspan="2">Assumed maximum concentration begins immediately below the gravel crush layer</td></tr>
<tr><td>T_{gw}</td><td>Groundwater temperature</td><td>K</td><td>288.15</td><td>288.15</td><td colspan="2">Default</td></tr>
<tr><td>ρ_b</td><td>Soil dry bulk density</td><td>g/cm^3</td><td>1.6</td><td>1.6</td><td colspan="2">Default for underlying gravel crush layer (MOE 2010)</td></tr>
<tr><td rowspan="2">h_i</td><td rowspan="2">Thickness of soil layer 'i'</td><td rowspan="2">cm</td><td>11.25</td><td>158</td><td colspan="2">Default depth below grade to bottom of foundation</td></tr>
<tr><td>30</td><td>30</td><td colspan="2">Default underlying gravel crush</td></tr>
<tr><td rowspan="2">n_i</td><td rowspan="2">Total effective porosity of soil layer 'i'</td><td rowspan="2">cm^3/cm^3</td><td>0.36</td><td>0.36</td><td colspan="2">Default for upper coarse soil</td></tr>
<tr><td>0.4</td><td>0.4</td><td colspan="2">Default for gravel crush (MOE 2010)</td></tr>
<tr><td rowspan="2">$\theta_{w,i}$</td><td rowspan="2">Water-filled porosity of soil layer 'i'</td><td rowspan="2">cm^3/cm^3</td><td>0.119</td><td>0.119</td><td colspan="2">Default for upper coarse soil</td></tr>
<tr><td>0.01</td><td>0.01</td><td colspan="2">Default for gravel crush (MOE 2010)</td></tr>
<tr><td rowspan="2">$\theta_{a,i}$</td><td rowspan="2">air-filled porosity of soil layer 'i'</td><td rowspan="2">cm^3/cm^3</td><td>0.241</td><td>0.241</td><td rowspan="2">$= n_i - \theta_{w,i}$</td><td>Upper coarse soil</td></tr>
<tr><td>0.390</td><td>0.390</td><td>Gravel crush</td></tr>
</table>

Note: Default values as per the MGRA (MOECC 2016a), unless otherwise specified.

Table 4.14 Chemical-Specific Values Used to Estimate Indoor Air Concentrations from Soil for a Generic Residential and Commercial Building

									Residential		Commercial	
Parameter	**Soil REMC**	**Soil REMC**	**Diffusivity in air**	**Diffusivity in Water**	**Henry's Law Constant**	**Soil Sat. Conc.**	**Soil water partition coefficient**	**Source Vapour Conc.**	**Infinite source indoor attenuation coefficient**	**Infinite source indoor air concentration[a]**	**Infinite source indoor attenuation coefficient**	**Infinite source indoor air concentration[a]**
	µg/g	**µg/kg**	**cm^2/s**	**cm^2/s**	**unitless**	**µg/kg**	**cm^3/g**	**$\mu g/m^3$**	**unitless**	**$\mu g/m^3$**	**unitless**	**$\mu g/m^3$**
	C_s	**C_s**	**D_a**	**D_w**	**H'_{TS}**	**C_{sat}**	**K_d**	**C_{source}**	**α**	**$C_{building}$**	**α**	**$C_{building}$**
Polycyclic Aromatic Hydrocarbons												
Acenaphthylene	2.64	2,640	0.04	$7.5x10^{-6}$	0.005	394,442	24	570	0.0027	1.5	-	-
Naphthalene	5.64	5,640	0.06	$7.5x10^{-6}$	0.009	228,118	7.3	6,724	0.0028	18.5	-	-
Volatile Organic Compounds												
Trichloroethylene	0.456	456	0.08	$9.1x10^{-6}$	0.3	480,360	0.27	341,257	0.0028	966	0.00061	297
BTEX												
Benzene	10	10,000	0.09	$9.8x10^{-6}$	0.2	1,260,060	0.66	2,096,887	0.0029	5,987	0.00061	1,282
Toluene	30	30,000	0.09	$8.6x10^{-6}$	0.17	588,000	1.07	4,415,167	0.0029	12,596	-	-
Ethylbenzene	5.76	5,760	0.08	$7.8x10^{-6}$	0.2	358,688	2.1	2,607,395	0.0028	1,412	-	-
Xylene	52	52,000	0.07	$9.3x10^{-6}$	0.3	195,539	1.8	7,835,825	0.0028	22,005	0.00060	4,568
PHC F1												
Aliphatic C_6-C_8	264	264,000	0.05	$6.0x10^{-6}$	52	154,085	16	$2.8x10^8$	0.0027	755,842[b]	0.00058	160,000[b]
Aliphatic $C_{>8}$-C_{10}	173	172,800	0.05	$6.0x10^{-6}$	83	63,072	126	$3.6x10^7$	0.0027	96,379[b]	0.00058	0.00021[b]
Aromatic $C_{>8}$-C_{10}	43.2	43,200	0.05	$6.0x10^{-6}$	0.5	420,350	6.3	3,318,673	0.0027	8,984	0.00058	1,936
PHC F2												
Aliphatic $C_{>10}$-C_{12}	734	734,400	0.05	$6.0x10^{-6}$	124	35,191	1,005	4,222,765	0.0027	11,431[b]	0.00058	2,463[b]
Aliphatic $C_{>12}$-C_{16}	897	897,600	0.05	$6.0x10^{-6}$	538	15,336	20,000	409,029	0.0027	1,107[b]	0.00058	239[b]
Aromatic $C_{>10}$-C_{12}	183	183,600	0.05	$6.0x10^{-6}$	0.1	252,228	10	2,636,844	0.0027	7,138	0.00058	1,538
Aromatic $C_{>12}$-C_{16}	224	224,400	0.05	$6.0x10^{-6}$	0.05	116,389	20	318,156	0.0027	861[b]	0.00058	186[b]

Note: Chemical-specific parameters obtained from the MGRA spreadsheet (MOECC 2016a)

[a] Estimated using the Johnson & Ettinger Model spreadsheet from the U.S. EPA.

[b] Based on saturation concentration, which is below estimate based on REMC soil concentration.

'-' indicates the air concentration is not required.

Table 4.15 Chemical-Specific Values for Carcinogenic PAHs Used to Estimate Indoor Air Concentrations from Soil for a Generic Residential Building

Parameter	Soil REMC	Soil REMC	Diffusivity in air	Diffusivity in Water	Henry's Law Constant	Soil Sat. Conc.	Soil water partition coefficient	Source Vapour Conc.	Residential: Infinite source indoor attenuation coefficient	Residential: Infinite source indoor air concentration[a]
	µg/g	µg/kg	cm^2/s	cm^2/s	unitless	µg/kg	cm^3/g	$µg/m^3$	unitless	$µg/m^3$
	C_s	C_s	D_a	D_w	H'_{TS}	C_{sat}	K_d	C_{source}	α	$C_{building}$
Acenaphthene	1.68	1,680	0.042	$7.7x10^{-6}$	0.003	95,550	24.5	206	0.0026	0.55
Acenaphthylene	2.64	2,640	0.042	$7.7x10^{-6}$	0.005	394,442	24.5	570	0.0027	1.52
Anthracene	10.44	10,440	0.032	$7.7x10^{-6}$	0.0008	3,542	81.6	35	0.0025	0.09[b]
Benz[a]anthracene	6.60	6600	0.051	$9.0 x10^{-6}$	0.00013	8,686	924	2.9	0.0027	0.0079
Benzo[a]pyrene	10.3	10320	0.043	$9.0 x10^{-6}$	$3.6 x10^{-6}$	5,100	3,148	0.030	0.0027	$8.0x10^{-5}$[b]
Benzo[b]fluoranthene	16.8	16800	0.023	$5.6 x10^{-6}$	$6.3 x10^{-6}$	4,818	3,212	0.040	0.0024	$9.5x10^{-5}$[b]
Benzo[ghi]perylene	10.1	10080	0.0	$5.2 x10^{-6}$	$1.4 x10^{-5}$	2,787	10,720	0.0035	0.0028	$9.8x10^{-6}$[b]
Benzo[k]fluoranthene	6.12	6120	0.023	$5.6 x10^{-6}$	$5.0 x10^{-6}$	2,518	3,148	0.019	0.0024	$4.5x10^{-5}$[b]
Chrysene	6.60	6600	0.025	$6.2 x10^{-6}$	$5.3 x10^{-5}$	1,888	944	0.43	0.0024	0.0010[b]
Dibenz[a h]anthracene	2.40	2400	0.020	$5.2 x10^{-6}$	$3.5 x10^{-7}$	10,794	10,480	0.0010	0.0023	$2.2x10^{-6}$
Fluoranthene	14.4	14400	0.030	$6.4 x10^{-6}$	0.00012	73,738	284	15	0.0025	0.04
Indeno[1 2 3-cd]pyrene	10.0	9960	0.019	$5.7 x10^{-6}$	$2.6 x10^{-6}$	2,037	10,720	0.0027	0.0023	$6.1x10^{-6}$[b]
Pyrene	9.6	9600	0.027	$7.2x10^{-6}$	0.00015	37,477	278	14	0.0025	0.03
Total Carcinogenic PAHs										2.24

Note: Chemical-specific parameters obtained from the MGRA spreadsheet (MOECC 2016a)
[a] Estimated using the Johnson & Ettinger model spreadsheet from the U.S. EPA.
[b] Based on saturation concentration, which is below estimate based on REMC soil concentration.

Indoor Air Concentrations from Groundwater

For groundwater, C_{source} in equation 4-3 is calculated based on the maximum of the measured groundwater concentration and theoretical saturation concentration, as per equation 4-8:

$$C_{source} = min(C_{gw}, C_{sat}) \times H'_{TS} \times 1000 \qquad (4\text{-}8)$$

Where

C_{gw}	=	Concentration of COC in groundwater [mg/L] {Table 4.16; Table 4.17}
C_{sat}	=	Saturation concentration of COC (pure component solubility) [mg/L] {Table 4.16; Table 4.17}
H'_{TS}	=	Dimensionless Henry's law constant of COC at average soil/groundwater temperature {noted in Table 4.13} [-] {Table 4.16; Table 4.17}
1000	=	conversion from mg/L to mg/m^3

The U.S. EPA has also developed a J&E Model for Groundwater Contamination as an Excel spreadsheet (GW-ADV, Version 3.1, February); however, the MECP considers the J&E Model applicable for estimating the attenuation coefficient only when the groundwater is at least 1 m below the building foundation. When the separation distance is less than this, default attenuation coefficients of 0.02 for residential and 0.004 for industrial scenarios are required in equation 4-3. As previously mentioned, the Site is considered a shallow groundwater condition due to the minimum depth to groundwater of 0.34 m. Therefore, the default attenuation factors are applicable to estimate the indoor air concentrations of volatile COCs originating from the C_{source} generated from equation 4-8.

Table 4.16 and Table 4.17 present the estimated indoor air concentrations from groundwater along with the variables used in the calculations for a residential building and a commercial building, respectively.

Table 4.16 Chemical-Specific Values Used to Estimate Indoor Air Concentrations from Groundwater for a Generic Residential Building

Parameter	Groundwater REMC	Saturation Conc.	Henry's Law Constant	Source Vapour Conc.	Infinite source indoor attenuation coefficient	Infinite source indoor air concentration
	mg/L	mg/L	unitless	mg/m^3	unitless	mg/m^3
	C_{gw}	C_{sat}	H'_{TS}	C_{source}	α[a]	$C_{building}$
Volatile Organic Compounds						
Trichloroethylene	0.0026	1,280	0.4	1.10	0.02	0.02
Vinyl chloride	0.00074	8,800	1.2	0.88	0.02	0.02
BTEX						
Benzene	0.0029	1,790	0.2	0.42	0.02	0.008
Petroleum Hydrocarbons						
PHC F2						
Aliphatic $C_{>10}$-C_{12}	0.029	0.034	124	3,577	0.02	72
Aliphatic $C_{>12}$-C_{16}	0.0024	0.00076	538	409[b]	0.02	8.2
Aromatic $C_{>10}$-C_{12}	0.72	25	0.2	105	0.02	2.1
Aromatic $C_{>12}$-C_{16}	0.45	5.8	0.06	24.4	0.02	0.5

Note: Chemical-specific parameters obtained from the MGRA spreadsheet (MOECC 2016a)
[a] Default MECP attenuation factor for shallow groundwater for a residential Site
[b] Based on pure component water solubility concentration, which is below estimate based on maximum PHC F2 groundwater concentration.

Table 4.17 Chemical-Specific Values Used to Estimate Indoor Air Concentrations from Groundwater for a Generic Commercial Building

Parameter	Groundwater REMC	Saturation Conc.	Henry's Law Constant	Source Vapour Conc.	Infinite source indoor attenuation coefficient	Infinite source indoor air concentration
	mg/L	mg/L	unitless	mg/m^3	unitless	mg/m^3
	C_{gw}	C_{sat}	H'_{TS}	C_{source}	α[a]	$C_{building}$
Volatile Organic Compounds						
Trichloroethylene	0.0026	1,280	0.4	1.10	0.004	0.0044
Vinyl chloride	0.00074	8,800	1.2	0.88	0.004	0.0035
BTEX						
Benzene	0.0029	1,790	0.2	0.42	0.004	0.0017
Petroleum Hydrocarbons						
PHC F2						
Aliphatic $C_{>10}$-C_{12}	0.029	0.034	124	3,577	0.004	14.3
Aliphatic $C_{>12}$-C_{16}	0.0024	0.00076	538	409[b]	0.004	1.64
Aromatic $C_{>10}$-C_{12}	0.72	25	0.2	105	0.004	0.42
Aromatic $C_{>12}$-C_{16}	0.45	5.8	0.06	24.4	0.004	0.098

Note: Chemical-specific parameters obtained from the MGRA spreadsheet (MOECC 2016a)
[a] Default MECP attenuation factor for shallow groundwater for a commercial/industrial Site
[b] Based on pure component water solubility concentration, which is below estimate based on maximum PHC F2 groundwater concentration.

4.2.4.3 Estimation of Outdoor Air Concentrations

Concentrations of volatile vapours in outdoor and trench air from groundwater and/or soil were estimated as per the methodologies below. Determination of volatility was based on the methodology outlined in Section 4.1.3 by the MECP (2019b). This approach states that either the Henry's Law constant has to be greater than $1x10^{-5}$ atm-m^3/mol or the vapour pressure greater than 1 mm Hg (equivalent to 1.0 Torr) to be considered a volatile COPC.

Outdoor Air Concentrations from Groundwater

To evaluate exposure to the outdoor worker to vapours migrating from groundwater to outdoor air, the approach provided by the American Society for Testing of Materials (ASTM 2010) was used. This involves multiplying the groundwater concentration by a volatilization factor (VF) to estimate the outdoor air concentration, as shown in equation 4-9:

$$C_a = C_{gw} \times CF \times VF \qquad (4\text{-}9)$$

Where:

C_a	=	Concentration of COC in outdoor air from groundwater [mg/m^3]
C_{gw}	=	Concentration of COC in groundwater [µg/L] {Table 4.20}
CF	=	Conversion factor [10^{-3} mg/µg]
VF	=	Volatilization factor [mg/m^3 air per mg/L water] {Table 4.20}

The volatilization factor is calculated according to equation 4-10:

$$VF = \frac{H'_{TS}}{1+\left[\frac{U_a \times \delta_a \times L_{gw}}{W \times D_{eff,oa}}\right]} \qquad (4\text{-}10)$$

Where:

VF	=	Volatilization factor [mg/m^3 air per mg/L water] {Table 4.20}
H'_{TS}	=	Dimensionless Henry's law constant of COC at average soil/groundwater temperature (noted in Table 4.18) [-] {Table 4.20}
U_a	=	Average windspeed [cm/s] {Table 4.18}
δ_a	=	Ambient air mixing zone height [cm] {Table 4.18}
L_{gw}	=	Depth to groundwater [cm] {Table 4.18}
W	=	Width of source area parallel to wind direction [cm] {Table 4.18}
$D_{eff,oa}$	=	Overall effective diffusion coefficient between groundwater and soil surface [cm^2/s] {Table 4.20}

The overall effective diffusion coefficient ($D_{eff,oa}$) from groundwater through the soil (saturated capillary fringe and unsaturated vadose soil layers) is calculated as follows:

$$D_{eff,oa} = \left(h_{cap} + h_v\right) \times \left(\frac{h_{cap}}{D_{eff,cap}} + \frac{h_v}{D_{eff,s}}\right)^{-1} \qquad (4\text{-}11)$$

Where:

$D_{eff,oa}$	=	Overall effective diffusion coefficient between groundwater and soil surface [cm^2/s] {Table 4.20}
h_{cap}	=	Height of capillary fringe layer [cm] {Table 4.18}
h_v	=	Height of vadose soil layer [cm] {Table 4.18}
$D_{eff,cap/s}$	=	Effective diffusion coefficient through capillary fringe ('cap') or vadose soil ('s') layer [cm^2/s] {Table 4.20}

The effective diffusion coefficients ($D_{eff,i}$) through each of the saturated capillary fringe and unsaturated vadose soil layers (layer 'i') are calculated as per equation 4-7 (repeated below as equation 4-12):

$$D_{eff,i} = D_a \frac{(\theta_{a,i})^{10/3}}{(n_i)^2} + \frac{D_W}{H'_{TS}} \frac{(\theta_{w,i})^{10/3}}{(n_i)^2} \qquad (4\text{-}12)$$

Where:

$D_{eff,i}$	=	Effective diffusion coefficient through soil layer 'i' [cm^2/s]
$D_{a/w}$	=	Diffusivity of COC in air ('a') or water ('w') [cm^2/s] {Table 4.20}
$\theta_{a/w,i}$	=	Air- ('a') or water ('w')-filled porosity of soil layer 'i' [cm^3/cm^3] {Table 4.18}
n_i	=	Total effective porosity of soil layer 'i' [cm^3/cm^3] {Table 4.18}
H'_{TS}	=	Dimensionless Henry's law constant of COC at average soil/groundwater temperature (noted in Table 4.18) [-] {Table 4.20}

The variables used in the above-detailed equations were obtained from the approved MGRA model (MOECC 2016a) and are summarized in Table 4.18, while the resulting estimated outdoor air concentrations from groundwater are summarized in Table 4.19.

Table 4.18 Variables Used to Estimate Outdoor Air Concentrations from Groundwater

Variable	Description	Units	Value	Comment	
W	Width of source area parallel to wind direction	cm	100	MOE (2011) default	
δ_a	Ambient air mixing zone height	cm	200	MOE (2011) default	
U_a	Ambient air windspeed	cm/s	410	MGRA (2016) default	
L_{gw}	Depth to groundwater	cm	34	Site specific	
h_{cap}	Thickness of capillary fringe	cm	17	Calculated from U.S. EPA (2004a) for groundwater between 5°C and 25°C	
h_v	Thickness of vadose zone	cm	17	$=L_{gw} - h_{cap}$	
T_{gw}	Groundwater temperature	K	288.15	Default	
n_i	Total effective porosity of soil layer 'i'	cm^3/cm^3	0.36	Default for coarse soil (vadose)	
			0.375	Default for sandy soil (capillary fringe) (MOE 2010)	
$\theta_{w,i}$	Water -filled porosity of soil layer 'i'	cm^3/cm^3	0.119	Default for coarse soil (vadose)	
			0.253	Calculated from U.S. EPA (2004a) for sandy soil in the capillary fringe layer	
$\theta_{a,i}$	air-filled porosity of soil layer 'i'	cm^3/cm^3	0.241	$= n_i-\theta_{w,i}$	Coarse soil (vadose)
			0.122		Sandy soil (capillary fringe)

Note: Default values as per the MGRA (MOECC 2016a), unless otherwise noted.

Table 4.19 Estimated Outdoor Air Concentrations from Groundwater

Parameter	REMC	Diffusivity in air	Diffusivity in Water	Henry's Law Constant	Effective Diffusion Coefficient through Capillary Fringe	Effective Diffusion Coefficient through Vadose Soil	Overall Effective Diffusion Coefficient	Volatilization Factor	Groundwater to Outdoor Air Concentration
	μg/L	(cm^2/s)	(cm^2/s)	unitless	cm^2/s	cm^2/s	cm^2/s	mg/m^3 air per mg/L water	mg/m^3
	C_{gw}	D_a	D_w	H'_{TS}	$D_{eff,cap}$	$D_{eff,s}$	$D_{eff,OA}$	VF	C_a
Volatile Organic Compounds									
Trichloroethylene	2.6	0.08	$9.1x10^{-6}$	0.3	$5.1x10^{-4}$	$5.3x10^{-3}$	$9.2x10^{-4}$	$8.4x10^{-6}$	$2.2 x10^{-8}$
Vinyl chloride	0.7	0.1	$1.2x10^{-6}$	0.9	$6.7x10^{-4}$	$7.1x10^{-3}$	$1.2x10^{-3}$	$3.9x10^{-5}$	$2.9 x10^{-8}$
BTEX									
Benzene	2.88	0.09	$9.8x10^{-6}$	0.2	$5.6x10^{-4}$	$5.9x10^{-3}$	$1.0x10^{-3}$	$5.4x10^{-6}$	$1.6 x10^{-8}$
PHC F2									
Aliphatic $C_{>10}$-C_{12}	28.8	0.05	$6.0x10^{-6}$	124	$3.2x10^{-4}$	$3.4x10^{-3}$	$5.8x10^{-4}$	$2.6x10^{-3}$	$7.4 x10^{-5}$
Aliphatic $C_{>12}$-C_{16}	2.4	0.05	$6.0x10^{-6}$	538	$3.2x10^{-4}$	$3.4x10^{-3}$	$5.8x10^{-4}$	$1.1x10^{-2}$	$2.7 x10^{-5}$
Aromatic $C_{>10}$-C_{12}	724	0.05	$6.0x10^{-6}$	0.14	$3.2x10^{-4}$	$3.4x10^{-3}$	$5.8x10^{-4}$	$3.0x10^{-6}$	$2.2 x10^{-6}$
Aromatic $C_{>12}$-C_{16}	445	0.05	$6.0x10^{-6}$	0.05	$3.3x10^{-4}$	$3.4x10^{-3}$	$5.9x10^{-4}$	$1.2x10^{-6}$	$5.2 x10^{-7}$

Outdoor Air Concentrations in a Trench from Groundwater

To evaluate exposure of the subsurface worker to volatile vapours migrating from groundwater into a trench, the same method was used as for groundwater to outdoor air (see Section 4.2.4.3), but applying the following changes:

- Reduced windspeed to stimulate more stagnant conditions (45 cm/s versus 410 cm/s (U.S. EPA 1999))
- Reduced depth to groundwater from the bottom of the trench (1 cm versus 34 cm)
- No capillary fringe layer (i.e., conservatively assuming diffusion through unsaturated vadose soil only)

Using the methodology discussed in Section 4.2.4.3 with modified parameters, the estimated outdoor air concentrations in a trench from groundwater are summarized in Table 4.20.

Table 4.20 Estimated Trench Air Concentrations from Groundwater

Parameter	REMC	Diffusivity in air	Diffusivity in Water	Henry's Law Constant	Overall Effective Diffusion Coefficient (vadose soil)	Volatilization Factor for Trench	Groundwater to Trench Air Concentration
	µg/L	(cm^2/s)	(cm^2/s)	unitless	cm^2/s	mg/m^3 air per mg/L water	mg/m^3
	C_{gw}	D_a	D_w	H'_{TS}	$D_{eff,OA}$	VF	C_a
Volatile Organic Compounds							
Trichloroethylene	2.6	0.08	$9.1x10^{-6}$	0.3	$5.3x10^{-3}$	$1.5x10^{-2}$	$4.0x10^{-5}$
Vinyl chloride	0.7	0.1	$1.2x10^{-6}$	0.9	$7.1x10^{-3}$	$7.0x10^{-2}$	$5.2x10^{-5}$
BTEX							
Benzene	2.88	0.09	$9.8x10^{-6}$	0.2	$5.9x10^{-3}$	$9.7x10^{-3}$	$2.8x10^{-5}$
PHC F2							
Aliphatic $C_{>10}$-C_{12}	28.8	0.05	$6.0x10^{-6}$	124	$3.4x10^{-3}$	4.7	$1.3x10^{-1}$
Aliphatic $C_{>12}$-C_{16}	2.4	0.05	$6.0x10^{-6}$	538	$3.4x10^{-3}$	20.2	$5.0x10^{-2}$
Aromatic $C_{>10}$-C_{12}	724	0.05	$6.0x10^{-6}$	0.14	$3.4x10^{-3}$	$5.4x10^{-3}$	$4.0x10^{-3}$
Aromatic $C_{>12}$-C_{16}	445	0.05	$6.0x10^{-6}$	0.05	$3.4x10^{-3}$	$2.1x10^{-3}$	$9.1x10^{-4}$

Outdoor Air Concentrations in a Trench from Soil

To estimate concentrations in trench air originating from contaminated soil, the Finite Source Jury Model, as per the MECP (MOE 2011), was used:

$$C_a = \frac{J \times Area}{U_a \times W \times \delta_a} \times CF \qquad (4\text{-}13)$$

Where:

C_a	=	Concentration of volatile COC in outdoor air from soil [mg/m^3]
J	=	COC flux at ground surface [mg/cm^2/s]
U_a	=	Average windspeed [cm/s] {Table 4.21}
δ_a	=	Ambient air mixing zone height [cm] {Table 4.21}
Area	=	Area of exposed soil [cm^2]
W	=	Width of source area parallel to wind direction [cm] {Table 4.21}
CF	=	Conversion factor [10^6 cm^3/m^3]

The flux at ground surface (J) is calculated as follows, assuming flux occurs over a period of one year through vadose zone soil (assuming contamination is full depth and not sub-surface):

$$J = (C_s \times [\rho_b \times CF])\sqrt{\frac{D_{eff,s}}{\pi t}}\left(1 - exp\left(-\frac{{L_s}^2}{4 \times D_{eff,s} \times t}\right)\right) \qquad (4\text{-}14)$$

Where:

J	=	COC flux at ground surface [mg/cm^2/s]
C_s	=	Concentration of COC in soil [mg/kg] {

Table 4.22}

ρ_b	=	Dry bulk density of vadose zone soil [g/cm^3] {Table 4.21}
CF	=	Conversion factor [10^{-3} kg/g]
$D_{eff,s}$	=	Effective diffusion coefficient through vadose zone soil [cm^2/s] {Table 4.22}
t	=	Time [s] {1 year, or 3.15x10^7 s}
L_s	=	Thickness of contaminated soil [cm] {Table 4.21}

The effective diffusion coefficient in vadose zone soil (assuming contamination is full depth and not sub-surface) is calculated in a manner similar to equation 4-12 for groundwater to outdoor air, but accounting for desorption from soil to water:

$$D_{eff,s} = \frac{\frac{\left(D_a \times \theta_a^{10/3} \times H'_{TS}\right) + \left(D_w \times \theta_w^{10/3}\right)}{n^2}}{\rho_b \times K_{oc} \times f_{oc} + \theta_w + \theta_a \times H'_{TS}} \tag{4-15}$$

Where:

$D_{eff,s}$	=	Effective diffusion coefficient through vadose zone soil [cm^2/s]
$D_{a/w}$	=	Diffusivity of COC in air ('a') or water ('w') [cm^2/s] {Table 4.22}
$\theta_{a/w}$	=	Air- ('a') or water ('w')-filled porosity of vadose zone soil [cm^3/cm^3] {Table 4.21}
n	=	Total effective porosity of vadose zone soil [cm^3/cm^3] {Table 4.21}
H'_{TS}	=	Dimensionless Henry's law constant of COC at average soil/groundwater temperature (noted in Table 4.18) [-] {Table 4.22}
ρ_b	=	Dry bulk density of vadose zone soil [g/cm^3] {Table 4.21}
K_{oc}	=	Organic carbon-water partition coefficient [cm^3/g] {Table 4.22}
f_{oc}	=	Fraction organic carbon of the soil [-] {Table 4.21}

The variables used in the above-detailed equations were obtained from the approved MGRA model (MOECC 2016a) and are summarized in Table 4.21. The estimated outdoor air concentrations in a trench are summarized in Table 4.22.

Table 4.21 Variables Used to Estimate Trench Air Concentrations from Soil

Variable	Description	Units	Value	Comment
W	Width of source area parallel to wind direction	cm	100	MOE (2011) default
A	Area of exposed soil in trench	cm^2	6.9×10^5	Based on default trench length of 1300 cm, assuming contaminated soil is exposed on all five sides of the trench
δ_a	Ambient air mixing zone height	cm	200	MOE (2011) default
U_a	Windspeed in a trench	cm/s	45	U.S. EPA (1999)
L_s	Thickness of contaminated soil	cm	200	MOE (2011) default
T_{gw}	Groundwater temperature	K	288.15	Default
n	Total effective porosity of vadose soil	cm^3/cm^3	0.36	Default for coarse soil (vadose)
θ_w	Water -filled porosity of vadose soil	cm^3/cm^3	0.119	Default for coarse soil (vadose)
θ_a	Air-filled porosity of vadose soil	cm^3/cm^3	0.241	$= n_i - \theta_{w,i}$
f_{oc}	Fraction organic carbon	-	0.005	Default
ρ	Dry bulk Density	g/cm^3	1.7	MOE (2011) default

Note: Default values as per the MGRA (MOECC 2016a), unless otherwise noted.

Table 4.22 Estimated Trench Air Concentrations from Soil

Parameter	REMC	REMC	Diffusivity in air	Diffusivity in Water	Organic Carbon-Water Partition Coefficient	Henry's Law Constant	Effective Diffusion Coefficient through Vadose Soil	Flux at Ground Surface	Soil to Trench Air Concentration
	mg/kg	µg/kg	cm^2/s	cm^2/s	cm^3/g	unitless	cm^2/s	$mg/cm^2/s$	mg/m^3
	C_s	C_s	D_a	D_w	K_{oc}	H'_{TS}	$D_{eff,s}$	J	C_a
Polycyclic Aromatic Hydrocarbons									
Acenaphthene	1.7	1,680	$4.2x10^{-2}$	$7.7x10^{-6}$	$1.2x10^{4}$	$3.0x10^{-3}$	$8.2x10^{-8}$	$8.2x10^{-14}$	$6.3x10^{-5}$
Acenaphthylene	2.6	2,640	$4.4x10^{-2}$	$7.5x10^{-6}$	$1.2x10^{4}$	$5.3x10^{-3}$	$1.5x10^{-7}$	$1.7x10^{-13}$	$1.3x10^{-4}$
Anthracene	10	10,440	$3.2x10^{-2}$	$7.7x10^{-6}$	$4.1x10^{4}$	$8.0x10^{-4}$	$5.2x10^{-9}$	$1.3x10^{-13}$	$9.9x10^{-5}$
Benz[a]anthracene	5,500	5.50	0.051	$9.0x10^{-6}$	$4.6x10^{5}$	$1.3x10^{4}$	$1.3x10^{-10}$	$1.3x10^{-14}$	$9.9x10^{-6}$
Naphthalene	5.64	5,640	$5.9x10^{-2}$	$7.5x10^{-6}$	$3.6x10^{3}$	$8.8x10^{-3}$	$1.1x10^{-6}$	$1.0x10^{-12}$	$7.8x10^{-4}$
Pyrene	8,000	8.00	0.027	$7.2x10^{-6}$	$1.4x10^{5}$	$1.5x10^{4}$	$2.7x10^{-10}$	$2.7x10^{-14}$	$2.7x10^{-5}$
Volatile Organic Compounds									
Trichloroethylene	456	0.46	$7.9x10^{-2}$	$9.1x10^{-6}$	$1.4x10^{2}$	$2.5x10^{-1}$	$1.0x10^{-3}$	$6.7x10^{-13}$	$5.1x10^{-4}$
BTEX									
Benzene	10	10,080	$8.8x10^{-2}$	$9.8x10^{-6}$	$3.3x10^{2}$	$1.5x10^{-1}$	$2.9x10^{-4}$	$1.9x10^{-11}$	$1.5x10^{-2}$
Toluene	30	30,000	$8.7x10^{-2}$	$8.6x10^{-6}$	$5.4x10^{2}$	$1.7x10^{-1}$	$2.0x10^{-4}$	$5.8x10^{-11}$	$4.4x10^{-2}$
Ethylbenzene	5.76	5,760	$7.5x10^{-2}$	$7.8x10^{-6}$	$1.0x10^{3}$	$1.8x10^{-1}$	$1.0x10^{-4}$	$9.5x10^{-12}$	$7.3x10^{-3}$
Xylene Mixture	52	51,600	$7.1x10^{-2}$	$9.3x10^{-6}$	$8.9x10^{2}$	$2.8x10^{-1}$	$1.7x10^{-4}$	$9.7x10^{-11}$	$7.5x10^{-2}$
PHC F1									
Aliphatic C_6-C_8	264	264,000	$5.0x10^{-2}$	$6.0x10^{-6}$	$8.0x10^{3}$	$5.2x10^{1}$	$2.2x10^{-3}$	$2.9x10^{-10}$	$2.2x10^{-1}$
Aliphatic $C_{>8}$-C_{10}	173	172,800	$5.0x10^{-2}$	$6.0x10^{-6}$	$6.3x10^{4}$	$8.3x10^{1}$	$5.0x10^{-4}$	$3.1x10^{-10}$	$2.4x10^{-1}$
Aromatic $C_{>8}$-C_{10}	43	43,200	$5.0x10^{-2}$	$6.0x10^{-6}$	$3.2x10^{3}$	$5.0x10^{-1}$	$6.1x10^{-5}$	$5.7x10^{-11}$	$4.4x10^{-2}$
PHC F2									
Aliphatic $C_{>10}$-C_{12}	734	734,400	$5.0x10^{-2}$	$6.0x10^{-6}$	$5.0x10^{5}$	$1.2x10^{2}$	$9.7x10^{-5}$	$1.2x10^{-9}$	$9.1x10^{-1}$
Aliphatic $C_{>12}$-C_{16}	898	897,600	$5.0x10^{-2}$	$6.0x10^{-6}$	$1.0x10^{7}$	$5.4x10^{2}$	$2.1x10^{-5}$	$7.1x10^{-10}$	$5.4x10^{-1}$
Aromatic $C_{>10}$-C_{12}	184	183,600	$5.0x10^{-2}$	$6.0x10^{-6}$	$5.0x10^{3}$	$1.4x10^{-1}$	$1.1x10^{-5}$	$1.1x10^{-10}$	$8.1x10^{-2}$
Aromatic $C_{>12}$-C_{16}	224	224,400	$5.0x10^{-2}$	$6.0x10^{-6}$	$1.0x10^{4}$	$5.5x10^{-2}$	$2.2x10^{-6}$	$5.6x10^{-11}$	$4.3x10^{-2}$

Note: The following COC are not included as they were determined to be not volatile based on Henry's Law constant less than $1x10^{-5}$ atm-m^3/mol or the vapour pressure less than 1 mm Hg: benzo[a]pyrene, anthracene, benzo[b]fluoranthene, benzo[ghi]perylene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluoranthene, and indeno[1,2,3-cd]pyrene.

4.2.5 Direct Contact with Soil

4.2.5.1 Soil Dermal Contact Pathway

Dermal exposure from soil for the residents, outdoor maintenance worker, and subsurface worker was calculated using the following equation:

$$I_{s,d} = \frac{C_S \times SA \times (SL \times CF) \times AF_{s,d} \times EF_S \times \frac{ET_d \times ET_{wk}}{365}}{BW} \times \frac{ED}{AT} \qquad (4\text{-}16)$$

Where:

$I_{s,d}$	=	Intake of COC through the soil dermal contact pathway [mg/kg/d]
C_s	=	Concentration of COC in soil [mg/kg] {Table 3.10}
SA	=	Exposed skin surface area for soil contact [cm^2] {Table 4.8}
SL	=	Soil loading to exposed skin [mg/cm^2/event] {Table 4.8}
CF	=	Conversion factor [10^{-6} kg/mg]
$AF_{s,d}$	=	Dermal absorption factor from soil [-] (MOECC 2016a)
EF_s	=	Exposure frequency to soil [events/d] {Table 4.8}
ET_d	=	Days per week exposed outdoors [d/wk] {Table 4.8}
ET_{wk}	=	Weeks per year exposed outdoors [wk/yr] {Table 4.8}
365	=	Total days in a year [d]
ED	=	Total exposure duration [y] {for carcinogenic COC only} {Table 4.8}
AT	=	Averaging time [y] {for carcinogenic COC only} {Table 4.8}
BW	=	Body weight [kg] {Table 4.8}

The value for the soil loading to exposed skin is based on the soil adherence value, which represents the amount of soil retained on the skin, and the skin surface area. Several studies have attempted to determine the soil adherence value and are summarized in the U.S. EPA (2011) Exposure Factors Handbook. Values used in this assessment are from the MECP (MOECC 2016a).

Doses of COCs from dermal contact with soil for residents and composite receptor (cancer) are presented in Table 4.26 and Table 4.27, respectively. Doses of COCs for the outdoor maintenance worker and subsurface worker are presented in Table 4.32 and Table 4.34, respectively.

4.2.5.2 Soil Ingestion Pathway

Ingestion of soil was calculated using the following equation:

$$I_{s,ing} = \frac{C_S \times IR_S \times AF_{s,o} \times \frac{ET_d \times ET_{wk}}{365}}{BW} \times \frac{ED}{AT} \qquad (4\text{-}17)$$

Where:

$I_{s,ing}$	=	Intake of COC through the soil ingestion pathway [mg/kg/d]
C_s	=	Concentration of COC in soil [mg/kg] {Table 3.10}
IR_s	=	Soil ingestion rate [kg/d] {Table 4.8}
$AF_{s,o}$	=	Oral absorption factor from soil [-] (MOECC 2016a)
ET_d	=	Days per week exposed outdoors [d/wk] {Table 4.8}
ET_{wk}	=	Weeks per year exposed outdoors [wk/yr] {Table 4.8}
365	=	Total days in a year [d]
ED	=	Total exposure duration [y] {for carcinogenic COC only} {Table 4.8}
AT	=	Averaging time [y] {for carcinogenic COC only} {Table 4.8}
BW	=	Body weight [kg] {Table 4.8}

Doses of COCs from ingestion of soil for residents and composite residential receptor (cancer) are presented in Table 4.26 and Table 4.27, respectively. Doses of COCs for the outdoor maintenance worker and subsurface worker are presented in Table 4.32 and Table 4.34, respectively.

4.2.6 Direct Contact with Groundwater

4.2.6.1 Groundwater Dermal Contact Pathway

Dermal exposure to COCs in groundwater is estimated from equation 4-18:

$$I_{gw,d} = \frac{DA_{gw,ev} \times SA \times EF_{gw} \times \frac{ET_d \times ET_{wk}}{365}}{BW} \times \frac{ED}{AT} \qquad (4\text{-}18)$$

Where:

$I_{gw,d}$	=	Intake of COC through the groundwater dermal contact pathway [mg/kg/d]
$DA_{gw,ev}$	=	Absorbed dose from groundwater dermal contact [mg/cm^2/event] {see below}
SA	=	Exposed skin surface area [cm^2] {Table 4.8}
EF_{gw}	=	Exposure frequency to groundwater [event/d] {Table 4.8}
ET_d	=	Days per week exposed outdoors [d/wk] {Table 4.8}
ET_{wk}	=	Weeks per year exposed outdoors [wk/yr] {Table 4.8}
365	=	Total days in a year [d]

ED	=	Total exposure duration [y] {for carcinogenic COC only} {Table 4.8}
AT	=	Averaging time [y] {for carcinogenic COC only} {Table 4.8}
BW	=	Body weight [kg] {Table 4.8}

Depending on the contact time and the time to reach steady state, equations 4-19 and 4-20 can be used to estimate the absorbed dose ($DA_{gw,ev}$):

If $t_{ev} \leq t^*$ $$DA_{gw,ev} = 2 \times AF_{gw,d} \times K_p \times \frac{C_{gw}}{CF}\sqrt{6\tau\frac{t_{ev}}{\pi}} \quad (4\text{-}19)$$

If $t_{ev} > t^*$ $$DA_{gw,ev} = AF_{gw,d} \times K_p \times \frac{C_{gw}}{CF}\left[\frac{t_{ev}}{1+B} + 2\tau\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right] \quad (4\text{-}20)$$

Where:

t_{ev}	=	Duration of groundwater contact event [hr/event] {Table 4.8}
t^*	=	Time to reach steady state [h] {equations 4-21 and 4-22 below }
$DA_{gw,ev}$	=	Absorbed dose from groundwater dermal contact [mg/cm^2/event]
$AF_{gw,d}$	=	Dermal absorption factor from groundwater [-] (MOECC 2016a)
K_p	=	Partition coefficient [cm/h] {equation 4-26 below}
C_{gw}	=	Concentration of COC in groundwater [µg/L]
CF	=	Conversion factor 10^6 [(mg/cm^3)/(µg/L)]
τ	=	Lag time [h] {equation 4-27 below}
B	=	Ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis {equation 4-25 below}

For highly lipophilic chemicals or for chemicals that have a long lag time, some of the chemical dissolved into skin may be lost due to desquamation during that absorption period. The fraction absorbed ($AF_{gw,d}$) term has been included to account for this loss of chemical due to desquamation. The default for this parameter is 1.

The calculation of the time to reach steady state (t^*) is calculated according to the following equation:

If B ≤ 0.6: $$t^* = 2.4\tau \quad (4\text{-}21)$$

If B > 0.6: $$t^* = 6\tau\left(b - \sqrt{b^2 - c^2}\right) \quad (4\text{-}22)$$

where $$b = 2\,\frac{(1+B)^2}{\pi - c} \quad (4\text{-}23)$$

and $$c = \frac{1+3B+3B^2}{3(1+B)} \quad (4\text{-}24)$$

The ratio of the permeability of the stratum corneum to that of the epidermis (B) can be approximated by:

$$B = K_p \frac{\sqrt{MW}}{2.6} \quad (4\text{-}25)$$

An empirical predictive correlation is provided to estimate the partition coefficient (K_p) for organics:

$$logK_p = -2.80 + 0.66logK_{ow} - 0.0056MW \quad (4\text{-}26)$$

Where:

K_p	=	Partition coefficient [cm/h]
$logK_{ow}$	=	Log of Octanol-water partition coefficient (MOECC 2016a)
MW	=	Molecular weight [g/mol] (MOECC 2016a)

Assuming the thickness of the stratum corneum is 0.001 cm the following equation can be used to determine the lag time (τ):

$$\tau = 0.105 \times 10^{0.0056MW} \quad (4\text{-}27)$$

Doses of PHC F2 from dermal contact with groundwater for the subsurface worker are presented in Table 4.35.

4.2.6.2 Groundwater Ingestion Pathway

Ingestion of groundwater by human receptors was calculated using equation 4-28:

$$I_{gw,ing} = \frac{C_{gw} \times IR_{gw} \times AF_{gw,o} \times \frac{ET_d \times ET_{wk}}{365}}{BW \times CF} \times \frac{ED}{AT} \quad (4\text{-}28)$$

Where:

$I_{gw,d}$	=	Intake of COC through the groundwater ingestion pathway [mg/kg/d]
C_{gw}	=	Concentration of COC in groundwater [µg/L]
IR_{gw}	=	Groundwater ingestion rate [L/d] {Table 4.8}
$AF_{gw,o}$	=	Oral absorption factor from groundwater [-] (MOECC 2016a)
ET_d	=	Days per week exposed outdoors [d/wk] {Table 4.8}
ET_{wk}	=	Weeks per year exposed outdoors [wk/yr] {Table 4.8}
365	=	Total days in a year [d]
ED	=	Total exposure duration [y] {for carcinogenic COC only} {Table 4.8}

AT = Averaging time [y] {for carcinogenic COC only} {Table 4.8}

BW = Body weight [kg] {Table 4.8}

CF = Conversion factor 1.0×10^{-3} [mg/µg]

Doses of COCs from ingestion of groundwater for the subsurface worker are presented in Table 4.35.

4.3 Toxicity Assessment

The potential adverse effects of the identified COCs are investigated in the toxicity assessment phase of the RA, which involves collection of quantitative toxicity information and draws on information from sources that are well documented and reviewed and are generally acceptable to regulatory agencies. Toxicity refers to the ability of a chemical to cause temporary or permanent adverse effects in the body and depends on several factors such as the form of the chemical, the amount of exposure, and the duration of the exposure.

A contaminant can be classified as either carcinogenic or non-carcinogenic depending on its mode of action. For non-carcinogens, there is a permissible (safe) level or threshold dose below which adverse health effects are not expected to occur. These permissible levels are set by regulatory agencies such as Health Canada and the U.S. EPA based on scientific studies from laboratory animal tests or on human epidemiological studies or workplace exposure investigations. Carcinogens have no such “safe level” and any level of exposure theoretically presents an increased risk of developing cancer over a receptor’s lifetime.

Scientific studies are reviewed by a number of experienced scientists in a wide range of scientific disciplines in order to determine the maximum dose that a human can be exposed to without having an adverse health effect. This dose is the TRV.

For non-carcinogenic effects, the TRV is typically referred to as a Reference Dose (RfD, in units of mg/kg/d) for oral or dermal exposure or as a Reference Concentration (RfC, in units of mg/m^3) for inhalation exposure. In general, this benchmark is an estimate of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime (U.S. EPA 2002). These values are generally extrapolated from data from animal or human occupational studies.

For carcinogenic effects, the TRV is referred to as a Slope Factor (SF, in units of $(mg/kg/d)^{-1}$) for oral or dermal exposure or as a Unit Risk (UR, in units of $(mg/m^3)^{-1}$) for inhalation exposure. They represent a plausible upper bound estimate of the probability of a carcinogenic response per unit intake of a contaminant over a lifetime. It is used to evaluate the probability of a cancer developing due to a lifetime of exposure. For carcinogens, no threshold is assumed to exist (i.e., every dose presents some risk).

The specific TRVs used in this assessment were obtained from the MGRA (MOECC 2016a) and the updated recommendations from the Ministry (MECP 2019a). The selected TRVs are summarized in Table 4.24 for non-carcinogenic effects and in Table 4.25 for carcinogenic effects. No TRVs are available for dermal exposure; TRVs for oral exposure are used as surrogates.

4.3.1 Nature of Toxicity (Hazard Assessment)

The carcinogenic potential of each COC is consistent with MECP recommendations (MOECC 2016b; MECP 2019a). The results are provided in Table 4.23. The potential adverse health effects of each of the COC are examined further in the following section.

Table 4.23 Carcinogenicity of COCs

Parameter	Carcinogenic for oral exposure?	Carcinogenic for inhalation exposure?
Metals		
Antimony	No	No
Arsenic	Yes	Yes
Cadmium	No	Yes
Cobalt	No	No
Copper	No	No
Lead	No	No
Polycyclic Aromatic Hydrocarbons		
Acenaphthylene	Yes	Yes
Benz[a]anthracene	Yes	Yes
Benzo[a]pyrene	Yes	Yes
Benzo[b]fluoranthene	Yes	Yes
Benzo[k]fluoranthene	Yes	Yes
Dibenz[a,h]anthracene	Yes	Yes
Indeno[1,2,3-cd]pyrene	Yes	Yes
Methylnaphthalene, 2-(1-)	No	No
Naphthalene	No	No
Volatile Organic Compounds		
Trichloroethylene	Yes	Yes
Vinyl Chloride	Yes	Yes
BTEX		
Benzene	Yes	Yes
Toluene	No	No
Ethylbenzene	No	No
Xylene Mixture	No	No
Petroleum Hydrocarbons		
PHC F1	No	No
PHC F2	No	No
PHC F3	No	No
PHC F4	No	No

4.3.2 Dose Response Assessment

TRVs were selected for all the COCs to assess their non-carcinogenic risks and carcinogenic risks of oral and inhalation exposures. Credible TRVs were obtained from reputable agencies (MOE 2011; TPHCWG 1997; ATSDR 2004; U.S. EPA 2019)

A check for updated TRVs was conducted for all COC identified for the Site (as shown in Table 3.4 and Table 3.5). The updated values were used in the MGRA model to develop the components for the secondary screening shown in Table 4.6 and Table 4.7. TRVs that were modified are discussed in this section. The values for barium, beryllium, molybdenum, nickel, selenium, uranium, and zinc were confirmed to be unchanged from the values provided in the MGRA model and are not discussed further in this section. For PAHs, the non-carcinogenic endpoints for acenaphthene, anthracene, benzo[ghi]perylene, chrysene, fluoranthene, fluorene, phenanthrene, and pyrene are unchanged from the MGRA. The carcinogenic endpoint for the PAHs was considered through the TEF as shown in Table 4.12.

4.3.2.1 Non-Carcinogenic Risks

Table 4.24 summarizes the RfDs and RfCs of all the COCs used in the human health risk assessment for oral and inhalation exposures, respectively.

Table 4.24 Toxicological Reference Values for Non-carcinogenic Effects

Parameter	RfD (mg/kg/d)	Endpoint	Source (Cited in)	RfC (mg/m^3)	Endpoint	Source (Cited in)
Metals						
Antimony	0.0004	Longevity, blood glucose, and cholesterol	U.S. EPA IRIS, 1991 (MOE 2011)	0.0002	Antimony trioxide; Pulmonary toxicity, chronic interstitialin-flammation	U.S. EPA IRIS, 1995 (MOE 2011)
Arsenic	0.0003	Hyperpigmentation, keratosis and possible vascular complications	U.S. EPA IRIS 1991, ATSDR 2007 (MECP 2019a)	3.00×10^{-5}	Development; cardiovascular system; nervous system; respiratory system; skin	CalEPA ChREL 2000 (MOE 2011)
Cadmium	3.20×10^{-5}	Kidney toxicity	modified from CalEPA DW 2006 (MOE 2011)	3.00×10^{-5}	Health	modified from MOE 24 hour AAQC 2007 (MOE 2011)
Cobalt	0.001	Hematological toxicity	modified from ATSDR 2004 (MOE 2011)	0.0005	Asthma and sensitisation in humans	RIVM 2001 (MOE 2011)
Copper	0.01	Gastrological	ATSDR 2004 (MECP 2019a)	0.001	Respiratory and immunological effects	RIVM 2001 (MECP 2019a)
Lead	-	-	none selected	-	-	none selected
Polycyclic Aromatic Hydrocarbons						
Acenaphthylene	0.06	Hepatotoxicity	U.S. EPA IRIS 1994 (proxy) (MOE 2011)	-		none selected
Benz[a]anthracene	-	-	none selected	-	-	none selected
Benzo[a]pyrene	0.0003	Neurodevelopment	U.S. EPA IRIS 2017 (MECP 2019a)	2.00×10^{-6}	Development – Embryonic Survival	U.S. EPA IRIS 2017 (MECP 2019a)
Benzo[b]fluoranthene	-	-	none selected	-	-	none selected
Benzo[k]fluoranthene	-	-	none selected	-	-	none selected
Dibenz[a,h]anthracene	-	-	none selected	-	-	none selected

Parameter	RfD (mg/kg/d)	Endpoint	Source (Cited in)	RfC (mg/m^3)	Endpoint	Source (Cited in)
Indeno[1,2,3-cd]pyrene	-	-	none selected	-	-	none selected
Methylnaphthalene, 2-(1-)	0.004	Pulmonary alveolar proteinosis	U.S. EPA IRIS 2003 (MOE 2011)	-	-	none selected
Naphthalene	0.02	Decreased mean terminal body weight in males	U.S. EPA IRIS 1998 (MOE 2011)	0.0037	Respiratory	ATSDR 2005 (MOE 2011)
Volatile Organic Compounds						
Trichloroethylene	0.0005	Developmental effects	(MOECC 2016a)	0.002	Developmental effects	(MOECC 2016a)
Vinyl Chloride	0.003	Hepatic toxicity	ATSDR 2006; IRIS 2000 (MOE 2011)	0.1	Liver cell polymorphism	U.S. EPA IRIS 2000 (MOE 2011)
BTEX						
Benzene	0.004	Immune system - Decreased lymphocyte count	U.S. EPA IRIS 2003 (MOE 2011)	0.03	Immune system - Decreased lymphocyte count	U.S. EPA IRIS 2003 (MOE 2011)
Toluene	0.08	Increased kidney weight	U.S. EPA IRIS 2005 (MOE 2011)	5	Neurological effects in occupationally-exposed workers	U.S. EPA IRIS 2005 (MOE 2011)
Ethylbenzene	0.1	Liver and kidney toxicity	U.S. EPA IRIS 1991; RIVM 2001; WHO DW 2003; HC CSD 2010 (MECP 2019a)	1.9	Renal toxicity in rats	TCEQ 2010 (MECP 2019a)
Xylene Mixture	0.2	Decreased body weight, increased mortality	U.S. EPA IRIS 2003; ATSDR 2007 (MOE 2011)	0.7	Impaired motor coordination (decreased rotarod performance)	CalEPA chREL 2005 (MOE 2011)
Petroleum Hydrocarbons						
PHC F1						
Aliphatic C_6-C_8	5	Neurotoxicity	TPHCWG 1997; CCME 2000 (MOE 2011)	18~~.4~~	Neurotoxicity	TPHCWG 1997; CCME 2000 (MOE 2011)
Aliphatic $C_{>8}$-C_{10}	0.1	Hepatic and haematological changes	TPHCWG 1997; CCME 2000 (MOE 2011)	1	Hepatic and haematological changes	TPHCWG 1997; CCME 2000 (MOE 2011)
Aromatic $C_{>8}$-C_{10}	0.04	Decreased body weight	TPHCWG 1997; CCME 2000 (MOE 2011)	0.2	Decreased body weight	TPHCWG 1997; CCME 2000 (MOE 2011)
PHC F2						
Aliphatic $C_{>10}$-C_{12}	0.1	Hepatic and haematological changes	TPHCWG 1997; CCME	1	Hepatic and haematological changes	TPHCWG 1997; CCME 2000 (MOE 2011)

Parameter	RfD (mg/kg/d)	Endpoint	Source (Cited in)	RfC (mg/m^3)	Endpoint	Source (Cited in)
			2000 (MOE 2011)			
Aliphatic $C_{>12}$-C_{16}	0.1	Hepatic and haematological changes	TPHCWG 1997; CCME 2000 (MOE 2011)	1	Hepatic and haematological changes	TPHCWG 1997; CCME 2000 (MOE 2011)
Aromatic $C_{>10}$-C_{12}	0.04	Decreased body weight	TPHCWG 1997; CCME 2000 (MOE 2011)	0.2	Decreased body weight	TPHCWG 1997; CCME 2000 (MOE 2011)
Aromatic $C_{>12}$-C_{16}	0.04	Decreased body weight	TPHCWG 1997; CCME 2000 (MOE 2011)	0.2	Decreased body weight	TPHCWG 1997; CCME 2000 (MOE 2011)
PHC F3						
Aliphatic $C_{>16}$-C_{21}	2	Hepatic granuloma	TPHCWG 1997; CCME 2000 (MOE 2011)	-	-	none selected
Aliphatic $C_{>21}$-C_{34}	2	Hepatic granuloma	TPHCWG 1997; CCME 2000 (MOE 2011)	-	-	none selected
Aromatic $C_{>16}$-C_{21}	0.03	Nephrotoxicity	TPHCWG 1997; CCME 2000 (MOE 2011)	-	-	none selected
Aromatic $C_{>21}$-C_{34}	0.03	Nephrotoxicity	TPHCWG 1997; CCME 2000 (MOE 2011)	-	-	none selected
PHC F4						
Aliphatic $C_{>34}$	20	Hepatic granuloma	TPHCWG 1997; CCME 2000 (MOE 2011)	-	-	none selected
Aromatic $C_{>34}$	0.03	Nephrotoxicity	TPHCWG 1997; CCME 2000 (MOE 2011)	-	-	none selected

Note: Values obtained from the Approved Modified Generic Risk Assessment model (MOECC 2016a), unless otherwise noted.
Shade indicates developmental toxicant

Although MECP withdrew the TRV for non-carcinogenic endpoint for arsenic, the previously accepted value was retained as a conservative approach in the assessment.

As discussed in Section 4.2.3, COC that are developmental toxicants are assessed without time adjustments to the exposure, and represent a pregnant female. Although the critical effect for benzo[a]pyrene is neurodevelopmental, it occurs during the post-natal period and is not expected to occur during a short critical window and is thus not evaluated as a developmental toxicant. Developmental toxicantss for the inhalation pathway includes trichloroethylene and arsenic; however, arsenic is not being quantitatively evaluated via this pathway. Trichloroethylene is also a developmental toxicant for the ingestion pathway. Therefore, a pregnant adult female will be assessed without time adjustments to exposure.

4.3.2.2 Carcinogenic Risks

Table 4.25 summarizes the carcinogenic TRVs of all the COCs used in the human health risk assessment for oral and inhalation exposures.

Table 4.25 Toxicological Reference Values for Carcinogenic Effects

Parameter	Oral Slope Factor (mg/kg-day)$^{-1}$	Endpoint	Source (Cited in)	Inhalation Unit Risk (mg/m^3)$^{-1}$	Endpoint	Source (Cited in)
Metals						
Arsenic	1.8	Carcinogenic: bladder, lung, liver	HC DW 2006; HC CSD 2010 (MOE 2011)	0.15	Lung cancer	TCEQ 2012 (MECP 2019a)
Cadmium	-	-	none selected	9.8	Carcinogenic: lung	Health Canada 1996 (MOE 2011)
Polycyclic Aromatic Hydrocarbons						
Acenaphthylene	0.01	Same as benzo(a)pyrene	U.S. EPA IRIS 2017; Kalberlah et al. 1995 (TEF=0.01); (MECP 2019a)	0.006	Same as benzo(a)pyrene	U.S. EPA IRIS 2017; Kalberlah et al. 1995 (TEF=0.01); (MECP 2019a)
Benz[a]anthracene	0.1	Same as benzo(a)pyrene	U.S. EPA IRIS 2017; Kalberlah et al. 1995 (TEF=0.1); (MECP 2019a)	0.06	Same as benzo(a)pyrene	U.S. EPA IRIS 2017; Kalberlah et al. 1995 (TEF=0.1); (MECP 2019a)
Benzo[a]pyrene*	1	Model derived, tumor appearance and other sources of mortality	U.S. EPA IRIS 2017; Kalberlah et al., 1995 (TEF=1); (MECP 2019a)	0.6	Model derived, tumor appearance and other sources of mortality	U.S. EPA IRIS 2017; Kalberlah et al., 1995 (TEF=1); (MECP 2019a)
Benzo[b]fluoranthene	0.1	Same as benzo(a)pyrene	U.S. EPA IRIS 2017; Kalberlah et al. 1995 (TEF=0.1);	0.06	Same as benzo(a)pyrene	U.S. EPA IRIS 2017; Kalberlah et al. 1995 (TEF=0.1);

Parameter	Oral Slope Factor (mg/kg-day)$^{-1}$	Endpoint	Source (Cited in)	Inhalation Unit Risk (mg/m^3)$^{-1}$	Endpoint	Source (Cited in)
			(MECP 2019a)			(MECP 2019a)
Benzo[k]fluoranthene	0.1	Same as benzo(a)pyrene	U.S. EPA IRIS 2017; Kalberlah et al. 1995 (TEF=0.1); (MECP 2019a)	0.06	Same as benzo(a)pyrene	U.S. EPA IRIS 2017; Kalberlah et al. 1995 (TEF=0.1); (MECP 2019a)
Dibenz[a,h]anthracene	1	Same as benzo(a)pyrene	U.S. EPA IRIS 2017; Kalberlah et al., 1995 (TEF=1); (MECP 2019a)	0.6	Same as benzo(a)pyrene	U.S. EPA IRIS 2017; Kalberlah et al., 1995 (TEF=1); (MECP 2019a)
Indeno[1,2,3-cd]pyrene	0.1	Same as benzo(a)pyrene	U.S. EPA IRIS 2017; Kalberlah et al. 1995 (TEF=0.1) (MECP 2019a)	0.06	Same as benzo(a)pyrene	U.S. EPA IRIS 2017; Kalberlah et al. 1995 (TEF=0.1) (MECP 2019a)
Volatile Organic Compounds						
Trichloroethylene	0.046	Renal cell carcinoma, non-Hodgkin's lymphoma, and liver tumors	U.S. EPA IRIS 2011 (MOECC 2016a)	0.0041	Renal cell carcinoma, non-Hodgkin's lymphoma, and liver tumors	U.S. EPA IRIS 2011 (MOECC 2016a)
Vinyl Chloride	1.4	Liver angiosarcomas, angiomas, hepatomas, and neoplastic nodules	U.S. EPA IRIS 2000 (MOE 2011)	0.0088	Liver angiosarcomas, angiomas, hepatomas, and neoplastic nodules	U.S. EPA IRIS 2000 (MOE 2011)
BTEX						
Benzene	0.085	Leukemia	HC DW (Sept. 2007 draft) (MOE 2011)	0.0022	Leukemia	U.S. EPA IRIS 2000 (MOE 2011)

Note: Values obtained from the Approved Modified Generic Risk Assessment model (MOECC 2016a).

* In addition to the PAHs identified as COC all carcinogenic PAHs were included in the calculation of the total cancer risk including acenaphthene (TEF=0.001), anthracene (TEF=0.01), benzo[ghi]perylene (TEF=0.01), chrysene (TEF=0.01, fluoranthene (TEF=0.01) and pyrene (TEF=0.001)

4.3.2.3 Uncertainties in Toxicity Values

There is uncertainty in the TRVs, the values are generally extrapolated from data from animal or human occupational studies. The TRVs used in the assessment were derived by regulatory agencies and are meant to be protective of sensitive sub-populations. Although they are associated with uncertainty, it is expected that these values will provide an over-estimate of the actual risk to most receptors at the site.

The MECP does not have a recommended TRV for lead, thus a qualitative assessment has been undertaken for this COC. There is also a lack of toxicity data for inhalation of 2-(1-)methylnaphthalene.

4.4 Risk Characterization

Risk characterization involves the integration of the information from the exposure assessment and the toxicity assessment. For this Site, both non-carcinogens and carcinogens were present.

4.4.1 Interpretation of Health Risks

For each COC, having regard to the exposure assessment and the toxicity assessment, the non-carcinogenic and carcinogenic risks of exposure to the contaminant were assessed for all the human receptors on the RA property, using either a quantitative or qualitative analysis. Human receptors involved in this assessment include residents, indoor workers, outdoor maintenance workers, and subsurface workers.

4.4.1.1 Non-carcinogenic Effects

Chronic RfDs and RfCs with incorporated uncertainty factors were used in this assessment to account for differences between individuals and using animal-based data. For each COC, a Hazard Quotient (HQ) was calculated to assess the non-carcinogenic risk from estimated exposures using the following equation:

$$HQ = \frac{Dose}{TRV} \tag{4-29}$$

Where:

HQ	=	Hazard Quotient [-]
Dose	=	Estimated average daily intake [mg/m^3 or mg/kg/d]
TRV	=	Toxicity Reference Value – either a Reference Dose [mg/kg/d] or Reference Concentration [mg/m^3] of the COC

The calculated HQs were then compared with an acceptable value of 0.2 (0.5 for PHCs and TCE). If the HQ of a COC is less than or equal to the acceptable value, it is unlikely to pose a non-carcinogen risk to the exposed human receptors, while a further examination of the exposure pathways is needed if it exceeds.

4.4.1.2 Carcinogenic Effects

SFs and URs with incorporated uncertainty factors were used in this assessment to account for differences between individuals and using animal-based data. For each COC, an Incremental Lifetime Cancer Risk (ILCR) was calculated to assess the carcinogenic risk from estimated exposures using the following equation:

$$ILCR = Dose \times TRV \qquad (4\text{-}30)$$

Where:

ILCR = Incremental Lifetime Cancer Risk [-]

Dose = Estimated average daily intake [mg/m^3 or mg/kg/d]

TRV = Toxicity Reference Value – either a Slope Factor, SF, in [$(mg/kg/d)^{-1}$] or Unit Risk, UR, [$(mg/m^3)^{-1}$] of the COC

The calculated ILCRs were then compared with an acceptable value of $1x10^{-6}$. If the ILCR of a COC is less than or equal to $1x10^{-6}$, it is unlikely to pose a carcinogen risk to the exposed human receptors, while a further examination of the exposure pathways is needed if it exceeds.

4.4.2 Quantitative Interpretation of Health Risks

A quantitative evaluation of potential risks was undertaken for the residents (infant, toddler, child, teen and adult), indoor worker, outdoor maintenance worker and subsurface worker for direct contact with soil and inhalation of volatile vapours from soil and groundwater, and for the direct contact with groundwater and inhalation of volatile vapours in a trench from soil and groundwater. The REMCs, as discussed in Section 3.3.2.4, were used in the evaluation.

As previously noted, non-carcinogenic HQ and carcinogenic risk values were calculated by comparing the estimated intake for a pathway of exposure to an appropriate TRV for non-carcinogenic or carcinogenic effects, and comparing to an acceptable HQ value of 0.2 and risk level of $1x10^{-6}$. The exception to this is PHCs and TCE can be compared to an HQ of 0.5 and copper can be compared to an HQ of 0.8. The HQ values and risk levels from oral and dermal exposures are summed since the same oral TRVs are applied to both pathways. It is noted that since PSS are based on both a qualitative and quantitative approach these values are presented in Section 4.4.7.

4.4.2.1 Resident

Future residential receptors on Site include infants, toddlers, children, teens, and adults. Pathways being examined in this section include direct contact with soils, as well as inhalation of indoor air vapours (migrating from soil and groundwater).

Direct Contact with Soil

Using the methodology presented in Section 4.2.4.1, 4.2.5.1 and 4.2.5.2, the estimated doses and risks to residents of all ages (i.e., infant, toddler, child, teen and adult) from direct contact with COCs in soil is presented in Table 4.26 and Table 4.27. From Table 4.26, the HQ values and risk levels for select metals, PAHs, and PHCs are above the acceptable levels. Table 4.27 provides the carcinogenic risk results for a composite receptor (i.e. includes consideration of exposure throughout a lifetime of exposure at different lifestages). From Table 4.27, the ILCR for arsenic, total carcinogenic PAHs (with exceedances of individual PAHs for benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, indeno[1,2,3-cd]pyrene), and benzene are above the acceptable level. Therefore, soil cover will be required as a RMM to prevent resident direct contact exposure to Site soil for all lifestages for both carcinogenic and non-carcinogenic endpoints.

Table 4.26 Doses and Hazard Quotients for Residents from Direct Contact with COCs in Soil

Parameter	Infant			Toddler			Child			Teen			Adult		
	Soil - Ingestion	Soil - Dermal Contact	HQ	Soil - Ingestion	Soil - Dermal Contact	HQ	Soil - Ingestion	Soil - Dermal Contact	HQ	Soil - Ingestion	Soil - Dermal Contact	HQ	Soil - Ingestion	Soil - Dermal Contact	HQ
	mg/kg-day	mg/kg-day	-	mg/kg-day	mg/kg-day	-	mg/kg-day	mg/kg-day	-	mg/kg-day	mg/kg-day	-	mg/kg-day	mg/kg-day	-
Metals															
Antimony	2.9×10^{-4}	7.5×10^{-5}	0.91	9.6×10^{-4}	1.7×10^{-4}	**2.82**	1.2×10^{-4}	1.4×10^{-4}	**0.64**	6.6×10^{-5}	3.6×10^{-5}	**0.26**	5.6×10^{-5}	3.4×10^{-5}	**0.23**
Arsenic	1.8×10^{-4}	2.8×10^{-5}	0.70	6.0×10^{-4}	6.3×10^{-5}	**2.21**	7.5×10^{-5}	5.1×10^{-5}	**0.42**	4.1×10^{-5}	1.3×10^{-5}	0.18	3.5×10^{-5}	1.3×10^{-5}	0.16
Cadmium	5.9×10^{-6}	1.5×10^{-7}	0.19	2.0×10^{-5}	3.4×10^{-7}	**0.62**	2.5×10^{-6}	2.8×10^{-7}	0.09	1.4×10^{-6}	7.3×10^{-8}	0.04	1.1×10^{-6}	7.0×10^{-8}	0.04
Cobalt	1.6×10^{-4}	4.1×10^{-6}	0.16	5.2×10^{-4}	9.1×10^{-6}	**0.53**	6.6×10^{-5}	7.4×10^{-6}	0.07	3.6×10^{-5}	2.0×10^{-6}	0.04	3.1×10^{-5}	1.9×10^{-6}	0.03
Copper	9.2×10^{-4}	1.4×10^{-4}	0.11	3.1×10^{-3}	3.2×10^{-4}	0.34	3.8×10^{-4}	2.6×10^{-4}	0.06	2.1×10^{-4}	6.8×10^{-5}	0.03	1.8×10^{-4}	6.5×10^{-5}	0.02
Polycyclic Aromatic Hydrocarbons															
Benz[a]anthracene	1.8×10^{-5}	6.1×10^{-6}	No TRV	6.0×10^{-5}	1.4×10^{-5}	No TRV	7.5×10^{-6}	1.1×10^{-5}	No TRV	4.1×10^{-6}	2.9×10^{-6}	No TRV	3.5×10^{-6}	2.8×10^{-6}	No TRV
Benzo[a]pyrene	2.8×10^{-5}	9.5×10^{-6}	0.13	9.4×10^{-5}	2.1×10^{-5}	**0.38**	1.2×10^{-5}	1.7×10^{-5}	0.10	6.5×10^{-6}	4.6×10^{-6}	0.04	5.5×10^{-6}	4.3×10^{-6}	0.03
Benzo[b]fluoranthene	4.6×10^{-5}	1.5×10^{-5}	No TRV	1.5×10^{-4}	3.5×10^{-5}	No TRV	1.9×10^{-5}	2.8×10^{-5}	No TRV	1.1×10^{-5}	7.4×10^{-6}	No TRV	8.9×10^{-6}	7.0×10^{-6}	No TRV
Benzo[k]fluoranthene	1.7×10^{-5}	5.6×10^{-6}	No TRV	5.6×10^{-5}	1.3×10^{-5}	No TRV	7.0×10^{-6}	1.0×10^{-5}	No TRV	3.8×10^{-6}	2.7×10^{-6}	No TRV	3.2×10^{-6}	2.6×10^{-6}	No TRV
Dibenz[a,h]anthracene	6.6×10^{-6}	2.2×10^{-6}	No TRV	2.2×10^{-5}	4.9×10^{-6}	No TRV	2.7×10^{-6}	4.0×10^{-6}	No TRV	1.5×10^{-6}	1.1×10^{-6}	No TRV	1.3×10^{-6}	1.0×10^{-6}	No TRV
Indeno[1,2,3-cd]pyrene	2.7×10^{-5}	9.2×10^{-6}	No TRV	9.1×10^{-5}	2.1×10^{-5}	No TRV	1.1×10^{-5}	1.7×10^{-5}	No TRV	6.3×10^{-6}	4.4×10^{-6}	No TRV	5.3×10^{-6}	4.2×10^{-6}	No TRV
BTEX															
Benzene	2.8×10^{-5}	2.1×10^{-6}	0.01	9.2×10^{-5}	4.8×10^{-6}	0.02	1.1×10^{-5}	3.9×10^{-6}	0.0038	6.3×10^{-6}	1.0×10^{-6}	0.0018	5.3×10^{-6}	9.8×10^{-7}	0.0016
Petroleum Hydrocarbons															
PHC F3															
Aliphatic $C_{>16}$-C_{21}	0.070	0.036	0.05	0.232	0.081	0.16	0.029	0.066	0.05	0.016	0.017	0.02	0.014	0.016	0.02
Aliphatic $C_{>21}$-C_{34}	0.030	0.015	0.02	0.099	0.035	0.07	0.012	0.028	0.02	0.007	0.007	0.01	0.006	0.007	0.01
Aromatic $C_{>16}$-C_{21}	0.018	0.009	**0.89**	0.058	0.020	**2.61**	0.007	0.016	**0.79**	0.004	0.004	0.28	0.003	0.004	0.25
Aromatic $C_{>21}$-C_{34}	0.008	0.004	0.38	0.025	0.009	**1.12**	0.003	0.007	0.34	0.002	0.002	0.12	0.001	0.002	0.11
Total PHC F3	0.13	0.064	**1.34**	0.41	0.145	**3.96**	0.051	0.12	**1.2**	0.029	0.03	0.43	0.024	0.029	0.39
PHC F4															
Aliphatic $C_{>34}$	0.058	0.030	0.0044	0.19	0.067	0.013	0.024	0.054	0.0039	0.013	0.014	0.0014	0.011	0.014	0.0012
Aromatic $C_{>34}$	0.014	0.007	**0.73**	0.048	0.017	**2.16**	0.006	0.014	**0.65**	0.003	0.004	0.23	0.003	0.003	0.21
Total PHC F4	0.072	0.037	**0.73**	0.24	0.084	**2.17**	0.03	0.068	**0.65**	0.016	0.018	0.23	0.014	0.017	0.21

Note: **bold** shading indicates an HQ > 0.2 for all COC except PHC (which uses 0.5) and copper (which uses 0.8).

Table 4.27 Doses and Risk Levels for a Composite Resident Receptor from Direct Contact with COCs in Soil

Parameter	Soil - Ingestion	Soil - Dermal Contact	Cancer Risk - ILCR
	mg/kg-day	mg/kg-day	-
Metals			
Arsenic	$7.4x10^{-5}$	$1.9x10^{-5}$	**$1.7x10^{-4}$**
Polycyclic Aromatic Hydrocarbons			
Acenaphthene	$1.6x10^{-6}$	$8.9x10^{-7}$	$2.5x10^{-9}$
Acenaphthylene	$2.5x10^{-6}$	$1.4x10^{-6}$	$3.9x10^{-8}$
Anthracene	$9.7x10^{-6}$	$5.5x10^{-6}$	$1.5x10^{-7}$
Benz[a]anthracene	$7.4x10^{-6}$	$4.2x10^{-6}$	**$1.2x10^{-6}$**
Benzo[a]pyrene	$1.2x10^{-5}$	$6.6x10^{-6}$	**$1.8x10^{-5}$**
Benzo[b]fluoranthene	$1.9x10^{-5}$	$1.1x10^{-5}$	**$2.9x10^{-6}$**
Benzo[ghi]perylene	$9.4x10^{-6}$	$5.4x10^{-6}$	$1.5x10^{-7}$
Benzo[k]fluoranthene	$6.8x10^{-6}$	$3.9x10^{-6}$	**$1.1x10^{-6}$**
Chrysene	$6.2x10^{-6}$	$3.5x10^{-6}$	$9.7x10^{-8}$
Dibenz[a,h]anthracene	$2.7x10^{-6}$	$1.5x10^{-6}$	**$4.2x10^{-6}$**
Fluoranthene	$1.3x10^{-5}$	$7.7x10^{-6}$	$2.1x10^{-7}$
Indeno[1,2,3-cd]pyrene	$1.1x10^{-5}$	$6.4x10^{-6}$	**$1.7x10^{-6}$**
Pyrene	$8.9x10^{-6}$	$5.1x10^{-6}$	$1.4x10^{-8}$
Total Carcinogenic PAHs	$1.9x10^{-5}$	$1.1x10^{-5}$	**$3.0x10^{-5}$**
BTEX			
Benzene	$1.1x10^{-5}$	$1.5x10^{-6}$	**$1.1x10^{-6}$**

Note: **bold** shading indicates an ILCR > $1x10^{-6}$

Direct Contact with Groundwater

With the shallow depth to groundwater it is possible that residents will occasionally have direct contact with groundwater. It is not expected that this would be a regular occurrence, only when more intensive activities would occur. Therefore, the assessment that is conducted for the sub-surface worker will be used as a surrogate for this pathway.

Inhalation of Indoor Air from Vapours Migrating from Soil

The risk and hazard calculations for each COC identified for the resident exposure to indoor air from soil through inhalation are presented in Table 4.28. Indoor air concentrations were compared to the MGRA-derived Health-Based Indoor Air Quality Criteria (HBIAC) for a residential building with a basement in a non-potable groundwater scenario. The HBIACs are the lowest risk levels of non-carcinogenic and carcinogenic risks, and therefore are protective of both pathways.

All COCs migrating from soil to indoor air exceeded the HBIACs (Table 4.28). To mitigate this exposure pathway an RMM will be required. As per the MGRA model (MOECC 2016b), an indoor air concentration that is 200 times the HBIAC component will require an active Soil Vapour Intrusion Mitigation System (SVIMS) as an RMM. Since concentrations of benzene and trichloroethylene are above 200 times the HBIAC, a robust SVIMS will be required that includes a vapour barrier or sealing of floors, joints, etc. to ensure minimal migration of COCs into indoor air. Based on studies of vapour intrusion it is expected that an active system can provide significantly more than 200 fold reduction (Folkes 2003; Folkes and Kurz 2002) and thus it is expected that this RMM will provide an adequate level of protection. Additionally, indoor air monitoring will be conducted to ensure levels of COCs remain below the HBIACs.

From the Phase Two ESA it is seen that many of the VOC impacts are on the western portion of the site. Therefore in the eastern portion of the site, an alternative RMM is available that all buildings would have below or at grade parking/storage garage. Discussion of the RMMs are described in detail in Section 7.1.1.2.

Table 4.28 Comparison of Estimated Indoor Air Concentrations from Volatile COCs Migrating from Soil to Residential HBIACs

Parameter	Indoor air concentration – no RMM	Indoor Air Concentration[a] – with RMM	Residential HBIAC
	$C_{building}$	SVIMS/Garage	HBIAC
	mg/m^3	mg/m^3	mg/m^3
Polycyclic Aromatic Hydrocarbons			
Acenaphthylene	**0.0015**	7.3 x10^{-6}	0.00019
Naphthalene	**0.019**	0.00009	0.00077
Volatile Organic Compounds			
Trichloroethylene	**0.97**	**0.0048**	0.00027
BTEX			
Benzene	**5.99**	**0.03**	0.00051
Toluene	**12.6**	0.06	1.04
Ethylbenzene	**1.41**	0.007	0.40
Xylene Mixture	**21.3**	0.11	0.15
Petroleum Hydrocarbons			
PHC F1			
Aliphatic C_6-C_8	**756**	3.78	9.59
Aliphatic $C_{>8}$-C_{10}	**96.4**	0.48	0.52
Aromatic $C_{>8}$-C_{10}	**8.98**	0.045	0.10
Total PHC F1	**861**	0.045	0.10
PHC F2			
Aliphatic $C_{>10}$-C_{12}	**11.4**	0.06	0.52
Aliphatic $C_{>12}$-C_{16}	**1.11**	0.01	0.52
Aromatic $C_{>10}$-C_{12}	**7.14**	0.036	0.10
Aromatic $C_{>12}$-C_{16}	**0.86**	0.0043	0.10
Total PHC F2	**20.5**	0.11	1.24

Note: only parameters exceeding the S-IA component value were considered in this RMM; **bold** shading indicates an indoor air concentration exceeding the HBIAC.
[a] An active SVIMS or storage garage is expected to reduce the indoor air concentration by a factor of at least 200.

Inhalation of Indoor Air from Vapours Migrating Groundwater

The risk and hazard calculations for each COC identified for the resident exposure to indoor air from groundwater through inhalation are presented in Table 4.29. Indoor air concentrations were compared to the MGRA-derived HBIAC for a residential building with a basement in a non-potable groundwater scenario.

All PHC F2 fractions, benzene, trichloroethylene and vinyl chloride indoor air concentrations for COCs migrating from groundwater were above the HBIACs. To mitigate this exposure pathway an RMM will be required. All concentrations were less than 200 times the HBIAC for an active SVIMS. Therefore, an active SVIMS is a sufficient RMM to address COCs migrating from groundwater. From the Phase Two ESA it is seen that many of the VOC impacts are on the western portion of the site. Therefore in the eastern portion of the site, an alternative RMM is available that all buildings would have below or at grade parking/storage garage.

Table 4.29 Comparison of Estimated Indoor Air Concentrations from Volatile COCs Migrating from Groundwater to Residential HBIACs

Parameter	Indoor air concentration – no RMM	Indoor Air Concentration[a] – with RMM	Residential HBIAC
	$C_{building}$	SVIMS	HBIAC
	mg/m^3	mg/m^3	mg/m^3
Volatile Organic Compounds			
Trichloroethylene	**0.022**	0.00011	0.00027
Vinyl Chloride	**0.018**	$8.8x10^{-5}$	0.00013
BTEX			
Benzene	**0.0084**	$4.2x10^{-5}$	0.00051
Petroleum Hydrocarbons			
PHC F2			
Aliphatic $C_{>10}$-C_{12}	**72**	0.36	0.52
Aliphatic $C_{>12}$-C_{16}	**8.2**	0.041	0.52
Aromatic $C_{>10}$-C_{12}	**2.1**	0.010	0.10
Aromatic $C_{>12}$-C_{16}	**0.49**	0.0024	0.10
Total PHC F2	**83**	0.41	1.24

Note: only parameters exceeding the GW2 component value were considered in this RMM; **bold** shading indicates an indoor air concentration exceeding the HBIAC.

[a] An active SVIMS is expected to reduce the indoor air concentration by a factor of at least 200.

4.4.2.2 Indoor Worker

Indoor workers in a commercial setting may be present on Site. The primary pathway considered for these receptors is the inhalation of indoor air from vapours migrating from soil and groundwater.

Inhalation of Indoor Air from Vapours Migrating from Soil

The risk and hazard calculations for each COC identified for the indoor worker exposure to indoor air from soil through inhalation are presented in. Indoor air concentrations were compared to the MGRA-derived HBIAC for a commercial slab-on-grade building in a non-potable groundwater scenario. As TCE is assessed as a developmental toxicant the air concentration used in the assessment is not adjusted for less than continuous exposure.

With the exception of PHC F2 Aliphatic C>12-C16 and PHC F2 Aromatic C>12-C16 as well as total PHC F2, all COCs migrating from soil to indoor air exceeded the HBIACs (Table 4.30) including for TCE exposure to the pregnant female receptor. To mitigate this exposure pathway an RMM will be required. As per the MGRA Approved Model from the former MOECC (2016a), an RMM of an active SVIMS will reduce the indoor air concentration by at least a factor of 200. Since concentrations of benzene and trichloroethylene are more than 200 times the HBIAC, a robust SVIMS will be required that includes a vapour barrier or sealing of floors, joints, etc. to ensure minimal migration of COCs into indoor air. Based on studies of vapour intrusion it is expected that an active system can provide significantly more than 200 fold reduction (Folkes 2003; Folkes and Kurz 2002) and thus it is expected that this RMM will provide an adequate level of protection. Additionally, indoor air monitoring needs to be conducted to ensure levels of COCs remain below the HBIACs.

From the Phase Two ESA it is seen that many of the VOC impacts are on the western portion of the site. Therefore in the eastern portion of the site, an alternative RMM is available that all buildings would have below or at grade parking/storage garage.

Table 4.30 Comparison of Estimated Indoor Air Concentrations from Soil to Commercial/Industrial HBIACs

Parameter	Indoor Air Concentration – no RMM	Indoor Air Concentration – with RMM	Commercial HBIAC
	$C_{building}$	SVIMS	HBIAC
	mg/m^3	mg/m^3	mg/m^3
Volatile Organic Compounds			
Trichloroethylene	**0.30**	**0.0015**	0.00087
BTEX			
Benzene	**1.28**	**0.0064**	0.0016
Xylene Mixture	**4.57**	0.023	0.50
Petroleum Hydrocarbons			
PHC F2			
Aliphatic $C_{>10}$-C_{12}	**2.46**	0.012	1.79
Aliphatic $C_{>12}$-C_{16}	0.24	0.0012	1.79
Aromatic $C_{>10}$-C_{12}	**1.54**	0.0077	0.36
Aromatic $C_{>12}$-C_{16}	0.19	0.00093	0.36
Total PHC F2	**4.43**	0.022	4.30

Note: only parameters exceeding the S-IA component value were considered in this RMM; **bold** shading indicates an indoor air concentration exceeding the HBIAC.
[a] An active SVIMS is expected to reduce the indoor air concentration by a factor of at least 200.

Inhalation of Indoor Air from Vapours Migrating from Groundwater

The risk and hazard calculations for each COC identified for the indoor worker exposure to indoor air from groundwater through inhalation are presented in Table 4.30. Indoor air concentrations were compared to the MGRA-derived HBIAC for a commercial slab-on-grade building in a non-potable groundwater scenario. As TCE is assessed as a developmental toxicant the air concentration used in the assessment is not adjusted for less than continuous exposure.

PHC F2 fractions aliphatic C>10-C12 and aromatic C>10-C12, benzene, trichloroethylene (for a pregnant female receptor) and vinyl chloride indoor air concentrations for COCs migrating from groundwater were above the HBIACs; however, the estimated air concentrations with SVIMS meets the HBIAC (Table 4.30). From the Phase Two ESA it is seen that many of the VOC impacts are on the western portion of the site. Therefore in the eastern portion of the site, an alternative RMM is available that all buildings would have below or at grade parking/storage garage.

Table 4.31 Comparison of Estimated Indoor Air Concentrations from Groundwater to Commercial/Industrial HBIACs

Parameter	Indoor Air Concentration – no RMM	Indoor Air Concentration[a] – with RMM	Commercial HBIAC
	$C_{building}$	SVIMS	HBIAC
	mg/m³	mg/m³	mg/m³
Volatile Organic Compounds			
Trichloroethylene	**0.0044**	2.2×10^{-5}	0.00087
Vinyl Chloride	**0.0035**	1.8×10^{-5}	0.00041
BTEX			
Benzene	**0.0017**	8.4×10^{-6}	0.0016
Petroleum Hydrocarbons			
PHC F2			
Aliphatic $C_{>10}$-C_{12}	**14**	0.072	1.79
Aliphatic $C_{>12}$-C_{16}	1.6	0.0082	1.79
Aromatic $C_{>10}$-C_{12}	**0.42**	0.0021	0.36
Aromatic $C_{>12}$-C_{16}	0.098	0.00048	0.36
Total PHC F2	**16.1**	0.083	4.30

Note: only parameters exceeding the GW2 component value were considered in this RMM; **bold** shading indicates an indoor air concentration exceeding the HBIAC.
[a] An active SVIMS is expected to reduce the indoor air concentration by a factor of at least 200.

4.4.2.3 Outdoor Maintenance Worker

In the absence of any RMMs, a long-term outdoor maintenance worker that may be present on the Site would be exposed to COC in soil from inhalation of and dermal contact with vapours migrating to outdoor air, soil (dust) inhalation, soil ingestion, and soil dermal contact. The dermal contact with vapours is an insignificant pathway. In addition, the inhalation of soil particles is a negligible pathway of exposure.

Direct Contact with Soil

Without the implementation of any RMMs, the HQ values and cancer risks for an outdoor maintenance worker is summarized in Table 4.32. From the table, antimony, arsenic and PHC F3 have HQs exceeding the acceptable limit of 0.2 and arsenic resulted in a cancer risk level greater than 10^{-6}. Therefore, a soil cover will be required as an RMM to prevent the outdoor maintenance worker coming into direct contact to Site soil.

Table 4.32 Exposures and Potential Risks for an Outdoor Maintenance Worker from Direct Contact with Soil

Parameter	Non-carcinogenic			Carcinogenic		
	Soil - Ingestion	Soil - Dermal Contact	HQ	Soil - Ingestion	Soil - Dermal Contact	Cancer Risk - ILCR
	ng/kg-day	ng/kg-day	-	ng/kg-day	ng/kg-day	-
Metals						
Antimony	$8.0x10^{-5}$	$5.4x10^{-5}$	**0.34**	NC	NC	NA
Arsenic	$5.0x10^{-5}$	$2.0x10^{-5}$	**0.23**	$5.0x10^{-5}$	$2.0x10^{-5}$	**$1.1x10^{-4}$**
Polycyclic Aromatic Hydrocarbons						
Acenaphthene	NA	NA	NA	$1.3x10^{-6}$	$1.1x10^{-6}$	$2.4x10^{-9}$
Acenaphthylene	NA	NA	NA	$2.0x10^{-6}$	$1.8x10^{-6}$	$3.8x10^{-8}$
Anthracene	NA	NA	NA	$7.9x10^{-6}$	$7.0x10^{-6}$	$1.5x10^{-7}$
Benz[a]anthracene	NA	NA	NA	$5.0x10^{-6}$	$4.4x10^{-6}$	$9.4x10^{-7}$
Benzo[a]pyrene[a]	$7.8x10^{-6}$	$6.9x10^{-6}$	0.05	$7.8x10^{-6}$	$6.9x10^{-6}$	**$1.5x10^{-5}$**
Benzo[b]fluoranthene[a]	$1.3x10^{-5}$	$1.1x10^{-5}$	No TRV	$1.3x10^{-5}$	$1.1x10^{-5}$	**$2.4x10^{-6}$**
Benzo[ghi]perylene	NA	NA	NA	$7.6x10^{-6}$	$6.8x10^{-6}$	$1.4x10^{-7}$
Benzo[k]fluoranthene	NA	NA	NA	$4.6x10^{-6}$	$4.1x10^{-6}$	$8.7x10^{-7}$
Chrysene	NA	NA	NA	$5.0x10^{-6}$	$4.4x10^{-6}$	$9.4x10^{-8}$
Dibenz[a,h]anthracene[a]	$1.8x10^{-6}$	$1.6x10^{-6}$	No TRV	$1.8x10^{-6}$	$1.6x10^{-6}$	**$3.4x10^{-6}$**
Fluoranthene	NA	NA	NA	$1.1x10^{-5}$	$9.6x10^{-6}$	$2.1x10^{-7}$
Indeno[1,2,3-cd]pyrene[a]	$7.5x10^{-6}$	$6.7x10^{-6}$	No TRV	$7.5x10^{-6}$	$6.7x10^{-6}$	**$1.4x10^{-6}$**
Pyrene	NA	NA	NA	$7.3x10^{-6}$	$6.4x10^{-6}$	$1.4x10^{-8}$
Total PAHs	NA	NA	NA	$8.2x10^{-5}$	$7.2x10^{-5}$	**$2.4x10^{-5}$**
Petroleum Hydrocarbons						
PHC F3						
Aliphatic $C_{>16}$-C_{21}	0.019	0.026	0.0228	NC	NC	NA
Aliphatic $C_{>21}$-C_{34}	0.0083	0.011	0.0098	NC	NC	NA
Aromatic $C_{>16}$-C_{21}	0.0048	0.0066	**0.38**	NC	NC	NA
Aromatic $C_{>21}$-C_{34}	0.0021	0.0028	0.16	NC	NC	NA
Total PHC F3	0.034	0.046	**0.57**	NC	NC	NA

Note: NC – Not Carcinogenic; **bold** shading indicates an HQ or ILCR exceeds the acceptable standards.
[a] Dose and risk estimated based on the REMC soil concentration, the other carcinogenic PAHs were estimated based on the maximums.

Direct Contact with Groundwater

With the shallow depth to groundwater it is possible that outdoor workers will occasionally have direct contact with groundwater. It is not expected that this would be a regular occurrence, only when more intensive activities such as planting of trees would occur. Therefore, the assessment that is conducted for the sub-surface worker will be used as a surrogate for this pathway. The assessment for the sub-surface worker (quantitative for PHC F2 and qualitative comparison to component values for the other COC) showed that there are no unacceptable risks to the subsurface worker from direct contact with groundwater, thus no RMMs are required for the maintenance worker to mitigate the direct contact exposure with groundwater.

Inhalation of Vapours Migrating from Groundwater

The exceedance of the residential GW2 indicates that COC was carried forward in the quantitative evaluation for an outdoor worker (outdoor air). Using the methodology presented in Section 4.2.4.3, the estimated outdoor air concentrations from groundwater and soil are summarized in Table 4.33. As TCE is assessed as a developmental toxicant the air concentration used in the assessment is not adjusted for less than continuous exposure. No unacceptable level of risk were identified, including that for the pregnant female receptor.

Table 4.33 Exposures and Potential Risks for an Outdoor Maintenance Worker to COCs Migrating from Groundwater

Parameter	Non-carcinogenic		Carcinogenic	
	Groundwater - Outdoor Air Inhalation	HQ	Groundwater - Outdoor Air Inhalation	Cancer Risk - ILCR
	mg/m^3	-	mg/m^3	-
Volatile Organic Compounds				
Trichloroethylene	4.0×10^{-8}	2.0×10^{-5}	8.7×10^{-9}	3.6×10^{-11}
Vinyl chloride	1.1×10^{-8}	1.1×10^{-7}	1.1×10^{-8}	1.0×10^{-10}
BTEX				
Benzene	6.1×10^{-9}	2.0×10^{-7}	6.1×10^{-9}	1.3×10^{-11}
Petroleum Hydrocarbons				
PHC F2				
Aliphatic $C_{>10}$-C_{12}	2.9×10^{-5}	2.9×10^{-5}	NC	NA
Aliphatic $C_{>12}$-C_{16}	1.1×10^{-5}	1.1×10^{-5}	NC	NA
Aromatic $C_{>10}$-C_{12}	8.7×10^{-7}	4.3×10^{-6}	NC	NA
Aromatic $C_{>12}$-C_{16}	2.0×10^{-7}	1.0×10^{-6}	NC	NA
Total PHC F2	4.1×10^{-5}	4.5×10^{-5}	NC	NA

Note: NC – Not Carcinogenic; **bold** shading indicates an HQ or ILCR exceeds the acceptable standards.

4.4.2.4 Subsurface Worker

The subsurface worker may be present during construction and may be exposed in shallow trenches (i.e., to 2.5 mbgs). This receptor is also included in the future to account for periodic sub-surface activities such as underground services and utilities repair in a shallow trench. A subsurface worker is expected to have brief but intense exposure to COC from inhalation of vapours migrating from soil and groundwater to outdoor (trench) air, soil (dust) inhalation, soil ingestion, soil dermal contact, incidental groundwater ingestion, and groundwater dermal contact. It is reasonable to assume that a subsurface worker would not be exposed to the maximum concentrations for the time while on Site, however, the REMCs were conservatively used in this assessment.

Direct Contact with Soil

Without the implementation of any RMMs, the doses, HQ values and cancer risks for subsurface workers direct contact with soils are summarized in Table 4.34. Although carcinogenic PAHs did not go through the screening, they were included in this assessment as a precaution. From the table, antimony, and arsenic have HQs exceeding the acceptable limit of 0.2 and arsenic resulted in a cancer risk level greater than 10^{-6}. Therefore, a soil cover will be required as an RMM to prevent the outdoor maintenance worker coming into direct contact to Site soil. However, given the subsurface worker may encounter soils at depths deeper than the soil cover, a health and safety plan (HASP) will be required as an RMM to prevent the subsurface worker direct contact exposure to Site soil.

The exposures and HQ values for the subsurface worker from inhalation of particulates (dust) are not presented; as discussed previously, this pathway of exposure is insignificant relative to direct ingestion of soil and to dermal absorption (Health Canada 2012). As shown in Table 4.36, the exposure from dust inhalation is also negligible compared to that from vapour inhalation.

Table 4.34 Exposures and Potential Risks for Subsurface Worker from Direct Contact with Soils

Parameter	Non-carcinogenic			Carcinogenic		
	Soil - Ingestion	Soil - Dermal Contact	HQ	Soil - Ingestion	Soil - Dermal Contact	Cancer Risk - ILCR
	mg/kg-day	mg/kg-day	-	mg/kg-day	mg/kg-day	-
Metals						
Antimony	$8.0x10^{-5}$	$5.4x10^{-5}$	**0.34**	NC	NC	NA
Arsenic	$5.0x10^{-5}$	$2.0x10^{-5}$	**0.23**	$1.3x10^{-6}$	$5.5x10^{-7}$	**$2.8x10^{-6}$**
Polycyclic Aromatic Hydrocarbons						
Acenaphthene	-	-	-	$3.4x10^{-8}$	$3.0x10^{-8}$	$6.4x10^{-11}$
Acenaphthylene	-	-	-	$5.4x10^{-8}$	$4.7x10^{-8}$	$1.0x10^{-9}$
Anthracene	-	-	-	$2.1x10^{-7}$	$1.9x10^{-7}$	$4.0x10^{-9}$
Benz[a]anthracene	-	-	-	$1.3x10^{-7}$	$1.2x10^{-7}$	$2.5x10^{-8}$
Benzo[a]pyrene[a]	$7.8x10^{-6}$	$6.9x10^{-6}$	0.05	$2.1x10^{-7}$	$1.9x10^{-7}$	$3.9x10^{-7}$
Benzo[b]fluoranthene	-	-	-	$3.4x10^{-7}$	$3.0x10^{-7}$	$6.4x10^{-8}$
Benzo[ghi]perylene	-	-	-	$2.0x10^{-7}$	$1.8x10^{-7}$	$3.9x10^{-9}$
Benzo[k]fluoranthene	-	-	-	$1.2x10^{-7}$	$1.1x10^{-7}$	$2.3x10^{-8}$
Chrysene	-	-	-	$1.3x10^{-7}$	$1.2x10^{-7}$	$2.5x10^{-9}$
Dibenz[a,h]anthracene	-	-	-	$4.9x10^{-8}$	$4.3x10^{-8}$	$9.2x10^{-8}$

Parameter	Non-carcinogenic			Carcinogenic		
	Soil - Ingestion	Soil - Dermal Contact	HQ	Soil - Ingestion	Soil - Dermal Contact	Cancer Risk - ILCR
	mg/kg-day	mg/kg-day	-	mg/kg-day	mg/kg-day	-
Fluoranthene	-	-	-	$2.9x10^{-7}$	$2.6x10^{-7}$	$5.5x10^{-9}$
Indeno[1,2,3-cd]pyrene	-	-	-	$2.0x10^{-7}$	$1.8x10^{-7}$	$3.8x10^{-8}$
Pyrene	-	-	-	$1.9x10^{-7}$	$1.7x10^{-7}$	$3.7x10^{-10}$
Total Carcinogenic PAHs				$2.2 x10^{-6}$	$1.9 x10^{-6}$	$6.5 x10^{-7}$

Note: NC – Not Carcinogenic; **bold** shading indicates an HQ or ILCR exceeds the acceptable standards.

[a] Dose and risk estimated based on the REMC soil concentration, the other carcinogenic PAHs were estimated based on the maximums.

Direct Contact with Groundwater

Under the Occupational Health and Safety Act for Construction Projects (O.Reg. 213/91, s. 230), excavation trenches must be kept reasonably free of water and, thus, any subsurface worker in a trench would be expected to have minimal contact with groundwater. However, the direct contact pathway was evaluated for a subsurface worker to be conservative. For direct contact, there are no component values for incidental ingestion and dermal contact with groundwater. Thus, exposure to the subsurface worker from these pathways was evaluated for all COC measured at maximum concentrations greater than the GW1 component (i.e., PHC F2). PHC F2 is not considered carcinogenic; therefore, cancer risks are not presented.

Without the implementation of any RMMs, and using the equations provided in Sections 4.2.6 and 4.2.6.2, the doses and risks from dermal contact with and incidental ingestion of groundwater by a subsurface worker are summarized in Table 4.35.

From these tables, there are no unacceptable risks to the subsurface worker from direct contact with PHC F2, indicating no RMMs are required. As F2 is a non-carcinogenic endpoint the subsurface worker can be taken as a conservative representative of the maintenance worker and resident contact with groundwater; therefore, no RMMs are required for any of these receptors.

Table 4.35 Exposures and Potential Risks for Subsurface Worker from Direct Contact with Groundwater – Non-carcinogenic Effects

Parameter	Non-carcinogenic		
	Groundwater - Ingestion	Groundwater - Dermal Contact	HQ
	mg/kg-d	mg/kg-d	-
Petroleum Hydrocarbons			
PHC F2			
Aliphatic $C_{>10}$-C_{12}	2.2×10^{-5}	0.0014	0.014
Aliphatic $C_{>12}$-C_{16}	1.82×10^{-6}	0.0006	0.0064
Aromatic $C_{>10}$-C_{12}	0.0005	0.0020	0.064
Aromatic $C_{>12}$-C_{16}	0.0003	0.0017	0.051
Total PHC F2	0.00084	0.0057	0.14

Note: **bold** shading indicates an HQ > 0.5.

Inhalation of Vapours Migrating from Soil

The exceedance of the residential S-IA component indicates that COC was carried forward in the quantitative evaluation for a subsurface worker (trench air). The doses and risks for the subsurface worker to volatile vapours migrating from soil into a trench are presented in Table 4.36. As TCE is assessed as a developmental toxicant the air concentration used in the assessment is not adjusted for less than continuous exposure. It is noted that the results for Total Carcinogenic PAHs from trench air shown in Table 4.36 only includes consideration of volatile PAHs. The PAHs that are considered non-volatile is consistent with the MECP definition (as discussed in the footnote on Table 4.22). This may add some uncertainty to the assessment but will not affect the conclusions for this pathway.

None of the COCs in soil exceeded the target risk of 10^{-6}. With the exception of Total PHC F2, none of the COCs in soil exceeded the target hazard of 0.2 (0.5 for PHCs and trichloroethylene) for the subsurface worker inhalation exposure to trench air from vapours migrating from soil, including consideration of a pregnant female as appropriate. Therefore, no RMMs are required for this exposure pathway.

Table 4.36 Exposures and Potential Risks for a Subsurface Worker from Inhalation of Vapours Migrating from Soil in a Trench

Parameter	Non-carcinogenic			Carcinogenic		
	Soil - Dust Inhalation	Soil - Outdoor Air Inhalation (Trench)	HQ	Soil - Dust Inhalation	Soil - Outdoor Air Inhalation (Trench)	Cancer Risk - ILCR
	mg/m^3	mg/m^3	-	mg/m^3	mg/m^3	-
Volatile Organic Compounds						
Trichloroethylene	4.9×10^{-8}	0.00092	0.46	2.9×10^{-10}	5.4×10^{-6}	2.2×10^{-8}
BTEX						
Benzene	1.2×10^{-7}	0.003	0.10	4.7×10^{-9}	0.0001	3.1×10^{-7}
Toluene	3.5×10^{-7}	0.008	0.002	NC	NC	NA
Ethylbenzene	6.8×10^{-8}	0.0014	0.0008	NC	NC	NA
Xylene Mixture	6.2×10^{-6}	0.02	0.02	NC	NC	NA
Polycyclic Aromatic Hydrocarbons						
Naphthalene	6.7×10^{-8}	0.00016	0.04	NC	NC	NA
Carcinogenic Polycyclic Aromatic Hydrocarbons [a]						
Acenaphthene	2.0×10^{-8}	1.3×10^{-5}	No TRV	7.8×10^{-10}	5.9×10^{-7}	3.5×10^{-10}
Acenaphthylene	3.2×10^{-8}	2.7×10^{-5}	No TRV	1.2×10^{-9}	1.2×10^{-6}	7.5×10^{-9}
Anthracene	1.2×10^{-7}	2.0×10^{-5}	No TRV	4.9×10^{-9}	9.2×10^{-7}	5.6×10^{-9}
Benz[a]anthracene[b]	7.9×10^{-8}	2.0×10^{-6}	No TRV	3.1×10^{-9}	5.3×10^{-8}	1.8×10^{-10}
Benzo[a]pyrene [b]	1.2×10^{-7}	Not Volatile	0.06	4.8×10^{-9}	Not Volatile	2.9×10^{-9}
Benzo[b]fluoranthene [b]	2.0×10^{-7}	Not Volatile	No TRV	7.8×10^{-9}	Not Volatile	4.7×10^{-10}
Benzo[ghi]perylene [b]	1.2×10^{-7}	Not Volatile	No TRV	4.7×10^{-9}	Not Volatile	2.8×10^{-11}
Benzo[k]fluoranthene [b]	7.3×10^{-8}	Not Volatile	No TRV	2.8×10^{-9}	Not Volatile	1.7×10^{-10}
Chrysene [b]	7.9×10^{-8}	Not Volatile	No TRV	3.1×10^{-9}	Not Volatile	1.8×10^{-11}
Dibenz[a,h]anthracene [b]	2.9×10^{-8}	Not Volatile	No TRV	1.1×10^{-9}	Not Volatile	6.7×10^{-10}

Parameter	Non-carcinogenic			Carcinogenic		
	Soil - Dust Inhalation	Soil - Outdoor Air Inhalation (Trench)	HQ	Soil - Dust Inhalation	Soil - Outdoor Air Inhalation (Trench)	Cancer Risk - ILCR
	mg/m^3	mg/m^3	-	mg/m^3	mg/m^3	-
Fluoranthene [b]	$1.7x10^{-7}$	Not Volatile	No TRV	$6.7 x10^{-9}$	Not Volatile	$4.0 x10^{-11}$
Indeno[1,2,3-cd]pyrene [b]	$1.2x10^{-7}$	Not Volatile	No TRV	$4.6 x10^{-9}$	Not Volatile	$2.8 x10^{-10}$
Pyrene [b]	$1.1x10^{-7}$	$4.2x10^{-6}$	No TRV	$4.5 x10^{-9}$	$1.1x10^{-7}$	$2.7 x10^{-12}$
Total Carcinogenic PAHs	$1.3x10^{-6}$	$5.9x10^{-5}$	0.06	$5.0 x10^{-8}$	$2.8 x10^{-6}$	$1.8 x10^{-8}$
Petroleum Hydrocarbons						
PHC F1						
Aliphatic C_6-C_8	$3.2 x10^{-6}$	0.04	0.002	NC	NC	NA
Aliphatic $C_{>8}$-C_{10}	$2.1 x10^{-6}$	0.05	0.05	NC	NC	NA
Aromatic $C_{>8}$-C_{10}	$5.2 x10^{-7}$	0.009	0.04	NC	NC	NA
Total PHC F1	$5.7 x10^{-6}$	0.10	0.09	NC	NC	NA
PHC F2						
Aliphatic $C_{>10}$-C_{12}	$8.8 x10^{-6}$	0.18	0.18	NC	NC	NA
Aliphatic $C_{>12}$-C_{16}	$1.1 x10^{-5}$	0.11	0.11	NC	NC	NA
Aromatic $C_{>10}$-C_{12}	$2.2 x10^{-6}$	0.016	0.08	NC	NC	NA
Aromatic $C_{>12}$-C_{16}	$2.7 x10^{-6}$	0.009	0.04	NC	NC	NA
Total PHC F2	$1.6 x10^{-5}$	0.13	0.23	NC	NC	NA

Note: NC – Not Carcinogenic; **bold** shading indicates an HQ or ILCR exceeds the acceptable standards.
[a] Dose and risk estimated based on the REMC soil concentration, the other carcinogenic PAHs were estimated based on the maximums.
[b] Not a COC for this pathway, included in the estimation of Total Carcinogenic PAHs

Inhalation of Vapours Migrating from Groundwater

The exceedance of the residential GW2 component indicates that COC was carried forward in the quantitative evaluation for a subsurface worker (trench air). The doses and risks for the subsurface worker to volatile vapours migrating from groundwater into a trench are presented in Table 4.37. As TCE is assessed as a developmental toxicant the air concentration used in the assessment is not adjusted for less than continuous exposure.

None of the COCs in soil resulted in exceedances of the target risk of 10^{-6} or the target hazard of 0.2 (0.5 for PHCs and TCE) for the subsurface worker inhalation exposure to trench air from vapours migrating from groundwater, including consideration of a pregnant female as appropriate. Therefore, no RMMs are required for this exposure pathway.

Table 4.37 Exposures and Potential Risks for a Subsurface Worker from Inhalation of Vapours Migrating from Groundwater in a Trench

Parameter	Non-carcinogenic		Carcinogenic	
	Groundwater - Outdoor Air Inhalation (Trench)	HQ	Groundwater - Outdoor Air Inhalation (Trench)	Cancer Risk - ILCR
	mg/m^3	-	mg/m^3	-
Volatile Organic Compounds				
Trichloroethylene	$7.1x10^{-5}$	0.036	$2.1x10^{-7}$	$8.6x10^{-10}$
Vinyl chloride	$1.0x10^{-5}$	0.0001	$2.7x10^{-7}$	$3.2x10^{-9}$
BTEX				
Benzene	$5.5x10^{-6}$	0.0002	$1.5x10^{-7}$	$3.2x10^{-10}$
Petroleum Hydrocarbons				
PHC F2				
Aliphatic $C_{>10}$-C_{12}	0.03	0.03	NC	NA
Aliphatic $C_{>12}$-C_{16}	0.01	0.01	NC	NA
Aromatic $C_{>10}$-C_{12}	0.0008	0.004	NC	NA
Aromatic $C_{>12}$-C_{16}	0.0002	0.0009	NC	NA
Total PHC F2	0.04	0.04	NC	NA

Note: NC – Not Carcinogenic; **bold** shading indicates an HQ or ILCR exceeds the acceptable standards.

4.4.3 Qualitative Interpretation of Health Risks

A qualitative assessment was conducted for a number of COC and pathways as discussed in this section. It is noted that since PSS are based on both a qualitative and quantitative approach these values are presented in Section 4.4.7.

4.4.3.1 Generic Components

The components of the generic standard that relate to the human health component were used to refine the list of COC to be evaluated quantitatively in the human health risk assessment, as shown in Table 4.6 and Table 4.7. This constitutes a qualitative assessment. The toxicity reference values were updated to reflect the current state of science (Section 4.3) and the default receptor characteristics were determined to be appropriate for this site. Therefore, the component values from the MGRA model were used in the qualitative assessment.

4.4.3.2 Lack of Toxicity Data

In addition, a qualitative approach was taken for some COC where there is missing toxicity information.

- Lead was identified as a COC for direct contact with soil for residents, outdoor maintenance worker, and the subsurface worker; however, there is no TRV available for lead within the MGRA model. The MECP is currently updating the toxicity data for lead, and request that it is qualitatively assessed using the Ontario background soil concentration of 120 µg/g. The REMC for lead in soil was 8160 µg/g at the Site; therefore an RMM is required to protect residents and users of the Site. The recommended RMMs include a soil cover and HASP. With the RMMs implemented, there will be no exposure to the lead in soil and the proposed standard for lead is set to the REMC of 8160 µg/g.

- There was a lack of toxicity values for 2-(1-)methylnaphthalene for the inhalation pathway. If the toxicity of 2-(1-)methylnaphthalene is assumed the same as that of naphthalene then there is a potential concern from inhalation in the indoor environment for residents and workers. The RMM for soil vapour management is appropriate to mitigate this exposure.

- There was a lack of toxicity values to allow for the assessment of direct contact of soil containing phenanthrene. As the risk assessment showed the potential for health issues with other PAHs, it is possible that phenanthrene could also pose a health risk in a no risk management scenario. The RMM of a cover and HASP will mitigate this exposure pathway for all receptors.

4.4.3.3 Gardens

Development plans have not yet been finalized, however, it is reasonable to assume that some residents may install a backyard garden and grow and consume produce at the Site. To protect residents from the consumption of foods grown directly in impacted soils, a landscape restriction will be implemented to prohibit the installation of vegetable gardens, other than those planted in above ground containers isolated from subsurface conditions. Due to the shallow groundwater, it is also possible that deep rooting plants could have contact with groundwater. The RMM as outlined will also mitigate this pathway.

The S-Nose pathway was shown to be a potential concern for 2-(1-)methylnaphthalene, naphthalene, toluene, ethylbenzene, and xylenes mixture. This pathway is based on a human receptor exposed to soil odour by smelling a handful of soil during gardening. The RMM of a cover at the Site will eliminate this pathway.

4.4.3.4 Other Negligible Pathways

The dermal contact of receptors with vapours present in indoor and outdoor air was not quantitatively assessed, as its contribution was considered negligible when compared with those of vapour inhalation exposure pathways. The US EPA (2004b) concluded that chemicals with low vapor pressure and low environmental concentrations cannot achieve adequate vapor concentration to pose a dermal exposure hazard and chemicals with the potential to achieve adequate vapor concentrations are primarily absorbed through the respiratory tract.

The inhalation of soil particles was assessed for the sub-surface worker but not the other receptors, consistent with the approach used to derive the generic standards. The inhalation of dust is expected to be a negligible source of exposure. This is supported by the assessment conducted for the subsurface worker (shown in Table 4.36) where the inhalation of soil particles is shown to be a small exposure pathway even under a high intensity exposure scenario.

4.4.3.5 Receptor Utilizing the Off-site Surface Water

There is the potential for receptors at the site to utilize the Bay directly adjacent to the Site for recreational purposes such as swimming and/or fishing in the area. As a result, there is potential for exposure to these receptors to the off-Site environment via migration of COC from the site into the Bay.

Table 4.7 shows that the REMCs for all COC in groundwater are below the GW1 component for all COC except PHC F2. This component is used to help the assessment to all direct water pathways. The off-site aquatic environment is a bay which would provide immediate significant dispersion. The REMC for PHC F2 is only a factor of 4 greater than the GW1 component. This is below the MECP default assumption of a factor of 10 dilution in surface water. In addition, i) this represents the maximum concentration and the overall contribution from the Site would be lower and ii) it is expected that there will be significant dilution (well beyond a factor of 10) as groundwater enters the bay.

There is also the possibility of soil migration to the aquatic environment and affecting the water and sediment quality. The RMM of a cover at the Site would remove this potential.

Overall, recreational use is considered to be a negligible exposure pathway and there is not expected to be any concern with recreational use of the adjacent Midland Bay due to the presence of COC at the Site.

4.4.4 Special Considerations

The site is not classified as an environmental sensitivity site as defined by Section 41 of O.Reg. 153/04; therefore no special considerations are required for the setting of PSS for human health based on this factor.

The site is adjacent to water so does meet Section 43.1. Consideration of the receptors and pathways associated with this has been included with the risk characterization results summarized in Section 4.4.3.5. Thus the health standard being proposed for the RA property has taken into account the site conditions.

4.4.5 Interpretation of Off-Site Human Health Risks

The purpose of this section is to assess whether the human health standards being proposed for the RA property are likely to result in a concentration greater than the applicable full depth site condition standard at the nearest human receptor located off the RA property.

There is widespread surface soil impact so movement of soil beyond boundaries to adjacent parcels could occur to the west and east. In addition, currently there is the potential for soil to migrate to sediment in the adjacent waterbody. There is expected to be minimal migration of soil off the property with the implementation of the RMMs and thus the PSS for soil should not result in an exceedance of the generic standard off the property.

Groundwater is mobile and regional groundwater flow was expected to be to the northerly towards Midland Bay. The Phase 2 ESA confirms that the plumes are confined to the site and do not migrate outside of the property boundary, either to the west or toward the water..

Human receptors in the lake include general recreational use (e.g. swimming and/or fishing in the vicinity of the Site); the potential for exposure to these off-site receptors via migration of groundwater impacts and their discharge into the lake was discussed in Section 4.4.3 although this is conservative as migration is not expected to extend off-site.

Groundwater standards do not apply for the off-site aquatic environment and the only site condition standards that are available are for sediment. As discussed previously, the soil cover will prevent erosion and there is significant dilution within the bay. Therefore, it is not expected that the PSS for the Site will result in the exceedance of the applicable generic standards at the nearest off-site human receptor.

4.4.6 Discussion of Uncertainty

Risk assessments are, by their very nature, attended by many areas of uncertainty. To be able to place a level of confidence in the results, an accounting of the magnitude and type of the uncertainty must be completed, and its significance in relation to the results is to be determined. In recognition of the presence of these uncertainties, conservative assumptions were used in establishing the receptor characteristics and in the selection of parameters associated with physical site conditions to ensure that the potential for an adverse effect would not be underestimated. Several of the major assumptions that were made, in this regard, are outlined below.

The exposure times and durations for the receptors were conservative. For example, it was assumed that the outdoor worker will be employed at the same location for 56 years, and that work will be conducted at the Site for 10 hours per working day. Additionally, to calculate exposure from dermal contact for the subsurface worker, it was assumed that a dermal contact event lasted for one hour, which is unlikely given that any trench is required to be kept free of water. There is uncertainty is averaging short-term exposure over a year (e.g. 5 weeks of exposure); however, there is a lack of sub-chronic TRVs to evaluate this exposure averaged over a shorter exposure period.

There are many assumptions used in the exposure assessment. In general these are consistent with those selected by MECP for the derivation of the generic standards. As discussed in the Rationale (MOE 2011) the level of conservatism in these parameters range from being a central tendency to conservative. Modifications to these values are expected to decrease the estimated exposure and thus decrease the risk.

There is uncertainty associated with the measurements of contaminants in environmental media, and it is therefore always a possibility that the real maximum concentration has not been captured in the sampling programs. As such, REMCs are derived from the maximum measured concentrations of COC to account for this uncertainty and capture the likely maximum concentrations in the area.

Uncertainties are also inherent in the vapour migration modelling techniques employed to estimate vapour-phase contaminant concentrations. As a conservative measure, indoor air, outdoor and trench air concentrations were estimated using groundwater and soil REMCs (based on maximum concentrations). Thus, air concentrations are likely overestimated.

The use of single values for toxicity is also another area of uncertainty. The TRVs are selected to be very protective and are for the most part those recommended by the MECP (MOE 2011). There are also some COC that are lacking TRVs, these were discussed in

Section 4.4.3.2. A surrogate approach was adopted for the assessment for 1-/2-methylnaphthylene (using naphthalene) and phenanthrene (using other non-carcinogenic PAHs). There is uncertainty in this approach as the toxicity is not specific to the contaminant. Due to potential risks identified to COC the recommended risk management measured would mitigate the exposure to these COC as well as other COC that were assessed qualitatively (lead). Thus, the lack of toxicity data is not expected to affect the conclusions of the RA.

In general, cautious assumptions were applied in order to ensure that exposure would not be underestimated. For example, the maximum concentration of benzene in groundwater from one monitoring well was used in the assessment even though concentrations in other monitoring wells across the Site are much lower. Thus, the risks provided in this report can be taken as an upper bound of the potential for an adverse effect.

Based on an overall assessment of the uncertainty it is expected that the risk assessment and the conclusions are conservative and likely represent and upper bound of the potential risk. Therefore, the conclusions are conservative and the implication of alternative assumptions would only be to decrease the rigour of the risk management measures.

4.4.7 Setting of Property Specific Standards

The PSSs for the soil and groundwater COCs that are protective of human health are presented in Table 4.38 and Table 4.39, respectively

Table 4.38 Property Specific Standards (PSS) Protective of Human Health in Soil

Parameter	Unit	REMC	Table 9 SCS	Human Health	
				PSS-HH	Risk Management Requirement
Metals					
Antimony	µg/g	105.6	1.3	105.6	RMM-1 & RMM-3
Arsenic	µg/g	132	18	132	RMM-1 & RMM-3
Barium	µg/g	1,764	220	1,764	None required because REMC < applicable component(s)
Beryllium	µg/g	3.84	2.5	3.84	None required because REMC < applicable component(s)
Cadmium	µg/g	2.16	1.2	2.16	RMM-1
Cobalt	µg/g	57.6	22	57.6	RMM-1
Copper	µg/g	336	92	336	None required because REMC < applicable component(s)
Cyanide (CN-)	µg/g	0.084	0.051	0.084	None required because REMC < applicable component(s)
Lead	µg/g	8,160	120	8,160	RMM-1 and RMM-3 based on qualitative assessment
Mercury	µg/g	1.68	0.27	1.68	None required because not volatile
Molybdenum	µg/g	8.16	2	8.16	None required because REMC < applicable component(s)

Parameter	Unit	REMC	Table 9 SCS	Human Health	
				PSS-HH	Risk Management Requirement
Nickel	µg/g	100.8	82	100.8	None required because REMC < applicable component(s)
Selenium	µg/g	11.04	1.5	11.04	None required because REMC < applicable component(s)
Silver	µg/g	1.44	0.5	1.44	None required because REMC < applicable component(s)
Uranium	µg/g	3.72	2.5	3.72	None required because REMC < applicable component(s)
Zinc	µg/g	1,560	290	1,560	None required because REMC < applicable component(s)
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	µg/g	1.68	0.072	1.68	None required because REMC < applicable component(s)
Acenaphthylene	µg/g	2.64	0.093	2.64	RMM-2
Anthracene	µg/g	10.44	0.22	10.44	None required because REMC < applicable component(s)
Benz[a]anthracene	µg/g	6.6	0.36	6.6	RMM-1
Benzo[a]pyrene	µg/g	10.32	0.3	10.32	RMM-1
Benzo[b]fluoranthene	µg/g	16.8	0.47	16.8	RMM-1
Benzo[ghi]perylene	µg/g	10.08	0.68	10.08	None required because REMC < applicable component(s)
Benzo[k]fluoranthene	µg/g	6.12	0.48	6.12	RMM-1
Chrysene	µg/g	6.6	2.8	6.6	None required because REMC < applicable component(s)
Dibenz[a,h]anthracene	µg/g	2.4	0.1	2.4	RMM-1
Fluoranthene	µg/g	14.4	0.69	14.4	None required because REMC < applicable component(s)
Fluorene	µg/g	1.68	0.19	1.68	None required because REMC < applicable component(s)
Indeno[1,2,3-cd]pyrene	µg/g	9.96	0.23	9.96	RMM-1
Methylnaphthalene, 2-(1-)	µg/g	14.4	0.59	14.4	RMM-1 & RMM-2
Naphthalene	µg/g	5.64	0.09	5.64	RMM-1 & RMM-2
Phenanthrene	µg/g	7.68	0.69	7.68	RMM-1
Pyrene	µg/g	9.6	1	9.6	None required because REMC < applicable component(s)
Volatile Organic Compounds					
Trichloroethylene	µg/g	0.456	0.05	0.456	RMM-2
BTEX					
Benzene	µg/g	10.08	0.02	10.08	RMM-1 & RMM-2
Toluene	µg/g	30	0.2	30	RMM-1 & RMM-2
Ethylbenzene	µg/g	5.76	0.05	5.76	RMM-1 & RMM-2
Xylene Mixture	µg/g	51.6	0.05	51.6	RMM-1 & RMM-2
Petroleum Hydrocarbons					
PHC F1	µg/g	480	25	480	RMM-2
PHC F2	µg/g	2,040	10	2,040	RMM-2
PHC F3	µg/g	45,600	240	45,600	RMM-1
PHC F4	µg/g	26,400	120	26,400	RMM-1

Notes:
PSS Property Specific Standard
REMC Reasonable Estimate Maximum Concentration: see Section 3.3.4.
SCS Site Condition Standard from MOE (2011): *Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act.*
'--' No standard available
NA Not assessed
Risk Management Measures:

- RMM-1: Soil or hard cover

- RMM-2: Soil vapour management for buildings at the site.
- RMM-3: Health and Safety Plan for the subsurface activities.

Table 4.39 Property Specific Standards (PSS) Protective of Human Health in Groundwater

Parameter	Unit	REMC	Table 9 SCS	Human Health	
				PSS-HH	Risk Management Requirement
Volatile Organic Compounds					
Trichloroethylene	µg/L	2.64	1.6	2.64	RMM-2
Vinyl Chloride (future worst case)	µg/L	0.744	0.5	0.744	RMM-2
BTEX					
Benzene	µg/L	2.88	44	2.88	RMM-2
Petroleum Hydrocarbons					
PHC F2	µg/L	1,200	150	1,200	RMM-2
PHC F3	µg/L	696	500	696	None required because REMC < applicable component(s)

Notes:
PSS Property Specific Standard
REMC Reasonable Estimate Maximum Concentration: see Section 3.3.4.
SCS Site Condition Standard from MOE (2011): *Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act.*
'--' No standard available
NA Not assessed
Risk Management Measures:

- RMM-2: Soil vapour management for buildings at the site.

5.0 ECOLOGICAL RISK ASSESSMENT

An Ecological Risk Assessment (ERA) is a scientific process used to describe and estimate the likelihood of potential risks (i.e., adverse health effects) to ecological receptors (terrestrial vegetation, soil-dwelling organisms, mammals and birds) resulting from exposure to COCs, taking receptor characteristics, exposure pathways, toxicity data, and mitigating circumstances into consideration. The four principal elements of an ERA comprise of the following:

- problem formulation
- exposure assessment
- toxicity assessment
- risk characterization

Each of these elements is discussed in more detail in the following subsections of the ERA conducted for the Site. It is noted that an ERA is concerned with the estimation of effects on multispecies populations, communities and ecosystems. Estimation of population level impacts is a complex issue and involves some level of scientific judgement.

5.1 Problem Formulation

The ERA needs a good understanding of Site conditions, including the nature, extent, and distribution of the contaminants as described in Section 3.0 as well as an understanding of the ecological receptors present at the Site. These components are integrated into a conceptual site model for the ERA.

5.1.1 Ecological Conceptual Site Model

The first step in the development of the conceptual site model for the ERA is to determine what ecological receptors may be exposed to COCs encountered at the Site. The Site is shown in Figure 1.1. The Site will used for parkland/residential/commercial purposes with some sections covered with buildings and asphalt pavements. Terrestrial populations, with breeding habitats, were considered as on-site receptors. Also, the Site is adjacent to the Midland Bay. The length of the property along the existing shoreline is approximately 1.1 kilometres (Shoreplan 2015). Therefore, both terrestrial and aquatic populations were selected as off-site receptors.

Potential on-site receptors include terrestrial vegetation, soil organisms, mammals, and birds. Aquatic biota (aquatic vegetation, benthic invertebrate, fish, etc.) were assessed as the off-site receptors.

The second step is to examine how the selected receptors may be exposed through a determination of potential pathways of exposure. These pathways are described below.

For on-site receptors, potential exposure pathways include the following:

- Root uptake from soil (direct contact) by terrestrial vegetation
- Incidental soil ingestion (direct contact) by soil organisms, mammals, and birds
- Ingestion of food (plant and animal) contaminated by soil COCs by mammals and birds
- Root uptake from groundwater (direct contact) by terrestrial vegetation
- Incidental groundwater ingestion by soil organisms

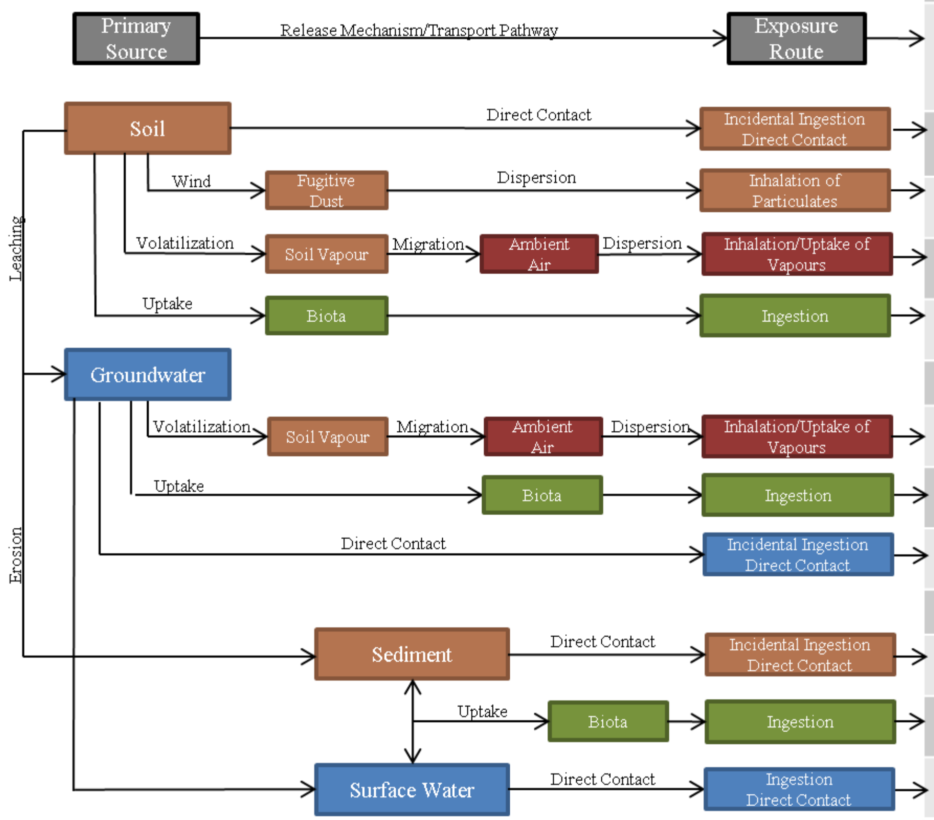
For off-site receptors, potential exposure pathways include the following:

- Incidental sediment ingestion (direct contact) by aquatic biota
- Ingestion of surface water (direct contact) by terrestrial and aquatic receptors
- Ingestion of food (plant and animal) by biota

Details of the exposure pathways for all the receptors are presented in the ecological conceptual site model without risk management (Figure 5.1).

Figure 5.1 Ecological Conceptual Site Model – Without Risk Management (Revised)

Ecological Conceptual Site Model – Without RMMs



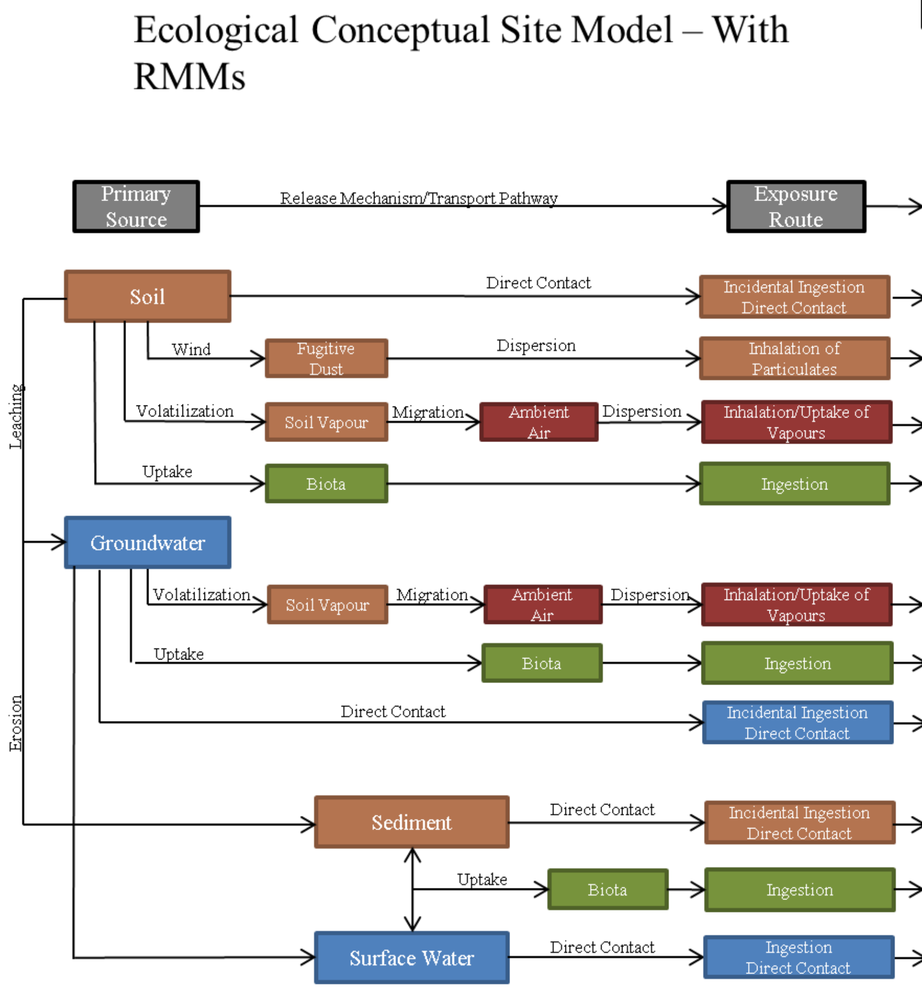
Receptor Characterization

Potentially Exposed Receptors

Exposure Route	On-Site				Off-Site	
	Vegetation	Soil Organisms	Mammals	Birds	Terrestrial Biota	Aquatic Biota
Incidental Ingestion Direct Contact	✓	✓	✓	✓	--	NA
Inhalation of Particulates	--	--	O	O	O	NA
Inhalation/Uptake of Vapours	O	O	O	O	O	NA
Ingestion	--	--	✓	✓	✓	NA
Inhalation/Uptake of Vapours	O	O	O	O	O	NA
Ingestion	--	--	O	O	O	NA
Incidental Ingestion Direct Contact	✓	✓	--	--	--	--
Incidental Ingestion Direct Contact	--	--	--	--	O	✓
Ingestion	--	--	--	--	O	O
Ingestion Direct Contact	--	--	--	--	✓	✓

✓	: Potential Pathway of Exposure (included in the ERA)
O	: Potential pathway of exposure but expected to be negligible; not considered further in the ERA
--	: Not a potential exposure pathway for this receptor/receptor not included in the ERA
NA	: Media not applicable

Figure 5.2 Ecological Conceptual Site Model – With Risk Management (Revised)



Receptor Characterization

Potentially Exposed Receptors

On-Site				Off-Site	
Vegetation	Soil Organisms	Mammals	Birds	Terrestrial Biota	Aquatic Biota
RMM-1	RMM-1	RMM-1	RMM-1	--	NA
--	--	RMM-1	RMM-1	RMM-1	NA
O	O	O	O	O	NA
--	--	RMM-1	RMM-1	RMM-1	NA
O	O	O	O	O	NA
--	--	RMM-1	RMM-1	O	NA
RMM-1	RMM-1	--	--	--	--
--	--	--	--	O	✓
--	--	--	--	O	O
--	--	--	--	✓	✓

✓	: Potential Pathway of Exposure (included in the ERA)
O	: Potential pathway of exposure but expected to be negligible; not considered further in the ERA
--	: Not a potential exposure pathway for this receptor/receptor not included in the ERA
NA	: Media not applicable

Risk Management Measures:
RMM-1: A cover (soil or hard cap) to be placed across the site

5.1.2 Contaminants of Concern for Ecological Receptors

As described in Section 3.0, several contaminants in soil and groundwater were retained as COCs that exceeded the Table 9 SCS. COCs were compared to ecological component values, calculated through the MGRA model.

- Metals: antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, cyanide, lead, mercury, molybdenum, nickel, selenium, silver, uranium and zinc
- PAHs: acenaphthene, acenaphthylene, anthracene, benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[ghi]perylene, benzo[k]fluoranthene, chrysene, dibenz[a, h]anthracene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene, 2-(1-)methylnaphthalene, naphthalene, phenanthrene, and pyrene
- VOCs: trichloroethylene, vinyl chloride
- BTEX: benzene, toluene, ethylbenzene, xylene mixture
- PHCs: F1, F2, F3, and F4

5.1.3 Soil Screening

Soil COCs identified in Section 3.3.5 were compared to the following ecological component values:

- Plants & Soil Organisms: soil values that are protective of plants and soil-dwelling organisms
- Mammals and birds: back-calculate soil concentrations to be protective of some representative mammalian and avian species (American woodcock, meadow vole, sheep, red-winged blackbird, red fox, short-tailed shrew)
- Sediment Quality: protective of sediment dwelling organisms

The soil leaching (S-GW3) component was not considered in this assessment given the presence of measured groundwater samples.

The comparison of the REMCs for COCs to the component values is presented in Table 5.1. As seen from the table, the following COCs will be carried forward to be evaluated quantitatively for the following pathways:

- Plants & Soil Organisms:
    - Metals: antimony, arsenic, barium, cobalt, copper, lead, nickel, selenium, zinc,

  - PAHs: anthracene, benz[a]anthracene, benzo[ghi]perylene, indeno[1,2,3-cd]pyrene, naphthalene, phenanthrene
  - PHCs: F1, F2, F3, F4
- Mammals and birds:
  - Metals: antimony, arsenic, barium, cadmium, lead, molybdenum, selenium, zinc
  - PAHs: fluoranthene
- Sediment Quality:
  - Metals: arsenic, cadmium, cobalt, copper, lead, mercury, nickel, silver, zinc
  - PAHs: anthracene, benz[a]anthracene, benzo[a]pyrene, benzo[ghi]perylene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene, phenanthrene, pyrene.

There are also some COC with missing component values. PHC is not assessed for mammals and birds as most PHC are readily metabolized by vertebrates and thus do not tend to accumulate in tissues (CCME 2008). In addition, PHC are not readily absorbed into and accumulated into plant tissues. For the other COC with missing plants and soil organisms (acenaphthene, acenaphthylene, benzo[b]fluoranthene, dibenz[a,h]anthracene, fluorene, pyrene) or mammals and birds (silver, acenaphthylene, benzo[a]anthracene, benzo[b]fluoranthene, benzo[ghi]perylene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluorene, indeno[1,2,3-c,d]pyrene, and 2-(1-)methylnaphthalene) a qualitative approach is taken. In addition, for those with missing sediment benchmarks a qualitative approach was taken.

Table 5.1 Comparison of Soil REMCs to Ecological Component Values

Parameter	Units	REMC	Ecological Component			Carried Forward for Quantitative Assessment?
			Plants & Soil Org.	Mammals & Birds	Sediment Quality	
Metals						
Antimony	µg/g	105.6	**20**	**25**	NV	**Yes**
Arsenic	µg/g	132	**20**	**51**	**6**	**Yes**
Barium	µg/g	1,764	**750**	**390**	NV	**Yes**
Beryllium	µg/g	3.84	4	13	NV	No

Parameter	Units	REMC	Ecological Component			Carried Forward for Quantitative Assessment?
			Plants & Soil Org.	Mammals & Birds	Sediment Quality	
Cadmium	µg/g	2.16	12	**1.9**	**0.6**	**Yes**
Cobalt	µg/g	57.6	**40**	180	**50**	**Yes**
Copper	µg/g	336	**140**	770	**16**	**Yes**
Cyanide (CN-)	µg/g	0.084	0.9	0.11	0.1	**No**
Lead	µg/g	8,160	**250**	**32**	**31**	**Yes**
Mercury	µg/g	1.68	10	20	**0.2**	**Yes**
Molybdenum	µg/g	8.16	40	**6.9**	NV	**Yes**
Nickel	µg/g	100.8	**100**	5000	**16**	**Yes**
Selenium	µg/g	11.04	**10**	**2.4**	NV	**Yes**
Silver	µg/g	1.44	20		**0.5**	**Yes**
Uranium	µg/g	3.72	500	33	NV	No
Zinc	µg/g	1,560	**400**	**340**	**120**	**Yes**
Polycyclic Aromatic Hydrocarbons						
Acenaphthene	µg/g	1.68		6,600	NV	No
Acenaphthylene	µg/g	2.64			NV	**Yes**
Anthracene	µg/g	10.44	**2.5**	38,000	**0.22**	**Yes**
Benz[a]anthracene	µg/g	6.6	**0.5**		**0.32**	**Yes**
Benzo[a]pyrene	µg/g	10.32	20	1,600	**0.37**	**Yes**
Benzo[b]fluoranthene	µg/g	16.8			NV	No
Benzo[ghi]perylene	µg/g	10.08	**6.6**		**0.17**	**Yes**
Benzo[k]fluoranthene	µg/g	6.12	7.6		**0.24**	**Yes**
Chrysene	µg/g	6.6	7		**0.34**	**Yes**
Dibenz[a,h]anthracene	µg/g	2.4			**0.06**	**Yes**
Fluoranthene	µg/g	14.4	50	**0.69**	**0.75**	**Yes**
Fluorene	µg/g	1.68			**0.19**	**Yes**
Indeno[1,2,3-cd]pyrene	µg/g	9.96	**0.38**		**0.2**	**Yes**
Methylnaphthalene, 2-(1-)	µg/g	14.4			NV	No
Naphthalene	µg/g	5.64	**0.6**	380	NV	**Yes**
Phenanthrene	µg/g	7.68	**6.2**	2,700	**0.56**	**Yes**
Pyrene	µg/g	9.6		4,700	**0.49**	**Yes**
Volatile Organic Compounds						
Trichloroethylene	µg/g	0.456	100	8.1	NV	No
BTEX						
Benzene	µg/g	10.08	25	370	NV	No
Toluene	µg/g	30	150	140	NV	No
Ethylbenzene	µg/g	5.76	55	90	NV	No
Xylene Mixture	µg/g	51.6	95	96	NV	No
Petroleum Hydrocarbons						

Parameter	Units	REMC	Ecological Component			Carried Forward for Quantitative Assessment?
			Plants & Soil Org.	Mammals & Birds	Sediment Quality	
PHC F1	µg/g	480	**210**		NV	**Yes**
PHC F2	µg/g	2,040	**150**		NV	**Yes**
PHC F3	µg/g	45,600	**300**		NV	**Yes**
PHC F4	µg/g	26,400	**2,800**		NV	**Yes**

Note: Concentrations are on a dry weight basis; ecological and human health components of Table 9 Site Condition Standards (SCS) for coarse textured soils and non-potable groundwater calculated from the Ontario Ministry of Environment, Conservation and Parks Modified Generic Risk Assessment (MGRA) (MOECC 2016a) model.

5.1.4 Groundwater Screening

Groundwater COCs identified in Section 3.3.2.2, the GW3 ecological component for the protection of aquatic life was applicable. The only COC exceeding the GW3 component was PHC F2, all others were eliminated from further assessment. Although there is no component value for PHC F3 it is not mobile and is not expected to have a significant impact on the surface water.

Table 5.2 Comparison of Groundwater REMCs to Ecological Component Values

Parameter	Units	REMC	Ecological Component	Carried Forward for Quantitative Assessment?
			GW3	
Volatile Organic Compounds				
Trichloroethylene	µg/L	2.64	220,000	No
Vinyl Chloride	µg/L	0.74	360,000	No
BTEX				
Benzene	µg/L	2.88	4,600	No
Petroleum Hydrocarbons				
PHC F2	µg/L	1,200	**170**	**Yes**
PHC F3	µg/L	696		No

Note: Concentrations are on a dry weight basis; ecological and human health components of Table 9 Site Condition Standards (SCS) for coarse textured soils and non-potable groundwater calculated from the Ontario Ministry of Environment, Conservation and Parks Modified Generic Risk Assessment (MGRA) (MOECC 2016a) model.

5.1.5 Risk Assessment Objectives

Site characterization information has been collected, as described in Section 3.2. The data used for the ERA are sufficient to meet the objectives of the assessment, as ESA requirements in Sections 41, 42 and Table 4 of Schedule E of O.Reg. 153/04 were followed.

5.1.5.1 Objectives

The objective of the ERA is to provide both a qualitative and quantitative evaluation of the potential risks to ecological receptors associated with the presence of COCs in soil and groundwater and develop PSS considered to be protective of ecological receptors at the Site. If any risks are associated with identified COCs in soil and groundwater to VECs based on residential land use at the Site identify risk management measures to mitigate exposures by ecological receptors based on the results of the ERA.

The land use of the Site is mixed commercial, parkland, and residential and thus, the identified receptors for this land use include a range of terrestrial biota (plants, soil organisms, mammals, birds) that may have direct contact to COC at the site and may also be exposed through diet. In addition, as the site is directly adjacent to Midland Bay off-site aquatic biota are also relevant. The receptors and pathways are discussed in more detail in Section 5.1.1. Ecological receptors should be protected at or below lowest observable effect levels from controlled dose response studies for the selected representative species showing the most sensitive response (effect) to a given contaminant dose (exposure) (MECP, 2011b).

Both quantitative and qualitative risk assessment approaches were used in the ERA for the purpose of developing PSS. Ecological risks/hazards are calculated for the Site following O.Reg. 153/04 in Schedule C, and the approach is a risk assessment other than those identified in O. Reg 153/04 Schedule C, Part II.

5.1.5.2 Data Quality

Cambium implemented a QA/QC program during the investigative activities at the Site to ensure that quality data were generated. As part of the quality control program, analysis of blind field duplicates and trip blanks was completed and the laboratory completed duplicate and method spikes as required by their certification.

The evaluation of the analytical data was based on QA/QC information provided by Maxxam Analytics, including laboratory blank data (spiked and method), laboratory duplicate data, and laboratory surrogate, matrix spike, and check recovery data.

Additional discussion on the sampling programs is included in Section 3.3.2.3. Based on the results of the data quality assessment and validation, the analytical data are suitable for use in the RA.

5.1.5.3 Uncertainty Analysis

As described in Section 3, multiple sampling programs have been conducted, and through these sampling programs, the presence of PHCs, VOCs, SVOCs, PAHs, PCBs, metals, and general chemistry parameters has been thoroughly characterized and no significant data gaps remain. QA/QC programs were implemented during the sampling programs, and the quality assessment of the data collected demonstrate that the analytical results are consistent, of high quality, and are suitable for use in the RA. To account for analytical variability, the REMC was used in the assessment. There were not identified issues related to poor data quality or gaps in data. Overall, the data are suitable for setting and meeting the objectives of the ERA.

5.2 Receptor Characterization

This section discusses the valued ecological receptors or VECs considered for the Site. The VECs assessed in the ERA are included in Table 5.3. Ecological receptor characteristics for these VECs are described in the MECP Rationale Document (MECP, 2011b).

Table 5.3 Ecological Receptors Included in the Risk Assessment

	Receptor

On-Site	• Plants and soil-dwelling organisms:
	• Mammals and birds:
	    • American woodcock (*Scolopax minor*)
	    • Meadow vole (field mouse, *Microtus Pennsylvanicus*)
	    • Short-tailed shrew (*Blarina brevicauda*)
	    • Red-tailed hawk (*Buteo jamaicensis*)
	    • Red-winged blackbird (*Agelarius phoeniceus*)
	    • Red fox (*Vulpes vulpes*)
	• Reptiles/amphibians:
	    • Eastern garter snake

Off-Site	• Aquatic invertebrates • Benthic invertebrates • Molluscs • Amphibian • Fish • Mammals and birds

Based on the Site characteristics and in consideration of the future residential land use, the Site-specific VECs consistent with those identified in the “Approved” MGRA Model

(MOECC 2016a) are appropriate for the Site. Off-Site VEC were selected based on the adjacent waterbody and surrounding R/P/I and industrial/commercial land use.

It is assumed that since aquatic biota are directly exposed to water and sediment these receptors will address any concerns for wildlife exposure. The only exception to this would be potentially mercury as it is known to biomagnify. As seen in the information presented in Section 5.5.2.2 mercury is not elevated in sediment and thus not expected to biomagnify. Therefore, the exposure to mammals and birds was not carried forward for a quantitative assessment.

5.2.1 Threatened and Endangered Species

Within the aquatic environment, aquatic biota (vegetation, benthic invertebrates, fish) may be exposed to COC in surface water and sediment.

To determine the potential presence of any Species at Risk (SAR), an online search of the Natural Heritage Information Centre (NHIC) Biodiversity Explorer of the Ministry of Natural Resources and Forestry (MNRF 2019) was conducted to identify SARs that may be present within the project area. The NHIC 1km grid containing the site was selected, as well as the surrounding eight 1km grids to ensure all species at risk that may come into contact with the Site were captured. To identify species of special concern, S1 (critically imperilled), S2 (imperilled) or S3 (vulnerable) status were evaluated. Apparently secure (S4) and secure (S5) rank species were not included.

This database compiles information from numerous sources including the Atlas of Rare Vascular Plants of Ontario, Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Rare Vascular Plant Database, Ontario Fish Distribution Database, Ontario Herpetofaunal Summary, Ontario Rare Breeding Bird Program, Atlas of the Breeding Birds of Ontario, Ontario Butterfly Atlas and Ontario Aquatic Invertebrate Database. The information obtained from Biodiversity Explorer was cross referenced with the Government of Canada (2019) SARA Public Registry to identify those species on Schedule 1 identified as endangered, threatened or of special concern. The following table, (Table 5.4) shows endangered or threatened aquatic species that were identified as likely to be present within 1.0 km of the site.

Table 5.4 Species at risk on and surrounding 420 Bayshore Drive, Midland

Common Name	Species Name	SR Rank	SARO Status	COSEWIC Status	Last Observed	Carried Through Assessment?
Massasauga	*Sistrurus catenatus pop. 1*	S3	THR	THR	1969	No
Mottled Darner	*Aeshna clepsydra*	S3	-	-	1992-08-23	No
Northern Map Turtle	*Graptemys geographica*	S3	SC	SC	2008-08-28	No
Lake Sturgeon	*Acipenser fulvescens pop. 3*	S2	THR	THR	2010-09-01	Yes
Snapping Turtle	*Chelydra serpentina*	S3	SC	SC	2009-10-12	No

Note: NHIC Grid IDs 988620, 988610, 988611, 988621, 988631, 988630, 988629, 988619

The presence of Mottled Darner was noted in 1992 (over 25 years ago) near the site, however, the species was not listed on the SARA registry and is therefore eliminated from further assessment. For the Massasuga SAR, the NHIC reports the presence of SARs within 1km of the site were observed 50 years in the area and are not likely to be present on the Site. The Northern Map Turtle and Snapping Turtle, aquatic SARs, were recently observed near the site in 2008 and 2019, respectively, and are designated at “Special Concern” according to the provincial species at risk listing (SARO) (MNRF 2018) and Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2010). Species designated of “Special Concern” are not considered in the risk assessment.

The Lake sturgeon was last observed in 2010 is designated as “Threatened” or “Endangered” (MNRF 2018) according to the provincial species at risk listing (SARO). This listing has resulted in provincial protection under the Endangered Species Act and the creation of a recovery strategy in accordance with the Act in order to recover this species’ population within the province of Ontario (MNRF 2018).

Lake sturgeon are a migratory species and move back and forth between lakes and large river systems. They are found throughout the Great Lakes Basin (USFWS 2020). Due to the large home ranges of the sturgeon, they are unlikely to remain within the region of the Site for very long and come into contact with impacted contaminants migrating from the Site. Additionally, a risk management measure being implemented, RMM-1, a soil cover (soil or hard cap) to be placed across the site would prevent impacted soil from migrating into sediment.

5.3 Exposure Assessment

The exposure assessment consists of the pathway analysis, which provides a summary of the complete exposure pathways evaluated in the ERA, and the exposure estimate, which determines the exposure of the terrestrial and aquatic VECs to the COCs identified at the Site.

5.3.1 Pathways Analysis

The potential exposure pathways for COCs in soil and groundwater to VECs are discussed in the following section.

5.3.1.1 Terrestrial Plants and Soil Invertebrates

The primary pathway from soil and groundwater exposure for terrestrial plants on the Site is through root uptake and/or direct contact with the impacted media. Incidental soil ingestion, groundwater uptake and dermal contact by soil invertebrates is the predominant pathway. The vapour (sourced from volatile COCs in soil and groundwater) inhalation by soil invertebrates is a potential pathway of exposure but expected to be negligible and therefore not considered further in the ERA. The dispersion of fugitive dust and inhalation of particulates is not considered to be a potential exposure pathway not included in the ERA. The uptake of soil and groundwater by food items and the subsequent ingestion of food items by vegetation and/or soil organisms is not considered to be a potential exposure pathway not included in the ERA. The following exposure pathways were quantitatively evaluated within the ERA:

- Incidental soil ingestion, groundwater uptake and dermal contact with soil and groundwater by soil invertebrates
- Exposure and uptake of COC in soil and groundwater for terrestrial plants
-

5.3.1.2 Mammals and birds

Although dermal exposure through direct contact with soil and groundwater may be a complete exposure pathway for mammals and birds, it is generally considered to be insignificant due to the low frequency and duration of exposures. Additionally, the information required to estimate dermal exposure of mammals and birds is not available. Fur on mammals is believed to reduce exposure by limiting contact with skin and the contaminated media. Consequently, dermal contact will not be quantitatively assessed for mammals and birds. The vapour (sourced from volatile COCs in soil and groundwater) inhalation by mammals and birds is a potential pathway of exposure but expected to be negligible and therefore not considered further in the ERA. The dispersion of fugitive dust and inhalation of particulates is a potential exposure pathways but considered to be a negligible and therefore not considered further in the ERA. The primary route of exposure for mammals and birds is via the ingestion of food/prey that may have accumulated contaminants from soil and groundwater, as well as incidental ingestion of soil during the consumption of food items or through interactions with soil (e.g., burrowing activities). The following exposure pathways are quantitatively evaluated within the ERA:

- Ingestion of impacted food/prey (i.e., plant and animal tissue) by terrestrial mammals and birds
- Incidental ingestion of soil

Wildlife receptor exposure characteristics used in the quantitatively evaluation of mammals and birds is presented in Table 5.5.

Table 5.5 Exposure Characteristics for Wildlife Receptors

Species Name	Body Weight (kg)	Food Ingestion Rate (g ww/d)	Soil Ingestion Rate (g dw/d)	Inhalation Rate (m^3/kg/d)	Skin Surface Area (cm^2)	Food Source
American Woodcock	0.198 [a,b]	150 [a,b]	2.5 [b]	0.594 [b]	340 [b]	Invertebrates
Meadow Vole	0.044 [a]	5[a]	0.018 [a,b]	1.02 [b]	144 [b]	Plants
Red Fox	4.5 [a,b]	430 [b]	3.85 [a,b]	0.403 [b]	2929 [b]	Mammals
Red-tailed Hawk	1.13 [b]	98.7 [b]	1.8[h]	0.397 [b]	1090 [b]	Mammals
Red-winged Blackbird	0.064 [c]	91 [c]	1.09[f]	1.92 [e]	160 [b]	Plants
Domestic Sheep	52 [d]	10,300 [c]	65 [f]	0.248 [c]	14,299 [c]	Plants
Short-tailed Shrew	0.015 [a,b]	9 [a,b]	0.187 [b]	1.26 [b]	71.5 [b]	Invertebrates
Spring Peeper	0.001 [g]	NA	NA	NA	1.1 [c]	Invertebrates

References:
a Sample and Suter, 1994
b U.S. EPA, 1993 –for woodcock, calculation based on earthworms at 84% moisture being the major portion of the diet, not averaged across all invertebrates. Therefore, the soil ingestion rate is 150 g ww food/d *0.16 dw/ww *0.104 g soil/g food = 2.5 g soil dw/d.for the woodcock and 9 g ww food/d *0.16 dw/ww *0.13 g soil/g food = 0.187 g soil dw/d for the shrew.
c NatureServe, 2001
d U.S. EPA, 1988
e allometric equation in U.S. EPA 1993
f estimated soil in diet from similar species in U.S. EPA, 1993
g average values from Morin (1987) and Russel et al. (1995).
h Based on USEPA 2007 ECO-SSL using 5.7% of FIR dry wt, for Hawk and 68% moisture of feed). (0.0987 kg wet *0.32*.057)

5.3.1.3 Off-Site Aquatic Biota

Off-site aquatic receptors may be exposed to impacted soil that would form sediment and groundwater that migrates from the Site into that adjacent waterbody. Vapours migrating into outdoor air would be diluted and not a concern for biota in this environment. The evaluation of off-site aquatic biota receptors was assumed to be protective of semi-aquatic mammals and birds.

The following are exposure pathways were quantitatively evaluated within the ERA:

- Incidental sediment ingestion and dermal contact by the off-site aquatic biota
- Surface water ingestion and direct contact by the off-site aquatic biota

5.3.1.4 Off-Site Terrestrial Biota

Off-site terrestrial receptors may be exposed to impacted soil and groundwater from the consumption of surface water that may have been impacted from contaminants migrating from the Site. Terrestrial receptors may also consume food items originating from the Site

5.3.2 Exposure Estimates

This section consists of assessing the exposure of aquatic and terrestrial VECs to the COCs identified in soil and groundwater.

5.4 Hazard Assessment

The hazard assessment involves the identifying screening benchmarks and TRVs used in the ERA. These were selected to be protective of ecological receptors and are based on changes to growth, reproduction, or survival. The relevant adverse ecological effects are provided in the MECP Rationale Document (MOE 2011).

5.5 Risk Characterization

Risk characterization involves the integration of the information from the exposure assessment and the toxicity assessment. Adverse effects of exposure to the COCs are predicted and assessed.

5.5.1 Interpretation of Ecological Risks

The assessment of potential risks to ecological receptors, defined as the screening index (SI), was determined by dividing the REMC by the ecological component value as shown in the following equation:

$$SI = \frac{REMC}{Ecological\ Component} \qquad (5\text{-}1)$$

Where:

SI = Screening Index [-]

REMC = Reasonable Estimates of the Maximum Concentrations [µg/g or µg/L]

Ecological Component = Applicable ecological component value for the COC [µg/g or µg/L]

Conservative uncertainty factors have been incorporated into the ecological component values for each COC. The calculated SIs were compared with an acceptable value of 1. If the SI of a COC is less than or equal to 1, it is unlikely to pose an adverse health risk to the exposed ecological receptors on the site, while a further examination of the exposure pathways is needed if it exceeds.

5.5.2 Quantitative Interpretation of Ecological Risks

A quantitative evaluation of potential risk was undertaken for the on-site receptors (vegetation, soil organisms, mammals, and birds) and off-site receptors (terrestrial biota and aquatic biota). Exposures to soil, groundwater, surface water, and sediment COCs were assessed using the SI approach. If the REMCs/maximum concentrations of the COCs are greater than the applicable ecological component values (i.e. SI > 1), they would be carried forward in the assessment.

5.5.2.1 On-site Environment

Soil

Table 5.6 presents the result of comparing the soil REMCs with individual ecological component values. Bolded and shaded values indicate an exceedance of an SI of greater than the acceptable level of 1.0.

From the table, the following exceedances were observed:

Plants and Soil Invertebrates:

- Metals: antimony, arsenic, barium, cobalt, copper, lead, nickel, selenium, zinc
- PAHs: anthracene, benz[a]anthracene, benzo[ghi]perylene, indeno[1,2,3-cd]pyrene, naphthalene, phenanthrene
- PHCs: F1, F2, F3, and F4

American woodcock:

- Metals: barium, cadmium, lead, selenium, zinc

Short-tailed shrew:

- Metals: antimony, arsenic, barium, lead, molybdenum, selenium
- PAHs: fluoranthene

Red-tailed hawk: N/A

Red-winged blackbird:

- Metals: barium, lead, selenium

Red fox: N/A

It is noted that there are no component values provided for garter snakes.

Based on the assessment shown in Table 5.6, there is an unacceptable level of exposure and thus a soil cover will be required as a RMM to prevent exposure of ecological receptors to on-site soil.

Table 5.6 Comparison of Soil REMCs to Ecological Component Values

Parameter	Units	REMC	Plant and Soil Invertebrates Residential	American Woodcock	Garter Snake	Meadow Vole	Red Winged Black Bird	Red Fox	Red Tailed Hawk	Short-Tailed Shrew
Metals										
Antimony	µg/g	105.6	**20**			2,140		1,470		**24.6**
Arsenic	µg/g	132	**20**	333		2,690	384	1,420	4,530	**51**
Barium	µg/g	1,764	**750**	**689**		4,950	**672**	6,750	11,900	**394**
Cadmium	µg/g	2.16	12	**1.9**		4,520	87	2,390	1,490	2.4
Cobalt	µg/g	57.6	**40** [a]	180		1,4543	400	10,288	4,896	239
Copper	µg/g	336	**140**	4,080		31,900	3,060	16,600	38,400	772
Lead	µg/g	8,160	**250**	**32**		185,000	**140**	88,200	163,000	**1,760**
Mercury	µg/g	1.68	10	20		1,590	26	216	178	32
Molybdenum	µg/g	8.16	40	74		557	497	3050	22000	**6.9**
Nickel	µg/g	100.8	**100** [a]	6,300		160,000	5,430	88,500	65,000	5,010
Selenium	µg/g	11.04	**10**	**5.7**		26	**5.5**	212	2,190	**2.4**
Silver	µg/g	1.44	20							
Zinc	µg/g	1,560	**400**	**337**		492,000	2,770	36,900	79,000	5,520
Polycyclic Aromatic Hydrocarbons										
Acenaphthylene	µg/g	2.64								
Anthracene	µg/g	10.44	**2.5** [a]			473,000		1,000,00 0		37,900
Benz[a]anthracene	µg/g	6.6	**0.5**							
Benzo[a]pyrene	µg/g	10.32	20			69,000		46,300		1,620
Benzo[ghi]perylene	µg/g	10.08	**6.6** [a]							
Benzo[k]fluoranthene	µg/g	6.12	7.6							
Chrysene	µg/g	6.6	7							
Dibenz[a,h]anthracene	µg/g	2.4								
Fluoranthene	µg/g	14.4	50			115,000		147,000		**0.69**
Fluorene	µg/g	1.68								
Indeno[1,2,3-cd]pyrene	µg/g	9.96	**0.38**							

Parameter	Units	REMC	Plant and Soil Invertebrates Residential	American Woodcock	Garter Snake	Meadow Vole	Red Winged Black Bird	Red Fox	Red Tailed Hawk	Short-Tailed Shrew
Naphthalene	µg/g	5.64	**0.6** [a]			1,260		11,800		379
Phenanthrene	µg/g	7.68	**6.2** [a]			36,000		82,400		2,650
Pyrene	µg/g	9.6				99,100		147,000		4,740
Petroleum Hydrocarbons										
PHC F1	µg/g	480	**210**							
PHC F2	µg/g	2,040	**150**							
PHC F3	µg/g	45,600	**300**							
PHC F4	µg/g	26,400	**2,800**							

Note: **Bolded** values are the ecological component values exceeded by the REMCs, indicating SI>1.

[a] Values exceeded the residential standards but not the commercial standards

Groundwater

Groundwater was determined to be shallow at this site (0.34 mbgs), as shown in the CSM (Figure 5.1). With a shallow depth it is possible that ecological receptors at the Site would come into contact with groundwater.

For the consideration of the potential impact of groundwater on on-site biota the GW3 component from MOE (2011) Table 3 for non-potable water and coarse soil texture was used. The MECP considers that GW3 components are also assumed to be protective of plants, soil organisms, mammals and birds (MOE 2011). As seen in Table 5.7, the REMC for PHC F2 of 1200 µg/L is above the GW3 component of 970 µg/L. As shown on Figure ~~-~~17a ~~in~~ from the Phase 2 CSM (Appendix G), PHC F2 was only detected at one location at levels that exceeds this value ((BH18-07 near the west edge of the site). The potential area of contamination shown on the figure is small and localized and the PHC F2 is present at a concentration only slightly above the relevant component (SI of 1.2), thus it is not expected that PHC would result in any population-level effects at the site. The presence of a cover at the Site would reduce (but not eliminate) the contact with groundwater by ecological receptors at the Site.

Table 5.7 Comparison of Groundwater REMCs to Ecological Component Values

Parameter	Units	REMC	Ecological Component
			GW3
Volatile Organic Compounds			
Trichloroethylene	µg/L	2.64	280,000
Vinyl Chloride	µg/L	0.74	450,000
BTEX			
Benzene	µg/L	2.88	5,800
Petroleum Hydrocarbons			
PHC F2	µg/L	1,200	**970**
PHC F3	µg/L	696	

Note: Concentrations are on a dry weight basis; ecological and human health components of Table 3 Site Condition Standards (SCS) for coarse textured soils and non-potable groundwater calculated from the Ontario Ministry of Environment, Conservation and Parks Modified Generic Risk Assessment (MGRA) (MOECC 2016a) model.

5.5.2.2 Off-site Aquatic Environment

Midland Bay is directly adjacent to the Site. The shoreline can be described as (Shoreplan 2015):

- eastern shoreline (304 m) is a steel sheet pile wall
- centre section (388 m) is generally stone and concrete rubble and timbers with some unprotected shoreline. There is also an embayment in this area
- western shoreline (388m) is mostly timber with some steel sheetwall

The shoreline will be rehabilitated when the Site is developed.

The comparison of groundwater REMC for PHC F2 to the ecological component is presented in Table 5.8. From the table, the SI for PHC F2 is exceeding the acceptable level of 1.0. There is also the potential for soil to move from the site to the environment; the comparison in Table 5.1 shows that the REMC for soil is greater than the sediment component for many COC.

Table 5.8 Comparison of Groundwater REMCs to Ecological Component Values

Parameter	REMC	GW3
	µg/L	µg/L
PHC F2	1,200	**170**

Note: **Bolded** values are the ecological component values exceeded by the REMCs, indicating SI>1.

PHC F2 was measured at a concentration greater than the Table 9 SCS at one location (BH18-07) in the western area of the Site. The monitoring wells closer to the shoreline do not show elevated levels of PHC indicating that the COC is limited in extent and is not entering the water in a significant manner.

A more detailed investigation was conducted for the soil and groundwater COCs that exceed the Sediment Quality guidelines and the GW3 ecological components. This includes examining the available information on surface water and sediment.

Surface Water Data

In the development of the GW3 component, a ten times dilution by the surface water body is assumed. However, it is expected that at this site a much larger dilution is available and thus the surface water data was examined. Surface water samples were collected in April 2014 in the Midland Bay along the northern boundary of the Site at each of the three transects perpendicular to the shoreline (Stantec 2014).

COCs identified in Section 5.1.3 and 5.1.4 as exceeding the sediment quality component or the GW3 component, respectively, were retained for the assessment of off-site surface water conditions. The full dataset of surface water samples is presented in Appendix I. Table 5.9 shows the maximum surface water concentrations of the COCs, compared against the Provincial Water Quality Objectives (PWQO) and the Aquatic Receptor Protection Values (APV) (MOEE 1994; MOE 2011). APVs are not the same as the Ministry's PWQOs, which were developed for the protection of aquatic life and recreational uses. PWQOs are numerical and narrative ambient surface water quality criteria that represent a desirable level of water quality that the Ministry strives to maintain in the surface waters of the Province. PWQOs for the protection of aquatic life are conservative values that, when met, are protective of all forms of aquatic life and all aspects of the aquatic life cycle during indefinite exposure to the water.

Zinc is the only COC exceeding the PWQO. The maximum measured concentration was only slightly above the PWQO and the maximum was the only sample that exceed the PWQO. The average of the data was 11 µg/L. It is also noted that zinc is not a COC in groundwater and thus any exceedances in surface water are not expected to be related to the Site.

Concentrations of COC not measured (i.e., below the method detection limit) were assumed not present/ present at negligible concentrations and were, therefore, not considered a potential concern for off-site receptors in in the assessment.

Table 5.9 Contaminants of Concern in Surface Water

Parameter	Units	Maximum Concentration	PWQO	APV	Potential Concern for Off-site Receptors?
Metals					
Arsenic	µg/L	<1.0	5	150	No
Cadmium	µg/L	<0.10	0.1[a]	0.21	No
Cobalt	µg/L	<0.50	0.9	5.2	No
Copper	µg/L	1.3	5[a]	6.9	No
Lead	µg/L	0.69	1[a]	2.0	No
Mercury	µg/L	-	0.2	0.77	No
Nickel	µg/L	<1.0	25	39	No
Silver	µg/L	<0.10	0.1	0.12	No
Zinc	µg/L	22	**20**	89	**Yes**
Polycyclic Aromatic Hydrocarbons					
Anthracene	µg/L	<0.05	0.0008	0.1	No
Benz[a]anthracene	µg/L	<0.05	0.0004	0.18	No
Benzo[a]pyrene	µg/L	<0.01	-	0.21	No

Parameter	Units	Maximum Concentration	PWQO	APV	Potential Concern for Off-site Receptors?
Benzo[ghi]perylene	µg/L	<0.05	$2x10^{-5}$	0.02	No
Benzo[k]fluoranthene	µg/L	<0.05	0.0002	0.14	No
Chrysene	µg/L	<0.05	0.0001	0.07	No
Dibenz[a,h]anthracene	µg/L	<0.05	0.002	0.04	No
Fluoranthene	µg/L	<0.05	0.0008	7.3	No
Fluorene	µg/L	<0.05	0.2	29	No
Indeno[1,2,3-cd]pyrene	µg/L	<0.05	-	0.14	No
Phenanthrene	µg/L	<0.03	0.03	38	No
Pyrene	µg/L	<0.05	-	0.57	No
Petroleum Hydrocarbons					
PHC F2	µg/L	<100	-	-	No
Aliphatic $C_{>10}$-C_{12}	µg/L	-	-	1.18	No
Aliphatic $C_{>12}$-C_{16}	µg/L	-	-	0.074	No
Aromatic $C_{>10}$-C_{12}	µg/L	-	-	96	No
Aromatic $C_{>12}$-C_{16}	µg/L	-	-	55.4	No

Note: Samples collected in April 2014; **bolded** values are exceeded by the maximum concentrations.

[a] Values based on hardness (as $CaCO_3$ in mg/L); average surface water hardness determined to be 28 mg/L.

Sediment Data

Sediment samples were taken in April 2014 in the Midland Bay along three transects extending 30 m into Midland Bay (Stantec 2014). Due to the coarse nature of the nearshore sediment, it was not always possible to collect a sample at this location.

COCs identified in Section 5.1.3 as exceeding the sediment quality component were retained for the assessment of off-site sediment conditions. Table 5.10 shows the maximum sediment concentrations of the selected COCs. The maximum concentrations were compared against the Sediment Quality guidelines and the provincial sediment standards (MOE 2008, 2011). There are two benchmarks in the provincial sediment standards: the Lowest Effect Level (LEL) and the Severe Effect Level (SEL). The LEL was set to provide an indication of a level of contamination that can be tolerated by the majority of sediment-dwelling organisms. Sediments meeting the LEL are considered clean to marginally polluted. The SEL indicates a level of contamination that is expected to be detrimental to the majority of sediment-dwelling organisms. Sediments exceeding the SEL are considered heavily contaminated. If the no provincial standards are available for the COCs, proper values are drawn from other reliable sources.

As seen from the table, ~~the~~ all COCs in sediments with the exception of arsenic, cobalt, ~~,~~ and mercury ~~and PHC F2~~ exceeded the sediment quality and LEL; however, none of the COCs exceeded the SEL. Sediment concentrations are at least half of the soil concentrations. The assessment also showed that several PAHs were also present at elevated levels at the nearby reference site. It is noted that the elevated concentrations in sediment have not led to unacceptable water quality.

Table 5.10 Screening of On-Site Contaminants of Concern in Off-Site Sediments

Parameter	Units	Soil REMC	Maximum Concentration	Sediment Quality	LEL	SEL
Metals						
Arsenic	µg/g	132	3.9	6	6	33
Cadmium	µg/g	2.16	0.64	**0.6**	**0.6**	10
Cobalt	µg/g	57.6	9.4	50	50[a]	-
Copper	µg/g	336	58	**16**	**16**	110
Lead	µg/g	8,160	130	**31**	**31**	250
Mercury	µg/g	1.68	0.18	0.2	0.2	2
Nickel	µg/g	100.8	54	**16**	**16**	75
Silver	µg/g	1.44	0.58	**0.5**	1[a]	2.2[b]
Zinc	µg/g	1,560	160	**120**	**120**	820
Polycyclic Aromatic Hydrocarbons						
Anthracene	µg/g	10.44	1.4	**0.22**	**0.22**	14.8[c]
Benz[a]anthracene	µg/g	6.6	1.8	**0.32**	**0.32**	59.2[c]
Benzo[a]pyrene	µg/g	10.32	1.7	**0.37**	**0.37**	57.6[c]
Benzo[ghi]perylene	µg/g	10.08	1.1	**0.17**	**0.17**	12.8[c]
Benzo[k]fluoranthene	µg/g	6.12	0.89	**0.24**	**0.24**	53.6[c]
Chrysene	µg/g	6.6	1.6	**0.34**	**0.34**	18.4[c]
Dibenz[a,h]anthracene	µg/g	2.4	0.26	**0.06**	**0.06**	5.2[c]
Fluoranthene	µg/g	14.4	4.7	**0.75**	**0.75**	40.8[c]
Fluorene	µg/g	1.68	0.57	**0.19**	**0.19**	6.4[c]
Indeno[1,2,3-cd]pyrene	µg/g	9.96	1.1	**0.2**	**0.2**	12.8[c]
Phenanthrene	µg/g	7.68	3.3	**0.56**	**0.56**	38[c]
Pyrene	µg/g	9.6	3.6	**0.49**	**0.49**	34[c]

Notes: Samples collected in April 2014; **bolded** values are exceeded by the maximum concentrations.
[a] Based on U.S. EPA (2018) – Region 4 Sediment Screening Values – Environmental Screening Values (ESV).
[b] Based on U.S. EPA (2018)– Region 4 Sediment Screening Values – Refinement Screening Values (RSV).
[c] Calculated from the provincial standards (MOE 2008) based on an organic carbon fraction of 4%.

In addition to the sediment data, a benthic invertebrate community assessment was conducted (Stantec 2014). It was found that the benthic invertebrate communities along the Midland Bay shoreline are indicative of long-term impacts from a variety of sources, including nearby historical industrial practices and invasive aquatic species. It was determined that the water column is eutrophic. One of the transects (T2 – located off-shore near the middle of the site) had high TOC and a coarse substrate, primarily as a result of the large proportion of coal in the sediments. This station also had the fewest pollution sensitivity organisms and was dominated by the most pollution-tolerant taxa. The transect near the west edge of the Site (T1) had the greatest diversity.

Based on the available information it is expected that there is some impairment of the sediment-dwelling community from historical use of the site, but there is still a range of benthic invertebrates in the sediment, so effects are limited. With the placement of a cover across the Site, any continuing influence of the site on the sediment will be eliminated.

Summary

A weight-of-evidence approach was taken for the off-site environment. There is the potential for groundwater to migrate into the off-site environment; however, the data do not support that this will have an adverse effect. Although historical land uses have resulted in sediment impacts, the cover on the soil will eliminate any ongoing influence.

5.5.3 Qualitative Interpretation of Ecological Risks

A qualitative assessment was conducted for a number of COC and pathways as discussed in this section. It is noted that since PSS are based on both a qualitative and quantitative approach these values are presented in Section 5.5.7.

5.5.3.1 Negligible Pathways

The following exposure pathways were qualitatively discussed in the ERA:

Terrestrial Vegetation/Invertebrates Gas Exchange of Soil Vapours

Although terrestrial vegetation and invertebrate gas exchange of COCs migrating from soils is a complete and dominant exposure pathway, there is significant uncertainty due to the lack of toxicity data to accurately evaluate exposure. Additionally, this is not a pathway required to be assessed under the MECP (MOE 2004). Therefore, this pathways was not quantitatively evaluated within the ERA.

Terrestrial Wildlife Inhalation of Soil Particulates/Vapour

Inhalation of soil particulates and/or soil vapour by terrestrial wildlife is not considered a dominant pathway within the ERA and would not contribute to the overall exposure. Therefore, this pathway was not quantitatively evaluated within the ERA.

Inhalation of vapours migrating from groundwater is considered a relevant pathway for terrestrial burrowing mammals, however, given the uncertainty associated with this pathway, it not quantatively assessed within the ERA. Additionally, this is not a pathway required to be assessed under the MECP (MOE 2004).

Terrestrial Wildlife Dermal Contact with Soil

Terrestrial wildlife dermal contact with soils is not considered a dominant pathway within the ERA due to the presence of fur and/or feathers limiting contact with the skin surface. Therefore, this pathway was not quantitatively evaluated within the ERA.

5.5.3.2 Missing Toxicity Information

As seen in Table 5.1 there are a number of missing components.

- PAHs in plants and soil organisms: acenaphthene, acenaphthylene, benzo[b]fluoranthene, dibenz[a,h]anthracene, fluorene, 2-(1-)methylnaphthalene, and pyrene. The most restrictive component for plants and soil organisms for PAHs is 0.38 µg/g for indeno[1,2,3-cd]pyrene. Using this as a surrogate for all PAHs with missing components shows that there is the potential for all of these PAHs to have an adverse effect. This will be mitigated by the RMM of a soil or hard cap.

- Silver for mammals and birds: There is no component value provided in the generic standards. The U.S. EPA has derived a value of 4.2 µg/g for the protection of avian receptors and 14 µg/g for mammals (U.S. EPA 2006). The REMC is well below these values therefore silver is not expected to be a concern.

- PAHs in mammals and birds: acenaphthylene, benz[a]anthracene, benzo[b]fluoranthene, benzo[ghi]perylene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluorene, indeno[1,2,3-cd]pyrene, 2-(1-)methylnaphthalene. The most restrictive component for mammals and birds for PAHs is 0.69 µg/g for fluoranthene. Using this as a surrogate for all PAHs with missing components shows that there is the potential for all of these PAHs to have an adverse effect. It is also recognized that there is no avian toxicity data for PAHs. All potential effects on mammals and birds will be mitigated by the RMM of a soil or hard cap.

In addition, there are no soil component values for garter snakes. The lack of toxicity data for this receptor does add to the uncertainty in the assessment for the no risk management scenario. With the placement of a cover (soil or hard cap) the exposure to these receptors to COC from the Site will be eliminated.

There are a number of COC with no sediment quality benchmarks (antimony, barium, molybdenum, selenium, uranium, acenaphthene, acenaphthylene, naphthalene, and PHC F1 to F4 fractions). The MECP used background soil as a surrogate when there is a lack of sediment quality benchmarks. As sediment was shown to be at least half of soil, 2x soil background was used in the qualitative assessment. VOCs are not expected to partition to sediment and thus risk management measures are not required to mitigate the exposure for these COC. Typically, it is expected that some soil will migrate into the adjacent body of water, however, the soil cover risk management measure (RMM-1) being implemented will prevent the movement of soil into the waterbody.

Table 5.11 Comparison of Soil REMCs without Sediment Quality Guidelines to Two Times the Ontario Soil Background Concentrations

Chemical Parameter	Ont Soil Bkgrd µg/g	2X Bkgrd µg/g	Soil REMC µg/g
Metals			
Antimony	1.3	2.6	**105.6**
Barium	220	440	**1764**
Beryllium	2.5	5	3.84
Molybdenum	2	4	8.16
Selenium	1.5	3	11.04
Uranium	2.8	5.6	3.72
Polycyclic Aromatic Hydrocarbons			
Acenaphthylene	0.093	0.186	**2.64**
Acenaphthene	0.072	0.144	**1.68**
Benzo[b]fluoranthene	0.47	0.94	**16.8**
Methylnaphthalene	0.59	1.2	**14.4**
Naphthalene	0.09	0.18	**5.64**
Petroleum Hydrocarbons			
PHC F1	25	50	**480**
PHC F2	10	20	**2,040**

Chemical Parameter	Ont Soil Bkgrd µg/g	2X Bkgrd µg/g	Soil REMC µg/g
PHC F3	240	480	**45,600**
PHC F4	120	240	**26,400**

Note: **bold shading** indicates exceedance of 2 times the Ontario background soil concentration from the Ontario Ministry of Environment, Conservation and Parks (MOE 2011).

5.5.4 Special Considerations

The RA property does not include and is not located within 30 metres of an “area of natural significance”. The site is not classified as an environmental sensitivity site as defined by Section 41 of O.Reg. 153/04; therefore no special considerations are required for the setting of PSS for ecological health.

The site is adjacent to water so does meet Section 43.1. Consideration of the receptors and pathways associated with this has been included with the risk characterization results summarized in Section 5.5.2.2. Thus the ecological standard being proposed for the RA property has taken into account the site conditions.

5.5.5 Interpretation of Off-Site Ecological Risks

The purpose of this section is to assess whether the ecological standards being proposed for the RA property are likely to result in a concentration greater than the applicable full depth site condition standard at the nearest ecological receptor located off the RA property.

There is expected to be minimal migration of soil off the property with the implementation of the RMMs and thus the PSS for soil should not lead to an exceedance of the generic standard off the property.

Groundwater is mobile and regional groundwater flow is expected to be to the northerly toward Midland Bay. The Phase 2 ESA confirms that the plumes are confined to the site and do not migrate outside of the property boundary, either to the west or toward the water.

Ecological receptors in the lake include a range of aquatic biota as well as wildlife may be present. As a conservative approach, the potential exposure to these off-site receptors via migration of groundwater impacts and their discharge into the lake was discussed in Section 5.5.2.2.

Groundwater standards do not apply for the off-site environment and the only SCS that are available are sediment. As discussed previously, the cover RMM will prevent erosion and there is significant dilution within the Bay. Therefore, it is not expected that the PSS for the Site will result in the exceedance of the applicable generic standards at the nearest off-site ecological receptor.

5.5.6 Discussion of Uncertainty

As with the HHRA, there are uncertainties associated with the ERA evaluation.

While the RA site has been sufficiently characterized for the purposes for the ERA, uncertainty does exist with the measured data, which are typically focused on identifying high concentrations in soil and groundwater. Thus, while the data are potentially biased towards elevated concentrations, it is also possible that the highest concentrations at the Site have not been identified through the course of the sampling programs. REMCs have thus been used to quantify exposure to the receptors to account for this uncertainty. Given the potentially biased program, this is considered to be a conservative estimate of the potential site-wide groundwater concentrations of the COC. These uncertainties are not considered significant enough to compromise the results of the RA.

In surface water, concentrations of COC not measured (i.e., below the method detection limit) were assumed not present/ present at negligible concentrations and were, therefore, not considered a potential concern for off-site receptors in in the assessment. Some of the elevated method detection limits may result in actual concentrations that exceed the applicable guidelines. In the case of surface water, a few COC were not detected in any of the samples obtained and the maximum method detection limit was used in the comparison to guidelines (PWQO and APV). For a few COCs, the reported method detection limits were equal to either the PWQO or the APV, however, there are others that exceed these guidelines. Therefore, there is some uncertainty associated with the assumption of actual concentrations for those reported to be less than the method detection limit, however, this assumption is not considered significant enough to compromise the results of the RA.

5.5.7 Setting of Property Specific Standards

The PSSs for the soil and groundwater COCs that are protective of ecological health are presented below:

Table 5.12 Property Specific Standards (PSS) Protective of Ecological Health in Soil

Parameter	Unit	REMC	Table 9 SCS	Ecological	
				PSS-Eco	Risk Management Requirement
Metals					
Antimony	µg/g	105.6	1.3	105.6	RMM-1

Parameter	Unit	REMC	Table 9 SCS	Ecological	
				PSS-Eco	Risk Management Requirement
Arsenic	µg/g	132	18	132	RMM-1
Barium	µg/g	1,764	220	1,764	RMM-1
Beryllium	µg/g	3.84	2.5	3.84	None required because REMC < applicable component(s)
Cadmium	µg/g	2.16	1.2	2.16	RMM-1
Cobalt	µg/g	57.6	22	57.6	RMM-1
Copper	µg/g	336	92	336	RMM-1
Cyanide (CN-)	µg/g	0.084	0.051	0.084	None required because REMC < applicable component(s)
Lead	µg/g	8,160	120	8,160	RMM-1
Mercury	µg/g	1.68	0.27	1.68	None required because REMC < applicable component(s)
Molybdenum	µg/g	8.16	2	8.16	RMM-1
Nickel	µg/g	100.8	82	100.8	RMM-1
Selenium	µg/g	11.04	1.5	11.04	RMM-1
Silver	µg/g	1.44	0.5	1.44	~~None required because REMC < applicable component(s)~~RMM-1
Uranium	µg/g	3.72	2.5	3.72	None required because REMC < applicable component(s)
Zinc	µg/g	1,560	290	1,560	RMM-1
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	µg/g	1.68	0.072	1.68	RMM-1
Acenaphthylene	µg/g	2.64	0.093	2.64	RMM-1
Anthracene	µg/g	10.44	0.22	10.44	RMM-1
Benz[a]anthracene	µg/g	6.6	0.36	6.6	RMM-1
Benzo[a]pyrene	µg/g	10.32	0.3	10.32	RMM-1
Benzo[b]fluoranthene	µg/g	16.8	0.47	16.8	RMM-1
Benzo[ghi]perylene	µg/g	10.08	0.68	10.08	RMM-1
Benzo[k]fluoranthene	µg/g	6.12	0.48	6.12	RMM-1
Chrysene	µg/g	6.6	2.8	6.6	RMM-1
Dibenz[a,h]anthracene	µg/g	2.4	0.1	2.4	RMM-1
Fluoranthene	µg/g	14.4	0.69	14.4	RMM-1
Fluorene	µg/g	1.68	0.19	1.68	RMM-1
Indeno[1,2,3-cd]pyrene	µg/g	9.96	0.23	9.96	RMM-1
Methylnaphthalene, 2-(1-)	µg/g	14.4	0.59	14.4	RMM-1
Naphthalene	µg/g	5.64	0.09	5.64	RMM-1
Phenanthrene	µg/g	7.68	0.69	7.68	RMM-1
Pyrene	µg/g	9.6	1	9.6	RMM-1
Volatile Organic Compounds					

Parameter	Unit	REMC	Table 9 SCS	Ecological	
				PSS-Eco	Risk Management Requirement
Trichloroethylene	µg/g	0.456	0.05	0.456	None required because REMC < applicable component(s)
BTEX					
Benzene	µg/g	10.08	0.02	10.08	None required because REMC < applicable component(s)
Toluene	µg/g	30	0.2	30	None required because REMC < applicable component(s)
Ethylbenzene	µg/g	5.76	0.05	5.76	None required because REMC < applicable component(s)
Xylene Mixture	µg/g	51.6	0.05	51.6	None required because REMC < applicable component(s)
Petroleum Hydrocarbons					
PHC F1	µg/g	480	25	480	RMM-1
PHC F2	µg/g	2,040	10	2,040	RMM-1
PHC F3	µg/g	45,600	240	45,600	RMM-1
PHC F4	µg/g	26,400	120	26,400	RMM-1

Notes:
PSS Property Specific Standard
REMC Reasonable Estimate Maximum Concentration: see Section 3.3.4.
SCS Site Condition Standard from MOE (2011): *Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act.*
Risk Management Measures:
- RMM-1: Soil or hard cover
- RMM-2: Soil vapour management for buildings at the site.
- RMM-3: Health and Safety Plan for the subsurface activities.

Table 5.13 Property Specific Standards (PSS) Protective of Ecological Health in Groundwater

Parameter	Unit	REMC	Table 9 SCS	Ecological	
				PSS-Eco	Risk Management Requirement
Volatile Organic Compounds					
Trichloroethylene	µg/L	2.64	1.6	2.64	None required because REMC < applicable component(s)
Vinyl Chloride (future worst case)	µg/L	0.744	0.5	0.744	None required because REMC < applicable component(s)
BTEX					
Benzene	µg/L	2.88	44	2.88	None required because REMC < applicable component(s)
Petroleum Hydrocarbons					
PHC F2	µg/L	1,200	150	1,200	None required based on weight-of-evidence assessment
PHC F3	µg/L	696	500	696	NA

Notes:
PSS Property Specific Standard
REMC Reasonable Estimate Maximum Concentration: see Section 3.3.4.
SCS Site Condition Standard from MOE (2011): *Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act.*
Risk Management Measures:

- RMM-2: Soil vapour management for buildings at the site.

6.0 CONCLUSIONS/RECOMMENDATIONS

6.1 Summary of Results

Risks to human health and the environment under the exposure of the soil and groundwater COCs were evaluated in this RA. In the HHRA and ERA comprising this RA, potential exposure pathways of human and ecological to the COCs were identified and the risks associated with the exposures were characterized. Summary of the results of the HHRA is provided in Table 6.1. The calculated inhalation risks for indoor air were compared with the HBIACs. The other calculated risks were compared with the applicable standards of 0.2 (0.5 for PHCs) for HQs and 1x10^{-6} for ILCRs.

Table 6.1 Summary of the HHRA Results

Receptor	Exposure Pathway	Exceed Applicable Standards	
Resident	Inhalation of indoor air from vapours migrating from soil	Yes (Acenaphthylene, Benzene, Toluene, Ethylbenzene, Naphthalene, 2-(1-)methylnaphthalene[b], PHC F1, PHC F2, Trichloroethylene, Xylene Mixture)	
	Inhalation of indoor air from vapours migrating from groundwater	Yes (Benzene, PHC F2, Trichloroethylene, Vinyl Chloride)	
	Indirect contact with soil from gardening	Yes Toluene, ethylbenzene, xylenes, methylnaphthalene, 2-(1-), naphthalene	
	Direct contact with soil	**Exceed HQ**	**Exceed ILCR**
	Infant	Yes (Lead[b], PHC F3 Aromatic $C_{>16}$-C_{21}, PHC F4 Aromatic $C_{>34}$)	N/A
	Toddler	Yes (Antimony, Arsenic, Benzo[a]pyrene, Phenanthrene[b], Cadmium, Cobalt, Lead[b], PHC F3 Aromatic $C_{>16}$-C_{21}, PHC F3 Aromatic $C_{>21}$-C_{34}, PHC F4 Aromatic $C_{>34}$	N/A
	Child	Yes (Antimony, Arsenic, Lead[b], PHC F3 Aromatic $C_{>16}$-C_{21}, PHC F4 Aromatic $C_{>34}$)	N/A
	Teen	Yes (Antimony, Lead[b])	N/A
	Adult	Yes (Antimony, Lead[b])	Yes[a] (Arsenic, Benz[a]anthracene,

Receptor	Exposure Pathway	Exceed Applicable Standards	
			Benzene, Benzo[a]pyrene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Dibenz[a,h]anthracene, Indeno[1,2,3-cd]pyrene, Total PAHs)
Indoor Worker	Inhalation of indoor air from vapours migrating from soil	Yes (Benzene, PHC F2 Aliphatic $C_{>10}$-C_{12}, PHC F2 Aromatic $C_{>10}$-C_{12}, Trichloroethylene, Xylene Mixture)	
	Inhalation of indoor air from vapours migrating from groundwater	Yes (Benzene, PHC F2 Aliphatic $C_{>10}$-C_{12}, PHC F2 Aromatic $C_{>10}$-C_{12}, Trichloroethylene, Vinyl Chloride)	
Outdoor Maintenance Worker	Direct contact with soil	**Exceed HQ**	**Exceed ILCR**
		Yes (Antimony, Arsenic, Lead[b], PHC F3)	Yes (Arsenic, Benzo[a]pyrene, Benzo[b]fluoranthene, Dibenz[a,h]anthracene, Indeno[1,2,3-cd]pyrene)
	Inhalation of vapours migrating from groundwater	**Exceed HQ**	**Exceed ILCR**
		No	No
Subsurface Worker	Direct contact with soil	**Exceed HQ**	**Exceed ILCR**
		Yes (Antimony, Arsenic, Lead[b])	Yes (Arsenic)
	Direct contact with groundwater	No	
	Inhalation of vapours migrating from soil	**Exceed HQ**	**Exceed ILCR**
		No	No
	Inhalation of vapours migrating from groundwater	**Exceed HQ**	**Exceed ILCR**
		No	No

Note: [a] Based on a composite receptor.

b Based on a qualitative assessment

Summary of the results of the ERA is presented in Table 6.2. The estimated risks were compared with the acceptable SI of 1.

Table 6.2 Summary of the ERA Results

Receptor	Exposure Pathway	Exceed Applicable Standards
On-Site		
Plants and Soil Invertebrates	Direct Contact/ Incidental Ingestion	Yes (Acenaphthene[a], Acenaphthylene[a], Antimony, Anthracene, Arsenic, Barium, Benz[a]anthracene, Benzo[b]fluoranthene[a], Benzo[ghi]perylene, Cobalt, Copper, Dibenz[a,h]anthracene, Fluorene, Indeno[1,2,3-cd]pyrene, Lead, Naphthalene, 2-/1-Methylnaphthalene[a], Nickel, PHC F1-F4, Phenanthrene, Pyrene[a] Selenium, Zinc)
American Woodcock	Ingestion of impacted food/prey, Incidental ingestion	Yes (Barium, Cadmium, Lead, Selenium, and Zinc
Meadow Vole	Ingestion of impacted food/prey, Incidental ingestion	No
Short-Tailed Shrew	Ingestion of impacted food/prey, Incidental ingestion	Yes (Acenaphthylene[a], Antimony, Arsenic, Barium, Benz[a]anthracene[a], Benzo[b]fluoranthene[a], Benzo[ghi]perylene[a], Benzo[k]fluoranthene[a], Chrysene[a], Dibenz[a,h]anthracene[a], Fluoranthene, Fluorene[a], Indeno[1,2,3-cd]pyrene[a], Lead, 2-(1-)Methylnaphthalene[a], Molybdenum, Selenium)
Red-Tailed Hawk	Ingestion of impacted food/prey, Incidental ingestion	No
Red-Winged Blackbird	Ingestion of impacted food/prey, Incidental ingestion	Yes (Barium, Lead, Selenium)
Red Fox	Ingestion of impacted food/prey, Incidental ingestion	No
Garter snake	Direct Contact, Ingestion of impacted food/prey, Incidental ingestion	Yes[a] (for all COC identified for other receptors)
Off-Site		
Aquatic Biota	Ingestion of impacted food/prey, Incidental ingestion, Direct contact	Yes Antimony[a], Barium[a], Cadmium, copper, lead, nickel, zinc, PHC

Receptor	Exposure Pathway	Exceed Applicable Standards
		F1[a], F2[a], F3[a], F4[a], Acenaphthylene[a], Acenaphthene[a], Anthracene, Benz[a]anthracene, Benzo[b]fluoranthene[a], Benzo[a]pyrene, Benzo[ghi]perylene, Benzo[k]fluoranthene, Chrysene, Dibenz[a,h]anthracene, Fluoranthene, Fluorene, Indeno[1,2,3-cd]pyrene, Naphthalene[a], 2-/1-Methylnaphthalene[a] Phenanthrene, Pyrene

Note: [a] Based on a qualitative assessment

6.2 Recommended Standards

A standard must be specific in the risk assessment for each contaminant of concern. The specified standard shall be, at a minimum, the more stringent of the human health standard and the ecological standard being proposed for the RA property.

Table 6.3 Soil Property Specific Standards

Parameter	Unit	REMC	Table 9 SCS	Human Health		Ecological		Selected PSS
				PSS-HH	Risk Management Requirement	PSS-Eco	Risk Management Requirement	
Metals								
Antimony	µg/g	105.6	1.3	105.6	RMM-1 & RMM-3	105.6	RMM-1	105.6
Arsenic	µg/g	132	18	132	RMM-1 & RMM-3	132	RMM-1	132
Barium	µg/g	1,764	220	1,764	None required because REMC < applicable component(s)	1,764	RMM-1	1,764
Beryllium	µg/g	3.84	2.5	3.84	None required because REMC < applicable component(s)	3.84	None required because REMC < applicable component(s)	3.84
Cadmium	µg/g	2.16	1.2	2.16	RMM-1	2.16	RMM-1	2.16
Cobalt	µg/g	57.6	22	57.6	RMM-1	57.6	RMM-1	57.6
Copper	µg/g	336	92	336	None required because REMC < applicable component(s)	336	RMM-1	336
Cyanide (CN-)	µg/g	0.084	0.051	0.084	None required because REMC < applicable component(s)	0.084	None required because REMC < applicable component(s)	0.084
Lead	µg/g	8,160	120	8,160	RMM-1 and RMM-3 based on qualitative assessment	8,160	RMM-1	8,160

Parameter	Unit	REMC	Table 9 SCS	Human Health		Ecological		Selected PSS
				PSS-HH	Risk Management Requirement	PSS-Eco	Risk Management Requirement	
Mercury	µg/g	1.68	0.27	1.68	None required because not volatile	1.68	None required because REMC < applicable component(s)	1.68
Molybdenum	µg/g	8.16	2	8.16	None required because REMC < applicable component(s)	8.16	RMM-1	8.16
Nickel	µg/g	100.8	82	100.8	None required because REMC < applicable component(s)	100.8	RMM-1	100.8
Selenium	µg/g	11.04	1.5	11.04	None required because REMC < applicable component(s)	11.04	RMM-1	11.04
Silver	µg/g	1.44	0.5	1.44	None required because REMC < applicable component(s)	1.44	~~None required because REMC < applicable component(s)~~RMM-1	1.44
Uranium	µg/g	3.72	2.5	3.72	None required because REMC < applicable component(s)	3.72	None required because REMC < applicable component(s)	3.72
Zinc	µg/g	1,560	290	1,560	None required because REMC < applicable component(s)	1,560	RMM-1	1,560
Polycyclic Aromatic Hydrocarbons								
Acenaphthene	µg/g	1.68	0.072	1.68	None required because REMC < applicable component(s)	1.68	RMM-1	1.68
Acenaphthylene	µg/g	2.64	0.093	2.64	RMM-2	2.64	RMM-1	2.64
Anthracene	µg/g	10.44	0.22	10.44	None required because REMC < applicable component(s)	10.44	RMM-1	10.44
Benz[a]anthracene	µg/g	6.6	0.36	6.6	RMM-1	6.6	RMM-1	6.6
Benzo[a]pyrene	µg/g	10.32	0.3	10.32	RMM-1	10.32	RMM-1	10.32
Benzo[b]fluoranthene	µg/g	16.8	0.47	16.8	RMM-1	16.8	RMM-1	16.8
Benzo[ghi]perylene	µg/g	10.08	0.68	10.08	None required because REMC < applicable component(s)	10.08	RMM-1	10.08
Benzo[k]fluoranthene	µg/g	6.12	0.48	6.12	RMM-1	6.12	RMM-1	6.12
Chrysene	µg/g	6.6	2.8	6.6	None required because REMC < applicable component(s)	6.6	RMM-1	6.6
Dibenz[a,h]anthracene	µg/g	2.4	0.1	2.4	RMM-1	2.4	RMM-1	2.4
Fluoranthene	µg/g	14.4	0.69	14.4	None required because REMC < applicable component(s)	14.4	RMM-1	14.4
Fluorene	µg/g	1.68	0.19	1.68	None required because REMC < applicable component(s)	1.68	RMM-1	1.68
Indeno[1,2,3-cd]pyrene	µg/g	9.96	0.23	9.96	RMM-1	9.96	RMM-1	9.96
Methylnaphthalene, 2-(1-)	µg/g	14.4	0.59	14.4	RMM-1 & RMM-2	14.4	RMM-1	14.4
Naphthalene	µg/g	5.64	0.09	5.64	RMM-1 & RMM-2	5.64	RMM-1	5.64

Parameter	Unit	REMC	Table 9 SCS	Human Health		Ecological		Selected PSS
				PSS-HH	Risk Management Requirement	PSS-Eco	Risk Management Requirement	
Phenanthrene	µg/g	7.68	0.69	7.68	RMM-1	7.68	RMM-1	7.68
Pyrene	µg/g	9.6	1	9.6	None required because REMC < applicable component(s)	9.6	RMM-1	9.6
Volatile Organic Compounds								
Trichloroethylene	µg/g	0.456	0.05	0.456	RMM-2	0.456	None required because REMC < applicable component(s)	0.456
BTEX								
Benzene	µg/g	10.08	0.02	10.08	RMM-1 & RMM-2	10.08	None required because REMC < applicable component(s)	10.08
Toluene	µg/g	30	0.2	30	RMM-1, RMM-2	30	None required because REMC < applicable component(s)	30
Ethylbenzene	µg/g	5.76	0.05	5.76	RMM-1, RMM-2	5.76	None required because REMC < applicable component(s)	5.76
Xylene Mixture	µg/g	51.6	0.05	51.6	RMM-1, RMM-2	51.6	None required because REMC < applicable component(s)	51.6
Petroleum Hydrocarbons								
PHC F1	µg/g	480	25	480	RMM-2	480	RMM-1	480
PHC F2	µg/g	2,040	10	2,040	RMM-2	2,040	RMM-1	2,040
PHC F3	µg/g	45,600	240	45,600	RMM-1	45,600	RMM-1	45,600
PHC F4	µg/g	26,400	120	26,400	RMM-1	26,400	RMM-1	26,400

Notes:
PSS Property Specific Standard
REMC Reasonable Estimate Maximum Concentration: see Section 3.3.4.
SCS Site Condition Standard from MOE (2011): *Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act.*
'--' No standard available
NA Not assessed
Risk Management Measures:
- RMM-1: Soil or hard cover
- RMM-2: Soil vapour management for buildings at the site.
- RMM-3: Health and Safety Plan for the subsurface activities.

Table 6.4 Groundwater Property Specific Standards

Parameter	Unit	REMC	Table 9 SCS	Human Health		Ecological		Selected PSS
				PSS-HH	Risk Management Requirement	PSS-Eco	Risk Management Requirement	
Volatile Organic Compounds								
Trichloroethylene	µg/L	2.64	1.6	2.64	RMM-2	2.64	None required because REMC < applicable component(s)	2.64
Vinyl Chloride (future worst case)	µg/L	0.744	0.5	0.744	RMM-2	0.744	None required because REMC < applicable component(s)	0.744
BTEX								
Benzene	µg/L	2.88	44	2.88	RMM-2	2.88	None required because REMC < applicable component(s)	2.88
Petroleum Hydrocarbons								
PHC F2	µg/L	1,200	150	1,200	RMM-2	1,200	None required based on weight-of-evidence assessment	1,200
PHC F3	µg/L	696	500	696	None required because REMC < applicable component(s)	696	NA	696

Notes:
PSS Property Specific Standard
REMC Reasonable Estimate Maximum Concentration: see Section 3.3.4.
SCS Site Condition Standard from MOE (2011): *Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act.*
'--' No standard available
NA Not assessed
Risk Management Measures:

- RMM-2: Soil vapour management for buildings at the site.

6.3 Special Considerations for Ground Water Standards

If a standard being proposed in the risk assessment for ground water in or under the RA property is greater than 50% of the solubility limit, demonstrate the risk of free product formation and propose any risk management measures necessary in order to mitigate the formation of free product.

As seen in Table 6.5 and Table 6.6, the REMC for PHC F3 and PHC F4 exceeded the free phase thresholds, and the REMC for PHC F2 and PHC F3 exceeded the half solubility limit in groundwater, suggesting that PHC free product has the potential form on the Site. However, the presence of the COC on the Site is limited and extensive field investigations found no observed free-phase during the Phase Two investigations (Cambium 2019a).

Table 6.5 Comparison of Soil Concentrations to Free Phase Threshold

Parameter	Units	REMC	Free Phase Threshold
Metals			
Antimony	µg/g	105.6	8,000
Arsenic	µg/g	132	12,000
Barium	µg/g	1,764	7,700
Beryllium	µg/g	3.84	3,900
Cadmium	µg/g	2.16	18,000
Cobalt	µg/g	57.6	19,000
Copper	µg/g	336	-
Cyanide (CN-)	µg/g	0.084	240,000
Lead	µg/g	8160	24,000
Mercury	µg/g	1.68	34,000
Molybdenum	µg/g	8.16	22,000
Nickel	µg/g	100.8	-
Selenium	µg/g	11.04	-
Silver	µg/g	1.44	22,000
Uranium	µg/g	3.72	40,000
Zinc	µg/g	1,560	15,000
Polycyclic Aromatic Hydrocarbons			
Acenaphthene	µg/g	1.68	2,800
Acenaphthylene	µg/g	2.64	2,900
Anthracene	µg/g	10.44	2,700
Benz[a]anthracene	µg/g	6.6	7,600
Benzo[a]pyrene	µg/g	10.32	7,600
Benzo[b]fluoranthene	µg/g	16.8	7,600
Benzo[ghi]perylene	µg/g	10.08	7,600

Parameter	Units	REMC	Free Phase Threshold
Benzo[k]fluoranthene	µg/g	6.12	7,600
Chrysene	µg/g	6.6	7,700
Dibenz[a,h]anthracene	µg/g	2.4	7,600
Fluoranthene	µg/g	14.4	7,600
Fluorene	µg/g	1.68	2,800
Indeno[1,2,3-cd]pyrene	µg/g	9.96	7,600
Methylnaphthalene, 2-(1-)	µg/g	14.4	3,600
Naphthalene	µg/g	5.64	2,800
Phenanthrene	µg/g	7.68	2,300
Pyrene	µg/g	9.6	7,700
Volatile Organic Compounds			
Trichloroethylene	µg/g	0.456	4,100
BTEX			
Benzene	µg/g	10.08	5,000
Toluene	µg/g	30	3,300
Ethylbenzene	µg/g	5.76	2,700
Xylene Mixture	µg/g	51.6	2,300
Petroleum Hydrocarbons			
PHC F1	µg/g	480	1,700
PHC F2	µg/g	2,040	2,700
PHC F3	µg/g	45,600	**5,800**
PHC F4	µg/g	26,400	**6,900**

Table 6.6 Comparison of Groundwater Concentrations to ½ Solubility

Parameter	Units	REMC	1/2 Solubility
Volatile Organic Compounds			
Trichloroethylene	µg/L	2.64	640,000
BTEX			
Benzene	µg/L	2.28	900,000
Petroleum Hydrocarbons			
PHC F2	µg/L	1,200	**150**
PHC F3	µg/L	696	**4.0×10^{-8}**

7.0 RISK MANAGEMENT PLAN

This risk management plan (RMP) was prepared to address identified risks to human health and ecological receptors for the Site. The RMP is described in the following sections, applied to the RMP areas shown at the end of this section in Figure 7.1. The RMP is attached as Appendix J.

7.1 Risk Management Performance Objectives

The calculations above show that RMMs are required at the Site in order to reduce the health risks that are associated with human and ecological receptors on the RA property exposed to COC in soil and groundwater via the following pathways:

The HHRA identified the following human health risks for which RMMs are required:

- direct contact with the soil by residents during regular activities – antimony, arsenic, cadmium, cobalt, lead, benzene, PHC F3 and F4, and PAHs
- direct contact with the soil by outdoor maintenance workers during regular activities – antimony, arsenic, lead, PHC F3, and PAHs
- direct contact with soil in a trench or excavation by subsurface workers – antimony, arsenic, and lead
- inhalation of indoor air by residents from vapours migrating from soil – acenaphthylene, benzene, toluene, ethylbenzene, xylenes, PHC F1 and F2, naphthalene, 2-(1-) methylnaphthalene, and trichloroethylene
- inhalation of indoor air by residents from vapours migrating from groundwater – benzene, PHC F2, trichloroethylene, and vinyl chloride
- inhalation of indoor air by an indoor worker from vapours migrating from soil – benzene, xylenes, PHC F2, and trichloroethylene
- inhalation of indoor air by an indoor worker from vapours migrating from groundwater – benzene, PHC F2, trichloroethylene, and vinyl chloride
- indirect exposure for residents via gardens – toluene, ethylbenzene, xylenes, methylnaphthalene, 2-(1-), and naphthalene

The ERA identified the following ecological risks for which RMMs are required:

- migration of soils into the aquatic environment – metals, PAHs, and PHC F1 to F4
- soil contact by terrestrial plants and soil invertebrates – metals, PAHs, and PHC F1 to F4

- soil contact by mammals and birds – metals and PAHs

Risk management is required to prevent direct exposure to COC in soil with concentrations exceeding the effects-based concentration (EBC). Risks can be mitigated through the implementation of the hard cap/fill cap barrier RMM as described in the MGRA model (MOECC 2016b). Capping measures should be implemented following site redevelopment for any areas that are not covered by building foundations. The hard cap/fill cap barrier RMM will also mitigate risk of migration of soil to the off-site aquatic environment, and soil contact by terrestrial plants and soil organisms and mammals and birds. For the subsurface worker that may have contact with soil below the cap, the RMM includes a Health and Safety Plan.

As part of the cover system, a restriction should be in place to prohibit the installation of vegetable gardens, other than those planted in above ground containers isolated from subsurface conditions, to protect residents from the consumption of foods grown directly in impacted soils.

Risk management is required to reduce exposure to volatile COCs via inhalation of indoor air with concentrations exceeding the EBC by the resident and indoor worker. As a result, future buildings must be constructed with measures to mitigate the migration of vapours from soil and groundwater to indoor air to ensure that this pathway does not represent a concern to human health. RMMs may include a soil vapour intrusion mitigation system (SVIMS) or an at or below grade storage/parking garage designed and constructed in accordance with the Ontario Building Code. In both of these RMMs, a vapour barrier will be installed to further mitigate the migration of vapours. This RMM is location dependant on the Site.

- Future building construction on the east portion of the Site (Area 1 on Figure 7.1) to include an at or below grade storage/parking garage with a vapour barrier or SVIMS to provide vapour mitigation.

- In the western portion of the site there are volatile COC in both the soil and groundwater (including the maximum measured soil concentrations), whereas on the eastern portion of the site there are no volatile COC in groundwater. Future buildings on the west portion of the Site (Area 2~~1~~ on Figure 7.1) shall include an SVIMS. Area 2~~1~~ includes a 30 metre buffer for all volatile COC.

The performance objective for this RMM is to meet the health-based indoor air trigger values. It is expected that the RMM will meet the required reductions (shown in Table 7.2 and Table 7.3); as acknowledged in Section 4.4.2.1 a robust system is required. Studies have shown that much higher effectiveness of a sub-slab depressurization mitigation system can be achieved (Folkes and Kurz 2002; Folkes 2003; U.S. EPA 2015), particularly in new construction. It is also noted that the COC with the highest reduction are limited spatially (TCE in soil only exceeds at BH18-11 and PHC F2 in groundwater only exceeds at BH18-07); therefore, it is expected that the risk assessment provides a very cautious estimate of the risk. Nonetheless, a robust vapour migration mitigation strategy has been recommended and this system is expected to achieve the required reductions. This will be confirmed through a monitoring program.

In addition to these RMMs, there will be a restriction on any future use of on-site groundwater for potable purposes. A soil and groundwater management plan is included to ensure that these media are handled appropriately during any future intrusive programs (e.g. construction activities). In addition, specifications for utility trenches (including trench plugs to mitigate potential migration of impacted groundwater) are included.

A summary of the performance objectives of the RMMs is provided in Table 7.1.

Table 7.1 Performance Objectives of the Risk Management Measures

Risk Management Measure	Estimated Reduction in Exposure
Hard Cap/Fill Cap Barrier	100% reduction in exposure to impacted soils for residents, outdoor maintenance workers, and terrestrial ecological receptors.
Hard Cap/Fill Cap Barrier	100% reduction in migration of soil to off-site aquatic environment.
Vegetable Garden Restriction	100% reduction in exposure to impacted soils for residents.
Health and Safety Plan	Reduction in exposure to impacted soil by subsurface workers (factor of 100)
Future building construction on the east portion of the Site (Area 1~~2~~ on Figure 7.1) to include an at or below grade storage/parking garage with a vapour barrier or SVIMS to provide vapour mitigation.	Reduction in the migration of vapours to indoor air to meet the health-based indoor air trigger values (refer to Table 7.2).
Future building construction on the west portion of the Site (Area 2~~1~~ on Figure 7.1) to include an SVIMS.	Reduction in the migration of vapours to indoor air to meet the health-based indoor air trigger values (refer to Table 7.3).

Table 7.2 and Table 7.3 summarize the EBCs protective of each of the human and ecological exposure scenarios for soil and groundwater, respectively, and presents the required concentration reduction required upon implementation of the identified RMMs.

Table 7.2 Effects-Based Concentrations Protective of Human Health and Ecological Receptors for COCs in Soil (µg/g)

Parameter	PSS	~~Terrestrial~~ Ecological Receptors (Terrestrial and Off-Site Aquatic)		Human Health - Direct Soil Contact		Human Health - Indoor Air*	
		EBC Protective of Ecological Receptors[a]	RMM (Required Reduction in Concentration)	EBC Protective of Human Health –Soil Contact[b]	RMM (Required Reduction in Concentration)	EBC Protective of Human Health – Indoor Air[c]	RMM (Required Reduction in Concentration)
Antimony	105.6	20[f]	Capping (5.3x)	7.5 63[h]	Capping (14.1x) HASP (1.7x)	NA	-
Arsenic	132	20	Capping (6.6x)	0.79 39[h]	Capping (167.1x) HASP (3.4x)	NA	-
Barium	1,764	390	Capping (4.5x)	3,800	-	NA	-
Cadmium	2.16	0.6	Capping (3.6x)	0.69	Capping (3.1x)	NA	-
Cobalt	57.6	40	Capping (1.4x)	22	Capping (2.6x)	NA	-
Copper	336	16	Capping (21x)	790	-	NA	-
Lead	8,160	31	Capping (263x)	120[d] 120[h]	Capping (68x) HASP (68x)	NA	-
Molybdenum	8.16	6.9	Capping (1.2x)	110	-	NA	-
Nickel	100.8	16	Capping (6.3x)	180	-	NA	-
Selenium	11.04	2.4	Capping (4.6x)	110	-	NA	-
Zinc	1,560	120	Capping (13x)	5,600	-	NA	-
Acenaphthene	1.68	NA	Capping (Qual.[e])	570	-	14	
Acenaphthylene	2.64	NV	Capping (Qual.[e])	57	-	0.82	Vapour mitigation (3.2x)
Anthracene	10.44	0.22	Capping (47.5x)	57	-	19	-
Benz[a]anthracene	6.6	0.32	Capping (20.6x)	5.7	Capping (1.2x)	120	-
Benzo[a]pyrene	10.32	0.37	Capping (27.9x)	0.57	Capping (18.1x)	340	-
Benzo[b]fluoranthene	16.8	NV	Capping (Qual.[e])	5.7	Capping (3x)	10,000	-
Benzo[ghi]perylene	10.08	0.17	Capping (59.3x)	57	-	NA	-
Benzo[k]fluoranthene	6.12	0.24	Capping (25.5x)	5.7	Capping (1.1x)	12,000	-
Chrysene	6.6	0.34	Capping (19.4x)	57	-	3,400	-
Dibenz[a,h]anthracene	2.4	0.06	Capping (40x)	0.57	Capping (4.2x)	60,000	-
Fluoranthene	14.4	0.69	Capping (20.9x)	57	-	450	-
Fluorene	1.68	0.19	Capping (8.8x)	720	-	NA	-
Indeno[1,2,3-cd]pyrene	9.96	0.2	Capping (49.8x)	5.7	Capping (1.8x)	84,000	-

Parameter	PSS	~~Terrestrial~~ Ecological Receptors (Terrestrial and Off-Site Aquatic)		Human Health - Direct Soil Contact		Human Health - Indoor Air*	
		EBC Protective of Ecological Receptors[a]	**RMM (Required Reduction in Concentration)**	**EBC Protective of Human Health –Soil Contact[b]**	**RMM (Required Reduction in Concentration)**	**EBC Protective of Human Health – Indoor Air[c]**	**RMM (Required Reduction in Concentration)**
Methylnaphthalene, 2-(1-)	14.4	NV	Capping (Qual.[e])	0.99 ~~[g]~~	Capping (14.5x)	NA	Vapour mitigation (Qual[e])
Naphthalene	5.64	0.6 [f]	Capping (9.4x)	4.5 ~~[g]~~	Capping (1.3x)	0.65	Vapour mitigation (8.7x)
Phenanthrene	6.4	0.56	Capping (11.4x)	NV	Capping (Qual.[e])	NA	-
Pyrene	9.6	0.49	Capping (19.6x)	540	-	3,500	-
Trichloroethylene	0.456	8.1	-	10	-	0.0011	Vapour mitigation (414.6x)
Benzene	10.08	25	-	9.3	Capping (1.1x)	0.21	Vapour mitigation (48x)
Toluene	30	150	-	2.3 ~~[g]~~	Capping (13x)	6.2	Vapour mitigation (4.9x)
Ethylbenzene	5.76	55	-	5.2 ~~[g]~~	Capping (1.1x)	2.1	Vapour mitigation (2.7x)
Xylene Mixture	51.6	95	-	35 ~~[g]~~	Capping (1.5x)	3.1	Vapour mitigation (16.7x)
PHC F1	480	210 [f]	Capping (2.3x)	6,900	-	130	Vapour mitigation (3.7x)
PHC F2	2,040	150 [f]	Capping (13.6x)	3,100	-	98	Vapour mitigation (20.8x)
PHC F3	45,600	300	Capping (152x)	5,800	Capping (7.9x)	NA	-
PHC F4	26,400	2,800 [f]	Capping (9.4x)	6,100	Capping (4.3x)	NA	-

Notes:

- \- Indicates that this COC is not a risk to this receptor.
- NA Not applicable
- NV No Value
- * See table below for breakdown for Area 1 (East) and Area 2 (West)
- a EBC is the lower of the Table 3~~9~~ component values calculated to be protective of plants/soil organisms and birds/mammals, or the Table 1 SCS for sediment.
- b EBC is the lower of the Table 3~~9~~ S1 and S2 component values protective of direct soil contact for residents and long-term outdoor workers.
- c EBC is the Table 3~~9~~ S-IA component value for R/P/I land use.

d MECP currently re-evaluating the TRV for lead; background value of 120 µg/g was used.
e RMM decision made based on a qualitative assessment, no risk reduction calculated. Risk reduction recommendations for other COC will be appropriate for these COC
f Qualitative assessment of potential impacts of soil on sediment indicates risk mitigation. Due to qualitative nature, EBC not provided but risk reduction recommendation will address this pathway.
g Based on S-Nose (no RMM is required for direct contact for these COC), other EBC in the column are based on direct contact
h For direct contact by the subsurface worker

Parameter	**PSS**	**EBC Protective of Human Health – Indoor Air[c]**	**Area 1 (East)**		**Area 2 (West)**	
			Maximum	**RMM (Required Reduction in Concentration)**	**Maximum**	**RMM (Required Reduction in Concentration)**
Acenaphthylene	2.64	0.82	2.2	Vapour mitigation (2.7x)	0.71	None
Methylnaphthalene, 2-(1-)	14.4	NA	9.1	Vapour mitigation (Qual[e])	12	Vapour mitigation (Qual[e])
Naphthalene	5.64	0.65	3.2	Vapour mitigation (4.9x)	4.7	Vapour mitigation (7.2x)
Trichloroethylene	0.456	0.0011	<0.03	Not detected, although DL is 27x EBC	0.38	Vapour mitigation (345x)
Benzene	10.08	0.21	8.4	Vapour mitigation (40x)	1.3	Vapour mitigation (6.2x)
Toluene	30	6.2	25	Vapour mitigation (4.0x)	4	None
Ethylbenzene	5.76	2.1	4.8	Vapour mitigation (2.3x)	1.3	None
Xylene Mixture	51.6	3.1	43	Vapour mitigation (14x)	9	Vapour mitigation (2.9x)
PHC F1	480	130	490	Vapour mitigation (3.7x)	220	Vapour mitigation (1.7x)
PHC F2	2,040	98	260	Vapour mitigation (2.7x)	1700	Vapour mitigation (17.3x)

Table 7.3 Effects-Based Concentrations Protective of Human Health for COCs in Groundwater (µg/L)

Parameter	PSS	EBC Protective of Human Health – Indoor Air[a]	RMM (Required Reduction in Concentration)*
Benzene	2.88	~~0.17~~0.5[b]	SVIMS (5.8~~17~~x)
PHC F2	1,200	150~~0.5~~[b]	SVIMS (8~~2,400~~x)
Trichloroethylene	2.64	0.5[b]	SVIMS (5.28x)
Vinyl chloride	0.74	0.5[b]	SVIMS (1.48x)

Notes:

* See table below for breakdown for Area 1 (East) and Area 2 (West)

a EBC is the Table 7 GW2 component values for R/P/I land use.

b The Ontario background concentration was greater than the GW2 component value and was thus selected.

Parameter	PSS	EBC Protective of Human Health – Indoor Air[a]	Area 1 (East)		Area 2 (West)	
			Maximum	RMM (Required Reduction in Concentration)	Maximum	RMM (Required Reduction in Concentration)
Benzene	2.88	0.5[b]	<0.2	None	2.4	Vapour mitigation (4.8x)
PHC F2	1,200	150[b]	<100	None	1000	Vapour mitigation (6.7x)
Trichloroethylene	2.64	0.5[b]	<0.2	None	2.2	Vapour mitigation (4.4x)
Vinyl chloride (current)	0.74	0.5[b]	<0.17	None	<0.2	None
Vinyl chloride (future)	0.74	0.5[b]	0.26	None	0.62	Vapour mitigation (1.2x)

7.1.1 Risk Management Measures

The RMMs that are required to eliminate, block, or manage exposure, for each COC and receptor are summarized in Table 7.4 for soil and Table 7.5 for groundwater. Detailed RMM requirements are presented in the following sub-sections.

Table 7.4 Risk Management Measures for Soil

Parameter	Ecological Receptors			Human Receptors			
	Plants & Soil Organisms	**Mammals & Birds**	**Aquatic Receptors**	**Residents (all ages)**	**Indoor Workers and Visitors (Indoor Air)**	**Long-Term Outdoor Workers**	**Subsurface Workers**
Metals							
Antimony	**Cover/fill**	**Cover/fill**	**Cover/fill**	**Cover/fill**	**-**	**Cover/fill**	~~Cover/fill~~ **HASP**
Arsenic	**Cover/fill**	**Cover/fill**	NA	**Cover/fill**	-	**Cover/fill**	~~Cover/fill~~ **HASP**
Barium	**Cover/fill**	**Cover/fill**	**Cover/fill**	NA	-	NA	NA
Beryllium	NA	NA	-	NA	-	NA	NA
Cadmium	NA	**Cover/fill**	**Cover/fill**	**Cover/fill**	**-**	NA	NA
Cobalt	**Cover/fill**	NA	NA	**Cover/fill**	-	NA	NA
Copper	**Cover/fill**	NA	**Cover/fill**	NA	-	NA	NA
Cyanide	NA	NA	NA	NA	-	NA	NA
Lead	**Cover/fill**	**Cover/fill**	**Cover/fill**	**Cover/fill**	**-**	**Cover/fill**	~~Cover/fill~~ **HASP**
Mercury	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	**Cover/fill**	-	NA	-	NA	NA
Nickel	**Cover/fill**	NA	**Cover/fill**	NA	-	NA	NA
Selenium	**Cover/fill**	**Cover/fill**	-	NA	-	NA	NA
Silver	NA	NA	NA	NA	-	NA	NA
Uranium	NA	NA	-	NA	-	NA	NA
Zinc	**Cover/fill**	NA	**Cover/fill**	NA	-	NA	NA
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	**Cover/fill**	NA	**Cover/fill**	NA	NA	NA	NA
Acenaphthylene	**Cover/fill**	**Cover/fill**	**Cover/fill**	**Vapour mitigation**	NA	NA	NA
Anthracene	**Cover/fill**	NA	**Cover/fill**	NA	NA	NA	NA
Benz[a]anthracene	**Cover/fill**	NA	**Cover/fill**	**Cover/fill**	NA	NA	NA
Benzo[a]pyrene	NA	NA	**Cover/fill**	**Cover/fill**	NA	**Cover/fill**	NA
Benzo[b]fluoranthene	**Cover/fill**	**Cover/fill**	**Cover/fill**	**Cover/fill**	NA	**Cover/fill**	NA
Benzo[ghi]perylene	**Cover/fill**	**Cover/fill**	**Cover/fill**	NA	**-**	NA	NA
Benzo[k]fluoranthene	NA	**Cover/fill**	**Cover/fill**	**Cover/fill**	NA	NA	NA
Chrysene	NA	**Cover/fill**	**Cover/fill**	NA	NA	NA	NA
Dibenz[a,h]anthracene	**Cover/fill**	**Cover/fill**	**Cover/fill**	**Cover/fill**	NA	**Cover/fill**	NA

Parameter	Ecological Receptors			Human Receptors			
	Plants & Soil Organisms	Mammals & Birds	Aquatic Receptors	Residents (all ages)	Indoor Workers and Visitors (Indoor Air)	Long-Term Outdoor Workers	Subsurface Workers
Fluoranthene	NA	**Cover/fill**	**Cover/fill**	NA	NA	NA	NA
Fluorene	**Cover/fill**	**Cover/fill**	**Cover/fill**	NA	-	NA	NA
Indeno[1,2,3-cd]pyrene	**Cover/fill**	**Cover/fill**	**Cover/fill**	**Cover/fill**	NA	**Cover/fill**	NA
Methylnaphthalene, 2-(1-)	**Cover/fill**	-	**Cover/fill**	**Cover/fill; Vapour mitigation**		NA	NA
Naphthalene	**Cover/fill**	NA	**Cover/fill**	**Cover/fill; Vapour mitigation**	NA	NA	NA
Phenanthrene	**Cover/fill**	NA	**Cover/fill**	-	-	-	-
Pyrene	**Cover/fill**	NA	**Cover/fill**	NA	NA	NA	NA
Volatile Organic Compounds							
Trichloroethylene	NA	NA	-	**Vapour mitigation**	**Vapour mitigation**	NA	NA
BTEX							
Benzene	NA	NA	-	**Cover/fill; Vapour mitigation**	**Vapour mitigation**	NA	NA
Toluene	NA	NA	-	**Cover/fill; vapour mitigation**	NA	NA~~**Cover/fill**~~	NA~~**Cover/fill**~~
Ethylbenzene	NA	NA	-	**Cover/fill; Vapour mitigation**	NA	NA	NA
Xylene Mixture	NA	NA	-	**Cover/fill; Vapour mitigation**	**Vapour mitigation**	NA	NA
Petroleum Hydrocarbons							
PHC F1	**Cover/fill**	-	**Cover/fill**	**Vapour mitigation**	NA	NA	NA
PHC F2	**Cover/fill**	-	**Cover/fill**	**Vapour mitigation**	**Vapour mitigation**	NA	NA
PHC F3	**Cover/fill**	-	**Cover/fill**	**Cover/fill**	-	**Cover/fill**	NA
PHC F4	**Cover/fill**	-	**Cover/fill**	**Cover/fill**	-	NA	NA

Notes:

NA – Not applicable, REMC does not exceed the component value
'-' – No component value available
Cover/fill – A hard cover or clean fill is required to block direct contact pathways
SVIMS – Soil Vapour Intrusion Management System and indoor air monitoring
Vapour mitigation – SVIMS or at or below grade garage/parking
HASP – Health and Safety Plan for subsurface worker

Table 7.5 Risk Management Measures for Groundwater

Parameter	Ecological Receptors	Human Receptors			
	GW3	**Residents (all ages)**	**Indoor Workers and Visitors (Indoor Air)**	**Long-Term Outdoor Workers**	**Shallow Subsurface Workers**
Volatile Organic Compounds					
Trichloroethylene	NA	**Vapour mitigation**	**Vapour mitigation**	NA	NA
Vinyl Chloride	NA	**Vapour mitigation**	**Vapour mitigation**	NA	NA
BTEX					
Benzene	NA	**Vapour mitigation**	**Vapour mitigation**	NA	NA
Petroleum Hydrocarbons					
PHC F2	None	**Vapour mitigation**	**Vapour mitigation**	NA	NA
PHC F3	-	-	-	-	-

Notes:
NA – Not applicable, the maximum concentration does not exceed the component value;
'-' – No component value available
SVIMS – Soil Vapour Intrusion Mitigation System and indoor air monitoring.
Vapour mitigation – SVIMS or at or below grade garage/parking

7.1.1.1 Hard Cap/Fill Cap Barrier

The hard cap/fill cap barrier RMM is similar to that described within the MGRA model. It consists of capping anywhere on the Site where there is less than 1 m of unimpacted soil between the soil surface and impacted soil to prevent direct exposure to the COCs or movement of impacted soils to the adjacent aquatic environment. This RMM is required for all areas that will not be covered by building foundations.

Unimpacted soil is soil in which no COCs are present, or in which COCs are present but at a concentration that is less than the applicable generic site condition standards for soil. Impacted soil is soil in which one or more COCs are present at a concentration greater than the applicable soil standard.

The barrier may consist entirely of a fill cap, or entirely of a hard cap, or of a hard cap in some areas of the Site and a fill cap in other areas of the Site. The application of capping measures within the RMP is required to ensure that unacceptable risks do not occur as a result of direct exposure to impacted soils.

Hard Cap RMM

The hard cap RMM (Figure 1, Appendix J) consists of capping of impacted soil on the Site not covered by at least 1 m of unimpacted soil with asphalt, concrete, a building slab, or a building foundation and floor slab, consisting of at least 150 millimetres of Granular “A” or equivalent material overlain by at least 75 millimetres of hot mix asphalt or concrete.

The implementation of the hard cap measure will include a site plan prepared and signed by a qualified person, retained by the owner of the Site, and made available for review by the MECP upon request, as amended from time to time following the completion of any alteration to the capping, which describes:

1. The Site
2. Placement of the capping on the Site including plan view and cross-section drawings specifying the vertical and lateral extent of the capping

Fill Cap RMM

The fill cap RMM (Figure 1, Appendix J) consists of capping of areas on the Site where impacted soils are present at or within 1 m below the soil surface with a minimum of 1 m of unimpacted fill cover, or at least 0.5 m of unimpacted fill cover immediately on top of a geotextile barrier.

At locations/areas where deep rooting vegetation will be planted, additional unimpacted fill material is required to provide sufficient contaminant free soil until the root system is established. A 1000 mm unimpacted growing medium thickness is considered sufficient to allow immature tree plantings (i.e., allow clean soil coverage over/around the root ball). An additional 1000 mm thickness by 4000 mm length/width excavation filled with unimpacted growing medium is considered adequate to provide sufficient contaminant free soil until the root system for new deep rooting plantings is established. The deep rooting vegetation fill cap is shown on Figure 1, Appendix J.

The fill cap RMM will include a site plan prepared and signed by a qualified person, retained by the owner of the Site, and made available for review by the MECP upon request, as amended from time to time following the completion of any alteration to the capping, which describes:

1. The Site
2. Placement of the capping on the Site including plan view and cross-section drawings specifying the vertical and lateral extent of the capping

7.1.1.2 Vapour Intrusion Mitigation Measures

Risks related to vapours migration to indoor air will be mitigated using an RMM that varies based on building location on the Site. Vapour intrusion mitigation may include a passive/active SVIMS or at or below storage/parking garage that is designed and constructed with a ventilation system that meets the requirements of the Building Code. Each of these measures is described in more detail below.

Passive/Active SVIMS

Future buildings on the west portion of the Site (Area 2~~1~~ on Figure 7.1) shall include an SVIMS (Figures 3 and 4, Appendix J). The area requiring the highest risk reduction (TCE in soil at BH18-11) is located on the west portion of the site. The SVIMS consists of a sub-slab venting layer in combination with a vapour intrusion barrier, with the following requirements:

1. Underneath the slab of the entire building area, a sub-slab venting layer consisting of:

   a. A network of perforated collection pipes (or geocomposite vapour collection drains) embedded in granular materials of appropriate permeability and thickness, and
   b. Vent boxes or junctions (or other suitable venting products) that convey all collected vapour into vent risers.
2. Immediately above the vapour venting layer, a geosynthetic vapour barrier meeting appropriate gas permeability and chemical resistance specifications, with a suitable protective geotextile between the venting layer and the geosynthetic vapour barrier.
3. Sealing of any penetrations through the geosynthetic vapour barrier to ensure integrity of the SVIMS.
4. Immediately above the geosynthetic vapour barrier and below the slab, a protective marker layer capable of providing warning to persons disturbing the slab of the existence of the geosynthetic vapour barrier and the vapour venting layer.
5. Vent risers to convey the vapour from the sub-slab vapour venting layer to the outside air above the top of the building(s) by means of wind-driven turbines designed and installed to be readily capable of conversion to active venting by means of an electrical fan or other powered device.
6. Monitoring ports in the vent risers to allow for sampling and assessment of vapour from beneath the slab.

The design and installation of the SVIMS shall be completed and signed by a qualified licensed professional engineer. Within 90 days of installation, the owner shall provide to the Director as-built drawings and detailed design specifications for the SVIMS.

Additional specifications for the sub-slab venting layer and the geosynthetic vapour barrier are provided below.

Sub-Slab Venting Layer

To depressurize the sub-slab environment and create a negative pressure with respect to the interior of the building, a sub-slab venting layer (Figure 3, Appendix J) is included in the construction of a new building. The sub-slab venting layer consists of a network of perforated collection pipes (or geocomposite vapour collection drains) embedded in granular materials, connected to vent boxes or junctions that convey collected vapour into vent risers. Wind-driven turbines draw vapour through the risers, which are vented to the outside air above the building. Pressure differentials created by this system will mitigate vapours from entering the building.

Geosynthetic Vapour Barrier

The vapour barrier (Figure 4, Appendix J) applied immediately above the vapour venting layer shall consist of a high-density polyethylene (HDPE) geomembrane and/or a spray-applied membrane. The membrane must surround the building structure completely at its contact with the ground.

An HDPE geomembrane system generally consists of three parts:

1. Base HDPE liner
2. Spray-applied composite material
3. Additional HDPE liner

The base HDPE liner is applied in a grid pattern over the sub-slab venting layer, with the grid shape and size designed prior to application and determined based on site-conditions. The HDPE liner is produced in an egg carton/honeycomb pattern, which is wrapped in geotextile material. It is referred to as a low-profile system due to its size, about 1” tall by 12” wide, and is provided in 100’ rolls. The wrapped HDPE liner is applied immediately over the sub-slab venting layer, followed by application of the spray-applied composite material, the additional HDPE liner, and the protective marker layer.

Storage/Parking Garage RMM

Future buildings on the east portion of the Site (Area 1~~2~~ on Figure 7.1) that are not constructed with an SVIMS shall include a storage/parking garage, as defined in the Building Code, with the following requirements:

1. The storage garage will be constructed at or below the final grade of the building
2. The storage garage will cover the entire building area at grade
3. ~~2.~~ An outer multi-layer membrane will be place to significantly reduce vapour migration through the foundation/floor slab (Figure 4, Appendix J) as described for SVIMS above.

A standard ventilation system in the storage garage will remove vapours that might enter the structure from the contaminated soil or groundwater. The following conditions will apply:

a. The ventilation and air duct systems serving the garage shall be separate from the systems serving all stories above the garage

b. Compliance with all applicable requirements of the Building Code including, without limitation, the provisions governing the following:
    i. Interconnection of air duct systems as set out in Division B, subsection 6.2.3.9 (2)
    ii. Provisions for air leakage as set out in Division B, section 5.4.

A ventilation system is mandatory for any storage garage to prevent the accumulation of toxic chemicals present in the exhaust from automobiles. The ventilation system is designed to provide a continuous supply of outdoor air at a rate of 3.9 L/s for each square metre of floor area, will would address concerns associated with chemicals present in automobile exhaust as well as the potential migration of vapours from underlying soil or groundwater to above-grade common areas and residential units.

7.1.1.3 Site Restrictions

In addition to the RMMs described in Section 7.1.1, the following restriction is required.

Vegetable Garden Restriction

The construction of vegetable gardens, other than those planted in above ground containers isolated from subsurface conditions, is restricted to protect residents from the consumption of foods grown directly in impacted soils. To ensure that gardens are isolated from the subsurface, raised vegetable garden beds may be constructed as follows:

1. Using a minimum of 60 cm of clean growing medium in areas where a Fill Cap is present that includes a geotextile barrier.
2. Using a minimum of 60 cm of clean growing medium immediately on top of a geotextile barrier in areas where the fill cap does not include a geotextile barrier.

7.2 Off-Site Implications of Risk Management Plan

RMMs (i.e., hard cap/fill cap barrier and vapour mitigation measures for future buildings) presented in the RMP are not anticipated to pose any adverse effects to off-site human or ecological receptors. Further, it is anticipated that the hard cap/fill cap barrier RMM will improve off-site conditions in the adjacent aquatic environment as a result of decreased surface soil migration into the water body.

7.3 Duration of Risk Management Measures

The RMMs are required until it can be demonstrated that concentrations in soil and groundwater meet the EBCs presented in Table 7.2 and Table 7.3, respectively.

7.4 Monitoring and Maintenance Requirements

Monitoring and maintenance requirements for the hard cap/fill cap and vapour intrusion mitigation RMMs are provided below.

7.4.1 Hard Cap/Fill Cap

The hard cap/fill cap RMM requires on-going inspection and maintenance of the capping to ensure the continuing integrity of the capping, including:

1. Semi-annual (spring and fall) inspections of the capping by the Owner or an assigned representative
2. Identification of any deficiencies observed during the inspection or at any other time
3. The repair forthwith of any such deficiencies
4. A permanent record of inspections, deficiencies, and repairs in a logbook maintained by or on behalf of the Owner and available for review by the MECP upon request.

7.4.2 At/Below Grade Garage

The At/Below Grade Garage RMM requires on-going inspection and maintenance to ensure the continuing integrity of the concrete structure, sealing of below grade slab/wall penetrations, and to ensure design flow rate is achieved and maintained, including:

1. Semi-annual (spring and fall) inspections of the structure and ventilation systems(s) by the Owner or an assigned representative
2. Identification of any deficiencies observed during the inspection or at any other time
3. The repair forthwith of any such deficiencies
4. A permanent record of inspections, deficiencies, and repairs in a logbook maintained by or on behalf of the Owner and available for review by the MECP upon request.

7.4.3 SVIMS

An inspection and maintenance program will be developed by a qualified professional (i.e, qualified engineer). A qualified professional representative of the property owner will inspect the SVIMS to ensure the continuing integrity of the SVIMS and to mitigate the entry of vapours from contaminated soil and groundwater to indoor air for buildings constructed within Area 2~~1~~ (see Figure 7.1). The program is to include:

1. Semi-annual (spring and fall) inspection of the SVIMS
2. Identification of deficiencies in the SVIMS observed during the inspection or at any other time
3. The repair forthwith of any such deficiencies
4. A permanent record of inspections, deficiencies, and repairs in a logbook maintained by or on behalf of the Owner and available for review by the MECP upon request.

A qualified engineer will prepare a report verifying that the system was constructed in conformance with the design specifications and certifying that the system adequately depressurizes the sub-slab void space. Leak testing will be undertaken to demonstrate a minimum depressurization of 0.02 inches H_2O or another depressurization target as specified by the engineer. Smoke testing may be used to identify leaks through preferential pathways between the sub-slab space and the building interior. The engineer's report will include the original design drawings that show the as-built locations of risers and monitoring ports in plan view and include recommendations for inspection, maintenance, and on-going performance monitoring. A copy of this report must be available for review by the MECP upon request.

To ensure that concentrations of vapours in indoor air within any future on-site buildings do not represent a risk to residents and indoor workers, sub-slab vapour samples will be collected from each monitoring port of newly constructed buildings following completion of construction and prior to building occupancy. Samples are required to meet the sub-slab vapour trigger values provided in Table 7.6. Sub-slab trigger values are modified HBIAC for residential property use divided by an attenuation factor (0.02). If all samples meet the trigger values, building occupancy may proceed. If an exceedance of a trigger value is identified, indoor air sampling must be conducted.

The sub-slab vapour sampling program must include the following:

i. The sub-slab vapour sampling must be completed in accordance with requirements of the *Draft Technical Guidance: Soil Vapour Intrusion Assessment Guideline* (MOECC 2013)
ii. Sampling must be protective of human health for any persons using or occupying the buildings on the Site
iii. The monitoring program must include analysis of the COCs identified in the Risk Assessment as representing a potential concern via the vapour infiltration pathway
iv. Records of all sampling data must be available for inspection by the MECP upon request
v. Should there be a reason to change the selected sampling location (s), the MECP must be notified in writing
vi. If the sub-slab vapour concentration for any COC exceeds the trigger value, the MECP must be notified in writing within three business days of the results and resampling will occur within ten days of receipt of the analytical data.

Following occupancy, sampling at each monitoring port will be conducted on a quarterly basis for two years. Samples must be collected during periods that are reflective of seasonal variability (i.e., spring, summer, fall, and winter). If the sub-slab results during the two-year period show that the COCs meet the trigger values, a Qualified Person, on behalf of the Owner, can submit a request to the MECP Director to alter or revoke the requirement for sub-slab vapour monitoring.

If sub-slab vapour results at any location are above the trigger values on one occasion, the MECP will be notified in writing within three business days and another sample must be collected and analyzed within ten days of receipt of the analytical data. If the second sample meets the trigger values, no further action is required. If two consecutive sub-slab vapour samples exceed the trigger values, indoor air samples must be collected to provide additional assessment of indoor air risks.

Indoor air monitoring will be conducted and compared to the HBIAC. Air samples should be collected over a 24-hour duration from the occupied spaces of the on-site building using a summa canister or sorbent tubes and submitted to an accredited laboratory for analysis and be consistent with the recommendations provided in the draft technical guidance (MOECC 2013). Indoor air and sub-slab vapour samples should be collected on a quarterly basis for two years. At least one sample each year must be collected in winter (December through February) and summer (June through August) to capture seasonal variability.

If indoor air results at any location are above the trigger values on one occasion, the MECP must be notified in writing within three business days and another sample must be collected from that same location and analyzed within ten days of receipt of the analytical data. If the second sample meets the trigger values, no further action is required. If two consecutive indoor air samples exceed the trigger values, the building resident would be notified (if feasible access to the indoor area should be restricted) and a Qualified Person will submit a detailed plan to mitigate exposures to the MECP within 45 days of receipt of the second set of analytical results.

Table 7.6 includes the indoor air and sub-slab vapour trigger values for COCs in soil and/or groundwater that represent a risk to human health via vapour migration to indoor air within Area 2~~1~~.

Table 7.6 Indoor Air and Sub-Slab Vapour Trigger Values

Parameter	Indoor Air Trigger Values - HBIAC ($\mu g/m^3$)[a]	Sub-Slab Trigger Values ($\mu g/m^3$) HBIAC ÷ 0.02
Benzene	0.506	25.3
Toluene	1042.9	52,143
Ethylbenzene	396.29	19,815
Xylenes mixtures	146	7,300
PHC F1	2490.6	124,530
PHC F2	470.6	23,530
Acenaphthylene	0.185	9.27
Naphthalene	0.77	38.5
Trichloroethylene	0.27	13.5
Vinyl chloride	0.13	6.5

Notes: [a] – HBIAC for residential land use in the MGRA Model (MOECC 2016b)

7.4.4 Groundwater Monitoring

TCE and PHC F2 and F3 exceeded the Table 9 SCS in groundwater. No on-going groundwater monitoring is recommended for the following reasons:

- The TCE plume is confined to the Site. As the TCE plume is likely related to historical paint shop activities that occurred on the Site several decades ago, this plume is considered stable and unlikely to expand toward Midland Bay. Further, at the concentrations present it is considered unlikely that degradation of the TCE would result in significant concentrations of vinyl chloride in the future.

- The PHC F2 and F3 likely extends to the west property boundary but does not extend to Midland Bay. As the PHC plume is likely related to historical fuel storage activities that occurred on the Site several decades ago, this plume is considered stable and unlikely to expand toward Midland Bay. Further, at the concentrations present, it is unlikely that migration of vapours to the nearest off-site receptor (cross-gradient to the west), a commercial/industrial property, would result in a vapour migration risk.

7.4.5 Record Keeping and Reporting

Inspections of the hard cap/fill cap will be documented to maintain a permanent record of the conditions at the Site. The Owner will prepare by March 31 of each year an annual report documenting activities undertaken in the previous calendar year related to the hard cap/fill cap. The Owner will maintain all records/reports and make them available to the MECP upon request.

A report documenting the vapour sampling will be prepared each year after the last vapour sampling event that is conducted for that year (discussed in Section 7.4.2). The Owner will maintain copies of these reports and will make them available to the MECP upon request.

A Soil and Groundwater Management Plan (see Section 7.6) will be developed for all future construction activities that will require the excavation and disturbance of soil and/or groundwater.

7.4.6 Contingency Plan

The RMMs proposed for the Site will block the exposure pathways of concern. Contingency plans for the engineered RMMs are outlined in this section.

<u>Hard Cap/Fill Cap</u>

The monitoring and maintenance program for the cap should avoid the need for contingency plans by identifying issues early and addressing them. However, if a significant breach of the cap is identified contingency measures could include the use of temporary fencing to restrict access to the area or providing a temporary barrier until a more permanent solution can be determined.

Vapour Mitigation

As discussed in the previous sections if two indoor air samples exceed the trigger values a Qualified Person will submit a detailed contingency plan to mitigate exposures to the MECP. The monitoring and maintenance program for the system should provide information to inform the contingency plan. Additional information may be required to determine whether the result is due to system failures (such as damaged components or new cracks in the slab) or poor performance (system is not mitigating the vapour intrusion as expected). Once the potential failure mechanism has been identified a detailed contingency plan (e.g., fix damaged components, increase air exchange rates for building) can be developed to address the specific concern identified.

At least one round of sub-slab sampling or indoor air sampling should be conducted after the implementation of the contingency program, with acceptable results, before resumption of the regular monitoring program.

In all cases the required repairs or modifications will be documented, and the records would be available to the MECP to review upon request.

7.5 Sub-Surface Worker HASP

A site-specific HASP must be implemented during sub-surface activities (e.g., excavation). A HASP for the sub-surface worker is provided as Appendix J.

7.6 Soil and Groundwater Management Plan

General soil and groundwater management plan requirements are presented below.

7.6.1 Soil Management

Detailed requirements for a Soil Management Plan will be outlined in the Certificate of Property Use (CPU) for the Site, under O. Reg. 153/04. A detailed Soil Management Plan will be prepared by a QP_{ESA} on behalf of the Owner if, and when, a future construction project is to take place. The Soil Management Plan must be made available to the MECP upon request.

1. The soil management plan will comply with Clauses 30 to 39 of Schedule E of O. Reg. 153/04. The soil management plan will address as a minimum, the following: Notification to construction and outdoor maintenance workers of the soil conditions.

2. Management of excess soil (e.g., direct loaded for disposal at an approved landfill facility or stockpiled on-site for further characterization). If any soil is exported from the S~~s~~ite it will follow O.Reg. 406/19 and the revised O.Reg. 153/04, when it comes into effect. If soil is stockpiled on-site, the following measures should be taken:
    - Stockpile material should be placed within an appropriately constructed berm on a low-permeability surface (e.g., polyethylene sheeting).
    - Stockpile material should be covered at the end of each workday to limit dust generation and the potential for erosion and run-off.
    - Stockpile material should be sampled by an environmental consultant (*i.e.*, QP_{ESA}) to assess the soil quality prior to reuse or disposal. At a minimum, soil samples should be submitted for analysis of the COCs.
3. Methods for soil tracking from the Site by vehicles, equipment, and personnel.
4. Information to be supplied by the contractor related to the off-site disposal of any impacted soil:
    - Soil disposal location
    - Proof of soil disposal (i.e., waybills or tonnage tracking sheets provided by the receiver)
    - Environmental Compliance Approval for the receiving facility or acceptance letter from the receiving property's QP_{ESA}
5. Dust control measures and prevention of soil tracking by vehicles and personnel from the Site, including wetting of soil with potable water, reduced speeds for on-Site vehicles, tire washing stations, and restricting working areas in high wind conditions.
6. Sampling of soil received at the Site in accordance with the requirements set out in Clause 31~~4~~ of Schedule E of O. Reg. 153/04. At least one sample shall be analyzed for each 160 m^3 of soil for the first 5,000 m^3 to be assessed at each source property from which soil is being brought to the Site, following which at least one sample for each additional 300 m^3 of soil which is to remain on, in or under the Site shall be analyzed.
7. Record keeping, including dates and duration of work, weather and Site conditions, location and depth of excavation activities, dust control measures, stockpile management and drainage, all material characterization results, names of the Qualified Person, contractors, haulers and receiving locations for any material removed from the Site, and any complaints received relating to Site activities.

Excavated soil with COCs in excess of the applicable generic soil standard (but below the PSS), may not remain at the surface of the Site after the completion of a construction project, unless it is capped in accordance with the hard cap/fill cap barrier RMM.

Excavated materials requiring off-Site disposal would need to be disposed of in accordance with the provisions of O. Reg. 347. Excavated material meeting the PSS may be placed on-site below the base of a Hard Cap of Fill Cap, if deemed suitable by the QP_{ESA} in consideration of the requirements of the Risk Assessment.

Excavated material meeting the generic Table 9~~3~~ SCS applicable for the Site may be placed on-site at any depth, if deemed suitable by the QP_{ESA} in consideration of the requirements of the Risk Assessment.

The characterization of excavated materials to determine whether it may be placed below the Hard Cap or Fill Cap, or incorporated within the Fill Cap, shall including the collection and analyses of soil samples in accordance with the requirements set out in Clause 34.1 and segregated and sampled in accordance with the requirements of Clause 35 and 36 of Schedule E of O. Reg. 153/04. For excavated soil volume of ≤5000 m^3, sampling will be completed in accordance with Schedule E, Table 2 of O. Reg. 153/04. For excavated soil volume of >5,000 m^3, sampling will be completed in accordance with the following formula as referenced in Schedule E, Clause 36.6 of O. Reg. 153/04.

$N = 32 + (V – 5000) \div 300$

Where:

N = the minimum number of samples

V = the stockpile volume in cubic metre

7.6.2 Groundwater Management

Detailed requirements for a Groundwater Management Plan will be outlined in the CPU for the Site, under O. Reg. 153/04. The Groundwater Management Plan must be made available to the MECP upon request.

A groundwater management plan shall be developed and implemented prior to commencing any intrusive works at the Site that will or may potentially involve removals of contaminated groundwater from the subsurface within Area 2~~1~~ (see Figure 7.1). Groundwater encountered during construction in Area 1~~2~~ must also~~still~~ be managed and disposed appropriately, and the groundwater quality must meet the criteria for the disposal method.

The plan shall be developed and overseen by, or under the supervision of a QP_{ESA} per Section 5 (2) of O. Reg. 153/04 (a "QPESA") and describe requirements relating to:

- Management of groundwater removals (e.g., of-site disposal or on-site treatment of disposal by a contractor with an MECP Environmental Compliance Approval), including temporary containment, environmental quality characterization, treatment, and final disposition requirements.

- Record keeping, including dates and duration of work, weather and Site conditions, location and depth of water extractions, names of the $QP_{ESA(s)}$, contractors, waste haulers and receiving locations for any water removed from the Site, and any complaints received relating to site activities, proof of disposal, Environmental Compliance Approval for the receiving facility. Record keeping should also include groundwater analytical results

7.6.2.1 Utility Trenches and Trench Plugs

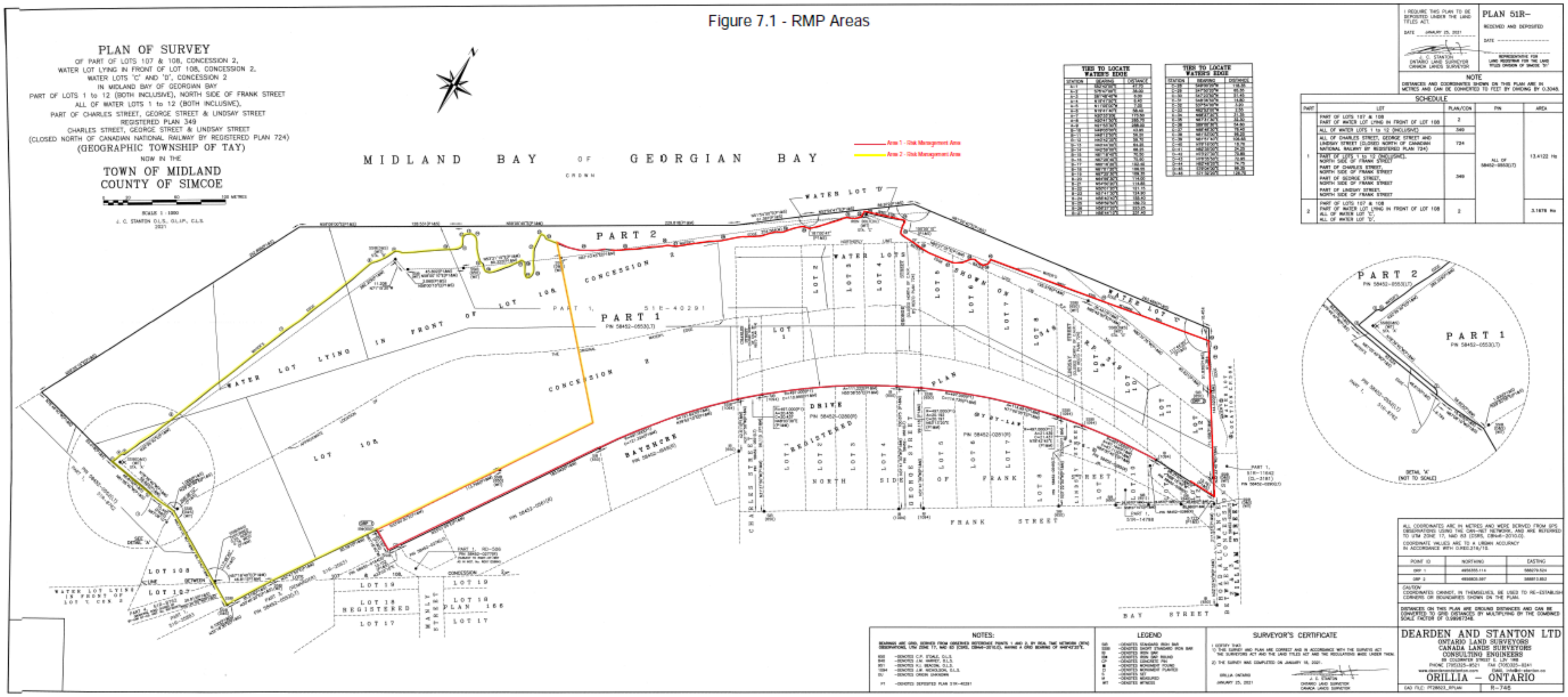
All new sub-surface utility conduits/piping within Areas 1 and 2 (see Figure 7.1) shall be installed in trenches backfilled with unimpacted fill material (see Figure 5, Appendix J).

To mitigate potential migration of impacted groundwater along future utility corridors to offsite locations, new service connections to the Site shall be equipped with trench plugs (see Figure 6, Appendix J) consisting of either clay plugs or cut-off collars located at or near the property boundary.

Clay plugs should be 1 metre thick measured along the pipe, and should completely replace the embedment and backfill material surrounding the service. Clay plugs should meet the content requirements and be compacted to the specifications determined by an appropriately qualified Professional Engineer licensed to practice in Ontario.

Alternatively, cut-off collars comprising unshrinkable fill can be installed around services, with watertight connections made between the collar and service wall. Collars should not be placed within 1 metre of a pipe joint, and appropriate precautions should be employed to ensure that backfill placed around the collars is appropriately compacted.

Figure 7.1 Risk Management Plan Areas (revised)



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LIST OF APPENDICES

APPENDIX A

PRE-SUBMISSION FORM (Electronic)

APPENDIX B

MINISTRY CORRESPONDENCE

SCHEDULE A

To Director's Notice dated July 8, 2019

Comments by Ministry of Environment, Conservation and Parks On Pre-Submission Form

420 Bayshore Drive, Midland
PSF1765-19
(IDS Ref No. 0155-BC6QVC)

The following are Ministry comments on the following Pre-Submission Form (PSF):

- **Pre-Submission Form for 420 Bayshore Drive, Midland, Ontario, report prepared by Canada North Environmental Services Limited Partnership, dated May 2019**

Ministry reviewers offer comments, observations and questions, as follow, for the proponent's consideration in preparing a risk assessment for submission under the Records of Site Condition Regulation, O. Reg. 153/04 (Regulation).

Comments provided by the Ministry on the content of this Pre-Submission Form are not in any way a Director's response to a risk assessment referred to in subsection 168.5 of the EPA.

It also should be noted that a risk assessment submitted to the Ministry under the Regulation must include all mandatory requirements for risk assessments as listed in Table 1 of Schedule C of the Regulation. These requirements must be met or the risk assessment will be deemed incomplete and may be returned without further review.

It should also be noted that a risk assessment submitted to the Ministry under the Regulation must include a copy of the PSF as well as a response outlining how the comments in this Ministry review have been considered in the risk assessment.

The Regulation, guidance documents and associated fact sheets have been prepared to assist proponents. They can be found posted to the following site:

https://www.ontario.ca/page/brownfields-redevelopment

Timeline for Review of Risk Assessment

The proposed Risk Assessment (RA) will be a RA other than those identified in O. Reg. 153/04, Schedule C, Part II OR. Therefore, the review timeline for the RA will be set at 16 weeks. Section 46 of the Regulation provides specified maximum timelines for review of a RA by the Ministry. The Ministry's timeline for review of the RA under Section 46 of the Regulation will commence on receipt by the Ministry of a risk assessment in accordance with Section 2 of Schedule C of the Regulation.

COMMENTS ON PRE-SUBMISSION FORM

The following comments pertain to the Pre-Submission Form (PSF) for 420 Bayshore Drive, Midland, Ontario, report prepared by Canada North Environmental Services Limited Partnership, dated May 2019

General Comments

The PSF is being submitted to support a Risk Assessment (RA) and Record of Site Condition (RSC) for the mixed use industrial and parkland property located at 420 Bayshore Drive in Midland, Ontario (the 'Site'). The Site, also identified as Midland Bay Landing, is approximately 16.24 hectares in size and extends into Midland Bay to the north. The Site was historically industrial/parkland use and was occupied by an aggregate processing plant, coal docks and coal storage with rail spurs, boat dry dock, parking lot, and park. Currently, a marine rail system and small shed is located within a chain-link fenced enclosure in the central portion of the Site and concrete and sheet pile retaining structures are present in the western portion of the Site. An RSC is being sought based on the proposed mixed commercial, residential and parkland use.

The Phase One Environmental Site Assessment (ESA) and Phase Two Conceptual Site Model (CSM) prepared by Cambium Inc. (Cambium) in 2019 summarize investigations conducted by Cambium and previous consultants on multiple Areas of Potential Environmental Concern (APECs) related to on- and off-Site Potentially Contaminating Activities (PCAs). The applicable soil Site Condition Standard (SCS) for the Site has been identified as the Table 9 Generic SCS for Use within 30 m of a Water Body in a Non-Potable Groundwater Condition for residential/parkland/institutional property use with coarse textured soils. A low pH sample was identified in surface soil by a previous consultant and additional soil samples were collected to assess the implications of that result; however, it is currently unclear if the low soil pH result was appropriately averaged in accordance with MECP (2007) guidance. Soil Contaminants of Concern (COCs) include metals and inorganic parameters, volatile organic compounds (VOCs), benzene, ethylbenzene, toluene, petroleum hydrocarbons (PHCs), and polycyclic aromatic hydrocarbons (PAHs). Due to the presence of shallow groundwater (minimum depth to groundwater of 0.34 metres below ground surface [mbgs]), the maximum measured groundwater concentrations were compared to the Table 7 Generic SCS for Shallow Soils in a Non-Potable Ground Water Condition for residential/parkland/institutional property use with coarse textured soils. Groundwater COCs include benzene, PHC F2, PHC F3, and trichloroethylene. To account for potential degradation of the chlorinated aliphatic compounds, vinyl chloride is also carried forward as a groundwater COC. Sediment and surface water samples were collected in Midland Bay. Sediment COCs include metals and PAHs, and surface water contaminants include copper, chromium (total), and zinc. The proposed RA will be a RA other than those identified in O. Reg. 153/04, Schedule C, Part II (i.e., Tier 3 RA).

Specific Review Comments

1) **Section 1 – Property Information.** Editorial Comment – It appears that the Site's municipality has been incorrectly indicated as Barrie. This should be revised in the RA report.

2) **Section 3.2 – Adjacent Property Use Information.** The information presented is not consistent with Section 2.1 (Phase One Property Information) of the Phase One ESA. Specifically, it appears the QP has mixed up the east and west neighbouring properties. This should be reviewed and revised accordingly.

3) **Section 3.3.11 – Depth of Organic Contamination in Soil and Section 3.3.12 – Depth of Inorganic Contamination in Soil.** For future PSFs, the QP is reminded that the depth of contamination should be presented as a range of soil depths where chemical parameters are in excess of the applicable SCS.

4) **Section 3.5.9 – Intended Use of the Property.** While the PSF has indicated that the intended use of the property will include commercial, parkland, and residential use, the PSF does not provide commentary on the proposed future development (i.e., low-rise and mid-rise commercial/residential condominium units, as presented in the Phase Two CSM). Details on the proposed developments at the site should be presented in the RA report, if known.

5) **Section 3.6 – Contaminant Inventory for Full Depth Soil.**

   a) A minimum soil pH of 4.11 has been reported, which is outside of the acceptable MECP range of 5 to 9 for surface soils and 5 to 11 for subsurface soils. There is no discussion of this low soil pH sample in the PSF; however, the Phase Two CSM does indicate that only one low pH soil sample was observed and four additional soil samples collected in the vicinity of this location had pH within the acceptable range. The QP is recommended to include all Certificates of Analysis (CofAs), analytical data summary tables, and appropriate discussion in the upcoming RA report so the reviewer can confirm that this low soil pH result was appropriately averaged in accordance with MECP (2007) guidance.

   b) The potential for exceedance of applicable SCSs at nearest off-site receptors has been left blank for cyanide (CN-) and mercury. Please clarify.

6) **Section 3.6 – Contaminant Inventory for Groundwater.** Based on the information presented in the PSF, the reviewer could not confirm whether the list of chemical parameters identified as COCs is complete. The QP is reminded that the RA report should provide full analytical data tables and CofAs for review.

7) **Section 3.6 – Contaminant Inventory for Surface Water.** The information presented in the PSF form appears to be incomplete as the Phase Two indicates that surface water was sampled for BTEX, PHCs, PAHs, and metals. Based on the available information, the

reviewer could not confirm whether the list of chemical parameters identified as COCs is complete. This information, if available, should be included in the RA. The QP is reminded that the RA report should provide full analytical data tables and CofAs for review.

8) **Section 5 – Human Health Conceptual Site Model – Without RMMs (Figure).**

   a) Since the RA property includes a portion of Midland Bay, the QP should clarify why direct and indirect contact with surface water and sediment by on-site receptors isn't considered to be a complete exposure pathway and included in the HHRA for quantitative assessment.

   b) Since the minimum depth to groundwater is 0.34 mbgs, there is the potential for residents/visitors working within vegetable gardens/flower beds and outdoor workers conducting site maintenance to come into direct contact with groundwater. The QP should consider these exposure pathways to be complete or provide supporting rationale to demonstrate that they are incomplete.

   c) For complete exposure pathways (i.e., potential pathway of exposure [included in the HHRA]), the QP is recommended to indicate whether each pathway will be quantitatively or qualitatively evaluated.

   d) Since Midland Bay may be used by visitors for fishing, the inclusion of an off-site visitor receptor scenario should be considered, for completeness.

   e) Given the shallow depth to groundwater, the QP should include groundwater uptake by biota and subsequent ingestion by on-site human receptors (i.e., potential for community garden with produce uptake from groundwater and subsequent ingestion by residents/visitors).

9) **Section 5 – Human Health Conceptual Site Model – With RMMs (Figure).**

   a) The QP should identify the potential RMM(s) that will be implemented to block/mitigate each exposure pathway.

   b) It is not clear what RMM will be proposed in the RA report to mitigate direct contact exposure with impacted groundwater by off-site subsurface workers. This should be clarified in the RA report.

10) **Section 6 – Ecological Conceptual Site Model – Valued Ecological Components.** It is not clear why mammals, avian species, and reptiles/amphibians with breeding habitat are indicated as not applicable. This should be clarified in the RA report.

11) **Section 6 – Ecological Conceptual Site Model – Terrestrial Ecological Pathways.** The PSF form indicates that root uptake of surface water is a complete pathway on-site; however, this pathway is indicated as incomplete in the ecological CSM figure. This discrepancy

should be clarified in the RA report.

12) **Section 7 – Conceptual Site Model, Subsection 3(8)(a.1)(v).** Since the Site includes and is adjacent to Midland Bay, the QP should clarify why this subsection is not applicable.

13) **Appendix A – Plan of Survey and Lawyer's Letter.** For the legal plan of survey, the QP is recommended to outline the RA property boundaries in a different colour to allow for a better understanding of the site's location.

14) **Appendix C – Notification of Nonpotable Groundwater Condition.** Any responses from municipalities on the submitted notification of nonpotable groundwater condition should be included in the RA.

15) **Appendix D – Risk Assessment Approach.**

    a) **Table 5 – Reasonable Estimate of the Mean for Soil Compared to applicable Components of Generic Standard – HHRA.**

        i) It appears that there is a typo in the table title and should instead state "Reasonable Estimate of the *Maximum Concentration* for Soil."

        ii) The QP is recommended to review the identification of component value exceedances. For example, the Reasonable Estimate of the Maximum Concentration (REMC) of PHC F4 is above its respective S1 component value and the REMC of acenaphthylene is above its respective S-IA component value; however, they were not flagged as exceedances in the table.

    b) **Table 6 – Reasonable Estimate of the Mean for Groundwater Compared to Applicable Components of Generic Standard – HHRA.**

        i) It appears there's a typo in the header and should state "Reasonable Estimate of the *Maximum Concentration* for Groundwater."

        ii) The REMC presented in Table 2 (Summary of COC in Groundwater) for vinyl chloride and PHC F3 is inconsistent with Table 6. This should be reviewed and revised in the RA report.

        iii) The QP should provide a rationale and reference for the derivation of the modified GW1 component value (for the protection of direct contact by subsurface workers) based on a daily incidental groundwater ingestion rate of 0.02 L/day.

    c) **Surface Water Exposure by Human Health Receptors.** The QP has not presented an approach on how surface water data will be utilized in the HHRA. This should be clarified.

d) **Table 8 – Toxicological Reference Values for Non-carcinogenic Effects Modified from MGRA, Ethylbenzene.** The chronic RfD presented of 0.01 mg/kg/day appears to be incorrect and should instead be 0.1 mg/kg/day. Additionally, the ethylbenzene RfC is not based on a developmental endpoint, as identified in Table 8. The QP should confirm whether the component values derived and presented in Table 5 (Reasonable Estimate of the Mean for Soil Compared to applicable Components of Generic Standard – HHRA) should be revised.

e) **Section 3.1 – Selection of Receptors.** The VECs listed in the ecological risk assessment approach are not consistent with those listed in the PSF form (i.e. mollusc and amphibian community are not discussed). This should be clarified in the RA report.

f) **Section 3.2.3 – Sediment.** The QP is reminded that the assessment of sediment should be consistent with MECP guidance: *Guidelines for Identifying, Assessing and Managing Contaminated Sediment in Ontario: An Integrated Approach* (MECP, 2008).

16) **Phase Two CSM – Applicable Site Condition Standard.** The QPESA has identified the applicable soil standards as Table 9 SCS and groundwater standards as Table 7 SCS. The QP is reminded that only one set of standards can apply to the Site. In addition to comparing groundwater parameters to the applicable SCS, to account for the shallow water table, the QP can conduct an additional screening of all volatile parameters in groundwater, that would address conditions where limited (or no biodegradation) is expected to occur (e.g. screen all volatiles in groundwater to Table 6/7 GW2 component values, as appropriate).

17) **Other Comments.**

a) The inclusion of borehole logs, certificates of analysis, and tables presenting all soil, groundwater, surface water and sediment analytical results relied upon in the PSF/RA is required.

b) It is noted that CVs were not provided as part of the PSF submission. The QP is reminded that the proposed RA team will need the appropriate level of experience for each discipline (e.g., RMM engineer, hydrogeologist) to complete the RA in accordance with O. Reg. 153/04 (as amended).

CSPB Comments on Phase Two CSM

CSPB is currently reviewing the phase two CSM for this file. It is recommended that the QPESA follow up directly with CSPB regarding the status of the phase two CSM review; the CSPB contact is Rose Ash; email: rosemary.ash@ontario.ca

Summary and Conclusions

Based on the information provided in the PSF, the reviewer recognizes the rationale to select Table 9 SCS for soil and sediment and Table 7 SCS for groundwater; however, the QP is reminded that only one set of standards can apply to the Site. Additionally, it is recommended that the HHRA and ERA CSMs are reviewed to ensure that all applicable exposure pathways have been considered.

Risk Management Measures (RMMs)

- This is a relatively large municipally owned water front property that is planned to be developed with a mixed use of commercial, residential and parkland Property Uses. As a result, even though a public communication plan is not required under the regulation for this risk assessment, it is recommended that one be undertaken by the owner/municipality as the general public will likely have a high interest in this project.

- The PSF has identified that risk management measures are to be utilized, however, they did not identify which types of risk management measures would be used. It should be noted that if the use of risk management measures are to be part of the risk assessment, details on these measures will be required to be included in the risk assessment report, including a clear description of the risk management measures and/or any property restrictions; performance objectives; duration; and any maintenance, monitoring, and contingency requirements. In addition, it should be noted that the use of risk management measures or property restrictions may require a certificate of property use be issued for this risk assessment if and when it is accepted by the ministry.

- If any RMMs include engineering designs and controls (barriers to site soils, soil vapour mitigation systems, etc.), a Professional Engineer licensed to practice in Ontario should sign and seal a design report and drawings that provide details these designs and specifications.

- Please ensure that the full RMP contains the required content and is formatted as set out in O. Reg. 153/04 Schedule C, Table 1.

Environmental Bill of Rights Requirements

For any Property Owner or their Agent with an interest in submitting a Risk Assessment to the Ministry for acceptance under the Environmental Protection Act s. 168.5 we want to bring to your attention important amendments under the Environmental Bill of Rights Act.

Ontario Regulation 681/94, Classification of Proposals for Instruments, under the Environmental Bill of Rights (EBR) has been amended to classify certificates of property use (CPUs) as a class II instrument under the EBR if the certificate of property use relates to a risk assessment submitted to the Ministry on or after October 1, 2005. This amendment was made through O. Reg. 505/05. This classification requires a minimum level of public notification (by the Ministry) prior to issuance of the CPU, including a posting on the EBR, of certificate of property use proposals, and provides third party leave to appeal a decision on a certificate of property use.

All decisions regarding a CPU are subject to the Environmental Bill of Rights (EBR). One purpose of the summary of the Risk Management Plan which must be provided in the Risk Assessment Report under the heading "Risk Management Requirements" is to support these requirements. This summary will allow the Ministry to prepare a notice for the EBR in a timely fashion so as not to delay the processing of the submission. The EBR posting allows public input regarding the pending decision of the Director to issue the CPU under Section 168.6 of the EPA.

The summary provided by the Qualified Person under the heading "Risk Management Requirements" will be posted. The Ministry reserves the right to change the wording of the description, as required, to ensure that the public is correctly notified of the subject of the application. The description should be simple and concise (typically under 100 words) and should include the following information:

- State the risk management measures (indicating the principle equipment and any proposed building or land use restrictions) and on-going monitoring, maintenance and contingency plan requirements.

The Regulation has been filed and can be viewed at e-laws:
https://www.ontario.ca/laws

SUBMISSION OF RISK ASSESSMENT

Submission of Risk Assessment

Four hard copies of the risk assessment (including a stand-alone electronic copy of the risk assessment [USB format]) should be delivered to:

The Director
Client Services and Permissions Branch
135 St. Clair Avenue West, 1st Floor
Toronto, ON, M4V 1P5
Telephone 416-314-8001

Of the four copies, at least one copy must contain the original signature of the QP_{RA} in the section on "mandatory certifications" as required by Section 5 of Schedule C of the Regulation. This original or master copy should be clearly labelled.

Change of Owner or QP_{RA}

Note that Section 3 (13) of Schedule C of the Regulation requires that the Director be notified in writing of a change of Property Owner, or change of QP_{RA} . It is requested that written notification of such a change be submitted to the Director at the above address and by email to the Risk Assessment Coordinator (address below). It is also requested that the notification include a copy of completed sections A, B, 1 and 10 of the Pre-Submission Form, completed and signed by all parties.

Risk Assessment

Many risk assessments fail because they do not satisfy basic requirements of the Regulation and/or because of misunderstandings about risk assessment processes under the Regulation. Before submitting a Risk Assessment to the Ministry, it is strongly recommended that the QP_{RA} review the mandatory requirements for risk assessments submitted under the Regulation, as outlined in **Sections 2, 4 and 5, and Table 1 of Schedule C of the Regulation**. As well, the QP_{RA} should refer to the Ministry's *Procedures for Use of Risk Assessment Under Part XV.1 of the Environmental Protection Act* for guidance in how to satisfy the requirements of the Regulation.

Use of Non-Standard Models

Please be advised that if the risk assessment submission uses a computer model as referred to in Schedule C, Section 9(4) and 9(5) of the Regulation, the Risk Assessment will be deemed a 'new science' risk assessment and the review timeline will be set at 22 weeks. Please note that the Qualified Person shall, upon request of the Director, include an electronic copy of the computer model in the risk assessment report in a manner that does not violate any person's copyright or other intellectual property rights.

Property Specific Standards

It is the responsibility of the QP_{RA} to ensure that the property specific standards (PSS) that are developed in the risk assessment (RA) will support filing of a Record of Site Condition (RSC) by the QP_{ESA}. This means that:

1) The correct table of site condition standards (SCS) must be used for selecting contaminants of concern (COC) in the risk assessment, and
2) PSS must be proposed for all COCs.
3) The QP_{RA} and QP_{ESA} must be able to make the requisite certifications in the RA/RSC.
4) Any parameters that do not have a PSS established in the RA must meet the applicable SCS.
5) If the QP_{ESA} finds that the RA does not support filing of the RSC (for example: the RA established PSS that are lower than concentrations found on-site; remediation has failed to reduce concentrations to below the PSS or applicable SCS), a new Pre-Submission Form (PFS) and RA must be submitted to the Ministry for review under the Regulation. RAs, once approved under the Regulation, cannot be 'reopened' or revised.

ESA Requirements and RSC Filing

Some of the comments included in this document (Schedule A) may be related to the adequacy of the environmental site assessment (ESA) work performed to support the approach and conclusions of the risk assessment (RA). Note that acceptance of the qualified person (QP's) responses on these ESA-related matters will be for the purpose of supporting a decision on the RA only; a full regulatory review of the ESAs will not be conducted as part of any future RA review. The Ministry may undertake a more in depth review of the phase one and phase two ESA reports at the time the record of site condition (RSC) is submitted for filing to ensure that all the regulatory requirements have been met. Information relevant to the phase one and two ESA reports (e.g., table of areas of environmental concern, the conceptual site models) that may be amended as part of the RA should be reflected in updated phase one and two ESA reports prior to submitting RSCs for filing. In addition, if the work on the phase one and two ESA exceeds 18 months prior to the submission date of the RSC, the phase one and two ESA reports will need to be updated prior to submitting RSCs for filing.

If the QP_{ESA} has any questions regarding meeting the ESA requirements at the time of RSC filing, it is suggested that they contact Rose Ash of Client Services and Permissions Branch; email: rosemary.ash@ontario.ca

Questions

If the $QP_{(RA)}$ has questions regarding the application of the Regulation or the above comments, they should be forwarded by email to:

Ann-Marie Deonarine
Risk Assessment Review Coordinator
Technical Assessment and Standards Development Branch
ann-marie.deonarine@ontario.ca

SCHEDULE A

To Director's Notice

Comments by the Ministry of the Environment, Conservation and Parks On Risk Assessment

for

420 Bayshore Drive, Midland, Ontario

RA1756-19a

IDS Ref. No. 0155-BC6QVC

The following are Ministry comments on the following Risk Assessment (RA):

- **Risk Assessment Report for 420 Bayshore Drive, Midland, Ontario, report prepared by CanNorth Environmental Services Limited Partnership, dated November 21, 2019**

- **Phase Two Conceptual Site Model Midland Bay Landing 420 Bayshore Drive, Midland, Ontario, report prepared by Cambium Inc., dated October 28, 2019**

Comments On Risk Assessment

General Comments

This Risk Assessment (RA) is being submitted to support the filing of a Record of Site Condition (RSC) for the mixed use industrial and parkland property located at 420 Bayshore Drive in Midland, Ontario (the 'Site'). The Site, also identified as Midland Bay Landing, is approximately 16.24 hectares in size and extends to Midland Bay to the north. The Site boundaries identified in the PSF included a water lot (i.e., portions of Midland Bay); however, in the RA submission, the Site boundaries have been revised to exclude Midland Bay.

The Site was historically industrial/parkland use and was occupied by an aggregate processing plant, coal docks and coal storage with rail spurs, boat dry dock, parking lot, and park. Currently, a marine rail system and small shed is located within a chain-link fenced enclosure in the central portion of the Site and concrete and sheet pile retaining structures are present in the western portion of the Site. An RSC is being sought based on the proposed mixed commercial, residential and parkland use.

The Phase One Environmental Site Assessment (ESA), Phase Two ESA and Phase Two Conceptual Site Model (CSM) prepared by Cambium Inc. (Cambium) summarize investigations conducted by Cambium and previous consultants on multiple Areas of Potential Environmental Concern (APECs) related to on- and off-Site Potentially Contaminating Activities (PCAs). The applicable soil Site Condition Standard (SCS) for the Site has been identified as Ministry of Environment, Conservation and Parks (MECP) (2011) Table 9 Generic SCS for Use within 30 m of a Water Body in a Non-Potable Groundwater Condition for residential/parkland/institutional property use with coarse textured soils. Soil Contaminants of Concern (COCs) include metals and inorganic parameters, volatile organic compounds (VOCs), benzene, ethylbenzene, toluene, xylenes (BTEX), trichloroethylene, and polycyclic aromatic hydrocarbons (PAHs). Due to the presence of shallow groundwater (minimum depth to groundwater of 0.34 metres below ground surface [mbgs]), the maximum measured groundwater concentrations were also compared to the Table 7 Generic SCS for Shallow Soils in a Non-Potable Ground Water Condition for residential/parkland/institutional property use with coarse textured soils. Groundwater COCs include benzene, PHC F2, PHC F3, and trichloroethylene. To account for potential degradation of the chlorinated aliphatic compounds, vinyl chloride is also carried forward as a groundwater COC. Sediment and surface water samples were collected in Midland Bay. It appears that the sediment and surface water quality previously presented in the Phase Two CSM of the PSF have been removed from the Phase Two CSM included in the RA, as the water lot is not considered part of the RA Property, and are also not included in the Phase Two ESA. However, this data is used for the qualitative assessment of off-site impacts in sediment and groundwater. The RA utilizes the standard risk assessment approach (i.e., a RA other than those identified in O. Reg. 153/04, Schedule C, Part II).

Note that some of the comments included in this document (Schedule A) may be related to the adequacy of the environmental site assessment (ESA) work performed to support the approach and conclusions of the RA. Note that acceptance of the qualified person (QP's) responses on these ESA-related matters is for the purpose of supporting a decision on the RA only; a full regulatory review of the ESAs has not been conducted. The Ministry may undertake a more in depth review of the phase one and phase two ESA reports at the time the record of site condition (RSC) is submitted for filing to ensure that all the regulatory requirements have been met. Information relevant to the phase one and two ESA reports (e.g., table of areas of environmental concern, the conceptual site models) that is amended as part of the RA should be reflected in updated phase one and two ESA reports prior to submitting RSCs for filing. If the QP_{ESA} has any questions regarding meeting the ESA requirements at the time of RSC filing, it is suggested that they contact Rose Ash of Client Services and Permissions Branch; email: rosemary.ash@ontario.ca

Specific Review Comments

Comments on the Pre-Submission Form

1. **Section 1 – Property Information.** The response addressed the comment.

2. **Section 3.2 – Adjacent Property Use Information.** The response addresses the comment.

3. **Section 3.3.11 – Depth of Organic Contamination in Soil and Section 3.3.12 – Depth of Inorganic Contamination in Soil.** The response is accepted.

4. **Section 3.5.9 – Intended Use of the Property.** The response is accepted.

5. **Section 3.6 – Contaminant Inventory for Full Depth Soil.** The responses address the comments.

6. **Section 3.6 – Contaminant Inventory for Groundwater.** The response addresses the comment; however this information should be presented in the main RA report (see RA comments below). No further response is required.

7. **Section 3.6 – Contaminant Inventory for Surface Water.** It is acknowledged that the site boundaries have been revised and that the aquatic lot is no longer within the RA boundary. However, the surface water data is discussed in the qualitative evaluation of the potential for off-site risks in the ERA, and this data is not included in the Phase Two ESA submitted with the RA. The full analytical data tables and CofAs should be incorporated into the RA, perhaps as a separate appendix.

8. **Section 5 – Human Health Conceptual Site Model – Without RMMs (Figure).** The responses address the comments.

9. **Section 5 – Human Health Conceptual Site Model – With RMMs (Figure).**
   a. The response is not accepted and additional comments have been provided below.
   b. The response is accepted; however, Figure 4.2 has not been corrected and should be revised accordingly.

10. **Section 6 – Ecological Conceptual Site Model – Valued Ecological Components.** The response addresses the comment.

11. **Section 6 – Ecological Conceptual Site Model – Terrestrial Ecological Pathways.** The response addresses the comment.

12. **Section 7 – Conceptual Site Model, Subsection 3(8)(a.1)(v.).** The response is accepted.

13. **Appendix A – Plan of Survey and Lawyer's Letter.** This response is accepted.

14. **Appendix C – Notification of Nonpotable Groundwater Condition.** This response is accepted.

15. **Appendix D – Risk Assessment Approach.**
   a. The responses are accepted.
   b. The responses are accepted.
   c. This response is accepted.
   d. This response is accepted.
   e. Section 3.1 – Selection of Receptors. The response addresses the comment.
   f. Section 3.2.3 – Sediment. The response addresses the comment.

16. **Phase Two CSM – Applicable Site Condition Standard.** The response addresses the comment.

17. **Other comments.**
    a. The response is not accepted and additional comments have been provided below.
    b. The response addresses the comment.

<u>Comments on the Risk Assessment</u>

1. **Section 1.0 – Summary of Recommendations/Findings.** Editorial comment – As per Schedule C, Table 1 of O.Reg. 153/04, this section is required to be titled, "Summary of Recommendations and Findings". This should be revised for consistency.

2. **Section 1.1 – Introduction.** Editorial comment – The third paragraph indicates that the RA was completed for residents, indoor workers, visitors, long-term outdoor workers, and short-term subsurface workers that may be exposed to COCs in soil and groundwater but makes no mention of ecological receptors. This should be revised.

3. **Section 1.2 – Risk Assessment Objectives and Approach.** Editorial comment - While it is indicated that this RA has been conducted using a standard full depth quantitative approach, it would be beneficial to update the text to state the specific RA approach used (e.g., a risk assessment other than those identified in O. Reg. 153/04, Schedule C, Part II).

4. **Section 1.3 – Deviations from Pre-submission Form.** It is stated that the RA property boundary has been revised to exclude aquatic environments (i.e. Midland Bay) and now only includes terrestrial areas; however, a review of the Phase Two ESA suggests that the Phase Two property boundary continues to includes portions of Midland Bay. An updated Legal Plan of Survey with a clearly labelled RA property boundary (and any other required legal documents – e.g. lawyer's letter) should be provided.

5. **Section 1.4 – Risk Assessment Standards.**

    a. Editorial Comment - The third sentence appears to be incomplete. This should be revised.

    b. Both Tables 1.1 (Property Specific Standards in Soil) and 1.2 (Property Specific Standards in Groundwater) present the Reasonable Estimate Maximum Concentration (REMC) rather than the maximum concentration as recommended by the MOE (2005) Procedures document titled, "*Procedures for the Use of Risk Assessment under Part XV.1 of the Environmental Protection Act*". The QP should consider also including the maximum concentrations in these tables.

6. **Section 3.1 – Property Information.** The site area presented (i.e., 16.24 ha) does not appear to be consistent with the Phase Two ESA (i.e., 14.6 ha). Please review and revise as required.

7. **Section 3.1.4.1 – On-Site Receptors.** Some applicable exposure pathways are not listed (e.g., inhalation of volatiles from soil to indoor air, trench air exposure pathways). This should be revised.

8. **Section 3.2 – Site Plan and Hydrogeological Interpretation.** Editorial comment – As per Schedule C, Table 1 of O.Reg. 153/04, this section is required to be titled, "Site Plan and Hydrogeological Interpretation of RA Property". This should be revised for consistency.

9. **Section 3.3.2.1 – Selection of Contaminants of Concern in Soil.** Editorial comment – The first paragraph describes the COCs for the site based on a comparison to Table 7 or Table 9 SCS, however only the Table 9 SCS are applied in the soil screening. This should be revised.

10. **Section 3.3.2.2 – Selection of Contaminants of Concern in Groundwater, Table 3.5 (Screening for Contaminants of Concern in Groundwater).** The maximum concentration of chloride appears to be incorrect due to a units issue (mg/L vs. µg/L). This error was also present in the Phase Two ESA. Please review the laboratory Certificates of Analysis (CofAs) and revise the chloride concentration accordingly.

11. **Section 3.3.2.3 – Sampling Programs.** This section describes the collection of sediment and surface water data and indicates that this data is included in the RA, but it is noted in Section 3.1 that the RA is only for the terrestrial portion of the property, therefore this data is from off-site. It appears that the off-site sediment and surface water data are later applied in the evaluation of potential off-site risks. The RA report should be clarified throughout to indicate that this data was not collected on the RA property.

12. **Table 3-8 – Number of Sediment Samples.** The table indicates that there were 11 samples of sediment analyzed for each of metals and inorganics, and PAHs. This is not consistent with the information presented in the Phase Two ESA (Appendix F.2), which indicates that sediment samples were submitted for analysis of BTEX, PHC F1-F4, PAHs, and metals. This should be clarified in the RA. It would also be helpful if the sediment data was incorporated into the risk assessment, perhaps as a separate appendix, so that information relating to the sediment can be verified.

13. **Section 4.1.1 – Human Health Conceptual Site Model.**

    a. The on-site receptors identified in the text should be consistent with the Human Health Conceptual Site Model figures. For consistency and completeness, Figures 4.1 and 4.2 (Human Health Conceptual Site Model – Without and With Risk Management) should be updated to include the trespasser.

    b. **Figure 4.2 (Human Health Conceptual Site Model – With Risk Management).** The specific RMM (e.g., capping, HASP) proposed for each exposure pathway should be specified.

14. **Section 4.1.1.1 – Resident.**

   a. The text incorrectly states that "no COCs were identified in groundwater". Furthermore, the text has incorrectly identified vapour intrusion into indoor air is limited to soil COCs as a potential exposure pathway. Please review and revise this section as appropriate or justify why groundwater COCs are not considered for vapour intrusion.

   b. **Table 4.1 – Potential Pathways of Exposure for the Resident.** Editorial comment – for the groundwater skin contact pathway, the comment text should be revised from 'Potential incidental ingestion during gardening…" to "Potential dermal contact during gardening…". This comment also applies to Tables 4.3 and 4.4.

15. **Section 4.1.1.2 – Indoor Worker, Table 4.2 (Potential Pathways of Exposure for Indoor Worker and Property Visitor).** Since the Site will be redeveloped for mixed- commercial, residential, and parkland use, it is possible that a property visitor would be outdoors at the parkland portions of the Site. Please clarify why the potential pathways of exposure for the property visitor are the same as the indoor worker (assumed to have negligible exposure to soil and other outdoor exposure pathways).

16. **Section 4.1.1.3 – Outdoor Maintenance Worker.** Since the minimum depth to groundwater is 0.34 mbgs, there is the potential that outdoor maintenance workers conducting planting activities at the Site (e.g., park) may be in direct contact with impacted groundwater. Dermal contact and incidental ingestion exposure to impacted groundwater by the Outdoor Maintenance Worker should be quantitatively or qualitatively assessed in the HHRA. Figure 4.1 (Human Health Conceptual Site Model – Without Risk Management) should also be updated to indicate that these exposure pathways are 'Potential pathway of exposure (included in the HHRA)'.

17. **Section 4.1.3 – Contaminants of Concern for Human Receptors.** The RA has identified a chemical that is sufficiently volatile for vapour inhalation assessment if the Henry's Law constant is greater than 1 Pa.m^3/mol and the molecular weight is less than 200 g/mol. As per recent Ministry guidance, a screening process as to whether (or not) a chemical is of potential concern for vapour intrusion includes an evaluation of both volatility and toxicity, using the following steps:

   Step 1: If either one of the following conditions is met, then the chemical is considered sufficiently volatile and screened in, to be further assessed as part of Step 2 :

   - Henry's Law constant is greater than $1x10^{-5}$ atm-m^3/mol; or,
   - Vapour pressure is greater than1.0 millimeter of mercury (equivalent to 1.0 Torr).

   Step 2: If the maximum theoretical indoor air concentration based on conservative assumptions (C_{air}) exceeds applicable health based indoor air concentration (HBIAC) or odour thresholds (if available), then the chemical should be retained in the vapour intrusion assessment, as follows:

- If Cair > HBIAC (or odour thresholds), then the chemical is considered a COPC for the vapour intrusion assessment; or,
- If Cair ≤ HBIAC (or odour thresholds), then the chemical is not considered a COPC for the vapour intrusion assessment.

The QP should consider the updated MECP guidance and determine whether additional chemical parameters should be retained for the vapour inhalation assessment.

18. **Section 4.1.3.2 – Groundwater.** The text does not fully discuss the component value exceedances presented in Table 4.7 (Comparison of Groundwater REMCs to Human Health Component Values). For example, the text indicates that trichloroethylene and benzene exceeded the residential and commercial/industrial GW2; however, the REMC of vinyl chloride (future worst case) and PHC F2 also exceeded these component values. Furthermore, there's no discussion of the REMC of PHC F2 exceeding the GW1 component value. Moreover, a discussion of ½ solubility is included in the text; however, this component value screening was not presented in Table 4.7. The text should be updated for completeness and to support your findings.

19. **Section 4.2.1 – Receptor Characteristics, Table 4.8 (Human Receptor Characteristics).**

    a. Since the COCs identified for quantitative evaluation in the HHRA includes at least one developmental toxicant (e.g., trichloroethylene), a pregnant adult should be assessed for each receptor scenario.

    b. Given that the soil direct contact pathways for the resident receptor are identified as complete in Figure 4.1 (Human Health Conceptual Site Model – Without Risk Management) and the REMCs for a number of soil COCs exceeded their respective S1 component value, it is unclear why the 'hours exposed per day – outdoor' for the resident receptor is 'NE – not evaluated'. This discrepancy should be clarified.

    c. The soil ingestion rate for long-term outdoor worker and short-term subsurface worker does not appear to be consistent with MOE (2011) Rationale document. Please provide supporting rationale for the selected value or update the table to be consistent with MOE (2011).

    d. The groundwater ingestion rate for the subsurface worker (0.02 L/day) is not consistent with the text (0.1 L/day). Please review and revise.

20. **Section 4.2.2 – Pathways Analysis, Table 4.9 (Exposure Pathways Evaluated for Human Receptors).**

    a. The soil to indoor air exposure pathway was quantitatively evaluated for acenaphthene and anthracene in Table 4.14. For consistency, Table 4.9 should be updated to indicate that these two (2) COCs were assessed for 'soil – indoor air'.

b. Since the soil REMC of trichloroethylene exceeded the S-IA component values, it should also be retained for quantitative evaluation of the soil-trench air exposure pathway.

21. **Section 4.2.4 – Inhalation Pathway.** Editorial comment – “equation 4-14” should be changed to “equation 4-1”.

22. **Section 4.2.4.2 – Estimation of Indoor Air Concentrations.**

a. **Table 4.13 (Variables Used to Estimate Indoor Air Concentrations from Soil).** The RA has assumed the MECP generic coarse soil texture to predict indoor air concentrations; however, the site-specific soil texture should be used, if available. If there are different types of soil texture present on the property, the coarsest type should be selected. Please update the RA accordingly.

b. **Table 4.14 (Chemical-Specific Values Used to Estimate Indoor Air Concentrations from Soil).** Editorial comment – The soil REMCs for benzene, xylene, and PHC F1 and F2 subfractions appear to have a minor discrepancy due to the varying number of significant digits when compared to other HHRA tables. The QP is recommended to update all exposure tables to present the same number of significant digits for the REMC.

23. **Section 4.2.4.3 – Estimation for Outdoor Air Concentrations,**

a. **Table 4-18 (Variables Used to Estimate Outdoor Air Concentrations from Groundwater).** The RA has assumed the MECP generic coarse soil texture for the vadose zone to predict outdoor air concentrations; however, the site-specific soil texture should be used, if available. If there are different types of soil texture present on the property, the coarsest type should be selected. Please update the RA accordingly. Additionally, it appears that the QP has assumed different soil textures for the vadose zone (coarse soil) and capillary fringe (sandy soil). Please confirm this is correct.

b. **Outdoor Air Concentrations in a Trench from Groundwater.** Editorial comment – ‘Section 0’ is referenced in numerous locations and should be corrected.

c. **Table 4-21 (Variables Used to Estimate Outdoor Air Concentrations from Soil).** The RA has assumed the MECP generic coarse soil texture to predict outdoor air concentrations; however, the site-specific soil texture should be used, if available. Please update the RA accordingly.

d. **Table 4-22 (Estimated Trench Air Concentrations from Soil).** Naphthalene was retained for the soil-trench air exposure pathway; however, it appears that it was excluded from this exposure table. Please review and revise.

24. **Section 4.2.6.2 – Groundwater Ingestion Pathway.** Editorial comment – the equation number should be updated to 4-28.

25. **Section 4.3.2.1 – Non-Carcinogenic Risks.**

    a. **Table 4.24 (Toxicological Reference Values for Non-carcinogenic Effects).** It appears that TRVs for non-COCs have been included (e.g., cyanide, silver). Please review and revise as necessary.

    b. **Developmental Toxicants.** The text states that the only developmental toxicant was the inhalation of arsenic. The text should be updated to recognize that trichloroethylene is also a developmental toxicant.

26. **Section 4.3.2.3 – Uncertainties in Toxicity Values.** Editorial comment – silver was not retained as a COC. Please update the text accordingly.

27. **Section 4.4.1.1 – Non-carcinogenic Effects.** Editorial comment – the equation numbers should be updated to follow the sequence in exposure assessment. This comment also applies to Section 4.4.1.2 (Carcinogenic Effects).

28. **Section 4.4.2 – Quantitative Interpretation of Health Risks.** As previously mentioned, since at least one developmental toxicant (e.g., trichloroethylene) has been retained as a COC for quantitative evaluation, exposure and risks to a pregnant adult should be assessed for the applicable receptor scenarios.

29. **Section 4.4.2.1 – Resident.**

    a. **Direct Contact with Soil.** Editorial comment – Section 4.2.4.1 should be updated to reference Section 4.2.5.1.

    b. **Direct Contact with Soil.** The text should be updated to discuss the results of Table 4.27 (Doses and Risk Levels for a Composite Resident Receptor).

    c. **Table 4.27 (Doses and Risk Levels for a Composite Resident Receptor).** Since exposure and risk estimates have been calculated for all carcinogenic PAHs in an effort to calculate an ILCR for Total Carcinogenic PAHs, the carcinogenic TRVs for non-COC PAHs should also be presented in the TRV table for completeness.

    d. **Inhalation of Indoor Air from Vapours Migrating from Soil.** The RA states that, *"From the Phase Two ESA it is seen that many of the VOC impacts are on the western portion of the site. Therefore in the eastern portion of the site, an alternative RMM is available that all buildings would have below or at grade parking/storage garage".* Additional rationale will be required to demonstrate that the implementation of different vapour intrusion RMMs at the different portions of the Site is appropriate. Moreover, a legal survey defining the different portions of the Site and consideration of a 30 m setback from the adjacent area as a buffer may be required for this approach. This comment is also applicable to other sections of the Risk Characterization where this discussion is presented.

30. **Section 4.4.2.3 – Outdoor Maintenance Worker, Table 4.32 – Exposures and Potential Risks for an Outdoor Maintenance Worker.** The HQs of the PHC subfractions should be summed to provide a total HQ. In the case of PHC F3, the total HQ would be greater than an acceptable limit of 0.5. Therefore, the text and all affected tables should be updated accordingly. This comment is applicable to all risk characterization tables.

31. **Section 4.4.2.4 – Subsurface Worker, Table 4.36 (Exposures and Potential Risks for a Subsurface Worker).**

    a. Since exposure and risk estimates have been calculated for all carcinogenic PAHs in an effort to calculate an ILCR for Total Carcinogenic PAHs, the intermediate calculations for non-COC PAHs should be included in Table 4.22 (Estimated Trench Air Concentrations from Soil).

    b. The HQs of the PHC subfractions should be summed to provide a total HQ. In the case of PHC F2, the total HQ would be greater than an acceptable limit of 0.5. Therefore, the text and all affected tables should be updated accordingly and RMMs will be required to mitigate this exposure pathway.

32. **Section 4.4.3.2 – Lack of Toxicity Data.** Silver is not a COC retained for assessment in the HHRA. As such, the discussion on lack of toxicity data for the inhalation of silver is not necessary.

33. **Section 4.4.3.4 – Other Negligible Pathways.** Please provide a more robust rationale and/or references to demonstrate that dermal contact with vapours and inhalation of soil particles are negligible pathways of exposure.

34. **Section 4.4.4 – Interpretation of Off-Site Human Health Risks.** Since COCs may be migrating off-site at concentrations greater than the applicable generic MECP Site Condition Standards, this section should specify the contaminant, the applicable site condition standard for that contaminant and the property where the human receptor is located and describe the human receptors that may be impacted (preferably in tabular form).

35. **Section 4.4.6 – Setting of Property Specific Standards, Table 4.38 (PSS Protective of Human Health in Soil).** Unacceptable direct soil contact risks by the resident were predicted for benzene; however, RMM-1 was not required. Please review Table 4.38 and other affect tables (e.g., Tables 1.1 and 6.3) to ensure it is correct.

36. **HHRA – Missing Report Section.** The risk characterization section of the HHRA appears to be missing a required subsection titled, “Special Considerations”. Please update the RA report accordingly.

37. **Section 5.1.1 – Ecological Conceptual Site Model.**

    a. Incidental ingestion, direct contact, and ingestion of biota contaminated by sediment and surface water and ingestion of surface water are indicated as potential exposure pathways for on-site receptors. However, elsewhere in the report, it is indicated that the RA is only for the terrestrial portion of the property, therefore these media are off-site. Please confirm that these exposure pathways are complete for on-site receptors. If not, this should be clarified in the text, and the CSM figures (Figures 5.1 and 5.2) should be updated.

    b. Ingestion of soil by off-site terrestrial biota is not discussed in the text but is indicated as a potential pathway in Figure 5-1. This should be revised for consistency.

38. **Section 5.1.2 – Contaminants of Concern for Ecological Receptors.**

    a. It is not clear how the COCs listed in this section were determined. They do not appear to align with the COCs determined by Table 9 screening (presented in Table 3.4), or the secondary screening presented in Section 5.1.3. This should be clarified.

    b. The text indicates that COCs were compared to ecological component values calculated through the MGRA model, however, Tables 5-1 and 5-2 indicate that the component values are from MOE 2011. This should be clarified.

39. **Table 5.1 – Comparison of Soil REMCs to Ecological Component Values.** It is not clear why cyanide is indicated as being carried forward for quantitative assessment, as the REMC is less than all component values. This should be clarified, and if updated in Table 5.1, carried through in subsequent tables.

40. **Section 5.1.2 – Soil Screening.**

    a. It is not clear how the COCs listed in this section were determined. They do not appear to align with the COCs determined by Table 9 screening (presented in Table 3.4), or the secondary screening presented in Section 5.1.3. This should be clarified.

    b. The text indicates that COCs were compared to ecological component values calculated through the MGRA model, however, Tables 5-1 and 5-2 indicate that the component values are from MOE 2011. This should be clarified.

41. **Section 5.1.4 – Groundwater Screening.** Minor editorial comment – The text refers to Section 3.3.6 of the report, however this section does not exist. This should be revised.

42. **Table 5.2 – Comparison of Groundwater REMCs to Ecological Component Values.** It appears that vinyl chloride was not carried forward from Section 3. This should be revised for consistency, although the reviewer notes that this will not affect the RA.

43. **Section 5.1.5.3 – Uncertainty Analysis.** Editorial comment – the last sentence indicates that the data are suitable for setting and meeting the objectives of the HHRA, however, this is the ERA. This should be revised for clarity.

44. **Section 5.2 – Receptor Characterization.**

    a. Editorial comment – The first sentence refers to Table 5-4 but it appears that it should refer to Table 5.3. This should be revised for clarity.

    b. The Lake sturgeon is identified as having been observed in 2010 and being protected under the Endangered Species Act. Additional discussion is required to address the potential for risks to this off-site receptor, noting the potential for risks from on-site soil migrating off-site identified in the ERA, as well as the off-site sediment data that indicated impacts above the sediment quality criteria.

45. **Section 5.3.1 – Pathways Analysis.** Editorial comment – This section does not appear to be a complete sentence. This should be revised for clarity.

46. **Sections 5.3.1.1 – Terrestrial Plants and Soil Invertebrates, Section 5.3.1.2 – Mammals and Birds, and Section 5.3.1.3 – Aquatic Biota.**

    a. Editorial comment – The bullets in these sections list exposure pathways but do not explicitly state which pathways are being evaluated, either quantitatively or qualitatively, in the ERA. This should be clarified.

    b. These sections should be carefully reviewed and revised for consistency with the Eco CSM (Figure 5.1). Examples include that direct contact with groundwater by terrestrial plants and soil organisms is not included in Section 5.3.1.1; the second bullet in Section 5.3.1.1 refers to mammals and birds in the Terrestrial Plants and Soil Invertebrates section; bullets speak to stem and foliar uptake of vapours (sourced from volatile COCs in soil); Section 5.3.1.2 does not include direct contact by mammals and birds, etc

47. **Table 5.5 – Exposure Characteristics for Wildlife Receptors.** There is no context provided for the inclusion of this table in the text. This should be clarified.

48. **Section 5.5.2.1 – On-Site Environment, Groundwater.** A table showing the comparison of the REMCs for all groundwater COCs to the applicable component values should be provided, similar to that provided in the soil section, for clarity and completeness.

49. **Section 5.5.2.2 – Off-site Aquatic Environment.**

a. The report includes an assessment of off-site surface water data to evaluate the potential effects to offsite aquatic receptors, however it was not possible to confirm the maximum surface water concentrations in Table 5.8, as Figure 7 of the Phase Two CSM appears to only present concentrations for parameters that exceeded the applicable standards (i.e. copper and zinc), and it does not appear that tables summarizing the off-site surface water data have been provided. This should be revised.

b. The applicable standard for copper is given as 5 µg/L in the RA but indicated as 1 µg/L in the Phase Two CSM. This discrepancy should be clarified. If the application of the value of 5 µg/L is based on the water hardness, this should be indicated in the table and the basis of the water hardness (e.g., testing) should be discussed.

c. It is not clear how the surface water COCs presented in Table 5.8 were determined. The Phase Two CSM indicates that surface water samples were submitted for analysis of BTEX, PHCs, PAHs, and metals but it appears that only a subset of these parameters are presented. Additional clarification or a table that presents the analytical results for all analyzed parameters and compares them to the applicable standards would be helpful. The QP should also consider whether it would be helpful to present the surface water data for all COCs identified in Site groundwater, regardless of whether they are considered a COC in off-site surface water, as the surface water data is being used to evaluate the potential for risk from Site groundwater migrating offsite.

d. It is not clear how the sediment COCs presented in Table 5.9 were determined. The Phase Two CSM indicates that sediment samples were submitted for analysis of BTEX, PHCs, PAHs, and metals but it appears that only a subset of these parameters are presented. Additional clarification or a table that presents the analytical results for all analyzed parameters and compares them to the applicable standards would be helpful. The QP should also consider whether it would be helpful to present the sediment data for all COCs identified in Site soil, regardless of whether they are considered a COC in off-site sediment, as the sediment data is being used to evaluate the potential for risk from Site soil migrating offsite.

e. The last paragraph of the surface water discussion indicates that concentrations of COCs not measured (i.e. below the method detection limit) were assumed not present/present at negligible concentrations and were not considered a potential concern for off-site receptors in the assessment. This approach should be discussed in the Discussion of Uncertainty in Section 5.5.5, particularly as a number of the detection limits for PAH parameters exceed the applicable PWQO values.

50. **Section 5.5.3.2 – Missing Toxicity Information.**

a. The first bullet does not discuss 2-(1-)methylnaphthalene, which is also missing a Plants and Soil Organisms component value. This should be clarified.

b. The last paragraph indicates that 2x soil background was used in the qualitative assessment. It would be helpful to present this qualitative assessment in the RA for clarity.

51. **Section 5.5 – Risk Characterization.** The text does not appear to include the mandatory section "Special Considerations" as outlined in Table 1 of O.Reg. 153/04 "Mandatory Requirements for Risk Assessment Reports". The QP is reminded that all mandatory sections should be addressed.

52. **Table 5.10 – Property Specific Standards (PSS) Protective of Ecological Health in Soil and Table 6.3 – Soil Property Specific Standards.** It is not clear why RMM-1 is indicated as being required for acenaphthene as this COC was not carried forward for the quantitative evaluation based on comparison to the Mammals and Birds component value presented in Table 5.1 or as exceeding the applicable standards in Table 6.2. This should be revised.

53. **ERA – Missing Report Section.** The risk characterization section of the ERA appears to be missing a required subsection titled, "Special Considerations". Please update the RA report accordingly.

54. **Section 6.1 – Summary of Results, Table 6.1 (Summary of the HHRA Results).** Certain exposure pathways (e.g., gardening) and COCs (e.g. lead) that were qualitatively assessed in the HHRA were not presented in this table. Please update Table 6.1 to ensure it is complete.

55. **Table 6-2 – Summary of the ERA Results.**

    a. This table should be checked for consistency against the results presented in Table 5-6. For example, Table 6-2 indicates that there were no exceedances of applicable standards for the American Woodcock, however Table 5.6 indicates there are exceedances for barium, cadmium, lead, selenium, and zinc. A selenium exceedance identified in Table 5.6 for the short-tailed shrew does not appear in Table 6.2.

    b. The exposure pathway column of the table is blank; this should be revised.

    c. The entries for off-site terrestrial and aquatic receptors are blank; the table should be revised.

56. **Table 6.3 – Soil Property Specific Standards.** It is not clear why RMM-1 is indicated as being required for acenaphthene based on the ecological risk assessment when this COC was not carried forward for the quantitative assessment and is not indicated as being carried forward for quantitative assessment in Table 5.1 or as exceeding the applicable standards in Table 6.2. This table should be checked for consistency and revised as necessary.

57. **Phase Two ESA (Appendix F.2).**

a. The table of contents indicates that Tables 17 through 21 present the sediment and surface water results, while Sections 6.9 and 6.10 indicate that Tables 17 through 22 present the sediment and surface results, however it appears that these tables have been removed from the Phase Two ESA report. This data is relied upon in the ERA and used for the qualitative assessment of off-site impacts in sediment and groundwater. It would be helpful if this data was somehow incorporated into the risk assessment, perhaps as a separate appendix, so that the data presented in Section 5 can be verified.

b. **Section 6.6.6 – Electrical Conductivity and Sodium Absorption Ratio.** Minor typographical error – should be 'adsorption' ratio.

c. **Appendix F – Surface Water and Sediment Results; Figure 7.** It is not clear what standards are being shown in the figure; legend entries for the red and green dots indicate that they correspond to exceedances of the Table 2 SCS, however the table showing the applicable standards does not present the Table 2 SCS and also refers to the PWQO. This should be clarified.

58. **Missing Appendices.** As required by O. Reg. 153/04 and/or MECP guidance, please include the following information as appendices in the revised RA: MECP review Schedule A document, borehole logs, summary tables of all analytical data relied upon in the RA, and summaries of the Phase One and Two ESA reports.

Phase Two Conceptual Site Model Comments

PSF – Phase Two CSM Comments provided August 23, 2019:

1. Responses to the Phase Two CSM Comments that were provided by the ministry for the PSF on August 23, 2019 do not appear to be included in Appendix B "Ministry Correspondence". A copy of these comments and responses should be included in this section for transparency.

   It should be noted that the PSF comments have generally been addressed in the RA Document and the Phase Two CSM. Any further specific comments are noted below.

Phase Two CSM:

2. In order to assist in the review of the Phase Two CSM, in particular Section 6 "Soil and Groundwater Characterization", it is recommended that a site plan be included showing the various test pit/borehole/monitoring well locations with an overlay showing the various APECs.

3. As required under subsection 7 of Schedule E of O.Reg. 153/04, as amended, the qualified person shall ensure that all areas on, in or under the phase two property where a contaminant is

present at a concentration greater than the applicable site condition standard for the contaminant shall be delineated laterally and vertically. Based on the information provided, it does not appear that the QP has met this requirement for the following parameters:

- The TCE ground water plume does not appear to be laterally delineated downgradient of BH18-11; and
- The PHC ground water plume does not appear to be laterally delineated cross-gradient and downgradient of BH18-07.

Further delineation and assessment of the potential risks to on and off-site receptors related to these impacts needs to be provided.

4. As required under subsection 6(4)(ii) “Phase Two Conceptual Site Model” of Table 1 of Schedule E of O.Reg. 153/04, as amended, the cross-section drawings do not appear to show the approximate depth to ground water. This should be included on all cross-sectional drawings.

5. As required under subsection 6(7) “Phase Two Conceptual Site Model” of Table 1 of Schedule E of O.Reg. 153/04, as amended, further justification for the use of the exemption under subsection 49.1(1) (i.e. a substance applied to surfaces for the safety of vehicular or pedestrian traffic under conditions of snow or ice or both.) is required for deeming the parameters EC, SAR, chloride and sodium as not being contaminants of concern at the Site.

Summary and Conclusions

Generally, the RA follows most conventions and guidance. The QP should review the current MECP guidance on volatility assessment and determine whether additional chemical parameters should be retained for the vapour inhalation assessment. Regarding the proposal of different vapour intrusion RMM systems for different portions of the Site, additional rationale will be required to demonstrate that this is appropriate.

It appears that the sediment and surface water quality previously presented in the Phase Two CSM of the PSF have been removed from the Phase Two CSM included in the RA, as the water lot is not considered part of the RA Property, and are also not included in the Phase Two ESA. However, this data is used for the qualitative assessment of off-site impacts in sediment and groundwater. It would be helpful if this data was somehow incorporated into the risk assessment, perhaps as a separate appendix, so that the data presented in Section 5 can be verified.

The RA report should be revised and resubmitted.

Comments On Risk Management

1. Section 7.1 – Risk Management Performance Objectives
    a. A number of inconsistencies between Sections 6 and 7 were noted and need to be addressed:
        - Copper in soil is listed in Table 6.1 as one of the COCs that could pose unacceptable risk to toddler via direct contact exposure but not in Section 7.1.
        - PHC fraction F3 is listed in Section 7.1 as one of the COCs that could pose unacceptable risk to outdoor worker via direct contact exposure but not in Table 6.1.
        - COCs with unacceptable risk to resident via ingestion of garden produce are discussed in Section 7.1 but not in Table 6.1.
        - COCs with unacceptable risk to aquatic receptors via migration of soil are discussed in Section 7.1 but not in Table 6.1.
        - Lead is shown in Table 7.2 as requiring RMM for "human health – direct contact" but not discussed in Section 7.1 or Table 6.1.
        - Lead is shown in Table 7.4 as requiring RMM barrier and health and safety plan (HASP) for subsurface worker, but the risk is not discussed in Table 6.1 or Section 7.1.
        - Mercury is shown in Table 7.2 as requiring RMM for "human health – indoor air" but not discussed in Section 7.1 or Table 6.1, and it is shown in Table 4.38 and Table 6.3 as not requiring RMM as it is "not volatile".
        - Acenaphthylene and anthracene are discussed in Table 6.1 as requiring VI RMM for resident, but not discussed in Section 7.1.
        - Naphthalene is shown in Table 6.3 and 7.4 as requiring VI RMM for indoor worker, but the risk is not discussed in Table 6.1 or Section 7.1.
        - Naphthalene is shown in Table 7.4 as requiring RMM barrier for indoor worker, but the risk is not discussed in Table 6.1 or Section 7.1. Is direct contact an exposure pathway of concern for an indoor worker?
        - The text indicates that the ERA identified risks requiring RMMs from migration of soils into the aquatic environment for metals, PAHs, and PHC F4. This is not consistent with the information presented in Table 6.2. The table and text should be reviewed and revised for consistency.

    b. The QP should provide further justification on how the proposed RMM option of "at or below grade parking garage" or SVIMS would provide adequate protection of the indoor air exposure pathway for future resident. Table 7.2 and Table 7.3 indicate that Trichloroethylene and PHC F2 requires at least 414 and 2400 times, respectively, in reduction for the protection of this exposure pathway. However, as the QP has identified that the RMM will be consistent with the MGRA model, the maximum allowable reduction factor is 200 for a building with storage garage with a continuous ventilation rate of at least 3.9 L/s/m2 and/or for active SVIMS.

    c. Based on Table 7.4 and 7.5, it appears that the QP is proposing different RMM to address indoor air risk for TCE in soil and groundwater: at or below grade parking for TCE in soil, and SVIMS for TCE in groundwater. The TCE impact in soil and groundwater were found at the same location (BH18-11). Therefore, it is unclear how different RMM can be implemented at the same location.

In addition, it should be noted that if a RMM is proposed for only a portion of the RA property, it will be necessary to have the limits of the RMM shown on a figure prepared by an Ontario Land Surveyor or an appropriately scaled site plan that could be used to identify the areal extents in the field of each RMM (Note: Figure 7.1 "Risk Management Plan Areas" does not meet this requirement). This figure will form part of the CPU for the RA property.

d. Table 7.4 should include a column for risk to aquatic receptors via migration of soil.

e. Table 7.4 proposed cover/fill RMM for toluene; however, this does not appear to be consistent with Section 4 of the RA. Further clarification should be provided.

2. Section 7.1.1.1 – Hard Cap/Fill Cap Barrier

a. In this section, the QP has indicated that "unimpacted" soil for use as cap material is soil "which no COCs are present" and/or may also be soil "which one or more COCs are present, but at a concentration that is less than the EBCs". Please note that the ministry typically defines "unimpacted soils" in the CPU as soil in which one or more Contaminants are present at concentrations less than the applicable generic site condition standards within the ministry's document entitled "***Soil, Ground water and Sediment Standards for Use under Part XV.1 of the Act"*** dated April 15, 2011.

b. The fill cap proposed can be either a 1-metre thick layer of unimpacted soil, or a 0.5 metre thick layer of unimpacted soil underlain by a geotextile fabric. While the latter is reasonable, the QP should note that this is not consistent with the MGRA fill cap barrier requirements for residential property. This contradicts the discussion that the proposed RMM barriers "are consistent with that described in the MGRA model".

In addition, in order to comply with Section 4(6)(7) "Mandatory Requirements of Risk Assessment Report" of Schedule C "Risk Assessments – Part 1 Mandatory Requirements" of O.Reg. 153/04, as amended, the design of engineered controls must be provided in a report in an appendix to the RA Document, with the report signed and sealed by a professional engineer. This also applies to the proposed design of the SVIMS.

c. Are underground utilities expected in the future development? If so, please discuss if barriers are required around future underground utilities for the protection of subsurface utility workers, i.e. trench plugs, etc.

3. Section 7.1.1.3 – Site Restrictions

The QP proposes "a minimum of 30 cm of clean growing medium in areas where a "Fill Cap is present that includes a geotextile barrier", i.e. where the proposed fill cap thickness is 0.5 m; and "a minimum of 60 cm of clean growing medium immediately on top of a geotextile barrier in areas where the fill cap does not include a geotextile barrier", i.e. where the proposed fill cap thickness is 1 m. It is unclear why the QP would propose a thinner soil layer for vegetable gardens in area where the fill cap layer is also thinner. Is the geoxtextile fabric underlying the thinner fill cap intended to prevent root penetration? Please clarify.

4. Section 7.3 – Duration of Risk Management Measures

Editorial comment - The QP states that "the RMMs are required until it can be demonstrated that concentrations in soil and/or groundwater meet the EBCs presented in Table 7.2 and Table 7.3, respectively". "And/or" should be revised to say "and".

5. Section 7.4.3 – SVIMS

   a. Please confirm if the inspection of the SVIMS is to be conducted by a QP, or "the Owner or an assigned representative".

   b. It is discussed that "to ensure that concentrations of vapours in indoor air within any future on-site buildings do not represent a risk **to indoor workers**, sub-slab vapour samples will be collected". This sentence should be revised to include "residents".

   c. It is recommended that indoor air samples be collected on a quarterly basis for two years, the same as for sub-slab vapour sampling, instead of the semi-annual basis proposed.

   d. It is noted that if indoor air results at any location are above the trigger levels, the MECP will be notified within 3 days and another sample collected. It should be noted that if there is an exceedance of the trigger values then the area in which the indoor air sample was obtained shall be restricted to access by only authorized personnel until such time that the indoor air results meet the trigger values. This section should be revised to address this requirement.

   e. The reference to converting from passive to active SVIMS should be removed as the use of passive SVIMS will not provide the appropriate risk reduction for vapour migration to indoor air for trichloroethylene and/or PHC F2 as noted above in Comment No. 1 (b) above.

   f. It is noted that the HBIAC trigger values shown on Table 7.6 differ from the MECP values shown on the MGRA model due to rounding off of the numbers. It is recommended that the HBIAC be presented with the same number of significant figures as in the MGRA model.

g. It appears that acenaphthylene, anthracene and mercury could pose unacceptable risk to resident via indoor air inhalation, in addition to the COCs listed in Table 7.6 (although there are inconsistencies in Sections 6 and 7, see comment #1a). Will these COCs be included in the sub-slab/indoor air monitoring program? If so, please include their trigger levels in Table 7.6.

6. Section 7.4.4 – Groundwater Monitoring

a. The QP discussed that the TCE plume is "confined" and hence further groundwater monitoring is not required. It appears that there is no horizontal delineation of the plume downgradient of the exceedance at BH18-11. Therefore, based on the data currently available, it cannot be determined that the plume is "confined". It is noted, however, that the concentration of the TCE at BH18-11 is unlikely to pose an unacceptable risk to aquatic receptors based on the Table 9 GW3 component value for TCE.

b. Please correct typo in second sentence of second bullet point. "TCE plume" should read "PHC plume".

c. The QP discussed that the PHC plume does not extend to Midland Bay. There is no horizontal delineation of the plume downgradient of the exceedance at BH18-07. Therefore, based on the data currently available, it cannot be determined that the plume does not extend to Midland Bay. Given that the F2 concentration at BH18-07 exceeds the Table 9 GW3 component value (1,000 ug/L vs 170 ug/L), groundwater monitoring should be considered, unless addition delineation shows that the plume is not extending to Midland Bay.

d. Are underground utilities expected in the future development? If so, please consider including trench plug as RMM to mitigate any preferential migration of impacted groundwater off-site via underground utility conduits.

7. Section 7.4.6 – Contingency Plan

The QP discussed that "a contingency plan is not required to ensure the effectiveness of the measures. Rather, it will be important to ensure that the measures are properly maintained and not disturbed following installation". The purpose of having a contingency plan is so that receptors remain protected in the event that the RMMs are found to be not properly maintained, or are disturbed. Please provide a contingency plan for the RMMs proposed; contingency plan is a requirement under O. Reg. 153/04, as amended.

8. Section 7.5 – HASP

There was no HASP provided as Appendix J.

9. Section 7.6.1 – Soil Management

   a. The RMP provided no details on Soil Management Plan, such as:
      i. Mitigation of potential direct exposure during subgrade work
      ii. Dust control
      iii. Sampling requirements and soil criteria for soil reuse
      iv. Sampling requirements and soil criteria for soil importation

   b. "Methods for of soil tracking from the Site by vehicles, equipment, and personnel". There appears to be missing word. Please clarify.

   c. The QP discussed that one of the information to be supplied by the contractor related to the off-site disposal of any impacted soil include "acceptance letter from the receiving property's QPESA". Does this imply that the impacted soil may be sent to another RSC property? Please clarify. Please note that any export of soil to another property should follow the new On-Site and Excess Soil Management O. Reg. 406/19 when it comes into effect and the revised O. Reg. 153/04, where applicable.

   d. The QP discussed that "excavated soil with COCs in excess of the EBCs, may not remain at the surface of the Site after the completion of a construction project, unless it is capped in accordance with the hard cap/fill cap barrier RMM". What about soil in excess of both the EBCs and PSS?

   e. It should be noted that the requirements for a Soil Management Plan will be outlined in the CPU.

10. Section 7.6.2 – Groundwater Management

It is discussed that groundwater management is required "if groundwater is encountered during excavation activities within Area 1". Are excavation activities not expected within Area 2? The RMP proposed at grade or below grade parking garages within Area 2. Therefore, it appears the construction of a below grade parking garage within Area 2 is a possibility, and excavation would be expected. As noted in Comment 1c, the proposed RMM will be applicable to the entire RA property, unless there are provisions for a registered survey or scaled site plan to separate the RMMs. It should also be noted that the requirements for a Ground Water Management Plan will be outlined in the CPU.

RESUBMISSION

The risk assessment should be revised and resubmitted to the following address:

The Director
Client Services and Permissions Branch
135 St. Clair Avenue West, 1st Floor
Toronto, ON, M4V 1P5

Telephone 416-314-8001

Four hard copies of the risk assessment should be submitted (one marked original), including a stand-alone, electronic copy of the risk assessment report (in USB format).

To assist MECP in its review of the resubmission, changes to the risk assessment from the version that is the subject of the above review should be outlined in a revision table or errata sheet attached to the resubmission. Use of a redline method in the body of the revised risk assessment also is recommended, if possible and where practicable.

It also is recommended that the QP_{RA} provide responses to the MECP review comments as an attachment to the submission or as an appendix in the revised risk assessment. This will provide an opportunity for the QP_{RA} to explain to MECP reviewers how the MECP review comments have been addressed in the risk assessment. The QP_{RA} should note that submission of a response to the MECP review comments without a revised risk assessment or addendum is not considered to be a resubmission of the risk assessment under the Regulation and it may not be reviewed.

The Property Owner and QP_{RA} should note that upon receipt and review of the resubmission, the Director may issue a decision under Section 168.5 (1) EPA to accept or not to accept the risk assessment. If the decision is not to accept the risk assessment, then subsequent resubmissions or provision of additional information cannot be accepted by the Ministry for review. Advancement of a risk assessment of the subject property will require submission of a new Pre Submission Form followed by a new risk assessment of the site in accordance with Schedule C of the Regulation.

It is recommended that before resubmission of the risk assessment, the QP_{RA} review the mandatory requirements for risk assessments submitted under the Regulation, as outlined in Section 4 and Table 1 of Schedule C of the Regulation. As well, the Ministry's *Procedures for Use of Risk Assessment Under Part XV.1 of the Environmental Protection Act* should be used for guidance in how to satisfy the requirements of the Regulation. **It is important that the QP_{RA} also confer with the QP_{ESA} to determine whether the PSS provided will support filing of a record of site condition.**

Some of the comments included in this document (Schedule A) may be related to the adequacy of the environmental site assessment (ESA) work performed to support the approach and conclusions of the risk assessment (RA). Note that acceptance of the qualified person (QP's) responses on these ESA-related matters is for the purpose of supporting a decision on the RA only; a full regulatory review of the ESAs has not been conducted. The Ministry may undertake a more in depth review of the phase one and phase two ESA reports at the time the record of site condition (RSC) is submitted for filing to ensure that all the regulatory requirements have been met. Information relevant to the phase one and two ESA reports (e.g., table of areas of environmental concern, the conceptual site models) that is amended as part of the RA should be reflected in updated phase one and two ESA reports prior to submitting RSCs for filing. In addition, if the work on the phase one and two ESA exceeds 18 months prior to the submission date of the RSC, the phase one and two ESA reports will need to be updated prior to submitting RSCs for filing.

If the QP_{ESA} has any questions regarding meeting the ESA requirements at the time of RSC filing, it is suggested that they contact Rose Ash of Client Services and Permissions Branch; email: rosemary.ash@ontario.ca

If the QP_{RA} has questions regarding the application of the Regulation or the above comments, they should be forwarded by email to:

Ann-Marie Deonarine
Risk Assessment Review Coordinator
Technical Assessment and Standards Development Branch
ann-marie.deonarine@ontario.ca

SCHEDULE A
To Director's Notice
Comments by the Ministry of the Environment, Conservation and Parks On Risk Assessment
for
420 Bayshore Drive, Midland, Ontario
RA1765-19b

IDS Ref. No. 0155-BC6QVC

The following are Ministry comments on the following Risk Assessment (RA):

- **Revised Risk Assessment Report for 420 Bayshore Drive, Midland, Ontario, report prepared by CanNorth Environmental Services Limited Partnership, dated June 2020**

Comments On Risk Assessment

General Comments

This Risk Assessment (RA) is being submitted to support the filing of a Record of Site Condition (RSC) for the mixed use industrial and parkland property located at 420 Bayshore Drive in Midland, Ontario (the 'Site'). The Site, also identified as Midland Bay Landing, is approximately 16.24 hectares in size and extends to Midland Bay to the north.

The Site was historically industrial/parkland use and was occupied by an aggregate processing plant, coal docks and coal storage with rail spurs, boat dry dock, parking lot, and park. Currently, a marine rail system and small shed is located within a chain-link fenced enclosure in the central portion of the Site and concrete and sheet pile retaining structures are present in the western portion of the Site. An RSC is being sought based on the proposed mixed commercial, residential and parkland use.

The RA has been revised since the last RA submission (dated November 2019) to address comments. The review of this revised RA has identified a number of outstanding issues that will need to be resolved in order for the RA to be considered in compliance with O. Reg. 153/04 (as amended).

Note that some of the comments included in this document (Schedule A) may be related to the adequacy of the environmental site assessment (ESA) work performed to support the approach and conclusions of the RA. Note that acceptance of the qualified person (QP's) responses on these ESA-related matters is for the purpose of supporting a decision on the RA only; a full regulatory review of the ESAs has not been conducted. The Ministry may undertake a more in depth review of the phase one and phase two ESA reports at the time the record of site condition (RSC) is submitted for filing to ensure that all the regulatory requirements have been met. Information relevant to the phase one and two ESA reports (e.g., table of areas of environmental concern, the conceptual site models) that is amended as part of the RA should be reflected in updated phase one and two ESA reports prior to submitting RSCs for filing. If the QP_{ESA} has any questions regarding meeting the ESA requirements at the time of RSC filing, it is suggested that they contact Rose Ash of Client Services and Permissions Branch; email: rosemary.ash@ontario.ca

Specific Review Comments

Comments on the Pre-Submission Form

6. **Section 3.6 – Contaminant Inventory for Groundwater.** Comment addressed.

7. **Section 3.6 – Contaminant Inventory for Surface Water.** Comment addressed. However, in future, it would be helpful if the QP's response indicated where in the RA or Response to Comments table a comment is addressed.

17. **Other comments.**
    a. Comment addressed, however it is noted that the response to comment is incomplete. The QP's response should clearly indicate where in the RA or Response to Comments table a comment was addressed.

Comments on the Risk Assessment

1. **Section 1.0 – Summary of Recommendations/Findings.** Comment addressed.

2. **Section 1.1 – Introduction.** Comment addressed.

3. **Section 1.2 – Risk Assessment Objectives and Approach.** Comment addressed.

4. **Section 1.3 – Deviations from Pre-submission Form.** The comment is partially addressed. The figure provided in Appendix K indicates that the Phase Two ESA/Risk Assessment Property have the same boundary which excludes the water lots, however, the Phase Two ESA report provided in Appendix F.2 indicates that the water lots are included within the Phase Two property boundary. This should be clarified, and the Phase Two ESA boundary updated in Appendix K and Figure 5 of Appendix F.2 if warranted.

   Furthermore, the QP is reminded that when property boundaries change, in addition to an updated plan of survey, an updated lawyer's letter is required, as part of the risk assessment. Currently, the legal description included in the Section 3.1 of the RA does not appear to match the RA property, as outlined in Appendix K. This will need to be addressed. The QP is referred to Schedule C, Section 3(4)(i).

5. **Section 1.4 – Risk Assessment Standards.**

   a. Editorial Comment – Comment addressed.

   b. Comment addressed.

6. **Section 3.1 – Property Information.** The response may not address the comment. As per Comment #4, it appears that the Phase Two Property boundary includes water lots, and the RA Property boundary is only for the terrestrial portion of the property. It appears that the Site Identification Information presented is for the Phase Two Property.

7. **Section 3.1.4.1 – On-Site Receptors.** Comment addressed.

8. **Section 3.2 – Site Plan and Hydrogeological Interpretation.** Comment addressed.

9. **Section 3.3.2.1 – Selection of Contaminants of Concern in Soil.** Comment addressed.

10. **Section 3.3.2.2 – Selection of Contaminants of Concern in Groundwater, Table 3.5 (Screening for Contaminants of Concern in Groundwater).** The response partially addresses the comment. The units issue has been addressed in the RA, however, the concentrations presented in Table 14 in the Phase Two ESA (Appendix F.2) have not been updated.

11. **Section 3.3.2.3 – Sampling Programs.** The response partially addresses the comment; it would be helpful to refer to the Sediment and Surface Water as "Off-Site Sediment" and "Off-Site Surface Water" for clarity.

12. **Table 3-8 – Number of Sediment Samples.** The response partially addresses the comment; it would add clarity if the Table 3-8 was updated to indicate "BTEX and PHCs".

13. **Section 4.1.1 – Human Health Conceptual Site Model.**

    a. Comment addressed.

    b. **Figure 4.2 (Human Health Conceptual Site Model – With Risk Management).** Comment addressed.

14. **Section 4.1.1.1 – Resident.**

    a. Comment addressed.

    b. **Table 4.1 – Potential Pathways of Exposure for the Resident.** Comment addressed

15. **Section 4.1.1.2 – Indoor Worker, Table 4.2 (Potential Pathways of Exposure for Indoor Worker and Property Visitor).** The QP has indicated that the Property Visitor will experience

the same exposure pathways as the resident (in response to comment table and in updated Table 4.1), however the HH CSM (Figure 4.1) still indicates that exposure pathways will be negligible. It is unclear where the QP has documented the justification for negligible exposure since there is no section identifying the Visitor characteristics that explain why exposure is negligible. The QP will have to address this discrepancy.

16. **Section 4.1.1.3 – Outdoor Maintenance Worker.** Response partially accepted. While the outdoor worker's exposure to groundwater was reported to be qualitatively assessed via the subsurface worker, the QP did not provide a discussion of how the qualitative assessment was conducted nor provide conclusions as to whether the qualitative risks were acceptable or not for the outdoor worker. All receptors and pathways require an interpretation of the risk.

17. **Section 4.1.3 – Contaminants of Concern for Human Receptors.** Response partially accepted. The QP is required to quantitatively or qualitatively assess the risk associated with all COCs for all complete pathways. If the QP is of the opinion that some COCs were not volatile despite the current guidance, the QP should provide a discussion and appropriate lines of evidence to exclude these COCs from the assessment. Where COCs are classified as volatile but are without an HBIAC, the QP should qualitatively assess the risks, and discuss the uncertainty in the assessment.

18. **Section 4.1.3.2 – Groundwater.** Response partially accepted. A discussion of ½ solubility used for screening is included in the text; however, this component value screening was not presented in Table 4.7. Table 4.7 should be updated for completeness and to support your findings.

19. **Section 4.2.1 – Receptor Characteristics, Table 4.8 (Human Receptor Characteristics).**

    a. Comment addressed.

    b. Response partially accepted. Table 4.8 has been updated for hours exposed per day outdoors, however, the toddler's hours indoors appears have been left at 24 hours per day. The QP should clarify if the exposure calculations have been appropriately updated compared to the data presented in Table 4.8.

    c. Comment addressed.

    d. Comment addressed.

20. **Section 4.2.2 – Pathways Analysis, Table 4.9 (Exposure Pathways Evaluated for Human Receptors).**

    a. Comment addressed.

    b. Comment addressed.

21. **Section 4.2.4 – Inhalation Pathway.** Comment addressed.

22. **Section 4.2.4.2 – Estimation of Indoor Air Concentrations.**

    a. **Table 4.13 (Variables Used to Estimate Indoor Air Concentrations from Soil).** Response accepted.

    b. **Table 4.14 (Chemical-Specific Values Used to Estimate Indoor Air Concentrations from Soil).** Comment addressed.

23. **Section 4.2.4.3 – Estimation for Outdoor Air Concentrations,**

    a. **Table 4-18 (Variables Used to Estimate Outdoor Air Concentrations from Groundwater).** Comment addressed.

    b. **Outdoor Air Concentrations in a Trench from Groundwater.** Comment addressed.

    c. **Table 4-21 (Variables Used to Estimate Outdoor Air Concentrations from Soil).** Comment addressed.

    d. **Table 4-22 (Estimated Trench Air Concentrations from Soil).** Comment addressed.

24. **Section 4.2.6.2 – Groundwater Ingestion Pathway.** Comment addressed.

25. **Section 4.3.2.1 – Non-Carcinogenic Risks.**

    a. **Table 4.24 (Toxicological Reference Values for Non-carcinogenic Effects).** Comment addressed.

    b. **Developmental Toxicants.** Comment addressed.

26. **Section 4.3.2.3 – Uncertainties in Toxicity Values.** Comment addressed.

27. **Section 4.4.1.1 – Non-carcinogenic Effects.** Comment addressed.

28. **Section 4.4.2 – Quantitative Interpretation of Health Risks.** Response not accepted. A discussion regarding the risk characterization for a pregnant female receptor’s exposure to developmental toxicants could not be located. The QP should include this discussion for completeness and transparency.

29. **Section 4.4.2.1 – Resident.**

    a. **Direct Contact with Soil.** Comment addressed.

b. **Direct Contact with Soil.** Comment partially addressed. For transparency the text should include a discussion identifying the risk results as that belonging to the composite receptor. The text that was updated doesn't specifically identify the composite receptor nor the implications of risk assessed as a composite receptor.

c. **Table 4.27 (Doses and Risk Levels for a Composite Resident Receptor).** Comment addressed.

d. **Inhalation of Indoor Air from Vapours Migrating from Soil.** RMP related comments will be captured under the Comments on Risk Management section, below.

30. **Section 4.4.2.3 – Outdoor Maintenance Worker, Table 4.32 – Exposures and Potential Risks for an Outdoor Maintenance Worker.** Comment addressed.

31. **Section 4.4.2.4 – Subsurface Worker, Table 4.36 (Exposures and Potential Risks for a Subsurface Worker).**

    a. Comment has not been addressed completely. For transparency, Table 4.22 should include the intermediate data needed to derive Table 4.36. The update to Table 4.22 appears to be incomplete. Several non-COC PAHs are still missing. Consider the list of PAHs in Table 4.36 when updating Table 4.22.

    b. Comment addressed.

32. **Section 4.4.3.2 – Lack of Toxicity Data.** Comment addressed.

33. **Section 4.4.3.4 – Other Negligible Pathways.** Comment addressed.

34. **Section 4.4.4 – Interpretation of Off-Site Human Health Risks.** The response is noted.

35. **Section 4.4.6 – Setting of Property Specific Standards, Table 4.38 (PSS Protective of Human Health in Soil).** Comment addressed.

36. **HHRA – Missing Report Section.** Comment addressed.

37. **Section 5.1.1 – Ecological Conceptual Site Model.**

    a. The response partially addresses the comment. The CSM figures have been revised, however there are two bullets in the text describing the potential exposure pathways for on-site receptors: "Ingestion of food (plant and animal) contaminated by sediment and surface water COCs by mammals and birds" and "Ingestion of surface water (direct contact) by mammals and birds". The text should be revised.

    b. Comment addressed.

38. **Section 5.1.2 – Contaminants of Concern for Ecological Receptors.**

   a. The response partially addresses the comment; it is not clear why vinyl chloride has been included as a COC in soil

   b. Comment addressed.

39. **Table 5.1 – Comparison of Soil REMCs to Ecological Component Values.** The response addresses the comment.

40. **Section 5.1.2 – Soil Screening.**
   a. As noted in the response to comments, this comment was a repeat of Comment 38a. No further comment.

   b. As noted in the response to comments, this comment was a repeat of Comment 38b. No further comment.

41. **Section 5.1.4 – Groundwater Screening.** Comment addressed.

42. **Table 5.2 – Comparison of Groundwater REMCs to Ecological Component Values.** Comment addressed.

43. **Section 5.1.5.3 – Uncertainty Analysis.** Comment addressed.

44. **Section 5.2 – Receptor Characterization.**

   a. Comment addressed.

   b. Comment addressed.

45. **Section 5.3.1 – Pathways Analysis.** Comment addressed.

46. **Sections 5.3.1.1 – Terrestrial Plants and Soil Invertebrates, Section 5.3.1.2 – Mammals and Birds, and Section 5.3.1.3 – Aquatic Biota.**

   a. Comment addressed.

   b. Comment addressed.

47. **Table 5.5 – Exposure Characteristics for Wildlife Receptors.** Comment addressed.

48. **Section 5.5.2.1 – On-Site Environment, Groundwater.** Comment addressed.

49. **Section 5.5.2.2 – Off-site Aquatic Environment.**

a. Comment addressed.

b. The response partially addresses the comment; footnote “a” should be added to the copper standard of 5 µg/L in Table 5.9 to indicate that the value has been adjusted for water hardness.

c. Comment addressed.

d. The response indicates that the COCs were those parameters that exceeded the sediment quality component values identified in Section 5.1.4, however Section 5.1.3 presents the sediment quality criteria. This should be clarified. Additionally, PHC F2 is carried forward as a COC in Table 5.10 and it is not identified as an exceedance in Table 5.1. Please clarify.

e. Comment addressed.

50. **Section 5.5.3.2 – Missing Toxicity Information.**

a. Comment addressed.

b. Comment addressed.

51. **Section 5.5 – Risk Characterization.** Comment addressed.

52. **Table 5.10 – Property Specific Standards (PSS) Protective of Ecological Health in Soil and Table 6.3 – Soil Property Specific Standards.** Comment addressed.

53. **ERA – Missing Report Section.** As noted in the response to comments, this comment was a repeat of Comment 51. No further comment.

54. **Section 6.1 – Summary of Results, Table 6.1 (Summary of the HHRA Results).** Certain exposure pathways (e.g., gardening) and COCs (e.g. lead) that were qualitatively assessed in the HHRA were not presented in this table. Please update Table 6.1 to ensure it is complete.

55. **Table 6-2 – Summary of the ERA Results.**

a. This table should be checked for consistency against the results presented in Table 5-6. For example, Table 6-2 indicates that there were no exceedances of applicable standards for the American Woodcock, however Table 5.6 indicates there are exceedances for barium, cadmium, lead, selenium, and zinc. A selenium exceedance identified in Table 5.6 for the short-tailed shrew does not appear in Table 6.2.

b. The exposure pathway column of the table is blank; this should be revised.

c. The entries for off-site terrestrial and aquatic receptors are blank; the table should be revised.

56. **Table 6.3 – Soil Property Specific Standards.** It is not clear why RMM-1 is indicated as being required for acenaphthene based on the ecological risk assessment when this COC was not carried forward for the quantitative assessment and is not indicated as being carried forward for quantitative assessment in Table 5.1 or as exceeding the applicable standards in Table 6.2. This table should be checked for consistency and revised as necessary.

57. **Phase Two ESA (Appendix F.2).**

a. Comment addressed.

b. **Section 6.6.6 – Electrical Conductivity and Sodium Absorption Ratio.** Comment not addressed. This comment was not included in the response to comments table. Please revise.

c. **Appendix F – Surface Water and Sediment Results; Figure 7.** Comment addressed.

58. **Missing Appendices.** Comment partially addressed. Borehole logs were located in Appendix D of Appendix F.2. The risk management plan was provided as Appendix J. Appendix F.1, F.3, and F.4, referred to in the response to comments, could not be located. Summaries of the Phase One and Two ESA reports should be provided in the revised RA. The QP is also referred to Section 4(6)(4) and 4(6)(4.1) of the Schedule C of the Regulation.

New RA Comments (October 2020)

59. **General comment.** In future, it is recommended that the QP's responses clearly indicate where in the RA or Response to Comments table a comment is addressed.

60. **Section 3.1 – Property Information.** The legal description provided in the "Site Identification Information" should be revised to reflect only the description of the RA Property; it currently appears to include the water lots. No figures were included with the RA report, although the reviewer was referenced to the ESA report in some sections of the RA report. The QP is reminded that figures should be provided *as part of the RA report* and should not reference the ESA report. If the QP wishes the reviewer to refer to the P2CSM figures, which are a part of the RA report, this should be clearly indicated, and appropriate P2CSM figures should be referenced in the applicable sections of the RA report.

Currently, some of the P2CSM figures do not clearly show/outline the RA property (for example, Figure 7, 8, 11a, and others). The QP is reminded that the RA property boundary should be clearly shown on the figures, even if the original P2ESA was done for a larger property. The QP will also need to ensure that the APECs/PCAs identified in the P2CSM are applicable to the RA property (e.g., based on the updates made to the RA property, previous APECs that were considered to be on-Site may now be off-Site. In addition, previous on-Site PCAs which resulted in on-Site APECs may now be considered off-Site PCAs to cause on-Site APECs). This will require review and revision, as appropriate.

61. **Section 4.4.2.1 – Resident - Inhalation of Indoor Air from Vapours Migrating from Soil.** The text indicates that all COCs migrating from soil to indoor air exceeded the HBIACs, however, this is not true as the indoor air concentrations for acenaphthene do not exceed the HBIAC. Please revise.

62. **Table 4-28. Comparison of Estimated Indoor Air Concentrations from Volatile COCs Migrating from Soil to Residential HBIACs.** It is not clear why acenaphthene and anthracene are included in this table, as they are not identified as exceeding the S-IA value in Table 4.6, although it is noted that the predicted indoor air concentration for anthracene does exceed the HBIAC. This should be clarified, and any related tables updated for consistency. The QP may wish to consider revising the component values in Table 4.6 to reflect more recent updates to the toxicity reference values.

63. **Section 4.4.6 – Discussion of Uncertainty.** The uncertainty section requires additional discussion related to:

- The screening of COCs for potential vapour intrusion, including the implications of assessing COCs without an HBIAC
- Qualitative assessments of risk due to exposure assumptions or use of surrogates
- Qualitative assessments of risk due to lack of toxicity data
- Where assumptions were used in the assessment of risk, the magnitude and direction of changes in risk should be discussed as an outcome of a change in the assumption, e.g. an increase in assumed incidental ingestion rate would increase or decrease the risk, and change or not change the outcome of the risk assessment.

64. **Section 5.5.2.1 – On-Site Environment.** This section refers the reader to Figure 16a of the P2CSM for PHC groundwater data, but PHC data is included in Figure 17a of the P2CSM. This should be corrected.

65. **Table 5-12. Property Specific Standards (PSS) Protective of Ecological Health in Soil.** The table indicates that RMM-1 is not required for silver, however, Table 5-10 shows that silver concentrations in off-site sediment exceeds the sediment quality criteria. This discrepancy should be clarified.

Phase Two Conceptual Site Model Comments

Previous comments have been addressed.

Summary and Conclusions

There are some remaining issues that will need to be resolved or additional clarification provided in order for the revised RA to be considered in compliance with O. Reg. 153/04. In particular, additional information is needed to clarify inconsistencies with respect to the property boundaries and legal description.

Comments On Risk Management

Previous Comments on RMP – Schedule A of Director's Notice dated March 20, 2020:

1. Section 7.1 – Risk Management Performance Objectives

   a. The response is partially accepted. There are still a number of inconsistencies between Sections 6 and 7 that remain:
      - Copper in soil is listed in Table 6.3 as not needing RMMs for human health, but Table 7.2 discusses that capping is required to reduce human health risk by 1.7 times. This should be clarified.
      - Table 6.2 and Table 7.4 discuss that a soil cap is required for PHC F2 for protection of aquatic receptors, however, the text only discusses PHC F4.

   b. The response is partially accepted. The scope of the SVIMS is unclear. Section 7.1 discussed that "*Future buildings on the west portion of the Site (Area 1 on Figure 7.1) shall include a SVIMS. Within Area 1 on the western portion of the site, all volatile COC are within the applicable standards within a 30 metre buffer*". Is SVIMS required for Area 1 on the western portion of the site?

   c. The response is accepted. For clarity, it is recommended that Table 7.1 and Table 1.1 in the RMP refer to the figure that shows the boundary of the east portion and west portion (Area 1) of the RA property.

   d. The response is accepted.

   e. The response is partially accepted. Section 4 discusses that 2-(1-) methylnaphthalene, naphthalene, toluene, ethylbenzene, and xylenes may pose potential concern for the S-Nose pathway, however, this was not discussed in Section 6 or 7 of the RA Document. For clarity, it is recommended that the pathway be added to Tables 6.1 and 7.2.

2. Section 7.1.1.1 – Hard Cap/Fill Cap Barrier

   a. The response is partially accepted. For clarity, please revise the criteria for "unimpacted soil" to mean "applicable generic site condition standards for soil" instead of "applicable soil standards".

b. The response is partially accepted. Further clarifications are required:
   - On Figure 1 "Fill/Hard Cap RMM" in Appendix J, the minimum thickness for unimpacted soil for the fill cap with a geotextile fabric is not shown.
   - On Figure 1 in Appendix J, the depiction of the fill cap for deep-rooted vegetation is not clear. A minimum horizontal distance of 2,000 mm is shown from a dotted line, but it is not clear if this is to represent the centre line of the excavation. Also, the fill cap for deep-rooted vegetation is not discussed within Section 7 or Appendix J. Also, further details as to why a minimum of 1000mm and 1500mm of unimpacted soils are required.
   - The RMM figures in Appendix J have not been signed and sealed by a professional engineer.
   - Reference to Appendix J, as well as, references to the various RMM figures within Appendix J should be included in various discussions within Section 7 of the RA Document.

c. The response is partially accepted. Further clarifications are needed:
   - A figure illustrating the conceptual design of a trench plug should be provided. The figure should show how high above the utility pipe the trench plug should extend.

3. Section 7.1.1.3 – Site Restrictions

The response is not accepted. The discussion about vegetable garden restriction appears to be contradictory. It indicates that "the construction of vegetable gardens, other than those planted in above ground containers isolated from subsurface conditions, is restricted", however, it was further discussed that "raised vegetable garden beds may be constructed". Please clarify if raised vegetable garden beds are allowed, or should vegetable gardens be restricted to containers isolated from subsurface conditions.

4. Section 7.3 – Duration of Risk Management Measures

The response is accepted.

5. Section 7.4.3 – SVIMS

a. The response is partially accepted. It is noted In Section 7.4.3 "SVIMS" that an inspection and maintenance program will be developed by "a *Qualified Person (i.e, qualified engineer) or other representative of the property owner*". It should be noted that "Qualified Person" under O. Reg. 153 does not only include an engineer. This is also a slight variation on the reference made under Section 1.5.3 "SVIMS" of Appendix J where it indicates the program will be developed by a "qualified engineer". These sections need to be consistent. In addition, the system should be inspected by a qualified professional, and the inspection and maintenance program should not be conducted by *representative of the property owner* who is not a qualified professional.

b. The response is accepted.

c. The response is accepted.

d. The response is accepted.

e. The response is accepted.

f. The response is accepted.

g. The response is partially accepted. The indoor air trigger value for acenaphthylene on Table 7.6 is shown as 1.85 $\mu g/m^3$. Based on the TRVs presented in Section 4.3.2, it appears that this value should be 0.185 $\mu g/m^3$. This should be revised.

6. Section 7.4.4 – Groundwater Monitoring

a. The response is accepted.

b. The response is accepted.

c. The response is accepted.

d. The response is accepted.

7. Section 7.4.6 – Contingency Plan

The response is accepted. Please note minor typographical error: “At least one round of sub-sampling….”. It is assumed that this is intended to read “At least one round of sub-slab sampling…”. Please revise.

8. Section 7.5 – HASP

The response is accepted. It is noted that the scope of the HASP appears to be rather general as it includes protection against pathways that were not identified in the Risk Assessment as needing risk mitigation, such as use of respirators to mitigate exposure to vapour.

9. Section 7.6.1 – Soil Management

a. The response is accepted.

b. The statement added to address this comment could not be found. Please clarify.

c. The response is not accepted. Excavated soil with COCs in excess of the PSS cannot remain on-site, even under a cap.

d. See 9c.

e. Response accepted.

10. Section 7.6.2 – Groundwater Management

The response is partially accepted. Please note:

- Record keeping should also include groundwater analytical results.
- The QP is reminded that even though groundwater on the East portion does not exceed the applicable generic Standards, groundwater encountered during construction must still be managed and disposed of appropriately, and the groundwater quality must meet the criteria for the disposal method.
- Editorial comment: The first paragraph refers to "soil management plan".

New Comments – RA Document June 2020:

11. Section 7.1 – Risk Management Performance Objectives

a. For clarity, this section should provide a discussion of all RMMs proposed; there are no discussions on health and safety plan, restriction of potable groundwater use, soil and groundwater management plan and trench plug requirements.

b. Clarifications needed for Table 7.2:

- The heading for Table 7.2 indicates "terrestrial ecological receptors". Should the criteria not be protective of aquatic receptors as well?
- Table 9 SCS does not have component values for direct contact exposure pathway for ecological and human health receptors. Table 9 references Table 3 component values.
- Where there is no value for sediment, the QP should consider background concentration, or at minimum LEL. For example, it appears that PHC F2 criteria for ecological receptors was set at the lowest terrestrial ecological component value for Table 3 because there was no sediment value. As per the Rationale Document, where sediment values are not available, the Ontario background concentrations apply. Please recheck EBC and revise the required reduction factor accordingly.

c. Table 7.4 indicates that RMM for protection of subsurface workers include cap barrier. Subsurface workers are expected to work below the depth of the cap. Therefore, cap barrier should not be considered a RMM for subsurface workers.

d. Table 6.1 and Section 7.1 discussed that antimony, arsenic, and lead pose potential direct contact risk to the subsurface worker. However, Table 7.4 shows that in addition to these parameters, "cover/fill" is required for protection of subsurface workers from exposure to 1,2-methylnaphthalene, naphthalene, and toluene in soil. Please clarify.

12. Section 7.1.1.2 – Vapour Intrusion Mitigation Measures

Based on the information in this section, it appears that the use of SVIMS RMM is proposed for the whole property (Area 1 and Area 2), whereas, the use of the Storage/Parking Garage RMM is only to be utilized in Area 2 if SVIMs are not to be implemented. This is based on the statement under "Storage/Parking Garage RMM" which states "Future buildings on the east portion of the Site (Area 2 on Figure 7.1) that are not constructed with an SVIMS include a storage garage…" Please confirm that this is the correct understanding and/or clarify.

13. Section 7.4.3 – SVIMS

It should be noted that in addition to the design and installation of the SVIMS being completed by a qualified licensed professional engineer for each building, a sub-slab/indoor air monitoring program shall also be required to be developed by a qualified licensed professional engineer in consultation with the Qualified Person taking into account factors such as building area and the design/configuration of the building foundations. This requirement will be outlined in the CPU.

14. Section 7.6.1 – Soil Management

a. Soil sampling requirements for soil importation shall meet Sections 31 to 34 of Schedule E, not just Section 34.

b. It is stated that "excavated material meeting the generic Table 3 SCS applicable for the Site may be placed on-site at any depth, if deemed suitable by the QPESA in consideration of the requirements of the Risk Assessment". Given that the applicable generic standards is Table 9 SCS, the QP should consider applying Table 9 SCS.

c. It is stated that "the characterization of excavated materials to determine whether it may be placed below the Hard Cap or Fill Cap, or incorporated within the Fill Cap, shall including the collection and analyses of soil samples in accordance with the requirements set out in Clause 34 of Schedule E of O. Reg. 153/04". Please note that Section 34 pertains to soil brought to Phase Two property, not soil reuse.

d. Please include the required sampling frequencies for soil reuse and soil importation, rather than only citing sections of the Regulation.

15. Appendix J – Risk Management Plan

    a. None of the figures presented in the RMP are referenced in the text of Section 7 of the RA Document. Nor is Appendix J referenced in Section 7 of the RA Document. References need to be included.

    b. None of the engineering drawings presented in the RMP were signed and sealed by a licensed professional engineer.

    c. Figure 3: The figure indicated "see Detail A", but there is no "Detail A" shown.

    d. It is unclear if Figure 5 is intended to show fill thickness for utility trenches or trench plug design. The figure was not referenced in the text or in Section 7. There is also no discussion of fill thickness for utility trenches in the text or in Section 7.

    e. Editorial comment – Table 1.4 appears not to have pdf'd properly and is difficult to read. Please revise.

RESUBMISSION

The risk assessment should be revised and resubmitted to the following address:

The Director
Client Services and Permissions Branch
135 St. Clair Avenue West, 1st Floor
Toronto, ON, M4V 1P5

Telephone 416-314-8001

Four hard copies of the risk assessment should be submitted (one marked original), including a stand-alone, electronic copy of the risk assessment report (in USB format). However, if the ministry is still working remotely, then please follow the interim submission process for risk assessments. Please ensure the electronic copy submitted during the interim submission process is a stand-alone document and that all sections within the submission are bookmarked.

To assist MECP in its review of the resubmission, changes to the risk assessment from the version that is the subject of the above review should be outlined in a revision table or errata sheet attached to the resubmission. Use of a redline method in the body of the revised risk assessment also is recommended, if possible and where practicable.

It also is recommended that the QP_{RA} provide responses to the MECP review comments as an attachment to the submission or as an appendix in the revised risk assessment. This will provide an opportunity for the QP_{RA} to explain to MECP reviewers how the MECP review comments have been addressed in the risk assessment. The QP_{RA} should note that submission of a response to the MECP review comments without a revised risk assessment or addendum is not considered to be a resubmission of the risk assessment under the Regulation and it may not be reviewed.

The Property Owner and QP_{RA} should note that upon receipt and review of the resubmission, the Director may issue a decision under Section 168.5 (1) EPA to accept or not to accept the risk assessment. If the decision is not to accept the risk assessment, then subsequent resubmissions or provision of additional information cannot be accepted by the Ministry for review. Advancement of a risk assessment of the subject property will require submission of a new Pre Submission Form followed by a new risk assessment of the site in accordance with Schedule C of the Regulation.

It is recommended that before resubmission of the risk assessment, the QP_{RA} review the mandatory requirements for risk assessments submitted under the Regulation, as outlined in Section 4 and Table 1 of Schedule C of the Regulation. As well, the Ministry's *Procedures for Use of Risk Assessment Under Part XV.1 of the Environmental Protection Act* should be used for guidance in how to satisfy the requirements of the Regulation. **It is important that the QP_{RA} also confer with the QP_{ESA} to determine whether the PSS provided will support filing of a record of site condition.**

Some of the comments included in this document (Schedule A) may be related to the adequacy of the environmental site assessment (ESA) work performed to support the approach and conclusions of the risk assessment (RA). Note that acceptance of the qualified person (QP's) responses on these ESA-related matters is for the purpose of supporting a decision on the RA only; a full regulatory review of the ESAs has not been conducted. The Ministry may undertake a more in depth review of the phase one and phase two ESA reports at the time the record of site condition (RSC) is submitted for filing to ensure that all the regulatory requirements have been met. Information relevant to the phase one and two ESA reports (e.g., table of areas of environmental concern, the conceptual site models) that is amended as part of the RA should be reflected in updated phase one and two ESA reports prior to submitting RSCs for filing. In addition, if the work on the phase one and two ESA exceeds 18 months prior to the submission date of the RSC, the phase one and two ESA reports will need to be updated prior to submitting RSCs for filing.

If the QP_{ESA} has any questions regarding meeting the ESA requirements at the time of RSC filing, it is suggested that they contact Rose Ash of Client Services and Permissions Branch; email: rosemary.ash@ontario.ca

If the QP_{RA} has questions regarding the application of the Regulation or the above comments, they should be forwarded by email to:

Ann-Marie Deonarine
Risk Assessment Review Coordinator

Technical Assessment and Standards Development Branch
ann-marie.deonarine@ontario.ca

SCHEDULE A

To Director's Notice

Comments by the Ministry of the Environment, Conservation and Parks On Risk Assessment

for

420 Bayshore Drive, Midland, Ontario

RA1765-19c

IDS Ref. No. 0155-BC6QVC

The following are Ministry comments on the following Risk Assessment (RA):

- **Midland Bay Landing Risk Assessment Report for 420 Bayshore Drive, Midland, Ontario, report prepared by CanNorth Environmental Services Limited Partnership, dated April 2021**

Comments On Risk Assessment

General Comments

This Risk Assessment (RA) is being submitted to support the filing of a Record of Site Condition (RSC) for the mixed use industrial and parkland property located at 420 Bayshore Drive in Midland, Ontario (the 'Site'). The Site, also identified as Midland Bay Landing, is approximately 16.24 hectares in size and extends to Midland Bay to the north.

The Site was historically industrial/parkland use and was occupied by an aggregate processing plant, coal docks and coal storage with rail spurs, boat dry dock, parking lot, and park. Currently, a marine rail system and small shed is located within a chain-link fenced enclosure in the central portion of the Site and concrete and sheet pile retaining structures are present in the western portion of the Site. An RSC is being sought based on the proposed mixed commercial, residential and parkland use.

The RA has been revised since the last RA submission (dated June 2020) to address comments. The review of this revised RA has identified a number of outstanding issues that will need to be resolved in order for the RA to be considered in compliance with O. Reg. 153/04 (as amended).

Note that some of the comments included in this document (Schedule A) may be related to the adequacy of the environmental site assessment (ESA) work performed to support the approach and conclusions of the RA. Note that acceptance of the qualified person (QP's) responses on these ESA-related matters is for the purpose of supporting a decision on the RA only; a full regulatory review of the ESAs has not been conducted. The Ministry may undertake a more in depth review of the phase one and phase two ESA reports at the time the record of site condition (RSC) is submitted for filing to ensure that all the regulatory requirements have been met. Information relevant to the phase one and two ESA reports (e.g., table of areas of environmental concern, the conceptual site models) that is amended as part of the RA should be reflected in updated phase one and two ESA reports prior to submitting RSCs for filing. If the QP_{ESA} has any questions regarding meeting the ESA requirements at the time of RSC filing, it is suggested that they contact Sridhar Sangaraju of Environmental Permissions Branch; email: Sridhar.Sangaraju@ontario.ca

Specific Review Comments

Comments on the Pre-Submission Form

7. **Section 3.6 – Contaminant Inventory for Surface Water.** No response required.

17. **Other comments.**
    a. Comment was previously addressed.

Comments on the Risk Assessment

4. **Section 1.3 – Deviations from Pre-submission Form.** Comments addressed.

6. **Section 3.1 – Property Information.** Comment addressed.

10. **Section 3.3.2.2 – Selection of Contaminants of Concern in Groundwater, Table 3.5 (Screening for Contaminants of Concern in Groundwater).** Comment addressed.

11. **Section 3.3.2.3 – Sampling Programs.** Comment addressed.

12. **Table 3-8 – Number of Sediment Samples.** Comment addressed.

15. **Section 4.1.1.2 – Indoor Worker, Table 4.2 (Potential Pathways of Exposure for Indoor Worker and Property Visitor).** Comment addressed.

16. **Section 4.1.1.3 – Outdoor Maintenance Worker.** The QP should also discuss whether this surrogate approach is appropriate given the different exposure assumptions for these two receptors. For example, an outdoor worker is expected to be on the Site for 56 years while a sub-surface worker is expected to be present for 1.5 years.

17. **Section 4.1.3 – Contaminants of Concern for Human Receptors.** Response partially accepted. The QP refers to the Phase Two ESA for the lack of gaseous forms of mercury and arsenic however unless specific methods and equipment are used, the lack of information in the Phase Two cannot be equated with the lack of these COCs on the RA Property. The Phase Two and RA would have to provide lines of evidence (e.g. nondetect for mercury in vapour using the proper

instruments, based on past use/APECS on the property no elemental mercury is expected, etc.) to exclude such COCs. Similarly, for PHC F3 and PHC F4, other lines of evidence are needed to exclude these COCs, since the QP has not shown how solubility is related to volatilization in their discussion. The QP is required to quantitatively or qualitatively assess the risk associated with all COCs for all complete pathways. If the QP is of the opinion that some COCs were not volatile despite the current guidance, the QP should provide a discussion and appropriate lines of evidence to exclude these COCs from the assessment. Where COCs are classified as volatile but are without an HBIAC, the QP should qualitatively assess the risks, and discuss the uncertainty in the assessment.

18. **Section 4.1.3.2 – Groundwater.** Comment addressed.

19. **Section 4.2.1 – Receptor Characteristics, Table 4.8 (Human Receptor Characteristics).**

    b. Comment addressed.

28. **Section 4.4.2 – Quantitative Interpretation of Health Risks.** Comment addressed.

29. **Section 4.4.2.1 – Resident.**

    b. **Direct Contact with Soil.** Comment addressed.

31. **Section 4.4.2.4 – Subsurface Worker, Table 4.36 (Exposures and Potential Risks for a Subsurface Worker).**

    a. Comment has not been addressed completely. Since Table 4.22 only presents trench air concentrations for volatile PAHs, the value in Table 4.36 Total Carcinogenic PAHs calculated for trench air should be discussed in the uncertainty section with regard to the PAHs that the QP considered non-volatile.

37. **Section 5.1.1 – Ecological Conceptual Site Model.**

    a. Comment addressed.

38. **Section 5.1.2 – Contaminants of Concern for Ecological Receptors.**

    a. Comment not addressed. The list of COCs in soil presented in the text of Section 5.1.2 is different from the one presented in Section 3.3.2.1. The text of Section 3.3.2.1 does not list vinyl chloride as a COC, and the text of Section 5.1.2 does list vinyl chloride as a COC. The text should be clarified for consistency.

49. **Section 5.5.2.2 – Off-site Aquatic Environment.**

    b. Comment addressed.

d. Comment addressed.

54. **Section 6.1 – Summary of Results, Table 6.1 (Summary of the HHRA Results).** Comment addressed.

55. **Table 6-2 – Summary of the ERA Results.**

    a. Comment addressed.

    b. Comment addressed.

    c. Comment addressed.

56. **Table 6.3 – Soil Property Specific Standards.** Comment addressed.

57. **Phase Two ESA (Appendix F.2).**

    b. **Section 6.6.6 – Electrical Conductivity and Sodium Absorption Ratio.** Comment addressed.

58. **Missing Appendices.** The response to comment incorrectly referred to Appendix F.1 as the location of the Phase Two ESA, but the information was found in Appendix F.2; comment addressed.

New RA Comments (October 2020)

59. No response required.

60. **Section 3.1 – Property Information.** Parts of the RA still refer to the P2ESA for the figures (e.g. Sections 3.1, 3.1.1, 3.1.2, 3.1.4, etc.). The RA should be updated to refer to the appropriate figures presented with the RA report (e.g. P2CSM figures in Appendix G). Alternatively, the RA report itself could include the figures (e.g. in an appendix).

61. **Section 4.4.2.1 – Resident - Inhalation of Indoor Air from Vapours Migrating from Soil.** Comment addressed.

62. **Table 4-28. Comparison of Estimated Indoor Air Concentrations from Volatile COCs Migrating from Soil to Residential HBIACs.** Comment addressed.

63. **Section 4.4.6 – Discussion of Uncertainty.** Comment addressed.

64. **Section 5.5.2.1 – On-Site Environment.** Comment addressed.

65. **Table 5-12. Property Specific Standards (PSS) Protective of Ecological Health in Soil.** A response to this comment was not provided in the response to comments table, and it does not appear to have been addressed. The table indicates that RMM-1 is not required for silver, however, Table 5-10 shows that silver concentrations in off-site sediment exceed the sediment quality criteria. This discrepancy should be clarified. The reviewer notes that Table 6.3 may also require similar updates.

New RA Comments (July 2021)

66. In follow up to Comment 62, the TRVs in Section 4.3 were reviewed for consistency with the response to comments. The reviewer could not find the discussion relating to the selection of the following TRVs:

    a. The QP has selected an RfC value for arsenic that is different from the MECP's published (January 2020) list of TRVs; the QP is required to provide a rationale for the selection of this value.

    b. The QP has selected an RfC value for Aliphatic C6-C8 that is different from the MECP's published (January 2020) list of TRVs; the QP is required to provide a rationale for the selection of this value.

67. **Section 5.5.2.2 – Off-site Aquatic Environment, "Sediment".** Table 5.10 was revised to remove PHC F2 to align with the COCs identified in Section 5.1.3. However, the text that precedes the table still indicates that PHC F2 exceeds the sediment quality and SEL. This should be revised.

68. **Table 6-2 – Summary of the ERA Results.** The table has been updated to reflect the qualitative assessment in Section 5.5.3.2 for PAHs for plants and soil invertebrates and the short-tailed shrew, but has not been updated to reflect the qualitative assessment for the garter snake. This should be revised.

Phase Two Conceptual Site Model Comments

Comments were previously addressed.

Summary and Conclusions

There are remaining issues that will need to be resolved or additional clarification provided in order for the revised RA to be considered in compliance with O. Reg. 153/04. A number of previous comments were either not fully addressed, or were missed, including the entire set of comments on the RMP from the review of the June 2020 RA document. Changes made in response to the RA comments were often not carried through the entire RA document, resulting in inconsistencies between the different sections and appendices. The report should be revised and resubmitted.

Comments On Risk Management

1. Section 7.1 – Risk Management Performance Objectives

   a. The response is accepted.

   b. The response is partially accepted. Figure 7.1 identifies the east portion of the Site as Area 1 and the west portion of this Site as Area 2. This is opposite of the discussions provided in Section 1.6, Section 7.1, and Table 7.1 of the RA Document. This needs to be clarified.

      In addition, Table 7.1 discussed that the RMM for the east portion of the site will be adequate for meeting the indoor air trigger values as shown on Table 7.2. However, Table 7.2 includes TCE in soil that requires more than 400 times reduction, which would not be achievable via the proposed storage garage RMM. Please clarify. It appears that the elevated TCE concentration was found on the west portion of the site, where SVIMS is required. For clarity, the maximum concentrations and VI RMM reduction factors should be presented separately for the west and east portions of the Site.

   c. The response is partially accepted. As noted above, Figure 7.1 identifies the east portion of the Site as Area 1 and the west portion of this Site as Area 2 which is opposite of the discussions provided in the RA Document.

   d. No response was required.

   e. The response is partially accepted. The S-Nose pathway is combined with the indoor air inhalation pathway instead of being standalone in Tables 6.1 and 7.2. As a result, it is not clear which of the parameters with indoor air risk also present a potential concern for the S-Nose pathway. This should be clarified.

2. Section 7.1.1.1 – Hard Cap/Fill Cap Barrier

   a. The response is accepted.

   b. The response is partially accepted. Further clarifications are required:
      - Figure 1 “Fill/Hard Cap RMM” comment is addressed.
      - On Figure 1 in Appendix J – response is partially accepted. Again there is no discussion of the fill cap for deep-rooted vegetation within Section 7 or Appendix J. Further details are required showing how the deep rooted vegetation fill cap is to be completed for tree root balls, etc. In addition, can deep rooted vegetation fill cap be utilized in areas of the shallow fill cap with only 500 mm and a geotextile?
      - The RMM figures in Appendix J have not been signed and sealed by a professional engineer – comment not addressed. The RMM figures are not signed and sealed by a professional engineer.

- Reference to Appendix J, as well as, references to the various RMM figures within Appendix J should be included in various discussions within Section 7 of the RA Document. – comment was not fully addressed and still needs to be completed.

  c. A figure illustrating the conceptual design of a trench plug - The response is partially accepted. As noted above, the RMM figures are not signed and sealed by a professional engineer. This needs to be completed.

3. Section 7.1.1.3 – Site Restrictions

   The response is partially accepted. The RMP allows for raised garden beds, with or without an underlying geotextile fabric. This could potentially contradict the discussion that vegetable gardens are restricted to "above ground containers isolated from surface conditions" and could result in confusion when implementing the RMP. Please clarify.

4. Section 7.3 – No response was required.

5. Section 7.4.3 – SVIMS

   a. The response is accepted. It should be noted that the inspection and maintenance program shall be developed and implemented by a licensed professional engineer. This requirement will be stipulated in the CPU.

   g. The response is accepted.

6. Section 7.4.4 – no response required.

7. Section 7.4.6 – Contingency Plan

   The response is accepted.

8. Section 7.5 – HASP - no response required.

9. Section 7.6.1 – Soil Management

   b. The response is accepted. It should be noted that the requirements for the soil management plan will be specified within the CPU.

   c. The response is accepted.

10. Section 7.6.2 – Groundwater Management

    The response is partially accepted. Please note:
    - Record keeping – the response is accepted.

- The response is partially accepted. This section should be revised to indicate that the groundwater management plan is applicable to the entire RA property. It should be noted that the requirements for the ground water management plan will be specified within the CPU.
- Editorial comment: - Comment addressed.

Previous Comments on RMP – Schedule A of Director's Notice dated October 9, 2020

The following comments were provided in the previous review as noted in the Schedule A of the Director's Notice dated October 9, 2020 and have not been addressed and do not appear in the response table provided in Appendix B of the RA Document. These comments need to be addressed.

As a result, they are being repeated here. Some minor clarifications to the comments have been made with respect to the revised RA Document as noted in bold italics.

11. Section 7.1 – Risk Management Performance Objectives

    a. For clarity, this section should provide a discussion of all RMMs proposed; there are no discussions on health and safety plan, restriction of potable groundwater use, soil and groundwater management plan and trench plug requirements.

    b. Clarifications needed for Table 7.2:
       - The heading for Table 7.2 indicates "terrestrial ecological receptors". Should the criteria not be protective of aquatic receptors as well?
       - Table 9 SCS does not have component values for direct contact exposure pathway for ecological and human health receptors. Table 9 references Table 3 component values.
       - Where there is no value for sediment, the QP should consider background concentration, or at minimum LEL. For example, it appears that PHC F2 criteria for ecological receptors was set at the lowest terrestrial ecological component value for Table 3 because there was no sediment value. As per the Rationale Document, where sediment values are not available, the Ontario background concentrations apply. Please recheck EBC and revise the required reduction factor accordingly.

    c. Table 7.4 indicates that RMM for protection of subsurface workers include cap barrier. Subsurface workers are expected to work below the depth of the cap. Therefore, cap barrier should not be considered a RMM for subsurface workers.

    d. Table 6.1 and Section 7.1 discussed that antimony, arsenic, and lead pose potential direct contact risk to the subsurface worker. However, Table 7.4 shows that in addition to these parameters, "cover/fill" is required for protection of subsurface workers from exposure to 1,2-methylnaphthalene, naphthalene, and toluene in soil. Please clarify.

12. Section 7.1.1.2 – Vapour Intrusion Mitigation Measures

    Based on the information in this section, it appears that the use of SVIMS RMM is proposed for the whole property (Area 1 and Area 2), whereas, the use of the Storage/Parking Garage RMM is only to be utilized in Area 2 if SVIMs are not to be implemented. This is based on the statement under "Storage/Parking Garage RMM" which states "Future buildings on the east portion of the Site (Area 2 on Figure 7.1) that are not constructed with an SVIMS shall include a storage garage…" Please confirm that this is the correct understanding and/or clarify.

13. Section 7.4.3 – SVIMS

    It should be noted that in addition to the design and installation of the SVIMS being completed by a qualified licensed professional engineer for each building, a sub-slab/indoor air monitoring program shall also be required to be developed by a qualified licensed professional engineer in consultation with the Qualified Person taking into account factors such as building area and the design/configuration of the building foundations. This requirement will be outlined in the CPU.

14. Section 7.6.1 – Soil Management

    a. Soil sampling requirements for soil importation shall meet Sections 31 to 34 of Schedule E, not just Section 34.

    b. It is stated that "excavated material meeting the generic Table 3 SCS applicable for the Site may be placed on-site at any depth, if deemed suitable by the QPESA in consideration of the requirements of the Risk Assessment". Given that the applicable generic standards is Table 9 SCS, the QP should consider applying Table 9 SCS.

    c. It is stated that "the characterization of excavated materials to determine whether it may be placed below the Hard Cap or Fill Cap, or incorporated within the Fill Cap, shall including the collection and analyses of soil samples in accordance with the requirements set out in Clause 34 of Schedule E of O. Reg. 153/04". Please note that Section 34 pertains to soil brought to Phase Two property, not soil reuse.

    d. Please include the required sampling frequencies for soil reuse and soil importation, rather than only citing sections of the Regulation.

15. Appendix J – Risk Management Plan

    a. None of the figures presented in the RMP are referenced in the text of Section 7 of the RA Document. Nor is Appendix J referenced in Section 7 of the RA Document ***with the exception of the HASP***. References need to be included for the other drawings.

    b. None of the engineering drawings presented in the RMP were signed and sealed by a licensed professional engineer.

c. Figure 3: The figure indicated “see Detail A”, but there is no “Detail A” shown. – ***comment has been addressed with the revised Figure 3.***

d. It is unclear if Figure 5 is intended to show fill thickness for utility trenches or trench plug design. The figure was not referenced in the text or in Section 7. There is also no discussion of fill thickness for utility trenches in the text or in Section 7.

e. Editorial comment – Table 1.4 appears not to have pdf’d properly and is difficult to read. Please revise. - ***comment has been addressed with the revised RMP in Appendix J.***

RESUBMISSION

The risk assessment should be revised and resubmitted to the following address:

The Director
Client Services and Permissions Branch
135 St. Clair Avenue West, 1st Floor
Toronto, ON, M4V 1P5

Telephone 416-314-8001

Four hard copies of the risk assessment should be submitted (one marked original), including a stand-alone, electronic copy of the risk assessment report (in USB format). However, if the ministry is still working remotely, then please follow the interim submission process for risk assessments. Please ensure the electronic copy submitted during the interim submission process is a stand-alone document and that all sections within the submission are bookmarked.

To assist MECP in its review of the resubmission, changes to the risk assessment from the version that is the subject of the above review should be outlined in a revision table or errata sheet attached to the resubmission. Use of a redline method in the body of the revised risk assessment also is recommended, if possible and where practicable.

It also is recommended that the QP_{RA} provide responses to the MECP review comments as an attachment to the submission or as an appendix in the revised risk assessment. This will provide an opportunity for the QP_{RA} to explain to MECP reviewers how the MECP review comments have been addressed in the risk assessment. The QP_{RA} should note that submission of a response to the MECP review comments without a revised risk assessment or addendum is not considered to be a resubmission of the risk assessment under the Regulation and it may not be reviewed.

The Property Owner and QP_{RA} should note that upon receipt and review of the resubmission, the Director may issue a decision under Section 168.5 (1) EPA to accept or not to accept the risk assessment. If the decision is not to accept the risk assessment, then subsequent resubmissions or provision of additional information cannot be accepted by the Ministry for review. Advancement of a risk assessment of the subject property will require submission of a new Pre Submission Form followed by a new risk assessment of the site in accordance with Schedule C of the Regulation.

It is recommended that before resubmission of the risk assessment, the QP_{RA} review the mandatory requirements for risk assessments submitted under the Regulation, as outlined in Section 4 and Table 1 of Schedule C of the Regulation. As well, the Ministry's *Procedures for Use of Risk Assessment Under Part XV.1 of the Environmental Protection Act* should be used for guidance in how to satisfy the requirements of the Regulation. **It is important that the QP_{RA} also confer with the QP_{ESA} to determine whether the PSS provided will support filing of a record of site condition.**

Some of the comments included in this document (Schedule A) may be related to the adequacy of the environmental site assessment (ESA) work performed to support the approach and conclusions of the risk assessment (RA). Note that acceptance of the qualified person (QP's) responses on these ESA-related matters is for the purpose of supporting a decision on the RA only; a full regulatory review of the ESAs has not been conducted. The Ministry may undertake a more in depth review of the phase one and phase two ESA reports at the time the record of site condition (RSC) is submitted for filing to ensure that all the regulatory requirements have been met. Information relevant to the phase one and two ESA reports (e.g., table of areas of environmental concern, the conceptual site models) that is amended as part of the RA should be reflected in updated phase one and two ESA reports prior to submitting RSCs for filing. In addition, if the work on the phase one and two ESA exceeds 18 months prior to the submission date of the RSC, the phase one and two ESA reports will need to be updated prior to submitting RSCs for filing.

If the QP_{ESA} has any questions regarding meeting the ESA requirements at the time of RSC filing, it is suggested that they contact Sridhar Sangaraju of Environmental Permissions Branch; email: Sridhar.Sangaraju@ontario.ca.

If the QP_{RA} has questions regarding the application of the Regulation or the above comments, they should be forwarded by email to:

Ann-Marie Deonarine
Risk Assessment Review Coordinator
Technical Assessment and Standards Development Branch
ann-marie.deonarine@ontario.ca

Response Tracking Table - 420 Bayshore Drive, Midland
PSF1765-19 (IDS Ref No. 0155-BC6QVC)

Comments on Pre-Submission Form							
No.	**Section/Area in Report**	**Ministry Comment (July 8, 2019)**	**Response**	**Ministry Comment (March 20, 2020)**	**Response**	**Ministry Comment (October 10, 2020)**	**Response**
1	Section 1 – Property Information.	Editorial Comment – It appears that the Site's municipality has been incorrectly indicated as Barrie. This should be revised in the RA report.	This has been updated.	The response addressed the comment.	No response required.		
2	Section 3.2 – Adjacent Property Use Information.	The information presented is not consistent with Section 2.1 (Phase One Property Information) of the Phase One ESA. Specifically, it appears the QP has mixed up the east and west neighbouring properties. This should be reviewed and revised accordingly.	The east and west properties were reversed in the PSF. This does not affect the Phase Two CSM or the Risk Assessment.	The response addresses the comment.	No response required.		
3	Section 3.3.11 – Depth of Organic Contamination in Soil and Section 3.3.12 – Depth of Inorganic Contamination in Soil.	For future PSFs, the QP is reminded that the depth of contamination should be presented as a range of soil depths where chemical parameters are in excess of the applicable SCS.	This is noted for future PSF submissions.	The response is accepted.	No response required.		
4	Section 3.5.9 – Intended Use of the Property.	While the PSF has indicated that the intended use of the property will include commercial, parkland, and residential use, the PSF does not provide commentary on the proposed future development (i.e., low-rise and mid-rise commercial/residential condominium units, as presented in the Phase Two CSM). Details on the proposed developments at the site should be presented in the RA report, if known.	The future development plans for the Site are not yet known. As a conservative measure, the generic MECP residential and commercial buildings were used in the estimation of exposure to receptors. If this information becomes available, it will be included in future resubmissions.	The response is accepted.	No response required.		
5a	Section 3.6 – Contaminant Inventory for Full Depth Soil.	A minimum soil pH of 4.11 has been reported, which is outside of the acceptable MECP range of 5 to 9 for surface soils and 5 to 11 for subsurface soils. There is no discussion of this low soil pH sample in the PSF; however, the Phase Two CSM does indicate that only one low pH soil sample was observed and four additional soil samples collected in the vicinity of this location had pH within the acceptable range. The QP is recommended to include all Certificates of Analysis (CofAs), analytical data summary tables, and appropriate discussion in the upcoming RA report so the reviewer can confirm that this low soil pH result was appropriately averaged in accordance with MECP (2007) guidance.	Seventy-five soil samples were submitted for laboratory analysis by Pinchin (2014) and Stantec (2014) to assess soil pH at the Site. Except for one surface soil sample, soil pH results were within the allowable ranges for surface and sub-surface soil. Five additional soil samples collected by Cambium in 2019 within 2 m of the original sample, including one sample collected at the original location and depth, were within the acceptable range for surface soil. Therefore, the single low pH sample result in the Stantec data was considered spurious and was removed from the dataset. Therefore, the pH values for the soil at the Site fall between 5 and 9. Accordingly, the MECP's assumptions regarding the mobility and bioavailability for chemicals used in the Rationale for the Development and Application of Generic Soil, Ground Water and Sediment Criteria for Use at Contaminated Sites in Ontario (MOE 2011) are applicable	The responses address the comments.	No response required.		
5b		The potential for exceedance of applicable SCSs at nearest off-site receptors has been left blank for cyanide (CN-) and mercury. Please clarify.	This is an error; cyanide (CN-) and mercury were identified as COC and have the potential for exceedance of applicable SCSs at nearest off-site receptors. This has been addressed within the RA.				
6	Section 3.6 – Contaminant Inventory for Groundwater.	Based on the information presented in the PSF, the reviewer could not confirm whether the list of chemical parameters identified as COCs is complete. The QP is reminded that the RA report should provide full analytical data tables and CofAs for review.	Full analytical data tables and CofAs are provided in the electronic version of the Phase Two ESA submitted with the RA.	The response addresses the comment; however, this information should be presented in the main RA report (see RA comments below). No further response is	No response required.	Comment addressed.	No response required.
7	Section 3.6 – Contaminant Inventory for Surface Water.	The information presented in the PSF form appears to be incomplete as the Phase Two indicates that surface water was sampled for BTEX, PHCs, PAHs, and metals. Based on the available information, the reviewer could not confirm whether the list of chemical parameters identified as COCs is complete. This information, if available, should be included in the RA. The QP is reminded that the RA report should provide full analytical data tables and CofAs for review.	Please note that the property boundary was revised, the updated boundaries show that there are no aquatic environments on the Site, only the terrestrial parcel. Full analytical data tables and CofAs are provided in the electronic version of the Phase Two ESA submitted with the RA.	It is acknowledged that the site boundaries have been revised and that the aquatic lot is no longer within the RA boundary. However, the surface water data is discussed in the qualitative evaluation of the potential for off- site risks in the ERA, and this data is not included in the Phase Two ESA submitted with the RA. The full	See response to Comment in the Risk Assessment Tracking Table	Comment addressed. However, in future, it would be helpful if the QP's response indicated where in the RA or Response to Comments table a comment is addressed.	Noted.
		a) Since the RA property includes a portion of Midland Bay, the QP should clarify why direct and indirect contact with surface water and sediment by on-site receptors isn't considered to be a complete exposure pathway and included in the HHRA for quantitative assessment.	The CSM did indicate that this was a complete pathway but expected to be negligible. The property boundary was revised, the updated boundaries show that there are no aquatic environments on the Site, only the terrestrial parcel.	The responses address the comments.	No response required.		

Response Tracking Table - 420 Bayshore Drive, Midland
PSF1765-19 (IDS Ref No. 0155-BC6QVC)

		Comments on Pre-Submission Form					
No.	Section/Area in Report	Ministry Comment (July 8, 2019)	Response	Ministry Comment (March 20, 2020)	Response	Ministry Comment (October 10, 2020)	Response
8	Section 5 – Human Health Conceptual Site Model – Without RMMs (Figure).	b) Since the minimum depth to groundwater is 0.34 mbgs, there is the potential for residents/visitors working within vegetable gardens/flower beds and outdoor workers conducting site maintenance to come into direct contact with groundwater. The QP should consider these exposure pathways to be complete or provide supporting rationale to demonstrate that they are incomplete.	The QP acknowledges the potential for residents/visitors working within vegetable gardens/flower beds and outdoor workers conducting site maintenance to come into direct contact with groundwater as a complete pathway. An RMM for Landscape Restriction to prohibit the installation of vegetable gardens, other than those planted in above ground containers isolated from subsurface conditions, to protect residents from the consumption of foods grown directly in impacted soils. The exposure pathway of the outdoor worker to groundwater is considered a complete pathway as well. A discussion of this is provided within the RA report.				
		c) For complete exposure pathways (i.e., potential pathway of exposure [included in the HHRA]), the QP is recommended to indicate whether each pathway will be quantitatively or qualitatively evaluated.	This has been addressed within the RA.				
		d) Since Midland Bay may be used by visitors for fishing, the inclusion of an off-site visitor receptor scenario should be considered, for completeness.	On and off-site residents and visitors utilizing the Bay for fishing was considered in the Risk Assessment. A qualitative discussion was provided within the HHRA Section.				
		e) Given the shallow depth to groundwater, the QP should include groundwater uptake by biota and subsequent ingestion by on-site human receptors (i.e., potential for community garden with produce uptake from groundwater and subsequent ingestion by residents/visitors).	Agree. This pathway has been added to the CSM. A RMM for Landscape Restriction to prohibit the installation of vegetable gardens, other than those planted in above ground containers isolated from subsurface conditions, to protect residents from the consumption of foods grown directly in impacted soils and groundwater.				
9	Section 5 – Human Health Conceptual Site Model – With RMMs (Figure).	a) The QP should identify the potential RMM(s) that will be implemented to block/mitigate each exposure pathway.	The recommended RMMs are described in detail in section 7 of the RA Report.	The response is not accepted and additional comments have been provided below.	RMMs have discussed in Section 7 of the Risk Assessment describe in detail those to be implemented to block/mitiagte each exposure pathway with unacceptable risks.		
		b) It is not clear what RMM will be proposed in the RA report to mitigate direct contact exposure with impacted groundwater by off-site subsurface workers. This should be clarified in the RA report.	This was an error. There are no RMMs proposed for off-site receptors. The groundwater flows toward the Bay, therefore impacts are not expected to flow to an area where the subsurface worker would be present. Additionally, as discussed in the RA report, there were no risks to the subsurface worker for direct contact with groundwater, therefore, no RMMs are required.	The response is accepted; however, Figure 4.2 has not been corrected and should be revised accordingly.	See revised Figure 4.2		
10	Section 6 – Ecological Conceptual Site Model – Valued Ecological Components	It is not clear why mammals, avian species, and reptiles/amphibians with breeding habitat are indicated as not applicable. This should be clarified in the RA report.	Mammals, avian species, and reptiles/amphibians with breeding habitat are applicable.	The response addresses the comment.	No response required.		
11	Section 6 – Ecological Conceptual Site Model – Terrestrial Ecological Pathways.	The PSF form indicates that root uptake of surface water is a complete pathway on-site; however, this pathway is indicated as incomplete in the ecological CSM figure. This discrepancy should be clarified in the RA report	As previously mentioned, the boundaries of the Site have been redefined and surface water is considered off-site. Consequently, there is no on-site surface water.	The response addresses the comment.	No response required.		
12	Section 7 – Conceptual Site Model, Subsection 3(8)(a.1)(v).	Since the Site includes and is adjacent to Midland Bay, the QP should clarify why this subsection is not applicable.	Agree. As the site is adjacent to Midland Bay Section 43.1 does apply.	The response is accepted.	No response required.		
13	Appendix A – Plan of Survey and Lawyer's Letter.	For the legal plan of survey, the QP is recommended to outline the RA property boundaries in a different colour to allow for a better understanding of the site's location.	This will be completed to support the RSC submission.	The response is accepted.	No response required.		
14	Appendix C – Notification of Nonpotable Groundwater Condition.	Any responses from municipalities on the submitted notification of nonpotable groundwater condition should be included in the RA.	To date, there have been no responses. If a response becomes available, it will be included in future resubmissions.	The response is accepted.	No response required.		
15	Appendix D – Risk Assessment Approach.	a) Table 5 – Reasonable Estimate of the Mean for Soil Compared to applicable Components of Generic Standard – HHRA. i) It appears that there is a typo in the table title and should instead state "Reasonable Estimate of the Maximum Concentration for Soil." ii) The QP is recommended to review the identification of component value exceedances. For example, the Reasonable Estimate of the Maximum Concentration (REMC) of PHC F4 is above its respective S1 component value and the REMC of acenaphthylene is above its respective S-IA component value; however, they were not flagged as exceedances in the table.	i) This editorial has been fixed in the RA report. ii) REMC exceedances with component values have been discussed in detail in the RA Report.	The responses are accepted.	No response required.		

Response Tracking Table - 420 Bayshore Drive, Midland
PSF1765-19 (IDS Ref No. 0155-BC6QVC)

		Comments on Pre-Submission Form					
No.	**Section/Area in Report**	**Ministry Comment (July 8, 2019)**	**Response**	**Ministry Comment (March 20, 2020)**	**Response**	**Ministry Comment (October 10, 2020)**	**Response**
		b) Table 6 – Reasonable Estimate of the Mean for Groundwater Compared to Applicable Components of Generic Standard – HHRA. i) It appears there's a typo in the header and should state "Reasonable Estimate of the Maximum Concentration for Groundwater." ii) The REMC presented in Table 2 (Summary of COC in Groundwater) for vinyl chloride and PHC F3 is inconsistent with Table 6. This should be reviewed and revised in the RA report. iii) The QP should provide a rationale and reference for the derivation of the modified GW1 component value (for the protection of direct contact by subsurface workers) based on a daily incidental groundwater ingestion rate of 0.02 L/day.	i) This editorial has been fixed in the RA report. ii) The REMCs have been updated in the RA report for consistency iii) An unmodified GW1 was considered in the direct contact (dermal and oral) pathway for the GW1 component was used to estimate the direct contact pathway for a subsurface worker.	The responses are accepted.	No response required.		
		c) Surface Water Exposure by Human Health Receptors. The QP has not presented an approach on how surface water data will be utilized in the HHRA. This should be clarified.	As previously mentioned, the boundaries of the Site have been redefined and surface water is considered off-site. Exposure to off-site surface water by human receptors has been qualitatively discussed within the RA report.	The response is accepted.	No response required.		
		d) Table 8 – Toxicological Reference Values for Non- carcinogenic Effects Modified from MGRA, Ethylbenzene. The chronic RfD presented of 0.01 mg/kg/day appears to be incorrect and should instead be 0.1 mg/kg/day. Additionally, the ethylbenzene RfC is not based on a developmental endpoint, as identified in Table 8. The QP should confirm whether the component values derived and presented in Table 5 (Reasonable Estimate of the Mean for Soil Compared to applicable Components of Generic Standard – HHRA) should be revised.	The TRVs have been updated to be consistent with the MECP toxicity data.	The response is accepted.	No response required.		
		e) Section 3.1 – Selection of Receptors. The VECs listed in the ecological risk assessment approach are not consistent with those listed in the PSF form (i.e. mollusc and amphibian community are not discussed). This should be clarified in the RA report.	The VECs have been updated to be consistent with those listed in the PSF.	The response addresses the comment.	No response required.		
		f) Section 3.2.3 – Sediment. The QP is reminded that the assessment of sediment should be consistent with MECP guidance: *Guidelines for Identifying, Assessing and Managing Contaminated Sediment in Ontario: An Integrated Approach* (MECP, 2008).	This is noted. As previously mentioned, the boundaries of the Site have been redefined and sediment is considered off-site.	The response addresses the comment.	No response required.		
16	Phase Two CSM – Applicable Site Condition Standard.	The QPESA has identified the applicable soil standards as Table 9 SCS and groundwater standards as Table 7 SCS. The QP is reminded that only one set of standards can apply to the Site. In addition to comparing groundwater parameters to the applicable SCS, to account for the shallow water table, the QP can conduct an additional screening of all volatile parameters in groundwater, that would address conditions where limited (or no biodegradation) is expected to occur (e.g. screen all volatiles in groundwater to Table 6/7 GW2 component values, as appropriate).	The Phase Two ESA/CSM have been revised to use the Table 9 SCS for use within 30 m of a waterbody. Analyzed parameters in soil and groundwater with concentrations that exceeded the Table 9 SCS were identified as COCs. Further, shallow groundwater is present at the Site; therefore, groundwater results were compared to the Table 7 SCS to identify volatile COCs. Analyzed parameters in groundwater with concentrations that exceeded the Table 7 SCS were identified as COCs.	The response addresses the comment.	No response required.		
17	Other Comments.	a) The inclusion of borehole logs, certificates of analysis, and tables presenting all soil, groundwater, surface water and sediment analytical results relied upon in the PSF/RA is required.	Full analytical data tables, CofAs, and borehole logs are provided in the electronic version of the Phase Two ESA submitted with the RA.	The response is not accepted and additional comments have been provided below.	See response to Comment ?? in the Risk Assessment Tracking Table	Comment addressed, however it is noted that the response to comment is incomplete. The QP's response should clearly indicate where in the RA or Response to Comments table a comment was addressed.	Full analytical data tables, CofAs, and borehole logs are provided in the electronic version of the Phase Two ESA submitted as Appendix F with the RA.
		b) It is noted that CVs were not provided as part of the PSF submission. The QP is reminded that the proposed RA team will need the appropriate level of experience for each discipline (e.g., RMM engineer, hydrogeologist) to complete the RA in accordance with O. Reg. 153/04 (as amended).	CVs have been included in the RA submission in Appendix C.	The response addresses the comment.	No response required.		

Response Tracking Table - 420 Bayshore Drive, Midland
RA1765-19 (IDS Ref No. 0155-BC6QVC)

Comments on Phase Two CSM			
No.	**Section/Area in Report**	**Ministry Comment (March 20, 2020)**	**Cambium Response**
1*	N/A	1. Subsection 43.1(1) of the Regulation – Subsection 43.1(1) applies in relation to a property if the property includes all or part of a water body or is adjacent to a water body or includes land that is within 30 metres (m) of a water body.	Agreed
		a. Based on the information provided in the Phase two conceptual site model (CSM), submission for this property, it appears that a portion of the RSC property is located within 30 m of a water body. If the RSC property is in fact located within 30 m of a water body, the qualified person (QP) is obligated to use the applicable site condition standards for properties adjacent to or within 30 m of a water body.	Agreed - The Table 9 SCS are applicable. The Phase Two CSM was revised prior to submission of the Risk Assessment dated November 22, 2019. No further revision is necessary.
		b. In addition, page #26 of the phase two CSM indicates that Table 9 standards would be applicable to the soil and Table 7 standards would be applicable to the ground water at the phase two property. Please note that there can only be one applicable site condition standard for the entire property.	Agreed - The Table 9 SCS are applicable. The Phase Two CSM was revised prior to submission of the Risk Assessment dated November 22, 2019. No further revision is necessary.
	Phase Two CSM section 5.2.1 and figures	2. Subsection 7(1) and 16 of Schedule E – The qualified person (QP) shall ensure that all areas on, in or under the phase two property where a contaminant is present at a concentration greater than the applicable site condition standard for the contaminant shall be delineated laterally and vertically for each contaminant present in soil, ground water or sediment, on, in or under the phase two property. In addition, section 16 specifies additional characterization requirements for when analysis shows that the contaminant is present at a concentration greater than the applicable site condition standard. The QP failed to appropriately delineate ground water and sediment both laterally and vertically (there are no deeper ground water and sediment sample results).	Agreed - Additional vertical assessment was completed prior to submission of the Risk Assessment dated November 22, 2019. Two additional deep wells (BH19-01 and BH19-02) were installed. Additional lateral delineation of the groundwater PHC and TCE plume was undertaken prior to this submission. Three additional shallow wells (BH20-01, BH20-02, BH20-03 were installed. See response to Comment 3 for additional detail.
	Phase Two CSM figures	Drawings provided along with the CSM are very cluttery as several colours were used to differentiate investigations completed during different times in the past. It may be OK to provide one drawing showing different colours to each set of boreholes completed during different periods in the past, but on the rest of the maps, it would be easy to understand if only two colours (probably red and green) were used to each location where the contaminants either exceeding or meeting the	Sample location colours were revised prior to submission of the Risk Assessment dated November 22, 2019. No further revision is necessary.
		If distribution and delineation of soil and groundwater impacts are shown on plan view figures, showing the depth of the soil samples and screen depths next to the monitoring wells will make it clear to the reviewer regarding the distribution and delineation of impacts to the next clean sampling location.	Figure revisions to address this comment were made prior to submission of the Risk Assessment dated November 22, 2019. No further revision is necessary.
2	Phase Two CSM Figures	In order to assist in the review of the Phase Two CSM, in particular Section 6 "Soil and Groundwater Characterization", it is recommended that a site plan be included showing the various test pit/borehole/monitoring well locations with an overlay showing the	APECs have been added to Figure 9.

Response Tracking Table - 420 Bayshore Drive, Midland
RA1765-19 (IDS Ref No. 0155-BC6QVC)

Comments on Phase Two CSM			
No.	**Section/Area in Report**	**Ministry Comment (March 20, 2020)**	**Cambium Response**
3	Phase Two CSM figures	As required under subsection 7 of Schedule E of O.Reg. 153/04, as amended, the qualified person shall ensure that all areas on, in or under the phase two property where a contaminant is present at a concentration greater than the applicable site condition standard for the contaminant shall be delineated laterally and vertically. Based on the information provided, it does not appear that the QP has met this requirement for the following parameters: • The TCE ground water plume does not appear to be laterally delineated downgradient of BH18-11; and • The PHC ground water plume does not appear to be laterally delineated cross-gradient and downgradient of BH18-07. Further delineation and assessment of the potential risks to on and off-site receptors related to these impacts needs to be provided.	BH20-03 was installed to delineate the TCE groundwater plume down-gradient (north) of BH18-11. In addition, BH11 was sampled to provide additional up-gradient delineation. See revisions to Figure 19a and cross-section D-D' on Figure 19b. Groundwater samples from BH11 and BH20-03 met the Table 9 SCS. BH20-01 and BH20-02 were installed to delineate the groundwater PHC plume cross-gradient (west) and down-gradient (north) of BH18-07, respectively. In addition, BH5 was sampled to provide cross-gradient delineation to the east of BH18-07.Groundwater samples from BH5, BH20-01, and BH20-02 met the Table 9 SCS. The QPESA notes that while the water levels in the wells were above the top of the screen, the results remain sufficient to show that groundwater results at these locations are suitable for delineation of the PHC plume since the results were non-detect, no hydrocarbon odour was detected during drilling or groundwater sampling, and no sheen or liquid phase product was observed during drilling or groundwater sampling. It is the $QP_{ESA's}$ opinion that further delineation is not required.
4	Phase Two figures	As required under subsection 6(4)(ii) “Phase Two Conceptual Site Model” of Table 1 of Schedule E of O.Reg. 153/04, as amended, the cross-section drawings do not appear to show the approximate depth to ground water. This should be included on all cross-sectional drawings.	Groundwater elevation data for February 15, 2019 have been added to Figures 10a and 10b. The QPESA notes that this addition does not add to the Phase Two CSM or the understanding of environmental conditions at the Site since the groundwater elevation data was already reported on all contaminant cross-section figures.

Response Tracking Table - 420 Bayshore Drive, Midland
RA1765-19 (IDS Ref No. 0155-BC6QVC)

Comments on Phase Two CSM			
No.	**Section/Area in Report**	**Ministry Comment (March 20, 2020)**	**Cambium Response**
5	N/A	As required under subsection 6(7) "Phase Two Conceptual Site Model" of Table 1 of Schedule E of O.Reg. 153/04, as amended, further justification for the use of the exemption under subsection 49.1(1) (i.e. a substance applied to surfaces for the safety of vehicular or pedestrian traffic under conditions of snow or ice or both.) is required for deeming the parameters EC, SAR, chloride and sodium as not being contaminants of concern at the Site.	No on-site use or source of sodium, chloride, EC, or SAR was identified by the Phase One ESA. The distribution of EC and SAR indicated that elevated levels of these parameters are typically present closer to the municipal roadway (Bayshore Drive) and not present closer to the water body. In addition, sodium and chloride met the Table 9 SCS in all analyzed samples further indicating an on-site source is not present. Therefore, the elevated levels of EC and SAR are considered related to road-salt use for safety purposes on the adjacent municipal roadway and exempt under O.Reg. 153/04. Further, per the recent amendment to O.Reg 153/04, elevated levels of these parameters as a result of on-site use of substance applied to surfaces for the safety of vehicular or pedestrian traffic under conditions of snow or ice or both are deemed not an exceedance of the applicable site condition standard. Therefore, elevated levels of EC and SAR at the Site are not exceedances.

1* - Comments from MECP August 22, 2019 review of the Phase Two Conceptual Site Model.

Response Tracking Table - 420 Bayshore Drive, Midland
RA1765-19 (IDS Ref No. 0155-BC6QVC)

				Comments on Risk Assessment			
No.	Section/Area in Report	Ministry Comment (March 20, 2020)	Response	Ministry Comment (October 10, 2020)	Response	Ministry Comment (July 22, 2021)	Response
1	Section 1 – Summary of Recommendations/Findings	Editorial comment – As per Schedule C, Table 1 of O.Reg. 153/04, this section is required to be titled, "Summary of Recommendations and Findings". This should be revised for consistency.	This has been updated in the RA report.	Comment addressed	No response required		
2	Section 1.1 – Introduction	Editorial comment – The third paragraph indicates that the RA was completed for residents, indoor workers, visitors, long-term outdoor workers, and short-term subsurface workers that may be exposed to COCs in soil and groundwater but makes no mention of ecological receptors. This should be revised.	This has been updated in the RA report.	Comment addressed	No response required		
3	Section 1.2 – Risk Assessment Objectives and Approach	Editorial comment - While it is indicated that this RA has been conducted using a standard full depth quantitative approach, it would be beneficial to update the text to state the specific RA approach used (e.g., a risk assessment other than those identified in O. Reg. 153/04, Schedule C, Part II).	This has been updated in the RA report.	Comment addressed	No response required		
4	Section 1.3 – Deviations from Pre-submission Form	It is stated that the RA property boundary has been revised to exclude aquatic environments (i.e. Midland Bay) and now only includes terrestrial areas; however, a review of the Phase Two ESA suggests that the Phase Two property boundary continues to includes portions of Midland Bay. An updated Legal Plan of Survey with a clearly labelled RA property boundary (and any other required legal documents – e.g. lawyer's letter) should be provided.	An updated site plan is provided in Appendix K. A signed sealed legal survey and other required documents will be provided to support the draft CPU and RSC submission.	The comment is partially addressed. The figure provided in Appendix K indicates that the Phase Two ESA/Risk Assessment Property have the same boundary which excludes the water lots, however, the Phase Two ESA report provided in Appendix F.2 indicates that the water lots are included within the Phase Two property boundary. This should be clarified, and the Phase Two ESA boundary updated in Appendix K and Figure 5 of Appendix F.2 if warranted. Furthermore, the QP is reminded that when property boundaries change, in addition to an updated plan of survey, an updated lawyer's letter is required, as part of the risk assessment. Currently, the legal description included in the Section 3.1 of the RA does not appear to match the RA property, as outlined in Appendix K. This will need to be addressed. The QP is referred to Schedule C, Section 3(4)(i).	Section 4.4 of the Phase Two ESA was updated to explain the difference in the Phase One and Phase Two property boundaries. The Phase Two ESA/CSM figures were revised to more clearly show the Phase One Property Boundary and the Phase Two Property Boundary. An updated legal survey and lawyer's letter are included in the RA submission. Section 3.1 of hte RA was revised to present the revised legal description of the Phase Two ESA/RA Property. PCA and APEC Tables in the Phase Two ESA/CSM were updated to remove APECs G and P, which were off-site due to the property boundary change and indicate PCA #7 does not contribute to an APEC.	Comment addressed	No response required
5	Section 1.4 – Risk Assessment Standards	a. Editorial Comment - The third sentence appears to be incomplete. This should be revised.	This has been updated in the RA report.	Comment addressed	No response required		
		b. Both Tables 1.1 (Property Specific Standards in Soil) and 1.2 (Property Specific Standards in Groundwater) present the Reasonable Estimate Maximum Concentration (REMC) rather than the maximum concentration as recommended by the MOE (2005) Procedures document titled, "*Procedures for the Use of Risk Assessment under Part XV.1 of the Environmental Protection Act*". The QP should consider also including the maximum concentrations in these tables.	The maximum concentrations have been added to Tables 1.1 and 1.2.	Comment addressed	No response required		
6	Section 3.1 – Property Information	The site area presented (i.e., 16.24 ha) does not appear to be consistent with the Phase Two ESA (i.e., 14.6 ha). Please review and revise as required.	This has been updated in the RA report.	The response may not address the comment. As per Comment #4, it appears that the Phase Two Property boundary includes water lots, and the RA Property boundary is only for the terrestrial portion of the property. It appears that the Site Identification Information presented is for the Phase Two Property	The area of the property presented in Section 3.1 has been updated consistent with the new legal survey.	Comment addressed	No response required
7	Section 3.1.4.1 – On-Site Receptors	Some applicable exposure pathways are not listed (e.g., inhalation of volatiles from soil to indoor air, trench air exposure pathways). This should be revised.	This has been updated in the RA report.	Comment addressed	No response required		
8	Section 3.2 – Site Plan and Hydrogeological Interpretation	Editorial comment – As per Schedule C, Table 1 of O.Reg. 153/04, this section is required to be titled, "Site Plan and Hydrogeological Interpretation of RA Property". This should be revised for consistency.	This has been updated in the RA report	Comment addressed	No response required		
9	Section 3.3.2.1 – Selection of Contaminants of Concern in Soil.	Editorial comment – The first paragraph describes the COCs for the site based on a comparison to Table 7 or Table 9 SCS, however only the Table 9 SCS are applied in the soil screening. This should be revised.	This has been updated in the RA report	Comment addressed	No response required		
10	Section 3.3.2.2 – Selection of Contaminants of Concern in Groundwater, Table 3.5 (Screening for Contaminants of Concern in Groundwater)	The maximum concentration of chloride appears to be incorrect due to a units issue (mg/L vs. µg/L). This error was also present in the Phase Two ESA. Please review the laboratory Certificates of Analysis (CofAs) and revise the chloride concentration accordingly.	The chloride concentration has been updated in the RA report.	The response partially addresses the comment. The units issue has been addressed in the RA, however, the concentrations presented in Table 14 in the Phase Two ESA (Appendix F.2) have not been updated.	The chloride units have been updated in Table 14 of the Phase Two ESA.	Comment addressed	No response required
11	Section 3.3.2.3 – Sampling Programs	This section describes the collection of sediment and surface water data and indicates that this data is included in the RA, but it is noted in Section 3.1 that the RA is only for the terrestrial portion of the property, therefore this data is from off-site. It appears that the off-site sediment and surface water data are later applied in the evaluation of potential off-site risks. The RA report should be clarified throughout to indicate that this data was not collected on the RA property.	This has been clarified in the RA report.	The response partially addresses the comment; it would be helpful to refer to the Sediment and Surface Water as "Off-Site Sediment" and "Off-Site Surface Water" for clarity.	The title for these two sections within Section 3.3.2.3 was modified.	Comment addressed	No response required
12	Table 3-8 – Number of Sediment Samples	The table indicates that there were 11 samples of sediment analyzed for each of metals and inorganics, and PAHs. This is not consistent with the information presented in the Phase Two ESA (Appendix F.2), which indicates that sediment samples were submitted for analysis of BTEX, PHC F1-F4, PAHs, and metals. This should be clarified in the RA. It would also be helpful if the sediment data was incorporated into the risk assessment, perhaps as a separate appendix, so that information relating to the sediment can be verified.	This has been updated in the RA report. BTEX parameters have been included within the PHC parameter group throughout Section 3.3.2.3. The sediment data has been added as Appendix I.	The response partially addresses the comment; it would add clarity if the Table 3-8 was updated to indicate "BTEX and PHCs".	Table 3.8 was modified as requested.	Comment addressed	No response required
13a	Section 4.1.1 – Human Health Conceptual Site Model	The on-site receptors identified in the text should be consistent with the Human Health Conceptual Site Model figures. For consistency and completeness, Figures 4.1 and 4.2 (Human Health Conceptual Site Model – Without and With Risk Management) should be updated to include the trespasser.	The trespasser has been added to Figures 4.1 and 4.2.	Comment addressed	No response required		

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No.	**Section/Area in Report**	**Ministry Comment (March 20, 2020)**	**Response**	**Ministry Comment (October 10, 2020)**	**Response**	**Ministry Comment (July 22, 2021)**	**Response**
13b		Figure 4.2 (Human Health Conceptual Site Model – With Risk Management). The specific RMM (e.g., capping, HASP) proposed for each exposure pathway should be specified.	The CSMs have been updated to indicate which RMM is proposed for each exposure pathway	Comment addressed	No response required		
14a	Section 4.1.1.1 – Resident	The text incorrectly states that "no COCs were identified in groundwater". Furthermore, the text has incorrectly identified vapour intrusion into indoor air is limited to soil COCs as a potential exposure pathway. Please review and revise this section as appropriate or justify why groundwater COCs are not considered for vapour intrusion.	This has been updated in the RA report.	Comment addressed	No response required		
14b		Table 4.1 – Potential Pathways of Exposure for the Resident. Editorial comment – for the groundwater skin contact pathway, the comment text should be revised from 'Potential incidental ingestion during gardening…" to "Potential dermal contact during gardening…". This comment also applies to Tables 4.3 and 4.4.	This has been updated in the RA report.	Comment addressed	No response required		
15	Section 4.1.1.2 – Indoor Worker, Table 4.2 (Potential Pathways of Exposure for Indoor Worker and Property Visitor)	Since the Site will be redeveloped for mixed- commercial, residential, and parkland use, it is possible that a property visitor would be outdoors at the parkland portions of the Site. Please clarify why the potential pathways of exposure for the property visitor are the same as the indoor worker (assumed to have negligible exposure to soil and other outdoor exposure pathways).	The potential pathways of exposure for the resident were also applied to the property visitor, which would account for the outdoor exposure this receptor might encounter on the RA property.	The QP has indicated that the Property Visitor will experience the same exposure pathways as the resident (in response to comment table and in updated Table 4.1), however the HH CSM (Figure 4.1) still indicates that exposure pathways will be negligible. It is unclear where the QP has documented the justification for negligible exposure since there is no section identifying the Visitor characteristics that explain why exposure is negligible. The QP will have to	Figure 4.1 and Figure 4.2 were revised so that the pathways for the visitor are consistent with the residential receptor.	Comment addressed	No response required
16	Section 4.1.1.3 – Outdoor Maintenance Worker	Since the minimum depth to groundwater is 0.34 mbgs, there is the potential that outdoor maintenance workers conducting planting activities at the Site (e.g., park) may be in direct contact with impacted groundwater. Dermal contact and incidental ingestion exposure to impacted groundwater by the Outdoor Maintenance Worker should be quantitatively or qualitatively assessed in the HHRA. Figure 4.1 (Human Health Conceptual Site Model – Without Risk Management) should also be updated to indicate that these exposure pathways are 'Potential pathway of exposure (included in the HHRA)'.	Direct contact with groundwater by an outdoor maintenance worker was qualitatively assessed in Section 4.4.2.3. With the shallow depth to groundwater it is possible that outdoor workers will occasionally have direct contact with groundwater. The quantitative assessment that is conducted for the sub-surface worker will be used as a surrogate for this pathway, which is appropriate as only COC with non-carcinogenic endpoints are included in the quantitative assessment. This has been further clarified in 4.1.1.3 and in Figure 4.1 (Human Health Conceptual Site Model – Without Risk Management).	Response partially accepted. While the outdoor worker's exposure to groundwater was reported to be qualitatively assessed via the subsurface worker, the QP did not provide a discussion of how the qualitative assessment was conducted nor provide conclusions as to whether the qualitative risks were acceptable or not for the outdoor worker. All receptors and pathways require an interpretation of the risk.	Additional discussion was added to Section 4.4.2.3 indicating that there is no unacceptable risk for direct contact with groundwater by the mainenance worker	The QP should also discuss whether this surrogate approach is appropriate given the different exposure assumptions for these two receptors. For example, an outdoor worker is expected to be on the Site for 56 years while a sub-surface worker is expected to be present for 1.5 years	As discussed in Section 4.4.2.4, "As F2 is a non-carcinogenic endpoint the subsurface worker can be taken as a conservative representative of the maintenance worker and resident contact with groundwater…" In Section 4.4.2.3 it is discussed that contact with groundwater by the maintenance worker is not expected to be a regular occurance. Therefore, for the COC identified for assessment, the use of the sub-surface worker represents a conservative approach and no further discussion was added to the assessment.
17	Section 4.1.3 – Contaminants of Concern for Human Receptors	The RA has identified a chemical that is sufficiently volatile for vapour inhalation assessment if the Henry's Law constant is greater than 1 Pa.m³/mol and the molecular weight is less than 200 g/mol. As per recent Ministry guidance, a screening process as to whether (or not) a chemical is of potential concern for vapour intrusion includes an evaluation of both volatility and toxicity, using the following steps: Step 1: If either one of the following conditions is met, then the chemical is considered sufficiently volatile and screened in, to be further assessed as part of Step 2 : • Henry's Law constant is greater than 1x10-5 atm-m3/mol; or, • Vapour pressure is greater than1.0 millimeter of mercury (equivalent to 1.0 Torr). Step 2: If the maximum theoretical indoor air concentration based on conservative assumptions (Cair) exceeds applicable health based indoor air concentration (HBIAC) or odour thresholds (if available), then the chemical should be retained in the vapour intrusion assessment, as follows: • If Cair > HBIAC (or odour thresholds), then the chemical is considered a COPC for the vapour intrusion assessment; or, • If Cair ≤ HBIAC (or odour thresholds), then the chemical is not considered a COPC for the vapour intrusion assessment. The QP should consider the updated MECP guidance and determine whether additional chemical parameters should be retained for the vapour inhalation assessment	Consideration was given to the recent MECP guidance regarding whether a chemical is considered sufficiently volatile for vapour inhalation. The QP notes the following chemical parameters retained within the RA would be considered volatile: Metals: arsenic, mercury, and selenium PAHs: benz[a]anthracene, and pyrene PHCs: F3 and F4 fractions. The Phase 2 ESA makes no mention of metals in a form that would be gaseous (such as elemental mercury or arsine gas). Therefore, metals were not retained. No HBIACs were available for PHC F3 and F4 fractions, therefore these chemicals were not retained. Components for PAHs benz[a]anthracene and pyrene were included Table 4.6 Comparison of Soil REMCs to Human Health Component Values. However, neither exceeded their applicable components and were not retained for the potential of vapour inhalation. In summary, none of the chemical parameters considered volatile with the new MECP guidance were retained for quantitative assessment.	Response partially accepted. The QP is required to quantitatively or qualitatively assess the risk associated with all COCs for all complete pathways. If the QP is of the opinion that some COCs were not volatile despite the current guidance, the QP should provide a discussion and appropriate lines of evidence to exclude these COCs from the assessment. Where COCs are classified as volatile but are without an HBIAC, the QP should qualitatively assess the risks, and discuss the uncertainty in the assessment.	Additional discussion was added to Section 4.1.3 to provide a rationale to exclude PHC F3 and F4 from requiring an assessment for vapour migration pathways.	Response partially accepted. The QP refers to the Phase Two ESA for the lack of gaseous forms of mercury and arsenic however unless specific methods and equipment are used, the lack of information in the Phase Two cannot be equated with the lack of these COCs on the RA Property. The Phase Two and RA would have to provide lines of evidence (e.g. nondetect for mercury in vapour using the proper instruments, based on past use/APECS on the property no elemental mercury is expected, etc.) to exclude such COCs. Similarly, for PHC F3 and PHC F4, other lines of evidence are needed to exclude these COCs, since the QP has not shown how solubility is related to volatilization in their discussion. The QP is required to quantitatively or qualitatively assess the risk associated with all COCs for all complete pathways. If the QP is of the opinion that some COCs were not volatile despite the current guidance, the QP should provide a discussion and appropriate lines of evidence to exclude these COCs from the assessment. Where COCs are classified as volatile but are without an HBIAC, the QP should qualitatively assess the risks, and discuss the uncertainty in the assessment	Metals: Additional discussion was added to Section 4.1.3 that provides evidence that volatile metals are not expected to be present. PHC F3 and F4: Henry's law is used to relate the amount present in vapour phase to that in a dissolved form in a liquid. As stated in the text, the solubility of F3 and F4 is low and there would not be any present in the liquid phase. Additional text was added to clarify this and that the vapour pressure of these compounds are low.
18	Section 4.1.3.2 – Groundwater	The text does not fully discuss the component value exceedances presented in Table 4.7 (Comparison of Groundwater REMCs to Human Health Component Values). For example, the text indicates that trichloroethylene and benzene exceeded the residential and commercial/industrial GW2; however, the REMC of vinyl chloride (future worst case) and PHC F2 also exceeded these component values. Furthermore, there's no discussion of the REMC of PHC F2 exceeding the GW1 component value. Moreover, a discussion of ½ solubility is included in the text; however, this component value screening was not presented in Table 4.7. The text should be updated for completeness and	This has been updated in the RA report	Response partially accepted. A discussion of ½ solubility used for screening is included in the text; however, this component value screening was not presented in Table 4.7. Table 4.7 should be updated for completeness and to support your findings.	The mention of ½ solubility was removed from the text. This component is addressed in Section 6.3 and is not required in Table 4.7.	Comment addressed	No response required
19a	Section 4.2.1 – Receptor Characteristics, Table 4.8 (Human Receptor Characteristics)	Since the COCs identified for quantitative evaluation in the HHRA includes at least one developmental toxicant (e.g., trichloroethylene), a pregnant adult should be assessed for each receptor scenario.	Agree. This has been updated in the RA report.	Comment addressed	No response required		
19c		Given that the soil direct contact pathways for the resident receptor are identified as complete in Figure 4.1 (Human Health Conceptual Site Model – Without Risk Management) and the REMCs for a number of soil COCs exceeded their respective S1 component value, it is unclear why the 'hours exposed per day – outdoor' for the resident receptor is 'NE – not evaluated'. This discrepancy should be clarified.	The hours per day spent outdoors for the resident have been updated to reflect the hours not spent indoors (i.e., Hours in a day – Hours spent indoors = Hours spent outdoors). This change is reflected in Table 4.8, as well as in the applicable exposure and risk tables.	Response partially accepted. Table 4.8 has been updated for hours exposed per day outdoors, however, the toddler's hours indoors appears have been left at 24 hours per day. The QP should clarify if the exposure calculations have been appropriately updated compared to the data presented in Table 4.8.	The hours per day was left at 24 hours for the toddler. The RA uses the toddler to assess non-cancer effects. For inhalation this was done using the HBIAC values and these were derived assuming 24 hour a day exposure. Although the difference between 22.5 hours a day and 24 hours a day is minor, the value was not changed as it is consistent	Comment addressed	No response required
19c		The soil ingestion rate for long-term outdoor worker and short-term subsurface worker does not appear to be consistent with MOE (2011) Rationale document. Please provide supporting rationale for the selected value or update the table to be consistent with MOE (2011)	The soil ingestion rate usedin the calculations for the long-term outdoor worker and the short-term subsurface worker calculations is consistent with the MOE (2011) Rationale document (i.e., 100 mg/day). Table 4.8 has been updated to reflect this editorial error.	Comment addressed	No response required		
19d		The groundwater ingestion rate for the subsurface worker (0.02 L/day) is not consistent with the text (0.1 L/day). Please review and revise.	An ingestion rate of 0.1 L/day was used in the calculations. Table 4.8 has been updated accordingly.	Comment addressed	No response required		

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No.	Section/Area in Report	Ministry Comment (March 20, 2020)	Response	Comments on Risk Assessment Ministry Comment (October 10, 2020)	Response	Ministry Comment (July 22, 2021)	Response
20a	Section 4.2.2 – Pathways Analysis, Table 4.9 (Exposure Pathways Evaluated for Human Receptors)	The soil to indoor air exposure pathway was quantitatively evaluated for acenaphthene and anthracene in Table 4.14. For consistency, Table 4.9 should be updated to indicate that these two (2) COCs were assessed for 'soil – indoor air'.	Table 4.9 has been updated to include acenaphthene and anthracene for the soil to indoor air pathway.	Comment addressed	No response required		
20b		Since the soil REMC of trichloroethylene exceeded the S-IA component values, it should also be retained for quantitative evaluation of the soil-trench air exposure pathway.	Trichloroethylene has been quantitatively evaluated for the soil-trench air exposure pathway.	Comment addressed	No response required		
21	Section 4.2.4 – Inhalation Pathway.	Editorial comment – "equation 4-14" should be changed to "equation 4-	This has been updated within the text.	Comment addressed	No response required		
22a	Section 4.2.4.2 – Estimation of Indoor Air Concentrations	Table 4.13 (Variables Used to Estimate Indoor Air Concentrations from Soil). The RA has assumed the MECP generic coarse soil texture to predict indoor air concentrations; however, the site-specific soil texture should be used, if available. If there are different types of soil texture present on the property, the coarsest type should be selected. Please update the RA accordingly.	Discussion was added to the report to indicate that the generic coarse soil texture is an appropriate respresentation of the soil type present (lacustrine deposits of sand and gravel with minor silt and clay).	Response accepted	No response required		
22b		Table 4.14 (Chemical-Specific Values Used to Estimate Indoor Air Concentrations from Soil). Editorial comment – The soil REMCs for benzene, xylene, and PHC F1 and F2 subfractions appear to have a minor discrepancy due to the varying number of significant digits when compared to other HHRA tables. The QP is recommended to update all exposure tables to present the same number of significant digits for the	The significant figures within Table 4.12 have been updated to be consistent with the rest of the report.	Comment addressed	No response required		
23a	Section 4.2.4.3 – Estimation for Outdoor Air Concentrations	Table 4-18 (Variables Used to Estimate Outdoor Air Concentrations from Groundwater). The RA has assumed the MECP generic coarse soil texture for the vadose zone to predict outdoor air concentrations; however, the site-specific soil texture should be used, if available. If there are different types of soil texture present on the property, the coarsest type should be selected. Please update the RA accordingly. Additionally, it appears that the QP has assumed different soil textures for the vadose zone (coarse soil) and capillary fringe (sandy soil). Please	As discussed in the response to comment 22a, coarse textured soils was selected for use at this Site. Sandy soil was selected for the capillary fringe as a conservative approach for the RA	Comment addressed	No response required		
		b. Outdoor Air Concentrations in a Trench from Groundwater. Editorial comment – 'Section 0' is referenced in numerous locations and should be corrected.	This has been corrected in the RA report.	Comment addressed	No response required		
23c		Table 4-21 (Variables Used to Estimate Outdoor Air Concentrations from Soil). The RA has assumed the MECP generic coarse soil texture to predict outdoor air concentrations; however, the site-specific soil texture should be used, if available. Please update the RA accordingly.	Please see response to comment 22a	Comment addressed	No response required		
23d		Table 4-22 (Estimated Trench Air Concentrations from Soil). Naphthalene was retained for the soil-trench air exposure pathway; however, it appears that it was excluded from this exposure table. Please	Agree, this was an oversight and naphthalene has been added to Table 4-22.	Comment addressed	No response required		
24	Section 4.2.6.2 – Groundwater Ingestion Pathway.	Editorial comment – the equation number should be updated to 4-28.	This has been corrected in the RA report.	Comment addressed	No response required		
25a	Section 4.3.2.1 – Non-Carcinogenic Risks	Table 4.24 (Toxicological Reference Values for Non-carcinogenic Effects). It appears that TRVs for non-COCs have been included (e.g., cyanide, silver). Please review and revise as necessary.	This has been updated in the RA report	Comment addressed	No response required		
25b		Developmental Toxicants. The text states that the only developmental toxicant was the inhalation of arsenic. The text should be updated to recognize that trichloroethylene is also a developmental toxicant.	This has been updated in the RA report	Comment addressed	No response required		
26	Section 4.3.2.3 – Uncertainties in Toxicity Values	Editorial comment – silver was not retained as a COC. Please update the text accordingly.	This has been updated in the RA report	Comment addressed	No response required		
27	Section 4.4.1.1 – Non-carcinogenic Effects	Editorial comment – the equation numbers should be updated to follow the sequence in exposure assessment. Thi s comment also applies to Section 4.4.1.2 (Carcinogenic Effects).	This has been updated in the RA report	Comment addressed	No response required		
28	Section 4.4.2 – Quantitative Interpretation of Health Risks	As previously mentioned, since at least one developmental toxicant (e.g., trichloroethylene) has been retained as a COC for quantitative evaluation, exposure and risks to a pregnant adult should be assessed for the applicable receptor scenarios.	This has been updated in the RA report	Response not accepted. A discussion regarding the risk characterization for a pregnant female receptor's exposure to developmental toxicants could not be located. The QP should include this discussion for completeness and transparency.	Additional discussion has been added into Section 4.4.2.3 and Section 4.4.2.4 to specifically identify the risk characterization for a pregnant femail receptor.	Comment addressed	No response required
29a	Section 4.4.2.1 – Resident	Direct Contact with Soil. Editorial comment – Section 4.2.4.1 should be updated to reference Section 4.2.5.1.	Section 4.4.2.1 has been updated to reference 4.2.5.1.	Comment addressed	No response required		
29b		Direct Contact with Soil. The text should be updated to discuss the results of Table 4.27 (Doses and Risk Levels for a Composite Resident Receptor).	This has been updated in the RA report	Comment partially addressed. For transparency the text should include a discussion identifying the risk results as that belonging to the composite receptor. The text that was updated doesn't specifically identify the composite receptor nor the implications of risk assessed as a composite receptor	Additional discussion was added to Section 4.4.2.1 regarding the composite receptor and the need to provide risk management measure to protect all lifestages.	Comment addressed	No response required
29c		Table 4.27 (Doses and Risk Levels for a Composite Resident Receptor). Since exposure and risk estimates have been calculated for all carcinogenic PAHs in an effort to calculate an ILCR for Total Carcinogenic PAHs, the carcinogenic TRVs for non- COC PAHs should also be presented in the TRV table for completeness.	A footnote was added to Table 4.25 to provide the information for non-COC PAHs for completeness.	Comment addressed	No response required		
29d		Inhalation of Indoor Air from Vapours Migrating from Soil. The RA states that, "From the Phase Two ESA it is seen that many of the VOC impacts are on the western portion of the site. Therefore in the eastern portion of the site, an alternative RMM is available that all buildings would have below or at grade parking/storage garage". Additional rationale will be required to demonstrate that the implementation of different vapour intrusion RMMs at the different portions of the Site is appropriate. Moreover, legal survey defining the different portions of the Site and consideration of a 30 m setback from the adjacent area as a buffer may be required for this approach. This comment is also applicable to other sections of the Risk Characterization where this	A discussion of RMMs and where they will be applied is discussed in greater detail in Section 7. In the western portion of the site there are volatile COC in both the soil and groundwater, whereas on the eastern portion of the site there are no volatile COC in groundwater. Future buildings on the west portion of the Site (Area 1 on Figure 7.1) shall include an SVIMS. Within Area 1 on the western portion of the site, all volatile COC are within the applicable standards within the 30 metre buffer.	RMP related comments will be captured under the Comments on Risk Management section, below.	No response required		
30	Section 4.4.2.3 – Outdoor Maintenance Worker, Table 4.32 – Exposures and Potential Risks for an Outdoor Maintenance Worker	The HQs of the PHC subfractions should be summed to provide a total HQ. In the case of PHC F3, the total HQ would be greater than an acceptable limit of 0.5. Therefore, the text and all affected tables should be updated accordingly. This comment is applicable to all risk	The sum of the HQ values for subfractions of PHC have been added to the tables and the text updated as needed.	Comment addressed	No response required		

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				Comments on Risk Assessment			
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31a	Section 4.4.2.4 – Subsurface Worker, Table 4.36 (Exposures and Potential Risks for a Subsurface Worker)	Since exposure and risk estimates have been calculated for all carcinogenic PAHs in an effort to calculate an ILCR for Total Carcinogenic PAHs, the intermediate calculations for non-COC PAHs should be included in Table 4.22 (Estimated Trench Air Concentrations from Soil).	The concentrations of non-COC PAHs have been added to Table 4.22.	Comment has not been addressed completely. For transparency, Table 4.22 should include the intermediate data needed to derive Table 4.36. The update to Table 4.22 appears to be incomplete. Several non-COC PAHs are still missing. Consider the list of PAHs in Table 4.36 when updating Table 4.22	It is unclear what the reviewer is requesting. Table 4.22 provides the air concentration for all volatile PAHs, including non-COC PAHs, and provides intermediate data. The PAH and dust calculations shown in Table 4.36 follows the approach outlined in Section 4.2.4.1. Appendix H provides a sample	Comment has not been addressed completely. Since Table 4.22 only presents trench air concentrations for volatile PAHs, the value in Table 4.36 Total Carcinogenic PAHs calculated for trench air should be discussed in the uncertainty section with regard to the PAHs that the QP considered non-volatile	Additional discussion was added to Section 4.4.2.4.
31b		The HQs of the PHC subfractions should be summed to provide a total HQ. In the case of PHC F2, the total HQ would be greater than an acceptable limit of 0.5. Therefore, the text and all affected tables should be updated accordingly and RMMs will be required to mitigate this	Please see response to comment 30.	Comment addressed	No response required		
32	Section 4.4.3.2 – Lack of Toxicity Data	Silver is not a COC retained for assessment in the HHRA. As such, the discussion on lack of toxicity data for the inhalation of silver is not necessary.	This has been updated in the RA report	Comment addressed	No response required		
33	Section 4.4.3.4 – Other Negligible Pathways	Please provide a more robust rationale and/or references to demonstrate that dermal contact with vapours and inhalation of soil particles are negligible pathways of exposure.	Additional discussion was provided on the dermal exposure to vapours and inhalation of soil particles. The consideration of these pathways is consistent with that adopted by the MECP in the development of the generic standards.	Comment addressed	No response required		
34	Section 4.4.4 – Interpretation of Off-Site Human Health Risks	Since COCs may be migrating off-site at concentrations greater than the applicable generic MECP Site Condition Standards, this section should specify the contaminant, the applicable site condition standard for that contaminant and the property where the human receptor is located and describe the human receptors that may be impacted (preferably in tabular form).	Section 4.4.4 has been updated. It is not expected that the PSS would lead to an exceedance of the SCS at the location of the nearest human receptor.	The response is noted	No response required		
35	Section 4.4.6 – Setting of Property Specific Standards, Table 4.38 (PSS Protective of Human Health in Soil)	Unacceptable direct soil contact risks by the resident were predicted for benzene; however, RMM-1 was not required. Please review Table 4.38 and other affect tables (e.g., Tables 1.1 and 6.3) to ensure it is correct.	The applicable tables and text have been updated within the RA report.	Comment addressed	No response required		
36	HHRA – Missing Report Section	The risk characterization section of the HHRA appears to be missing a required subsection titled, "Special Considerations". Please update the RA report accordingly.	This has been updated in the RA report and Section 4.4.4 has been added to discuss Special Considerations.	Comment addressed	No response required		
37a	Section 5.1.1 – Ecological Conceptual Site Model	Incidental ingestion, direct contact, and ingestion of biota contaminated by sediment and surface water and ingestion of surface water are indicated as potential exposure pathways for on-site receptors. However, elsewhere in the report, it is indicated that the RA is only for the terrestrial portion of the property, therefore these media are off-site. Please confirm that these exposure pathways are complete for on-site receptors. If not, this should be clarified in the text, and the CSM figures (Figures 5.1 and 5.2) should be updated.	Incidental ingestion, direct contact, and ingestion of biota contaminated by sediment and surface water and ingestion of surface water are not applicable to on-site receptors. The CSM and the text has been updated to reflect this.	The response partially addresses the comment. The CSM figures have been revised, however there are two bullets in the text describing the potential exposure pathways for on-site receptors: "Ingestion of food (plant and animal) contaminated by sediment and surface water COCs by mammals and birds" and "Ingestion of surface water (direct contact) by mammals and birds". The text should be revised.	Section 5.1.1 was edited to remove these bullets.	Comment addressed	No response required
37b		Ingestion of soil by off-site terrestrial biota is not discussed in the text but is indicated as a potential pathway in Figure 5-1. This should be revised for consistency.	Ingestion of soil by off-site terrestrial is considered not a potential exposure pathway and is therefore not considered in the ecological risk assessment. It has been updated in the	Comment addressed	No response required		
38a	Section 5.1.2 – Contaminants of Concern for Ecological Receptors	It is not clear how the COCs listed in this section were determined. They do not appear to align with the COCs determined by Table 9 screening (presented in Table 3.4), or the secondary screening presented in Section 5.1.3. This should be clarified.	This section has been updated to include all COCs identified in Table 3.4	The response partially addresses the comment; it is not clear why vinyl chloride has been included as a COC in soil	Vinyl chloride is not included in Table 5.1 which is the table for COC in soil.	Comment not addressed. The list of COCs in soil presented in the text of Section 5.1.2 is different from the one presented in Section 3.3.2.1. The text of Section 3.3.2.1 does not list vinyl chloride as a COC, and the text of Section 5.1.2 does list vinyl chloride as a COC. The text should be clarified for consistency	The discussion in Section 5.1.2 is for soil and groundwater (as mentioned in the introduction sentence). Vinyl chloride is a COC in groundwater; however, vinyl chloride did not exceed the standard in soil, which is why it is not flagged as a COC in Section 3.3.2.1. Vinyl chloride is not included in Section 5.1.3, which is specific to soil. No change was made to the RA.
38b		The text indicates that COCs were compared to ecological component values calculated through the MGRA model, however, Tables 5-1 and 5-2 indicate that the component values are from MOE 2011. This should be clarified.	The component values were calculated through Modified Generic Risk Assessment (MGRA) (MOECC 2016a) model. This has been updated within Table 5.1 and Table 5.2.	Comment addressed	No response required		
39	Table 5.1 – Comparison of Soil REMCs to Ecological Component Values	It is not clear why cyanide is indicated as being carried forward for quantitative assessment, as the REMC is less than all component values. This should be clarified, and if updated in Table 5.1, carried through in subsequent tables.	Cyanide is not being carried forward and Table 5.1 has been updated to reflect this.	The response addresses the comment.	No response required		
40a	Section 5.1.2 – Soil Screening	It is not clear how the COCs listed in this section were determined. They do not appear to align with the COCs determined by Table 9 screening (presented in Table 3.4), or the secondary screening presented in Section 5.1.3. This should be clarified.	This is repeated from above comment No. 38. Please refer to above for the response.	As noted in the response to comments, this comment was a repeat of Comment 38a. No further comment	No response required		
40b		The text indicates that COCs were compared to ecological component values calculated through the MGRA model, however, Tables 5-1 and 5-2 indicate that the component values are from MOE 2011. This should be clarified.	This is repeated from above comment No. 38. Please refer to above for the response.	As noted in the response to comments, this comment was a repeat of Comment 38b. No further comment.	No response required		
41	Section 5.1.4 – Groundwater Screening	Minor editorial comment – The text refers to Section 3.3.6 of the report, however this section does not exist. This should be revised.	This has been updated in the RA report	Comment addressed	No response required		
42	Table 5.2 – Comparison of Groundwater REMCs to Ecological Component Values	It appears that vinyl chloride was not carried forward from Section 3. This should be revised for consistency, although the reviewer notes that this will not affect the RA.	Vinyl chloride has been added into Table 5.2 and as noted by the reviewer, it does not affect the RA.	Comment addressed	No response required		
43	Section 5.1.5.3 – Uncertainty Analysis	Editorial comment – the last sentence indicates that the data are suitable for setting and meeting the objectives of the HHRA, however, this is the ERA. This should be revised for clarity.	This has been corrected within the RA Report.	Comment addressed	No response required		
44a	Section 5.2 – Receptor Characterization	a. Editorial comment – The first sentence refers to Table 5-4 but it appears that it should refer to Table 5.3. This should be revised for	This has been corrected within the RA Report.	Comment addressed	No response required		

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44b		The Lake sturgeon is identified as having been observed in 2010 and being protected under the Endangered Species Act. Additional discussion is required to address the potential for risks to this off-site receptor, noting the potential for risks from on-site soil migrating off-site identified in the ERA, as well as the off-site sediment data that indicated impacts above the sediment quality criteria.	Additional discussion has been included regarding the Lake Sturgeon. It is noted that with the implementation of RMM-1 a soil cover, impacted soil would not migrate into sediment.	Comment addressed	No response required		
45	Section 5.3.1 – Pathways Analysis	Editorial comment – This section does not appear to be a complete sentence. This should be revised for clarity.	This has been updated within the RA report.	Comment addressed	No response required		
46a	Sections 5.3.1.1 – Terrestrial Plants and Soil Invertebrates, Section 5.3.1.2 – Mammals and Birds, and Section 5.3.1.3 – Aquatic Biota	Editorial comment – The bullets in these sections list exposure pathways but do not explicitly state which pathways are being evaluated, either quantitatively or qualitatively, in the ERA. This should be clarified	Additional discussion has been added to these sections.	Comment addressed	No response required		
46b		These sections should be carefully reviewed and revised for consistency with the Eco CSM (Figure 5.1). Examples include that direct contact with groundwater by terrestrial plants and soil organisms is not included in Section 5.3.1.1; the second bullet in Section 5.3.1.1 refers to mammals and birds in the Terrestrial Plants and Soil Invertebrates section; bullets speak to stem and foliar uptake of vapours (sourced from volatile COCs in soil); Section 5.3.1.2 does not include direct contact by	This section has been updated to more clearly discuss which exposure pathways are being assessed within the ERA.	Comment addressed	No response required		
47	Table 5.5 – Exposure Characteristics for Wildlife Receptors	There is no context provided for the inclusion of this table in the text. This should be clarified.	This has been updated in the RA report	Comment addressed	No response required		
48	Section 5.5.2.1 – On-Site Environment, Groundwater	A table showing the comparison of the REMCs for all groundwater COCs to the applicable component values should be provided, similar to that provided in the soil section, for clarity and completeness.	A table with a comparison of the REMCs for all groundwater COCs to the GW3 component was provided in Section 5.5.2.1	Comment addressed	No response required		
49a	Section 5.5.2.2 – Off-site Aquatic Environment	The report includes an assessment of off-site surface water data to evaluate the potential effects to offsite aquatic receptors, however it was not possible to confirm the maximum surface water concentrations in Table 5.8, as Figure 7 of the Phase Two CSM appears to only present concentrations for parameters that exceeded the applicable standards (i.e. copper and zinc), and it does not appear that tables summarizing the off-site surface water data have been provided. This should be revised.	The surface water sampling results are provided in Appendix I	Comment addressed	No response required		
49b		The applicable standard for copper is given as 5 µg/L in the RA but indicated as 1 µg/L in the Phase Two CSM. This discrepancy should be clarified. If the application of the value of 5 µg/L is based on the water hardness, this should be indicated in the table and the basis of the water hardness (e.g., testing) should be discussed.	As a cautious approach, the surface water samples were compared to the lowest copper guideline in the Phase 2 ESA. However, in the ERA a more detailed examination of the hardness was conducted. As noted in a footnote to the table, the average hardness of the water samples was 28 mg/L and this value was used to select the appropriate	The response partially addresses the comment; footnote "a" should be added to the copper standard of 5 µg/L in Table 5.9 to indicate that the value has been adjusted for water hardness.	The footnote a was added to copper in Table 5.9.	Comment addressed	No response required
49c		It is not clear how the surface water COCs presented in Table 5.8 were determined. The Phase Two CSM indicates that surface water samples were submitted for analysis of BTEX, PHCs, PAHs, and metals but it appears that only a subset of these parameters are presented. Additional clarification or a table that presents the analytical results for all analyzed parameters and compares them to the applicable standards would be helpful. The QP should also consider whether it would be helpful to present the surface water data for all COCs identified in Site groundwater, regardless of whether they are considered a COC in off-site surface water, as the surface water data is being used to evaluate the potential for risk from Site groundwater migrating offsite.	Surface water COCs were identified as those parameters exceeding the GW3 or the sediment quality components. This has been clarified within text.	Comment addressed	No response required		
49d		It is not clear how the sediment COCs presented in Table 5.9 were determined. The Phase Two CSM indicates that sediment samples were submitted for analysis of BTEX, PHCs, PAHs, and metals but it appears that only a subset of these parameters are presented. Additional clarification or a table that presents the analytical results for all analyzed parameters and compares them to the applicable standards would be helpful. The QP should also consider whether it would be helpful to present the sediment data for all COCs identified in Site soil, regardless of whether they are considered a COC in off-site sediment, as the	Sediment COCs were identified as those parameters exceeding the sediment quality components identified in Section 5.1.4. This has been clarified within text. Sediment data are provided in Appendix I.	The response indicates that the COCs were those parameters that exceeded the sediment quality component values identified in Section 5.1.4, however Section 5.1.3 presents the sediment quality criteria. This should be clarified. Additionally, PHC F2 is carried forward as a COC in Table 5.10 and it is not identified as an exceedance in Table 5.1. Please clarify.	Agree that the screening is in Section 5.1.3, this was an error in the response but is correctly identified in the text and therefore no change was required. PHC F2 was removed from Table 5.10.	Comment addressed	No response required
49e		The last paragraph of the surface water discussion indicates that concentrations of COCs not measured (i.e. below the method detection limit) were assumed not present/present at negligible concentrations and were not considered a potential concern for off-site receptors in the assessment. This approach should be discussed in the Discussion of	A discussion of surface water concentrations that were reported as less than the method detection limit and how it relates to uncertainty was added into Section 5.5.5.	Comment addressed	No response required		
50a	Section 5.5.3.2 – Missing Toxicity Information	The first bullet does not discuss 2-(1-)methylnaphthalene, which is also missing a Plants and Soil Organisms component value. This should be clarified.	2-(1-)methylnaphthalene has been added into the list.	Comment addressed	No response required		
50b		The last paragraph indicates that 2x soil background was used in the qualitative assessment. It would be helpful to present this qualitative assessment in the RA for clarity.	The qualitative assessment was included in Table 5.11 for clarity.	Comment addressed	No response required		
51	Section 5.5 – Risk Characterization	The text does not appear to include the mandatory section "Special Considerations" as outlined in Table 1 of O.Reg. 153/04 "Mandatory Requirements for Risk Assessment Reports". The QP is reminded that all mandatory sections should be addressed.	Special considerations sections has been included in the RA report as Section 5.5.4	Comment addressed	No response required		
52	Table 5.10 – Property Specific Standards (PSS) Protective of Ecological Health in Soil and Table 6.3 – Soil Property Specific Standards	It is not clear why RMM-1 is indicated as being required for acenaphthene as this COC was not carried forward for the quantitative evaluation based on comparison to the Mammals and Birds component value presented in Table 5.1 or as exceeding the applicable standards in Table 6.2. This should be revised.	This has been revised to no RMM being required for acenaphthene.	Comment addressed	No response required		
53	ERA – Missing Report Section	The risk characterization section of the ERA appears to be missing a required subsection titled, "Special Considerations". Please update the RA report accordingly.	This is a repeat comment, similar to No. 51 above. Please refer to the response above.	As noted in the response to comments, this comment was a repeat of Comment 51. No further comment	No response required		

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54	Section 6.1 – Summary of Results, Table 6.1 (Summary of the HHRA Results)	Certain exposure pathways (e.g., gardening) and COCs (e.g. lead) that were qualitatively assessed in the HHRA were not presented in this table. Please update Table 6.1 to ensure it is complete.	This has been updated in the RA report	Certain exposure pathways (e.g., gardening) and COCs (e.g. lead) that were qualitatively assessed in the HHRA were not presented in this table. Please update Table 6.1 to ensure it is complete.	Please see edits to Table 6.1.	Comment addressed	No response required
55a	Table 6-2 – Summary of the ERA Results	This table should be checked for consistency against the results presented in Table 5-6. For example, Table 6-2 indicates that there were no exceedances of applicable standards for the American Woodcock, however Table 5.6 indicates there are exceedances for barium, cadmium, lead, selenium, and zinc. A selenium exceedance identified in Table 5.6 for the short-tailed shrew does not appear in Table 6.2.	This has been updated in the RA report	This table should be checked for consistency against the results presented in Table 5-6. For example, Table 6-2 indicates that there were no exceedances of applicable standards for the American Woodcock, however Table 5.6 indicates there are exceedances for barium, cadmium, lead, selenium, and zinc. A selenium exceedance identified in Table 5.6 for the short-tailed shrew does not appear in Table 6.2	It is unclear what the reviewer is requesting; it appears that the comment was not changed from the previous response. Table 6.2 was updated.	Comment addressed	No response required
55b		The exposure pathway column of the table is blank; this should be revised.	This has been updated in the RA report	The exposure pathway column of the table is blank; this should be revised.	It is unclear what the reviewer is requesting; it appears that the comment was not changed from the previous response. Table 6.2 was updated.	Comment addressed	No response required
55c		The entries for off-site terrestrial and aquatic receptors are blank; the table should be revised.	This has been updated in the RA report	The entries for off-site terrestrial and aquatic receptors are blank; the table should be revised	It is unclear what the reviewer is requesting; it appears that the comment was not changed from the previous response. Table 6.2 was updated.	Comment addressed	No response required
56	Table 6.3 – Soil Property Specific Standards	It is not clear why RMM-1 is indicated as being required for acenaphthene based on the ecological risk assessment when this COC was not carried forward for the quantitative assessment and is not indicated as being carried forward for quantitative assessment in Table 5.1 or as exceeding the applicable standards in Table 6.2. This table should be checked for consistency and revised as necessary.	This is a similar comment to above No. 52. Please refer to the response above.	It is not clear why RMM-1 is indicated as being required for acenaphthene based on the ecological risk assessment when this COC was not carried forward for the quantitative assessment and is not indicated as being carried forward for quantitative assessment in Table 5.1 or as exceeding the applicable standards in Table 6.2. This table should be checked for consistency and revised as necessary	It is unclear what the reviewer is requesting; it appears that the comment was not changed from the previous response.	Comment addressed	No response required
57a	Phase Two ESA (Appendix F.2)	The table of contents indicates that Tables 17 through 21 present the sediment and surface water results, while Sections 6.9 and 6.10 indicate that Tables 17 through 22 present the sediment and surface results, however it appears that these tables have been removed from the Phase Two ESA report. This data is relied upon in the ERA and used for the qualitative assessment of off-site impacts in sediment and groundwater. It would be helpful if this data was somehow incorporated into the risk assessment, perhaps as a separate appendix, so that the data presented in Section 5 can be verified.	As requested, Tables of sediment and surface water data as well as maps of sample locations have been added as Appendix I.	Comment addressed	No response required		
57b		Section 6.6.6 – Electrical Conductivity and Sodium Absorption Ratio. Minor typographical error – should be 'adsorption' ratio.		Comment not addressed. This comment was not included in the response to comments table. Please revise.	The heading in Section 6.6.6 of the Phase Two ESA has been revised to correct the spelling of Adsorption.	Comment addressed	No response required
57c		Appendix F – Surface Water and Sediment Results; Figure 7. It is not clear what standards are being shown in the figure; legend entries for the red and green dots indicate that they correspond to exceedances of the Table 2 SCS, however the table showing the applicable standards does not present the Table 2 SCS and also refers to the PWQO. This should	Reference has been corrected on Figure 7. The surface water results were compared to the PWQO. Sediment results were compared to Table 9 SCS for sediment quality.	Comment addressed	No response required		
58	Missing Appendices	As required by O. Reg. 153/04 and/or MECP guidance, please include the following information as appendices in the revised RA: MECP review Schedule A document, borehole logs, summary tables of all analytical data relied upon in the RA, and summaries of the Phase One and Two ESA reports.	Schedule A document has been included in Appendix B. Borehole logs and analytical data have been included in Appendix F as F.3 and F.4, respectivley. The summaries of the Phase one and Phase 2 ESA have been included in the Phase One and Phase Two reports as the Excutive summaries, which have been included in Appendix F as F1 and F2, respectively.	Comment partially addressed. Borehole logs were located in Appendix D of Appendix F.2. The risk management plan was provided as Appendix J. Appendix F.1, F.3, and F.4, referred to in the response to comments, could not be located. Summaries of the Phase One and Two ESA reports should be provided in the revised RA. The QP is also referred to Section 4(6)(4) and 4(6)(4.1) of the Schedule C of the Regulation	Summaries of the Phase one and Two ESA reports have been added to Appendix F. Appendix F.1 is the Phase Two ESA with appendices to that report containing the detailed information requested.	Comment addressed	No response required
59				In future, it is recommended that the QP's responses clearly indicate where in the RA or Response to Comments table a comment is addressed.	Noted		
60				Section 3.1 – Property Information. The legal description provided in the "Site Identification Information" should be revised to reflect only the description of the RA Property; it currently appears to include the water lots. No figures were included with the RA report, although the reviewer was referenced to the ESA report in some sections of the RA report. The QP is reminded that figures should be provided as part of the RA report and should not reference the ESA report. If the QP wishes the reviewer to refer to the P2CSM figures, which are a part of the RA report, this should be clearly indicated, and appropriate P2CSM figures should be referenced in the applicable sections of the RA report. Currently, some of the P2CSM figures do not clearly show/outline the RA property (for example, Figure 7, 8, 11a, and others). The QP is reminded that the RA property boundary should be clearly shown on the figures, even if the original P2ESA was done for a larger property. The QP will also need to ensure that the APECs/PCAs identified in the P2CSM are applicable to the RA property (e.g., based on the updates made to the RA property, previous APECs that were considered to be on-Site may now be off-Site. In addition, previous on-Site PCAs which resulted in on-Site APECs may now be considered off-Site PCAs to cause on-Site APECs). This will require review and revision, as appropriate.	See response to Comment #4.	Parts of the RA still refer to the P2ESA for the figures (e.g. Sections 3.1, 3.1.1, 3.1.2, 3.1.4, etc.). The RA should be updated to refer to the appropriate figures presented with the RA report (e.g. P2CSM figures in Appendix G). Alternatively, the RA report itself could include the figures (e.g. in an appendix).	The RA was revised to reference figures in the Phase Two CSM - Appendix G in the RA.
61				Section 4.4.2.1 – Resident - Inhalation of Indoor Air from Vapours Migrating from Soil. The text indicates that all COCs migrating from soil to indoor air exceeded the HBIACs, however, this is not true as the indoor air concentrations for acenaphthene do not exceed the HBIAC. Please revise	As pointed out in the following comment acenaphthene should not be presented in Table 4.28 therefore this change is not required.	Comment addressed	No response required

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62				Table 4-28. Comparison of Estimated Indoor Air Concentrations from Volatile COCs Migrating from Soil to Residential HBIACs. It is not clear why acenaphthene and anthracene are included in this table, as they are not identified as exceeding the S-IA value in Table 4.6, although it is noted that the predicted indoor air concentration for anthracene does exceed the HBIAC. This should be clarified, and any related tables updated for consistency. The QP may wish to consider revising the component values in Table 4.6 to reflect more recent updates to the toxicity reference values	The reviewer is correct as acenaphthene and anthracene are below the S-IA value in Table 4.6 they should not be in Table 4.28 and have been removed. The component values in Table 4.6 reflect the toxicity reference values provided in Section 4.3.	Comment addressed	No response required
63				Section 4.4.6 – Discussion of Uncertainty. The uncertainty section requires additional discussion related to: • The screening of COCs for potential vapour intrusion, including the implications of assessing COCs without an HBIAC • Qualitative assessments of risk due to exposure assumptions or use of surrogates • Qualitative assessments of risk due to lack of toxicity data • Where assumptions were used in the assessment of risk, the magnitude and direction of changes in risk should be discussed as an outcome of a change in the assumption, e.g. an increase in assumed incidental ingestion rate would increase or decrease the risk, and change or not change the outcome of the risk assessment.	Section 4.4.6 was edited to include additional discussion on the level of conservatism in the exposure assessment assumptions, lack of toxicity data as well as the use of the qualitative assessment.	Comment addressed	No response required
64				Section 5.5.2.1 – On-Site Environment. This section refers the reader to Figure 16a of the P2CSM for PHC groundwater data, but PHC data is included in Figure 17a of the P2CSM. This should be corrected	Edit made to Section 5.5.2.1.	Comment addressed	No response required
65						Table 5-12. Property Specific Standards (PSS) Protective of Ecological Health in Soil. A response to this comment was not provided in the response to comments table, and it does not appear to have been addressed. The table indicates that RMM-1 is not required for silver, however, Table 5-10 shows that silver concentrations in off-site sediment exceed the sediment quality criteria. This discrepancy should be clarified. The reviewer notes that Table 6.3 may also require similar	Changes were made to Table 1.1, Table 5.12, and Table 6.3 to indicate that RMM-1 is required for silver.
66						In follow up to Comment 62, the TRVs in Section 4.3 were reviewed for consistency with the response to comments. The reviewer could not find the discussion relating to the selection of the following TRVs: a. The QP has selected an RfC value for arsenic that is different from the MECP's published (January 2020) list of TRVs; the QP is required to provide a rationale for the selection of this value. b. The QP has selected an RfC value for Aliphatic C6-C8 that is different from the MECP's published (January 2020) list of TRVs; the QP is required to provide a rationale for the selection of this value.	Edits were made to Section 4.3.2.1. a. A sentence was added to explain that although the MECP have withdrawn the TRV, the previously accepted value was retained as a conservative approach. B. The difference was due to significant figures. The value was updated to be consistent with the MECP value.
67						Section 5.5.2.2 – Off-site Aquatic Environment, "Sediment". Table 5.10 was revised to remove PHC F2 to align with the COCs identified in Section 5.1.3. However, the text that precedes the table still indicates that PHC F2 exceeds the sediment quality and SEL. This should be revised.	Updated
68						Table 6-2 – Summary of the ERA Results. The table has been updated to reflect the qualitative assessment in Section 5.5.3.2 for PAHs for plants and soil invertebrates and the short-tailed shrew, but has not been updated to reflect the qualitative assessment for the garter snake. This should be revised.	Table 6.2 has been updated.

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1a		a. A number of inconsistencies between Sections 6 and 7 were noted and need to be addressed: • Copper in soil is listed in Table 6.1 as one of the COCs that could pose unacceptable risk to toddler via direct contact exposure but not in Section 7.1. • PHC fraction F3 is listed in Section 7.1 as one of the COCs that could pose unacceptable risk to outdoor worker via direct contact exposure but not in Table 6.1. • COCs with unacceptable risk to resident via ingestion of garden produce are discussed in Section 7.1 but not in Table 6.1. • COCs with unacceptable risk to aquatic receptors via migration of soil are discussed in Section 7.1 but not in Table 6.1. • Lead is shown in Table 7.2 as requiring RMM for "human health – direct contact" but not discussed in Section 7.1 or Table 6.1. • Lead is shown in Table 7.4 as requiring RMM barrier and health and safety plan (HASP) for subsurface worker, but the risk is not discussed in Table 6.1 or Section 7.1. • Mercury is shown in Table 7.2 as requiring RMM for "human health – indoor air" but not discussed in Section 7.1 or Table 6.1, and it is shown in Table • Acenaphthylene and anthracene are discussed in Table 6.1 as requiring VI RMM for resident, but not discussed in Section 7.1. • Naphthalene is shown in Table 6.3 and 7.4 as requiring VI RMM for indoor worker, but the risk is not discussed in Table 6.1 or Section 7.1. • Naphthalene is shown in Table 7.4 as requiring RMM barrier for indoor worker, but the risk is not discussed in Table 6.1 or Section 7.1. Is direct contact an exposure pathway of concern for an indoor • The text indicates that the ERA identified risks requiring RMMs from migration of soils into the aquatic environment for metals, PAHs, and PHC F4. This is not consistent with the information presented in Table 6.2. The table and text should be reviewed and revised for consistency.	This has been updated in the RA report. This has been updated in the RA report. This has been updated in the RA report. Toluene, ethylbenzene, xylenes, PHCs, methylnaphthalene, 2-(1-), naphthalene, and trichloroethylene have been added to Table 6.1 for unacceptable risks to residents via indirect contact with garden produce Cadmium, copper, lead, nickel, zinc, PHC F2, PHC F4, Anthracene, Benz[a]anthracene, Benzo[a]pyrene, Benzo[ghi]perylene, Benzo[k]fluoranthene, Chrysene, Dibenz[a,h]anthracene, Fluoranthene, Fluorene, Indeno[1,2,3-cd]pyrene, Phenanthrene, Pyrene were included in Lead has been included in Section 7.1 and Table 6.1 Lead has been included in Section 7.1 and Table 6.1 Elemental mercury was not observed on the site acording to the Phase Two ESA, therefore, mercury is not included in Table 7.1. Table 7.2, or Table 6.1 Acenaphthylene and anthracene have been added to the discussion in Section 7.1 Naphthalene has been added to Table 6.1 and Section 7.1 The primary pathway considered for these receptors is the inhalation of indoor air from vapours migrating from soil and groundwater. Cover/fill is not applicable to the indoor worker. Table 6.2 and subsequent text have been updated to reflect the COCs with unacceptable risks requiring RMMs.	The response is partially accepted. There are still a number of inconsistencies between Sections 6 and 7 that remain: Copper in soil is listed in Table 6.3 as not needing RMMs for human health, but Table 7.2 discusses that capping is required to reduce human health risk by 1.7 times. This should be clarified. • Table 6.2 and Table 7.4 discuss that a soil cap is required for PHC F2 for protection of aquatic receptors, however, the text only discusses PHC F4	The tables and text in Section 6 and 7 were reviewed and several changes were made. Agreed. Copper is not identified as risk and thus should not be included in Table 7.2. A soil cap is required for all PHC fractions based on the qualitative assessment provided in Table 5.11. Therefore Table 6.2 and Table 7.4 were amended.	Comment addressed	No response required
1b	Section 7.1 – Risk Management Performance Objectives	The QP should provide further justification on how the proposed RMM option of "at or below grade parking garage" or SVIMS would provide adequate protection of the indoor air exposure pathway for future resident. Table 7.2 and Table 7.3 indicate that Trichloroethylene and PHC F2 requires at least 414 and 2400 times, respectively, in reduction for the protection of this exposure pathway. However, as the QP has identified that the RMM will be consistent with the MGRA model, the maximum allowable reduction factor is 200 for a building with storage garage with a continuous ventilation rate of at least 3.9 L/s/m2 and/or for active SVIMS.	Additional discussion has been added to the RA. The MGRA is a generic RMM that applies to all types of buildings. It is expected that a new construction with a robust system on a site where the key COC are spatially limited will be much higher than the cautious value used in the MGRA. This will be supported by monitoring.	The response is partially accepted. The scope of the SVIMS is unclear. Section 7.1 discussed that "Future buildings on the west portion of the Site (Area 1 on Figure 7.1) shall include a SVIMS. Within Area 1 on the western portion of the site, all volatile COC are within the applicable standards within a 30 metre buffer". Is SVIMS required for Area 1 on the western portion of the site?	Yes - SVIMS is required for Area 1 on the western portion of the site. The text was reworded to clarify that Area 1 includes a 30 m buffer.	The response is partially accepted. Figure 7.1 identifies the east portion of the Site as Area 1 and the west portion of this Site as Area 2. This is opposite of the discussions provided in Section 1.6, Section 7.1, and Table 7.1 of the RA Document. This needs to be clarified. In addition, Table 7.1 discussed that the RMM for the east portion of the site will be adequate for meeting the indoor air trigger values as shown on Table 7.2. However, Table 7.2 includes TCE in soil that requires more than 400 times reduction, which would not be achievable via the proposed storage garage RMM. Please clarify. It appears that the elevated TCE concentration was found on the west portion of the site, where SVIMS is required. For clarity, the maximum concentrations and VI RMM reduction factors should be presented separately for the west and east portions of the Site.	Agree. The text was revised to be consistent with Area 1 and Area 2 as shown in Figure 7.1. TCE in soil was found above the standard at one location (BH18-11), which is located on the west portion of the site within Area 2. The required reduction was identified in a previous comment and a response was provided. (This included additional text being previously added to Sections 4.4.2.1 and 7.1 to explain the robust system planned for the newly constructed building and the limited spatial extent of the contamination.) However, in response to this comment, an additional requirement of the installation of a vapour barrier was added to the storage garage RMM. Tables that present the maximum concentrations and VI RMM reduction factors separately for the west and east portions of the Site were added below Table 7.2 and 7.3. During the creation of these tables it was found that the EBC for benzene and PHC F2 in groundwater were presented incorrectly, these have been updated
		Based on Table 7.4 and 7.5, it appears that the QP is proposing different RMM to address indoor air risk for TCE in soil and groundwater: at or below grade parking for TCE in soil, and SVIMS for TCE in groundwater. The TCE impact in soil and groundwater were found at the same location (BH18-11). Therefore, it is unclear how different RMM can be implemented at the same location.	As the groundwater plumes are only in the west part of the site where SVIMS was recommended, Table 7.5 only listed this as an RMM. For consistency, Table 7.5 was modified to indicate that vapour mitigation is required. This can be either a SVIMS or a garage.	The response is accepted. For clarity, it is recommended that Table 7.1 and Table 1.1 in the RMP refer to the figure that shows the boundary of the east portion and west portion (Area 1) of the RA property	Reference to Figure 7.1 was added to Table 7.1 and Table 1.1 as well as the text of Section 1.6.	The response is partially accepted. As noted above, Figure 7.1 identifies the east portion of the Site as Area 1 and the west portion of this Site as Area 2 which is opposite of the discussions provided in the RA Document.	Agree, the text has been modified to be consistent with Figure 7.1

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1c		In addition, it should be noted that if a RMM is proposed for only a portion of the RA property, it will be necessary to have the limits of the RMM shown on a figure prepared by an Ontario Land Surveyor or an appropriately scaled site plan that could be used to identify the areal extents in the field of each RMM (Note: Figure 7.1 "Risk Management Plan Areas" does not meet this requirement). This figure will form part of the CPU for the RA property.	A discussion of RMMs and where they will be applied is discussed in greater detail in Section 7. Future buildings on the west portion of the Site (Area 1 on Figure 7.1) shall include an SVIMS.				
1d		Table 7.4 should include a column for risk to aquatic receptors via migration of soil.	Agreed, this has been updated in the RA.	The response is accepted	No response required		
1e		Table 7.4 proposed cover/fill RMM for toluene; however, this does not appear to be consistent with Section 4 of the RA. Further clarification should be provided.	Table 7.4 is consistent with Section 4. Table 4.38 indicates that a cover is required, this was a result of the qualitative assessment of the S-Nose pathway.	The response is partially accepted. Section 4 discusses that 2-(1-) methylnaphthalene, naphthalene, toluene, ethylbenzene, and xylenes may pose potential concern for the S-Nose pathway, however, this was not discussed in Section 6 or 7 of the RA Document. For clarity, it is recommended that the pathway be added to Tables 6.1 and 7.2.	The gardening pathway was added to Table 6.1. The EBC in Table 7.2 was updated to include S-Nose.	The response is partially accepted. The S-Nose pathway is combined with the indoor air inhalation pathway instead of being standalone in Tables 6.1 and 7.2. As a result, it is not clear which of the parameters with indoor air risk also present a potential concern for the S-Nose pathway. This should be clarified.	S-Nose was not combined with indoor air. S-Nose is presented separately in Table 6.1 as "Indirect contact with soil from gardening". A footnote was added to Table 7.2 to distinguish which parameters are a potential concern for the S-Nose pathway.
2a		In this section, the QP has indicated that "unimpacted" soil for use as cap material is soil "which no COCs are present" and/or may also be soil "which one or more COCs are present, but at a concentration that is less than the EBCs". Please note that the ministry typically defines "unimpacted soils" in the CPU as soil in which one or more Contaminants are present at concentrations less than the applicable generic site condition standards within the ministry's document entitled "Soil, Ground water and Sediment Standards for Use under Part XV.1 of the Act" dated April 15, 2011.	Agreed, this has been updated in the RA.	The response is partially accepted. For clarity, please revise the criteria for "unimpacted soil" to mean "applicable generic site condition standards for soil" instead of "applicable soil standards".	The text in Section 7.1.1 has been amended as suggested.	The response is accepted	No response required
2b	Section 7.1.1.1 – Hard Cap/Fill Cap Barrier	The fill cap proposed can be either a 1-metre thick layer of unimpacted soil, or a 0.5 metre thick layer of unimpacted soil underlain by a geotextile fabric. While the latter is reasonable, the QP should note that this is not consistent with the MGRA fill cap barrier requirements for residential property. This contradicts the discussion that the proposed RMM barriers "are consistent with that described in the MGRA model". In addition, in order to comply with Section 4(6)(7) "Mandatory Requirements of Risk Assessment Report" of Schedule C "Risk Assessments – Part 1 Mandatory Requirements" of O.Reg. 153/04, as amended, the design of engineered controls must be provided in a report in an appendix to the RA Document, with the report signed and sealed by a professional engineer. This also applies to the	Agree. The text was edited to indicate that the RMM is similar to that described in the MGRA. Please see Appendix J	The response is partially accepted. Further clarifications are required: • On Figure 1 "Fill/Hard Cap RMM" in Appendix J, the minimum thickness for unimpacted soil for the fill cap with a geotextile fabric is not shown. • On Figure 1 in Appendix J, the depiction of the fill cap for deep-rooted vegetation is not clear. A minimum horizontal distance of 2,000 mm is shown from a dotted line, but it is not clear if this is to represent the centre line of the excavation. Also, the fill cap for deep-rooted vegetation is not discussed within Section 7 or Appendix J. Also, further details as to why a minimum of 1000mm and 1500mm of unimpacted soils are required. • The RMM figures in Appendix J have not been signed and sealed by a professional engineer. • Reference to Appendix J, as well as, references to the various RMM figures within Appendix J should be included in various discussions within Section 7 of the RA Document.	The minimum thickness for unimpacted soil for a fill cap with a geotextile fabric has been added to Figure 1 in the RMP. The dimensions for deep-rooted vegetation have been modified on Figure 1. A depth of 1000 mm was selected as it was considered sufficient to allow immature tree plantings (i.e., allow clean soil coverage over the root ball). The 2000 mm (revised from 1500 mm) by 4000 mm clean soil dimensions were selected since they were considered adequate to provide sufficient contaminant free soil until the root system for new tree plantings was established. References to Appendix J and the RMP figures have been added to Section 7 of the RA.	The response is partially accepted. Further clarifications are required: • Figure 1 "Fill/Hard Cap RMM" comment is addressed. • On Figure 1 in Appendix J – response is partially accepted. Again there is no discussion of the fill cap for deep-rooted vegetation within Section 7 or Appendix J. Further details are required showing how the deep rooted vegetation fill cap is to be completed for tree root balls, etc. In addition, can deep rooted vegetation fill cap be utilized in areas of the shallow fill cap with only 500 mm and a geotextile? • The RMM figures in Appendix J have not been signed and sealed by a professional engineer – comment not addressed. The RMM figures are not signed and sealed by a professional engineer. • Reference to Appendix J, as well as, references to the various RMM figures within Appendix J should be included in various discussions within Section 7 of the RA Document. – comment	Discussion of the fill cap for deep rooting vegetation has been added to Section 7.1.1.1 of the RA. The deep rooted vegetation RMM is more conservative than both the 0.5 m fill cap with geotextile and the 1 m fill cap with no geotextile. It can be used anywhere on the RA property. The figures in Appendix J have been sealed. Reference to Appendix J was added to Section 7.0 of the RA. Figure references have been added throughout Section 7 of the RA.
2c		Are underground utilities expected in the future development? If so, please discuss if barriers are required around future underground utilities for the	It is anticipated that trench plugs and sealing around utilities entering from the subsurface will be required in areas where vapour migration is possible. Please see Appendix J for additional discussion and design figure for the	The response is partially accepted. Further clarifications are needed: • A figure illustrating the conceptual design of a trench plug	A typical trench plug design consistent with OPSD 802.095 has been added to the RMP as Figure 6.	A figure illustrating the conceptual design of a trench plug - The response is partially accepted. As noted above, the RMM figures are not signed and sealed by a professional engineer. This needs	The trench plug figure has been sealed.
3	Section 7.1.1.3 – Site Restrictions	The QP proposes "a minimum of 30 cm of clean growing medium in areas where a "Fill Cap is present that includes a geotextile barrier", i.e. where the proposed fill cap thickness is 0.5 m; and "a minimum of 60 cm of clean growing medium immediately on top of a geotextile barrier in areas where the fill cap does not include a geotextile barrier", i.e. where the proposed fill cap thickness is 1 m. It is unclear why the QP would propose a thinner soil layer for vegetable gardens in area where the fill cap layer is also thinner. Is the geoxtextile fabric underlying the thinner fill cap intended to prevent root penetration? Please clarify.	This has been revised to be consistent. A thicker soil layer will be applied to the site to account for roots penetrating deeper in a vegetable garden.	The response is not accepted. The discussion about vegetable garden restriction appears to be contradictory. It indicates that "the construction of vegetable gardens, other than those planted in above ground containers isolated from subsurface conditions, is restricted", however, it was further discussed that "raised vegetable garden beds may be constructed". Please clarify if raised vegetable garden beds are allowed, or should vegetable gardens be restricted to containers isolated from subsurface conditions.	Additional text was added to Section 7.1.1.3 to clarify that vegetable gardens should be restricted to containers that are isolated from the subsurface.	The response is partially accepted. The RMP allows for raised garden beds, with or without an underlying geotextile fabric. This could potentially contradict the discussion that vegetable gardens are restricted to "above ground containers isolated from surface conditions" and could result in confusion when implementing the RMP. Please clarify.	This statement is incorrect. Per Section 7.1.1.3, both options for raised garden beds require a geotextile fabric. Option 1 assumes a 0.5 fill cap with a geotextile barrier is used as an RMM then requires an additional 0.5 m of clean growing medium within a raised garden bed. Option 2 requires installation of a geotextile barrier and 60 cm of clean growing media in any area where a geotextile barrier is not used (i.e., in areas where a fill cap of at least 1 m of clean soil is used as an RMM).

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4	Section 7.3 – Duration of Risk Management Measures	Editorial comment - The QP states that "the RMMs are required until it can be demonstrated that concentrations in soil and/or groundwater meet the EBCs presented in Table 7.2 and Table 7.3, respectively". "And/or" should be revised to say	The RA has been updated.	The response is accepted	No response required		
5a	Section 7.4.3 – SVIMS	Please confirm if the inspection of the SVIMS is to be conducted by a QP, or "the Owner or an assigned representative".	A qualified engineer or other representative of the property owner will inspect the SVIMS.	The response is partially accepted. It is noted In Section 7.4.3 "SVIMS" that an inspection and maintenance program will be developed by "a Qualified Person (i.e, qualified engineer) or other representative of the property owner". It should be noted that "Qualified Person" under O. Reg. 153 does not only include an engineer. This is also a slight variation on the reference made under Section 1.5.3 "SVIMS" of Appendix J where it indicates the program will be developed by a "qualified engineer". These sections need to be consistent. In addition, the system should be inspected by a qualified professional, and the inspection and maintenance program should not be conducted by representative of the property owner who is not a qualified professional	Section 7.4.3 was edited to clarify that an engineer should develop the inspection and maintenance program and a qualified professional should implement the program.	a. The response is accepted. It should be noted that the inspection and maintenance program shall be developed and implemented by a licensed professional engineer. This requirement will be stipulated in the CPU.	Noted
5b		It is discussed that "to ensure that concentrations of vapours in indoor air within any future on-site buildings do not represent a risk to indoor workers, sub-slab vapour samples will be collected". This sentence should be revised to include "residents".	The RA has been updated.	The response is accepted.	No response required		
5c		It is recommended that indoor air samples be collected on a quarterly basis for two years, the same as for sub-slab vapour sampling, instead of the semi-annual basis proposed.	Agreed, quarterly samples will be collected indoors and sub-slab vapour samples.	The response is accepted.	No response required		
5d		It is noted that if indoor air results at any location are above the trigger levels, the MECP will be notified within 3 days and another sample collected. It should be noted that if there is an exceedance of the trigger values then the area in which the indoor air sample was obtained shall be restricted to access by only authorized personnel until such time that the indoor air results meet the trigger values. This section should be revised to address this requirement.	This would be difficult to enforce in a residential scenario. Considering that potential health effects are chronic the exceedance of a trigger level, that would have been acceptable in all past monitoring campaigns and thus at most has been elevated for three months, does not necessarily warrant restricting access. A requirement has been added that the resident be notified of the results of the air monitoring and if feasible the area should be restricted.	The response is accepted.	No response required		
5e		The reference to converting from passive to active SVIMS should be removed as the use of passive SVIMS will not provide the appropriate risk reduction for vapour migration to indoor air for trichloroethylene and/or PHC F2 as noted above in Comment No. 1 (b) above.	The RA has been updated.	The response is accepted.	No response required		
5f		It is noted that the HBIAC trigger values shown on Table 7.6 differ from the MECP values shown on the MGRA model due to rounding off of the numbers. It is recommended that the HBIAC be presented with the same number of significant figures as in the MGRA model.	It is acknowledged that rounding was used to show the concentrations to two significant figures. These numbers have been edited to be consistent with the MGRA model. This does not affect the overall RMP.	The response is accepted.	No response required		
5g		It appears that acenaphthylene, anthracene and mercury could pose unacceptable risk to resident via indoor air inhalation, in addition to the COCs listed in Table 7.6 (although there are inconsistencies in Sections 6 and 7, see comment #1a). Will these COCs be included in the sub-slab/indoor air monitoring program? If so, please include their trigger levels in	The RA has been updated. Acenaphthlyene and anthracene have been added to Table 7.6 and be included in the monitoring program. As discussed in Section 4 mercury at the site is not volatile and therefore has not been included.	The response is partially accepted. The indoor air trigger value for acenaphthylene on Table 7.6 is shown as 1.85 µg/m3. Based on the TRVs presented in Section 4.3.2, it appears that this value should be 0.185 µg/m3. This should be revised.	Agree, this was an inadvertent error that has been corrected. Anthracene was removed from this table.	The response is accepted.	No response required
6a		The QP discussed that the TCE plume is "confined" and hence further groundwater monitoring is not required. It appears that there is no horizontal delineation of the plume downgradient of the exceedance at BH18-11. Therefore, based on the data currently available, it cannot be determined that the plume is "confined". It is noted, however, that the concentration of the TCE at BH18-11 is unlikely to pose an unacceptable risk to aquatic receptors based on the Table 9 GW3 component value for TCE.	This has been resolved - Please refer to appropriate response to Phase Two CSM (Comment No. 3)	The response is accepted.	No response required		
6b		Please correct typo in second sentence of second bullet point. "TCE plume" should read "PHC plume".	The RA has been updated.	The response is accepted.	No response required		

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6c	Section 7.4.4 – Groundwater Monitoring	The QP discussed that the PHC plume does not extend to Midland Bay. There is no horizontal delineation of the plume downgradient of the exceedance at BH18-07. Therefore, based on the data currently available, it cannot be determined that the plume does not extend to Midland Bay. Given that the F2 concentration at BH18-07 exceeds the Table 9 GW3 component value (1,000 ug/L vs 170 ug/L), groundwater monitoring should be considered, unless addition delineation shows that the plume is not	This has been resolved - Please refer to appropriate response to Phase Two CSM (Comment No. 3)	The response is accepted.	No response required		
6d		Are underground utilities expected in the future development? If so, please consider including trench plug as RMM to mitigate any preferential migration of impacted groundwater off-site via underground utility conduits.	A trench plug as an RMM is to be implemented. Please refer to response to above regarding trench plugs (Comment 2c).	The response is accepted.	No response required		
7	Section 7.4.6 – Contingency Plan	The QP discussed that "a contingency plan is not required to ensure the effectiveness of the measures. Rather, it will be important to ensure that the measures are properly maintained and not disturbed following installation". The purpose of having a contingency plan is so that receptors remain protected in the event that the RMMs are found to be not properly maintained, or are disturbed. Please provide a contingency plan for the RMMs proposed; contingency plan is a requirement under O. Reg.	The RA has been updated.	The response is accepted. Please note minor typographical error: "At least one round of sub-sampling….". It is assumed that this is intended to read "At least one round of sub-slab sampling…". Please revise.	Editorial error corrected.		
8	Section 7.5 – HASP	There was no HASP provided as Appendix J.	Acknowledged, this was an oversight. The HASP has been included as Appendix J.	The response is accepted. It is noted that the scope of the HASP appears to be rather general as it includes protection against pathways that were not identified in the Risk Assessment as needing risk mitigation, such as use of respirators to mitigate exposure to vapour.	No response required		
9a	Section 7.6.1 – Soil Management	The RMP provided no details on Soil Management Plan, such as: i. Mitigation of potential direct exposure during subgrade work ii. Dust control iii. Sampling requirements and soil criteria for soil reuse iv. Sampling requirements and soil criteria for soil importation	These requirements will be outlined in the Soil Management Plan provided with the CPU	The response is accepted.	No response required		
9b		The QP discussed that one of the information to be supplied by the contractor related to the off-site disposal of any impacted soil include "acceptance letter from the receiving property's QPESA". Does this imply that the impacted soil may be sent to another RSC property? Please clarify. Please note that any export of soil to another property should follow the new On-Site and Excess Soil Management O. Reg. 406/19 when it comes into effect and the revised O. Reg. 153/04, where applicable.	The final decision on where soil will be located is yet to be determined. If any soil is exported from the site it will follow O.Reg. 406/19 and the revised O.Reg. 153/04, when it comes into effect. A statement has been added to the RA to clarify this.	The statement added to address this comment could not be found. Please clarify.	This statement was added to Section 7.6.1.	b. The response is accepted. It should be noted that the requirements for the soil management plan will be specified within the CPU.	Noted
9c		The QP discussed that "excavated soil with COCs in excess of the EBCs, may not remain at the surface of the Site after the completion of a construction project, unless it is capped in accordance with the hard cap/fill cap barrier RMM". What about soil in excess of both the EBCs and PSS?	No excavated soil with COCs in excess of the EBCs or PSSs may remain at the surface of the Site unless capped in accordance with the hard cap/fill cap barrier RMM .	The response is not accepted. Excavated soil with COCs in excess of the PSS cannot remain on-site, even under a cap.	Agree. This was edited to be soil in excess of the applicable generic soil standard (and meeting the PSS).	The response is accepted.	No response required
9d		The QP discussed that "excavated soil with COCs in excess of the EBCs, may not remain at the surface of the Site after the completion of a construction project, unless it is capped in accordance with the hard cap/fill cap barrier RMM". What about soil in excess of both the EBCs and PSS?	No excavated soil with COCs in excess of the EBCs or PSSs may remain at the surface of the Site unless capped in accordance with the hard cap/fill cap barrier RMM .	See 9c.	See 9c.		
9e		It should be noted that the requirements for a Soil Management Plan will be outlined in the CPU.	Text was added to Section 7.6.1 to indicate that the requirements for Soil Management Plan will be outlined in the CPU.	Response accepted.	No response required		

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10	Section 7.6.2 – Groundwater Management	It is discussed that groundwater management is required "if groundwater is encountered during excavation activities within Area 1". Are excavation activities not expected within Area 2? The RMP proposed at grade or below grade parking garages within Area 2. Therefore, it appears the construction of a below grade parking garage within Area 2 is a possibility, and excavation would be expected. As noted in Comment 1c, the proposed RMM will be applicable to the entire RA property, unless there are provisions for a registered survey or scaled site plan to separate the RMMs. It should also be noted that the requirements for a Ground Water Management Plan will be outlined in the CPU.	As shown in the Phase 2 CSM there are no exceedances of groundwater SCS in Area 2. Text was added to Section 7.6.2 to indicate that the requirements for Groundwater Management Plan will be outlined in the CPU.	The response is partially accepted. Please note: • Record keeping should also include groundwater analytical results. • The QP is reminded that even though groundwater on the East portion does not exceed the applicable generic Standards, groundwater encountered during construction must still be managed and disposed of appropriately, and the groundwater quality must meet the criteria for the disposal method. • Editorial comment: The first paragraph refers to "soil management plan".	Additional text was added to Section 7.6.2 to address these comments.	The response is partially accepted. Please note: • Record keeping – the response is accepted. • The response is partially accepted. This section should be revised to indicate that the groundwater management plan is applicable to the entire RA property. It should be noted that the requirements for the ground water management plan will be specified within the CPU. • Editorial comment: - Comment addressed.	The comment regarding Groundwater Management Plan requirements was previously addressed and the changes indicate the plan applies to the entire site. See Section 7.6.2 paragraph 2. There are two RMM areas at the RA Property and both areas are referenced in this paragraph as requiring a Groundwater Management Plan. Minor wording changes were made to clarify.
11	Section 7.1 - Risk Management Performance Objectives					a. For clarity, this section should provide a discussion of all RMMs proposed; there are no discussions on health and safety plan, restriction of potable groundwater use, soil and groundwater management plan and trench plug requirements. b. Clarifications needed for Table 7.2: • The heading for Table 7.2 indicates "terrestrial ecological receptors". Should the criteria not be protective of aquatic receptors as well? • Table 9 SCS does not have component values for direct contact exposure pathway for ecological and human health receptors. Table 9 references Table 3 component values. • Where there is no value for sediment, the QP should consider background concentration, or at minimum LEL. For example, it appears that PHC F2 criteria for ecological receptors was set at the lowest terrestrial ecological component value for Table 3 because there was no sediment value. As per the Rationale Document, where sediment values are not available, the Ontario background concentrations apply. Please recheck EBC and revise the required reduction factor accordingly c. Table 7.4 indicates that RMM for protection of subsurface workers include cap barrier. Subsurface workers are expected to work below the depth of the cap. Therefore, cap barrier should not be considered a RMM for subsurface workers. d. Table 6.1 and Section 7.1 discussed that antimony, arsenic, and lead pose potential direct contact risk to the subsurface worker. However, Table 7.4 shows that in addition to these parameters, "cover/fill" is required for protection of subsurface workers from exposure to 1,2-methylnaphthalene, naphthalene, and toluene in	Text was added to Section 7.1 for the HASP, soil and groundwater management plan and trench plugs. The restriction of potable groundwater use was already identified in this section. Clarifications have been added to Table 7.2. • The heading was modified • The footnote was modified to indicate direct contact components were taken from Table 3 • As discussed in footnote f on Table 7.2, a qualitative assessment was undertaken for those COC without sediment benchmarks. Due to qualitative nature, EBC were not provided. Section 5.5.3 provides the qualitative assessment. As the cap will eliminate the migration of soil, the RMM will meet the necessary risk reduction for this pathway Table 7.4 was modified to removed the cap barrier for the subsurface worker. In Table 7.4 there is no risk management identified for the subsurface worker for 1,2-methylnaphthalene or naphthalene. The cover/fill RMM for toluene was an editorial error and has been removed for both the outdoor worker and
12	Section 7.1.1.2 - Vapour Intrusion Mitigation measures					Based on the information in this section, it appears that the use of SVIMS RMM is proposed for the whole property (Area 1 and Area 2), whereas, the use of the Storage/Parking Garage RMM is only to be utilized in Area 2 if SVIMS are not to be implemented. This is based on the statement under "Storage/Parking Garage RMM" which states "Future buildings on the east portion of the Site (Area 2 on Figure 7.1) that are not constructed with an SVIMS shall include a storage garage…" Please confirm that this is the correct understanding and/or clarify.	This understanding is correct.
13	Section 7.4.3 - SVIMS					It should be noted that in addition to the design and installation of the SVIMS being completed by a qualified licensed professional engineer for each building, a sub-slab/indoor air monitoring program shall also be required to be developed by a qualified licensed professional engineer in consultation with the Qualified Person taking into account factors such as building area and the design/configuration of the building foundations. This requirement will be outlined in the CPU.	Noted. These monitoring program requirements are addressed in Section 7.4.3.
14	Section 7.6.1 - Soil Management					a. Soil sampling requirements for soil importation shall meet Sections 31 to 34 of Schedule E, not just Section 34.	Revised to indicate Section 31 is applicable. The QP notes Sections 32 to 34 were revoked by O.Reg. 407/19.
						b. It is stated that "excavated material meeting the generic Table 3 SCS applicable for the Site may be placed on-site at any depth, if deemed suitable by the QPESA in consideration of the requirements of the Risk Assessment". Given that the applicable generic standards is Table 9 SCS, the QP should consider applying Table 9 SCS.	Revised to indicate the applicable generic standards are Table 9 SCS.

Response Tracking Table - 420 Bayshore Drive, Midland
RA1765-19 (IDS Ref No. 0155-BC6QVC)

Comments on RMP							
No.	**Section/Area in Report**	**Ministry Comment (March 20, 2020)**	**Response**	**Ministry Comment (October 9, 2020)**	**Response**	**Ministry Comment (July 22, 2021)**	**Response**
						c. It is stated that "the characterization of excavated materials to determine whether it may be placed below the Hard Cap or Fill Cap, or incorporated within the Fill Cap, shall including the collection and analyses of soil samples in accordance with the requirements set out in Clause 34 of Schedule E of O. Reg. 153/04". Please note that Section 34 pertains to soil brought to Phase Two property, not soil reuse. d. Please include the required sampling frequencies for soil reuse and soil importation, rather than only citing sections of the Regulation.	Revised to indicate excavated soil will meet the requirements of Section 34.1 (Soil Excavated at the Phase Two Property). Excavated and stockpiled soil will be sampled at the frequency specified in Section 36. Reference to the soil reuse (stockpile) frequency in Schedule E, Table 2 (for soil volume <5,000 m^3) and the equation in s36.6 (for soil volume >5,000 m^3) was added to the Section 7.6.1 of the RA. Soil importation sample frequency was added to Section 7.6.1 bullet 6 of the RA.
15	Appendix J - Risk Management Plan					a. None of the figures presented in the RMP are referenced in the text of Section 7 of the RA Document. Nor is Appendix J referenced in Section 7 of the RA Document with the exception of the HASP. References need to be included for the other b. None of the engineering drawings presented in the RMP were signed and sealed by a licensed professional engineer. c. Figure 3: The figure indicated "see Detail A", but there is no "Detail A" shown. – comment has been addressed with the revised Figure 3. d. It is unclear if Figure 5 is intended to show fill thickness for utility trenches or trench plug design. The figure was not referenced in the text or in Section 7. There is also no discussion of fill thickness for utility trenches in the text or in Section 7. e. Editorial comment – Table 1.4 appears not to have pdf'd properly and is difficult to read. Please revise. - comment has been addressed with the revised RMP in Appendix J.	Reference to Appendix J was added to Section 7.0 of the RA. Figure references were added throughout Section 7 of the RA. The figures in Appendix J have been sealed. No response required Section 7.6.2.1 has been revised to include reference to Figure 5 and a description of utility trench backfill. No response required

APPENDIX C

PROJECT TEAM CVs

Stacey Fernandes, M.A.Sc., P.Eng., QP$_{RA}$

Senior Environmental Engineer

EXPERTISE

Human Health and Ecological Risk Assessments

Environmental Modelling

Environmental Assessments

Peer Review

Project Management

EDUCATION

M.A.Sc. Chemical Engineering
University of Waterloo
1994

B.Sc. Chemical Engineering
University of Calgary
1992

AFFILIATIONS

Qualified Person – Risk Assessment; O.Reg. 153/04

Professional Engineers of Ontario

Association of Professional Engineers and Geoscientists of Saskatchewan

Society of Environmental Toxicology and Chemistry

Reliability Security Clearance

EMPLOYMENT HISTORY

2016–Present
Senior Environmental Engineer
Canada North Environmental Services
Markham, ON

1994–2015
Senior Environmental Engineer
SENES Consultants Limited (acquired by Arcadis in 2013)
Richmond Hill, ON

Stacey Fernandes has over 22 years of experience in human health and ecological risk assessment. She has been actively involved in assessments of modelling of the fate of contaminants in the environment for air emissions, industrial effluents and contaminated sites. She has extensive experience in the assessment of human health and ecological risk due to exposure to metals, inorganics, PHCs, PCBs, PAHs, BTEX compounds, chlorinated organic compounds, perfluoroalkyl substances and radiation.

Stacey has conducted a number of RAs for contaminated sites and assisted in the development of risk management plans. She is designated a Qualified Person – Risk Assessment (QP$_{RA}$) in Ontario under O.Reg. 153/04 and has considerable experience in conducting and reviewing risk assessments (human health and ecological) under the regulation. Currently she is a member of the Working Group for Human Health Toxicity Reference Values for the MOECC. In addition she has completed numerous risk assessments in accordance with Health Canada and Environment Canada protocols.

Stacey has been actively involved in environmental modelling for mining operations including detailed water and sediment quality modelling and fate and transport modelling of contaminants in the environment through the aquatic and terrestrial environments. Many of these projects were conducted in a probabilistic manner to account for the uncertainty and variability in the assessments

PROJECT EXPERIENCE

Ontario Ministry of the Environment, Conservation and Parks: Stacey is a project manager and core member of team conducting reviews of risk assessments for the Ontario Ministry of the Environment and Climate Change under Ontario Regulation 153/04 on behalf of the Ministry. She has primary technical responsibility for the review of the human health and ecological risk assessment components of the risk assessments. This included assessment of the technical content and ensure the assessments were done in accordance with the Regulation.

Ontario Ministry of the Environment and Climate Change: Stacey was the Senior Risk Assessor and one of the primary authors of the Community Assessment Report framework on behalf of the MOECC. The document provides an outline of the approach that can be adopted to complete these assessments under O.Reg. 153/04.

Public Works and Government Services Canada / Transport Canada: Stacey was the senior risk assessor for a RA to support a Record of Site Condition (RSC) under O.Reg. 153/04, as amended. This is a complicated site with four parcels of land directly adjacent to the Port Stanley harbour. Additional site characterization data (soil, groundwater, vapour) was collected from the site to support the risk RA and demonstrate contaminant delineation. Soil-vapour sampling and indoor air data used in the assessment. The recommended RMM included excavation and placement of caps, surface water monitoring and indoor air monitoring. Property Specific Standards (PSS) were developed for use in filing of an RSC. As part of the project Stacey helped develop presentation material and attended a Public Information Session.

PROJECT EXPERIENCE CONTINUED

Retail Mall, Oshawa, ON: A risk assessment was completed, under the technical direction of Stacey, for a retail plaza in Oshawa. A comprehensive risk assessment was undertaken to establish Property Specific Standards (PSS) for the site to support an RSC. The contamination in soil and groundwater primarily include chlorinated solvents and impacts from application of road salts; naturally elevated background concentrations are also present. The HHRA identified potential risks to individuals using the site from exposure to COC in soil and groundwater. Using soil-vapour data it was shown that existing building structures and systems are shown to provide adequate protection for human receptors when installed and operated as designed. Risk Management Measures were specified to provide protection to people and the environment. PSS were developed that included consideration of the RMM.

Industrial Site, Hamilton, ON: A risk assessment was completed, under the technical direction of Stacey, for an industrial site in Hamilton. A comprehensive risk assessment was undertaken to establish Property Specific Standards (PSS) for the site to support an RSC. The contamination included metals in soil and chlorinated VOC in groundwater. The assessment of vapour intrusion relied on all lines of evidence including modelling of vapours from groundwater, sub-slab sampling and indoor air. Risk Management Measures were specified to provide protection to people and the environment. PSS were developed that included consideration of the RMM.

Brownfield Redevelopment for Several Industrial/Commercial Clients Technical lead for risk assessment used to develop property-specific standards in support of Record of Site Conditions (RSC) for contaminated sites. Contaminants include polycyclic aromatic hydrocarbons (PAHs), metals (including arsenic), chlorinated volatile organic compounds (VOCs) and petroleum hydrocarbons (PHC). The Johnson-Ettinger model was used for estimating vapour migration into the indoor environment. Consideration of risk management measures that are needed to mitigate exposure was included to ensure acceptable level of exposure to contaminants. Assessments included external peer review and review by the Ontario Ministry of Environment. Included sites in the Portlands area of Toronto several industrial sites in Ontario, a shopping mall, a site on the Whitby Harbour for residential use and a commercial building in Kitchener.

Due Diligence Risk Assessment for Ferry Terminal in Kingston Senior Risk Assessor for a Due Diligence Risk Assessment (DDRA) completed in the spirit of O.Reg. 153/04 for a Ferry Terminal in Kingston, Ontario to ensure protection of workers during construction of the terminal and workers and visitors upon completion. The assessment was completed for the land portion of the Site, as well as the aquatic environment (Cataraqui River). COC included PAHs, PHCs, VOCs, metals, and inorganics.

Due Diligence Risk Assessments for Former Gas Station in Ontario Senior Risk Assessor for risk assessments currently being conducted for the on-site and off-site (adjacent roadway) contamination of a former gas station in Ontario. The DDRAs considers workers potentially exposed to BTEX and PHCs in soil and groundwater and includes consideration of vapour migration to indoor air in any future buildings.

Due Diligence Risk Assessments Stacey lead several risk assessments that were conducted in the spirit of O.Reg. 153/04, as amended, but were not submitted for a Record of Site Condition. This includes a former industrial site with chlorinated solvents, a waste management yard, a school yard and several sites for the Toronto Transit Commission.

Risk Assessment and Risk Management Plan for West Don Lands Stacey was the lead risk assessor for the preliminary risk assessments conducted to support the redevelopment of the 20 ha West Don Lands Brownfield site located to the east of downtown Toronto. Historically the site was occupied by a range of industrial faclities. The Risk Assessment addressed both human health and ecological concerns. The risk management plan incorporated hard landscaping surfaces, roadway pavements, concrete building floor slabs and clean soil barriers into the design of the residential and parkland facilities proposed for construction across the site. During the course of the program, a series of public meetings were held to obtain input from the general public and interest groups in the area. Extensive consultation and review of the risk assessment and risk management plan was provided by Ontario Realty Corporation (ORC), the City of Toronto, the Toronto Waterfront Revitalization Corporation (TWRC), the Ministry of the Environment (MOE) and the Toronto and Region Conservation Authority (TRCA).

Other Human Health and Ecological Risk Assessment

- Project manager and risk assessor for HHERA in support of the Giant Mine Remediation Project. Includes integrating information from numerous studies. Consultation with local Indigenous groups and risk communication important components of the assessment. Followed federal guidance for FSCAP properties from Health Canada and Environment Canada.
- Lead risk assessor for several federal contaminated sites for Department of Fisheries and Oceans, Transport Canada, National Capital Commission, and other agencies. Included evaluation of terrestrial impacts as well as sediment quality and water quality. Extensive experience with Health Canada's preliminary quantitative risk assessment (PQRA) tools.
- Conducted a human health risk assessment in support of remedial planning at a former coal gasification plant located at Rock Bay, in Victoria, B.C. on behalf of Transport Canada and BC Hydro.
- Technical lead for a risk assessment of a bay on Lake Superior that received pulp and paper mill effluent (Environment Canada). A detailed quantitative ecological risk assessment was conducted to assess the significance of the risk to receptors as a result of exposure to elevated levels of contaminants (dioxins and furans, PCBs, metals, total organic carbon (TOC), PAHs, organochlorine pesticides) found in sediments. Lines of evidence were selected and the assessment was completed using measured data where available.
- Several due diligence risk assessments that were conducted in the spirit of O.Reg. 153/04, as amended. This includes a former industrial site with chlorinated solvents, a waste management yard, a school yard, and several sites for the Toronto Transit Commission.
- Senior risk assessor for an assessment of tricholoroethylene (TCE) in groundwater to evaluate potential risks to workers from exposure to TCE in groundwater at an industrial facility. The assessment evaluated exposure via inhalation of volatile vapours and direct contact with production well water as well as potential for exposure to residents of nearby houses as a result of off-site migration.

Other Projects

- Project director for literature review of toxicity information and bioaccumulation for perfluorooctanoic acid (PFOA) and development of Environmental Quality Guidelines on behalf of Environment Canada.
- Provided advice to First Nations on water quality issues from a proposed mine. Participated in hearings. (Tłı̨chǫ Government).
- Senior technical lead in the development of a risk-based surface standards for PCB-coated natural gas pipelines in order to determine acceptable levels for pipe handling following PCB removal.
- Assessed the potential risks due to the presence of microbes and disinfection by-products in drinking water. Used a decision framework to evaluate water management alternatives (BC Health).
- Project manager and technical lead for a human health and ecological risk assessment of emissions from a proposed refinery. Fate and transport modelling was conducted based on the U.S. EPA Region 6 guidance.
- Provided technical support for several human health and ecological assessments related to coal-fired and natural gas-fired power plants in Ontario and Manitoba.
- Led the human health risk assessment for a proposed facility to handle mixed waste from the U.S. Department of Energy Hanford site (included assessment of radionuclides and hazardous chemicals), which was reviewed and accepted by the U.S. Environmental Protection Agency.

SELECTED RECENT CONFERENCE PRESENTATIONS

Thackeray, N., H. Phillips, K. Woolhouse, and S. Fernandes. 2018. An Approach to Scoring Toxicity Data for the Development of Wildlife TRVs. Presented at SETAC Laurentian, Kingston, June 2018.

Phillips, H., S. Fernandes, C. Lucas, N. Thackeray, R. Froess, J. Amphlett and E. Nyyssonen. 2018. Development of a Country Foods Dietary Survey and Collection of Voluntary Country Food Samples in Support of the Giant Mine Risk Assessment. Presented at RPIC May 2018.

Lucas, C., N. Thackeray, K. Woolhouse, S. Fernandes and H. Phillips. 2017. The Development of Regional Background Concentrations with Consideration of Naturally Elevated Areas. Presented at SETAC Laurentian, Oshawa, June 2017.

Thackeray, N., K. Woolhouse, H. Phillips and S. Fernandes. 2017. An Approach to Deriving Criteria for Elements with Insufficient Available Toxicity Data. Presented at SETAC Laurentian, Oshawa, 2017.

Nicole Thackeray, M.Env.Sc.

Environmental Scientist

EXPERTISE

Human Health Risk Assessment

Ecological Risk Assessment

Literature Review and valuation

Data Collection and Analysis

Field Sampling and Collection

EDUCATION

M.Env.Sc. Environmental Science
University of Toronto, 2013

B.Sc. (Hon.) Biology
Wilfrid Laurier University, 2011

AFFILIATIONS

Laurentian Society of Environmental Toxicology and Chemistry

EMPLOYMENT HISTORY

2016-Present
Risk Assessor
Canada North Environmental Services

2013-2016
Risk Analyst
Intrinsik Environmental Sciences Inc.

Nicole Thackeray has over seven years of experience in human health and ecological risk assessments (HHERAs) for a number of different sectors including: mining operations, energy from waste facility and contaminated residential, institutional, and commercial property use sites throughout Ontario. She completed her B.Sc. with Honours in Biology in 2011 and M.Env.Sc. in Environmental Science in 2013.

Nicole has been involved in the preparation of several risk assessments compliant with Ontario Regulation 153/04. She has been involved with each aspect of human health and ecological risk assessments, including assessing human health and ecological components for residential, institutional, commercial, community, and industrial property use. Nicole has completed exposure modelling for: vapour infiltration, swimming, trench working, fate and transport in aquatic environments. Additionally, Nicole has participated in the selection of Risk Management Measures (RMM) to address vapour infiltration, direct exposure to soil and groundwater, and surface runoff to the aquatic environment.

RELEVANT PROJECT EXPERIENCE

Ontario Regulation 153/04 Risk Assessment for a site in Maple

Completed a risk assessment under O.Reg. 153/04, to support an RSC for a residential property in Maple, Ontario, with a residential building, a parking area and a natural area with a stream running through the site. This assessment included estimating risk to a species at risk, the Red Side Dace.

Due Diligence Risk Assessment for Ferry Terminal in Kingston

Technical lead for a Due Diligence Risk Assessment (DDRA) completed in the spirit of O.Reg. 153/04 for a Ferry Terminal in Kingston, Ontario to ensure protection of workers during construction of the terminal and workers and visitors upon completion. The assessment was completed for the land portion of the Site, as well as the aquatic environment (Cataraqui River). COC included PAHs, PHCs, VOCs, metals, and inorganics.

Due Diligence Risk Assessments for Commerical Properties in Kitchener

Participated in a DDRA completed in the spirit of O.Reg. 153/04 for two adjacent industrial/commericial sites in Kitchener, Ontario. COCs in soil and groundwater included VOCs, PAHs, PHCs, metals, and inorganics. Measured sub-slab and soil vapour data were used when applicable to support the results of the assessment, and PSS were developed that included consideration of the RMMs for human and ecological receptors.

Due Diligence Risk Assessments for Former Gas Station in Ontario

On-site and off-site (adjacent roadway) contamination was investigated for a former gas station. The DDRAs consider workers potentially exposed to BTEX and PHCs in soil and groundwater and includes consideration of vapour migration to indoor air in any future buildings.

Due Diligence Risk Assessments for Former Fertilizer facility in Ontario

Historical contamination from a former ferilizer facility was investigated to ensure the leased land was left in an environmentally safe condition. Impacts from the site onto the Cornwall Canal directrly adjacent to the site were also investigated and RMMs were established. COCs in groundwater, soil and surface water included nutrients (ammonia, sulphate, nitrates), metals, PHCs and BTEX.

PROJECT EXPERIENCE CONTINUED

Other Risk Assessment Projects

- Serving as part of the technical team preparing the updated HHERA for the Giant Mine Site in the Northwest Territories. This work has included compiling, screening, and mapping all available Giant Mine and Yellowknife area data as well as developing Exposure Point Concentrations (EPCs) in various media around the site.
- Assisted with a HHERA for a proposed Peel Energy Recovery Center in Brampton, Ontario. Primary tasks for this included human health and ecological multiple pathway exposure and risk modelling for the proposed Energy from Waste (EFW) facility. Nicole provided support with the development, review, and compilation of human and ecological toxicological profiles for numerous chemicals including criteria air contaminants (CAC), metals, volatile organic compounds (VOC), chlorinated monocyclic aromatics, chlorinated polycyclic aromatics, and polycyclic aromatic hydrocarbons (PAH) for the proposed EFW facility.
- Assisted in evaluating country food data and the evluation of risks from eating country foods for the English River First Nation.
- Assisted in the review of Supporting Information Document (SID) regarding the ecological exposure assessment and characterization for cobalt and selenium. Primary tasks included the critique and review of the primary studies reported in SID as well as the data used to derive predicted environmental concentrations (PECs) and Risk Quotients (RQs).
- Evaluated exposures and risks of amphibians in wetlands within the vicinity of a Smelter in British Columbia. Primary tasks included compilation of amphibian toxicity data for several metals of interest from various databases. Additionally, Nicole conducted extensive literature searches and review of aquatic toxicity endpoints for metals of interest as well as comparison of water concentrations to the available water quality guidelines protective of aquatic life.
- Conducted extensive literature searches and review of aquatic and terrestrial toxicity endpoints for the development of non-radiological interim acceptance criteria for protection of persons and the environment.
- Assisted in the development of status reports for Tier I and Tier II substances for the Great Lake Basins under the Canada-Ontario Agreement.
- Conducted extensive literature searches and review of aquatic toxicity endpoints for flame retardants for Environment Canada Comprehensive Ecological Hazard Evaluation of Four Organic Flame Retardants Subject to the Chemical Management Plan Assessment.
- Development of human health toxicological profiles for chemicals in consumer products and evaluation of safety of consumer products based on chemical ingredients.

CONFERENCE PRESENTATIONS

Thackeray, N. 2014. Assessing PAH Emissions from Residential Wood Fuel Combustion – An Unwholesome Way to Heat Your Home? Platform presentation at the Annual General Meeting of the Society of Environmental Toxicology and Chemistry, Laurentian Chapter. University of Guelph, Guelph, Ontario.

Thackeray, N., Hull, R.N., Moore, C., and Marshall, L. 2015. Evaluating Inorganic Water Quality Guidelines for Aquatic Risk Assessments – Are They Appropriate for Amphibians? SETAC-Laurentian, University of Ottawa, Ottawa, Ontario.

Thackeray, N., Woolhouse, K., Phillips, H., and Fernandes, S. 2017 An Approach to Deriving Provisional Interim Acceptance Criteria with Insufficient Available Toxicity Data. SETAC-Laurentian University of Ontario Institute of Technology, Oshawa, Ontario.

Thackeray, N., Phillips, H., Woolhouse, K., and Fernandes, S. 2018 An Approach to Scoring Toxicity Data for the Development of Wildlife TRVs. SETAC-Laurentian Queen's University. Kingston, Ontario.

WORKSHOPS

- Laurentian SETAC Short Course: Environmental Statistics - Power Analysis, Ordination and Cluster Analysis (2015)
- Laurentian SETAC Short Course: Computational Applications Using R-Studio for Biostatistics (2017)

Leah Leon, M.A.Sc.

Intermediate Risk Assessor

YEARS OF EXPERIENCE

10

EXPERTISE

Human Health Risk Assessment

Ecological Risk Assessment

Literature Review and Evaluation

Data Collection and Analysis

Project Management

EDUCATION

M.A.Sc. Chemical Engineering and Applied Chemistry
University of Toronto, 2008

B.A.Sc. (Hon.) Chemical Engineering & Applied Chemistry
University of Toronto, 2006

AFFILIATIONS

Laurentian Society of Environmental Toxicology and Chemistry

EMPLOYMENT HISTORY

2016-Present
Risk Assessor
Canada North Environmental Services
Markham, ON

2008-2015
Environmental Specialist
SENES Consultants Ltd.
(acquired by Arcadis in 2013)
Richmond Hill, ON

Leah Leon has ten years of experience in completing human health and ecological risk assessments (RAs) for contaminated residential, parkland, commerical, and industrial sites throughout Ontario and northern Canada. She has prepared pre-submission forms (PSFs), screening-level RAs, and detailed RAs. She is experienced in site characterization, selection of contaminants fo concern (COC), development of RA conceptual site models (CSMs), receptor selection and characterization, exposure estimation, hazard assessment, risk analysis, and consideration of risk management measures (RMMs) and property specific standards (PSS). In addition to completing RAs that are compliant with or in the spirit of Ontario Regulation (O.Reg.) 153/04, she has also participated in the review of PSFs and RAs on behalf of the Ontario Ministry of Environment, Conservation and Parks (MECP).

RELEVANT PROJECT EXPERIENCE

Ontario Regulation 153/04 Risk Assessment for Collingwood

Participated in the completion of an RA under O.Reg. 153/04, as amended, to support a record of site condition (RSC) for an industrial property in Collingwood, Ontario, with an industrial building, a large parking area, and a natural area. A portion of the site was deemed sensitive and thus was evaluated separately using more restrictive site condition standards.

Due Diligence Risk Assessment for Ferry Terminal in Kingston

Risk assessor with responsibility for the calculations for a Due Diligence Risk Assessment (DDRA) completed in the spirit of O.Reg. 153/04 for a Ferry Terminal in Kingston, Ontario to ensure protection of workers during construction of the terminal and workers and visitors upon completion. The assessment was completed for the land portion of the Site, as well as the aquatic environment (Cataraqui River). COC included PAHs, PHCs, VOCs, metals, and inorganics.

Due Diligence Risk Assessments for Commerical Properties in Kitchener

Risk assessor with responsibility for the calculations for a DDRA completed in the spirit of O.Reg. 153/04 for two adjacent industrial/commericial sites in Kitchener, Ontario. COCs in soil and groundwater included VOCs, PAHs, PHCs, metals, and inorganics. Measured sub-slab and soil vapour data were used when applicable to support the results of the assessment, and PSS were developed that included consideration of the RMMs.

Due Diligence Risk Assessments for Former Gas Station in Ontario

On-site and off-site (adjacent roadway) contamination is currently being investigated for a former gas station in Ontario. The DDRAs consider workers potentially exposed to BTEX and PHCs in soil and groundwater and includes consideration of vapour migration to indoor air in any future buildings.

Site Specific Risk Assessment for North Bay

An RA was completed following the methodology of O.Reg. 153/04 to support the development of the North Bay Hotel & Convention Centre in North Bay, Ontario. The assessment considered commercial use of the portion of the site, as well as continued daily recreational use of the adjacent beach area of Lake Nipissing by different age groups of people.

RELEVANT PROJECT EXPERIENCE CONTINUED

Screening Level Risk Assessments for a Series of Bus Garages in Toronto

In order to evaluate potential exposure of industrial and office workers to PHCs and BTEX from soil and groundwater while working at Toronto Transit Commission (TTC) facilities, screening level risk assessments (SLRAs) were carried out for five bus garages and maintenance facilities around the City of Toronto. Free product had been observed in some of the monitoring wells at one or more of the sites. Concentrations of volatile vapours in indoor and/or outdoor air as a result of vapour intrusion from the contaminated soil and/or groundwater were estimated using the Johnson & Ettinger model.

Risk Assessments of Contaminated Sites in Ottawa and Gatineau

Carried out a series of site-specific human health and environmental risk assessments for six National Capital Commission (NCC) properties in Ottawa and Gatineau. The assessments involved evaluation of potential exposure of members of the public and wildlife to contaminants (metals, PHCs, PAHs, BTEX) in soil and/or groundwater at the sites, with the end goal of determining whether the sites could continue to be used for recreational purposes without any risk of adverse effects.

Site-Specific Risk Assessments for Historical Lightstations in Ontario

In support of the management of contaminated sites under the Federal Contaminated Sites Action Plan (FCSAP), Leah completed site-specific risk assessments for two historical lightstations in Ontario (the Tobermory Lighthouse in Big Tub Harbour, Tobermory, and Great Duck Lighthouse on Great Duck Island in Lake Huron). Remediation of the Tobermory Lighthouse was recommended given the elevated levels of lead in soil associated with historic use of lead-based paints at the site. Further sampling was recommended at the Great Duck Lighthouse, which is an environmentally sensitive site due to the presence of coastal sand dunes, to delineate mercury contamination in soil believed to be localized to the immediate vicinity of the lighthouse.

Screening Level Risk Assessment for Trichloroethylene in Groundwater

An SLRA was completed for trichloroethylene (TCE) in groundwater at an industrial site in Fergus, Ontario. The SLRA was conducted to determine whether there are any potential risks to industrial employees as a result of exposure to TCE, primarily from inhalation of vapours migrating from the shallow, perched overburden groundwater to indoor air. The assessment also evaluated potential exposure to residents of nearby houses as a result of off-site migration of the TCE groundwater plume. Concentrations of TCE in indoor air were estimated using vapour modelling algorithms for subsurface vapour intrusion into buildings. The results were used to help inform decision making for future work at the site including the need for and locations of soil vapour gas measurements, as well as the need for obtaining measured indoor air concentrations of TCE.

Develop Environmental Quality Guidelines for PFOA

Team lead and assistant project manager for the development of environmental quality guidelines for Environment Canada for PFOA in soil, groundwater, and wildlife tissue following existing protocols of the Canadian Council of Ministers of the Environment (CCME). The first phase involved an extensive literature search to compile information on the fate, behaviour, bioaccumulation potential, levels of PFOA in the Canadian environment, and toxicity-to-aquatic and -terrestrial biota. The second phase involved a critical review of the toxicological data in order to identify data considered to be acceptable according to CCME definition for deriving the environmental quality guidelines. Lastly, the guidelines were derived and all the work was detailed in a technical report.

RELEVANT TRAINING AND WORKSHOPS

- Ontario Ministry of the Environment and Climate Change (MOECC) Training Session: Using the MOECC Modified Generic Risk Assessment (MGRA) Tool (2018).
- Laurentian SETAC Short Course: Practical Approaches of Vapour Intrusion, From Site Assessment to Risk Management (2015)
- Environment Canada Professional Development Course: Federal Contaminated Sites Action Plan (FCSAP) Ecological Risk Assessment Guidance for Federal Contaminated Sites (2015)

Nick Young, M.Eng., P.Geo., QPESA/RA *Senior Environmental Scientist*

SUMMARY OF PROFESSIONAL EXPERIENCE

2017	Senior Environmental Scientist. Cambium Inc. Oshawa, Ontario, Canada *Responsible for senior project management including budgeting and analysis, coordination of multi-disciplinary project staff and contractors, liaison with clients and regulators, ensuring compliance with federal, provincial, and municipal regulatory requirements, data analysis and interpretation, report preparation, and senior technical review.*
2015 - 2017	Senior Environmental Consultant. PGL Environmental Consultants Whitby, Ontario, Canada
2012 - 2014	Senior Consultant, Associate. Stantec Inc. Burlington / Stoney Creek, Ontario, Canada
2005 - 2012	Project Manager. Dillon Consulting Limited Cambridge / Oakville, Ontario, Canada
2004 - 2005	Sr. Environmental Scientist / Team Leader. Trow Associates Kitchener, Ontario, Canada
2001 - 2004	Project Manager. O'Connor Associates Environmental Inc. Oakville, Ontario, Canada
1998 - 2000	Environmental Geologist. DJA Environmental Consultants Inc. Oakville, Ontario, Canada
1996 - 1997	Sr. Staff Geologist. Marshall Miller & Associates Raleigh, North Carolina, United States
1993 – 1995	Staff Geologist. ENSCI Environmental Inc. Raleigh, North Carolina, United States

EDUCATION & TRAINING

2016	LEED Green Associate
2010	LEED Accredited Professional
2007	M.Eng., Civil Engineering, University of Waterloo
1993	OHSA – 40 Hour Health and Safety
1991	B.Sc. Honours Earth Science, University of Waterloo

PROJECT SUMMARY

PHASE I AND II ESAs OF DOWNSTREAM PETROLEUM FACILITIES – VARIOUS LOCATIONS IN ONTARIO

Senior Project Manager responsible for Phase I and II ESAs at Downstream Petroleum facilities in Ontario (2012 to 2017). Investigations included assessment of soil and groundwater for petroleum hydrocarbons, volatile organic compounds, polycyclic aromatic hydrocarbons, and metals & inorganics. The results were used to identify potential environmental liabilities, long-term management strategies, develop remediation programs and/or support risk assessment and identification of risk management measures.

PHASE I AND II ESAs OF AUTOMOTIVE DEALERSHIPS

Project Manager responsible for Phase I and II ESAs at numerous automotive dealerships to support transfer of ownership from the auto manufacturer to the dealer operator (2003 to 2006). Typical sources of contamination included underground storage tanks (fuelling and waste oil), waste water collection systems (oil/water separators), and in-ground hydraulic hoists. The investigations were used to support remedial excavation programs at several of the dealerships.

PHASE I AND II ESAs OF HYDRO SERVICE CENTRES AND DISTRIBUTION STATIONS

Point of Contact and Project Manager responsible for Phase I and II ESAs at numerous Hydro facilities in Ontario (2003 to 2006, and 2015). Typical sources of contamination included underground storage tanks (fuelling and waste oil), waste water collection systems (oil/water separators), storage of treated hydro poles, and storage of out of service PCB containing transformers. The investigations were used to support remedial excavation programs and due diligence risk assessments.

PHASE I AND II ESAs OF UNDEVELOPED PROPERTIES – VARIOUS LOCATIONS

Project Manager responsible for numerous Phase I and Phase II ESAs and supplementary investigations including surface soil, sediment and surface water, and groundwater sampling for petroleum hydrocarbons, volatile organic compounds, polycyclic aromatic hydrocarbons, metals, phenols, and dioxins & furans. Investigations also included assessments of historical activities and potential sources of contamination. Property types included undeveloped and vacant lands, and municipally owned lands.

PHASE II ESAs OF RAIL YARDS

Project Manager responsible for Phase II ESAs and supplemental investigations at five rail yards in eastern Ontario and four in northern Ontario (2008 to 2009). Typical sources of contamination included underground storage tanks (fuelling and waste oil), waste water collection systems (oil/water separators), transportation system maintenance activities, and fuel releases. Investigations included assessment of soil and groundwater for petroleum hydrocarbons, volatile organic compounds, polycyclic aromatic hydrocarbons, and heavy metals. The results were used to identify potential environmental liabilities and long-term management strategies.

ENVIRONMENTAL SITE REMEDIATION PROJECTS, HYDRO DISTRIBUTION STATIONS

Main point of contact and Project Manager for assessment, remediation (on-site and off-site), and management of soil and groundwater impacts related to historical operations at hydro distribution stations (2003 to 2006, and 2015). Typical sources of contamination included underground storage tanks (fuelling and waste oil), waste water collection systems (oil/water separators), storage of treated hydro poles, and storage of out of service PCB containing transformers.

ENVIRONMENTAL SITE REMEDIATION PROJECTS, DOWNSTREAM PETROLEUM FACILITIES – VARIOUS LOCATIONS IN ONTARIO

Senior Project Manager for remedial excavation programs at Downstream Petroleum facilities in Ontario (1993 to 1996). Responsibilities included senior technical review and guidance, ensuring reporting consistency, quality assurance, report review.

RISK ASSESSMENTS – VARIOUS PROPERTIES IN ONTARIO

Senior Environmental Consultant and risk assessor for regulatory (Suncor) and due diligence Risk Assessments (CTREL and Bentall-Kennedy) from 2015 to 2017. Responsibilities included coordination of multi-disciplinary project team, identification of receptors, exposure pathways, and contaminants of concern, development of risk models, report preparation, review of reports for technical quality assurance, preparing responses to MOECC comments, and liaison with client Site Remediation Advisors and MOECC staff (e.g., district engineers, Brownfield Filing & Review staff, Risk Assessment Coordinators, etc.). Regulatory Risk Assessments were completed to support RSC filing.

BROWNFIELD RISK ASSESSMENT, CAMBRIDGE, ONTARIO

Project Lead responsible for site assessment and risk assessment at a former manufacturing site to evaluate human health and ecological risks associated with historical operation of a former knitting mill. Risk assessment was used to support filing a Record of Site Condition to allow redevelopment for multi-tenant residential use.

PUBLIC PARK RISK ASSESSMENT, HAMILTON, ONTARIO

Project coordinator and QPESA responsible for evaluation of human health and ecological risks associated with historical operation auto fuelling and repair facilities, fill placement, and an offsite wool dying facility. The risk assessment was used to support filing a Record of Site Condition for the property.

RISK ASSESSMENT FOR UNDEVELOPED PROPERTY, FORT ERIE, ONTARIO

Project lead on human health and ecological risk assessment for a property that included provincially significant wetland and a former municipal landfill. The objective of the project was to obtain regulatory acknowledgment of the risk assessment prior to transfer of the property from the current owner back to the previous owner.

SCREENING LEVEL RISK ASSESSMENTS, RAIL YARDS, VARIOUS, NORTHERN ONTARIO

Project Manager and senior reviewer for screening level assessment of human health and ecological risks related to historical activities at rail yards in Mactier, Sudbury, Agincourt, and Selim, Ontario.

BROWNFIELD RISK ASSESSMENT, CAMBRIDGE, ONTARIO

Project Manager and QP_{RA} for the redevelopment of a light industrial property with soil and groundwater contamination. Soil contamination was excavated prior to completion of a risk assessment. Groundwater contamination originated from two up-gradient properties. Coordinated review and acceptance of an affidavit by the Municipality of Waterloo to allow holding provisions on the property to be lifted, and redevelopment as a commercial property prior to filing a Record of Site Condition. Managed submission of the risk assessment and responses to Ministry comments.

PEER AND TECHNICAL REVIEW

Senior technical reviewer for hundreds of Phase I and II ESAs, remediation, and risk assessment reports in the past 15 years for a variety of sites including Downstream Petroleum facilities, redevelopment properties, vacant lands, landfills, and provincially significant wetlands.

Senior Peer Reviewer for projects to support land conveyances (and RSC filing) from private properties to the City of Toronto.

BERNIE TAYLOR, P.ENG.

Project Manager

Mr. Taylor holds a Bachelor of Engineering degree from Dalhousie University and a Master of Environmental Studies degree from York University. Mr. Taylor is a licensed Professional Engineer (P.Eng.) with Professional Engineers Ontario (PEO) and is a Qualified Person (QP_{ESA}) for Environmental Site Assessments under the Environmental Protection Act. He has over 10 years of employment experience in the environmental field, working throughout Ontario.

SUMMARY OF PROFESSIONAL EXPERIENCE

2014 - Present — Project Manager. Cambium Inc.
Peterborough, Ontario, Canada

Provide technical support and coordination for environmental site assessments (ESAs), contaminant remediation, and hydrogeological and wastewater assessments. Mr. Taylor has extensive experience with proposal and report preparation including data compilation, interpretation, and review of final reports.

2014 — Project Engineer. The Greer Galloway Group
Peterborough, Ontario, Canada

Coordinated environmental projects including landfill monitoring, contaminated site work, and permit applications. Consulted with regulatory agencies to obtain environmental permits for infrastructure projects (road rehabilitation, culvert replacements, etc.), and provided contract administration and supervision for these projects.

2012 - 2014 — Project Engineer. AiMS Environmental
Markham, Ontario, Canada

Conducted ESAs for manufacturing facilities, gas stations, repair shops and dry cleaners. Mr. Taylor provided peer review of environmental work conducted by others, successfully filed numerous Ministry of Environment approved Record of Site Conditions (RSCs), and worked with contractors to remediate contaminated sites.

2009 - 2012 — Environmental Planner. City of Toronto, Forestry Department
Toronto, Ontario, Canada

Implemented and managed multi-stakeholder brownfield restoration projects. Mr. Taylor coordinated consultants performing ecological and environmental studies, negotiated capital project funding commitments from external municipal departments, and coordinated public consultation meetings with diverse stakeholder groups.

2002 - 2006 — Engineer in Training. WESA
Kingston, Ontario

Worked on a broad range of environmental projects, including ESAs, groundwater characterization studies for mining sites, contaminated site remediation, groundwater supply assessment for land severance and development, drinking water treatment evaluations, designated substance surveys and permit applications related to waste management, biosolid spreading and water.

PROFESSIONAL ASSOCIATIONS

- Licenced Member, Professional Engineers Ontario

EDUCATION & TRAINING

Education

2009	Master in Environmental Studies. York University.
2002	B.Eng. (Environmental Engineering). Dalhousie University.

Courses

2017	Smart Remediation Conference, Toronto, Ontario
2015	Smart Remediation Conference, Toronto, Ontario
2013, 2015	Brownfields Remediation Seminar, Toronto, Ontario
2011	Hands-on HEC-HMS (Hydrologic Modeling System), Toronto, Ontario
2008	GIS for Planning and Resource Management. York University, Toronto, Ontario
2006	Stormwater Modelling with SWMM and PCSWMM, Mississauga, Ontario
2005	Stormwater Management and Advancement Treatment and Design, Kingston, Ontario
2004	Small Landfill Operators Course, Kingston, Ontario
2003	Operation of Small Drinking Water Systems, Kingston, Ontario

SELECTED EXPERIENCE

ENVIRONMENTAL SITE ASSESSMENTS

Mr. Taylor has completed hundreds of Environmental Site Assessments on brownfield sites, existing commercial and industrial properties, and vacant lands. Various assessments included the removal of fuel storage tanks, contaminant delineation and remediation, risk assessment, and submission of a Record of Site Condition (RSC). Contaminants of concern have included petroleum hydrocarbons, chlorinated solvents, volatile and semi-volatile organic compounds, polycyclic aromatic hydrocarbons and metals.

CONTAMINATED SITE REMEDIATION

Projects included the remediation of 200 tonnes of contaminated soil caused by a perforated heating oil underground storage tank (UST) at an apartment complex in Toronto. Work included: coordinating an age-dating investigation to determine approximately when the fuel leak began, delineation of onsite contamination via borehole and monitoring well installation, supervising excavation of impacted soil from both inside and outside the building, supervision of building underpinning installation, and performing confirmation testing as per O.Reg. 153/04.

RECORD OF SITE CONDITION

Submitted RSC applications for residential development sites in the Greater Toronto Area. Mr. Taylor designed Phase One and One ESA work plans, conducted field work and/or coordinated field staff for the collection of soil and groundwater samples, complied RSC reports and application packages, and consulted with the Ministry to ensure successful permit applications.

MUNICIPAL INFRASTRUCTURE PROJECTS

Provided contract administration for road rehabilitation and culvert installation projects for several municipalities, which included contractor liaison, field supervision, and preparation of payment certificates. Mr. Taylor also inspected culverts and storm and sanitary sewers, and assisted with the preparation of detail design drawings. For bridge and culvert work, Mr. Taylor consulted with regulatory agencies (DFO, MOE, MNR, Transport Canada and Conservation Authority) to obtain environmental permits.

ECOLOGICAL RESTORATION

Worked as part of a team to implement and manage urban ecological restoration projects, including a large wetland and bird meadow project in the Don River valley. Mr. Taylor coordinated consultants performing environmental and ecological studies (including surveys for birds, flora, and other fauna), and coordinated site design revisions based on consultations with stakeholder groups such as the Conservation Authority.

GROUND WATER CHARACTERIZATION (MINING)

Worked with senior staff on groundwater and surface water characterization studies for mining sites near Sudbury and Thunderbay. Produced hydrographs, stratigraphy cross-sections and potentiometric maps, and interpreted analytical data. Conducted hydraulic testing in the field, interpreted hydrogeological data using AquiferTest software; and field supervised packer testing and down-hole camera inspections.

DRINKING WATER TREATMENT EVALUATIONS

Mr. Taylor performed drinking water evaluations for several municipalities and retirement homes in accordance with O. Reg. 170/03 to ensure that facilities were supplying safe drinking water. The evaluations included: water supply testing, identification of treatment deficiencies, conceptual treatment design, and coordination with water treatment subcontractor to ensure that compliant systems were installed as designed.

WATER SUPPLY AND SEPTIC ASSESSMENT

Assessed groundwater supply for land severance and development purposes by performing pump tests and collecting samples of water supply wells. Where water yield was insufficient in comparison with Ministry guidelines, Mr. Taylor supervised hydraulic fracturing of water supply wells. Mr. Taylor also assessed soil conditions for residential septic effluent, which included collecting soil samples for percolation tests.

WASTE MANAGEMENT

Prepared annual reports for municipal landfills, which included an assessment of surface water and ground water analytical data to characterize potential contaminant plumes, and a review of operational requirements (signage, waste cover, site access, etc.). Mr. Taylor also established a waste transfer station at a closed landfill, and worked as part of a team to perform a recycling audit as part of a waste reclamation program.

BIOSOLID SPREADING

Assessed the suitability of numerous agriculture areas for the application of a compost mixture from a cardboard paper mill, as per Ministry guidelines. Mr. Taylor conducted fieldwork to determine soil nutrient content, produced maps showing areas of permitted biosolid spreading, prepared permit applications, and worked with Ministry to obtain Certificate of Approval.

NATALIE WRIGHT, P.Eng., PMP

Project Coordinator

Ms. Wright holds a Bachelor of Engineering degree from Western University and a Post-Graduate Certificate in Environmental Engineering Applications from Conestoga College. Ms. Wright is a licensed Professional Engineer (P.Eng.) with Professional Engineers Ontario (PEO) and is certified as a Project Management Professional (PMP) with the Project Management Institute. Ms. Wright's professional experience includes 5 years in the environmental consulting industry, during which time she has developed extensive experience completing Phase I and II Environmental Site Assessments, Spill and Contaminated Site Remediation projects and monitoring of Brownfield sites.

SUMMARY OF PROFESSIONAL EXPERIENCE

2015 - Present

Project Coordinator. Cambium Inc.

Barrie, Ontario, Canada

Ms. Wright's responsibilities include the coordination and management of projects related to brownfield redevelopment, environmental site assessments, and soil and groundwater remediation. Ms. Wright has extensive experience with proposal and report preparation including data compilation, interpretation, and completion of final reports.

2013 - 2015

Environmental Scientist. MTE Consultants Inc.

Kitchener, Ontario, Canada

Completed environmental site assessments for various industrial, commercial, and residential properties and for future filing for Records of Site Condition. Responsibilities included conducting detailed site inspections, designing work plans for field activities, soil/groundwater sampling, surveying, data collection and completion of final reports.

2011

Water Resources Intern. Water Resources Commission

Bolgatanga, Upper East Region, Ghana

Conducted field visits and met with community members and government representatives to assess the progress of pilot projects in rainwater harvesting, environmental restoration, and climate change adaptation.

2008-2011

Project Manager. Teva Canada Limited

Toronto, Ontario, Canada

Led the successful launch of products in 10 European countries ensuring all country-specific regulatory, quality and design requirements were met. Designed detailed phase-in plans to complete a successful company name change preventing product supply and service interruptions.

EDUCATION & TRAINING

2015	Workplace Hazardous Materials Information System (WHIMIS)
2014	Standard First Aid and CPR/AED
2013	Hazardous Waste Operations and Emergency Response (HAZWOPER)
2013	Environmental Engineering Applications Post-Graduate Co-op Certificate. Conestoga College Cambridge, Ontario, Canada
2010	Project Management Professional Certification. Project Management Institute Toronto, Ontario, Canada
2004	Bachelor of Engineering Science, Chemical Engineering. Western University London, Ontario, Canada

SELECTED EXPERIENCE

RISK MANAGEMENT MONITORING AND ENVIRONMENTAL PROTECTION – ORILLIA, ONTARIO

Annual assessment of on- and off-site groundwater, surface water and sediment sampling, soil vapour sampling, in addition to an ecological assessment of plants, the aquatic community, and wildlife. Environmental services are conducted as per the Certificate of Property Use (CPU) and the Risk Management Measures developed for the site.

Once approved for development, the City moved forward to prepare the site as home for their future Recreation Centre. Cambium continues to work on the project as an environmental consultant for the use and management of this brownfield site. Activities coordinated or completed by Ms. Wright include dewatering treatment system sampling, construction air monitoring, soil and water sampling, risk management measures oversight, soil management, etc.

FORMER BULK FUEL PLAN AND RETAIL SERVICE STATION, PHASE ONE AND PHASE TWO ESA AND RSC – PETERBOROUGH, ONTARIO

Phase One and Phase Two ESA conducted at a former bulk fuel plant and retail service station site to summarize existing conditions, including the delineation of soil and groundwater impacts (PHCs, PAHs and metals), for the purpose of filing an RSC.

RECORD OF SITE CONDITION (RSC)

Successful filing and acceptance by the MECP of RSCs for numerous sites of varying complexity throughout the GTA, including the required framework for completion of Risk Assessments. Ms. Wright designed Phase One and Two Environmental Site Assessment (ESA) work plans, conducted fieldwork and/or coordinated field staff for the collection of soil and groundwater samples, completed Phase One and Two ESA reports in accordance with O.Reg. 153/04, and corresponded with the MECP on the filing and review process.

LIMITED PHASE II ESA AND REMEDIATION OF HEATING TANK SPILL – TINY, ONTARIO

A limited Phase II ESA conducted determined the presence of environmental impacts resulting from an oil spill at a residential property. Scope consisted of a soil investigation conducted by use of a hand auger, and advancing up to 7 boreholes in the vicinity of the suspected spills. Contaminants of concern included petroleum hydrocarbons (PHC) fractions 1 through 4 (F1-F4), and benzene, toluene, ethylbenzene, and xylenes (BTEX). Cambium completed confirmatory soil and groundwater sampling following the excavation of impacted soils located beneath the basement floor, in addition to a temporary monitoring well. The remediation was successful with no significant environmental liability in soil or groundwater.

PHASE II ESA AND REMEDIATION OF PHC IMPACTS AT TWO ADJACENT PROPERTIES – BRADFORD, ONTARIO

Completion of a Phase II ESA at a commercial property which identified potential on-site sources of contamination relating to current and former operations of a repair garage which included 2 exterior storage tanks and a former building of unknown use. Subsequent removal of petroleum hydrocarbon impacted soil and the completion of a Verification Soil Sampling program within the excavation. The petroleum-related impacts identified in soil as part of the Phase II ESA were removed where practically feasible, and additional recommendations were provided to the client going forward.

APPENDIX D

MANDATORY CERTIFICATIONS

APPENDIX D: MANDATORY CERTIFICATIONS

5 (1) Qualified Person's Certification

1. I have conducted or supervised a risk assessment report in accordance with the regulation.
2. I am a qualified person, as defined in section 168.1 of the Act, and have the qualifications required by section 6 of the regulation.
3. I have in place an insurance policy that satisfies the requirements of section 7 of the regulation.
4. The risk assessment team included members with expertise in all of the disciplines required to complete the risk assessment in accordance with the regulation.
5. The opinions expressed in the risk assessment are engineering or scientific opinions made in accordance with generally accepted principles and practices as recognized by members of the environmental engineering or science profession or discipline practising at the same time and in the same or similar location.
6. To the best of my knowledge, the certifications and statements in this risk assessment are true as of September 7, 2021.
7. By making these certifications in this risk assessment report, I make no express or implied warranties or guarantees.

5 (2) Risk Assessment Property Certification

1. As of September 7, 2021, it is my opinion that based on the phase one environmental site assessment and the phase two environmental site assessment and other relevant property information, the approach taken in the conduct of the risk assessment,
   i. is appropriate to evaluate human health and ecological risks from the contaminants of concern at the concentrations proposed as the standards specified in the risk assessment and assuming no measures have been taken at the RA property which have the effect of reducing the risk from the contaminants, and
   ii. is consistent with the approach set out in the pre-submission form with the exception of those deviations listed in Report Section 1 (Summary of Recommendations/Findings) of the report under the heading "Deviations from Pre-Submission Form".
2. As of September 7, 2021, it is my opinion that, taking into consideration the assumptions specified in the risk assessment report, including the use of the property specified in Report Section 3 (Property Information, Site Plan and Geological Interpretation) of the risk assessment, and any risk management measures recommended in the report, as long as the RA property satisfies those assumptions and meets the standards specified in the risk

assessment report, the contaminants of concern are unlikely to pose a human health or ecological risk greater than the level of risk that was intended in the development of the applicable full-depth site condition standards for those contaminants.

3. As of September 7, 2021, it is my opinion that the implementation of the risk management plan described in Report Section 7 (Risk Management Plan) of the risk assessment report is necessary for a contaminant of concern addressed in the risk assessment report to prevent, eliminate or ameliorate any adverse effect from that contaminant to the human or ecological receptors addressed in the report and located on the RA property and is sufficient to address the current and potential future transport and exposure pathways.
4. As of September 7, 2021, the risk assessment report completely and accurately reflects the risk assessment assumptions and conclusions and all pertinent information has been included in the report and the appendices to the report.

As of the submission date, it is my opinion that, taking into consideration the assumptions specified in the risk assessment report including any risk management measures recommended in the report, as long as the RA property satisfies those assumptions and meets the standards specified in the report, the applicable full depth site condition standards will likely be met at the nearest off-site ecological and human receptors identified in the report.

Signed:

Date:

September 7, 2021

Stacey Fernandes, M.A.Sc., P.Eng., QPRA
CanNorth

APPENDIX E

LIST OF DOCUMENTS RELIED UPON FOR RISK ASSESSMENT

APPENDIX E: LIST OF DOCUMENTS RELIED UPON IN RISK ASSESSMENT

Cambium. 2018. Phase One Environmental Site Assessment, 420 Bayshore Drive, Midland, Ontario. Cambium Inc. August 31, 2018.

Cambium 2019. Phase Two Conceptual Site Model - Midland Bay Landing, 420 Bayshore Drive, Midland, Ontario.

Cambium. 2019. Phase Two Environmental Site Assessment - Midland Bay Landing, 420 Bayshore Drive, Midland, Ontario.

Stantec. 2014. Supplemental Phase Two Environmental Site Assessment, 288 and 420 Bayshore Drive, Midland, Ontario. Stantec Consulting Ltd. July 15, 2014.

APPENDIX F

SUMMARY OF ENVIRONMENTAL INVESTIGATIONS (Submitted Separately)

APPENDIX F: SUMMARY OF ENVIRONMENTAL INVESTIGATIONS

This appendix provides summaries of the Phase One Environmental Site Assessment (ESA) and the Phase Two ESA relied upon for the current Risk Assessment (RA) followed by the complete documents that contain the detailed information.

Summary of Phase One ESA

Phase One Environmental Site Assessment – Midland Bay Landing: 420 Bayshore Drive, Midland, Ontario. Prepared by Cambium Inc., prepared for the Town of Midland. April 1, 2019.

A Phase One Environmental Site Assessment (ESA) was undertaken for the property at 420 Bayshore Drive in Midland, Ontario (Cambium 2019a). The Phase One ESA was completed to meet the requirements of Ontario Regulation 153/04.

The Site is on the north side of Bayshore Drive and extends from William Street to Queen Street in Midland, Ontario in the County of Simcoe. The Site was historically three separate municipal addresses 288 Bayshore Drive (east parcel) and 420 Bayshore Drive (west parcel), each with a property identifier number (PIN), and 475 Bayshore Drive (south parcel) that was included in the PINs for the other two parcels. The parcels were combined under a single PIN in 2015. The Phase One ESA records review was completed for all three municipal addresses. The QP_{ESA} considered the area within 250 m from the property boundary sufficient to identify areas of potential concern at the site.

A records review was completed including fire insurance plans, chain of titles, environmental reports, city directories, Ecolog ERIS data, Brownfields Environmental Site Registry as well as others. Interviews and site reconnaissance were also undertaken.

Review of fire insurance plans indicated that the Site was developed for industrial use prior to 1911. With the exception of a marine rail system and small shed housing the motor and pulley located within a chain-link fenced enclosure on the central portion of the Site all other historical structures had been removed.

The Phase One ESA identified 25 PCAs (14 on-site and 11 off-site) within the Phase One Study Area. The on-site PCAs and six off-site PCAs contributed to APECs at the Site. The list of PCAs and APECs are included below. The related contaminants of potential environmental concern were benzene, toluene, ethylbenzene, xylenes, petroleum hydrocarbons, volatile organic compounds, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, metals, electrical conductivity, and sodium adsorption ratio. Potentially contaminated media was soil, sediment, and groundwater.

	Potentially Contaminating Activity (PCA)	Location of PCA	PCA Description	Contaminants of Potential Environmental Concern	APEC (Yes/No)
1	PCA #46 - Rail Yards, Tracks and Spurs	Rail sidings traversing the Site from east to west; Grand Trunk Railway main line and spur lines along the south side of the Site	On-site rail lines, spurs, and sidings	PHCs, PAHs, Metals	Yes
2	Unidentified PCA	Playfair Coal Dock present on the eastern portion of the Site	On-site storage of coal	PAHs, Metals	Yes
3	PCA #55 - Transformer Manufacturing, Processing and Use	Transformer house along the east side of Area 2	On-site transformer use – east portion of 288 Bayshore Drive	PCBs	Yes
4	PCA #28 - Gasoline and Associated Products Storage in Fixed Tanks	Gasoline UST north of the sawmill/joiner shop building in Area 1	On-site storage of gasoline in a UST to north of sawmill/joiner shop building	BTEX, PHCs, Metals	Yes
5	PCA #28 - Gasoline and Associated Products Storage in Fixed Tanks	Fuel oil USTs south of the sawmill/joiner shop building in Area 1	On-site storage of fuel oil in USTs to the south of the sawmill/joiner shop building	BTEX, PHCs	Yes
6	PCA #28 - Gasoline and Associated Products Storage in Fixed Tanks	Fuel oil USTs east of the furnace shop building in Area 1	On-site storage of fuel oil in USTs to the east of the former furnace shop building	BTEX, PHCs	Yes
7	PCA #44 - Port Activities, including Operation and Maintenance of Wharves and Docks	On-site along the west side of the SIte	On-site port activities related to off-loading of coal and Unimin aggregates	PHCs, PAHs, metals	Yes
8	PCA #39 - Paints Manufacturing, Processing and Bulk Storage	Paint shop building along the north side of Area 1	On-site painting activities	VOCs, Metals	Yes
9	PCA #34 - Metal Fabrication	Punch/machine shop building in the central portion of Area 1	On-site machine shop activities	VOCs, Metals	Yes
10	PCA #33 - Metal Treatment, Coating, Plating and Finishing	Furnace shop building in the southwest corner of Area 1	On-site furnace/smithing shop activities	Metals	Yes
11	PCA #28 - Gasoline and Associated Products Storage in Fixed Tanks	Oil House on west side of Area 1	On-site oil house	BTEX, PHCs, Metals	Yes
12	PCA #7 - Boat Manufacturing	Off-site adjacent to the west	Industrial activities at the Midland Boat Works to the west	VOCs, PHCs, Metals	Yes
13	PCA #34 - Metal Fabrication	Off-site to the south	Industrial activities at the Midland Engine Works and Manton Foundry (machine shop) to the south	VOCs, PHCs, Metals	Yes
14	PCA #30 - Importation of Fill Material of Unknown Quality	Across the entire Site	Importation of fill material of unknown quality to the Site	PHCs, PAHs, Metals	Yes
15	PCA #55 - Transformer Manufacturing, Processing and Use	Northeast corner of Area 1	On-site storage of PCBs – northeast corner of 420 Bayshore Drive (Area 1)	PCBs	Yes
16	PCA #58 - Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners	Off-site to the southeast	Waste management activities at 200 Bay Street	N/A	No
17	PCA #27 - Garages and Maintenance and Repair of Railcars, Marine Vehicles and Aviation Vehicles	Off-site adjacent to the west	Repair of marine vehicles at 171 Midland Avenue	VOCs, PHCs, Metals	Yes
18	PCA #44 - Port Activities, including Operation and Maintenance of Wharves and Docks	Off-site adjacent to the west	Port activities at 171 Midland Avenue	PHCs, PAHs	Yes
19	PCA #28 - Gasoline and Associated Products Storage in Fixed Tanks	Off-site adjacent to the west	Storage of fuel in fixed tanks at 171 Midland Avenue	BTEX, PHCs, Metals	Yes
20	PCA #28 - Gasoline and Associated Products Storage in Fixed Tanks	Off-site to the southwest	Storage of fuel in fixed tanks at 475 Bay Street	N/A	No
21	PCA #52 - Storage, maintenance, fuelling and repair of equipment, vehicles, and material used to maintain transportation systems	Off-site to the southwest	Operation of transportation systems at 475 Bay Street	N/A	No
22	Unidentified PCA	Off-site to the southwest	Fuel release at 202 King Street	N/A	No
23	PCA #44 - Port Activities, including Operation and Maintenance of Wharves and Docks	Off-site to the west	Presence of contaminated sediment at Midland Public Harbour	N/A	No
24	PCA #55 - Transformer Manufacturing, Processing and Use	On-site transformer use within and south of Unimin main building (Area 1)	On-site transformer use – within and south of the main Unimin building	PCBs	Yes
25	PCA #52 - Storage, maintenance, fuelling and repair of equipment, vehicles, and material used to maintain transportation systems	On-site within the Marine Railway Enclosure	Operation of transportation systems and fuelling within the Marine Railway enclosure	BTEX, PHCs, Metals	Yes

Area of Potential Environmental Concern[1]	Location of Area of Potential Environmental Concern on the Phase One Property	Potentially Contaminating Activity[2]	Location of PCA (on-site or off-site)	Contaminants of Potential Concern[3]	Media Potentially Impacted (Groundwater, soil, and/or sediment)
APEC A	Footprint of the Site	46. Rail Yards, Tracks and Spurs	on-site	PHCs, PAHs, Metals	Soil & Groundwater
APEC B	Area 2	Unidentified PCA (coal storage)	on-site	PAHs, Metals	Soil
APEC C	Footprint of transformer house along the east side of Area 2	55. Transformer Manufacturing, Processing and Use	on-site	PCBs	Soil
APEC D	Footprint of gasoline UST north of the sawmill/joiner shop building in Area 1	28. Gasoline and Associated Products Storage in Fixed Tanks	on-site	BTEX, PHCs, Metals	Soil & Groundwater
APEC E	Footprint of fuel oil USTs south of the sawmill/joiner shop building in Area 1	28. Gasoline and Associated Products Storage in Fixed Tanks	on-site	BTEX, PHCs	Soil & Groundwater
APEC F	Footprint of fuel oil USTs east of the furnace shop building in Area 1	28. Gasoline and Associated Products Storage in Fixed Tanks	on-site	BTEX, PHCs	Soil & Groundwater
APEC G	Water Lot portion of Site at docks. Northwest and southwest corners of Area 1; northwest corner of Area 2.	44. Port Activities, including Operation and Maintenance of Wharves and Docks	on-site	PHCs, PAHs, Metals	Surface Water & Sediment
APEC H	Footprint of paint shop building along the north side of Area 1	39. Paints Manufacturing, Processing and Bulk Storage	on-site	VOCs, Metals	Soil & Groundwater
APEC I	Footprint of punch/machine shop building in the central portion of Area 1	34. Metal Fabrication	on-site	VOCs, Metals	Soil & Groundwater
APEC J	Footprint of furnace shop building in the southwest corner of Area 1	33. Metal Treatment, Coating, Plating and Finishing	on-site	Metals	Soil
APEC K	West property boundary	7. Boat Manufacturing	off-site adjacent to the west	VOCs, PHCs, Metals	Groundwater
APEC L	South property boundary	27. Garages and Maintenance and Repair of Railcars, Marine Vehicles and Aviation Vehicles 34. Metal Fabrication	off-site to the south	VOCs, PHCs, Metals	Groundwater
APEC M	PCB Storage Area in northeast corner of Area 1	55. Transformer Manufacturing, Processing and Use	on-site	PCBs	Soil
APEC N	Footprint of the Site	30. Importation of Fill Material of Unknown Quality	on-site	PHCs, PAHs, Metals	Soil
APEC O	Transkformers within and south of main Unimin building	55. Transformer Manufacturing, Processing and Use	on-site	PCBs	Soil
APEC P	Northwest property boundary	44. Port Activities, including Operation and Maintenance of Wharves and Docks	off-site adjacent to the west	PHCs, PAHs, Metals	Surface Water & Sediment
APEC Q	Southwest property boundary	28. Gasoline and Associated Products Storage in Fixed Tanks	off-site adjacent to the west	BTEX, PHCs, Metals	Groundwater
APEC R	West side of marine rail system enclosure	52. Storage, maintenance, fuelling and repair of equipment, vehicles, and material used to maintain transportation systems	on-site	BTEX, PHCs, Metals	Soil & Groundwater
APEC S	Footprint of Oil House building	28. Gasoline and Associated Products Storage in Fixed Tanks	on-site	BTEX, PHCs, Metals	Soil & Groundwater

Notes:

1. Area of Potential Environmental Concern means the area on, in or under a phase one property where one or more contaminants are potentially present, as determined through the phase one environmental site assessment
2. Potentially Contaminating Activity means a use or activity set out in Column A of Table 2 of Schedule D that is occurring or has occurred in a phase one study area
3. Method groups as defined in Protocol for in the Assessment of Properties under Part XV.1 of the Environmental Protection Act, March 9, 2004, amended as of July 1, 2011
4. When submitting a record of site condition for filing, a copy of this table must be attached

Based on the observations and information obtained for the site during the Phase One ESA, a Phase Two ESA is required to support filing an RSC.

Summary of Phase Two ESA

Phase Two Environmental Site Assessment – Midland Bay Landing 420 Bayshore Drive, Midland, Ontario. Prepared by Cambium Inc. on behalf of Town of Midland. November 20, 2020 – rev March 2021

A Phase Two Environmental Site Assessment (ESA) was conducted for the property at 420 Bayshore Drive in Midland, Ontario (Cambium 2019b). The Phase Two ESA was completed to meet the requirements of Ontario Regulation 153/04.

The roughly 14.6 ha Site is on the north site of Bayshore Drive and extends from William Street to Queen Street in Midland, Ontario.

Site Identification Information

Municipal Address	420 Bayshore Drive, Ontario
Historical Land Use	Mixed industrial and parkland
Current Land Use	Vacant former industrial and parkland
Future Land Use	Mixed commercial and residential/parkland
PIN	58452-0553 (LT)
Roll No.	437402000227500
Universal Transverse Mercator Coordinates*	Zone 17T 588386 m E, 4956586 m N
Legal Description	**420 Bayshore Drive – PIN 58452-0553 (LT)** Part Lots 107 & 108, Part Lots 1 to 12 N/S Frank Street, Part Charles Street, Part George Street & Part Lindsay Street Plan 349; Part Charles Street, Part George Street & Part Lindsay Street, Closed North of CNR Plan 724 Being Part 1 51R40291; Town of Midland.
Site Area	≈14.6 ha (36 acres)

* The Universal Transverse Mercator measurements were obtained from Google Earth Pro.

Justification for the sampling program used in undertaking the phase two environmental site assessment

The Phase One ESA identified 25 potentially contaminating activities (PCAs) within the Phase One Study Area. These PCAs contributed to 20 areas of potential environmental concern (APECs).

To investigate the APECs, the following investigations were completed:

- Excavated 52 test pits to depths ranging from 0.6 m to 5.2 mbgs and collected 24 surface soil samples

- Advanced 101 boreholes, to depths ranging from 1.5 m to 21.8 mbgs, with 39 monitoring wells

- Collected sediment and surface water samples along three transects adjacent to the Site and at one reference transect

- Submitted soil, groundwater, sediment, and surface water samples for analysis of various contaminants of potential concern, pH, and grain size

The sampling programs were prepared and executed based on the findings of previous investigations conducted on the RA Property and the Phase One ESA. Sampling locations were selected to assess for potential impacts related to APECs, previous activities, and to define the extent and magnitude of identified impacts.

After completion of the Phase One ESA and the development of the initial sampling plan it was decided that the water lots would be excluded from the risk assessment property. As such, the Phase Two property boundary was changed to exclude the water lots. As such APECs G and P were removed from the Phase Two CSM. The associated PCA #7 was changed to not contributing to an APEC since it applied to an APEC that was not on the Phase Two property.

The Phase Two ESA identified the following:

- PHC impacts were present in soil and groundwater. Soil impacts extended across the entire Site, and groundwater impacts were localized along the west side of the Site, extending to the west property boundary.
- BTEX impacts extended across the entire Site. There were no BTEX impacts in groundwater.
- VOC impacts (TCE) were present in soil and groundwater and were localized to a small area on the west portion of the Site.
- PAH impacts were present in soil and extended across the eastern half of the Site. There were no PAH impacts in groundwater.
- Metal impacts were present in soil and extended across a large portion of the Site. There were no metals impacts in groundwater.

Summary of quality assurance and quality controls used for the sampling program and analysis of the samples

The sampling programs were conducted by trained personnel following industry standard soil and groundwater sampling protocols and using appropriate sampling equipment. The Phase Two ESA was subject to a Quality Assurance/Quality Control (QA/QC) program, including blind duplicate soil and groundwater samples and trip blanks as outlined in the

Sampling and Analysis Plan (SAP) in Appendix C of the Phase Two ESA. A minimum rate of one duplicate sample for every 10 samples submitted was collected. Blind duplicate samples were collected at the same time as the original sample and placed into a separate container. All equipment and tools used to obtain soil samples was cleaned with Alconox and distilled water before the collection of each sample. Technicians wore dedicated nitrile gloves which were replaced between samples. Cambium coordinated and supervised all subcontractors and sub-consultants required to complete the Phase Two ESA, including utility locators and a licensed well drilling contractor.

Maxxam was used as the analytical laboratory, Maxxam is accredited by the Canadian Association of Laboratory Accreditation Inc. (CALA). The assessment of the trip and field blank water samples showed that samples collected during the sampling events were not biased by cross-contamination during handling and transport to the receiving laboratory. The laboratory QA/QC results were reported in the Certificates of Analysis, including laboratory blank data (spiked and method), laboratory duplicate data, and laboratory surrogate, matrix spike, and check recovery data.

Assessment of whether the sampling program is sufficient for the purposes of the risk assessment

The overall assessment indicates that the soil and groundwater samples were collected generally with an acceptable level of precision, and the data is of acceptable quality for meeting the objectives of the RA. Based on the results of the data quality assessment and validation, the analytical data are suitable for use in the RA.

Rationale for and description of any hydrogeological and geological interpretations which differ from assumptions on which the Soil, Ground Water and Sediment Standards are based

Intended Property-Use	The proposed future use of the Site is mixed commercial, residential and parkland. Therefore, the applicable land use category is residential/parkland/institutional (RPI).
Soil Characteristics	Investigations completed at the Site have identified a complex overburden stratigraphic profile that includes fill (crushed rock, and silty sand and sand with variable gravel content, and cobble and boulders), discontinuous localized peat and organic silt layers, clay, till (sand and sand and gravel), sand, and sand and gravel. Based on grain size distribution testing completed by Pinchin (2014), Stantec (Stantec 2014), and PML (2017) coarse-textured soil was considered applicable since the unconfined aquifer at the Site is present within both the fine and coarse-textured soil.
Environmentally Sensitive Areas	Areas of Natural and Scientific Interest - Based on a site sensitivity search completed as per the requirements of Section 41 of O.Reg.153/04, no areas of natural

	significance as defined by the regulation, were identified on or within 30 m of the Site. Therefore, the Site was not considered an environmentally sensitive area and the generic SCS were applicable. Soil pH - Seventy-five soil samples were submitted for laboratory analysis by Pinchin (2014) and Stantec (2014) to assess soil pH at the Site. Except for one surface soil sample, soil pH results were within the allowable ranges for surface and sub-surface soil. Five additional soil samples collected by Cambium (2019b) within 2 m of the original sample, including one sample collected at the original location and depth were within the acceptable range for surface soil. Therefore, the single low pH sample result in the Pinchin/Stantec data was considered spurious and was removed from the dataset.
Proximity of Water Bodies and Shallow Bedrock	The risk assessment property is adjacent to Midland Bay to the north and is therefore considered within 30 m of a water body. The generic SCS established for properties within 30 m of a water body (i.e., Tables 8 or 9) were considered applicable for the Site. Subsurface investigations completed at the Site by PML (2017) and Cambium did not encounter bedrock to a maximum depth of about 22 mbgs. While Pinchin (2014) indicated that bedrock was encountered at depths ranging from 2.9 to 7.5 mbgs, Stantec (Stantec 2014) speculated that the inferred bedrock reported by Pinchin was refusal on boulders or cobbles. Cambium concurs with this opinion; therefore, the generic SCS established for properties with shallow soil (i.e., Tables 6 and 7) are not applicable.
Shallow Groundwater and Groundwater Use	Groundwater levels measured by Cambium in 2018 and 2019 ranged from 0.34 to 4.41 mbgs. Generally, the depth to groundwater is less than 2 mbgs except for the west side of the Site and close to the south property line on the eastern side of the Site. The shallow groundwater condition will be considered in the risk assessment and the applicable GW2 (groundwater to indoor air vapor migration pathway) criteria will be used to identify volatile parameters to be retained as COCs in the risk assessment.
Potable or Non-Potable	The Town of Midland municipal system obtains drinking water from a series of 10 operational groundwater wells. The nearest to the Site is Well #17, which is about 1,200 m west of the Site, west of Midland Bay. This well, along with five others, is within the Vinden Flume well field, which is under the direct influence of surface water sources (Midland 2017). Cambium contracted ERIS to provide a database report for the Phase One study area (ERIS 2018). The ERIS report did not identify drinking water wells on or within 250 m of the Site. A review of the mapping provided by the Source Protection Information Atlas (MOECC 2018) indicated the Site is within an area categorized as Highly Vulnerable Aquifer (score 6) and Significant Groundwater Recharge Area (score 6). In addition, land at the northwest corner of the Site is within an area mapped as Wellhead Protection Area D (score 4), which represents a 25 year travel time for groundwater migration to a well. The Town of Midland and the County of Simcoe were notified by letters dated June 15, 2018 of the intention to apply non-potable groundwater standards at the Site. Neither the Town nor the County responded with an objection within 30 days; therefore, in accordance with Section 35(3)(e), non-potable SCS are considered acceptable by both. These letters were resent on March 20, 2019 with no response received from either party.

Qualified Person Opinion

Geologic and hydrogeological parameters that influence the derivation of the O.Reg.153/04 generic SCS were compared to site-specific data and the generic values used in the derivation of the SCS. The site-specific parameters were consistent with the defaults; therefore, it was the QP’s opinion that the generic SCS were applicable.

Based on the foregoing, the Table 9: Generic Site Condition Standards for Use within 30 m of a Water Body in a Non-Potable Groundwater Condition were considered applicable.

In addition, the groundwater results were screened against the Table 7 GW2 criteria for consideration of the groundwater to indoor air pathway due to the shallow groundwater condition.

References

Cambium. 2019a. Phase One Environmental Site Assessment, 420 Bayshore Drive, Midland, Ontario. Cambium Inc. April 1, 2019.

Cambium. 2019b. Phase Two Environmental Site Assessment - Midland Bay Landing, 420 Bayshore Drive, Midland, Ontario.

ERIS. 2018. ERIS Database Report, 288 & 420 Bayshore Drive, Midland, ON. Environmental Risk Information Services. March 20, 2018.

Midland. 2017. 2017 Midland Drinking Water Annual Summary Report. Engineering/Water Watewater Services Division, Town of Midland. March 5, 2018.

MOECC. 2018. Source Protection Information Atlas. Retrieved from Ministry of the Environment and Climate Change: https://www.gisapplication.lrc.gov.on.ca/SourceWaterProtection/Index.html?viewer=SourceWaterProtection.SWPViewer&locale=en-US. August 1, 2018.

Pinchin. 2014. Phase Two Environmental Site Assessment, 288 and 420 Bayshore Drive, Midland, Ontario. Pinchin Environmental Ltd. January 2014.

PML. 2017. Preliminary Geotechnical Investigation Proposed Midland Bay Landing Residential Development Bayshore Drive, Midland, Ontario. Peto MacCallum Ltd. July 2017.

Stantec. 2014. Supplemental Phase Two Environmental Site Assessment, 288 and 420 Bayshore Drive, Midland, Ontario. Stantec Consulting Ltd. July 15.

APPENDIX G

PHASE TWO CSM (Submitted Separately)

APPENDIX H

HHRA SUPPORTING INFORMATION

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APPENDIX H: HHRA SUPPORTING INFORMATION

H.1 Sample Calculations

The exposure parameters for the equations presented in this section were obtained from the appropriate tables in the main report, as indicated in brackets below the equations.

H.1.1 Direct Contact with Soil

Direct contact with soil includes dermal contact with skin as well as ingestion, the exposures from which are summed to provide an overall risk estimate for direct contact.

H.1.1.1 Exposure from Dermal Contact with Soil

Exposures from dermal contact with soil were calculated using the following equation:

$$I_{s,d} = \frac{C_s \times SA \times (SL \times CF) \times AF_{s,d} \times EF_s \times \frac{ET_d \times ET_{wk}}{365}}{BW} \times \frac{ED}{AT} \qquad (1)$$

Where:

$I_{s,d}$	=	Intake of COC through the soil dermal contact pathway [mg/kg/d]
C_s	=	Concentration of COC in soil [mg/kg] {Table 3.10}
SA	=	Exposed skin surface area for soil contact [cm^2] {Table 4.8}
SL	=	Soil loading to exposed skin [mg/cm^2/event] {Table 4.8}
CF	=	Conversion factor [10^{-6} kg/mg]
$AF_{s,d}$	=	Dermal absorption factor from soil [-] (MOECC 2016)
EF_s	=	Exposure frequency to soil [events/d] {Table 4.8}
ET_d	=	Days per week exposed outdoors [d/wk] {Table 4.8}
ET_{wk}	=	Weeks per year exposed outdoors [wk/yr] {Table 4.8}
365	=	Total days in a year [d]
ED	=	Total exposure duration [y] {for carcinogenic COC only} {Table 4.8}
AT	=	Averaging time [y] {for carcinogenic COC only} {Table 4.8}
BW	=	Body weight [kg] {Table 4.8}

Exposure assumptions related to the resident (toddler) are applied to demonstrate this calculation. The COC selected for demonstration is antimony. As antimony is non-carcinogenic, an averaging time representative of non-carcinogenic exposure is applied. As such, the exposure parameters are as follows:

C_s = 105.6 mg/kg

SA = 1745 cm^2

SL = 0.2 mg/cm^2/event

CF = 10^{-6} kg/mg

$AF_{s,d}$ = 0.10

EF_s = 1 event/d

ET_d = 7 d/wk

ET_{wk} = 39 wk/yr

BW = 16.5 kg

$$I_{s,d} = \frac{105.6 \times 1745 \times \left(0.2 \times 10^{-6}\right) \times 0.1 \times 1 \times \frac{7 \times 39}{365}}{16.5}$$

$$I_{s,d} = 1.7E - 04\; mg/kg/d$$

H.1.1.2 Exposure from Soil Ingestion

Exposures from soil ingestion were calculated using the following equation:

$$I_{s,ing} = \frac{C_S \times IR_S \times AF_{s,o} \times \frac{ET_d \times ET_{wk}}{365}}{BW} \times \frac{ED}{AT} \qquad (2)$$

Where:

$I_{s,ing}$ = Intake of COC through the soil ingestion pathway [mg/kg/d]

C_s = Concentration of COC in soil [mg/kg] {Table 3.10}

IR_s = Soil ingestion rate [kg/d] {Table 4.8}

$AF_{s,o}$ = Oral absorption factor from soil [-] (MOECC 2016)

ET_d = Days per week exposed outdoors [d/wk] {Table 4.8}

ET_{wk} = Weeks per year exposed outdoors [wk/yr] {Table 4.8}

365 = Total days in a year [d]

ED = Total exposure duration [y] {for carcinogenic COC only} {Table 4.8}

AT = Averaging time [y] {for carcinogenic COC only} {Table 4.8}

BW = Body weight [kg] {Table 4.8}

The exposure parameters for antimony in soil for a toddler resident are as follows:

C_s = 105.6 mg/kg

IR_s = 0.0002 kg/d

$AF_{s,o}$ = 1 (MOECC 2016)

ET_d = 7 d/wk

ET_{wk} = 39 wk/yr

BW = 16.5 kg

$$I_{s,ing} = \frac{105.6 \times 0.0002 \times 1 \times \frac{7 \times 39}{365}}{16.5}$$

$$I_{s,\mathrm{ing}} = 9.6E - 04\ mg/kg/d$$

H.1.1.3 Risk from Direct Contact with Soil

The HQ from non-carcinogenic exposures from direct contact with soil is estimated as:

$$HQ_s = \frac{(I_{s,d} + I_{s,ing})}{RfD} \tag{3}$$

Where:

HQ_s = Hazard Quotient from soil direct contact contact [-]

$I_{s,d}$ = Intake of COC through the soil dermal contact pathway [mg/kg/d]

$I_{s,ing}$ = Intake of COC through the soil ingestion pathway [mg/kg/d]

RfD = Reference Dose [mg/kg/d] {Table 4.24}

For the toddler resident, the inputs to calculate the HQ from direct contact with antimony in soil are as follows:

$I_{s,d}$ = 1.7×10^{-4} mg/kg/d

$I_{s,ing}$ = 9.6×10^{-4} mg/kg/d

RfD = 4.0×10^{-4} mg/kg/d

$$HQ_s = \frac{(1.7E-04 + 9.6E-04)}{4.0E-04}$$

$$HQ_s = 2.8$$

H.1.2 Direct Contact with Groundwater

Direct contact with groundwater includes dermal contact with skin as well as ingestion, the exposures from which are summed to provide an overall risk estimate for direct contact.

H.1.2.1 Exposure from Dermal Contact with Groundwater

Exposures from dermal contact with groundwater were calculated using the following equation:

$$I_{gw,d} = \frac{DA_{gw,ev} \times SA \times EF_{gw} \times \frac{ET_d \times ET_{wk}}{365}}{BW} \times \frac{ED}{AT} \qquad (4)$$

Where:

$I_{gw,d}$	=	Intake of COC through the groundwater dermal contact pathway [mg/kg/d]
$DA_{gw,ev}$	=	Absorbed dose from groundwater dermal contact [mg/cm^2/event]
SA	=	Exposed skin surface area [cm^2] {Table 4.8}
EF_{gw}	=	Exposure frequency to groundwater [event/d] {Table 4.8}
ET_d	=	Days per week exposed outdoors [d/wk] {Table 4.8}
ET_{wk}	=	Weeks per year exposed outdoors [wk/yr] {Table 4.8}
365	=	Total days in a year [d]
ED	=	Total exposure duration [y] {for carcinogenic COC only} {Table 4.8}
AT	=	Averaging time [y] {for carcinogenic COC only} {Table 4.8}
BW	=	Body weight [kg] {Table 4.8}

The absorbed dose from groundwater dermal contact in the above equation ($DA_{gw,ev}$) is calculated based on the contact time and the time to reach steady state:

If $t_{ev} \leq t^*$
$$DA_{gw,ev} = 2 \times AF_{gw,d} \times K_p \times \frac{C_{gw}}{CF}\sqrt{6\tau\frac{t_{ev}}{\pi}} \qquad (5)$$

If $t_{ev} > t^*$
$$DA_{gw,ev} = AF_{gw,d} \times K_p \times \frac{C_{gw}}{CF}\left[\frac{t_{ev}}{1+B} + 2\tau\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right] \qquad (6)$$

Where:

t_{ev}	=	Duration of groundwater contact event [hr/event] {Table 4.8}
t^*	=	Time to reach steady state [h] {see equations 7 and 8 below}
$DA_{gw,ev}$	=	Absorbed dose from groundwater dermal contact [mg/cm^2/event]
$AF_{gw,d}$	=	Dermal absorption factor from groundwater [-] (MOECC 2016)
K_p	=	Partition coefficient [cm/h] {see equation 12 below}
C_{gw}	=	Concentration of COC in groundwater [µg/L] {Table 4.11}
CF	=	Conversion factor 10^6 [(mg/cm^3)/(µg/L)]
τ	=	Lag time [h] {see equation 13 below}
B	=	Ratio of the permeability coefficient of a compound through the stratum corneum relative to its partition coefficient across the viable epidermis {see equation 11 below}

For highly lipophilic chemicals or for chemicals that have a long lag time, some of the chemical dissolved into skin may be lost due to desquamation during that absorption period. The fraction absorbed ($AF_{gw,d}$) term has been included to account for this loss of chemical due to desquamation. The default for this parameter is 1.

The calculation of the time to reach steady state (t^*) is calculated according to the following equation:

If B ≤ 0.6: $$t^* = 2.4\tau \quad (7)$$

If B > 0.6: $$t^* = 6\tau\left(b - \sqrt{b^2 - c^2}\right) \quad (8)$$

where $$b = 2\,\frac{(1+B)^2}{\pi - c} \quad (9)$$

and $$c = \frac{1+3B+3B^2}{3(1+B)} \quad (10)$$

The ratio of the permeability of the stratum corneum to that of the epidermis (B) can be approximated by:

$$B = K_p\,\frac{\sqrt{MW}}{2.6} \quad (11)$$

An empirical predictive correlation is provided to estimate the partition coefficient (K_p) for organics:

$$logK_p = -2.80 + 0.66logK_{ow} - 0.0056MW \quad (12)$$

Where:

K_p	=	Partition coefficient [cm/h]
$logK_{ow}$	=	Log of Octanol-water partition coefficient (MOECC 2016)
MW	=	Molecular weight [g/mol] (MOECC 2016)

Assuming the thickness of the stratum corneum is 0.001 cm the following equation can be used to determine the lag time (τ):

$$\tau = 0.105 \times 10^{0.0056MW} \quad (13)$$

Exposure assumptions related to the subsurface worker are applied to demonstrate this calculation. The COC selected for demonstration is PHC F2 (Aliphatic C_{10}-C_{12}). As this COC is non-carcinogenic, an averaging time representative of non-carcinogenic exposure is applied. As such, the exposure parameters are as follows:

Equation 4:

SA = 3400 cm^2

EF_{gw} = 1 event/d

ET_d = 5 d/wk

ET_{wk} = 39 wk/yr

BW = 70.7 kg

Equations 5 through 13

t_{ev} = 1 hr/event

t^* = 3.5 h {as per equation 8 as B>0.6}

b = 9.8 {equation 9}

c = 3.7 {equation 10}

$AF_{gw,d}$ = 1

K_p = 0.74 cm/h {equation 12}

$LogK_{ow}$ = 5.4

MW = 160 g/mol

C_{gw} = 29 µg/L

τ = 0.83 h

B = 3.6 {equation 11}

For $t_{ev} \leq t^*$ $$DA_{gw,ev} = 2 \times 1 \times 0.74 \times \frac{29}{10^6}\sqrt{6 \times 0.83\frac{1}{\pi}}$$

$$DA_{gw,ev} = 5.3E-05\ \mathrm{mg/cm^2/event}$$

And $$I_{gw,d} = \frac{5.3E-05 \times 3400 \times 1 \times \frac{5 \times 39}{365}}{70.7}$$

$$I_{gw,d} = 1.4E-03\ mg/kg/d$$

H.1.2.2 Exposure from Ingestion of Groundwater

Exposures from ingestion of groundwater were calculated using the following equation:

$$I_{gw,ing} = \frac{C_{gw} \times IR_{gw} \times AF_{gw,o} \times \frac{ET_d \times ET_{wk}}{365} \times CF}{BW} \times \frac{ED}{AT} \quad (14)$$

Where:

$I_{gw,d}$	=	Intake of COC through the groundwater ingestion pathway [mg/kg/d]
C_{gw}	=	Concentration of COC in groundwater [µg/L] {Table 4.11}
IR_{gw}	=	Groundwater ingestion rate [L/d] {Table 4.8}
$AF_{gw,o}$	=	Oral absorption factor from groundwater [-] (MOECC 2016)
ET_d	=	Days per week exposed outdoors [d/wk] {Table 4.8}
ET_{wk}	=	Weeks per year exposed outdoors [wk/yr] {Table 4.8}
365	=	Total days in a year [d]
ED	=	Total exposure duration [y] {for carcinogenic COC only} {Table 4.8}
AT	=	Averaging time [y] {for carcinogenic COC only} {Table 4.8}
BW	=	Body weight [kg] {Table 4.8}
CF	=	Conversion factor 10^{-3} [mg/µg]

For exposure of a subsurface worker from incidental ingestion of non-carcinogenic PHC F2 (Aliphatic C_{10}-C_{12}) in groundwater, the exposure parameters are as follows:

C_{gw}	=	29 µg/L
IR_{gw}	=	0.1 L/d
$AF_{gw,o}$	=	1
ET_d	=	5 d/wk
ET_{wk}	=	39 wk/yr
BW	=	70.7 kg

$$I_{gw,ing} = \frac{29 \times 0.1 \times 1 \times \frac{5 \times 39}{365} \times 10^{-3}}{70.7}$$

$$I_{gw,ing} = 2.2E - 05\ mg/kg/d$$

H.1.2.3 Risk from Direct Contact with Groundwater

The HQ from non-carcinogenic exposures from direct contact with groundwater is estimated as:

$$HQ_{gw} = \frac{(I_{gw,d} + I_{gw,ing})}{RfD} \qquad (15)$$

Where:

HQ_{gw}	=	Hazard Quotient from groundwater direct contact [-]
$I_{gw,d}$	=	Intake of COC through the groundwater dermal contact pathway [mg/kg/d]

$I_{gw,ing}$ = Intake of COC through the groundwater ingestion pathway [mg/kg/d]

RfD = Reference Dose [mg/kg/d] {Table 4.24}

For the subsurface worker, the inputs to calculate the HQ from direct contact with PHC F2 Aliphatic C_{10}-C_{12} in groundwater are as follows:

$I_{gw,d}$ = $1.4x10^{-3}$ mg/kg/d

$I_{gw,ing}$ = $2.2x10^{-5}$ mg/kg/d

RfD = $4.0x10^{-4}$ mg/kg/d

$$HQ_{gw} = \frac{(1.4E{-}03 + 2.2E{-}05)}{4.0E{-}04}$$

$$HQ_{gw} = 0.01$$

H.1.3 Inhalation

Inhalation intake by human receptors of COC vapours and dust was calculated using equation 16:

$$I_{inh} = C_a \times AF_{inh} \frac{ET_h \times ET_d \times ET_{wk}}{24 \times 365} \times IRA \times \frac{ED}{AT} \qquad (16)$$

Where:

I_{inh} = Intake of COC through the inhalation pathway [mg/m^3]

C_a = Concentration of COC in dust, indoor air, or outdoor air [mg/m^3]

AF_{inh} = Inhalation absorption factor [-] {assumed to be 1}

ET_h = Hours per day exposed indoors or outdoors [h/d] {Table 4.8}

ET_d = Days per week exposed indoors or outdoors [d/wk] {Table 4.8}

ET_{wk} = Weeks per year exposed indoors or outdoors [wk/yr] {Table 4.8}

24 = Total hours in a day [h]

365 = Total days in a year [d]

IRA = Inhalation rate adjustment factor for to account for higher breathing rate during physical labour [-] { Table 4.8}

ED = Total exposure duration [y] {for carcinogenic COC only} {Table 4.8}

AT = Averaging time [y] {for carcinogenic COC only} {Table 4.8}

H.1.3.1 Exposure from Dust Inhalation

In the absence of measured air concentrations, concentrations of COC associated with particulate in ambient air can be estimated from soil data using an assumed respirable (≤ 10 µm aerodynamic diameter) particulate concentration as follows:

$$C_{a,p} = C_s \times P_a \quad (17)$$

Where:

$C_{a,p}$ = Particulate air concentration of COC [mg/m^3]
C_s = Concentration of COC in soil [mg/kg] {Table 3.10}
P_a = Particulate concentration in air [kg/m^3]

For the outdoor maintenance worker, a respirable particulate concentration (Pa) of 0.76 µg/m^3 (or 7.6x10^{-10} kg/m^3) was used as provided by Health Canada (2012) for areas with no construction activities. For the subsurface workers who may be exposed to a higher concentration of particulates as a result of soil resuspension during typical activities, a value of 60 µg/m^3 (or 6.0x10^{-8} kg/m^3) was used (MOE 2011). For the subsurface worker exposed to anthracene in dust, which is carcinogenic, the values of the parameters in equations 16 and 17 are:

AF_{inh} = 1
ET_h = 9.8 h/d
ET_d = 5 d/wk
ET_{wk} = 39 wk/yr
IRA = 1.8
ED = 56 y
AT = 1.5 y
C_s = 10.4 mg/kg
P_a = 6.0x10^{-8} kg/m^3

$$C_{a,p} = 10.4 \times 6.0\mathrm{E}-8$$

$$C_{a,p} = 6.3\mathrm{E}-07\ mg/m^3$$

$$I_{inh} = 6.3E-07 \times 1 \times \frac{9.8\times5\times39}{24\times365} \times 1.8 \times \frac{1.5}{56}$$

$$I_{inh} = 6.6E-09\ mg/m^3$$

H.1.3.2 Exposure from Volatile Vapours

Sections 4.2.4.2 and 4.2.4.3 of the report provide the methodology for estimating concentrations of volatile vapours in indoor and outdoor air from soil and groundwater. For a subsurface worker exposed to anthracene vapours migrating from soil to trench air, the values of the parameters in equation 16 is:

C_a = 9.9×10^{-5} mg/m^3 {Table 4.22}
AF_{inh} = 1
ET_h = 9.8 h/d
ET_d = 5 d/wk
ET_{wk} = 39 wk/yr
IRA = 1.8
ED = 1.5 y
AT = 56 y

$$I_{inh} = 9.9E - 05 \times 1 \times \frac{9.8 \times 5 \times 39}{24 \times 365} \times 1.8 \times \frac{1.5}{56}$$

$$I_{inh} = 1.0E - 06\ mg/m^3$$

H.1.3.3 Risk from Inhalation

The carcinogenic risk from exposure to anthracene in dust and volatile vapours is estimated as:

$$ILCR = I_{inh} \times TRV \qquad (18)$$

Where:

ILCR = Incremental Lifetime Cancer Risk [-]
I_{inh} = Intake of COC through the inhalation pathway [mg/m^3]
TRV = Toxicity Reference Value –Unit Risk, UR, [(mg/m^3)$^{-1}$] of the COC {Table 4.25}

For the subsurface worker, the inputs to calculate the risk from inhalation of anthracene in dust and trench air migrating from soil are as follows:

$I_{inh(dust)}$ = 6.6×10^{-9} mg/m^3
$I_{inh(vapour)}$ = 1.0×10^{-6} mg/m^3

UR = 6.0×10^{-3} $(mg/m^3)^{-1}$

$$ILCR = (6.6E-09 + 1.0E-06) \times 6.0E-03$$

$$ILCR = 6.3E-09$$

H.1.4 Literature Cited

Health Canada. 2012. Federal contaminated site risk assessment in Canada, Part I: Guidance on human health preliminary quantitative risk assessment (PQRA). Version 2.0.

MOE. 2011. Rationale for the development of soil and ground water standards for use at contaminated sites in Ontario. Prepared.

MOECC. 2016. Modified Generic Risk Assessment “Approved Model.” Standards Development Branch, Ontario Ministry of the Environment and Climate Change. November.

H.2 Johnson & Ettinger Input and Intercalcs – Soil to Indoor Air

H.2.1 Residential

H.2.1.1 PHC F1

Aliphatic C6-C8

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
PHCAL0608	264,000	Aliphatic C6-C8

Site Specific
MOE Defualt

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
				Totals must add up to value of L_t (cell G28)				OR	
15	158	188	0	158	30				1.63E-07

MORE ↓

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
Lookup Soil Parameters					Lookup Soil Parameters					Lookup Soil Parameters				
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2
				Used to calculate risk-based soil concentration.	

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (μg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	1.54E+05	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	8,874	7.27E-01	51.7073	1.77E-04	3.38E-03	1.36E-02	0.00E+00	1.36E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.59E+01	2.79E+08	0.10	1.41E+02	3.38E-03	4.90E+02	5.42E+295	2.71E-03	7.56E+05	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	1.8E-02

END

Aliphatic C>8-C10

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES X

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
PHCAL0810	172,800	Aliphatic C>8-C10

MORE

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
15	158	188	0	158	30				1.63E-07

Totals must add up to value of L_t (cell G28)

MORE

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
Lookup Soil Parameters					Lookup Soil Parameters					Lookup Soil Parameters				
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R ($\mu g/kg$)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	6.31E+04	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	11,521	9.97E-01	82.7993	1.77E-04	3.38E-03	1.36E-02	0.00E+00	1.36E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.26E+02	3.56E+07	0.10	1.41E+02	3.38E-03	4.90E+02	5.43E+295	2.71E-03	9.64E+04	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	1.0E-03

END

Aromatic C>8-C10

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
PHCAR0810	43,200	Aromatic C>8-C10

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell G28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
15	158	188	0	158	30			OR	1.63E-07

MORE ↓

ENTER Stratum A SCS soil type Lookup Soil Parameters	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type Lookup Soil Parameters	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type Lookup Soil Parameters	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	4.32E+04	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	11,054	6.15E-03	0.4968	1.77E-04	3.38E-03	1.36E-02	0.00E+00	1.36E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	Finite source β term (unitless)	Finite source ψ term (sec)$^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
6.34E+00	3.32E+06	0.10	1.41E+02	3.38E-03	4.90E+02	5.34E+295	2.71E-03	8.98E+03	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF (µg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	2.0E-04

END

H.2.1.2 PHC F2

Aliphatic C>10-C12

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
PHCAL1012	734,400	Aliphatic C>10-C12

Site Specific
MOE Defualt

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
				Totals must add up to value of L_t (cell G28)				OR	
15	158	188	0	158	30				1.63E-07

MORE ↓

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
Lookup Soil Parameters					Lookup Soil Parameters					Lookup Soil Parameters				
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2
				Used to calculate risk-based soil concentration.	

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (μg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	3.52E+04	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	13,385	1.34E+00	124.1990	1.77E-04	3.38E-03	1.36E-02	0.00E+00	1.36E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.00E+03	4.22E+06	0.10	1.41E+02	3.38E-03	4.90E+02	5.43E+295	2.71E-03	1.14E+04	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	1.0E-03

END

Aliphatic C>12-C16

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
PHCAL1216	897,600	Aliphatic C>12-C16

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
				Totals must add up to value of L_t (cell G28)				OR	
15	158	188	0	158	30				1.63E-07

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (μg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	1.53E+04	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	17,623	4.53E+00	538.1956	1.77E-04	3.38E-03	1.36E-02	0.00E+00	1.36E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
2.00E+04	4.09E+05	0.10	1.41E+02	3.38E-03	4.90E+02	5.43E+295	2.71E-03	1.11E+03	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	1.0E-03

END

Aromatic C>10-C12

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
PHCAR1012	183,600	Aromatic C>10-C12

MORE ↓

Totals must add up to value of L_t (cell G28)

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
15	158	188	0	158	30				1.63E-07

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R ($\mu g/kg$)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	1.84E+05	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	13,525	1.55E-03	0.1449	1.77E-04	3.38E-03	1.36E-02	0.00E+00	1.36E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.00E+01	2.64E+06	0.10	1.41E+02	3.38E-03	4.90E+02	5.14E+295	2.71E-03	7.14E+03	NA	NA	NA	NA

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	2.0E-04

END

Aromatic C>12-C16

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
PHCAR1216	224,400	Aromatic C>12-C16

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
15	158	188	0	158	30				1.63E-07

Totals must add up to value of L_t (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R ($\mu g/kg$)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	1.16E+05	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	19,559	4.12E-04	0.0549	1.77E-04	3.38E-03	1.36E-02	0.00E+00	1.36E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
2.00E+01	3.18E+05	0.10	1.41E+02	3.38E-03	4.90E+02	4.71E+295	2.71E-03	8.61E+02	NA	NA	NA	NA

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	2.0E-04

END

H.2.1.3 Benzene

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
71432	10,080	Benzene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell G28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
15	158	188	0	158	30				1.63E-07

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	1.01E+04	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	8,071	3.46E-03	0.1464	1.77E-04	5.94E-03	2.39E-02	0.00E+00	2.39E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	Finite source β term (unitless)	Finite source ψ term (sec)$^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
6.62E-01	2.10E+06	0.10	1.41E+02	5.94E-03	4.90E+02	1.04E+168	2.86E-03	5.99E+03	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF (µg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	2.2E-06	3.0E-05

END

H.2.1.4 Ethylbenzene (revised March 2021)

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
100414	5,760	Ethylbenzene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
15	158	188	0	158	30				1.63E-07

(add up to value of L_t (cell G28) — applies to h_A, h_B, h_C)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	**Initial soil concentration used, C_R (μg/kg)**	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	**5.76E+03**	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	10,098	4.36E-03	0.1845	1.77E-04	5.07E-03	2.04E-02	0.00E+00	2.04E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (μg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (μg/m^3)	**Finite source β term (unitless)**	**Finite source ψ term (sec)$^{-1}$**	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
2.07E+00	5.01E+05	0.10	1.41E+02	5.07E-03	4.90E+02	1.40E+197	2.82E-03	1411.765164	**NA**	**NA**	**NA**	**NA**

Finite source indoor attenuation coefficient, <α> (unitless)	**Mass limit** bldg. conc., $C_{building}$ (μg/m^3)	Finite source bldg. conc., $C_{building}$ (μg/m^3)	Final finite source bldg. conc., $C_{building}$ (μg/m^3)	Unit risk factor, URF (μg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
NA	**NA**	**NA**	NA	NA	1.0E-03

END

H.2.1.5 Toluene (added March 2021)

SL-ADV Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
108883	30,000	Toluene

Site Specific

MOE Defualt

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER (add up to value of L_t (cell G28)) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
15	158	188	0	158	30			OR	1.63E-07

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)		ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3		8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	**Initial soil concentration used, C_R (µg/kg)**	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	**3.00E+04**	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	9,100	3.89E-03	0.1646	1.77E-04	5.88E-03	2.36E-02	0.00E+00	2.36E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	**Finite source β term (unitless)**	**Finite source ψ term $(sec)^{-1}$**	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.07E+00	4.42E+06	0.10	1.41E+02	5.88E-03	4.90E+02	8.97E+169	2.85E-03	12596.03602	**NA**	**NA**	**NA**	**NA**

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	**Mass limit** bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	**NA**	**NA**	NA	NA	5.0E-03

END

~~H.2.1.5~~H.2.1.6 Xylene Mixture

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
1330207	51,600	Xylene Mixture

Site Specific
MOE Defualt

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
				Totals must add up to value of L_t (cell G28)				OR	
15	158	188	0	158	30				1.63E-07

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (μg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	5.16E+04	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	11,378	3.41E-03	0.2805	1.77E-04	4.82E-03	1.94E-02	0.00E+00	1.94E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.77E+00	7.84E+06	0.10	1.41E+02	4.82E-03	4.90E+02	1.22E+207	2.81E-03	2.20E+04	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	7.0E-04

END

~~H.2.1.6~~H.2.1.7 Naphthalene

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
91203	5,640	Naphthalene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell G28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
15	158	188	0	158	30				1.63E-07

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	5.64E+03	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	12,861	2.07E-04	0.0088	1.77E-04	3.99E-03	1.60E-02	0.00E+00	1.60E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	Finite source β term (unitless)	Finite source ψ term (sec)$^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
7.35E+00	6.72E+03	0.10	1.41E+02	3.99E-03	4.90E+02	1.89E+250	2.76E-03	1.85E+01	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF (µg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	6.0E-07	3.7E-06

END

~~H.2.1.7~~H.2.1.8 Hexane (n)

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
110543	4,680	Hexane

MORE

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
				Totals must add up to value of L_t (cell G28)					
15	158	188	0	158	30				1.63E-07

MORE

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
Lookup Soil Parameters					Lookup Soil Parameters					Lookup Soil Parameters				
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2
				Used to calculate risk-based soil concentration.	

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	4.68E+03	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	7,650	1.15E+00	76.1754	1.77E-04	1.35E-02	5.43E-02	0.00E+00	5.43E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	Finite source β term (unitless)	Finite source ψ term (sec)$^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
5.96E-01	1.86E+07	0.10	1.41E+02	1.35E-02	4.90E+02	8.58E+73	2.98E-03	5.53E+04	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF (µg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	2.5E-03

END

~~H.2.1.8~~H.2.1.9 Trichloroethylene

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
79016	456	Trichloroethylene

MORE

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell G28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
15	158	188	0	158	30				1.63E-07

MORE

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	4.56E+02	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	8,495	6.00E-03	0.2536	1.77E-04	5.34E-03	2.15E-02	0.00E+00	2.15E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	Finite source β term (unitless)	Finite source ψ term (sec)$^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
2.71E-01	3.41E+05	0.10	1.41E+02	5.34E-03	4.90E+02	1.46E+187	2.83E-03	9.66E+02	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF (µg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	4.1E-06	2.0E-06

END

~~H.2.1.9~~H.2.1.10 Acenaphthene

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
83329	1,680	Acenaphthene

MORE

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
				Totals must add up to value of L_t (cell G28)					
15	158	188	0	158	30				1.63E-07

MORE

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	1.68E+03	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	16,062	7.11E-05	0.0030	1.77E-04	2.86E-03	1.14E-02	0.00E+00	1.14E-02	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
2.45E+01	2.06E+02	0.10	1.41E+02	2.86E-03	4.90E+02	#NUM!	2.65E-03	5.46E-01	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	6.0E-07	NA

END

~~H.2.1.10~~H.2.1.11 Acenaphthylene

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
208968	2,640	Acenaphthylene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell G28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
15	158	188	0	158	30				1.63E-07

MORE ↓

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
Lookup Soil Parameters					Lookup Soil Parameters					Lookup Soil Parameters				
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm³/cm³)	Stratum B soil air-filled porosity, θ_a^B (cm³/cm³)	Stratum C soil air-filled porosity, θ_a^C (cm³/cm³)	Stratum A effective total fluid saturation, S_{te} (cm³/cm³)	Stratum A soil intrinsic permeability, k_i (cm²)	Stratum A soil relative air permeability, k_{rg} (cm²)	Stratum A soil effective vapor permeability, k_v (cm²)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm³/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	2.64E+03	4.58E+04

Area of enclosed space below grade, A_B (cm²)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m³/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm²/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm²/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm²/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm²/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	25,499	2.81E-05	0.0053	1.77E-04	2.97E-03	1.19E-02	0.00E+00	1.19E-02	30	158

Soil-water partition coefficient, K_d (cm³/g)	Source vapor conc., C_{source} (µg/m³)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm³/s)	Crack effective diffusion coefficient, D^{crack} (cm²/s)	Area of crack, A_{crack} (cm²)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m³)	Finite source β term (unitless)	Finite source ψ term (sec)$^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
2.45E+01	5.70E+02	0.10	1.41E+02	2.97E-03	4.90E+02	#NUM!	2.66E-03	1.52E+00	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m³)	Finite source bldg. conc., $C_{building}$ (µg/m³)	Final finite source bldg. conc., $C_{building}$ (µg/m³)	Unit risk factor, URF (µg/m³)$^{-1}$	Reference conc., RfC (mg/m³)
NA	NA	NA	NA	6.0E-06	NA

END

~~H.2.1.11~~H.2.1.12 Anthracene

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
120127	10,440	Anthracene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
				Totals must add up to value of L_t (cell G28)				OR	
15	158	188	0	158	30				1.63E-07

MORE ↓

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
Lookup Soil Parameters					Lookup Soil Parameters					Lookup Soil Parameters				
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
8	40	1225	1225	366	0.1	0.3	8.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2
				Used to calculate risk-based soil concentration.	

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (μg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.63E-07	4,900	3.54E+03	4.58E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
2.27E+06	2.15E-04	158	18,289	1.90E-05	0.0008	1.77E-04	2.25E-03	8.80E-03	0.00E+00	8.80E-03	30	158

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
8.16E+01	3.49E+01	0.10	1.41E+02	2.25E-03	4.90E+02	#NUM!	2.54E-03	8.88E-02	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	6.0E-06	NA

END

H.2.2 Commercial

H.2.2.1 PHC F1

Aliphatic C6-C8

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
PHCAL0608	264,000	Aliphatic C6-C8

Site Specific
MOE Defualt

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
				Totals must add up to value of L_t (cell G28)				OR	
15	11.25	41.25	0	11.25	30				1.78E-07

MORE ↓

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
Lookup Soil Parameters					Lookup Soil Parameters					Lookup Soil Parameters				
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
11.25	20	2000	1500	300	0.1	1	9.8

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2
				Used to calculate risk-based soil concentration.	

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.78E-07	7,000	1.54E+05	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
3.00E+06	2.33E-04	11.25	8,874	7.27E-01	51.7073	1.77E-04	3.38E-03	1.36E-02	0.00E+00	1.36E-02	30	11.25

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.59E+01	2.79E+08	0.10	1.63E+02	3.38E-03	7.00E+02	#NUM!	5.83E-04	1.63E+05	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	1.8E-02

END

Aliphatic C>8-C10

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
PHCAL0810	172,800	Aliphatic C>8-C10

MORE

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell G28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
15	11.25	41.25	0	11.25	30				1.78E-07

MORE

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
11.25	20	2000	1500	300	0.1	1	9.8

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (μg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.78E-07	7,000	6.31E+04	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
3.00E+06	2.33E-04	11.25	11,521	9.97E-01	82.7993	1.77E-04	3.38E-03	1.36E-02	0.00E+00	1.36E-02	30	11.25

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.26E+02	3.56E+07	0.10	1.63E+02	3.38E-03	7.00E+02	#NUM!	5.83E-04	2.08E+04	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	1.0E-03

END

Aromatic C>8-C10

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
PHCAR0810	43,200	Aromatic C>8-C10

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
				Totals must add up to value of L_t (cell G28)					
15	11.25	41.25	0	11.25	30				1.78E-07

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
11.25	20	2000	1500	300	0.1	1	9.8

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.78E-07	7,000	4.32E+04	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
3.00E+06	2.33E-04	11.25	11,054	6.15E-03	0.4968	1.77E-04	3.38E-03	1.36E-02	0.00E+00	1.36E-02	30	11.25

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	Finite source β term (unitless)	Finite source ψ term (sec)$^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
6.34E+00	3.32E+06	0.10	1.63E+02	3.38E-03	7.00E+02	#NUM!	5.83E-04	1.94E+03	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF (µg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	2.0E-04

END

H.2.2.2 PHC F2

Aliphatic C>10-C12

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
PHCAL1012	734,400	Aliphatic C>10-C12

Site Specific
MOE Defualt

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
				Totals must add up to value of L_t (cell G28)				OR	
15	11.25	41.25	0	11.25	30				1.78E-07

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
11.25	20	2000	1500	300	0.1	1	9.8

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2
				Used to calculate risk-based soil concentration.	

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R ($\mu g/kg$)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.78E-07	7,000	3.52E+04	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
3.00E+06	2.33E-04	11.25	13,385	1.34E+00	124.1990	1.77E-04	3.38E-03	1.36E-02	0.00E+00	1.36E-02	30	11.25

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.00E+03	4.22E+06	0.10	1.63E+02	3.38E-03	7.00E+02	#NUM!	5.83E-04	2.46E+03	NA	NA	NA	NA

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	1.0E-03

END

Aliphatic C>12-C16

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
PHCAL1216	897,600	Aliphatic C>12-C16

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell G28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
15	11.25	41.25	0	11.25	30				1.78E-07

MORE ↓

ENTER Stratum A SCS soil type Lookup Soil Parameters	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type Lookup Soil Parameters	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type Lookup Soil Parameters	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
11.25	20	2000	1500	300	0.1	1	9.8

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm³/cm³)	Stratum B soil air-filled porosity, θ_a^B (cm³/cm³)	Stratum C soil air-filled porosity, θ_a^C (cm³/cm³)	Stratum A effective total fluid saturation, S_{te} (cm³/cm³)	Stratum A soil intrinsic permeability, k_i (cm²)	Stratum A soil relative air permeability, k_{rg} (cm²)	Stratum A soil effective vapor permeability, k_v (cm²)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (μg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm³/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.78E-07	7,000	1.53E+04	2.50E+05

Area of enclosed space below grade, A_B (cm²)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m³/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm²/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm²/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm²/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm²/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
3.00E+06	2.33E-04	11.25	17,623	4.53E+00	538.1956	1.77E-04	3.38E-03	1.36E-02	0.00E+00	1.36E-02	30	11.25

Soil-water partition coefficient, K_d (cm³/g)	Source vapor conc., C_{source} (μg/m³)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm³/s)	Crack effective diffusion coefficient, D^{crack} (cm²/s)	Area of crack, A_{crack} (cm²)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (μg/m³)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
2.00E+04	4.09E+05	0.10	1.63E+02	3.38E-03	7.00E+02	#NUM!	5.83E-04	2.39E+02	NA	NA	NA	NA

Finite source indoor attenuation coefficient, $\langle\alpha\rangle$ (unitless)	Mass limit bldg. conc., $C_{building}$ (μg/m³)	Finite source bldg. conc., $C_{building}$ (μg/m³)	Final finite source bldg. conc., $C_{building}$ (μg/m³)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m³)
NA	NA	NA	NA	NA	1.0E-03

END

Aromatic C>10-C12

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
PHCAR1012	183,600	Aromatic C>10-C12

Site Specific
MOE Defualt

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
				Totals must add up to value of L_t (cell G28)				OR	
15	11.25	41.25	0	11.25	30				1.78E-07

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
11.25	20	2000	1500	300	0.1	1	9.8

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (μg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.78E-07	7,000	1.84E+05	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
3.00E+06	2.33E-04	11.25	13,525	1.55E-03	0.1449	1.77E-04	3.38E-03	1.36E-02	0.00E+00	1.36E-02	30	11.25

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.00E+01	2.64E+06	0.10	1.63E+02	3.38E-03	7.00E+02	#NUM!	5.83E-04	1.54E+03	NA	NA	NA	NA

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	2.0E-04

END

Aromatic C>12-C16

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
PHCAR1216	224,400	Aromatic C>12-C16

Site Specific
MOE Defualt

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell G28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
15	11.25	41.25	0	11.25	30			OR	1.78E-07

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
11.25	20	2000	1500	300	0.1	1	9.8

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (μg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.78E-07	7,000	1.16E+05	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
3.00E+06	2.33E-04	11.25	19,559	4.12E-04	0.0549	1.77E-04	3.38E-03	1.36E-02	0.00E+00	1.36E-02	30	11.25

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
2.00E+01	3.18E+05	0.10	1.63E+02	3.38E-03	7.00E+02	#NUM!	5.83E-04	1.86E+02	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	2.0E-04

END

H.2.2.3 Benzene

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
71432	10,080	Benzene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
				Totals must add up to value of L_t (cell G28)				OR	
15	11.25	41.25	0	11.25	30				1.78E-07

MORE ↓

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
Lookup Soil Parameters					Lookup Soil Parameters					Lookup Soil Parameters				
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
11.25	20	2000	1500	300	0.1	1	9.8

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2
				Used to calculate risk-based soil concentration.	

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (μg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.78E-07	7,000	1.01E+04	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
3.00E+06	2.33E-04	11.25	8,071	3.46E-03	0.1464	1.77E-04	5.94E-03	2.39E-02	0.00E+00	2.39E-02	30	11.25

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
6.62E-01	2.10E+06	0.10	1.63E+02	5.94E-03	7.00E+02	6.57E+191	6.12E-04	1.28E+03	NA	NA	NA	NA

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	2.2E-06	3.0E-05

END

H.2.2.4 Xylene Mixture

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
1330207	51,600	Xylene Mixture

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell G28): Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
15	11.25	41.25	0	11.25	30			OR	1.78E-07

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
11.25	20	2000	1500	300	0.1	1	9.8

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R ($\mu g/kg$)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.78E-07	7,000	5.16E+04	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
3.00E+06	2.33E-04	11.25	11,378	3.41E-03	0.2805	1.77E-04	4.82E-03	1.94E-02	0.00E+00	1.94E-02	30	11.25

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.77E+00	7.84E+06	0.10	1.63E+02	4.82E-03	7.00E+02	2.63E+236	6.03E-04	4.72E+03	NA	NA	NA	NA

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	NA	7.0E-04

END

H.2.2.5 Trichloroethylene

SL-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

Site Specific
MOE Defualt

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
79016	456	Trichloroethylene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell G28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
15	11.25	41.25	0	11.25	30			OR	1.78E-07

MORE ↓

ENTER Stratum A SCS soil type Lookup Soil Parameters	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type Lookup Soil Parameters	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type Lookup Soil Parameters	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
CS	1.7	0.36	0.119	0.002	G	1.6	0.4	0.01	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
11.25	20	2000	1500	300	0.1	1	9.8

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
56	25	25	250	1.0E-06	0.2

Used to calculate risk-based soil concentration.

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (μg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	30	0.241	0.390	ERROR	#N/A	#N/A	#N/A	1.78E-07	7,000	4.56E+02	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
3.00E+06	2.33E-04	11.25	8,495	6.00E-03	0.2536	1.77E-04	5.34E-03	2.15E-02	0.00E+00	2.15E-02	30	11.25

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
2.71E-01	3.41E+05	0.10	1.63E+02	5.34E-03	7.00E+02	4.74E+213	6.07E-04	2.07E+02	NA	NA	NA	NA

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	NA	NA	NA	4.1E-06	2.0E-06

END

APPENDIX I

INFORMATION FOR OFF-SITE AQUATIC ENVIRONMENT

Table 4
Summary of Sediment Analytical Results (Sediment Criteria)
288 and 420 Bayshore Drive, Midland, ON
Town of Midland

Sample Location			TR-1	TR-2	TR-3	TS1-1		TS1-3	TS1-4	TS2-1	TS2-2		TS2-3	TS3-3
Sample Date			11-Apr-14	11-Apr-14	11-Apr-14	10-Apr-14	10-Apr-14	10-Apr-14	10-Apr-14	10-Apr-14	10-Apr-14	10-Apr-14	10-Apr-14	11-Apr-14
Sample ID			TR-1	TR-2	TR-3	TS1-1	TS1-1LR	TS1-3	TS1-4	TS2-1	TS2-2	DUP	TS2-3	TS3-3
Sample Depth			6.1 m	7.9 m	9.1 m	1 m		1.5 m	2.3 m	9.1 m	8.4 m	8.4 m	10 m	10.9 m
Sampling Company			STANTEC	STANTEC	STANTEC	STANTEC		STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC
Laboratory			MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX
Laboratory Work Order			B459615	B459615	B459615	B459615	B459615	B459615	B459615	B459615	B459615	B459615	B459615	B459615
Laboratory Sample ID			VN6554	VN6555	VN6556	VN6547	VN6547	VN6548	VN6549	VN6550	VN6551	VN6557	VN6552	VN6553
Sample Type	Units	Ontario SCS					Lab Replicate					Field Duplicate		
General Chemistry														
Available (CaCl2) pH	S.U.	n/v	6.67	6.33	6.33	7.12	-	6.90	7.18	6.28	7.03	7.01	6.21	6.84
Cyanide (Free)	µg/g	0.1[A]	0.01	0.02	0.02	< 0.01	-	< 0.01	< 0.01	0.06	0.03	0.03	0.03	0.05
Electrical Conductivity, Lab	mS/cm	n/a	0.18	0.23	0.28	0.16	-	0.19	0.40	2.9	0.40	0.34	0.38	5.3
Moisture Content	%	n/v	31	45	40	23	-	26	37	66	58	59	58	53
Sodium Adsorption Ratio (SAR)	none	n/a	0.30	0.41	0.38	0.28	-	0.37	0.92	9.3	0.72	0.58	0.52	44
BTEX and Petroleum Hydrocarbons														
Benzene	µg/g	n/v	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.060	< 0.040	< 0.040	< 0.040	< 0.020
Toluene	µg/g	n/v	< 0.020	< 0.020	0.048	< 0.020	< 0.020	0.031	< 0.020	< 0.060	0.11	0.21	0.18	0.069
Ethylbenzene	µg/g	n/v	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.060	< 0.040	< 0.040	< 0.040	< 0.020
Xylene, m & p-	µg/g	n/v	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.12	< 0.080	< 0.080	< 0.080	0.058
Xylene, o-	µg/g	n/v	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.060	< 0.040	< 0.040	< 0.040	0.036
Xylenes, Total	µg/g	n/v	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.12	< 0.080	< 0.080	< 0.080	0.094
PHC F1 (C6-C10 range)	µg/g	n/v	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 30	< 20	< 20	< 20	< 10
PHC F2 (>C10-C16 range)	µg/g	n/v	< 10	< 10	< 10	< 10	-	< 10	< 10	< 30	< 20	< 20	< 20	22
PHC F3 (>C16-C34 range)	µg/g	n/v	83	120	110	100	-	< 50	51	400	170	160	240	760
PHC F4 (>C34-C50 range)	µg/g	n/v	81	69	60	< 50	-	< 50	< 50	180	< 100	< 100	< 100	420
PHC F4 (>C34) Gravimetric	µg/g	n/v	760	610	490	-	-	-	-	-	-	720	-	1900
Chromatogram to baseline at nC50	µg/g	n/v	NO	NO	NO	YES	-	YES	YES	YES	YES	NO	YES	NO
Metals														
Antimony	µg/g	n/v	< 0.20	< 0.20	0.30	0.34	-	< 0.20	< 0.20	0.57	0.23	0.36	0.31	1.1
Arsenic	µg/g	6[A]	1.4	1.4	1.8	1.7	-	< 1.0	1.3	3.9	3.3	3.1	3.7	3.1
Barium	µg/g	n/v	43	52	59	19	-	10	24	130	110	81	100	120
Beryllium	µg/g	n/v	< 0.20	0.20	0.25	< 0.20	-	< 0.20	< 0.20	0.58	0.33	0.30	0.42	0.38
Boron	µg/g	n/v	< 5.0	< 5.0	< 5.0	< 5.0	-	< 5.0	< 5.0	6.4	5.8	10	7.2	5.1
Boron (Available)	µg/g	n/a	0.25	0.34	0.30	0.12	-	0.18	0.22	0.56	0.19	0.17	0.38	0.76
Cadmium	µg/g	0.6[A]	0.29	0.37	0.38	< 0.10	-	< 0.10	0.14	**0.64[A]**	0.37	0.39	0.44	0.53
Chromium (Hexavalent)	µg/g	n/v	< 0.2	< 0.2	< 0.2	< 0.2	-	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (Total)	µg/g	26[A]	24	**36[A]**	**36[A]**	5.7	-	3.3	6.9	**36[A]**	20	18	**30[A]**	**83[A]**
Cobalt	µg/g	50[A]	3.5	4.3	5.0	1.9	-	1.5	2.5	9.4	6.6	6.1	7.5	6.3
Copper	µg/g	16[A]	13	16	**22[A]**	3.3	-	5.1	14	**29[A]**	**18[A]**	15	**23[A]**	**58[A]**
Lead	µg/g	31[A]	20	25	**32[A]**	**130[A]**	-	5.3	12	**50[A]**	**89[A]**	**60[A]**	**46[A]**	**94[A]**
Mercury	µg/g	0.2[A]	< 0.050	< 0.050	0.086	< 0.050	-	< 0.050	< 0.050	0.11	0.063	0.070	0.080	0.18
Molybdenum	µg/g	n/v	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	0.59	< 0.50	0.88
Nickel	µg/g	16[A]	**17[A]**	**23[A]**	**27[A]**	2.9	-	2.7	4.9	**26[A]**	**17[A]**	15	**24[A]**	**54[A]**
Selenium	µg/g	n/v	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	0.81	< 0.50	0.51	0.68	< 0.50
Silver	µg/g	0.5[A]	< 0.20	< 0.20	< 0.20	< 0.20	-	< 0.20	< 0.20	0.26	< 0.20	< 0.20	0.21	**0.58[A]**
Thallium	µg/g	n/v	0.069	0.089	0.11	< 0.050	-	< 0.050	< 0.050	0.20	0.13	0.12	0.18	0.16
Uranium	µg/g	n/v	0.43	0.44	0.56	0.36	-	0.22	0.28	0.94	0.53	0.47	0.76	0.62
Vanadium	µg/g	n/v	17	20	21	12	-	7.4	12	36	22	20	29	25
Zinc	µg/g	120[A]	53	67	78	31	-	14	30	**140[A]**	88	91	100	**160[A]**

See notes on last page

Table 4
Summary of Sediment Analytical Results (Sediment Criteria)
288 and 420 Bayshore Drive, Midland, ON
Town of Midland

Sample Location			**TR-1**	**TR-2**	**TR-3**	**TS1-1**		**TS1-3**	**TS1-4**	**TS2-1**	**TS2-2**		**TS2-3**	**TS3-3**
Sample Date			**11-Apr-14**	**11-Apr-14**	**11-Apr-14**	**10-Apr-14**	**10-Apr-14**	**10-Apr-14**	**10-Apr-14**	**10-Apr-14**	**10-Apr-14**	**10-Apr-14**	**10-Apr-14**	**11-Apr-14**
Sample ID			**TR-1**	**TR-2**	**TR-3**	**TS1-1**	**TS1-1LR**	**TS1-3**	**TS1-4**	**TS2-1**	**TS2-2**	**DUP**	**TS2-3**	**TS3-3**
Sample Depth			**6.1 m**	**7.9 m**	**9.1 m**	**1 m**		**1.5 m**	**2.3 m**	**9.1 m**	**8.4 m**	**8.4 m**	**10 m**	**10.9 m**
Sampling Company			**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**		**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**
Laboratory			**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**
Laboratory Work Order			**B459615**	**B459615**	**B459615**	**B459615**	**B459615**	**B459615**	**B459615**	**B459615**	**B459615**	**B459615**	**B459615**	**B459615**
Laboratory Sample ID			**VN6554**	**VN6555**	**VN6556**	**VN6547**	**VN6547**	**VN6548**	**VN6549**	**VN6550**	**VN6551**	**VN6557**	**VN6552**	**VN6553**
Sample Type	**Units**	**Ontario SCS**					**Lab Replicate**					**Field Duplicate**		
Polycyclic Aromatic Hydrocarbons														
Acenaphthene	µg/g	n/v	0.021	0.022	0.027	0.22	-	< 0.0050	< 0.010	< 0.030 MI	0.10	0.023	0.025	0.14
Acenaphthylene	µg/g	n/v	0.038	0.043	0.035	0.011	-	< 0.0050	< 0.010	0.029	0.025	0.016	0.025	0.069
Anthracene	µg/g	0.22^{A}	0.071	0.092	0.096	**1.4**^{A}	-	< 0.0050	0.019	0.065	0.073	0.052	0.064	**0.39**^{A}
Benzo(a)anthracene	µg/g	0.32^{A}	0.26	**0.36**^{A}	**0.34**^{A}	**0.85**^{A}	-	0.0093	0.050	0.22	0.17	0.16	0.18	**1.8**^{A}
Benzo(a)pyrene	µg/g	0.37^{A}	0.26	0.37	0.34	**0.61**^{A}	-	0.0099	0.046	0.23	0.14	0.14	0.18	**1.7**^{A}
Benzo(b/j)fluoranthene	µg/g	n/v	0.37	0.53	0.51	0.85	-	0.017	0.074	0.39	0.22	0.25	0.29	2.5
Benzo(g,h,i)perylene	µg/g	0.17^{A}	**0.18**^{A}	**0.26**^{A}	**0.24**^{A}	**0.36**^{A}	-	0.0075	0.036	**0.20**^{A}	0.099	0.11	0.15	**1.1**^{A}
Benzo(k)fluoranthene	µg/g	0.24^{A}	0.13	0.20	0.18	**0.32**^{A}	-	0.0058	0.027	0.13	0.075	0.081	0.11	**0.89**^{A}
Chrysene	µg/g	0.34^{A}	0.21	0.30	0.29	**0.50**^{A}	-	0.011	0.043	0.20	0.14	0.13	0.17	**1.6**^{A}
Dibenzo(a,h)anthracene	µg/g	0.06^{A}	0.042	0.060	0.057	**0.081**^{A}	-	< 0.0050	< 0.010	0.040	0.023	0.023	0.031	**0.26**^{A}
Fluoranthene	µg/g	0.75^{A}	0.53	**0.82**^{A}	**0.82**^{A}	**2.7**^{A}	-	0.027	0.12	0.53	0.36	0.40	0.46	**4.7**^{A}
Fluorene	µg/g	0.19^{A}	0.023	0.028	0.032	**0.57**^{A}	-	< 0.0050	< 0.010	0.029	0.15	0.028	0.040	0.16
Indeno(1,2,3-cd)pyrene	µg/g	0.2^{A}	0.19	**0.27**^{A}	**0.25**^{A}	**0.37**^{A}	-	0.0075	0.036	0.20	0.095	0.12	0.14	**1.1**^{A}
Methylnaphthalene (Total)	µg/g	n/v	0.025	0.035	0.040	0.066	-	0.0093	0.056	0.21	2.4	0.21	0.32	0.17
Methylnaphthalene, 1-	µg/g	n/v	0.0078	0.013	0.014	0.052	-	< 0.0050	0.015	0.055	1.0	0.084	0.14	0.061
Methylnaphthalene, 2-	µg/g	n/v	0.017	0.022	0.026	0.014	-	0.0093	0.041	0.15	1.4	0.13	0.19	0.11
Naphthalene	µg/g	n/v	0.0091	0.019	0.023	0.017	-	< 0.0050	0.018	0.044	1.2	0.083	0.11	0.11
Phenanthrene	µg/g	0.56^{A}	0.25	0.34	0.39	**3.3**^{A}	-	0.012	0.077	0.25	**0.65**^{A}	0.23	0.32	**1.8**^{A}
Pyrene	µg/g	0.49^{A}	0.44	**0.66**^{A}	**0.66**^{A}	**2.1**^{A}	-	0.021	0.094	0.44	0.30	0.32	0.37	**3.6**^{A}

Notes:

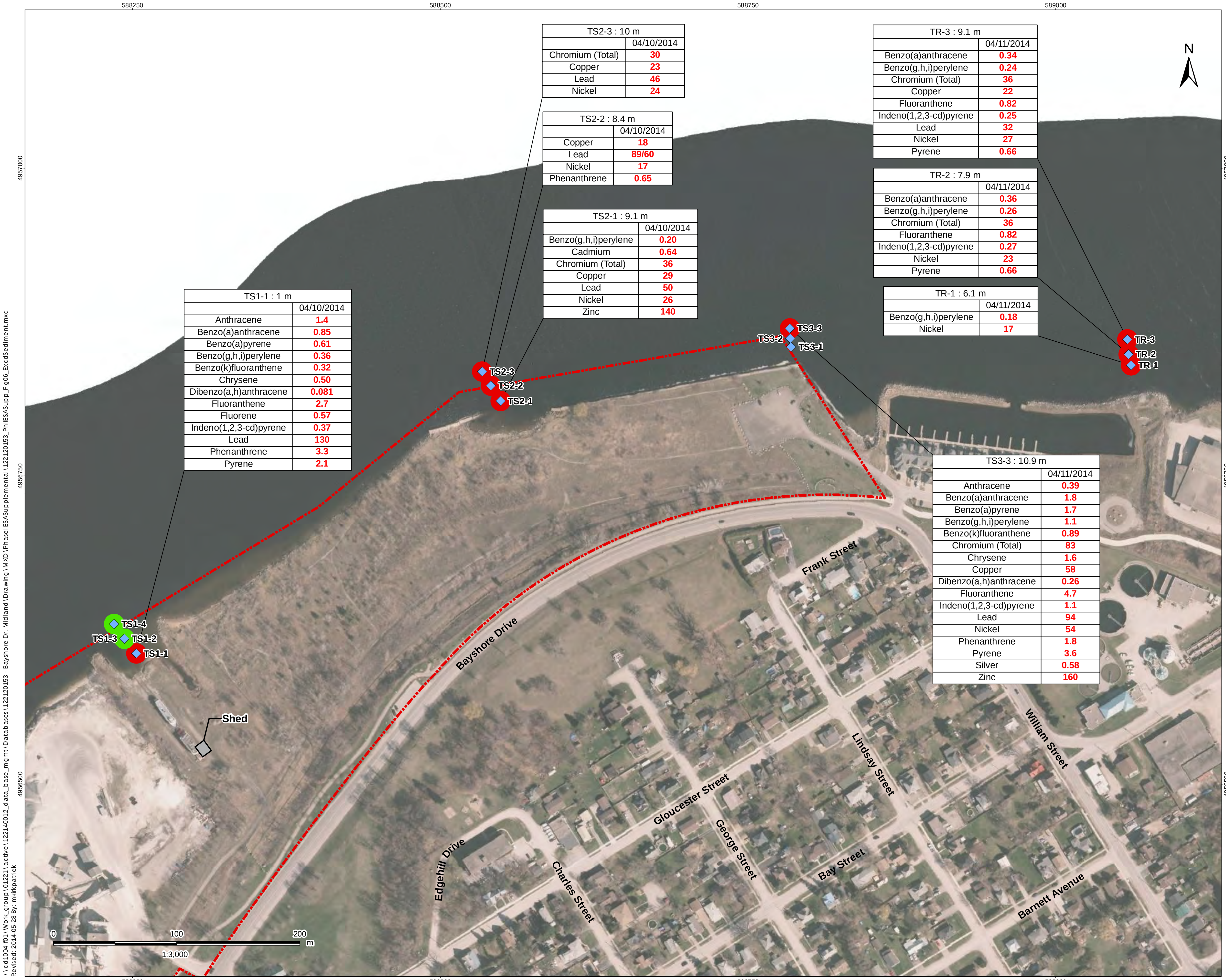
Ontario SCS	Ministry of the Environment "Soil, Ground Water and Sediment Standards for use under Part XV.I of the Environmental Protection Act" (April 15, 2011)
^{A}	MOE Table 9Site Condition Standards - All Types of Property Use
6.5^{A}	Concentration exceeds the indicated standard.
15.2	Concentration was detected but did not exceed applicable standard.
< 0.50	Laboratory reportable detection limit exceeded standard.
< 0.03	The analyte was not detected at a concentration greater than the laboratory reportable detection limit.
n/v	No standard/guideline value.
-	Parameter not analyzed / not available.
n/a	Not applicable.
n/v	No value derived.
MI	Detection limit was raised due to matrix interferences.

Table 5
Summary of Surface Water Analytical Results
288 and 420 Bayshore Drive, Midland, ON
Town of Midland

Sample Location			TS1-1				TS2-3	TS3-1		TR-3	FIELD BLANK	TRIP BLANK
Sample Date			10-Apr-14	10-Apr-14	28-Apr-14	28-Apr-14	10-Apr-14	11-Apr-14	11-Apr-14	11-Apr-14	11-Apr-14	11-Apr-14
Sample ID			TS1-1	TS1-1LR	SW 1	SW 1LR	TS2-3	TS3-1	DUP2	TR-3	FIELD BLANK	TRIP BLANK
Sampling Company			STANTEC		STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC
Laboratory			MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX
Laboratory Work Order			B459583	B459583	B470975	B470975	B459583	B459583	B459583	B459583	B459583	B459583
Laboratory Sample ID			VN6467	VN6467	VT1438	VT1438	VN6468	VN6469	VN6470	VN6473	VN6471	VN6472
Sample Type	Units	PWQO		Lab Replicate		Lab Replicate			Field Duplicate		Field Blank	Trip Blank
General Chemistry												
Alkalinity, Total (as CaCO3)	mg/L	$_{s16}^{A}$	23	-	65	-	1.9	16	16	26	-	-
Hardness (as CaCO3)	mg/L	n/v	27	-	92	-	1.9	13	13	20	-	-
BTEX and Petroleum Hydrocarbons												
Benzene	µg/L	100_b^C	< 0.20	< 0.20	-	-	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Toluene	µg/L	0.8^C	0.78	0.74	-	-	0.71	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Ethylbenzene	µg/L	8^C	< 0.20	< 0.20	-	-	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Xylene, m & p-	µg/L	2_{s17}^B	0.46	0.47	-	-	0.59	< 0.40	< 0.40	< 0.40	< 0.40	< 0.40
Xylene, o-	µg/L	40_b^C	< 0.20	< 0.20	-	-	0.22	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Xylenes, Total	µg/L	72_{s10}^B	0.46	0.47	-	-	0.81	< 0.40	< 0.40	< 0.40	< 0.40	< 0.40
PHC F1 (C6-C10 range)	µg/L	n/v	< 25	< 25	-	-	< 25	< 25	37	< 25	< 25	< 25
PHC F1 (C6-C10 range) minus BTEX	µg/L	n/v	< 25	< 25	-	-	< 25	< 25	37	< 25	< 25	< 25
PHC F2 (>C10-C16 range)	µg/L	n/v	< 100	-	-	-	< 100	< 100	< 100	< 100	< 100	< 100
PHC F3 (>C16-C34 range)	µg/L	n/v	< 200	-	-	-	< 200	< 200	< 200	< 200	< 200	< 200
PHC F4 (>C34-C50 range)	µg/L	n/v	< 200	-	-	-	< 200	< 200	< 200	< 200	< 200	< 200
Chromatogram to baseline at nC50	µg/L	n/v	YES	-	-	-	YES	YES	YES	YES	YES	YES
Metals Dissolved												
Aluminum	µg/L	75^C	5	-	17	15	< 5	8	9	9	-	-
Calcium	µg/L	n/v	9100	-	-	-	650	4500	4500	6800	-	-
Magnesium	µg/L	n/v	930	-	-	-	62	380	370	760	-	-
Metals Total												
Antimony	µg/L	20^C	< 0.50	-	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	-	-
Arsenic	µg/L	100^A 5^C	< 1.0	-	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	-	-
Beryllium	µg/L	1100_{s3}^A	< 0.50	-	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	-	-
Boron	µg/L	200_a^C	< 10	-	< 10	-	< 10	< 10	< 10	< 10	-	-
Cadmium	µg/L	0.2^A $0.1/0.5_{s12}^C$	< 0.10	-	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	-	-
Chromium (Total)	µg/L	1_{s11}^A	***< 5.0***	-	***< 5.0***	-	***< 5.0***	***< 5.0***	***< 5.0***	***< 5.0***	-	-
Cobalt	µg/L	0.9^A	< 0.50	-	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	-	-
Copper	µg/L	5^A $1/5_{s13}^C$	1.2	-	< 1.0	-	1.0	< 1.0	**1.3^C**	< 1.0	-	-
Iron	µg/L	300^A	< 100	-	< 100	-	110	< 100	< 100	< 100	-	-
Lead	µg/L	$5/10/20/25_{s14}^A$ $1/3/5_{s15}^C$	< 0.50	-	< 0.50	-	0.69	< 0.50	< 0.50	< 0.50	-	-
Molybdenum	µg/L	40^C	< 0.50	-	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	-	-
Nickel	µg/L	25^A	< 1.0	-	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	-	-
Selenium	µg/L	100^A	< 2.0	-	< 2.0	-	< 2.0	< 2.0	< 2.0	< 2.0	-	-
Silver	µg/L	0.1^A	< 0.10	-	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	-	-
Tellurium	µg/L	n/v	< 1.0	-	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	-	-
Thallium	µg/L	0.3_b^C	0.063	-	< 0.050	-	< 0.050	< 0.050	< 0.050	< 0.050	-	-
Tungsten	µg/L	30_a^C	< 1.0	-	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	-	-
Uranium	µg/L	5_a^C	< 0.10	-	0.20	-	< 0.10	< 0.10	< 0.10	< 0.10	-	-
Vanadium	µg/L	6^C	< 0.50	-	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	-	-
Zinc	µg/L	30^A 20^C	**22^C**	-	< 5.0	-	9.3	11	11	9.4	-	-
Zirconium	µg/L	4_a^C	< 1.0	-	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	-	-
Polycyclic Aromatic Hydrocarbons												
Acenaphthene	µg/L	n/v	< 0.050	-	-	-	< 0.050	< 0.050	< 0.050	< 0.050	-	-
Acenaphthylene	µg/L	n/v	< 0.050	-	-	-	< 0.050	< 0.050	< 0.050	< 0.050	-	-
Anthracene	µg/L	0.0008_a^C	***< 0.050***	-	-	-	***< 0.050***	***< 0.050***	***< 0.050***	***< 0.050***	-	-
Benzo(a)anthracene	µg/L	0.0004_a^C	***< 0.050***	-	-	-	***< 0.050***	***< 0.050***	***< 0.050***	***< 0.050***	-	-
Benzo(a)pyrene	µg/L	n/v	< 0.010	-	-	-	< 0.010	< 0.010	< 0.010	< 0.010	-	-
Benzo(b/j)fluoranthene	µg/L	n/v	< 0.050	-	-	-	< 0.050	< 0.050	< 0.050	< 0.050	-	-
Benzo(g,h,i)perylene	µg/L	0.00002_a^C	***< 0.050***	-	-	-	***< 0.050***	***< 0.050***	***< 0.050***	***< 0.050***	-	-
Benzo(k)fluoranthene	µg/L	0.0002_a^C	***< 0.050***	-	-	-	***< 0.050***	***< 0.050***	***< 0.050***	***< 0.050***	-	-
Chrysene	µg/L	0.0001_a^C	***< 0.050***	-	-	-	***< 0.050***	***< 0.050***	***< 0.050***	***< 0.050***	-	-
Dibenzo(a,h)anthracene	µg/L	0.002_a^C	***< 0.050***	-	-	-	***< 0.050***	***< 0.050***	***< 0.050***	***< 0.050***	-	-
Fluoranthene	µg/L	0.0008_a^C	***< 0.050***	-	-	-	***< 0.050***	***< 0.050***	***< 0.050***	***< 0.050***	-	-
Fluorene	µg/L	0.2_a^C	< 0.050	-	-	-	< 0.050	< 0.050	< 0.050	< 0.050	-	-
Indeno(1,2,3-cd)pyrene	µg/L	n/v	< 0.050	-	-	-	< 0.050	< 0.050	< 0.050	< 0.050	-	-
Methylnaphthalene (Total)	µg/L	n/v	< 0.071	-	-	-	< 0.071	< 0.071	< 0.071	< 0.071	-	-
Methylnaphthalene, 1-	µg/L	2_b^C	< 0.050	-	-	-	< 0.050	< 0.050	< 0.050	< 0.050	-	-
Methylnaphthalene, 2-	µg/L	2_b^C	< 0.050	-	-	-	< 0.050	< 0.050	< 0.050	< 0.050	-	-
Naphthalene	µg/L	7_a^C	< 0.050	-	-	-	< 0.050	< 0.050	< 0.050	< 0.050	-	-
Phenanthrene	µg/L	0.03_a^C	< 0.030	-	-	-	< 0.030	< 0.030	< 0.030	< 0.030	-	-
Pyrene	µg/L	n/v	< 0.050	-	-	-	< 0.050	< 0.050	< 0.050	< 0.050	-	-

Notes:

PWQO	Provincial Water Quality Objectives of the Ministry of Environment and Energy, July 1994, reprinted February 1999
^{A}	PWQO Table 2
^{B}	PWQO Table 2 - Calc
^{C}	PWQO Table 2 - Interim
6.5^A	Concentration exceeds the indicated standard.
15.2	Concentration was detected but did not exceed applicable standards.
< 0.50	Laboratory reportable detection limit exceeded standard.
< 0.03	The analyte was not detected above the laboratory reportable detection limit.
n/v	No standard/guideline value.
-	Parameter not analyzed / not available.
$_a$	This Interim PWQO was set for emergency purposes based on the best information readily available. Employ due caution when applying this value.
$_b$	This Interim PWQO is currently under development. The value is subject to change upon publication by MOE.
$_{s3}$	The PWQO for beryllium is hardness dependent. If hardness <75 mg/L than PWQO is 0.011 mg/L. For hardness > 75 mg/L, PWQO is 1.1 mg/L.
$_{s10}$	The PWQO value for Total Xylenes is 72 ug/L, which represents the most conservative individual value for the m-, p- and o-xylene isomers.
$_{s11}$	The value for hexavalent chromium has been applied for analysis of total chromium.
$_{s12}$	The interim PWQO for cadmium is hardness dependent. If hardness <100 mg/L than PWQO is 0.0001 mg/L. For hardness >100 mg/L, PWQO is 0.0005 mg/L.
$_{s13}$	The interim PWQO for copper is hardness dependent. If hardness <20 mg/L than PWQO is 0.001 mg/L. For hardness >20 mg/L, PWQO is 0.005 mg/L.
$_{s14}$	PWQO for lead is alkalinity dependent. For alkalinity <20 mg/L, PWQO is 0.005 mg/L. For alkalinity between 20-40 mg/L, PWQO is 0.01 mg/L. For alkalinity between 40-80 mg/L, PWQO is 0.02 mg/L. For alkalinity >80 mg/L, PWQO is 0.025 mg/L.
$_{s15}$	Interim PWQO for lead is hardness dependent. For hardness <30 mg/L, interim PWQO is 0.001 mg/L. For hardness between 30-80 mg/L, interim PWQO is 0.003 mg/L. For hardness >80 mg/L, interim PWQO is 0.005 mg/L.
$_{s16}$	Alkalinity should not be decreased by more than 25% of the natural concentration.
$_{s17}$	The PWQO value for m&p-Xylenes is 2 ug/L, which represents the most conservative individual value for the m- and p-xylene isomers.



TS1-1 : 1 m	
	04/10/2014
Anthracene	1.4
Benzo(a)anthracene	0.85
Benzo(a)pyrene	0.61
Benzo(g,h,i)perylene	0.36
Benzo(k)fluoranthene	0.32
Chrysene	0.50
Dibenzo(a,h)anthracene	0.081
Fluoranthene	2.7
Fluorene	0.57
Indeno(1,2,3-cd)pyrene	0.37
Lead	130
Phenanthrene	3.3
Pyrene	2.1

TS2-3 : 10 m	
	04/10/2014
Chromium (Total)	30
Copper	23
Lead	46
Nickel	24

TS2-2 : 8.4 m	
	04/10/2014
Copper	18
Lead	89/60
Nickel	17
Phenanthrene	0.65

TS2-1 : 9.1 m	
	04/10/2014
Benzo(g,h,i)perylene	0.20
Cadmium	0.64
Chromium (Total)	36
Copper	29
Lead	50
Nickel	26
Zinc	140

TR-3 : 9.1 m	
	04/11/2014
Benzo(a)anthracene	0.34
Benzo(g,h,i)perylene	0.24
Chromium (Total)	36
Copper	22
Fluoranthene	0.82
Indeno(1,2,3-cd)pyrene	0.25
Lead	32
Nickel	27
Pyrene	0.66

TR-2 : 7.9 m	
	04/11/2014
Benzo(a)anthracene	0.36
Benzo(g,h,i)perylene	0.26
Chromium (Total)	36
Fluoranthene	0.82
Indeno(1,2,3-cd)pyrene	0.27
Nickel	23
Pyrene	0.66

TR-1 : 6.1 m	
	04/11/2014
Benzo(g,h,i)perylene	0.18
Nickel	17

TS3-3 : 10.9 m	
	04/11/2014
Anthracene	0.39
Benzo(a)anthracene	1.8
Benzo(a)pyrene	1.7
Benzo(g,h,i)perylene	1.1
Benzo(k)fluoranthene	0.89
Chromium (Total)	83
Chrysene	1.6
Copper	58
Dibenzo(a,h)anthracene	0.26
Fluoranthene	4.7
Indeno(1,2,3-cd)pyrene	1.1
Lead	94
Nickel	54
Phenanthrene	1.8
Pyrene	3.6
Silver	0.58
Zinc	160

Stantec

Legend

- Approximate Site Boundary
- Sediment Sample Location (Stantec)
- Parameters Tested Do Not Exceed Regulatory Standards (Table 9)
- Parameters Tested Exceed Regulatory Standards (Table 9)

Sample ID — TR-1 : 6.1 m — Sample Depth
04/11/2014 — Sample Date
Parameter — Nickel | 17 — Value (µg/g)

MOE Table 9 SCS	
Constituent	Standard (µg/g)
Anthracene	0.22
Benzo(a)anthracene	0.32
Benzo(a)pyrene	0.37
Benzo(g,h,i)perylene	0.17
Benzo(k)fluoranthene	0.24
Cadmium	0.6
Chromium (Total)	26
Chrysene	0.34
Copper	16
Dibenzo(a,h)anthracene	0.06
Fluoranthene	0.75
Fluorene	0.19
Indeno(1,2,3-cd)pyrene	0.2
Lead	31
Nickel	16
Phenanthrene	0.56
Pyrene	0.49
Silver	0.5
Zinc	120

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2013.
3. Orthoimagery © First Base Solutions, 2013.

May 2014
122120153

Client/Project

Town of Midland
Supplemental Phase II ESA
288 and 420 Bayshore Drive

Figure No.
6

Title

Sediment Analytical Results, Table 9 SCS

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Legend

- Approximate Site Boundary
- Approximate Surface Water Sample Location (Stantec)
- Parameters Tested Do Not Exceed Regulatory Standards (Table 2)
- Parameters Tested Exceed Regulatory Standards (Table 2)

Sample ID — TS1-1
Sample Date — 04/10/2014
Parameter — Zinc
Duplicate Value (Õg/L) — 22 / 21
Value (Õg/L)

(PWOO)	
Constituent	**Standard (µg/L)**
Copper	1
Zinc	20

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources É Queen's Printer for Ontario, 2013.
3. Orthoimagery É First Base Solutions, 2013.

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122120153

Client/Project
Town of Midland
Supplemental Phase II ESA
288 and 420 Bayshore Drive

Figure No.
7

Title
Surface Water Analytical Results, PWQO

Your P.O. #: 16300R-20
Your Project #: 122120153
Your C.O.C. #: 46609801, 466098-01-01

Attention: Karen Wright
Stantec Consulting Ltd
835 Paramount Drive, Suite 200
Stoney Creek, ON
L8J 0B4

Report Date: 2014/04/22
Report #: R3007878
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B459583
Received: 2014/04/14, 13:05

Sample Matrix: Water
Samples Received: 7

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Methylnaphthalene Sum	5	N/A	2014/04/21	CAM SOP-00301	EPA 8270
Dissolved Aluminum (0.2 u, clay free)	5	N/A	2014/04/17	CAM SOP-00447	SW846, 6020
Alkalinity	5	N/A	2014/04/17	CAM SOP-00448	SM 2320B
Petroleum Hydro. CCME F1 & BTEX in Water	6	N/A	2014/04/17	CAM SOP-00315	CCME CWS
Petroleum Hydro. CCME F1 & BTEX in Water	1	N/A	2014/04/21	CAM SOP-00315	CCME CWS
Petroleum Hydrocarbons F2-F4 in Water	7	2014/04/19	2014/04/21	CAM SOP-00316	CCME Hydrocarbons
Hardness (calculated as CaCO3)	5	N/A	2014/04/22	CAM SOP 00102/00408/00447	SM 2340 B
Dissolved Metals by ICPMS	5	N/A	2014/04/21	CAM SOP-00447	EPA 6020
Total Metals Analysis by ICPMS	5	N/A	2014/04/17	CAM SOP-00447	EPA 6020
PAH Compounds in Water by GC/MS (SIM)	5	2014/04/16	2014/04/17	CAM SOP-00318	EPA 8270

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. Reporting results to two significant figures at the RDL is to permit statistical evaluation and is not intended to be an indication of analytical precision.

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

* Results relate only to the items tested.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B459583
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Maria Contreras, Project Manager
Email: MContreras@maxxam.ca
Phone# (905) 817-5700

==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

Maxxam Job #: B459583
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

RESULTS OF ANALYSES OF WATER

Maxxam ID		VN6467	VN6468	VN6469	VN6470	VN6473		
Sampling Date		2014/04/10 10:51	2014/04/10 14:45	2014/04/11 10:00	2014/04/11 10:00	2014/04/11 11:00		
	Units	**TS1-1**	**TS2-3**	**TS3-1**	**DUP2**	**TR-3**	**RDL**	**QC Batch**
Calculated Parameters								
Hardness (CaCO3)	mg/L	27	1.9	13	13	20	1.0	3572953
Inorganics								
Alkalinity (Total as CaCO3)	mg/L	23	1.9	16	16	26	1.0	3576488

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B459583
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID		VN6467	VN6468	VN6469	VN6470	VN6473		
Sampling Date		2014/04/10 10:51	2014/04/10 14:45	2014/04/11 10:00	2014/04/11 10:00	2014/04/11 11:00		
	Units	**TS1-1**	**TS2-3**	**TS3-1**	**DUP2**	**TR-3**	**RDL**	**QC Batch**
Metals								
Dissolved (0.2u) Aluminum (Al)	ug/L	5	<5	8	9	9	5	3576671
Total Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	3576670
Total Arsenic (As)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	3576670
Total Beryllium (Be)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	3576670
Total Boron (B)	ug/L	<10	<10	<10	<10	<10	10	3576670
Total Cadmium (Cd)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	3576670
Dissolved Calcium (Ca)	ug/L	9100	650	4500	4500	6800	200	3576816
Total Chromium (Cr)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	3576670
Total Cobalt (Co)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	3576670
Total Copper (Cu)	ug/L	1.2	1.0	<1.0	1.3	<1.0	1.0	3576670
Total Iron (Fe)	ug/L	<100	110	<100	<100	<100	100	3576670
Total Lead (Pb)	ug/L	<0.50	0.69	<0.50	<0.50	<0.50	0.50	3576670
Dissolved Magnesium (Mg)	ug/L	930	62	380	370	760	50	3576816
Total Molybdenum (Mo)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	3576670
Total Nickel (Ni)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	3576670
Total Selenium (Se)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	3576670
Total Silver (Ag)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	3576670
Total Tellurium (Te)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	3576670
Total Thallium (Tl)	ug/L	0.063	<0.050	<0.050	<0.050	<0.050	0.050	3576670
Total Tungsten (W)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	3576670
Total Uranium (U)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	3576670
Total Vanadium (V)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	3576670
Total Zinc (Zn)	ug/L	22	9.3	11	11	9.4	5.0	3576670
Total Zirconium (Zr)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	3576670

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B459583
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

SEMI-VOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		VN6467	VN6468	VN6469	VN6470	VN6473		
Sampling Date		2014/04/10 10:51	2014/04/10 14:45	2014/04/11 10:00	2014/04/11 10:00	2014/04/11 11:00		
	Units	**TS1-1**	**TS2-3**	**TS3-1**	**DUP2**	**TR-3**	**RDL**	**QC Batch**
Calculated Parameters								
Methylnaphthalene, 2-(1-)	ug/L	<0.071	<0.071	<0.071	<0.071	<0.071	0.071	3572550
Polyaromatic Hydrocarbons								
Acenaphthene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
Acenaphthylene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
Anthracene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
Benzo(a)anthracene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
Benzo(a)pyrene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	3576026
Benzo(b/j)fluoranthene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
Benzo(g,h,i)perylene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
Benzo(k)fluoranthene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
Chrysene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
Dibenz(a,h)anthracene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
Fluoranthene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
Fluorene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
Indeno(1,2,3-cd)pyrene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
1-Methylnaphthalene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
2-Methylnaphthalene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
Naphthalene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
Phenanthrene	ug/L	<0.030	<0.030	<0.030	<0.030	<0.030	0.030	3576026
Pyrene	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	3576026
Surrogate Recovery (%)								
D10-Anthracene	%	98	97	100	98	94		3576026
D14-Terphenyl (FS)	%	90	89	92	89	90		3576026
D8-Acenaphthylene	%	94	95	99	96	95		3576026

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Job #: B459583
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

PETROLEUM HYDROCARBONS (CCME)

Maxxam ID		VN6467	VN6468	VN6469	VN6470	VN6471	VN6472	VN6473		
Sampling Date		2014/04/10 10:51	2014/04/10 14:45	2014/04/11 10:00	2014/04/11 10:00	2014/04/11 14:30	2014/04/11 14:30	2014/04/11 11:00		
	Units	**TS1-1**	**TS2-3**	**TS3-1**	**DUP2**	**FIELD BLANK**	**TRIP BLANK**	**TR-3**	**RDL**	**QC Batch**
BTEX & F1 Hydrocarbons										
Benzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	3576782
Toluene	ug/L	0.78	0.71	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	3576782
Ethylbenzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	3576782
o-Xylene	ug/L	<0.20	0.22	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	3576782
p+m-Xylene	ug/L	0.46	0.59	<0.40	<0.40	<0.40	<0.40	<0.40	0.40	3576782
Total Xylenes	ug/L	0.46	0.81	<0.40	<0.40	<0.40	<0.40	<0.40	0.40	3576782
F1 (C6-C10)	ug/L	<25	<25	<25	37	<25	<25	<25	25	3576782
F1 (C6-C10) - BTEX	ug/L	<25	<25	<25	37	<25	<25	<25	25	3576782
F2-F4 Hydrocarbons										
F2 (C10-C16 Hydrocarbons)	ug/L	<100	<100	<100	<100	<100	<100	<100	100	3578051
F3 (C16-C34 Hydrocarbons)	ug/L	<200	<200	<200	<200	<200	<200	<200	200	3578051
F4 (C34-C50 Hydrocarbons)	ug/L	<200	<200	<200	<200	<200	<200	<200	200	3578051
Reached Baseline at C50	ug/L	YES	YES	YES	YES	YES	YES	YES		3578051
Surrogate Recovery (%)										
1,4-Difluorobenzene	%	99	100	100	101	100	99	100		3576782
4-Bromofluorobenzene	%	98	99	100	99	98	98	100		3576782
D10-Ethylbenzene	%	115	118	116	104	113	118	116		3576782
D4-1,2-Dichloroethane	%	97	98	101	100	100	99	100		3576782
o-Terphenyl	%	96	93	86	90	90	85	91		3578051

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Job #: B459583
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

Test Summary

Maxxam ID VN6467
Sample ID TS1-1
Matrix Water

Collected 2014/04/10
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572550	N/A	2014/04/21	Automated Statchk
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	3576671	N/A	2014/04/17	Prempal Bhatti
Alkalinity	PH	3576488	N/A	2014/04/17	Surinder Rai
Petroleum Hydro. CCME F1 & BTEX in Wat	HSGC/MSFD	3576782	N/A	2014/04/17	Haibin Wu
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	3578051	2014/04/19	2014/04/21	Biljana Lazovic
Hardness (calculated as CaCO3)		3572953	N/A	2014/04/22	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	3576816	N/A	2014/04/21	John Bowman
Total Metals Analysis by ICPMS	ICP/MS	3576670	N/A	2014/04/17	John Bowman
PAH Compounds in Water by GC/MS (SIM)	GC/MS	3576026	2014/04/16	2014/04/17	Darryl Tiller

Maxxam ID VN6467 Dup
Sample ID TS1-1
Matrix Water

Collected 2014/04/10
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Wat	HSGC/MSFD	3576782	N/A	2014/04/17	Haibin Wu

Maxxam ID VN6468
Sample ID TS2-3
Matrix Water

Collected 2014/04/10
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572550	N/A	2014/04/21	Automated Statchk
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	3576671	N/A	2014/04/17	Prempal Bhatti
Alkalinity	PH	3576488	N/A	2014/04/17	Surinder Rai
Petroleum Hydro. CCME F1 & BTEX in Wat	HSGC/MSFD	3576782	N/A	2014/04/17	Haibin Wu
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	3578051	2014/04/19	2014/04/21	Biljana Lazovic
Hardness (calculated as CaCO3)		3572953	N/A	2014/04/22	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	3576816	N/A	2014/04/21	John Bowman
Total Metals Analysis by ICPMS	ICP/MS	3576670	N/A	2014/04/17	John Bowman
PAH Compounds in Water by GC/MS (SIM)	GC/MS	3576026	2014/04/16	2014/04/17	Darryl Tiller

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Maxxam Job #: B459583
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

Test Summary

Maxxam ID VN6469
Sample ID TS3-1
Matrix Water

Collected 2014/04/11
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572550	N/A	2014/04/21	Automated Statchk
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	3576671	N/A	2014/04/17	Prempal Bhatti
Alkalinity	PH	3576488	N/A	2014/04/17	Surinder Rai
Petroleum Hydro. CCME F1 & BTEX in Wat	HSGC/MSFD	3576782	N/A	2014/04/17	Haibin Wu
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	3578051	2014/04/19	2014/04/21	Biljana Lazovic
Hardness (calculated as CaCO3)		3572953	N/A	2014/04/22	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	3576816	N/A	2014/04/21	John Bowman
Total Metals Analysis by ICPMS	ICP/MS	3576670	N/A	2014/04/17	John Bowman
PAH Compounds in Water by GC/MS (SIM)	GC/MS	3576026	2014/04/16	2014/04/17	Darryl Tiller

Maxxam ID VN6470
Sample ID DUP2
Matrix Water

Collected 2014/04/11
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572550	N/A	2014/04/21	Automated Statchk
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	3576671	N/A	2014/04/17	Prempal Bhatti
Alkalinity	PH	3576488	N/A	2014/04/17	Surinder Rai
Petroleum Hydro. CCME F1 & BTEX in Wat	HSGC/MSFD	3576782	N/A	2014/04/21	Haibin Wu
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	3578051	2014/04/19	2014/04/21	Biljana Lazovic
Hardness (calculated as CaCO3)		3572953	N/A	2014/04/22	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	3576816	N/A	2014/04/21	John Bowman
Total Metals Analysis by ICPMS	ICP/MS	3576670	N/A	2014/04/17	John Bowman
PAH Compounds in Water by GC/MS (SIM)	GC/MS	3576026	2014/04/16	2014/04/17	Darryl Tiller

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Maxxam Job #: B459583
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

Test Summary

Maxxam ID VN6471
Sample ID FIELD BLANK
Matrix Water

Collected 2014/04/11
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Wat	HSGC/MSFD	3576782	N/A	2014/04/17	Haibin Wu
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	3578051	2014/04/19	2014/04/21	Biljana Lazovic

Maxxam ID VN6472
Sample ID TRIP BLANK
Matrix Water

Collected 2014/04/11
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Wat	HSGC/MSFD	3576782	N/A	2014/04/17	Haibin Wu
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	3578051	2014/04/19	2014/04/21	Biljana Lazovic

Maxxam ID VN6473
Sample ID TR-3
Matrix Water

Collected 2014/04/11
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572550	N/A	2014/04/21	Automated Statchk
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	3576671	N/A	2014/04/17	Prempal Bhatti
Alkalinity	PH	3576488	N/A	2014/04/17	Surinder Rai
Petroleum Hydro. CCME F1 & BTEX in Wat	HSGC/MSFD	3576782	N/A	2014/04/17	Haibin Wu
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	3578051	2014/04/19	2014/04/21	Biljana Lazovic
Hardness (calculated as CaCO3)		3572953	N/A	2014/04/22	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	3576816	N/A	2014/04/21	John Bowman
Total Metals Analysis by ICPMS	ICP/MS	3576670	N/A	2014/04/17	John Bowman
PAH Compounds in Water by GC/MS (SIM)	GC/MS	3576026	2014/04/16	2014/04/17	Darryl Tiller

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Success Through Science®

Maxxam Job #: B459583
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units
3576026	D10-Anthracene	2014/04/16			92	50 - 130	91	%
3576026	D14-Terphenyl (FS)	2014/04/16			80	50 - 130	75	%
3576026	D8-Acenaphthylene	2014/04/16			93	50 - 130	92	%
3576026	Acenaphthene	2014/04/17			100	50 - 130	<0.050	ug/L
3576026	Acenaphthylene	2014/04/17			107	50 - 130	<0.050	ug/L
3576026	Anthracene	2014/04/17			99	50 - 130	<0.050	ug/L
3576026	Benzo(a)anthracene	2014/04/17			102	50 - 130	<0.050	ug/L
3576026	Benzo(a)pyrene	2014/04/17			102	50 - 130	<0.010	ug/L
3576026	Benzo(b/j)fluoranthene	2014/04/17			106	50 - 130	<0.050	ug/L
3576026	Benzo(g,h,i)perylene	2014/04/17			94	50 - 130	<0.050	ug/L
3576026	Benzo(k)fluoranthene	2014/04/17			105	50 - 130	<0.050	ug/L
3576026	Chrysene	2014/04/17			107	50 - 130	<0.050	ug/L
3576026	Dibenz(a,h)anthracene	2014/04/17			84	50 - 130	<0.050	ug/L
3576026	Fluoranthene	2014/04/17			101	50 - 130	<0.050	ug/L
3576026	Fluorene	2014/04/17			102	50 - 130	<0.050	ug/L
3576026	Indeno(1,2,3-cd)pyrene	2014/04/17			90	50 - 130	<0.050	ug/L
3576026	1-Methylnaphthalene	2014/04/17			81	50 - 130	<0.050	ug/L
3576026	2-Methylnaphthalene	2014/04/17			78	50 - 130	<0.050	ug/L
3576026	Naphthalene	2014/04/17			80	50 - 130	<0.050	ug/L
3576026	Phenanthrene	2014/04/17			104	50 - 130	<0.030	ug/L
3576026	Pyrene	2014/04/17			102	50 - 130	<0.050	ug/L
3576488	Alkalinity (Total as CaCO3)	2014/04/17			96	85 - 115	<1.0	mg/L
3576670	Total Antimony (Sb)	2014/04/17			111	80 - 120	<0.50	ug/L
3576670	Total Arsenic (As)	2014/04/17			111	80 - 120	<1.0	ug/L
3576670	Total Beryllium (Be)	2014/04/17			114	80 - 120	<0.50	ug/L
3576670	Total Boron (B)	2014/04/17			115	80 - 120	<10	ug/L
3576670	Total Cadmium (Cd)	2014/04/17			110	80 - 120	<0.10	ug/L
3576670	Total Chromium (Cr)	2014/04/17			109	80 - 120	<5.0	ug/L
3576670	Total Cobalt (Co)	2014/04/17			110	80 - 120	<0.50	ug/L
3576670	Total Copper (Cu)	2014/04/17			107	80 - 120	<1.0	ug/L
3576670	Total Iron (Fe)	2014/04/17			112	80 - 120	<100	ug/L
3576670	Total Lead (Pb)	2014/04/17			110	80 - 120	<0.50	ug/L
3576670	Total Molybdenum (Mo)	2014/04/17			111	80 - 120	<0.50	ug/L
3576670	Total Nickel (Ni)	2014/04/17			109	80 - 120	<1.0	ug/L
3576670	Total Selenium (Se)	2014/04/17			112	80 - 120	<2.0	ug/L
3576670	Total Silver (Ag)	2014/04/17			109	80 - 120	<0.10	ug/L
3576670	Total Tellurium (Te)	2014/04/17			108	80 - 120	<1.0	ug/L
3576670	Total Thallium (Tl)	2014/04/17			114	80 - 120	<0.050	ug/L
3576670	Total Tungsten (W)	2014/04/17			110	80 - 120	<1.0	ug/L

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QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units
3576670	Total Uranium (U)	2014/04/17			110	80 - 120	<0.10	ug/L
3576670	Total Vanadium (V)	2014/04/17			108	80 - 120	<0.50	ug/L
3576670	Total Zinc (Zn)	2014/04/17			112	80 - 120	5.7, RDL=5.0	ug/L
3576670	Total Zirconium (Zr)	2014/04/17			113	80 - 120	<1.0	ug/L
3576671	Dissolved (0.2u) Aluminum (Al)	2014/04/17			100	80 - 120	<5	ug/L
3576782	1,4-Difluorobenzene	2014/04/17			99	70 - 130	100	%
3576782	4-Bromofluorobenzene	2014/04/17			100	70 - 130	99	%
3576782	D10-Ethylbenzene	2014/04/17			112	70 - 130	114	%
3576782	D4-1,2-Dichloroethane	2014/04/17			97	70 - 130	98	%
3576782	Benzene	2014/04/17	118	70 - 130	111	70 - 130	<0.20	ug/L
3576782	Toluene	2014/04/17	115	70 - 130	107	70 - 130	<0.20	ug/L
3576782	Ethylbenzene	2014/04/17	121	70 - 130	111	70 - 130	<0.20	ug/L
3576782	o-Xylene	2014/04/17	124	70 - 130	113	70 - 130	<0.20	ug/L
3576782	p+m-Xylene	2014/04/17	109	70 - 130	102	70 - 130	<0.40	ug/L
3576782	F1 (C6-C10)	2014/04/17	86	70 - 130	101	70 - 130	<25	ug/L
3576782	Total Xylenes	2014/04/17					<0.40	ug/L
3576782	F1 (C6-C10) - BTEX	2014/04/17					<25	ug/L
3576816	Dissolved Calcium (Ca)	2014/04/21			102	80 - 120	<200	ug/L
3576816	Dissolved Magnesium (Mg)	2014/04/21			102	80 - 120	<50	ug/L
3578051	o-Terphenyl	2014/04/21			97	60 - 130	95	%
3578051	F2 (C10-C16 Hydrocarbons)	2014/04/21			102	60 - 130	<100	ug/L
3578051	F3 (C16-C34 Hydrocarbons)	2014/04/21			99	60 - 130	<200	ug/L
3578051	F4 (C34-C50 Hydrocarbons)	2014/04/21			99	60 - 130	<200	ug/L

N/A = Not Applicable
RDL = Reportable Detection Limit
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

Validation Signature Page

Maxxam Job #: B459583

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Eva Pranjic CHARTERED CHEMIST

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

M. Riskallah

Medhat Riskallah, Manager, Hydrocarbon Department

Suzana Popovic

Suzana Popovic, Supervisor, Hydrocarbons

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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Maxxam IMMEDIATE TEST Maxxam Analytics International Corporation o/a Maxxam Analytics
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STANT

14-Apr-14 13:05
Maria Contreras
B459583
MAF ENV-572

Page 1 of 1

INVOICE INFORMATION:		REPORT INFORMATION(if differs from invoice):		PROJECT INFORMATION:	
Company Name:	#14741 Stantec Consulting Ltd	Company Name:		Quotation #:	B42133 STANTEC
Contact Name:	Accounts Payable	Contact Name:	Karen Wright	Task #:	
Address:	835 Paramount Drive, Suite 200	Address:		Project #:	122120153
	Stoney Creek ON L8J 0B4			Profit Centre:	1221
Phone:	(905) 381-3211 x Fax:	Phone:	(905) 381-3277 Fax:	Site #:	
Email:	Stantec.Accounts.Payable.Invoices@Stantec.com	Email:	Karen.Wright@stantec.com	Sampled By:	TI/DW

Bottle Order #: 466098

Project Manager: Maria Contreras

C#466098-01-01

Regulation 153 (2011): Table1, Table2, Table3, [X] Table 9; Res/Park, Ind/Comm, Agri/Other, Medium/Fine, Coarse, [X] For RSC

Other Regulations: CCME, Reg 558, MISA, [X] PWQO, Other; Sanitary Sewer Bylaw, Storm Sewer Bylaw, Municipality

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? N

Note: For MOE regulated drinking water samples - please use the Drinking Water Chain of Custody Form

SAMPLES MUST BE KEPT COOL (< 10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: [X]
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details

Job Specific Rush TAT (if applies to entire submission)
Date Required: Time Required:
Rush Confirmation Number: (call lab for #)

ANALYSIS REQUESTED (Please be specific):

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Regulated Drinking Water ? (Y/N)	Metals Field Filtered ? (Y/N)	Metals&Inorganics	~~VOC RSC~~ BTEX F1	PAH	PHC F1-F4		Aluminum hardness/alkalinity metals					# of Bottles	Comments
1		TS 1-1	April 10, 2014	10:51	SW	N	Y		X	X	X		X					7	LIMITED RECOVERY
2		TS2-3	April 10, 2014	2:45	SW				X	X	X		X					7	
3		TS 3-1	April 11, 2014	10:00	SW				X	X	X		X					7	
4		Dup 2	April 11 2014	10:00	SW				X	X	X		X					7	
5		FIELD BLANK	April 11, 2014	2:30	SW				X		X							5	
6		TRIP BLANK	April 11 2014	2:30	SW				X		X							7	
7		TR-3	April 11, 2014	11:00	SW				X	X	X		X					7	
8																			
9																			
10																			

*RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	# jars used and not submitted
Michael Stowlis	14/04/14	9:30Am	JENNIFER MCCARTHY	2014/04/14	13:05	0

Laboratory Use Only

Time Sensitive	Temperature (°C) on Receipt	CustodySeal	Yes	No
	1/4/4°C	Present		✓
		Intact		

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

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STANTEC CHAIN OF CUSTODY RECORD

Page 2 of 2

IMMEDIATE TEST

INVOICE INFORMATION:	REPORT INFORMATION(if differs from invoice):	PROJECT INFORMATION:	Laboratory Use Only:
Company Name: #14741 Stantec Consulting Ltd	Company Name:	Quotation #: B42133 STANTEC	Maxxam Job #:
Contact Name: Accounts Payable	Contact Name: Karen Wright	Task #:	Bottle Order #: 466094
Address: 835 Paramount Drive, Suite 200 Stoney Creek ON L8J 0B4	Address:	Project #: 122120153	Chain of Custody #: C#466094-02-01
Phone: (905) 381-3211 x Fax:	Phone: (905) 381-3277 Fax:	Profit Centre: 1221	Project Manager: Maria Contreras
Email: Stantec.Accounts.Payable.Invoices@Stantec.com	Email: Karen.Wright@stantec.com	Site #: Sampled By: TI/RW	

Regulation 153 (2011): [ ] Table1 [ ] Table2 [ ] Table3 [X] Table 9; [ ] Res/Park [ ] Ind/Comm [ ] Agri/Other; [ ] Medium/Fine [ ] Coarse [X] For RSC

Other Regulations: [ ] CCME [ ] Reg 558 [ ] MISA [ ] PWQO [ ] Other ____; [ ] Sanitary Sewer Bylaw [ ] Storm Sewer Bylaw; Municipality ____

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ____

Note: For MOE regulated drinking water samples - please use the Drinking Water Chain of Custody Form

SAMPLES MUST BE KEPT COOL (< 10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

Turnaround Time (TAT) Required:

Please provide advance notice for rush projects

Regular (Standard) TAT: [X]
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission) [ ]
Date Required: ____ Time Required: ____
Rush Confirmation Number: ____ (call lab for #)

ANALYSIS REQUESTED (Please be specific):

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Regulated Drinking Water ? (Y / N)	Metals Field Filtered ? (Y / N)	BTEX PHC F1 to F4	PAHs	Metals&Inorganics Package							# of Bottles	Comments
1		Dup	April 10, 2013		SO	N	N	X	X	X							5	LIMITED RECOVERY
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

*RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	# jars used and not submitted
/ TRENT/RWIF	14/04/14	9:30	Jennifer McCarthy	2014/04/14	13:05	

Laboratory Use Only				
Time Sensitive	Temperature (°C) on Receipt	CustodySeal	Yes	No
	1/4/4°C	Present		✓
		Intact		

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics

Your P.O. #: 16300R-20
Your Project #: 122120153
Your C.O.C. #: 46623501, 466235-01-01

Attention: Karen Wright
Stantec Consulting Ltd
835 Paramount Drive, Suite 200
Stoney Creek, ON
L8J 0B4

Report Date: 2014/04/22
Report #: R3008308
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B459615
Received: 2014/04/14, 13:05

Sample Matrix: Soil
Samples Received: 11

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Methylnaphthalene Sum	11	N/A	2014/04/17	CAM SOP-00301	EPA 8270
Hot Water Extractable Boron	10	2014/04/17	2014/04/18	CAM SOP-00408	R153 Ana. Prot. 2011
Hot Water Extractable Boron	1	2014/04/21	2014/04/21	CAM SOP-00408	R153 Ana. Prot. 2011
Free (WAD) Cyanide	11	N/A	2014/04/17	CAM SOP-00457	Ontario MOE CN-E3015
Conductivity	11	N/A	2014/04/21	CAM SOP-00414	MOE LSB E3138 v2
Hexavalent Chromium in Soil by IC (1)	11	2014/04/17	2014/04/21	CAM SOP-00436	EPA SW846-3060/7199
Petroleum Hydro. CCME F1 & BTEX in Soil	11	2014/04/14	2014/04/20	CAM SOP-00315	CCME CWS
Petroleum Hydrocarbons F2-F4 in Soil	2	2014/04/17	2014/04/17	CAM SOP-00316	CCME CWS
Petroleum Hydrocarbons F2-F4 in Soil	9	2014/04/17	2014/04/18	CAM SOP-00316	CCME CWS
F4G (CCME Hydrocarbons Gravimetric)	5	2014/04/22	2014/04/22	CAM SOP-00316	CCME CWS
Acid Extr. Metals (aqua regia) by ICPMS	10	2014/04/17	2014/04/17	CAM SOP-00447	EPA 6020
Acid Extr. Metals (aqua regia) by ICPMS	1	2014/04/21	2014/04/21	CAM SOP-00447	EPA 6020
Moisture	11	N/A	2014/04/16	CAM SOP-00445	R.Carter,1993
PAH Compounds in Soil by GC/MS (SIM)	10	2014/04/15	2014/04/15	CAM SOP - 00318	EPA 8270
PAH Compounds in Soil by GC/MS (SIM)	1	2014/04/15	2014/04/16	CAM SOP - 00318	EPA 8270
pH CaCl2 EXTRACT	11	2014/04/17	2014/04/17	CAM SOP-00413	SM 4500H+ B
Sodium Adsorption Ratio (SAR)	11	2014/04/14	2014/04/21	CAM SOP-00102	EPA 6010

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. Reporting results to two significant figures at the RDL is to permit statistical evaluation and is not intended to be an indication of analytical precision.

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

* Results relate only to the items tested.

(1) Soils are reported on a dry weight basis unless otherwise specified.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Maria Contreras, Project Manager
Email: MContreras@maxxam.ca
Phone# (905) 817-5700

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

Maxxam Job #: B459615
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

RESULTS OF ANALYSES OF SOIL

Maxxam ID		VN6547	VN6548	VN6549	VN6550	VN6551	VN6552		
Sampling Date		2014/04/10	2014/04/10	2014/04/10	2014/04/10	2014/04/10	2014/04/10		
	Units	**TS1-1**	**TS1-3**	**TS1-4**	**TS2-1**	**TS2-2**	**TS2-3**	**RDL**	**QC Batch**
Calculated Parameters									
Sodium Adsorption Ratio	N/A	0.28	0.37	0.92	9.3	0.72	0.52		3572438
Inorganics									
Chromium (VI)	ug/g	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	3576582
Conductivity	mS/cm	0.16	0.19	0.40	2.9	0.40	0.38	0.002	3578630
Free Cyanide	ug/g	<0.01	<0.01	<0.01	0.06	0.03	0.03	0.01	3576419
Moisture	%	23	26	37	66	58	58	1.0	3576464
Available (CaCl2) pH	pH	7.12	6.90	7.18	6.28	7.03	6.21		3577013

Maxxam ID		VN6553	VN6554	VN6555	VN6556		VN6557		
Sampling Date		2014/04/11	2014/04/11	2014/04/11	2014/04/11		2014/04/10		
	Units	**TS3-3**	**TR-1**	**TR-2**	**TR-3**	**QC Batch**	**DUP**	**RDL**	**QC Batch**
Calculated Parameters									
Sodium Adsorption Ratio	N/A	44	0.30	0.41	0.38	3572438	0.58		3573057
Inorganics									
Chromium (VI)	ug/g	<0.2	<0.2	<0.2	<0.2	3576582	<0.2	0.2	3576582
Conductivity	mS/cm	5.3	0.18	0.23	0.28	3578630	0.34	0.002	3578630
Free Cyanide	ug/g	0.05	0.01	0.02	0.02	3576419	0.03	0.01	3576419
Moisture	%	53	31	45	40	3576464	59	1.0	3576464
Available (CaCl2) pH	pH	6.84	6.67	6.33	6.33	3577013	7.01		3577013

N/A = Not Applicable
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		VN6547	VN6548	VN6549		VN6550		VN6551	VN6552		
Sampling Date		2014/04/10	2014/04/10	2014/04/10		2014/04/10		2014/04/10	2014/04/10		
	Units	**TS1-1**	**TS1-3**	**TS1-4**	**QC Batch**	**TS2-1**	**QC Batch**	**TS2-2**	**TS2-3**	**RDL**	**QC Batch**
Metals											
Hot Water Ext. Boron (B)	ug/g	0.12	0.18	0.22	3576812	0.56	3578468	0.19	0.38	0.050	3576812
Acid Extractable Antimony (Sb)	ug/g	0.34	<0.20	<0.20	3576797	0.57	3578487	0.23	0.31	0.20	3576797
Acid Extractable Arsenic (As)	ug/g	1.7	<1.0	1.3	3576797	3.9	3578487	3.3	3.7	1.0	3576797
Acid Extractable Barium (Ba)	ug/g	19	10	24	3576797	130	3578487	110	100	0.50	3576797
Acid Extractable Beryllium (Be)	ug/g	<0.20	<0.20	<0.20	3576797	0.58	3578487	0.33	0.42	0.20	3576797
Acid Extractable Boron (B)	ug/g	<5.0	<5.0	<5.0	3576797	6.4	3578487	5.8	7.2	5.0	3576797
Acid Extractable Cadmium (Cd)	ug/g	<0.10	<0.10	0.14	3576797	0.64	3578487	0.37	0.44	0.10	3576797
Acid Extractable Chromium (Cr)	ug/g	5.7	3.3	6.9	3576797	36	3578487	20	30	1.0	3576797
Acid Extractable Cobalt (Co)	ug/g	1.9	1.5	2.5	3576797	9.4	3578487	6.6	7.5	0.10	3576797
Acid Extractable Copper (Cu)	ug/g	3.3	5.1	14	3576797	29	3578487	18	23	0.50	3576797
Acid Extractable Lead (Pb)	ug/g	130	5.3	12	3576797	50	3578487	89	46	1.0	3576797
Acid Extractable Molybdenum (Mo)	ug/g	<0.50	<0.50	<0.50	3576797	<0.50	3578487	<0.50	<0.50	0.50	3576797
Acid Extractable Nickel (Ni)	ug/g	2.9	2.7	4.9	3576797	26	3578487	17	24	0.50	3576797
Acid Extractable Selenium (Se)	ug/g	<0.50	<0.50	<0.50	3576797	0.81	3578487	<0.50	0.68	0.50	3576797
Acid Extractable Silver (Ag)	ug/g	<0.20	<0.20	<0.20	3576797	0.26	3578487	<0.20	0.21	0.20	3576797
Acid Extractable Thallium (Tl)	ug/g	<0.050	<0.050	<0.050	3576797	0.20	3578487	0.13	0.18	0.050	3576797
Acid Extractable Uranium (U)	ug/g	0.36	0.22	0.28	3576797	0.94	3578487	0.53	0.76	0.050	3576797
Acid Extractable Vanadium (V)	ug/g	12	7.4	12	3576797	36	3578487	22	29	5.0	3576797
Acid Extractable Zinc (Zn)	ug/g	31	14	30	3576797	140	3578487	88	100	5.0	3576797
Acid Extractable Mercury (Hg)	ug/g	<0.050	<0.050	<0.050	3576797	0.11	3578487	0.063	0.080	0.050	3576797

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam

Maxxam Job #: B459615
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		VN6553		VN6554		VN6555	VN6556	VN6557		
Sampling Date		2014/04/11		2014/04/11		2014/04/11	2014/04/11	2014/04/10		
	Units	**TS3-3**	**QC Batch**	**TR-1**	**QC Batch**	**TR-2**	**TR-3**	**DUP**	**RDL**	**QC Batch**
Metals										
Hot Water Ext. Boron (B)	ug/g	0.76	3576812	0.25	3576726	0.34	0.30	0.17	0.050	3576812
Acid Extractable Antimony (Sb)	ug/g	1.1	3576797	<0.20	3576709	<0.20	0.30	0.36	0.20	3576797
Acid Extractable Arsenic (As)	ug/g	3.1	3576797	1.4	3576709	1.4	1.8	3.1	1.0	3576797
Acid Extractable Barium (Ba)	ug/g	120	3576797	43	3576709	52	59	81	0.50	3576797
Acid Extractable Beryllium (Be)	ug/g	0.38	3576797	<0.20	3576709	0.20	0.25	0.30	0.20	3576797
Acid Extractable Boron (B)	ug/g	5.1	3576797	<5.0	3576709	<5.0	<5.0	10	5.0	3576797
Acid Extractable Cadmium (Cd)	ug/g	0.53	3576797	0.29	3576709	0.37	0.38	0.39	0.10	3576797
Acid Extractable Chromium (Cr)	ug/g	83	3576797	24	3576709	36	36	18	1.0	3576797
Acid Extractable Cobalt (Co)	ug/g	6.3	3576797	3.5	3576709	4.3	5.0	6.1	0.10	3576797
Acid Extractable Copper (Cu)	ug/g	58	3576797	13	3576709	16	22	15	0.50	3576797
Acid Extractable Lead (Pb)	ug/g	94	3576797	20	3576709	25	32	60	1.0	3576797
Acid Extractable Molybdenum (Mo)	ug/g	0.88	3576797	<0.50	3576709	<0.50	<0.50	0.59	0.50	3576797
Acid Extractable Nickel (Ni)	ug/g	54	3576797	17	3576709	23	27	15	0.50	3576797
Acid Extractable Selenium (Se)	ug/g	<0.50	3576797	<0.50	3576709	<0.50	<0.50	0.51	0.50	3576797
Acid Extractable Silver (Ag)	ug/g	0.58	3576797	<0.20	3576709	<0.20	<0.20	<0.20	0.20	3576797
Acid Extractable Thallium (Tl)	ug/g	0.16	3576797	0.069	3576709	0.089	0.11	0.12	0.050	3576797
Acid Extractable Uranium (U)	ug/g	0.62	3576797	0.43	3576709	0.44	0.56	0.47	0.050	3576797
Acid Extractable Vanadium (V)	ug/g	25	3576797	17	3576709	20	21	20	5.0	3576797
Acid Extractable Zinc (Zn)	ug/g	160	3576797	53	3576709	67	78	91	5.0	3576797
Acid Extractable Mercury (Hg)	ug/g	0.18	3576797	<0.050	3576709	<0.050	0.086	0.070	0.050	3576797

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B459615
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

SEMI-VOLATILE ORGANICS BY GC-MS (SOIL)

Maxxam ID		VN6547	VN6548		VN6549		VN6550		VN6551	VN6552		
Sampling Date		2014/04/10	2014/04/10		2014/04/10		2014/04/10		2014/04/10	2014/04/10		
	Units	**TS1-1**	**TS1-3**	**RDL**	**TS1-4**	**RDL**	**TS2-1**	**RDL**	**TS2-2**	**TS2-3**	**RDL**	**QC Batch**
Calculated Parameters												
Methylnaphthalene, 2-(1-)	ug/g	0.066	0.0093	0.0071	0.056	0.014	0.21	0.028	2.4	0.32	0.014	3572624
Polyaromatic Hydrocarbons												
Acenaphthene	ug/g	0.22	<0.0050	0.0050	<0.010	0.010	<0.030(1)	0.030	0.10	0.025	0.010	3574422
Acenaphthylene	ug/g	0.011	<0.0050	0.0050	<0.010	0.010	0.029	0.020	0.025	0.025	0.010	3574422
Anthracene	ug/g	1.4	<0.0050	0.0050	0.019	0.010	0.065	0.020	0.073	0.064	0.010	3574422
Benzo(a)anthracene	ug/g	0.85	0.0093	0.0050	0.050	0.010	0.22	0.020	0.17	0.18	0.010	3574422
Benzo(a)pyrene	ug/g	0.61	0.0099	0.0050	0.046	0.010	0.23	0.020	0.14	0.18	0.010	3574422
Benzo(b/j)fluoranthene	ug/g	0.85	0.017	0.0050	0.074	0.010	0.39	0.020	0.22	0.29	0.010	3574422
Benzo(g,h,i)perylene	ug/g	0.36	0.0075	0.0050	0.036	0.010	0.20	0.020	0.099	0.15	0.010	3574422
Benzo(k)fluoranthene	ug/g	0.32	0.0058	0.0050	0.027	0.010	0.13	0.020	0.075	0.11	0.010	3574422
Chrysene	ug/g	0.50	0.011	0.0050	0.043	0.010	0.20	0.020	0.14	0.17	0.010	3574422
Dibenz(a,h)anthracene	ug/g	0.081	<0.0050	0.0050	<0.010	0.010	0.040	0.020	0.023	0.031	0.010	3574422
Fluoranthene	ug/g	2.7	0.027	0.0050	0.12	0.010	0.53	0.020	0.36	0.46	0.010	3574422
Fluorene	ug/g	0.57	<0.0050	0.0050	<0.010	0.010	0.029	0.020	0.15	0.040	0.010	3574422
Indeno(1,2,3-cd)pyrene	ug/g	0.37	0.0075	0.0050	0.036	0.010	0.20	0.020	0.095	0.14	0.010	3574422
1-Methylnaphthalene	ug/g	0.052	<0.0050	0.0050	0.015	0.010	0.055	0.020	1.0	0.14	0.010	3574422
2-Methylnaphthalene	ug/g	0.014	0.0093	0.0050	0.041	0.010	0.15	0.020	1.4	0.19	0.010	3574422
Naphthalene	ug/g	0.017	<0.0050	0.0050	0.018	0.010	0.044	0.020	1.2	0.11	0.010	3574422
Phenanthrene	ug/g	3.3	0.012	0.0050	0.077	0.010	0.25	0.020	0.65	0.32	0.010	3574422
Pyrene	ug/g	2.1	0.021	0.0050	0.094	0.010	0.44	0.020	0.30	0.37	0.010	3574422
Surrogate Recovery (%)												
D10-Anthracene	%	87	86		89		88		86	89		3574422
D14-Terphenyl (FS)	%	106	103		102		100		102	105		3574422
D8-Acenaphthylene	%	87	87		87		84		85	88		3574422

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
(1) - Detection Limit was raised due to matrix interferences.

SEMI-VOLATILE ORGANICS BY GC-MS (SOIL)

Maxxam ID		VN6553		VN6554		VN6555	VN6556	VN6557		
Sampling Date		2014/04/11		2014/04/11		2014/04/11	2014/04/11	2014/04/10		
	Units	**TS3-3**	**RDL**	**TR-1**	**RDL**	**TR-2**	**TR-3**	**DUP**	**RDL**	**QC Batch**
Calculated Parameters										
Methylnaphthalene, 2-(1-)	ug/g	0.17	0.014	0.025	0.0071	0.035	0.040	0.21	0.014	3572624
Polyaromatic Hydrocarbons										
Acenaphthene	ug/g	0.14	0.010	0.021	0.0050	0.022	0.027	0.023	0.010	3574422
Acenaphthylene	ug/g	0.069	0.010	0.038	0.0050	0.043	0.035	0.016	0.010	3574422
Anthracene	ug/g	0.39	0.010	0.071	0.0050	0.092	0.096	0.052	0.010	3574422
Benzo(a)anthracene	ug/g	1.8	0.010	0.26	0.0050	0.36	0.34	0.16	0.010	3574422
Benzo(a)pyrene	ug/g	1.7	0.010	0.26	0.0050	0.37	0.34	0.14	0.010	3574422
Benzo(b/j)fluoranthene	ug/g	2.5	0.010	0.37	0.0050	0.53	0.51	0.25	0.010	3574422
Benzo(g,h,i)perylene	ug/g	1.1	0.010	0.18	0.0050	0.26	0.24	0.11	0.010	3574422
Benzo(k)fluoranthene	ug/g	0.89	0.010	0.13	0.0050	0.20	0.18	0.081	0.010	3574422
Chrysene	ug/g	1.6	0.010	0.21	0.0050	0.30	0.29	0.13	0.010	3574422
Dibenz(a,h)anthracene	ug/g	0.26	0.010	0.042	0.0050	0.060	0.057	0.023	0.010	3574422
Fluoranthene	ug/g	4.7	0.010	0.53	0.0050	0.82	0.82	0.40	0.010	3574422
Fluorene	ug/g	0.16	0.010	0.023	0.0050	0.028	0.032	0.028	0.010	3574422
Indeno(1,2,3-cd)pyrene	ug/g	1.1	0.010	0.19	0.0050	0.27	0.25	0.12	0.010	3574422
1-Methylnaphthalene	ug/g	0.061	0.010	0.0078	0.0050	0.013	0.014	0.084	0.010	3574422
2-Methylnaphthalene	ug/g	0.11	0.010	0.017	0.0050	0.022	0.026	0.13	0.010	3574422
Naphthalene	ug/g	0.11	0.010	0.0091	0.0050	0.019	0.023	0.083	0.010	3574422
Phenanthrene	ug/g	1.8	0.010	0.25	0.0050	0.34	0.39	0.23	0.010	3574422
Pyrene	ug/g	3.6	0.010	0.44	0.0050	0.66	0.66	0.32	0.010	3574422
Surrogate Recovery (%)										
D10-Anthracene	%	91		87		85	89	90		3574422
D14-Terphenyl (FS)	%	95		102		101	106	104		3574422
D8-Acenaphthylene	%	87		85		82	87	86		3574422

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Job #: B459615
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Sampler Initials: TI

PETROLEUM HYDROCARBONS (CCME)

Maxxam ID		VN6547	VN6548	VN6549		VN6550		VN6551	VN6552		
Sampling Date		2014/04/10	2014/04/10	2014/04/10		2014/04/10		2014/04/10	2014/04/10		
	Units	**TS1-1**	**TS1-3**	**TS1-4**	**RDL**	**TS2-1**	**RDL**	**TS2-2**	**TS2-3**	**RDL**	**QC Batch**
BTEX & F1 Hydrocarbons											
Benzene	ug/g	<0.020	<0.020	<0.020	0.020	<0.060	0.060	<0.040	<0.040	0.040	3578046
Toluene	ug/g	<0.020	0.031	<0.020	0.020	<0.060	0.060	0.11	0.18	0.040	3578046
Ethylbenzene	ug/g	<0.020	<0.020	<0.020	0.020	<0.060	0.060	<0.040	<0.040	0.040	3578046
o-Xylene	ug/g	<0.020	<0.020	<0.020	0.020	<0.060	0.060	<0.040	<0.040	0.040	3578046
p+m-Xylene	ug/g	<0.040	<0.040	<0.040	0.040	<0.12	0.12	<0.080	<0.080	0.080	3578046
Total Xylenes	ug/g	<0.040	<0.040	<0.040	0.040	<0.12	0.12	<0.080	<0.080	0.080	3578046
F1 (C6-C10)	ug/g	<10	<10	<10	10	<30	30	<20	<20	20	3578046
F1 (C6-C10) - BTEX	ug/g	<10	<10	<10	10	<30	30	<20	<20	20	3578046
F2-F4 Hydrocarbons											
F2 (C10-C16 Hydrocarbons)	ug/g	<10	<10	<10	10	<30	30	<20	<20	20	3577042
F3 (C16-C34 Hydrocarbons)	ug/g	100	<50	51	50	400	150	170	240	100	3577042
F4 (C34-C50 Hydrocarbons)	ug/g	<50	<50	<50	50	180	150	<100	<100	100	3577042
Reached Baseline at C50	ug/g	YES	YES	YES		YES		YES	YES		3577042
Surrogate Recovery (%)											
1,4-Difluorobenzene	%	93	93	89		90		91	92		3578046
4-Bromofluorobenzene	%	102	103	102		102		103	102		3578046
D10-Ethylbenzene	%	90	99	85		102		88	98		3578046
D4-1,2-Dichloroethane	%	89	89	89		91		91	91		3578046
o-Terphenyl	%	86	87	89		104		87	93		3577042

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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PETROLEUM HYDROCARBONS (CCME)

Maxxam ID		VN6553		VN6554	VN6555	VN6556		VN6557		
Sampling Date		2014/04/11		2014/04/11	2014/04/11	2014/04/11		2014/04/10		
	Units	**TS3-3**	**RDL**	**TR-1**	**TR-2**	**TR-3**	**RDL**	**DUP**	**RDL**	**QC Batch**
BTEX & F1 Hydrocarbons										
Benzene	ug/g	<0.020	0.020	<0.020	<0.020	<0.020	0.020	<0.040	0.040	3578046
Toluene	ug/g	0.069	0.020	<0.020	<0.020	0.048	0.020	0.21	0.040	3578046
Ethylbenzene	ug/g	<0.020	0.020	<0.020	<0.020	<0.020	0.020	<0.040	0.040	3578046
o-Xylene	ug/g	0.036	0.020	<0.020	<0.020	<0.020	0.020	<0.040	0.040	3578046
p+m-Xylene	ug/g	0.058	0.040	<0.040	<0.040	<0.040	0.040	<0.080	0.080	3578046
Total Xylenes	ug/g	0.094	0.040	<0.040	<0.040	<0.040	0.040	<0.080	0.080	3578046
F1 (C6-C10)	ug/g	<10	10	<10	<10	<10	10	<20	20	3578046
F1 (C6-C10) - BTEX	ug/g	<10	10	<10	<10	<10	10	<20	20	3578046
F2-F4 Hydrocarbons										
F4G-sg (Grav. Heavy Hydrocarbons)	ug/g	1900	100	760	610	490	100	720	100	3579700
F2 (C10-C16 Hydrocarbons)	ug/g	22	20	<10	<10	<10	10	<20	20	3577042
F3 (C16-C34 Hydrocarbons)	ug/g	760	100	83	120	110	50	160	100	3577042
F4 (C34-C50 Hydrocarbons)	ug/g	420	100	81	69	60	50	<100	100	3577042
Reached Baseline at C50	ug/g	NO		NO	NO	NO		NO		3577042
Surrogate Recovery (%)										
1,4-Difluorobenzene	%	92		92	92	92		91		3578046
4-Bromofluorobenzene	%	106		102	104	103		103		3578046
D10-Ethylbenzene	%	88		108	99	99		99		3578046
D4-1,2-Dichloroethane	%	90		90	90	89		92		3578046
o-Terphenyl	%	90		89	89	88		88		3577042

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B459615
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

Test Summary

Maxxam ID VN6547
Sample ID TS1-1
Matrix Soil

Collected 2014/04/10
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572624	N/A	2014/04/17	Automated Statchk
Hot Water Extractable Boron	ICP	3576812	2014/04/17	2014/04/18	Suban Kanapathippllai
Free (WAD) Cyanide	TECH	3576419	N/A	2014/04/17	Xuanhong Qiu
Conductivity	COND	3578630	N/A	2014/04/21	Lemeneh Addis
Hexavalent Chromium in Soil by IC	IC/SPEC	3576582	2014/04/17	2014/04/21	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	3578046	2014/04/14	2014/04/20	Abdi Mohamud
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	3577042	2014/04/17	2014/04/17	Barbara Wowk
Acid Extr. Metals (aqua regia) by ICPMS	ICP/MS	3576797	2014/04/17	2014/04/17	Viviana Canzonieri
Moisture	BAL	3576464	N/A	2014/04/16	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	3574422	2014/04/15	2014/04/15	Darryl Tiller
pH CaCl2 EXTRACT		3577013	2014/04/17	2014/04/17	Neil Dassanayake
Sodium Adsorption Ratio (SAR)	CALC/MET	3572438	2014/04/21	2014/04/21	Automated Statchk

Maxxam ID VN6547 Dup
Sample ID TS1-1
Matrix Soil

Collected 2014/04/10
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	3578046	2014/04/14	2014/04/20	Abdi Mohamud

Maxxam ID VN6548
Sample ID TS1-3
Matrix Soil

Collected 2014/04/10
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572624	N/A	2014/04/17	Automated Statchk
Hot Water Extractable Boron	ICP	3576812	2014/04/17	2014/04/18	Suban Kanapathippllai
Free (WAD) Cyanide	TECH	3576419	N/A	2014/04/17	Xuanhong Qiu
Conductivity	COND	3578630	N/A	2014/04/21	Lemeneh Addis
Hexavalent Chromium in Soil by IC	IC/SPEC	3576582	2014/04/17	2014/04/21	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	3578046	2014/04/14	2014/04/20	Abdi Mohamud

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Maxxam Job #: B459615
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

Test Summary

Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	3577042	2014/04/17	2014/04/17	Barbara Wowk
Acid Extr. Metals (aqua regia) by ICPMS	ICP/MS	3576797	2014/04/17	2014/04/17	Viviana Canzonieri
Moisture	BAL	3576464	N/A	2014/04/16	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	3574422	2014/04/15	2014/04/15	Darryl Tiller
pH CaCl2 EXTRACT		3577013	2014/04/17	2014/04/17	Neil Dassanayake
Sodium Adsorption Ratio (SAR)	CALC/MET	3572438	2014/04/21	2014/04/21	Automated Statchk

Maxxam ID VN6549
Sample ID TS1-4
Matrix Soil

Collected 2014/04/10
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572624	N/A	2014/04/17	Automated Statchk
Hot Water Extractable Boron	ICP	3576812	2014/04/17	2014/04/18	Suban Kanapathippllai
Free (WAD) Cyanide	TECH	3576419	N/A	2014/04/17	Xuanhong Qiu
Conductivity	COND	3578630	N/A	2014/04/21	Lemeneh Addis
Hexavalent Chromium in Soil by IC	IC/SPEC	3576582	2014/04/17	2014/04/21	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	3578046	2014/04/14	2014/04/20	Abdi Mohamud
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	3577042	2014/04/17	2014/04/18	Barbara Wowk
Acid Extr. Metals (aqua regia) by ICPMS	ICP/MS	3576797	2014/04/17	2014/04/17	Viviana Canzonieri
Moisture	BAL	3576464	N/A	2014/04/16	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	3574422	2014/04/15	2014/04/15	Darryl Tiller
pH CaCl2 EXTRACT		3577013	2014/04/17	2014/04/17	Neil Dassanayake
Sodium Adsorption Ratio (SAR)	CALC/MET	3572438	2014/04/21	2014/04/21	Automated Statchk

Maxxam ID VN6550
Sample ID TS2-1
Matrix Soil

Collected 2014/04/10
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572624	N/A	2014/04/17	Automated Statchk
Hot Water Extractable Boron	ICP	3578468	2014/04/21	2014/04/21	Jolly John
Free (WAD) Cyanide	TECH	3576419	N/A	2014/04/17	Xuanhong Qiu
Conductivity	COND	3578630	N/A	2014/04/21	Lemeneh Addis
Hexavalent Chromium in Soil by IC	IC/SPEC	3576582	2014/04/17	2014/04/21	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	3578046	2014/04/14	2014/04/20	Abdi Mohamud

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Test Summary

Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	3577042	2014/04/17	2014/04/18	Barbara Wowk
Acid Extr. Metals (aqua regia) by ICPMS	ICP/MS	3578487	2014/04/21	2014/04/21	John Bowman
Moisture	BAL	3576464	N/A	2014/04/16	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	3574422	2014/04/15	2014/04/15	Darryl Tiller
pH CaCl2 EXTRACT		3577013	2014/04/17	2014/04/17	Neil Dassanayake
Sodium Adsorption Ratio (SAR)	CALC/MET	3572438	2014/04/21	2014/04/21	Automated Statchk

Maxxam ID VN6551
Sample ID TS2-2
Matrix Soil

Collected 2014/04/10
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572624	N/A	2014/04/17	Automated Statchk
Hot Water Extractable Boron	ICP	3576812	2014/04/17	2014/04/18	Suban Kanapathippllai
Free (WAD) Cyanide	TECH	3576419	N/A	2014/04/17	Xuanhong Qiu
Conductivity	COND	3578630	N/A	2014/04/21	Lemeneh Addis
Hexavalent Chromium in Soil by IC	IC/SPEC	3576582	2014/04/17	2014/04/21	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	3578046	2014/04/14	2014/04/20	Abdi Mohamud
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	3577042	2014/04/17	2014/04/18	Barbara Wowk
Acid Extr. Metals (aqua regia) by ICPMS	ICP/MS	3576797	2014/04/17	2014/04/17	Viviana Canzonieri
Moisture	BAL	3576464	N/A	2014/04/16	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	3574422	2014/04/15	2014/04/15	Darryl Tiller
pH CaCl2 EXTRACT		3577013	2014/04/17	2014/04/17	Neil Dassanayake
Sodium Adsorption Ratio (SAR)	CALC/MET	3572438	2014/04/21	2014/04/21	Automated Statchk

Maxxam ID VN6552
Sample ID TS2-3
Matrix Soil

Collected 2014/04/10
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572624	N/A	2014/04/17	Automated Statchk
Hot Water Extractable Boron	ICP	3576812	2014/04/17	2014/04/18	Suban Kanapathippllai
Free (WAD) Cyanide	TECH	3576419	N/A	2014/04/17	Xuanhong Qiu
Conductivity	COND	3578630	N/A	2014/04/21	Lemeneh Addis
Hexavalent Chromium in Soil by IC	IC/SPEC	3576582	2014/04/17	2014/04/21	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	3578046	2014/04/14	2014/04/20	Abdi Mohamud

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Test Summary

Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	3577042	2014/04/17	2014/04/18	Barbara Wowk
Acid Extr. Metals (aqua regia) by ICPMS	ICP/MS	3576797	2014/04/17	2014/04/17	Viviana Canzonieri
Moisture	BAL	3576464	N/A	2014/04/16	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	3574422	2014/04/15	2014/04/15	Darryl Tiller
pH CaCl2 EXTRACT		3577013	2014/04/17	2014/04/17	Neil Dassanayake
Sodium Adsorption Ratio (SAR)	CALC/MET	3572438	2014/04/21	2014/04/21	Automated Statchk

Maxxam ID VN6553
Sample ID TS3-3
Matrix Soil

Collected 2014/04/11
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572624	N/A	2014/04/17	Automated Statchk
Hot Water Extractable Boron	ICP	3576812	2014/04/17	2014/04/18	Suban Kanapathippllai
Free (WAD) Cyanide	TECH	3576419	N/A	2014/04/17	Xuanhong Qiu
Conductivity	COND	3578630	N/A	2014/04/21	Lemeneh Addis
Hexavalent Chromium in Soil by IC	IC/SPEC	3576582	2014/04/17	2014/04/21	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	3578046	2014/04/14	2014/04/20	Abdi Mohamud
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	3577042	2014/04/17	2014/04/18	Barbara Wowk
F4G (CCME Hydrocarbons Gravimetric)	BAL	3579700	2014/04/22	2014/04/22	Raheela Usmani
Acid Extr. Metals (aqua regia) by ICPMS	ICP/MS	3576797	2014/04/17	2014/04/17	Viviana Canzonieri
Moisture	BAL	3576464	N/A	2014/04/16	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	3574422	2014/04/15	2014/04/15	Darryl Tiller
pH CaCl2 EXTRACT		3577013	2014/04/17	2014/04/17	Neil Dassanayake
Sodium Adsorption Ratio (SAR)	CALC/MET	3572438	2014/04/21	2014/04/21	Automated Statchk

Maxxam ID VN6554
Sample ID TR-1
Matrix Soil

Collected 2014/04/11
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572624	N/A	2014/04/17	Automated Statchk
Hot Water Extractable Boron	ICP	3576726	2014/04/17	2014/04/18	Suban Kanapathippllai
Free (WAD) Cyanide	TECH	3576419	N/A	2014/04/17	Xuanhong Qiu
Conductivity	COND	3578630	N/A	2014/04/21	Lemeneh Addis
Hexavalent Chromium in Soil by IC	IC/SPEC	3576582	2014/04/17	2014/04/21	Sally Coughlin

Maxxam Job #: B459615
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

Test Summary

Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	3578046	2014/04/14	2014/04/20	Abdi Mohamud
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	3577042	2014/04/17	2014/04/18	Barbara Wowk
F4G (CCME Hydrocarbons Gravimetric)	BAL	3579700	2014/04/22	2014/04/22	Raheela Usmani
Acid Extr. Metals (aqua regia) by ICPMS	ICP/MS	3576709	2014/04/17	2014/04/17	Viviana Canzonieri
Moisture	BAL	3576464	N/A	2014/04/16	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	3574422	2014/04/15	2014/04/15	Darryl Tiller
pH CaCl2 EXTRACT		3577013	2014/04/17	2014/04/17	Neil Dassanayake
Sodium Adsorption Ratio (SAR)	CALC/MET	3572438	2014/04/21	2014/04/21	Automated Statchk

Maxxam ID VN6555
Sample ID TR-2
Matrix Soil

Collected 2014/04/11
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572624	N/A	2014/04/17	Automated Statchk
Hot Water Extractable Boron	ICP	3576812	2014/04/17	2014/04/18	Suban Kanapathippllai
Free (WAD) Cyanide	TECH	3576419	N/A	2014/04/17	Xuanhong Qiu
Conductivity	COND	3578630	N/A	2014/04/21	Lemeneh Addis
Hexavalent Chromium in Soil by IC	IC/SPEC	3576582	2014/04/17	2014/04/21	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	3578046	2014/04/14	2014/04/20	Abdi Mohamud
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	3577042	2014/04/17	2014/04/18	Barbara Wowk
F4G (CCME Hydrocarbons Gravimetric)	BAL	3579700	2014/04/22	2014/04/22	Raheela Usmani
Acid Extr. Metals (aqua regia) by ICPMS	ICP/MS	3576797	2014/04/17	2014/04/17	Viviana Canzonieri
Moisture	BAL	3576464	N/A	2014/04/16	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	3574422	2014/04/15	2014/04/15	Darryl Tiller
pH CaCl2 EXTRACT		3577013	2014/04/17	2014/04/17	Neil Dassanayake
Sodium Adsorption Ratio (SAR)	CALC/MET	3572438	2014/04/21	2014/04/21	Automated Statchk

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Maxxam Job #: B459615
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

Test Summary

Maxxam ID VN6556
Sample ID TR-3
Matrix Soil

Collected 2014/04/11
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572624	N/A	2014/04/17	Automated Statchk
Hot Water Extractable Boron	ICP	3576812	2014/04/17	2014/04/18	Suban Kanapathippllai
Free (WAD) Cyanide	TECH	3576419	N/A	2014/04/17	Xuanhong Qiu
Conductivity	COND	3578630	N/A	2014/04/21	Lemeneh Addis
Hexavalent Chromium in Soil by IC	IC/SPEC	3576582	2014/04/17	2014/04/21	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	3578046	2014/04/14	2014/04/20	Abdi Mohamud
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	3577042	2014/04/17	2014/04/18	Barbara Wowk
F4G (CCME Hydrocarbons Gravimetric)	BAL	3579700	2014/04/22	2014/04/22	Raheela Usmani
Acid Extr. Metals (aqua regia) by ICPMS	ICP/MS	3576797	2014/04/17	2014/04/17	Viviana Canzonieri
Moisture	BAL	3576464	N/A	2014/04/16	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	3574422	2014/04/15	2014/04/15	Darryl Tiller
pH CaCl2 EXTRACT		3577013	2014/04/17	2014/04/17	Neil Dassanayake
Sodium Adsorption Ratio (SAR)	CALC/MET	3572438	2014/04/21	2014/04/21	Automated Statchk

Maxxam ID VN6557
Sample ID DUP
Matrix Soil

Collected 2014/04/10
Shipped
Received 2014/04/14

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	3572624	N/A	2014/04/17	Automated Statchk
Hot Water Extractable Boron	ICP	3576812	2014/04/17	2014/04/18	Suban Kanapathippllai
Free (WAD) Cyanide	TECH	3576419	N/A	2014/04/17	Xuanhong Qiu
Conductivity	COND	3578630	N/A	2014/04/21	Lemeneh Addis
Hexavalent Chromium in Soil by IC	IC/SPEC	3576582	2014/04/17	2014/04/21	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	3578046	2014/04/14	2014/04/20	Abdi Mohamud
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	3577042	2014/04/17	2014/04/18	Barbara Wowk
F4G (CCME Hydrocarbons Gravimetric)	BAL	3579700	2014/04/22	2014/04/22	Raheela Usmani
Acid Extr. Metals (aqua regia) by ICPMS	ICP/MS	3576797	2014/04/17	2014/04/17	Viviana Canzonieri
Moisture	BAL	3576464	N/A	2014/04/16	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	3574422	2014/04/15	2014/04/16	Darryl Tiller
pH CaCl2 EXTRACT		3577013	2014/04/17	2014/04/17	Neil Dassanayake
Sodium Adsorption Ratio (SAR)	CALC/MET	3573057	2014/04/21	2014/04/21	Automated Statchk

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GENERAL COMMENTS

Custody seal was not present on the cooler.

Sample VN6547-01: SAR Analysis: Sodium was not detected. To report SAR the sodium detection limit was used in the calculation. This value represents a maximum ratio.

Sample VN6549-01: PAH Analysis: Detection limits were adjusted for high moisture content.

Sample VN6550-01: PAH Analysis: Detection limits were adjusted for high moisture content.

F1- BTEX & F2-F4 Analysis: Detection limits were adjusted for high moisture content and sample weight.

Sample VN6551-01: PAH Analysis: Detection limits were adjusted for high moisture content.

F1- BTEX & F2-F4 Analysis: Detection limits were adjusted for high moisture content and sample weight.

Sample VN6552-01: PAH Analysis: Detection limits were adjusted for high moisture content.

F1- BTEX & F2-F4 Analysis: Detection limits were adjusted for high moisture content and sample weight.

Sample VN6553-01: PAH Analysis: Detection limits were adjusted for high moisture content.
F2-F4 Analysis: Detection limits were adjusted for high moisture content and sample weight.

Sample VN6554-01: SAR Analysis: Sodium was not detected. To report SAR the sodium detection limit was used in the calculation. This value represents a maximum ratio.

Sample VN6555-01: PAH Analysis: Detection limits were adjusted for high moisture content.

Sample VN6556-01: PAH Analysis: Detection limits were adjusted for high moisture content.

Sample VN6557-01: PAH Analysis: Detection limits were adjusted for high moisture content.
F1- BTEX & F2-F4 Analysis: Detection limits were adjusted for high moisture content and sample weight.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B459615
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	% Recovery	QC Limits
3574422	D10-Anthracene	2014/04/15			84	50 - 130	89	%		
3574422	D14-Terphenyl (FS)	2014/04/15			69	50 - 130	98	%		
3574422	D8-Acenaphthylene	2014/04/15			85	50 - 130	87	%		
3574422	Acenaphthene	2014/04/15			94	50 - 130	<0.0050	ug/g		
3574422	Acenaphthylene	2014/04/15			94	50 - 130	<0.0050	ug/g		
3574422	Anthracene	2014/04/15			91	50 - 130	<0.0050	ug/g		
3574422	Benzo(a)anthracene	2014/04/15			90	50 - 130	<0.0050	ug/g		
3574422	Benzo(a)pyrene	2014/04/15			86	50 - 130	<0.0050	ug/g		
3574422	Benzo(b/j)fluoranthene	2014/04/15			87	50 - 130	<0.0050	ug/g		
3574422	Benzo(g,h,i)perylene	2014/04/15			77	50 - 130	<0.0050	ug/g		
3574422	Benzo(k)fluoranthene	2014/04/15			88	50 - 130	<0.0050	ug/g		
3574422	Chrysene	2014/04/15			91	50 - 130	<0.0050	ug/g		
3574422	Dibenz(a,h)anthracene	2014/04/15			70	50 - 130	<0.0050	ug/g		
3574422	Fluoranthene	2014/04/15			92	50 - 130	<0.0050	ug/g		
3574422	Fluorene	2014/04/15			94	50 - 130	<0.0050	ug/g		
3574422	Indeno(1,2,3-cd)pyrene	2014/04/15			70	50 - 130	<0.0050	ug/g		
3574422	1-Methylnaphthalene	2014/04/15			83	50 - 130	<0.0050	ug/g		
3574422	2-Methylnaphthalene	2014/04/15			84	50 - 130	<0.0050	ug/g		
3574422	Naphthalene	2014/04/15			90	50 - 130	<0.0050	ug/g		
3574422	Phenanthrene	2014/04/15			92	50 - 130	<0.0050	ug/g		
3574422	Pyrene	2014/04/15			93	50 - 130	<0.0050	ug/g		
3576419	Free Cyanide	2014/04/17			104	80 - 120	<0.01	ug/g		
3576582	Chromium (VI)	2014/04/21			100	80 - 120	<0.2	ug/g	114	80 - 120
3576709	Acid Extractable Antimony (Sb)	2014/04/17			102	80 - 120	<0.20	ug/g		
3576709	Acid Extractable Arsenic (As)	2014/04/17			100	80 - 120	<1.0	ug/g		
3576709	Acid Extractable Barium (Ba)	2014/04/17			99	80 - 120	<0.50	ug/g		
3576709	Acid Extractable Beryllium (Be)	2014/04/17			101	80 - 120	<0.20	ug/g		
3576709	Acid Extractable Boron (B)	2014/04/17			98	80 - 120	<5.0	ug/g		
3576709	Acid Extractable Cadmium (Cd)	2014/04/17			99	80 - 120	<0.10	ug/g		
3576709	Acid Extractable Chromium (Cr)	2014/04/17			101	80 - 120	<1.0	ug/g		
3576709	Acid Extractable Cobalt (Co)	2014/04/17			103	80 - 120	<0.10	ug/g		
3576709	Acid Extractable Copper (Cu)	2014/04/17			101	80 - 120	0.81, RDL=0.50	ug/g		
3576709	Acid Extractable Lead (Pb)	2014/04/17			106	80 - 120	<1.0	ug/g		
3576709	Acid Extractable Molybdenum (Mo)	2014/04/17			100	80 - 120	<0.50	ug/g		
3576709	Acid Extractable Nickel (Ni)	2014/04/17			102	80 - 120	<0.50	ug/g		
3576709	Acid Extractable Selenium (Se)	2014/04/17			103	80 - 120	<0.50	ug/g		
3576709	Acid Extractable Silver (Ag)	2014/04/17			102	80 - 120	<0.20	ug/g		
3576709	Acid Extractable Thallium (Tl)	2014/04/17			95	80 - 120	<0.050	ug/g		
3576709	Acid Extractable Uranium (U)	2014/04/17			104	80 - 120	<0.050	ug/g		

Maxxam Job #: B459615
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	% Recovery	QC Limits
3576709	Acid Extractable Vanadium (V)	2014/04/17			101	80 - 120	<5.0	ug/g		
3576709	Acid Extractable Zinc (Zn)	2014/04/17			104	80 - 120	<5.0	ug/g		
3576709	Acid Extractable Mercury (Hg)	2014/04/17			109	80 - 120	<0.050	ug/g		
3576726	Hot Water Ext. Boron (B)	2014/04/17			102	75 - 125	<0.050	ug/g		
3576797	Acid Extractable Antimony (Sb)	2014/04/17			99	80 - 120	<0.20	ug/g		
3576797	Acid Extractable Arsenic (As)	2014/04/17			97	80 - 120	<1.0	ug/g		
3576797	Acid Extractable Barium (Ba)	2014/04/17			96	80 - 120	<0.50	ug/g		
3576797	Acid Extractable Beryllium (Be)	2014/04/17			99	80 - 120	<0.20	ug/g		
3576797	Acid Extractable Boron (B)	2014/04/17			95	80 - 120	<5.0	ug/g		
3576797	Acid Extractable Cadmium (Cd)	2014/04/17			99	80 - 120	<0.10	ug/g		
3576797	Acid Extractable Chromium (Cr)	2014/04/17			100	80 - 120	<1.0	ug/g		
3576797	Acid Extractable Cobalt (Co)	2014/04/17			102	80 - 120	<0.10	ug/g		
3576797	Acid Extractable Copper (Cu)	2014/04/17			99	80 - 120	<0.50	ug/g		
3576797	Acid Extractable Lead (Pb)	2014/04/17			99	80 - 120	<1.0	ug/g		
3576797	Acid Extractable Molybdenum (Mo)	2014/04/17			96	80 - 120	<0.50	ug/g		
3576797	Acid Extractable Nickel (Ni)	2014/04/17			100	80 - 120	<0.50	ug/g		
3576797	Acid Extractable Selenium (Se)	2014/04/17			101	80 - 120	<0.50	ug/g		
3576797	Acid Extractable Silver (Ag)	2014/04/17			99	80 - 120	<0.20	ug/g		
3576797	Acid Extractable Thallium (Tl)	2014/04/17			90	80 - 120	<0.050	ug/g		
3576797	Acid Extractable Uranium (U)	2014/04/17			94	80 - 120	<0.050	ug/g		
3576797	Acid Extractable Vanadium (V)	2014/04/17			100	80 - 120	<5.0	ug/g		
3576797	Acid Extractable Zinc (Zn)	2014/04/17			100	80 - 120	<5.0	ug/g		
3576797	Acid Extractable Mercury (Hg)	2014/04/17			101	80 - 120	<0.050	ug/g		
3576812	Hot Water Ext. Boron (B)	2014/04/18			101	75 - 125	<0.050	ug/g		
3577042	o-Terphenyl	2014/04/17			87	50 - 130	87	%		
3577042	F2 (C10-C16 Hydrocarbons)	2014/04/18			89	80 - 120	<10	ug/g		
3577042	F3 (C16-C34 Hydrocarbons)	2014/04/18			93	80 - 120	<50	ug/g		
3577042	F4 (C34-C50 Hydrocarbons)	2014/04/18			87	80 - 120	<50	ug/g		
3578046	1,4-Difluorobenzene	2014/04/20			93	60 - 140	90	%		
3578046	4-Bromofluorobenzene	2014/04/20			104	60 - 140	101	%		
3578046	D10-Ethylbenzene	2014/04/20			102	60 - 140	86	%		
3578046	D4-1,2-Dichloroethane	2014/04/20			89	60 - 140	87	%		
3578046	Benzene	2014/04/20	77	60 - 140	91	60 - 140	<0.020	ug/g		
3578046	Toluene	2014/04/20	78	60 - 140	95	60 - 140	<0.020	ug/g		
3578046	Ethylbenzene	2014/04/20	91	60 - 140	109	60 - 140	<0.020	ug/g		
3578046	o-Xylene	2014/04/20	91	60 - 140	109	60 - 140	<0.020	ug/g		
3578046	p+m-Xylene	2014/04/20	82	60 - 140	99	60 - 140	<0.040	ug/g		
3578046	F1 (C6-C10)	2014/04/20	67	60 - 140	97	80 - 120	<10	ug/g		
3578046	Total Xylenes	2014/04/20					<0.040	ug/g		

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Maxxam Job #: B459615
Report Date: 2014/04/22

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TI

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	% Recovery	QC Limits
3578046	F1 (C6-C10) - BTEX	2014/04/20					<10	ug/g		
3578468	Hot Water Ext. Boron (B)	2014/04/21			91	75 - 125	<0.050	ug/g		
3578487	Acid Extractable Antimony (Sb)	2014/04/21			103	80 - 120	<0.20	ug/g		
3578487	Acid Extractable Arsenic (As)	2014/04/21			102	80 - 120	<1.0	ug/g		
3578487	Acid Extractable Barium (Ba)	2014/04/21			100	80 - 120	<0.50	ug/g		
3578487	Acid Extractable Beryllium (Be)	2014/04/21			109	80 - 120	<0.20	ug/g		
3578487	Acid Extractable Boron (B)	2014/04/21			105	80 - 120	<5.0	ug/g		
3578487	Acid Extractable Cadmium (Cd)	2014/04/21			99	80 - 120	<0.10	ug/g		
3578487	Acid Extractable Chromium (Cr)	2014/04/21			102	80 - 120	<1.0	ug/g		
3578487	Acid Extractable Cobalt (Co)	2014/04/21			104	80 - 120	<0.10	ug/g		
3578487	Acid Extractable Copper (Cu)	2014/04/21			101	80 - 120	<0.50	ug/g		
3578487	Acid Extractable Lead (Pb)	2014/04/21			104	80 - 120	<1.0	ug/g		
3578487	Acid Extractable Molybdenum (Mo)	2014/04/21			99	80 - 120	<0.50	ug/g		
3578487	Acid Extractable Nickel (Ni)	2014/04/21			102	80 - 120	<0.50	ug/g		
3578487	Acid Extractable Selenium (Se)	2014/04/21			102	80 - 120	<0.50	ug/g		
3578487	Acid Extractable Silver (Ag)	2014/04/21			102	80 - 120	<0.20	ug/g		
3578487	Acid Extractable Thallium (Tl)	2014/04/21			92	80 - 120	<0.050	ug/g		
3578487	Acid Extractable Uranium (U)	2014/04/21			101	80 - 120	<0.050	ug/g		
3578487	Acid Extractable Vanadium (V)	2014/04/21			100	80 - 120	<5.0	ug/g		
3578487	Acid Extractable Zinc (Zn)	2014/04/21			106	80 - 120	<5.0	ug/g		
3578487	Acid Extractable Mercury (Hg)	2014/04/21			105	80 - 120	<0.050	ug/g		
3578630	Conductivity	2014/04/21			100	90 - 110	<0.002	mS/cm		
3579700	F4G-sg (Grav. Heavy Hydrocarbons)	2014/04/22			98	65 - 135	<100	ug/g		

N/A = Not Applicable
RDL = Reportable Detection Limit
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

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Validation Signature Page

Maxxam Job #: B459615

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Eva Pranjic CHARTERED CHEMIST

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

Medhat Riskallah, Manager, Hydrocarbon Department

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

14-Apr-14 13:05
Maria Contreras
B459615
DKN ENV-597

Maxxam IMMEDIATE TEST — Maxxam Analytics International Corporation o/a Maxxam Analytics
6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel (905) 817-5700 Toll-Free 800-563-6266 Fax (905) 817-5777 www.maxxam.ca

STAN

Page 1 of 2

INVOICE INFORMATION:		REPORT INFORMATION (if differs from invoice):		PROJECT INFORMATION:	
Company Name	#14741 Stantec Consulting Ltd	Company Name		Quotation #	B42133 STANTEC
Contact Name	Accounts Payable	Contact Name	Karen Wright	Task #	
Address	835 Paramount Drive, Suite 200 Stoney Creek ON L8J 0B4	Address		Project #	122120153
				Profit Centre	1221
Phone	(905) 381-3211 x Fax	Phone	(905) 381-3277 Fax	Site #	
Email	Stantec.Accounts.Payable.Invoices@Stantec.com	Email	Karen.Wright@stantec.com	Sampled By	TI/PW

Only: Bottle Order #: 466235
Chain of Custody #: C#466235-01-01
Project Manager: Maria Contreras

Regulation 153 (2011): ☐ Table1 ☐ Res/Park ☐ Medium/Fine; ☐ Table2 ☐ Ind/Comm ☐ Coarse; ☐ Table3 ☐ Agri/Other; ☒ Table 9 ☒ For RSC

Other Regulations: ☐ CCME ☐ Reg 558 ☐ MISA ☐ PWQO ☐ Other ☐ Sanitary Sewer Bylaw ☐ Storm Sewer Bylaw Municipality

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)?

Note: For MOE regulated drinking water samples - please use the Drinking Water Chain of Custody Form

SAMPLES MUST BE KEPT COOL (< 10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects
Regular (Standard) TAT: ☒
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details
Job Specific Rush TAT (if applies to entire submission)
Date Required: Time Required: ☐
Rush Confirmation Number: (call lab for #)

ANALYSIS REQUESTED (Please be specific):

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Regulated Drinking Water ? (Y/N)	Metals Field Filtered ? (Y/N)	O.Reg 153 Dissolved ICPMS Metals (incl. Al)	Hardness (calculated as CaCO3)	Alkalinity	PHC F1-F4	~~VOC RSC~~ BTEX F1	PAH	Metals + Inorganics Package				# of Bottles	Comments
1		TS1-1	April 10 2014		SO	N	N				X	X	X	X				4	LIMITED RECOVERY - Sediment Samples
2		TS1-3	↓		↓	↓	↓				X	X	X	X				↓	↓
3		TS1-4	↓		↓	↓	↓				X	X	X	X				↓	↓
4		TS2-1	↓		↓	↓	↓				X	X	X	X				↓	↓
5		TS2-2	↓		↓	↓	↓				X	X	X	X				↓	↓
6		TS2-3	↓		↓	↓	↓				X	X	X	X				↓	↓
7		TS3-3	April 11 2014		↓	↓	↓				X	X	X	X				↓	↓
8		~~TR1-1~~ TR-1	↓		↓	↓	↓				X	X	X	X				↓	↓
9		TR-2	↓		↓	↓	↓				X	X	X	X				↓	↓
10		TR-3	↓		↓	↓	↓				X	X	X	X				↓	↓

*RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	# jars used and not submitted
Trent Irwin	April 14/14	9:30	Jennifer McCarthy	2014/04/14	13:05	0

Laboratory Use Only

Time Sensitive	Temperature (°C) on Receipt	CustodySeal	Yes	No
	1/3/4°C	Present		—
		Intact		

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics
6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel:(905) 817-5700 Toll-Free:800-563-6266 Fax:(905) 817-5777 www.maxxam.ca

STAN

14-Apr-14 13:05
Maria Contreras
B459615
DKN ENV-597

Page 2 of 2

INVOICE INFORMATION:		REPORT INFORMATION(if differs from invoice):		PROJECT INFORMATION:	
Company Name:	#14741 Stantec Consulting Ltd	Company Name:		Quotation #:	B42133 STANTEC
Contact Name:	Accounts Payable	Contact Name:	Karen Wright	Task #:	
Address:	835 Paramount Drive, Suite 200	Address:		Project #:	122120153
	Stoney Creek ON L8J 0B4			Profit Centre:	1221
Phone:	(905) 381-3211 x Fax:	Phone:	(905) 381-3277 Fax:	Site #:	
Email:	Stantec.Accounts.Payable.Invoices@Stantec.com	Email:	Karen.Wright@stantec.com	Sampled By:	TI/DW

nly:
Bottle Order #: 466094
Chain of Custody #: C#466094-01-01
Project Manager: Maria Contreras

Regulation 153 (2011): Table1, Table2, Table3, [X] Table 9; Res/Park, Ind/Comm, Agri/Other; Medium/Fine, Coarse, [X] For RSC

Other Regulations: CCME, Reg 558, MISA, PWQO, Other; Sanitary Sewer Bylaw, Storm Sewer Bylaw, Municipality

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)?

Note: For MOE regulated drinking water samples - please use the Drinking Water Chain of Custody Form

SAMPLES MUST BE KEPT COOL (< 10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: [X]
(will be applied if Rush TAT is not specified).
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: Time Required:
Rush Confirmation Number: *(call lab for #)*

ANALYSIS REQUESTED (Please be specific):

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Regulated Drinking Water ? (Y / N)	Metals Field Filtered ? (Y / N)	BTEX PHC F1 to F4	PAHs	Metals&Inorganics Package	~~Metals + Hg~~						# of Bottles	Comments
1		Dup	April 10 2014		SO	N	N	X	X	X							4	Limited Sample Recovery
2																		
3																		
4																		sediment sample
5																		
6																		
7																		
8																		
9																		
10																		

*RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	# jars used and not submitted
TREWT/DWIN	Apr 14/14	9:30	Jennifer McCarthy	2014/04/14	13:05	0

Laboratory Use Only

Time Sensitive	Temperature (°C) on Receipt	Custody Seal	Yes	No
	1/3/4°C	Present		/
		Intact		

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

Your P.O. #: 16300R-20
Your Project #: 122120153
Your C.O.C. #: 46609403, 466094-03-01

Attention: Karen Wright
Stantec Consulting Ltd
835 Paramount Drive, Suite 200
Stoney Creek, ON
L8J 0B4

Report Date: 2014/05/09
Report #: R3024415
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B470975
Received: 2014/05/01, 13:20

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Dissolved Aluminum (0.2 u, clay free)	1	N/A	2014/05/08	CAM SOP-00447	SW846, 6020
Alkalinity	1	N/A	2014/05/03	CAM SOP-00448	SM 2320B
Hardness (calculated as CaCO3)	1	N/A	2014/05/06	CAM SOP 00102/00408/00447	SM 2340 B
Total Metals Analysis by ICPMS	1	N/A	2014/05/08	CAM SOP-00447	EPA 6020

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. Reporting results to two significant figures at the RDL is to permit statistical evaluation and is not intended to be an indication of analytical precision.

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

* Results relate only to the items tested.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Maria Contreras, Project Manager
Email: MContreras@maxxam.ca
Phone# (905) 817-5700

==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

Maxxam Job #: B470975
Report Date: 2014/05/09

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TT

RESULTS OF ANALYSES OF WATER

Maxxam ID		VT1438		
Sampling Date		2014/04/28		
	Units	**SW 1**	**RDL**	**QC Batch**
Calculated Parameters				
Hardness (CaCO3)	mg/L	92	1.0	3591131
Inorganics				
Alkalinity (Total as CaCO3)	mg/L	65	1.0	3592428

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam

Success Through Science®

Maxxam Job #: B470975
Report Date: 2014/05/09

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TT

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID		VT1438		
Sampling Date		2014/04/28		
	Units	**SW 1**	**RDL**	**QC Batch**
Metals				
Dissolved (0.2u) Aluminum (Al)	ug/L	17	5	3596808
Total Antimony (Sb)	ug/L	<0.50	0.50	3597371
Total Arsenic (As)	ug/L	<1.0	1.0	3597371
Total Beryllium (Be)	ug/L	<0.50	0.50	3597371
Total Boron (B)	ug/L	<10	10	3597371
Total Cadmium (Cd)	ug/L	<0.10	0.10	3597371
Total Chromium (Cr)	ug/L	<5.0	5.0	3597371
Total Cobalt (Co)	ug/L	<0.50	0.50	3597371
Total Copper (Cu)	ug/L	<1.0	1.0	3597371
Total Iron (Fe)	ug/L	<100	100	3597371
Total Lead (Pb)	ug/L	<0.50	0.50	3597371
Total Molybdenum (Mo)	ug/L	<0.50	0.50	3597371
Total Nickel (Ni)	ug/L	<1.0	1.0	3597371
Total Selenium (Se)	ug/L	<2.0	2.0	3597371
Total Silver (Ag)	ug/L	<0.10	0.10	3597371
Total Tellurium (Te)	ug/L	<1.0	1.0	3597371
Total Thallium (Tl)	ug/L	<0.050	0.050	3597371
Total Tungsten (W)	ug/L	<1.0	1.0	3597371
Total Uranium (U)	ug/L	0.20	0.10	3597371
Total Vanadium (V)	ug/L	<0.50	0.50	3597371
Total Zinc (Zn)	ug/L	<5.0	5.0	3597371
Total Zirconium (Zr)	ug/L	<1.0	1.0	3597371

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Job #: B470975
Report Date: 2014/05/09

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TT

Test Summary

Maxxam ID VT1438
Sample ID SW 1
Matrix Water

Collected 2014/04/28
Shipped
Received 2014/05/01

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	3596808	N/A	2014/05/08	Prempal Bhatti
Alkalinity	PH	3592428	N/A	2014/05/03	Yogesh Patel
Hardness (calculated as CaCO3)		3591131	N/A	2014/05/06	Automated Statchk
Total Metals Analysis by ICPMS	ICP/MS	3597371	N/A	2014/05/08	Prempal Bhatti

Maxxam ID VT1438 Dup
Sample ID SW 1
Matrix Water

Collected 2014/04/28
Shipped
Received 2014/05/01

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	3596808	N/A	2014/05/08	Prempal Bhatti

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

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Maxxam Job #: B470975
Report Date: 2014/05/09

Stantec Consulting Ltd
Client Project #: 122120153

Your P.O. #: 16300R-20
Sampler Initials: TT

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units
3592428	Alkalinity (Total as CaCO3)	2014/05/03			96	85 - 115	<1.0	mg/L
3596808	Dissolved (0.2u) Aluminum (Al)	2014/05/08	104	80 - 120	102	80 - 120	<5	ug/L
3597371	Total Antimony (Sb)	2014/05/08			110	80 - 120	<0.50	ug/L
3597371	Total Arsenic (As)	2014/05/08			101	80 - 120	<1.0	ug/L
3597371	Total Beryllium (Be)	2014/05/08			102	80 - 120	<0.50	ug/L
3597371	Total Boron (B)	2014/05/08			101	80 - 120	<10	ug/L
3597371	Total Cadmium (Cd)	2014/05/08			105	80 - 120	<0.10	ug/L
3597371	Total Chromium (Cr)	2014/05/08			102	80 - 120	<5.0	ug/L
3597371	Total Cobalt (Co)	2014/05/08			102	80 - 120	<0.50	ug/L
3597371	Total Copper (Cu)	2014/05/08			103	80 - 120	<1.0	ug/L
3597371	Total Iron (Fe)	2014/05/08			100	80 - 120	<100	ug/L
3597371	Total Lead (Pb)	2014/05/08			104	80 - 120	<0.50	ug/L
3597371	Total Molybdenum (Mo)	2014/05/08			103	80 - 120	<0.50	ug/L
3597371	Total Nickel (Ni)	2014/05/08			101	80 - 120	<1.0	ug/L
3597371	Total Selenium (Se)	2014/05/08			104	80 - 120	<2.0	ug/L
3597371	Total Silver (Ag)	2014/05/08			103	80 - 120	<0.10	ug/L
3597371	Total Tellurium (Te)	2014/05/08			104	80 - 120	<1.0	ug/L
3597371	Total Thallium (Tl)	2014/05/08			103	80 - 120	<0.050	ug/L
3597371	Total Tungsten (W)	2014/05/08			105	80 - 120	<1.0	ug/L
3597371	Total Uranium (U)	2014/05/08			105	80 - 120	<0.10	ug/L
3597371	Total Vanadium (V)	2014/05/08			102	80 - 120	<0.50	ug/L
3597371	Total Zinc (Zn)	2014/05/08			104	80 - 120	<5.0	ug/L
3597371	Total Zirconium (Zr)	2014/05/08			107	80 - 120	<1.0	ug/L

N/A = Not Applicable

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

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Validation Signature Page

Maxxam Job #: B470975

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Brad Newman, Scientific Specialist

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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STANTE

1-May-14 13:20
Maria Contreras
B470975
CPR ENV-809

Page 1 of 1

IMMEDIATE TEST

INVOICE INFORMATION:		REPORT INFORMATION (if differs from invoice):		PROJECT INFORMATION:	
Company Name:	#14741 Stantec Consulting Ltd	Company Name:		Quotation #:	B42133
Contact Name:	Accounts Payable	Contact Name:	Karen Wright	Task #:	
Address:	835 Paramount Drive, Suite 200	Address:		Project #:	122120153
	Stoney Creek ON L8J 0B4			Profit Centre:	1221
Phone:	(905) 381-3211 x Fax:	Phone:	(905) 381-3277 Fax:	Site #:	
Email:	Stantec.Accounts.Payable.Invoices@Stantec.com	Email:	Karen.Wright@stantec.com	Sampled By:	T/DW

Bottle Order #: 466094

Project Manager: Maria Contreras

C#466094-03-01

Regulation 153 (2011): ☐ Table1 ☐ Table2 ☐ Table3 ☐ Table ___ ☐ Res/Park ☐ Ind/Comm ☐ Agri/Other ☐ Medium/Fine ☐ Coarse ☐ For RSC

Other Regulations: ☐ CCME ☐ Reg 558. ☐ MISA ☒ PWQO ☐ Other ___ ☐ Sanitary Sewer Bylaw ☐ Storm Sewer Bylaw Municipality ___

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ___

Note: For MOE regulated drinking water samples - please use the Drinking Water Chain of Custody Form

SAMPLES MUST BE KEPT COOL (< 10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

ANALYSIS REQUESTED (Please be specific):

Turnaround Time (TAT) Required:

Please provide advance notice for rush projects

Regular (Standard) TAT: ☒
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission) ☐
Date Required: ___ Time Required: ___
Rush Confirmation Number: ___ (call lab for #)

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Regulated Drinking Water ? (Y/N)	Metals Field Filtered ? (Y/N)	BTEX PHC F1 to F4	PAHs	Metals&Inorganics Package	aluminum, hardness alkalinity metals.						# of Bottles	Comments
1		SW 1	April 28 2013	-	SW	N	Y				X						2	General Bottle not filtered for Metals only 2mL 18% Nitric Acid Bottle.
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

*RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	# jars used and not submitted
K Wright	May 1/14	10am	MARIA KERRER	2014/05/01	13:20	0

Laboratory Use Only

Time Sensitive	Temperature (°C) on Receipt	Custody Seal	Yes	No
	0/0/1 °C	Present		✓
		Intact		✓

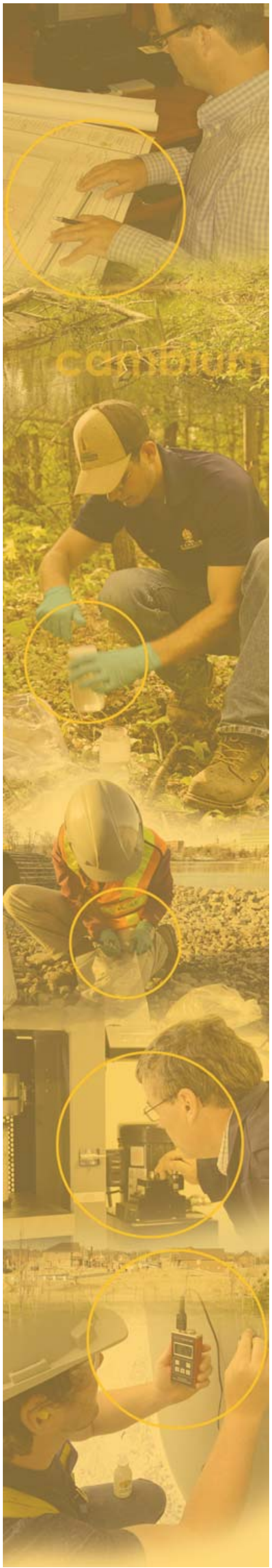
* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

202 554

APPENDIX J

RISK MANGEMENT PLAN INFORMATION



Health and Safety Plan, 420 Bayshore Drive, Midland, Ontario

Cambium Reference No.: 6820-001

2020-02-06

Prepared for: The Town of Midland

Cambium Inc.

P.O. Box 325
52 Hunter Street East, Peterborough
Ontario, K9H 1G5

Telephone: (866) 217.7900
Facsimile: (705) 742.7907

cambium-inc.com

Table of Contents

1.0 Introduction

This Health and Safety Plan (HASP) has been prepared by Cambium Inc. (Cambium) to address the environmental health and safety concerns identified in the Risk Assessment for 420 Bayshore Drive in Midland, Ontario (Site). The Risk Assessment identified risk management measures to protect sub-surface construction/utility workers from contaminants in soil and groundwater.

Specifically, this HASP ensures appropriate protection is in place if a subsurface worker carries out intrusive work in the soil below fill/hard cap. This HASP considers the presence of the site-specific contaminants of concern and direct exposure through dermal contact with soil, incidental soil ingestion, and inhalation of soil particles or vapours. The combination of a fill/hard cap and a HASP, is intended to ensure that subsurface workers are protected.

This HASP is not intended to replace a general health and safety document required for construction sites, but rather to supplement the primary health and safety documents and protocols developed by the site contractor(s).

A copy of this HASP should be provided to future owners of the Site.

2.0 Health and Safety Plan

2.1 Contractors Responsibilities

The Contractor must at all times ensure that the work is conducted in a safe and appropriate manner with due regard for environmental concerns and in accordance with applicable rules, regulations, by-laws, permits and the terms of this HASP. The work is to be conducted in a manner to reduce the impacts, including dust, noise and odours to on-site personnel and the environment.

Those working on the site (either employed by the Contractor or by a subcontractor) must attend a safety meeting organized by the Contractor prior to working on the site. The topics covered by the safety meeting are to include a discussion of measures to protect worker health and safety. The contractor is to maintain a log with signatures of those who attended the safety meeting(s).

All health and safety complaints, accidents and near misses must be reported to the Contractor’s foreman and to the Town. If the report is related to an environmental hazard, the Town’s environmental consultant needs to be included in the reporting correspondence.

2.2 Emergency Information

Hospital:	Georgian Bay General Hospital 1112 St. Andrew's Drive Midland, Ontario L4R 4P4 Phone: (705) 526-1300 (non-emergency)
Emergency Location:	East side of St. Andrew’s Drive
Emergency Number:	911
Fire Department:	Non-emergency (705) 745-3281
Police Detachment:	Non-emergency (705) 876-1122

2.2.1 Hospital Directions

Proceed west on Bayshore Drive. Turn left (south) onto Fourth Street and take the first right (west) onto Dominion Avenue. Continue on Dominion Avenue heading west for 2.1 km to Penetanguishene Road. Turn right (north) onto Penetanguishene Road, then left (west) onto St. Andrew's Drive and follow signs for Emergency. The entrance to the emergency department will be on the right.

2.3 Potential Chemical Hazards

The purpose of this HASP is to identify protective measures, activities, and contingency plans required by contractors working within the existing soil at the site. The chemical parameters identified in this HASP are those which were evaluated by the Risk Assessment as causing potential adverse effects to sub-surface workers, and thus warrant inclusion in this HASP in order to protect workers at the Site.

The major pathways of exposure to the chemical parameters in soil are through direct contact, incidental ingestion, or inhalation.

2.4 Regulatory Aspects

The Risk Assessment process is regulated by Ontario Regulation 153/04 under the *Environmental Protection Act*. The regulation requires a risk management plan to block exposure pathways if risks to human receptors from exposure to contaminants of concern are greater than the regulated “acceptable” risks. This HASP is part of the risk management plan for the Site.

The Risk Assessment identified the following substances at levels for which risk management is required to protect subsurface workers from contact with antimony, arsenic, and lead in soil.

This HASP identifies two substances, arsenic and lead, designated under the Occupational Health and Safety Act. The exposure of workers to these designated substances is controlled by R.R.O. Regulation 843 (Arsenic) and O.Reg. 109/04 (Lead). It is a requirement under these regulations that employers advise workers of the presence of designated substances and ensure that workers are protected from possible adverse short term or chronic effects that may result from exposure to these designated substances.

2.5 Precautionary Measures

Health concerns associated with the concentration of chemical parameters identified at the Site can be addressed by reducing the contact between the worker and the soil at the Site. As a result, workers shall take precautions to reduce contact between the soil, and/or dust and vapours that may be associated with the soil at the site. Specifically, workers shall take the following precautions:

- Work in well ventilated areas
- Retain a respirator with organic vapour cartridges for use when observance of noxious odours or vapours, or if airborne dust is present
- Use gloves that are impervious to the applicable chemicals when handling the soil at the site
- Use appropriate footwear that is impervious to water when in contact with saturated soil
- Remove excess soil and mud from clothes and footwear and change clothes and footwear if they become wet from contact with water, such as if a boot leak develops
- Wash hands and face before eating, drinking and smoking

Workers must wear gloves when handling soil at the Site or when operating equipment that disturbs the soil at the Site. Workers must wear footwear appropriate to the task involved. Leather, rubber or footwear containing a combination of these materials is acceptable provided that the footwear provides an impervious barrier to soil and/or water, whichever is appropriate given the work involved. Workers should change socks and footwear if their feet become wet as a result of a boot leak.

Female workers at the Site who are pregnant should be particularly vigilant in using personal protection equipment and following this HASP to reduce the risk of adverse effects to the fetus.

The Contractor shall be responsible for the safety of the workers on the site. If worker training is required under the Occupational Health and Safety Act or any other applicable act or regulation, the Contractor shall be responsible for conducting such training and providing documentation of training applicable to the conditions at the subject site.

2.6 Personal Protective Equipment

The use of personal protective equipment is mandatory and includes such items as:

- hard hat
- safety vest
- safety boots
- safety glasses
- gloves
- hearing protection (if required during construction)
- dust masks
- half face respirators for organic vapours, dust or other identified environmental concern
- protective coverall (cloth, Tyvek, or equivalent)

All workers involved in intrusive activities on the site are required to wear a hard hat, safety vest, safety boots and safety glasses. Appropriate respiratory protection, including half mask respirators with appropriate cartridges as well as hearing protection must be available on site and be available to any worker who requests these items. Impervious gloves appropriate to the task involved shall be worn by all those working in the vicinity of potentially impacted soil and groundwater.

Prior to leaving an area where impacted soil may be present, the worker shall remove soil and mud from clothing and footwear. Soiled clothing, including clothing saturated with groundwater, is to be deposited in a designated bin for cleaning or disposal by the contractor.

3.0 Implementation

An experienced Health and Safety Officer shall be proposed by the Contractor for approval by the Town and who shall oversee the implementation of the HASP and instruct the Contractor to use different levels of personal protection equipment as the Health and Safety Officer deems appropriate.

All health and safety complaints, accidents and near misses must be reported to the Contractor's foreman and to the Town. If the report is related to an environmental hazard, the Town's environmental consultant needs to be included in the reporting correspondence.

3.1 Notifications

The Town of Peterborough and Cambium shall be notified immediately if any of the following occur:

- Soil with strong odours is encountered during excavation
- A sheen is observed on the surface of water at the Site
- A spill or other incident that is required to be reported to the Ministry of the Environment, Conservation or Parks (Ministry) or other regulatory body
- Any incident that may be of an environmental concern.

APPENDIX K

OTHER SUPPORTING INFORMATION

PLAN OF SURVEY

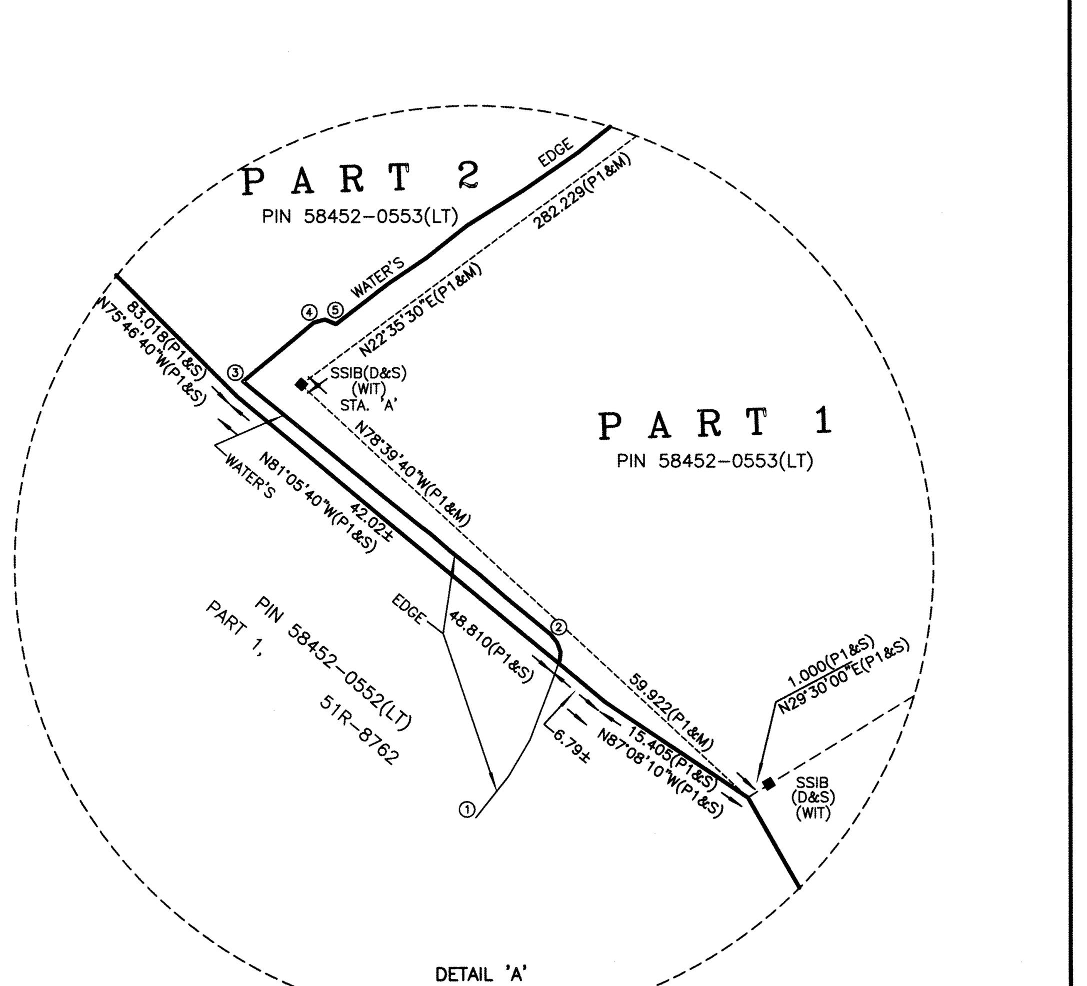
OF PART OF LOTS 107 & 108, CONCESSION 2,
WATER LOT LYING IN FRONT OF LOT 108, CONCESSION 2,
WATER LOTS 'C' AND 'D', CONCESSION 2
IN MIDLAND BAY OF GEORGIAN BAY
PART OF LOTS 1 to 12 (BOTH INCLUSIVE), NORTH SIDE OF FRANK STREET
ALL OF WATER LOTS 1 to 12 (BOTH INCLUSIVE),
PART OF CHARLES STREET, GEORGE STREET & LINDSAY STREET
REGISTERED PLAN 349
CHARLES STREET, GEORGE STREET & LINDSAY STREET
(CLOSED NORTH OF CANADIAN NATIONAL RAILWAY BY REGISTERED PLAN 724)
(GEOGRAPHIC TOWNSHIP OF TAY)
NOW IN THE

TOWN OF MIDLAND
COUNTY OF SIMCOE

0 20 60 100 METRES

SCALE 1 : 1000

J. C. STANTON O.L.S., O.L.I.P., C.L.S.
2021



DETAIL 'A'
(NOT TO SCALE)

TIES TO LOCATE WATER'S EDGE		
STATION	BEARING	DISTANCE
A-1	S52°42'00"E	47.70
A-2	S75°47'00"E	36.00
A-3	S61°48'40"W	6.00
A-4	N19°41'50"E	6.40
A-5	N11°05'00"W	7.00
A-6	N19°41'40"E	58.40
A-7	N20°33'20E	173.50
A-8	N20°41'50"E	265.70
A-9	N21°53'30"E	288.00
B-10	N49°03'00"E	43.95
B-11	N48°12'50"E	56.20
B-12	N40°42'30"E	59.70
B-13	N40°44'00"E	64.25
B-14	N42°59'00"E	68.25
B-15	N61°18'40"E	70.50
B-16	N67°29'40"E	75.90
B-17	N60°16'20"E	102.40
B-18	N61°01'20"E	106.55
B-19	N67°25'30"E	109.35
B-20	N64°59'30"E	114.00
B-21	N54°50'20"E	114.85
B-22	N50°01'20"E	121.15
B-23	N51°41'30"E	124.90
B-24	N56°40'40"E	155.40
B-25	N56°59'50"E	189.70
B-26	N56°27'20"E	223.25
B-27	N56°44'10"E	231.40

TIES TO LOCATE WATER'S EDGE		
STATION	BEARING	DISTANCE
C-28	S49°00'20"W	118.35
C-29	S47°50'20"W	65.35
C-30	S47°23'50"W	51.45
C-31	S48°36'50"W	14.80
C-32	S37°54'00"W	3.20
C-33	N62°53'00"W	2.55
C-34	N68°27'20"E	31.35
C-35	N87°31'30"E	32.30
C-36	S89°00'30"E	54.60
C-37	N88°48'30"E	78.40
C-38	N81°53'00"E	96.20
C-39	N81°51'40"E	106.65
C-40	N79°16'00"E	18.70
D-41	N82°35'00"E	24.25
D-42	N73°27'30"E	70.85
D-43	N76°35'50"E	72.95
D-44	N82°46'20"E	74.75
D-45	S79°04'00"E	99.35
D-46	S71°32'20"E	126.70

I REQUIRE THIS PLAN TO BE DEPOSITED UNDER THE LAND TITLES ACT.

DATE JANAURY 25, 2021

J. C. STANTON
ONTARIO LAND SURVEYOR
CANADA LANDS SURVEYOR

PLAN 51R-

RECEIVED AND DEPOSITED

DATE

REPRESENTATIVE FOR LAND REGISTRAR FOR THE LAND TITLES DIVISION OF SIMCOE '51'

NOTE

DISTANCES AND COORDINATES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048.

SCHEDULE

PART	LOT	PLAN/CON	PIN	AREA
1	PART OF LOTS 107 & 108 PART OF WATER LOT LYING IN FRONT OF LOT 108	2	ALL OF 58452-0553(LT)	13.4122 Ha
	ALL OF WATER LOTS 1 to 12 (INCLUSIVE)	349		
	ALL OF CHARLES STREET, GEORGE STREET AND LINDSAY STREET (CLOSED NORTH OF CANADIAN NATIONAL RAILWAY BY REGISTERED PLAN 724)	724		
	PART OF LOTS 1 to 12 (INCLUSIVE), NORTH SIDE OF FRANK STREET PART OF CHARLES STREET, NORTH SIDE OF FRANK STREET PART OF GEORGE STREET, NORTH SIDE OF FRANK STREET PART OF LINDSAY STREET. NORTH SIDE OF FRANK STREET	349		
2	PART OF LOTS 107 & 108 PART OF WATER LOT LYING IN FRONT OF LOT 108 ALL OF WATER LOT 'C', ALL OF WATER LOT 'D',	2		3.1676 Ha

ALL COORDINATES ARE IN METRES AND WERE DERIVED FROM GPS OBSERVATIONS USING THE CAN-NET NETWORK, AND ARE REFERRED TO UTM ZONE 17, NAD 83 (CSRS, CBNv6-2010.0).

COORDINATE VALUES ARE TO A URBAN ACCURACY IN ACCORDANCE WITH 0.REG.216/10.

POINT ID	NORTHING	EASTING
ORP 1	4956355.114	588279.524
ORP 2	4956805.597	588810.853

CAUTION
COORDINATES CANNOT, IN THEMSELVES, BE USED TO RE-ESTABLISH CORNERS OR BOUNDARIES SHOWN ON THE PLAN.

DISTANCES ON THIS PLAN ARE GROUND DISTANCES AND CAN BE CONVERTED TO GRID DISTANCES BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.99967348.

NOTES:

BEARINGS ARE GRID, DERIVED FROM OBSERVED REFERENCE POINTS 1 AND 2, BY REAL TIME NETWORK (RTN) OBSERVATIONS, UTM ZONE 17, NAD 83 (CSRS, CBNv6-2010.0), HAVING A GRID BEARING OF N49°42'25"E.

650 -DENOTES C.P. O'DALE, O.L.S.
840 -DENOTES J.M. HARVEY, O.L.S.
951 -DENOTES K.I. BEACOM, O.L.S.
1094 -DENOTES J.W. NICHOLSON, O.L.S.
OU -DENOTES ORIGIN UNKNOWN

P1 -DENOTES DEPOSITED PLAN 51R-40291

LEGEND

SIB -DENOTES STANDARD IRON BAR
SSIB -DENOTES SHORT STANDARD IRON BAR
IB -DENOTES IRON BAR
IBø -DENOTES IRON BAR ROUND
CP -DENOTES CONCRETE PIN
■ -DENOTES MONUMENT FOUND
□ -DENOTES MONUMENT PLANTED
S -DENOTES SET
M -DENOTES MEASURED
WIT -DENOTES WITNESS

SURVEYOR'S CERTIFICATE

I CERTIFY THAT:
1) THIS SURVEY AND PLAN ARE CORRECT AND IN ACCORDANCE WITH THE SURVEYS ACT THE SURVEYORS ACT AND THE LAND TITLES ACT AND THE REGULATIONS MADE UNDER THEM.

2) THE SURVEY WAS COMPLETED ON JANUARY 18, 2021.

ORILLIA ONTARIO
JANUARY 25, 2021

J. C. STANTON
ONTARIO LAND SURVEYOR
CANADA LANDS SURVEYOR

DEARDEN AND STANTON LTD
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CANADA LANDS SURVEYORS
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ORILLIA - ONTARIO

CAD FILE: PT28823_RPLAN | R-746

HGR GRAHAM PARTNERS LLP
LAWYERS • MEDIATORS

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Law Clerk Louise Maurice
705.526.2232 ext 235
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March 19, 2021

Financial Assurance and Brownfields Unit
Client Services and Permissions Branch
Ministry of the environment, Conservation and Parks
135 St. Clair Avenue West, 1st Floor
Toronto ON M4V 1P5

Attention: Record of Site Condition Officer

Dear Sir/Madam:

RE: Record of Site Condition
420 Bayshore Drive, Midland
Our File No. JW13.355.246LM

I am the solicitor for The Corporation of the Town of Midland with respect to the above noted matter. I confirm that:

1. The Corporation of the Town of Midland is the owner in fee simple with Absolute Plus title to the above-noted property.

2. I have reviewed the reference plan prepared by Dearden and Stanton Ltd., Ontario Land Surveyors deposited with the Land Titles Office as 51R-42857 on March 8, 2021 and confirm that the legal description of the Phase Two ESA property (not including the water lots shown as Part 2, 51R-42857) is:

   PT LTS 107 & 108, PT WATER LOT LYING IN FRONT LT 108 CON 2, TAY, WATER LTS 1 TO 12, PT LTS 1 TO 12 N/S FRANK ST, PT CHARLES ST, , PT GEORGE ST & PT LINDSAY ST ALL N/S FRANK ST PL 349; PT CHARLES ST, PT GEORGE ST & PT LINDSAY ST, CLOSED NORTH OF CNR PL 724; DESCRIBED AS PT 1, 51R-42857; TOWN OF MIDLAND; COUNTY OF SIMCOE.

3. The municipal address for the property is 420 Bayshore Drive, Midland, Ontario.

4. The assessment roll number is 43 74 020 002 27500

The information is submitted for the purposes of assisting the Corporation of the Town of Midland in filing a Record of Site Condition for the subject property

Yours very truly,

HGR Graham Partners LLP

John Walker
JEW:lm