20 October 2016 CG2430.1E04

Sears Canada Inc.
Revised Soil Vapour Monitoring Program (Update Fall 2016)

Hounsfield Heights and North Hill Mall
Calgary, Alberta

Pre-Face

Clifton Associates Ltd. (Clifton) is pleased to submit this Revised Soil Vapour Monitoring Program (Update Fall 2016) prepared on behalf of Sears Canada Inc. The presented update is based upon the Soil Vapour Monitoring Program (Revised) prepared by Clifton, and dated 24 June 2016. The update is taking into account review remarks by Alberta Environment and Parks as expressed in an e-mail to Clifton, dated 26 July 2016.

In order to address results of the above referenced review, the following parts of the presented document were modified:

- Table 4-Soil Vapour Monitoring Points – Nested Installation;
- Table 6-Sub-Slab Soil Vapour Monitoring and Indoor Air Quality Monitoring;
- Section 7.0-Increased Monitoring Frequency Trigger; and,
- Section 6.1- Soil Vapour Quality Guidelines.

In addition, Intrinsik Environmental Sciences Inc. issued a new set of the Site-specific soil vapour quality guidelines (SVQG) on 31 August 2016. The following updates were incorporated in the revised SVQG:

- A number of SVQG were presented for certain chemicals and depths that were above maximum theoretical vapour concentrations and should have been reported as no guideline required (NGR); and,
- The exposure term of 0.27 recommended by 2016 AEP Tier 2 Soil and Groundwater Remediation Guidelines was not applied to the calculated SVQG for commercial land use and depths greater than 100 cm. The result was that calculated commercial land use SVQG for depths greater than 100 cm have increased.

The full version of the revised SVQG can be found in Appendix A of this document.

Yours Truly,

Clifton Associates Ltd.

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Appendices

1.0 Introduction

Clifton Associates Ltd. (Clifton) was retained by Sears Canada Inc. (Sears) in 2013 to update and implement the Site Management Plan for the Hounsfield Heights community and North Hill Mall area within the City of Calgary (hereinafter referred to as the Site). Both groundwater and soils at the Site are known to be impacted by petroleum hydrocarbon compounds (PHCs). The Soil Vapour Monitoring Program (Revised) (SVMP) presented in this document is part of the detailed Site characterization and supports the upcoming preparation for the remedial plans at the Site.

The presented document is based on the environmental work completed for Sears in both the Mall area and the Hounsfield Heights area by Clifton and by Intrinsik Environmental Sciences Inc. (Intrinsik). Therefore, the presented document should be read and understood in conjunction with the following reports:

- Clifton Associates Ltd.: *Subsurface Investigation-Mall Area and Hounsfield Heights,* 22 January 2016 (2016 SI);
- Clifton Associates Ltd.: *Updated Site Management Plan (2014), Hounsfield Heights-Briar Hill Community, Calgary, Alberta,* April 2014 (2014 Updated SMP);
- Intrinsik Environmental Sciences Inc.: *Draft Report-Human Health and Ecological Risk Assessment for the Hounsfield Heights Community and North Hill Mall Areas, Calgary, Alberta,* December 2015 (2015 HHERA); and,
- Intrinsik Environmental Sciences Inc.: *Final Report-Development of Soil Vapour Quality Guidelines*, 8 April 2016 (refer to Appendix A).

The presented SVMP follows guidance, protocols, and scientific rationale outlined in the following (but not limited to) provincial and federal documents:

- Alberta Environment and Parks: *Alberta Tier 1 Soil and Groundwater Remediation Guidelines*, 2016 (2016 AEP Tier 1 Guidelines);
- Alberta Environment and Parks: *Alberta Tier 2 Soil and Groundwater Remediation Guidelines*, 2016 (2016 AEP Tier 2 Guidelines);
- Canadian Council of Ministers of the Environment: *A Protocol for the Derivation of Soil Vapour Quality Guidelines for Protection of Human Exposures via Inhalation of Vapors*, 2014 (2014 CCME Protocol);
- British Columbia Ministry of Environment: *Technical Guidance on Contaminated Sites 4,* version 1, September 2010 (BC TG-4);
- Golder Associates Ltd.: *Guidance on Site Characterization for Evaluation of Soil Vapour Intrusion into Buildings,* Submitted to the British Columbia Ministry of Environment by Science Advisory Board for Contaminated Sites in British Columbia, May 2011 (2011 Golder Guidance);
- Health Canada: *Federal Contaminated Site Risk Assessment in Canada, Part VII: Guidance for Soil Vapour Intrusion Assessment at Contaminated Sites*, September 2010 (2010 HC); and,
- Johnson, P.C., & R. Ettinger: *Heuristic Model for predicting the Intrusion Rate of Contaminant Vapours into Buildings*, 1991(J&E Model).

2.0 Project Background

Since 1998, site investigations have revealed the presence of PHCs in the subsurface soils and groundwater beneath City of Calgary properties in the Hounsfield Heights community in Calgary, Alberta. The source of the PHCs is suspected to be a former gasoline station on the property owned by Sears located at the North Hill Shopping Centre as stipulated in the 2014 Updated SMP. Evidence suggests that gasoline may have leaked from underground fuel storage tanks prior to their removal in the mid-1990s when the gasoline station was decommissioned.

In 2006, Intrinsik (operating as Cantox Environmental at the time of the report) completed a risk assessment of the Hounsfield Heights community (Cantox 2006). The purpose of the assessment was to identify the potential health risks to people residing in the Hounsfield Heights community, as well as to ecological receptors that frequent the area, from the PHC-impacted subsurface soils and groundwater. Concentrations of various hydrocarbon constituents (*e.g.,* benzene, toluene, ethyl benzene, xylenes-BTEX) and PHCs fractions (*e.g.,* F1 and F2) measured in the soils and groundwater beneath the City-owned properties (e.g. parks, roads, and alleyways) were compared to the corresponding generic ('Tier 1') guidelines from Alberta Environment and Sustainable Resource Development (Alberta ESRD, formerly Alberta Environment) for the protection of human health, safety, and the environment. In addition, site-specific ('Tier 3') risk management guidelines were developed for selected hydrocarbons (*i.e*., benzene and the F1 PHC fraction). Overall, assessment results indicated that the potential for adverse effects to human health and ecological receptors was low. However, some uncertainties were identified surrounding the on-site impacts (i.e., Mall Area), presence of free-product off-site (Hounsfield Heights area), and an expanding dissolved phase plume off-site. These uncertainties were addressed through the implementation of remediation and monitoring programs.

Since 2006, a summary of the remediation and monitoring programs is as follows (2014 Updated SMP):

- Between 2006 and 2007, remedial excavation of the impacted soils in the Mall area was completed;
- Groundwater monitoring has continued within the Hounsfield Heights and Mall area at specific monitoring wells through a groundwater sampling program on an approximate bi-annual basis; and,
- A dual-phase vapour extraction (DPVE) system was installed in 2008 to remove Liquid Petroleum Hydrocarbons (LPH) in the Hounsfield Heights area. The system began running full time in 2011.

On 20 July 2012, Alberta ESRD requested that Sears update its site management plan for the Mall and Hounsfield Heights area and address the following points:

- Fully delineate the dissolved plume south of 11th Avenue NW;
- Sample the groundwater adjacent to where it discharges to the surface in the southern portion of Zone 3 (south of 11th Avenue NW) and evaluate it for risk to ecological receptors;
- Delineate the soil gas/vapour plume in Zones 1, 2, and 3;
- Assess potential risks from indoor air infiltration of petroleum hydrocarbon vapours in areas where the vapour inhalation pathway exceeds guidelines, and in areas where it has been determined that elevated soil gas/vapours are present;

- Establish a soil gas monitoring program on properties that may be at risk from indoor air infiltration. Compare current needs with those previously identified in the Clifton April 5, 2007 response to Alberta Environment regarding the soil vapour monitoring;
- Implement additional remediation techniques to deal with the expanding dissolved phase plume. As discussed, this could include enhanced bioremediation. Monitored natural attenuation is not appropriate while liquid petroleum hydrocarbon (LPH) is being removed and the dissolved plume is not stable. Multiple remediation approaches are needed to address the petroleum hydrocarbon impacts;
- Review the groundwater monitoring and sampling program to ensure adequate coverage based on current conditions and trends; and,
- Apply the 2014 AEP Tier 1 Guidelines to monitoring well locations along 11th Avenue NW and include these wells in the groundwater monitoring and sampling program.

In order to address these requirements, Clifton abandoned groundwater monitoring wells not meeting requirements in 2014, in preparation for a future environmental monitoring program. The next step (fall 2014-spring 2015) included the installation of 70 new groundwater monitoring wells coupled with a soil sampling program focused on better understanding of the soil stratigraphy south of 11th Avenue NW. In addition, the 2015 Subsurface Investigation included four rounds of the groundwater sampling in the Mall and Hounsfield Heights areas, as well as limited (five residences) indoor air quality monitoring.

Indoor air sampling locations were determined based on historically (i.e. before 2015 Site Investigation) measured benzene concentrations in groundwater monitoring wells that were above guidelines for the protection of the vapour inhalation exposure pathway as defined by the 2014 AEP Tier 1 Guidelines. One round of the indoor air sampling was conducted at the following residential properties in 2015:

- 1601 11th Avenue NW;
- 1604 11th Avenue NW;
- 1605 11th Avenue NW;
- 1609 11th Avenue NW; and,
- 1301 15th Street NW.

In addition, the indoor air sampling also included one sub-slab soil gas sample from the residence located at 1609 11th Avenue NW. For collected data and description of the sampling methodology refer to 2015 HHREA, Table D-1. These data were not included as part of the identification of Contaminants of Potential Concern (CoPCs), but were used as part of additional lines of evidence in Risk Characterization for 2015 HHREA completed by Intrinsik.

The 2015 HHREA included detailed investigation of the vapour inhalation pathway for human receptors present at the Site for both soil and groundwater and compared the results against the Residential/Parkland Land Use Guidelines (Hounsfield Heights area) and Commercial Land Use Guidelines (North Hill Mall area) as defined by AEP Tier 1 and 2 Guidelines. The following CoPCs in soil at the Site were identified for vapour inhalation pathway:

Table 1 – Constituents identified as CoPCs by 2015 HHREA in soil for vapour inhalation pathway and human receptors at the Site[1]

Constituent in Soil	Hounsfield Heights Area (Residential/Parkland Land Use)	North Hill Mall Area (Commercial Land Use)
	Petroleum Hydrocarbons	
Benzene	YES	YES
Toluene	NO	NO
Ethylbenzene	NO	NO
Xylenes	YES	NO
F1-BTEX (C_6—C_{10})	YES	NO
F2 (C_{10}-C_{16})	YES	NO
	Polycyclic Aromatic Hydrocarbons (PAHs)	
Naphthalene	YES	NO
	Volatile Organic Compounds (VOCs)	
1,2 Dichloroethane (1,2-DCA)	YES	YES

[1] Please note that other constituents in soils may be present at the Site in concentrations exceeding different exposure pathways for human and ecological receptors as defined by the 2016 AEP Tier 1 Guidelines, and are not part of the objectives of this SVMP.

The following COPCs in groundwater at the Site were identified for vapour inhalation pathway:

Table 2 – Constituents identified as CoPCs by 2015 HHREA in groundwater for vapour inhalation pathway and human receptors at the Site[2]

Constituent in Groundwater	Hounsfield Heights Area (Residential/Parkland Land Use)	North Hill Mall Area (Commercial Land Use)
	Petroleum Hydrocarbons	
Benzene	YES	NO
Toluene	NO	NO
Ethylbenzene	NO	NO
Xylenes	YES	NO
F1-BTEX (C_6—C_{10})	YES	NO
F2 (C_{10}-C_{16})	NO	NO
	Polycyclic Aromatic Hydrocarbons (PAHs)	
Naphthalene	NO	NO
	Volatile Organic Compounds (VOCs)	
1,2 Dichloroethane (1,2-DCA)	YES	NO

The 2015 HHREA also used data collected by Clifton during the subsurface investigation to calculate Site-specific groundwater and soil guidelines for the protection of vapour inhalation within the Hounsfield Heights and North Hill Mall areas. These Site-specific calculated guidelines are at the moment pending review and approval by the regulators. Therefore, until a regulatory decision is known, 2016 AEP Tier 1 Guidelines for Vapour Inhalation Pathway in both groundwater and soil will be used as a guidance for the SVMP at the Site.

[2] Please note that other constituents in groundwater may be present at the Site in concentrations exceeding different exposure pathways for human and ecological receptors as defined by the 2016 AEP Tier 1 Guidelines, and are not part of the objectives of this SVMP.

The 2015 HHREA recommends implementing a soil vapour monitoring program for assessing vapour inhalation and possible infiltration into indoor air, which should meet the following guiding principles:

- The program should provide broader spatial measurement of soil-gas concentrations in the Hounsfield Heights Area. Soil vapour monitoring locations should take into consideration the PHC levels present in groundwater throughout the community and the Site-specific geology;
- The program should include the installation of vapour monitoring points that collect soil-gas at multiple depth intervals. Ideally, three collection intervals would be installed with the lowest interval located above the groundwater and the upper interval located 2 to 3 metres below ground surface. The middle interval would be evenly spaced between the upper and lower interval. This would allow calculation of site-specific attenuation coefficients, which includes natural diffusion and biodegradation; and,
- The vapour monitoring points should be located in areas that would not restrict access (e.g., public areas) to allow for repeated sampling at fixed time intervals throughout the year.

3.0 Objectives of the Proposed Soil Vapour Monitoring Program

The principle objective of the proposed SVMP will be evaluating potential risk to human health from inhalation of subsurface vapours in indoor air in both residential and commercial structures present at the Site. To address requirements of the Alberta Environment and Parks (AEP), Alberta Health Services (AHS), and conclusions of 2015 HHREA, this SVMP will focus on the following:

- Install external soil vapour monitoring points and collect representative soil vapour samples from areas identified by 2015 SI as having CoPCs concentrations in groundwater or soil exceeding the 2016 AEP Tier 1 Guidelines for vapour inhalation exposure pathway with focus on the area south of 11th Avenue NW;
- Convert soil vapour concentrations from external soil vapour monitoring points to indoor air concentrations in the investigated structures at the Site using attenuation factors developed on the basis of the 2014 CCME Protocol;
- Where recorded soil vapour concentrations imply a possibility for an active indoor vapour pathway, collect without any undue delay additional concurrent sub-slab soil vapour and indoor air quality (IAQ) samples directly from a structure;
- If evaluation of sub-slab soil vapour and indoor air quality sampling results provides a line-of-evidence for a soil vapour intrusion into a structure to the extent constituting a potential health risk for residents, trigger a Contingency Plan measures;
- Install and sample nested soil vapour monitoring points at locations representing changing stratigraphy of the Site to provide representative data for evaluation of the Site-specific vertical soil vapour migration and biodegradation; and,
- Install and sample soil vapour monitoring locations constituting lateral transects to facilitate lateral delineation of the soil vapour plume extent at the Site.

4.0 Site Overview

4.1 Layout and Topography of the Site

The Site consists of two distinctive portions divided by 13th Avenue NW - the Hounsfield Heights area and the North Hill Mall (Mall) area:

- The Hounsfield Heights area is bound by: the southern edge of the LRT line to the north; 14th Street NW to the east; 10th Avenue SW (extending west to 17A Street NW) to the south; and, 17A Street NW to the west. The area is zoned as residential, as it primarily consists of single detached dwellings with basements. There are three areas of the Site that are zoned as Special Purpose: Hounsfield Heights Park; a parcel of land along 10th Avenue SW between 15th Street NW and 16th Street NW; and, the area between the LRT line and 13th Avenue NW.
- The Mall area is bound by: 16th Avenue NW to the north; 14th Street NW to the east; the northern edge of the LRT line to the south; and, to the west by the western edge of the North Hill Centre property and a line extending south to the northern edge of the LRT line.

Capitol Hill, a residential area, is located to the north of the Site. To the east is SAIT Polytechnic and the Alberta College of Art + Design. Hillhurst and Briar Hill, both residential areas, are found south and west of the Site, respectively.

The Site topography is characterized by a gently south-sloping river valley plateau on the northern portion of the Site, and a more moderately sloping valley wall towards the southeast portion. The Site varies in elevation from approximately 1,094 m above sea level in the northwestern corner along 13th Avenue NW, to approximately 1,068 m above sea level in the southeastern corner, north of the intersection of 15th Street NW and 10th Avenue NW.

For Site layout, refer to Appendix B, Figures 1 and 2.

4.2 Soil Stratigraphy of the Site

Soil stratigraphy as described in the sections below is based upon the investigative findings as summarized in the 2015 SI document. Please note that full vertical and horizontal soil contaminant plume delineation at the Site has not been achieved yet, especially in the areas south of 11th Avenue NW and south west of 14th Avenue NW. Additional borehole installations and soil sampling program in these areas are scheduled for 2016.

North Hill Mall Area

Unit 1-Upper Silty Sand

The upper silty sand unit consists of a brown, well-sorted, fine- to medium-grained, loose sand near the surface that transitioned to a silty sand through the formation, with more clays near the base. Trace gravels were found in the material and the sand became wet near the base, indicating a perched water unit. The unit is approximately three and a half to five meters thick in the northern portions of the Mall area, and decreases in thickness from west to east, while increasing in thickness as the unit transitions to the south.

In some portions of the unit, channel deposits were identified as separate from the main unit. These occurred exclusively in the northern portion of the Site in the Mall Area.

<u>Unit 2 – Upper Clayey Silt</u>

The upper clayey silt unit consists of a brown, moist, plastic, clay near the surface of the unit that transitioned to a silty clay or clayey silt through the formation, with more silt near the base. Trace sand and gravels were found in the material. The unit is approximately two meters thick in the northwestern portions of the Mall area, and increases in thickness from west to east, to approximately four meters. The unit increases in thickness as the unit transitions to the south to a maximum thickness of approximately nine meters in the west within the northern section of the Hounsfield Heights area. In general, as the formation moves towards the east, the unit thickens and then maintains a relatively constant thickness of approximately four meters.

In some portions of the unit, channel deposits were identified as separate from the main unit. These occurred exclusively in the north-central portion of the Site, in the Mall Area just south of the Kal-Tire structure.

<u>Unit 3 – Middle Sandy Silt</u>

The middle silty sand unit consists of a brown, fine-grained, loose sand near the top of the formation that transitioned to a silty sand through the formation, with more clays near the base. Trace gravels were found in the material and the sand was wet throughout, indicating confined conditions. The unit is approximately seven to ten meters thick in the northern portions of the Mall area, and decreases in thickness from west to east, while increasing in thickness as the unit transitions to the south in the central portion of the Site. The unit decreases in thickness from north to south in the western portion of the Site, while maintaining a constant eight meters in thickness on the eastern portion of the Site.

In some portions of the unit, channel deposits were identified as separate from the main unit. These occurred exclusively in the central-eastern portion of the Site in the Hounsfield Heights Area.

<u>Unit 4 – Lower Clayey Silt</u>

The lower clayey silt unit consists of a grey, medium-plastic clay near the surface of the unit that transitioned to a silty clay or clayey silt through the formation, with more clay near the base. The unit is approximately three meters thick in the west-central portions of the Site, at the northern portions of the Hounsfield Heights area. In the western portions of the Site, the unit pinches out midway into the Hounsfield Heights area. In the north-central portions of the Mall Area, the unit is approximately eight meters thick and decreases in thickness from north to south, to approximately one meter in the far south. In the eastern portions of the Site, the unit maintains a fairly consistent one to three meter thickness, decreasing in thickness to the south. In the southern portions of the Site, the unit appears to split and is identified as Unit 4a, Unit 4b, and Unit 4c. Where it splits, the unit maintains a thickness of approximately one meter.

<u>Unit 5 – Lower Silty Sand and Gravel</u>

The lower silty sand and gravel unit consists of a rounded gravel, with loose sand, occasional cobbles, and trace silt and clay. The gravel was wet throughout, indicating a confined unit. The unit is approximately a half meter thick at first contact in the northern portions of the Mall area, and decreases in thickness from west to east, while increasing in thickness as the unit transitions to the south. Below the gravel is a sand layer approximately 3 meters in thickness, followed by another gravel layer at least two meters in thickness. More gravel layers are found towards the north-central portion of the Site, separated by either thin silt or clay layers. The sand layer increases in thickness to approximately 5 meters.

Hounsfield Heights Area – Central Portion (North of 11th Avenue NW)

The soil stratigraphy in the central portion of the Site (as looking from north to south) is very much as previously described. The soil borings and associated monitoring wells during the 2015 Site Investigation were not drilled as deep in the central portion of the Site to prevent cross contamination of the newly identified, lower permeable zones (Unit 5). Evidence of channel deposits (erosional channels backfilled with glacio-fluvial materials) was identified.

In general, the deposits can be described as in the previous sections, except that the river valley slope begins a steep incline to the south.

Hounsfield Heights Area – South Portion (South of 11th Avenue NW)

The soil stratigraphy in the southern portion of the Site is initially as previously described; however, the Site makes a rather steep drop off between 13th Avenue NW and 11th Avenue NW. This elevation change has Unit 1 disappearing near 11th Avenue, while Unit 2 is continuous in the western portions of the Site through the furthest extents of the investigation (midway between 11th Avenue NW and 10th Avenue NW). However, Unit 2 disappears around two or three lots south of 11th Avenue NW in the central and eastern portions of the Site.

Several lots (beginning approximately 50 m south of 11th Avenue NW) have Unit 3 soils at or near the surface. Homes with basements or foundations crossing the 1,078 m asl reference have likely encountered the top of Unit 3. Therefore, homes built on the 1,081 m asl surface contour, and which have basements, are likely in contact with Unit 3.

4.3 Hydrogeology of the Site

Hydrogeology of the Site as described in the sections below is based upon the investigative findings as summarized in the 2014 Updated Site Management Plan and 2015 Site Investigation documents. Please note that full vertical and horizontal groundwater contaminant plume delineation at the Site has not been achieved yet, especially in the areas south of 11th Avenue NW and south west of 14th Avenue NW. Additional groundwater monitoring well installations and groundwater sampling program are scheduled in these areas for 2016.

Groundwater Elevation and Flow Direction

Measured groundwater elevations ranged from 1061.91 m asl (BH1946) to 1086.28 m asl (BH1905) across the Site. The measured water levels indicate that the generalized shallow groundwater flow direction is to the south-southeast, which matches the findings of previous investigations. The groundwater flow direction of the individual Units was not determined as part of the 2015 investigation.

<u>Unit 1</u>

Measured groundwater elevations in Unit 1 ranged from 1083.57 m asl (BH1975) to 1086.28 m asl (BH1905) across the Site.

<u>Unit 2</u>

Measured groundwater elevations in Unit 2 ranged from 1079.18 m asl (BH1972) to 1084.99 m asl (BH1913) across the Site.

Unit 3

Measured groundwater elevations in Unit 3 ranged from 1071.21 m asl (BH1944) to 1081.40 m asl (BH1985) across the Site.

Unit 4

Measured groundwater elevations in Unit 4 ranged from 1072.30 m asl (BH1980) to 1074.36 m asl (BH1939) across the Site.

Unit 5

Measured groundwater elevations in Unit 5 ranged from 1061.91 m asl (BH1946) to 1077.35 m asl (BH1903) across the Site.

Water Bodies

Surface runoff on-Site is topographically driven, owing to the large gradient between the northern portion of the Site and the southern portion located closer to the valley bottom. The development of the Mall area channels surface runoff in the parking areas to artificial lows and catch basins, which diverts the storm water to the municipal storm sewer. In the Hounsfield Heights area, runoff from impermeable surfaces (such as driveways and roads) is directed to storm drains in the streets, which convey the water to the municipal storm system.

The nearest surface water body to the Hounsfield Heights area is the Bow River, located approximately 1.5 km to the south of the Site. An ephemeral marshy area may be located within the new boundaries of the Hounsfield Heights area, east of 17A Street NW and south of 12th Avenue NW.

Water Wells

Clifton personnel reviewed AEP records for water wells located within a 500 m radius of the Site. The AEP database generally limits results to the nearest quarter section in which the well is located, and does not give a specific well address. Therefore, the exact distances from the Site to the groundwater wells are unknown. Any wells within the adjacent quarter sections, which may be within 500 m of the Site, have been cited.

There were no registered water wells located either on-Site, or in any of the adjacent quarter sections; therefore, there are no records of potable water wells located within a 500 m radius of the Site. This does not mean that potable water wells do not exist within this area at all, just that they are not publically identifiable and would need to be researched through other means.

4.4 Structures at the Site

The Hounsfield Heights area, as outlined in the Section 4.1, encompasses a total of 95 residential properties, which might be potentially affected by soil vapour intrusions. In 2015, Clifton conducted a survey of the properties by online questionnaire focused on the specific features that might be relevant during the soil vapour monitoring at the Site, such as age of the structures, presence of visible cracks, basements, crawl spaces, earthen floors, sumps etc. A total of 25 property owners answered Clifton's questionnaire and the results are summarized in Appendix C.

Generally, the prevalent type of the residential structure at the Site is a detached house with developed or partially developed basement. The building's age ranges widely from the early 20th century to quite recently constructed infills. Numerous property owners reported visible cracks in concrete slabs and walls. Cracks occurrence seems to be closely related to the age of a structure. Sumps and drains are quite common features of the residences at the Site. The owners of the properties located at 1318 and 1312 16th Street NW, declared a presence of the crawl spaces with earthen floors. Presence of the structures with low air exchange rate was not identified at the Site.

Clifton will carry out additional door-to-door properties survey in person as a part of soil vapour monitoring point installation with objective to obtain an additional building-specific information with respect to the properties where the owners did not respond to the initial online survey.

The Kal Tire service centre building in the North Hill Mall represents a commercial building located immediately to the northeast of the original underground storage tanks nest. Portions of the parking lot around this building were remediated between 2006 and 2007. However, residual petroleum hydrocarbons impacts are still present in the areas immediately adjacent to the Kal Tire building. These impacts are results of the limitations encountered during the remediation including considerations for building integrity, space limitations and utility right-of-way. The Kal Tire service center includes both slab-on-grade construction and a basement with a foundation approximately 4.0 to 4.6 m bgs.

5.0 Proposed Soil Vapour Monitoring Methodology

5.1 Soil Vapour Sampling Approach and Design

Clifton will follow a bottom-up soil vapour characterization approach starting with deeper, near contamination source vapour sampling (i.e., soil vapour sampling points will be installed immediately above vadose zone of the soil stratigraphic Unit 3)[3], followed by concurrent sub-slab soil vapour and indoor air quality sampling in structures, where exceedances of soil vapour quality guidelines imply a possibility for active indoor vapour pathway. High spatial and temporal variability of soil vapour concentrations are expected at the Site and both proposed sampling frequency, and proposed length of the soil vapour monitoring program are taking these factors into account. Other factors considered during the sampling plan preparation included size and distribution of the known contamination source, geologic characteristics and heterogeneity, as well as receptor (building) condition. Anthropogenic features under consideration included presence of utility corridors, access rights, drilling restrictions, and permitting requirements.

In the process of the data evaluation, Clifton will strive to use multiple-lines-of-evidence context into account, which may improve Site characterization and can be used as a cross-check to assess quality of soil vapour measurements. These will include:

- Comparison of the soil vapour measurements from deeper probes against predicted from groundwater (taking into account attenuation of vapors in capillary transition zone);
- Vertical vapour profiles vapour concentrations comparison; and,
- Development of the measured soil vapour data contours with focus on anomalous data.

[3] The referenced rule will be followed in portions of the Site where the stratigraphic Unit 3 is present with sufficient thickness (>1 m) for soil vapour investigation. For the Mall area, 2015 HHREA states that soil, not groundwater is the source driving vapour migration with assumed depth of soil impact 6.1 m bgs.

5.2 Considerations for Sampling Locations

As stated in Section 5.1, final design of soil vapour monitoring locations is taking into account both natural and anthropogenic features specific to the Site. As a general guiding principle, every structure present at the Site, within the recommended 30 m radius (HC 2010) of groundwater monitoring wells showing exceedances of either soil or groundwater guidelines, will be evaluated for a possible vapour intrusion. This expected radius of influence may be extended if a known underground utility corridor is present, which could act as a soil vapour preferential pathway. Both soil and groundwater data available in the 2016 Site Investigation document were compared against 2016 AEP Tier 1 Guidelines for vapour inhalation exposure pathway.

In addition to the above stated general principles, the following additional design guidance principles were followed:

- Kal-Tire service center building in the Mall area will be further investigated for possible soil vapour intrusion;
- Soil vapour characterization will be strongly focused on the Hounsfield Heights area south of 11th Avenue NW for the following reasons:
    - Intermittent, thin or altogether missing clay (fine grained) stratum (Unit 2) in this area;
    - Potentially contaminated soils of the stratigraphic Unit 3 might be in the direct contact with foundations; and,
    - Shallow depth of groundwater.

- Residence located at 1509 11th Avenue NW, where sub-slab soil vapour monitoring point was installed by Clifton in 2015, will be included in each round of the soil vapour sampling at the Site by additional sub-slab soil vapour sampling;
- Recommendation to install and sample nested soil vapour monitoring points at points representing changing stratigraphy of the Site to provide representative data for evaluation of the Site-specific vertical soil vapour migration and biodegradation;
- Structure investigated for possible soil vapour intrusion should ideally have at least two external soil vapour monitoring points, one of these points should be installed between the structure and the contamination source area as indicated by inferred groundwater flow direction at the Site to the point of technical feasibility;
- Soil vapour monitoring points external to structures will be installed at a distance greater than 1 m and ideally not exceeding 10 m from the foundations;
- Maximum soil vapour monitoring points installation depth will be restricted to a depth, which equals the mean average of water table in the identified stratigraphic Unit 3 at the Site minus 0.5 m (accounting for transient capillary zone), therefore providing expected maximum ("worst case scenario") concentration of soil vapours, or 10 m (seal integrity restrictions), whichever value is lower;
- Minimum soil vapour monitoring depth will not be less than 1 m (seal integrity restriction);
- Should groundwater elevation at some portions of the Site require construction of a soil vapour monitoring point with depth 1 m or less, Clifton will in lieu of it install a sub-slab soil vapour monitoring point within an investigated structure (provided agreement of the property owner);
- If multiple soil and groundwater sampling data for CoPCs within the contamination plume are available, the highest reading will take preference;
- Additional soil vapour monitoring locations constituting lateral transects are required to facilitate lateral delineation of the soil vapour plume extent at the Site; and,
- Dominant underground utility corridors will be covered by soil vapour monitoring points to the point of technical feasibility.

The final soil vapour monitoring locations will be also affected by access restrictions, presence of utilities, permitting requirements, and technical limitations for drilling rig access.

5.3 Proposed Soil Vapour Monitoring Locations

The proposed soil vapour monitoring point locations as presented in Appendix B, Figure 3, are reflecting recommended bottom up approach and design guidance principles as outlined above. At the same time, these locations are taking into account limitations constituted by access restrictions, presence of utilities, permitting requirements, and technical limitations for drilling rig access at the Site.

Based on the available groundwater and soil sampling data from 2015, proposed soil vapour monitoring points will target estimated 30 m diameter zone of potential influence at the following groundwater monitoring wells:

Table 3 - Soil Vapour Monitoring Locations – External Monitoring Points

Monitoring Well ID	Constituent(s) Exceeding 2016 AEP Tier 1 Guidelines	Media	Properties within 30 m Zone of Influence	Proposed Soil Vapour Monitoring Point(s)
BH1904	Benzene (B), Toluene (T), Ethylbenzene (E)	Soil	Kal Tire Service Center	SV1, SV2
BH1924	Naphthalene, B, PHC F1	Groundwater	1340 16A St. NW	SV3, SV4
BH1921	B, T, E, PHC F1, 1,2-Dichloroethane (1,2-DCE)	Groundwater	1329 16 St. NW, 1325 16 St. NW, 1323 16 St. NW, 1319 16 St. NW, 1330 16 St. NW, 1326 16 St. NW, 1324 16 St. NW	SV 12, SV 13, SV 14, SV 15
BH1925	B, T, E, 1,2- DCE	Groundwater	1331 15 St. NW	SV 16
BH 1956	B, T, E, 1,2-DCE	Groundwater	1305 15 St. NW, 1301 15 St. NW, 1604 11 Ave NW, 1610 11 Ave NW, 1616 11 Ave NW	SV 17, SV 18, SV 19, SV 20, SV 22, SV 25
BH1928	1,2-DCE	Groundwater	1125 16A St. NW, 1123 16A St. NW	SV 7, SV 8, SV 9

Table 3 - Soil Vapour Monitoring Locations – External Monitoring Points (continued)

Monitoring Well ID	Constituent(s) Exceeding 2016 AEP Tier 1 Guidelines	Media	Properties within 30 m Zone of Influence	Proposed Soil Vapour Monitoring Point(s)
BH1929	B, 1,2-DCE	Groundwater	1124 16 St. NW	SV 26
BH 1982	B, T, E, Xylenes, 1,2 DCE	Groundwater	1124 16 St. NW, 1613 11 Ave NW, 1609 11 NW, 1605 11 Ave NW	SV22, SV 24, SV 38, Sub-Slab Monitoring Point Installed @ 1609 11 Ave NW
BH1981	B, 1,2-DCE	Groundwater	1118 16 St. NW, 1116 16 St. NW,	SV 28, SV 29
BH1943	B	Groundwater	1115 16 St. NW	SV 41
BH 1941	B	Soil	1119 16 St. NW, 1501 11 Ave NW, 1507 11 Ave NW, 1124 15 St. NW, 1120 15 St. NW, 1116 15 St. NW	SV 36, SV 37, SV 11, SV 39, SV 40

The following table summarizes proposed installation of the nested soil vapour monitoring points at locations where there is a change in the stratigraphy to provide more representative data for the evaluation of the Site-specific vertical soil vapour migration and biodegradation:

Table 4-Soil Vapour Monitoring Points – Nested Installation

Soil Vapour Monitoring Point ID	Area of the Site
SV 13	Hounsfield Heights-Central Portion (Area N1 in 2015 HHRE)[4]
SV 18	Hounsfield Heights-Central Portion (Area N2 in 2015 HHRE)[5]

[4] As HHREA for the Site presented by Intrinsik has not yet been approved by AEP, the geographical division of the Site is just a proposed one and may be subject to a change in the future.
[5] As HHREA for the Site presented by Intrinsik has not yet been approved by AEP, the geographical division of the Site is just a proposed one and may be subject to a change in the future.

Soil Vapour Monitoring Point ID	Area of the Site
SV 26	Hounsfield Heights-South Portion (Area S1 in 2015 HHRE)[6]

The following soil vapour monitoring points will be installed in form of the lateral transects to allow horizontal delineation of the soil vapour plume at the Site:

Table 5- Soil Vapour Monitoring Points – Lateral Transects

Lateral Transect Position & Direction	Soil Vapour Monitoring Points IDs
Along 16A Street NW, south east to north west	SV 10, SV 8, SV 7, SV 6, SV 5
Between 11 & 10 Avenue NW, west to east	SV 10, SV 30, SV 31, SV 32
Along laneway and 15 Street NW, direction from south to north and north west	SV 32, SV 33, SV 34, SV 35

In addition to the above listed soil vapour monitoring points, SVMP includes the following actions based on the building-specific data from the online survey:

Table 6- Sub-Slab Soil Vapour Monitoring and Indoor Air Quality Monitoring

Location	Recommended Action	Reason	Sampling Frequency
1312 16 Street NW	Install sub-slab soil vapour monitoring point, sample concurrently with indoor air[7]	Unusual building feature (earthen floor)	The same as external soil vapour monitoring points
1318 16 Street NW	Install sub-slab soil vapour monitoring point, sample concurrently with indoor air[8]	Unusual building feature (earthen floor)	The same as external soil vapour monitoring points

[6] As HHREA for the Site presented by Intrinsik has not yet been approved by AEP, the geographical division of the Site is just a proposed one and may be subject to a change in the future.

[7] Special protocol for soil vapour characterization and interpretation at this property is proposed, refer to Section 6.1 Soil Vapour Quality Guidelines for details.

[8] Special protocol for soil vapour characterization and interpretation at this property is proposed, refer to Section 6.1 Soil Vapour Quality Guidelines for details.

Location	Recommended Action	Reason	Sampling Frequency
1509 11 Avenue NW	Sample previously installed sub-slab vapour soil monitoring point	Proximity of groundwater monitoring wells BH1982, BH1943	The same as external soil vapour monitoring points

As shown in the tables above, the proposed installation plan combines external and monitoring points with lateral transects, and where required, direct sub-slab soil vapour measurements. Please note that the presented installation plan is not final. Soil vapour sampling results may require additional installations in the future, such as higher density of the monitoring points in some locations, additional lateral transects or transects with higher monitoring points density, “step-in” external points installed at a privately-owned land, as well as sub-slab monitoring points installation.

Proposed external soil vapour monitoring points installed at the City of Calgary-owned Right-Of-Ways (ROWs) have the following advantages:

- Simplified permitting process;
- Unlimited access to monitoring points for sampling; and,
- Accessibility for installation by drilling rig without any danger of damaging privately-owned land.

5.4 Soil Vapour Probes Construction and Installation

Clifton proposes use of the permanent soil vapour probes installed in boreholes advanced by auger drilling for the Site characterization. Soil vapour monitoring points will be advanced using a hollow stem auger drilling rig in areas with unrestricted access (the City of Calgary-owned Right-Of-Ways).

Every installation will require: written Access Rights Agreements (privately-owned properties at the Site); necessary permitting (Utility Line Assignment, License of Occupation Agreement amendments, Excavation Permits etc.) in the case of the installations within the City of Calgary-owned Right-Of-Ways (ROWs), as well as by utility locates; and, clearance by Alberta One Corporation and a private locating company.

Proposed materials for soil vapour monitoring points at the Site are inert, non-porous, and with minimal sorption, in order to avoid material-induced bias of soil vapour measurements, especially with respect to VOCs. Stainless-steel and Teflon (PTFE) would be utilized for the monitoring point construction as follows:

- Stainless-steel permanent soil vapour implant equipped by stainless steel mesh and PTFE umbrella followed by an appropriate length of ¼ in. (6.35 mm) diameter of PTFE tubing;
- Stainless steel valve installed at the upper end of the tubing with female Swagelok stainless-steel fitting for a sampling train connection; and,
- Flush-mounted 4 in. (101.6 mm) casted aluminium heavy duty cover will provide monitoring point surface finish and protection against elements.

Coarse sand (4-10) will surround the screened portion of the soil vapour probe and extend at least 0.15 m above the screened zone. A competent bentonite seal will be constructed above the screened zone by using dry granular bentonite (16 mesh) hydrated in at least three lifts by distilled water. The seal will be a minimum of 0.3 m thick. The remainder of the borehole annulus will be sealed by mixing bentonite powder with water to create thick slurry (Volclay grout). Each installed monitoring point will be assigned a unique identification code, which will be marked at the field installation.

Sub-slab monitoring point installation will include drilling through a slab to an approximate depth of 0.3 m within sub-slab gravel layer (if present), and installing flush-mounted soil vapour monitoring probe made of stainless steel manufactured by AMS. The borehole annulus will be then sealed by neat hydraulic cement hydrated by distilled water. Installation will be finished by the attaching stainless steel tamper proof cap at the top.

Refer to Appendix D for the soil vapour monitoring point installation schematic, as well as details for proposed construction parts.

Waste management during the installation will consist of collecting soil drill cuttings into lined, double-wall soil bags. A composite sample of cuttings at an approximate rate of 1 per 100 m^3 of cuttings will be collected and submitted to Maxxam Analytics Inc. for Alberta Class II Landfill Analysis. Drill cuttings will be subsequently collected and appropriately disposed by a qualified sub-contractor. Other produced waste (packaging materials, broken concrete etc.) will be collected at the end of the installation and disposed as general waste.

5.5 Soil Vapour Sampling Procedures

External Soil Vapour Monitoring Points

In order to achieve required resolution of the laboratory detection limits for investigated constituents (especially 1,2 – DCA), and to extend validity of collected samples, Clifton proposes to use as soil vapour sampling media 1.4L Summa canisters, which are proofed and cleaned by the laboratory as per the United States Environmental Protection Agency (USEPA) reference method TO-14A. The sampling train will include: an orifice equipped flow controller calibrated for a sampling rate between 20-200 mL/min; and, a length of the dedicated PTFE tubing with stainless steel fitting to connect to a valve at the top of the soil vapour monitoring point.

Before any sampling attempt, an installed monitoring point will be allowed to equilibrate for at least 48-hours. The next step will be to complete a seal integrity check of the monitoring point using helium tracer. A monitoring point meeting seal integrity criteria will be subsequently purged by the vacuum pump for at least three probe volumes. Purging vacuum rate will not exceed 10” (254 mm) of water column in order to avoid excessive moisture influx to the radius of influence.

The soil vapour sampling event will include: measuring the initial and final Summa canister vacuum levels by standalone vacuum gauge; recording the start and finish time of the sampling; monitoring point identifier check; and weather observations, especially barometric pressure at the time of sampling and precipitation. The stainless steel valve installed at the top of a soil vapour monitoring point will be kept in a closed position, except when purging and sampling.

Sub-Slab Soil Vapour Monitoring Points

Before any sampling attempt, an installed sub-slab soil vapour monitoring point will be allowed to equilibrate for at least 48-hours. The next step will be competent seal integrity check of the monitoring point by helium tracer. A monitoring point meeting seal integrity criteria will be subsequently purged by the vacuum for at least three probe volumes. Purging vacuum rate will not exceed 10" of water column in order to avoid excessive moisture influx to the radius of influence.

Subsequently, a length of new PTFE tubing connected to a 1.4L Summa canister will be attached to stainless steel fitting and soil vapour sample taken. After recording final vacuum, sampling time and other field observations, Summa canister will be marked by a unique ID and submitted to Maxxam Analytics Inc. under the Chain-Of-Custody protocol. The sampling point will be secured by re-attaching a tamper-proof stainless top cap until next sampling event.

Indoor Air Quality Sampling

Indoor air quality sampling will be preferably carried out concurrently with sub-slab soil vapour sampling within the same building to assure consistency of data. Clifton proposes to collect indoor air samples using a Summa canister (6-Liter capacity) equipped with a critical orifice flow-regulation device sized to allow an air sample to be collected over an eight-hour sampling period (commercial buildings), or twenty four-hour sampling period (residential buildings), respectively. Air sampling canisters will be deployed at representative indoor sampling locations, based on the results of the preliminary sampling Site visit findings, and away from any forced air influence emanating from HVAC, vents, or heaters in the breathing zone, which is characterized at a level height of approximately 1.5 m. Final sampling locations will be also based on the results of the field screening by a photoionization detector (PID) calibrated to the non-methane VOC standard , and an evaluation of the air flow/pressure gradients/stack effects in the building by digital micro-manometer, which might be caused by any HVAC systems, drafts around doors and windows, exhaust fans etc.

The stakeholders will be asked for their cooperation in obtaining representative indoor air samples by refraining from activities that might affect planned indoor air sampling, such as: painting, heavy cleaning, and indoor storage of the chemicals in the period ideally up to seventy-two-hours before the sampling.

5.6 Quality Control/Quality Assurance (QA/QC)

A comprehensive QA/QC program will be implemented to insure that the sampling and analyses follow established protocols and provide defendable, representative results. The program includes all aspects of data collection from the field to the laboratory. The field QA/QC will consist of the following components:

- Labelling air sampling containers with the specific sample number to ensure adequate identification;
- Using laboratory-prepared batch-proofed and cleaned air sampling containers cleaned as per USEPA TO-14A reference method;
- Using individually-proofed air sampling containers (including individually-proofed flow controllers) for soil vapour sampling at the monitoring points previously indicating exceedance of the Soil Vapour Quality Guidelines for the investigated structure;
- Conducting an integrity 15-minutes shut-in vacuum test on sampling trains;
- Conducting helium tracer competent seal integrity testing;
- Collecting field blank duplicates and evaluating Relative Percent Difference (RPD) ratio;
- Measuring initial and final vacuum levels by the independent, standalone gauge to ensure sample validity;

- Forwarding collected samples under the Chain-of -Custody protocols to Maxxam Analytics Inc.; and,
  Reviewing the laboratory quality assurance data.

5.7 Soil Vapour Analytical Methods

Clifton proposes to use soil vapour analytical methods compatible with performance-based reference method USEPA TO-15[9] based on the gas chromatography and mass spectrometry (GC/MS). As stipulated in Section 5.2, all COPCs for vapour inhalation pathway as identified by the 2015 HHREA will be investigated. Therefore, the proposed analytical suite will include the following:

- PHCs fraction F1;
- PHCs fraction F2;
- BTEX (benzene, toluene, ethylbenzene, xylenes);
- VOCs in air (full scan as defined by USEPA TO-15)[10]; and,
- Fixed Gases (O_2, N_2, CO_2, CH_4)[11]

The above stated analytical package will be used for all collected soil vapour samples. This includes field blind duplicates, which will be collected simultaneously with the primary sample, using stainless steel splitter at a rate of approximately one duplicate per ten samples, per a sampling event. Primary and duplicate analytical results above the detection limit will be compared using the following equation:

$$RPD\ (\%) = [abs(x_1-x_2)/(x_1+x_2)/2] * 100$$

Where: x_1, x_2 are the parameter concentrations for the primary and duplicate samples, respectively. USEPA TO-15 method requires the RPD to be below 25%.

In addition, collected samples from selected soil vapour monitoring points (especially nested points allowing vertical soil vapour profiling) will be analyzed for fixed gases (oxygen, nitrogen, carbon dioxide, methane) for increased insight into the Site-specific rates of soil vapour attenuation by biodegradation and diffusion.

Clifton proposes to use Maxxam Analytics Inc. (Maxxam) as a provider of the laboratory services for this SVMP. Maxxam is accredited under ISO/IEC 17025-2005, the Canadian Association for Laboratory Accreditation (CALA), EPA Good Laboratory Practices (GLP) as well as under the National Environmental Laboratory Accreditation Program (NELAP). They are fully qualified to provide laboratory analytical services as per required standards. The full Statement of Qualification for Maxxam can be found in Appendix E.

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[9] The United States Environmental Protection Agency. *Compendium of Methods for the Determination of Compounds in Ambient Air, Second Edition, Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GCMS).* EPA/625/R96/01b, 1999.

[10] Please note that naphthalene, albeit technically semi-volatile PAH, is included in this proposed analytical package.

[11] Applicable for sub-slab soil vapour samples.

5.8 Sampling Frequency

Detailed sampling frequency will be determined following evaluation of the initial soil vapour sampling results and discussion of the stakeholders. However, as a minimum, the following soil vapour frequency principles shall be implemented:

- Soil vapour sampling will be conducted twice a year, with one sampling event occurring during the expected maximum level of the water table at the Site (usually the second half of April and the first half of May), and an additional soil vapour sampling event during the expected minimum level of the water table at the Site (usually the second half of September and the first half of October); and,
- SVMP should last for three continuous years starting in spring 2016.

The above outlined sampling frequency in combination with the SVMP duration should, in Clifton's opinion, address expected temporal fluctuations in soil vapour concentrations caused by seasonal water table fluctuation, as well as changing temperature of soil and groundwater and saturation levels in soils at the Site. Conducting the SVMP over the next three years should be sufficient for trends analysis with respect to the biodegradation and soil vapour concentrations.

6.0 Sampling Results Interpretation

6.1 Soil Vapour Quality Guidelines

The Site-specific Soil Vapour Quality Guidelines (SVQG) were developed by Intrinsik and are attached as the following standalone document in Appendix A:

- Intrinsik Environmental Sciences Inc.: *Final Report, Development of Soil Vapour Quality Guidelines*, 8 April 2016.

SVQG were calculated according to the methods and assumptions defined by 2014 CCME Protocol and 2016 AEP Tier 1 and Tier 2 Guidelines. Tables 7-1 and 7-2 present SVQG that are protective of indoor air quality for a residential building on fine-textured soil and coarse-textured soil, respectively. Similarly, Table 7-3 and Table 7-4 present SVQG that are protective of indoor air quality for a commercial building on fine-textured soil and coarse-textured soil, respectively. Finally, Table 7-5 and Table 7-6 present the SVQG that are protective of outdoor air quality for fine and coarse-textured soils, respectively.

Appendices A and B of the above referred document present the input values that were assumed for each model and CoPCs required to calculated the indoor SVQG for residential and commercial use, respectively. Finally, Appendix C presents an example for the SVQG calculations for benzene at a depth of 1.0 m that is protective of indoor air quality in a residential building on fine-textured soil at the Site.

With respect to the properties identified as having unusual features during the Door-to-Door survey, Clifton will ideally carry out steps described in the Table 6 - Sub-Slab Soil Vapour Monitoring and Indoor Air Quality Monitoring. Should the property owners disagree with indoor air quality monitoring and sub-slab soil vapour monitoring points installation at their respective properties, Clifton would use the following conservative approach to estimate indoor air quality:

- An external soil vapour monitoring point located in the shortest distance from the property will be used for a rough estimate of indoor air quality. No allowance will be made for either lateral or vertical biodegradation of soil vapour regardless of the soil vapour monitoring point installation depth, i.e., recorded concentrations of CoPCs in soil vapour will be directly projected within the property and compared against SVQG for depth of 0 m bgs.

6.2 Reporting

Clifton proposes the following reporting frequency for SVMP implementation:

- Clifton will prepare an initial installation and soil vapour monitoring report, as a standalone document and will submit it to the stakeholders (including the City of Calgary) by 31 July 2016;
- Clifton will prepare annual reports starting onwards from March 2017 for the duration of this SVMP at the Site, which will cover all soil vapour monitoring activities conducted at the Site in previous calendar year. This report will be a portion of the Annual Site Monitoring Report by Clifton;
- In the case of the soil vapour monitoring installations and sampling at a privately-owned property, Clifton will prepare a simplified letter-format report for the property owner summarizing installation and sampling data and submit it to the property owner. Copies of these reports will be forwarded to Sears, AEP and AHS representatives; and,
- Should the Contingency Plan be triggered (as described in the Section 7.0), ongoing communication with affected stakeholders would be conducted without any undue delays and in addition to the above outlined regular reporting frequency.

7.0 Risk Management and Contingency Plan

Clifton proposes to implement the following procedures, strategies and communication protocols as a part of the Risk Management and Contingency Plan for the SVMP.

Increased Monitoring Frequency Trigger

Should results of the soil vapour monitoring at an external or sub-slab monitoring point return CoPCs concentration either within 90%-100% of the SVQG[12], or a concentration exceeding the SVQG, Clifton will increase soil vapour monitoring frequency of the given monitoring point to seasonal. In addition, should a group of the external soil vapour monitoring points in the same area indicate similar pattern of exceedances or readings within 90% of the calculated SVQG, Clifton will consider additional soil vapour monitoring point installations in this area. These proposed additions to the soil vapour monitoring network at the Site would be presented to the stakeholders in the form of an addenda to the SVMP, and might include (where required) “step-in” installation(s) from the area in a question towards foundation of a structure.

Additional Building Monitoring Trigger

In the case of recorded exceedance at an external soil vapour monitoring point, Clifton will without any undue delay (i.e., within 10 days once the laboratory results become available) carry out the following additional steps in respect to any residential or commercial structure within a 15[13] m radius:

- Communicate exceedance and proposed course of further action to the stakeholders;

[12] Increased monitoring frequency trigger as proposed in the text above was approved by AEP on a trial basis. The trigger settings are to be re-evaluated, should they be found ineffective in the future.

[13] External monitoring points will be ideally installed in a distance of up to 10 m from a structure. Using a distance of 15 m for additional investigation is to provide an additional level of conservativism and safety to the residents and tenants at the Site.

- Establish lines of communication with the property owner; arrange meeting outlining reasons for an additional environmental work at the property; discuss with the owner available options; and, obtain the owner's approval with one of the following options (options stated in the order from the most to the least desirable):
    - o Sub-slab monitoring point installation, followed by concurrent sampling of the sub-slab soil vapour and indoor air quality;
    - o Additional installation of at least one (but ideally two) external monitoring point located between structure and contaminant source in a distance of 1.0 m from foundation to a depth of 1.0 m below foundation to be sampled concurrently with indoor air quality; and,
    - o Standalone indoor air quality sampling.

Clifton will have an appropriate number of the sub-slab soil vapour installations kits available for duration of the SVMP to speed up the installation process. Other required sampling material for the additional monitoring (Summa canisters, flow controllers) is available from Maxxam within 5 business days on rush order.

Additional Building Monitoring Results Interpretation and Possible Follow up Actions
Depending on the sampling results, three possible scenarios might occur:

1. Neither sub-slab soil vapour, nor indoor air quality samples shows exceedances for CoPCs. Follow up action will require to continue sampling at the regular frequency set for SVMP until:
    - o Five consequent representative set of samples without exceedances are recorded; or,
    - o The stakeholders agree that based on the sampling data, an active vapour pathway scenario for the structure can be excluded, and further soil vapour monitoring is not required.
2. Sampling results are inconclusive, i.e., indoor air quality exceedance is recorded, but is not supported by an additional line-of-evidence:
    - o Arrange additional sampling round including outdoor air sampling, exclude possible other factors affecting indoor air quality (chemicals storage, indoor smoking etc.). Additional sampling should lead to sampling results reassessment as either scenario 1. or 3.
3. Exceedances are recorded, and a line-of-evidence for active soil vapour intrusion exposure pathway scenario in a structure can be established:
    - o Trigger the Contingency Plan measures as described in the paragraph below.

Contingency Plan
If the above stated trigger conditions for the Contingency Plan are met, Clifton shall implement the following measures:
- Affected stakeholders will be contacted by Clifton and provided with laboratory results including interpretation and recommended further steps for exposure control;
- Should, in opinion of AHS, extent of the exposure to CoPCs in air found in a building rendered it inhabitable until effective exposure controls are applied, Clifton will arrange, on the account of Sears, temporary relocation of residents until satisfactory exposure controls measures are applied;
  Clifton will implement exposure control measures that may (where required) include the following:
    - o Joints and cracks sealing, installation of sump covers;
    - o Application of spray-on vapour barrier system; and,

- o Installation of Active Soil Depressurization (ASD) system.

Proposed exposure control measures will always be structure-specific, taking into account building type, extent of the exposure, technical feasibility and ability to obtain the property-owner consent with a particular exposure control strategy. Effectivity of any selected mitigation strategy will have to be confirmed by additional indoor air quality sampling at the extent satisfactory to all stakeholders. Generally, Clifton will follow exposure control strategies outlined in the following documents:

- California Environmental Protection Agency: *Vapour intrusion Mitigation Advisory*, 2009;
- ASTM International: *Standard Guide for Application of Engineering Controls to Facilitate Use or Redevelopment of Chemical-Affected Properties*, E-2435-0, 2005; and,
- 2014 *Alberta Building Code.*

8.0 Closure

This report was prepared by Clifton Associates Ltd. for the account of Sears Canada Inc. The material in it reflects Clifton Associates Ltd. best judgment available to it at the time of preparation. Any use that a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Clifton Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

This report has been prepared in accordance with generally accepted engineering practice common to the local area. No other warranty, expressed or implied is made.

The work was based in part upon the environmental quality guidelines and regulations in effect when the work was begun. Future regulatory changes may require reassessment of the statements in this document.

Yours truly,

Clifton Associates Ltd.

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20 October 2016

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PROFESSIONAL ENGINEER CLAUDE DAVID ALBERTA
20 Oct. 2016

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Association of Professional Engineers
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Permit to Practice P4823

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31 August 2016

Sears Canada Inc.
222 Jarvis Street
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Dear Mr. Greg Paliouras and Mr. Wayne E. Prada

Subject: Soil Vapour Quality Guidelines for Hounsfield Heights and Mall Areas

On June 24 2016 the revised soil vapour monitoring program developed by Clifton Associates Ltd. (CAL 2016) was available on the Alberta Environment and Parks (AEP) Environmental Site Assessment Repository (ESAR). The report contained soil vapour quality guidelines (SVQG) that were developed by Intrinsik (2016a) and were presented in Appendix A of the CAL (2016) report. After the document was posted to the ESAR, Intrinsik identified errors and has revised the SVQG report for the Hounsfield Heights and Mall areas.

The following updates were incorporated in the revised report (Intrinsik 2016b):

- A number of SVQG were presented for certain chemicals and depths that were above maximum theoretical vapour concentrations and should have been reported as no guideline required (NGR).
- The exposure term of 0.27 (AEP 2016a) was not applied to the calculated SVQG for commercial land use and depths greater than 100 cm. The result was that calculated commercial land use SVQG for depths greater than 100 cm have increased.

- The SVQG have been presented in scientific notation with two significant digits.
- The revised report included a summary table of the most stringent SVQG for residential and commercial land use at the beginning of the report for quick reference.
- SVQG were developed using a specific set of assumptions and equations. In some cases, the assumptions used to derive SVQG may not be protective for particular sites. A number of conditions identified by the CCME (2014) and AEP (2016a,b) that may invalidate some of the assumptions used in the development of SVQG were discussed.

If further information is required or if you have any questions, please do not hesitate to contact the undersigned at kbresee@intrinsik.com or call me at 403-237-0275.

Yours truly,

Intrinsik

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SCIENCE INTEGRITY KNOWLEDGE

FINAL REPORT

DEVELOPMENT OF SOIL VAPOUR QUALITY GUIDELINES

August 31, 2016

Prepared For: **Sears Canada Inc.**
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DEVELOPMENT OF SOIL VAPOUR QUALITY GUIDELINES

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Development of Soil Vapour Quality Guidelines

1.0 INTRODUCTION

Intrinsik Corp. (Intrinsik) followed the CCME protocol (2014) and AEP (2016a,b) guidance to calculate soil vapour quality guidelines (SVQG) for the protection of indoor and outdoor air vapour inhalation of benzene, toluene, ethylbenzene and xylenes (BTEX), 1,2-dichloroethane (1,2-DCA) and petroleum hydrocarbon (PHC) fractions 1 and 2. Naphthalene was also added as measured soil concentrations exceeded guidelines for the protection of vapour inhalation in the northern portion of the Hounsfield Heights area. These petroleum hydrocarbon constituents were identified as chemicals of potential concern (COPC) based on the human health and ecological risk assessment that was completed for the Hounsfield Heights and North Hill Mall areas (Intrinsik 2015).

The CCME (2014) protocol and AEP (2016a,b) guidance were also used to calculate SVQG for residential and commercial land use and for various depth intervals. The calculation of multiple SVQG is required for the soil vapour monitoring program that was proposed for Hounsfield Heights and North Hill Mall by Clifton Associates Ltd. (CAL 2016). The goal of the work was to calculate SVQG for comparison to measured soil vapour concentrations from the soil vapour monitoring program. In addition, fixed gas concentrations should be analyzed in the soil vapour samples (i.e., carbon dioxide-CO_2, oxygen-O_2 and methane-CH_4). According to US EPA (2015) and CCME (2014), when oxygen supply from the atmosphere is sufficient (>5%), biodegradation of PHC constituents can occur relatively quickly and can result in substantial attenuation of vapours over relatively short distances.

2.0 SOIL VAPOUR QUALITY GUIDELINES (DEPTH <100 CM)

Table 2-1 presents the SVQGs for residential and commercial buildings for a depth of <100 cm below the building foundation or surface for a slab-on-grade building. Guidelines have also been calculated for various depths below the building foundation ranging from <1 m (i.e., sub-slab) to a depth of 6 m by increments of 0.5 m. These guidelines for additional sampling depths are presented in Section 8.0.

Table 2-1 Soil Vapour Quality Guidelines Protective of Indoor Air Quality for Residential and Commercial Buildings for Samples Taken from a Depth of <100 cm [µg/m³]

Chemical	Residential	Commercial
	Fine and Coarse	Fine and Coarse
Benzene	3.0E+02	1.1E+03
Toluene	1.9E+05	6.8E+05
Ethylbenzene	5.0E+04	1.8E+05
Xylenes	8.9E+03	3.2E+04
1,2-DCA	4.0E+01	1.5E+02
Naphthalene	1.0E+02	3.7E+02
F1		
Aliphatic C6-C8	9.2E+05	3.3E+06
Aliphatic >C8-C10	4.8E+04	1.7E+05
Aromatic >C8-C10	8.1E+03	3.0E+04
F2		
Aliphatic >C10-C12	5.0E+04	1.8E+05
Aromatic >C10-C12	1.0E+04	3.6E+04
Aliphatic >C12-C16	5.0E+04	1.8E+05
Aromatic >C12-C16	1.0E+04	3.6E+04

3.0 METHODS

SVQG were calculated according to the methods and assumptions defined by CCME (2014) and AEP (2016a,b). The SVQG for the protection of indoor air quality are based on a combination of empirical data and the Johnson and Ettinger (1991) model that predicts the migration of soil vapours from the subsurface into buildings. The $SVQG_{IAQ}$ apply to soil vapour collected at a minimum distance of one metre from the building foundation, and assume that at least 1 m of clean soil is present immediately beneath the building. Therefore, SVQG were calculated for soil vapour measurements ranging in depth from one metre to six metres below the surface or building. In situations where the minimum separation distance is less than one metre it is recommended that the calculated $SVQG_{IAQ}$ are not based on the Johnson and Ettinger (1991) model. Instead the calculated $SVQG_{IAQ}$ should be based on the default attenuation factor of 0.01 (i.e., DF = 100) for a residential or commercial building (AEP 2016b). The Johnson and Ettinger (1991) model was used to predict $SVQG_{IAQ}$ for depths greater than one metre based on the assumptions and protocol recommended by CCME (2014).

SVQG were developed using a specific set of assumptions and equations. In some cases, the assumptions used to derive SVQGs may not be protective for particular sites. A number of conditions identified by the CCME (2014) and AEP (2016a,b) that may invalidate some of the assumptions used in the development of SVQGs are discussed below (Table 3-1).

Table 3-1 Interpretation of Conditions That May Invalidate Some Assumptions Used in Development of SVQGs

<table>
<tr><th>Condition</th><th>Interpretation</th></tr>
<tr><td>The water table is within 1 m of a building foundation (possible wet-basement scenario) or the source of vapours is in close proximity to the foundation (floor drains, or other sub-floor utilities) (CCME 2014).</td><td rowspan="2">In these cases, soil vapour screening may be done through shallow soil vapour samples (short distance below building foundation) or sub-slab samples (CCME 2014). It is recommended that the calculated SVQGs be based on the default attenuation coefficient of 0.01 (i.e., a dilution factor of 100) for residential and commercial buildings (AEP 2016b). Soil vapour remediation guidelines for a depth of <1 m, which are based on the recommended default attenuation coefficient of 0.01, are provided in Section 8.0.</td></tr>
<tr><td>The source-building separation distance is less than 1 m (e.g., shallow unsaturated soils with elevated volatile organic compound concentrations) (CCME 2014).</td></tr>
<tr><td>The building is taller than four floors (possible enhanced stack effect resulting in greater pressure differential than typical default values) (CCME 2014). The “stack effect” can occur within a building, particularly during the heating season in the winter months as a result of hot air rising and leaving near the top of the building (e.g., through a chimney, leaky attic, exhaust vent), which creates a negative pressure in the building thereby drawing outdoor air and soil gas into the building through openings with the lower regions of the building (i.e., doors, windows, cracks and/or the building foundation) (OMOE 2010).</td><td>The model that was used to calculate the SVQGs, which is based on Johnson and Ettinger (1991), was developed for a typical residential or commercial building of specific dimensions. The inclusion of this condition in CCME (2014) is based on the possibility of the stack effect, which may occur in certain buildings taller than four floors.

Although it is possible that the stack effect could occur in a tall building, it is expected to be offset by the effect of a larger building volume as well as the heating, ventilation and air conditioning (HVAC) system requirements of a larger building (Manitoba Sustainable Development [MSD] 2016). It should be noted that the buildings at the Site typically do not exceed four floors in height.</td></tr>
</table>

Condition	Interpretation
Preferential pathways are present in the subsurface that provide a direct conduit from the vapour source to the inside of the building over and above that of a typical residential building (e.g., wet basements, basements with a sump basin, highly permeable and atypical utility conduits, dirt floors, fractured media immediately below the building) (CCME 2014) and very coarse textured materials (i.e., gravel) that may enhance vapour transport (AEP 2016a,b). Additionally, unique building features, including earthen floors or unusually low air exchange rates (AEP 2016a,b). This condition refers to conduits located between the source of contamination and the building.	It is possible that some residences in the Hounsfield Heights Area and Mall Area (e.g., Kal Tire building) may have a sump basin and should be addressed on a site-specific basis. The primary concern with a sump is when water within the sump is impacted with COPCs due to groundwater infiltration. Sumps that are not impacted with COPCs in groundwater and have been installed properly would provide adequate protection from indoor vapour migration.
Methanogenic conditions, which are defined as environmental soil conditions that allow microorganisms to produce methane as a metabolic by-product in anoxic conditions, are observed in close proximity to the building foundation (possible gas pressure-driven flow and/or explosion risk) (CCME 2014).	Areas that are capable of producing methanogenic conditions (e.g., waste disposal or landfill areas) are unlikely to be found at the Site or in proximity to the Site.

The following equations were used to calculate $SVQG_{IAQ}$ for the indoor air inhalation pathway (CCME 2014):

Threshold chemical $$SVQG_{IAQ} = \frac{(TC - C_a) \times AF \times BAF}{\propto \times ET}$$ (Equation 1)

Non-threshold chemical $$SVQG_{IAQ} = \frac{(RsC) \times BAF}{\propto \times ET}$$ (Equation 2)

Similarly, the following equations were used to predict $SVQG_{OAQ}$ for the outdoor air inhalation pathway (CCME 2014):

Threshold chemical $$SVQG_{OAQ} = \frac{(TC - C_a) \times AF \times BAF}{VF_{sv,amb} \times ET}$$ (Equation 3)

Non-threshold chemical $$SVQG_{OAQ} = \frac{(RsC) \times BAF}{VF_{sv,amb} \times ET}$$ (Equation 4)

Where:

$SVQG_{IAQ}$	=	soil vapour quality guideline for the protection of indoor air quality [mg/m³]
$SVQG_{OAQ}$	=	soil vapour quality guideline for the protection of outdoor air quality [mg/m³]
TC	=	tolerable concentration or reference concentration [mg/m³]
C_a	=	background indoor air concentration [mg/m³]
AF	=	allocation factor [Unitless]
BAF	=	bioattenuation factor [Unitless]
α	=	attenuation factor calculated from Johnson and Ettinger (1991) model
ET	=	exposure term [Unitless]
RsC	=	risk-specific concentration [mg/m³]
$VF_{sv,amb}$	=	volatilization factor for subsurface soil to ambient air [Unitless]

Dilution factor from soil gas to indoor air ***(Equation 5)***

$$DF = \frac{1}{\alpha}$$

$$\alpha = \frac{\left(\frac{D_T^{eff}\, A_B}{Q_B L_T}\right)\exp\left(\frac{Q_{soil}\, L_{crack}}{D_{crack}\, A_{crack}}\right)}{exp\left(\frac{Q_{soil}\, L_{crack}}{D_{crack}\, A_{cract}}\right) + \left(\frac{D_T^{eff}\, A_B}{Q_B L_T}\right) + \left(\frac{D_T^{eff}\, A_B}{Q_{soil} L_T}\right)\left[exp\left(\frac{Q_{soil}\, L_{crack}}{D_{crack}\, A_{crack}}\right) - 1\right]}$$

Where:

DF	=	dilution factor [Unitless]
α	=	attenuation coefficient [Unitless]
D_T^{eff}	=	effective porous media diffusion coefficient [cm²/s]
A_B	=	building area [cm²]
Q_B	=	building ventilation rate [cm³/s]
L_T	=	distance from contaminant source to foundation [cm]
Q_{soil}	=	volumetric flow rate of soil gas into the building [cm³/s]
L_{crack}	=	thickness of the foundation [cm]
D_{crack}	=	effective vapour diffusion coefficient through the crack [cm²/s]
A_{crack}	=	area of cracks through which the contaminant vapours enter [cm²]

Calculation of D_T^{eff} ***(Equation 6)***

$$D_T^{eff} = D^{air} \times \left(\frac{\theta_a^{\frac{10}{3}}}{n^2}\right) + \left(\frac{D^{water}}{H'}\right) \times \left(\frac{\theta_w^{\frac{10}{3}}}{n^2}\right)$$

Where:

D_T^{eff}	=	overall effective porous media diffusion coefficient [cm²/s]
D^{air}	=	pure component molecular diffusivity in air [cm²/s]
θ_a	=	air filled porosity [Unitless]
n	=	total porosity [Unitless]
D^{water}	=	pure component molecular diffusivity in water [cm²/s]

H'	=	Dimensionless Henry's Law constant [Unitless] at soil temperature (e.g., 15°C)
θ_w	=	moisture/water filled porosity [Unitless]

Calculation of D_{crack} **(Equation 7)**

$$D_{crack} \approx D_{air} \times \left(\frac{n^{10/3}}{n^2}\right)$$

Where:

D_{crack}	=	effective vapour diffusion coefficient through the crack [cm²/s]
D_{air}	=	diffusion coefficient in air [cm²/s]
n	=	total porosity [Unitless]

Volatilization Factor **(Equation 8)**

$$VF_{sv,amb} = \left(1 + \frac{L_s \times U_{air} \times M_{air}}{D_T^{eff} \times W}\right)^{-1}$$

Where:

$VF_{sv,amb}$	=	volatilization factor, subsurface soil vapour to ambient air [dimensionless]
D_T^{eff}	=	overall effective porous media diffusion coefficient [cm²/s]
L_s	=	depth to subsurface soil vapour sample [cm]
U_{air}	=	ambient air velocity in mixing zone [cm/s]
W	=	width of source-zone area parallel to the wind direction [cm]
M_{air}	=	mixing zone height [cm]

Appendix A and B present the input values that were assumed for each model input variable and COPC required to calculate the indoor attenuation factor (α), volatilization factor (VF) and SVQG for residential and commercial land use, respectively.

4.0 TEMPERATURE ADJUSTED HENRY'S CONSTANT

The volatilization rate of a chemical from soil or water is dependent on the Henry's Law constant, which is dependent on system temperature. The value of Henry's Law constant is provided at a standard temperature of 25 degrees Celsius (AEP 2016a); however, the average groundwater temperature in the Hounsfield Heights area was measured to be 10.8 ± 2.7 degrees Celsius between February and September 2015 (n=174). Use of the Henry's Law constant at 25 degrees Celsius may over predict the volatility of the chemical such that the resulting SVQG may be artificially low. Therefore, Henry's constant can be adjusted for temperature based on the Clausius-Clapeyron relationship (US EPA 2001, Health Canada 2010). Henry's Law Constant can be adjusted based on temperature based on the following equation:

$$H_{TS} = \frac{EXP\left[-\frac{\Delta H_{v,TS}}{R_C}\left(\left(\frac{1}{T_S}\right)-\left(\frac{1}{T_R}\right)\right)\right]\times H_R}{RT_S}$$ (Equation 8)

Where:

H_{TS}	=	corrected dimensionless Henry's law constant
$\Delta H_{v,TS}$	=	enthalpy of vaporization at soil temperature [cal/K]
T_S	=	average soil temperature [K]
T_R	=	Henry's Law Constant reference temperature [K]
H_R	=	Henry's Law Constant at reference temperature [atm-m³/mol]
R_C	=	gas constant [1.9872 cal/mol-K]
R	=	gas constant [8.205E-05 atm-m³/mol-K]

The above equation yields a corrected dimensionless Henry's Law Constant (i.e., H') for benzene at 15 degrees Celsius of 0.141, as opposed to the 'default' value of 0.225 at 25 degrees Celsius. Appendix A presents the input values that were assumed to calculate the dimensionless Henry's Law Constant for each COPC based on a system temperature of 15 degrees Celsius. The temperature adjusted Henry's Constants are presented in Appendix A for information purposes only and were not used to calculate SVQG.

5.0 BIO-ATTENUATION FACTOR

The CCME (2014) indicates that the bio-attenuation factor (BAF) can be adjusted for various depths when there is no non-aqueous phase liquid (NAPL) present, the total hydrocarbon vapour concentration is less than 10 mg/L and subsurface oxygen content is >5%. CCME (2014) recommends a BAF of 10 at >1 to 3m depth, a BAF of 100 at >3 to 5m depth and 1000 at >5m depth. Table 5-1 presents the BAF values that were used to calculate SVQG. Although greater BAF values are permitted at greater depths, the SVQG did not apply these adjustments to be conservative.

Table 5-1 Bio-Attenuation Factor Values Used to Calculate SVQG

Chemical	***Depth Specific Bio-Attenuation Factor (BAF) Values [Unitless]***	
	<1m	***≥1m***
Benzene	1	10
Toluene	1	10
Ethylbenzene	1	10
Xylenes	1	10
1,2-DCA	1	1
Naphthalene	1	1
F1 - Aliphatic C6-C8	1	10
F1 - Aliphatic C8-C10	1	10
F1 - Aromatic C8-C10	1	10
F2 - Aliphatic C10-C12	1	10
F2 - Aromatic C10-C12	1	10
F2 - Aliphatic C12-C16	1	10
F2 - Aromatic C12-C16	1	10

6.0 VOLUMETRIC FLOW RATE INTO BUILDING (Q_{SOIL})

The volumetric flow rate of soil gas into the building (Q_{soil}) is based on the “perimeter crack” equation, which is defined as follows:

$$Q_{soil} = \frac{2 \times \pi \times \Delta P \times K_v \times X_{crack}}{\mu \times ln\left[\frac{2 \times Z_{crack}}{r_{crack}}\right]}$$

Where:

Q_{soil}	=	volumetric flow rate of soil gas into the building [cm³/s]
ΔP	=	pressure differential [g/cm/s²]
k_v	=	soil permeability to vapour flow [cm²]
X_{crack}	=	length of idealized cylinder [cm]
μ	=	vapour viscosity [g/cm/s]
Z_{crack}	=	distance below grade to idealized cylinder [cm]
r_{crack}	=	radius of idealized cylinder [cm]

Under the guidance of AEP (2016a), the Q_{soil} variable is calculated based on default soil vapour permeability values that range from 1E-09 to 6E-08 cm^2 for fine and coarse textured soils. Under the CCME (2014) protocol, the Q_{soil} variable is fixed based on alternative approaches that have been adopted for estimating. The CCME (2014) recommends that the perimeter crack model should not be used but SVQG should be based on Q_{soil} values of 10 L/min (167 cm³/sec) for coarse textured soils and 1 L/min (16.7 cm³/sec) for fine and medium textured soils. The SVQG presented in Section 8.0 were based on the recommend CCME (2014) Q_{soil} values.

7.0 TOXICITY REFERENCE VALUES

The following two types of limits were used for the assessment of inhalation risks and development of SVQG:

1. Risk-specific concentration (RsC) is used for a carcinogenic chemical (i.e., benzene and 1,2-DCA) and is the concentration that one can breathe every day for a lifetime without exceeding the acceptable benchmark level of increased cancer risk. The acceptable benchmark level for cancer risk in Alberta is 1 in 100,000 or 0.00001 risk (AEP 2016a); and
2. Reference concentration (RfC) is used for a non-carcinogenic chemical and the toxicity reference value is the concentration of the chemical that one can breathe every day for a lifetime that is not anticipated to cause harmful non-carcinogenic health effects.

Table 7-1 presents the toxicity reference values that were used to develop the SVQG. The SVQG are based on chronic inhalation limits recommended by AEP (2016a) which are based on CCME (2008), Health Canada (2010) or US EPA (2016).

Table 7-1 Toxicity Reference Values Used to Derive Soil Vapour Inhalation Guidelines

Chemical	*Toxicity Reference Value [µg/m³]*	*Comment / Reference*
Benzene	3.0	Risk-specific concentration at 1 in 100,000 risk level (AEP 2016a)
Toluene	3,800	Reference concentration (AEP 2016a)
Ethylbenzene	1,000	Reference concentration (AEP 2016a)
Xylenes	180	Reference concentration (AEP 2016a)
1,2-DCA	0.4	Risk-specific concentration at 1 in 100,000 risk level (AEP 2016a)
Naphthalene	3.0	Reference concentration (AEP 2016a)
F1 - Aliphatic C6-C8	18,400	Reference concentration (AEP 2016a)
F1 - Aliphatic C8-C10	1,000	Reference concentration (AEP 2016a)
F1 - Aromatic C8-C10	200	Reference concentration (AEP 2016a)
F2 - Aliphatic C10-C12	1,000	Reference concentration (AEP 2016a)
F2 - Aromatic C10-C12	200	Reference concentration (AEP 2016a)
F2 - Aliphatic C12-C16	1,000	Reference concentration (AEP 2016a)
F2 - Aromatic C12-C16	200	Reference concentration (AEP 2016a)

8.0 SOIL VAPOUR QUALITY GUIDELINES (DEPTHS >100 CM)

Table 8-1 and Table 8-2 present SVQG that are protective of indoor air quality for a residential building on fine-textured soil and coarse-textured soil, respectively. Similarly, Table 8-3 and Table 8-4 present SVQG that are protective of indoor air quality for a commercial building on fine-textured soil and coarse-textured soil, respectively. Finally, Table 8-5 and Table 8-6 present the SVQG that are protective of outdoor air quality for fine and coarse textured soils, respectively.

Appendix A and B present the input values that were assumed for each model input variable and COPC required to calculate the indoor SVQG for residential and commercial land use, respectively. Finally, Appendix C presents a worked example for the SVQG for benzene at a depth of 100cm that is protective of indoor air quality in a residential building on fine-textured soil.

Table 8-1 Soil Vapour Quality Guidelines Protective of Indoor Air Quality for a Residential Building on Fine-textured Soil [µg/m³]

Depth (cm)	*Benzene*	*Toluene*	*Ethyl-benzene*	*Xylenes*	*1,2-DCA*	*Naphtha-lene*	*F1*			*F2*			
							Aliphatic C6-C8	*Aliphatic >C8-C10*	*Aromatic >C8-C10*	*Aliphatic >C10-C12*	*Aromatic >C10-C12*	*Aliphatic >C12-C16*	*Aromatic >C12-C16*
<100(1)	3.0E+02	1.9E+05	5.0E+04	8.9E+03	4.0E+01	1.0E+02	9.2E+05	4.8E+04	8.1E+03	5.0E+04	1.0E+04	5.0E+04	1.0E+04
100	1.5E+05	9.1E+07	2.4E+07	4.4E+06	1.8E+03	5.2E+03	NGR	2.5E+07	4.2E+06	NGR	NGR	NGR	NGR
150	1.5E+05	9.5E+07	2.6E+07	4.6E+06	1.9E+03	5.5E+03	NGR	2.6E+07	4.5E+06	NGR	NGR	NGR	NGR
200	1.6E+05	9.8E+07	2.7E+07	4.7E+06	1.9E+03	5.7E+03	NGR	2.8E+07	4.7E+06	NGR	NGR	NGR	NGR
250	1.6E+05	1.0E+08	2.8E+07	4.9E+06	2.0E+03	6.0E+03	NGR	2.9E+07	5.0E+06	NGR	NGR	NGR	NGR
300	1.7E+05	1.1E+08	2.9E+07	5.1E+06	2.0E+03	6.3E+03	NGR	3.1E+07	5.3E+06	NGR	NGR	NGR	NGR
350	1.8E+05	1.1E+08	3.0E+07	5.3E+06	2.1E+03	6.6E+03	NGR	3.3E+07	5.5E+06	NGR	NGR	NGR	NGR
400	1.8E+05	1.1E+08	3.1E+07	5.5E+06	2.2E+03	6.9E+03	NGR	3.4E+07	5.8E+06	NGR	NGR	NGR	NGR
450	1.9E+05	1.2E+08	3.2E+07	5.7E+06	2.2E+03	7.2E+03	NGR	NGR	6.1E+06	NGR	NGR	NGR	NGR
500	1.9E+05	1.2E+08	3.3E+07	5.9E+06	2.3E+03	7.5E+03	NGR	NGR	6.3E+06	NGR	NGR	NGR	NGR
550	2.0E+05	1.2E+08	3.4E+07	6.1E+06	2.3E+03	7.7E+03	NGR	NGR	6.6E+06	NGR	NGR	NGR	NGR
600	2.0E+05	1.3E+08	3.5E+07	6.2E+06	2.4E+03	8.0E+03	NGR	NGR	6.9E+06	NGR	NGR	NGR	NGR

Notes:

NGR No guideline required, as calculated guideline value results in a vapour concentration greater than the maximum possible vapour concentration for that chemical, assuming no NAPL is present. Maximum vapour concentration calculated according to Health Canada (2010) guidance.

(1) Based on default attenuation coefficient of 0.01 (AEP 2016b).

Table 8-2 Soil Vapour Quality Guidelines Protective of Indoor Air Quality for a Residential Building on Coarse-textured Soil [µg/m³]

Depth (cm)	*Benzene*	*Toluene*	*Ethyl-benzene*	*Xylenes*	*1,2-DCA*	*Naphtha-lene*	*F1*			*F2*			
							Aliphatic C6-C8	*Aliphatic >C8-C10*	*Aromatic >C8-C10*	*Aliphatic >C10-C12*	*Aromatic >C10-C12*	*Aliphatic >C12-C16*	*Aromatic >C12-C16*
<100(1)	3.0E+02	1.9E+05	5.0E+04	8.9E+03	4.0E+01	1.0E+02	9.2E+05	4.8E+04	8.1E+03	5.0E+04	1.0E+04	5.0E+04	1.0E+04
100	2.0E+04	1.2E+07	3.4E+06	6.0E+05	2.3E+02	7.7E+02	7.4E+07	3.9E+06	6.6E+05	4.0E+06	8.1E+05	NGR	NGR
150	2.3E+04	1.4E+07	4.0E+06	7.1E+05	2.7E+02	9.3E+02	9.0E+07	4.7E+06	8.0E+05	NGR	9.9E+05	NGR	NGR
200	2.6E+04	1.6E+07	4.6E+06	8.1E+05	3.0E+02	1.1E+03	1.1E+08	5.6E+06	9.5E+05	NGR	1.2E+06	NGR	NGR
250	2.9E+04	1.8E+07	5.2E+06	9.1E+05	3.3E+02	1.2E+03	1.2E+08	6.5E+06	1.1E+06	NGR	1.3E+06	NGR	NGR
300	3.2E+04	2.0E+07	5.8E+06	1.0E+06	3.6E+02	1.4E+03	1.4E+08	7.3E+06	1.2E+06	NGR	1.5E+06	NGR	NGR
350	3.5E+04	2.2E+07	6.4E+06	1.1E+06	4.0E+02	1.5E+03	1.6E+08	8.2E+06	1.4E+06	NGR	1.7E+06	NGR	NGR
400	3.8E+04	2.4E+07	7.0E+06	1.2E+06	4.3E+02	1.7E+03	1.7E+08	9.0E+06	1.5E+06	NGR	1.9E+06	NGR	NGR
450	4.1E+04	2.6E+07	7.5E+06	1.3E+06	4.6E+02	1.9E+03	1.9E+08	9.9E+06	1.7E+06	NGR	2.1E+06	NGR	NGR
500	4.4E+04	2.8E+07	8.1E+06	1.4E+06	4.9E+02	2.0E+03	2.0E+08	1.1E+07	1.8E+06	NGR	2.2E+06	NGR	NGR
550	4.7E+04	3.0E+07	8.7E+06	1.5E+06	5.3E+02	2.2E+03	2.2E+08	1.2E+07	2.0E+06	NGR	2.4E+06	NGR	NGR
600	5.1E+04	3.2E+07	9.3E+06	1.6E+06	5.6E+02	2.3E+03	2.4E+08	1.2E+07	2.1E+06	NGR	2.6E+06	NGR	NGR

Notes:

NGR No guideline required, as calculated guideline value results in a vapour concentration greater than the maximum possible vapour concentration for that chemical, assuming no NAPL is present. Maximum vapour concentration calculated according to Health Canada (2010) guidance.

(1) Based on default attenuation coefficient of 0.01 (AEP 2016b).

Table 8-3 Soil Vapour Quality Guidelines Protective of Indoor Air Quality for a Commercial Building on Fine-textured Soil [µg/m³]

Depth (cm)	Benzene	Toluene	Ethyl-benzene	Xylenes	1,2-DCA	Naphtha-lene	F1			F2			
							Aliphatic C6-C8	Aliphatic >C8-C10	Aromatic >C8-C10	Aliphatic >C10-C12	Aromatic >C10-C12	Aliphatic >C12-C16	Aromatic >C12-C16
<100(1)	1.1E+03	6.8E+05	1.8E+05	3.2E+04	1.5E+02	3.7E+02	3.3E+06	1.7E+05	3.0E+04	1.8E+05	3.6E+04	1.8E+05	3.6E+04
100	1.5E+06	NGR	NGR	4.6E+07	1.8E+04	5.5E+04	NGR	NGR	NGR	NGR	NGR	NGR	NGR
150	1.6E+06	NGR	NGR	4.8E+07	1.9E+04	5.8E+04	NGR	NGR	NGR	NGR	NGR	NGR	NGR
200	1.6E+06	NGR	NGR	5.0E+07	2.0E+04	6.1E+04	NGR	NGR	NGR	NGR	NGR	NGR	NGR
250	1.7E+06	NGR	NGR	NGR	2.0E+04	6.4E+04	NGR	NGR	NGR	NGR	NGR	NGR	NGR
300	1.8E+06	NGR	NGR	NGR	2.1E+04	6.7E+04	NGR	NGR	NGR	NGR	NGR	NGR	NGR
350	1.8E+06	NGR	NGR	NGR	2.1E+04	6.9E+04	NGR	NGR	NGR	NGR	NGR	NGR	NGR
400	1.9E+06	NGR	NGR	NGR	2.2E+04	7.2E+04	NGR	NGR	NGR	NGR	NGR	NGR	NGR
450	1.9E+06	NGR	NGR	NGR	2.3E+04	7.5E+04	NGR	NGR	NGR	NGR	NGR	NGR	NGR
500	2.0E+06	NGR	NGR	NGR	2.3E+04	7.8E+04	NGR	NGR	NGR	NGR	NGR	NGR	NGR
550	2.0E+06	NGR	NGR	NGR	2.4E+04	8.1E+04	NGR	NGR	NGR	NGR	NGR	NGR	NGR
600	2.1E+06	NGR	NGR	NGR	2.4E+04	8.3E+04	NGR	NGR	NGR	NGR	NGR	NGR	NGR

Notes:

NGR No guideline required, as calculated guideline value results in a vapour concentration greater than the maximum possible vapour concentration for that chemical, assuming no NAPL is present. Maximum vapour concentration calculated according to Health Canada (2010) guidance.

(1) Based on default attenuation coefficient of 0.01 (AEP 2016b).

Table 8-4 Soil Vapour Quality Guidelines Protective of Indoor Air Quality for a Commercial Building on Coarse-textured Soil [$\mu g/m^3$]

Depth (cm)	***Benzene***	***Toluene***	***Ethyl-benzene***	***Xylenes***	***1,2-DCA***	***Naphtha-lene***	***F1***			***F2***			
							Aliphatic C6-C8	***Aliphatic >C8-C10***	***Aromatic >C8-C10***	***Aliphatic >C10-C12***	***Aromatic >C10-C12***	***Aliphatic >C12-C16***	***Aromatic >C12-C16***
<100[(1)]	1.1E+03	6.8E+05	1.8E+05	3.2E+04	1.5E+02	3.7E+02	3.3E+06	1.7E+05	3.0E+04	1.8E+05	3.6E+04	1.8E+05	3.6E+04
100	2.1E+05	1.3E+08	3.6E+07	6.4E+06	2.5E+03	8.1E+03	NGR	NGR	6.8E+06	NGR	NGR	NGR	NGR
150	2.4E+05	NGR	4.2E+07	7.4E+06	2.8E+03	9.6E+03	NGR	NGR	8.3E+06	NGR	NGR	NGR	NGR
200	2.7E+05	NGR	4.8E+07	8.4E+06	3.1E+03	1.1E+04	NGR	NGR	9.7E+06	NGR	NGR	NGR	NGR
250	3.0E+05	NGR	5.3E+07	9.4E+06	3.4E+03	1.3E+04	NGR	NGR	1.1E+07	NGR	NGR	NGR	NGR
300	3.3E+05	NGR	NGR	1.0E+07	3.8E+03	1.4E+04	NGR	NGR	1.3E+07	NGR	NGR	NGR	NGR
350	3.6E+05	NGR	NGR	1.1E+07	4.1E+03	1.6E+04	NGR	NGR	1.4E+07	NGR	NGR	NGR	NGR
400	3.9E+05	NGR	NGR	1.2E+07	4.4E+03	1.7E+04	NGR	NGR	1.5E+07	NGR	NGR	NGR	NGR
450	4.2E+05	NGR	NGR	1.3E+07	4.7E+03	1.9E+04	NGR	NGR	1.7E+07	NGR	NGR	NGR	NGR
500	4.5E+05	NGR	NGR	1.4E+07	5.0E+03	2.0E+04	NGR	NGR	1.8E+07	NGR	NGR	NGR	NGR
550	4.8E+05	NGR	NGR	1.5E+07	5.4E+03	2.2E+04	NGR	NGR	2.0E+07	NGR	NGR	NGR	NGR
600	5.1E+05	NGR	NGR	1.6E+07	5.7E+03	2.3E+04	NGR	NGR	2.1E+07	NGR	NGR	NGR	NGR

Notes:
NGR No guideline required, as calculated guideline value results in a vapour concentration greater than the maximum possible vapour concentration for that chemical, assuming no NAPL is present. Maximum vapour concentration calculated according to Health Canada (2010) guidance.
(1) Based on default attenuation coefficient of 0.01 (AEP 2016b).

Table 8-5 Soil Vapour Quality Guidelines Protective of Outdoor Air Quality for Fine-textured Soil [µg/m³]

Depth (cm)	Benzene	Toluene	Ethyl-benzene	Xylene	1,2-DCA	Naphtha-lene	F1			F2			
							Aliphatic C6-C8	Aliphatic C8-C10	Aromatic C8-C10	Aliphatic C10-C12	Aromatic C10-C12	Aliphatic C12-C16	Aromatic C12-C16
100	8.1E+06	NGR	NGR	NGR	8.6E+04	4.1E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR
150	1.2E+07	NGR	NGR	NGR	1.3E+05	6.2E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR
200	1.6E+07	NGR	NGR	NGR	1.7E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR
250	2.0E+07	NGR	NGR	NGR	2.1E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR
300	2.4E+07	NGR	NGR	NGR	2.6E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR
350	2.8E+07	NGR	NGR	NGR	3.0E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR
400	3.3E+07	NGR	NGR	NGR	3.4E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR
450	3.7E+07	NGR	NGR	NGR	3.9E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR
500	4.1E+07	NGR	NGR	NGR	4.3E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR
550	4.5E+07	NGR	NGR	NGR	4.7E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR
600	4.9E+07	NGR	NGR	NGR	5.1E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR

Notes:
NGR – Indicates no guideline required as calculated SVQG exceeds maximum theoretical vapour concentration.

Table 8-6 Soil Vapour Quality Guidelines Protective of Outdoor Air Quality for Coarse-textured Soil [µg/m³]

Depth (cm)	Benzene	Toluene	Ethyl-benzene	Xylene	1,2-DCA	Naphtha-lene	F1			F2			
							Aliphatic C6-C8	Aliphatic C8-C10	Aromatic C8-C10	Aliphatic C10-C12	Aromatic C10-C12	Aliphatic C12-C16	Aromatic C12-C16
100	4.4E+06	NGR	NGR	NGR	4.7E+04	2.2E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR
150	6.6E+06	NGR	NGR	NGR	7.0E+04	3.4E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR
200	8.9E+06	NGR	NGR	NGR	9.3E+04	4.5E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR
250	1.1E+07	NGR	NGR	NGR	1.2E+05	5.6E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR
300	1.3E+07	NGR	NGR	NGR	1.4E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR
350	1.5E+07	NGR	NGR	NGR	1.6E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR
400	1.8E+07	NGR	NGR	NGR	1.9E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR
450	2.0E+07	NGR	NGR	NGR	2.1E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR
500	2.2E+07	NGR	NGR	NGR	2.3E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR
550	2.4E+07	NGR	NGR	NGR	2.6E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR
600	2.7E+07	NGR	NGR	NGR	2.8E+05	NGR	NGR	NGR	NGR	NGR	NGR	NGR	NGR

Notes:
NGR – Indicates no guideline required as calculated SVQG exceeds maximum theoretical vapour concentration.

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Appendix A
Model for the Derivation of Residential Soil Vapour Quality Guidelines

Table A-1 Default Soil Vapour Quality Guidelines Protective of Indoor Air Quality for Residential buildings (Depths 0 to <100m)

Chemical	**Tolerable Concentration** µg/m3	**Background Air** µg/m3	**Allocation Factor** Unitless	**Attenuation Factor (alpha)**[(1)] Unitless	**Exposure Term** Unitless	**Bioattenuation Factor** Unitless	**Soil Vapour Quality Guideline [µg/m3]** Non-carcinogen	Carcinogen
Benzene	3	0	1	0.01	1	1		300
Toluene	3800	44.2	0.5	0.01	1	1	187790	
Ethylbenzene	1000	7.5	0.5	0.01	1	1	49625	
Xylenes	180	1.82	0.5	0.01	1	1	8909	
1,2-DCA	0.4	0	1	0.01	1	1		40
Naphthalene	3	0.95	0.5	0.01	1	1	103	
Aliphatic C6-C8	18400	91.1	0.5	0.01	1	1	915445	
Aliphatic >C8-C10	1000	38.8	0.5	0.01	1	1	48060	
Aromatic >C8-C10	200	37.5	0.5	0.01	1	1	8125	
Aliphatic >C10-C12	1000	0	0.5	0.01	1	1	50000	
Aromatic >C10-C12	200	0	0.5	0.01	1	1	10000	
Aliphatic >C12-C16	1000	0	0.5	0.01	1	1	50000	
Aromatic >C12-C16	200	0	0.5	0.01	1	1	10000	

(1) Default attenuation factor for sub-slab soil-gas sample (AEP 2016b)

For non-carcinogens (CCME 2014):

$$SVRG = \frac{(TC - C_a) \times AF \times BAF}{a \times ET}$$

For carcinogens (CCME 2014):

$$SVRG = \frac{RSC \times BAF}{a \times ET}$$

Table A-2 Input Variables for Indoor Vapour Inhalation

Required Input Variables	Land Use	Soil Type
	Residential	Fine

Below Ground Surface Area of Building

Description	Abbreviation	Units	Value	Reference/Comment
Building length	L_b	cm	1225	CCME 2014
Building width	W_b	cm	1225	CCME 2014
Building Area	A_b	cm^2	2.7E+06	CCME 2014

Flow Rate of Fresh air Into Building

Description	Abbreviation	Units	Value	Reference/Comment
Building length	L_b	cm	1225	
Building width	W_b	cm	1225	
Building height	H_b	cm	360	CCME 2014
Indoor air exchange rate per hour	ACH	exch/hr	0.5	CCME 2014
Building ventilation rate	Q_b	cm^3/s	7.50E+04	CCME 2014

Pressure-driven Soil Gas Flow Rate From Subsurface Into Building

Description	Abbreviation	Units	Value	Reference/Comment
Building length	L_b	cm	1.23E+03	
Building width	W_b	cm	1.23E+03	
Crack area	A_{crack}	cm^2	994.5	CCME 2014
Building Area	A_b	cm^2	2.70E+06	
Soil gas flow rate	Q_{soil}	cm^3/s	16.7	CCME 2014

Soil Parameters for Site

Description	Abbreviation	Units	Value	Reference/Comment
Stratum A moisture content	O_w^A	m^3-water / m^3-soil	0.167	CCME 2014
Stratum B moisture content	O_{wB}	m^3-water / m^3-soil		
Stratum C moisture content	O_w^C	m^3-water / m^3-soil		
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	CCME 2014
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil		
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil		
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	CCME 2014
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil		
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil		
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	CCME 2014
Stratum B soil dry bulk density	Pb^B	g/cm^3		
Stratum C soil dry bulk density	Pb^C	g/cm^3		
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm		
Stratum C thickness	S_c	cm		
Total thickness of vadose zone	L_t	cm	100	

Miscelaneous Attenuation Coefficient Variables

Description	Abbreviation	Units	Value	Reference/Comment
Building floor thickness	L_{crack}	cm	11.25	CCME 2014
Building Area	A_b	cm^2	2.70E+06	

Exposure Variables

Description	Abbreviation	Units	Value	Reference/Comment
Exposure term	ET	Unitless	1.00	CCME 2014

Volatilization Factor Parameters for Soil Vapour to Ambient Air

Description	Abbreviation	Units	Value	Reference/Comment
Depth to subsurface soil vapour sample	L_s	cm	100	CCME 2014
Ambient air velocity in mixing zone	U_{air}	cm/s	400	CCME 2014
Width of source-zone area parallel to the wind direction	W	cm	3000	CCME 2014
Mixing zone height	M_{air}	cm	150	CCME 2014

Table A-3 Calculation of Temperature-Corrected Dimensionless Henry's Law Constant

Parameters	1,2-DCA	Naphthalene	Benzene	Toluene	Ethylbenzene	Xylenes
Average soil temperature (degrees Celsius)	15	15	15	15	15	15
Average soil temperature (K)	288.15	288.15	288.15	288.15	288.15	288.15
Henry's Law constant (atm-m3/mol)	1.20E-03	4.24E-04	5.50E-03	6.71E-03	8.75E-03	7.30E-03
Enthalpy of vapourization at normal boiling point (cal/mol)	8.03E+03	1.04E+04	7.72E+03	8.51E+03	9.25E+03	9.47E+03
Critical temperature (K)	5.61E+02	7.48E+02	5.62E+02	5.92E+02	6.17E+02	6.21E+02
Normal boiling point (K)	3.58E+02	4.91E+02	3.53E+02	3.84E+02	4.09E+02	4.12E+02
Reference temperature (K)	2.98E+02	2.98E+02	2.98E+02	2.98E+02	2.98E+02	2.98E+02
n	3.57E-01	3.70E-01	3.49E-01	3.64E-01	3.75E-01	3.74E-01
Enthalpy of vapourization at average soil temp (cal/mol)	8.93E+03	1.29E+04	8.48E+03	9.76E+03	1.10E+04	1.13E+04
Dimensionless Henry's Law constant	4.89E-02	1.73E-02	2.25E-01	2.74E-01	3.58E-01	3.00E-01
Temperature-corrected dimensionless Henry's Law constant	3.00E-02	8.44E-03	1.41E-01	1.60E-01	1.94E-01	1.60E-01

Sources:
Health Canada 2010; Part VII: Guidance for Soil Vapour Intrusion Assessment at Contaminated Sites
Health Canada 2009; Part V: DQRA Spreadsheet

Table A-4 Soil Vapour Guideline for Indoor Vapour Inhalation - Benzene
Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	147,079	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	46.04	
	--	--	No	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	8,141,900	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	2,549	
	--	--	No	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.23	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	8.80E-02	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	9.80E-06	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RsC	mg/m^3	0.0030	ESRD 2014a
Allocation Factor	AF	Unitless	1	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	ESRD 2014a
Vapour pressure at STP	V_{stp}	Pa	12640	ESRD 2014a
Molecular Weight	MW	g/mole	78.11	ESRD 2014a
Solubility	S	mg/L	1780	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	398,270	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	398,270,077	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	124,667	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	400,500	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	400,500,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	125,365	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.088	
Diffusion coefficient in water	D_w	cm^2/s	9.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.225	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	7.44E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.088	
Diffusion coefficient in water	D_w	cm^2/s	9.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.225	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.088	
Diffusion coefficient in water	D_w	cm^2/s	9.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.225	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	7.44E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	7.44E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	3.22E-02	
Alpha	Alpha	Unitless	2.06E-04	
Dilution Factor	DF	Unitless	4,854	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	3.72E-06	

Tble A-5 Soil Vapour Guideline for Indoor Vapour Inhalation - Toluene

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	91,241,810	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	24,212	
	--	--	No	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	5,103,681,728	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	1,354,313	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.27	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	8.70E-02	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	8.60E-06	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0.0442	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	3.8	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	ESRD 2014a
Vapour pressure at STP	V_{stp}	Pa	3800	Health Canada 2009
Molecular Weight	MW	g/mole	92.14	Health Canada 2009
Solubility	S	mg/L	515	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	141,238	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	$\mu g/m^3$	141,237,837	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	37,479	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	141,110	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	$\mu g/m^3$	141,110,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	37,445	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.087	
Diffusion coefficient in water	D_w	cm^2/s	8.60E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.274	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	7.36E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.087	
Diffusion coefficient in water	D_w	cm^2/s	8.60E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.274	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.087	
Diffusion coefficient in water	D_w	cm^2/s	8.60E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.274	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	7.36E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	7.36E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	3.18E-02	
Alpha	Alpha	Unitless	2.06E-04	
Dilution Factor	DF	Unitless	4,859	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	3.68E-06	

Table A-6 Soil Vapour Guideline for Indoor Vapour Inhalation - Ethylbenzene

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	24,447,145	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	5,639	
	--	--	No	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	1,564,492,908	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	360,867	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.36	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	7.50E-02	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0.0075	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	1	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	ESRD 2014a
Vapour pressure at STP	V_{stp}	Pa	1270	ESRD 2014a
Molecular Weight	MW	g/mole	106.00	ESRD 2014a
Solubility	S	mg/L	152	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	54,304	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	54,304,217	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	12,526	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	54,416	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	54,416,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	12,552	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.075	
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.358	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	6.34E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.075	
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.358	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.075	
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.358	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	6.34E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	6.34E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	2.74E-02	
Alpha	Alpha	Unitless	2.03E-04	
Dilution Factor	DF	Unitless	4,926	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	3.17E-06	

Table A-7 Soil Vapour Guideline for Indoor Vapour Inhalation - Xylenes

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	4,372,661	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	1,009	
	--	--	No	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	270,061,338	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	62,292	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.25	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	7.80E-02	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0.00182	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	0.18	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	ESRD 2014a
Vapour pressure at STP	V_{stp}	Pa	1070	ESRD 2014a
Molecular Weight	MW	g/mole	106.00	ESRD 2014a
Solubility	S	mg/L	198	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	45,752	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	45,752,371	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	10,553	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	49,896	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	49,896,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	11,509	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.078	
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.252	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	6.60E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.078	
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.252	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.078	
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.252	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	6.60E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	6.60E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	2.85E-02	
Alpha	Alpha	Unitless	2.04E-04	
Dilution Factor	DF	Unitless	4,908	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	3.30E-06	

Table A-8 Soil Vapour Guideline for Indoor Vapour Inhalation - 1,2-DCA

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	1,803	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	0	
	--	--	No	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	85,769	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	21	
	--	--	No	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.040	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	1.04E-01	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	9.90E-06	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RsC	mg/m^3	0.0004	ESRD 2014a
Allocation Factor	AF	Unitless	1	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	1	ESRD 2014a
Vapour pressure at STP	V_{stp}	Pa	10531.13385	EPI Suite
Molecular Weight	MW	g/mole	98.96	ESRD 2014a
Solubility	S	mg/L	8520	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	420,396	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	420,396,204	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	103,867	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	341,652	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	341,652,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	84,412	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.104	
Diffusion coefficient in water	D_w	cm^2/s	9.90E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.0401	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	8.80E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.104	
Diffusion coefficient in water	D_w	cm^2/s	9.90E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.0401	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.104	
Diffusion coefficient in water	D_w	cm^2/s	9.90E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.0401	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	8.80E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	8.80E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	3.80E-02	
Alpha	Alpha	Unitless	2.09E-04	
Dilution Factor	DF	Unitless	4,778	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	4.40E-06	

Table A-9 Soil Vapour Guideline for Indoor Vapour Inhalation - Naphthalene

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	5,175	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	1	
	--	--	No	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	410,443	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	78	
	--	--	No	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.020	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	5.90E-02	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	7.50E-06	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	9.50E-04	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RsC	mg/m^3	0.0030	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	1	ESRD 2014a
Vapour pressure at STP	V_{stp}	Pa	10.4	Health Canada 2009
Molecular Weight	MW	g/mole	128.00	Health Canada 2009
Solubility	S	mg/L	32	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	537	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	536,991	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	103	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	648	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	647,980	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	124	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.059	
Diffusion coefficient in water	D_w	cm^2/s	7.50E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.020441	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.99E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.059	
Diffusion coefficient in water	D_w	cm^2/s	7.50E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.020441	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.059	
Diffusion coefficient in water	D_w	cm^2/s	7.50E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.020441	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.99E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.99E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	2.16E-02	
Alpha	Alpha	Unitless	1.98E-04	
Dilution Factor	DF	Unitless	5,049	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.50E-06	

Table A-10 Soil Vapour Guideline for Indoor Vapour Inhalation - F1 (C6-C8 Aliphatic)
Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	471,439,219	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	115,267	Not applicable to fractions of hydrocarbons
	--	--	Yes	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	43,292,531,190	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	10,585,024	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	50	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	0.05	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0.09111	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	18.4	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	
Vapour pressure at STP	V_{stp}	Pa	6383	ESRD 2014a
Molecular Weight	MW	g/mole	100.00	ESRD 2014a
Solubility	S	mg/L	5.4	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	257,502	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	$\mu g/m^3$	257,502,309	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	62,959	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	270,000	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	$\mu g/m^3$	270,000,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	66,015	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	
Dimensionless Henry's Law Constant	H	Unitless	50	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	50	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	50	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.23E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	1.83E-02	
Alpha	Alpha	Unitless	1.94E-04	
Dilution Factor	DF	Unitless	5,150	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.11E-06	

Table A-11 Soil Vapour Guideline for Indoor Vapour Inhalation - F1 (C8-C10 Aliphatic)

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	24,749,872	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	4,655	Not applicable to fractions of hydrocarbons
	--	--	No	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	2,272,795,163	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	427,460	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	80	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	0.05	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0.03881	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	1	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	
Vapour pressure at STP	V_{stp}	Pa	638	ESRD 2014a
Molecular Weight	MW	g/mole	130.00	ESRD 2014a
Solubility	S	mg/L	0.43	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	33,475	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	33,475,300	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	6,296	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	34,400	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	34,400,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	6,470	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	
Dimensionless Henry's Law Constant	H	Unitless	80	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	80	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	80	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.23E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	1.83E-02	
Alpha	Alpha	Unitless	1.94E-04	
Dilution Factor	DF	Unitless	5,150	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.11E-06	

Table A-12 Soil Vapour Guideline for Indoor Vapour Inhalation - F1 (C8-C10 Aromatic)

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	4,185,502	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	853	Not applicable to fractions of hydrocarbons
	--	--	No	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	384,338,009	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	78,309	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.48	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	0.05	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0.03745	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	0.2	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	
Vapour pressure at STP	V_{stp}	Pa	638	ESRD 2014a
Molecular Weight	MW	g/mole	120.00	ESRD 2014a
Solubility	S	mg/L	65	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	30,900	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	$\mu g/m^3$	30,900,277	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	6,296	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	31,200	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	$\mu g/m^3$	31,200,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	6,357	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	
Dimensionless Henry's Law Constant	H	Unitless	0.48	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	0.48	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	0.48	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.23E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	1.83E-02	
Alpha	Alpha	Unitless	1.94E-04	
Dilution Factor	DF	Unitless	5,150	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.11E-06	

Table A-13 Soil Vapour Guideline for Indoor Vapour Inhalation - F2 (C10-C12 Aliphatic)

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	25,749,198	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	#DIV/0!	Not applicable to fractions of hydrocarbons
	--	--	Yes	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	2,364,564,157	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	#DIV/0!	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	120	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	0.05	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	1	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	
Vapour pressure at STP	V_{stp}	Pa		ESRD 2014a
Molecular Weight	MW	g/mole		ESRD 2014a
Solubility	S	mg/L	0.034	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	-	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	-	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	#DIV/0!	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	4,080	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	4,080,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	#DIV/0!	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	
Dimensionless Henry's Law Constant	H	Unitless	120	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	120	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	120	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.23E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	1.83E-02	
Alpha	Alpha	Unitless	1.94E-04	
Dilution Factor	DF	Unitless	5,150	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.11E-06	

Table A-14 Soil Vapour Guideline for Indoor Vapour Inhalation - F2 (C10-C12 Aromatic)
Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	5,149,711	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	#DIV/0!	Not applicable to fractions of hydrocarbons
	--	--	Yes	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	472,820,219	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	#DIV/0!	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.14	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	0.05	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	0.2	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	
Vapour pressure at STP	V_{stp}	Pa		ESRD 2014a
Molecular Weight	MW	g/mole		ESRD 2014a
Solubility	S	mg/L	25	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	-	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	$\mu g/m^3$	-	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	#DIV/0!	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	3,500	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	$\mu g/m^3$	3,500,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	#DIV/0!	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	
Dimensionless Henry's Law Constant	H	Unitless	0.14	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	0.14	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	0.14	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.23E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	1.83E-02	
Alpha	Alpha	Unitless	1.94E-04	
Dilution Factor	DF	Unitless	5,150	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.11E-06	

Table A-15 Soil Vapour Guideline for Indoor Vapour Inhalation - F2 (C12-C16 Aliphatic)

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	25,749,199	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	#DIV/0!	Not applicable to fractions of hydrocarbons
	--	--	Yes	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	2,364,564,574	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	#DIV/0!	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	520	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	0.05	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	1	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	
Vapour pressure at STP	V_{stp}	Pa		ESRD 2014a
Molecular Weight	MW	g/mole		ESRD 2014a
Solubility	S	mg/L	0.00076	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	-	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	$\mu g/m^3$	-	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	#DIV/0!	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	395	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	$\mu g/m^3$	395,200	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	#DIV/0!	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	
Dimensionless Henry's Law Constant	H	Unitless	520	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	520	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	520	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.23E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	1.83E-02	
Alpha	Alpha	Unitless	1.94E-04	
Dilution Factor	DF	Unitless	5,150	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.11E-06	

Table A-16 Soil Vapour Guideline for Indoor Vapour Inhalation - F2 (C12-C16 Aromatic)

Required Input Variables

Calculated Guidelines

Description	Abbreviation	Units	Value	Reference/Comment
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	5,149,500	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	#DIV/0!	Not applicable to fractions of hydrocarbons
	--	--	Yes	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	472,668,096	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	#DIV/0!	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties

Description	Abbreviation	Units	Value	Reference/Comment
Dimensionless Henry's Law Constant	H	Unitless	0.053	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	0.05	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	0.2	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	
Vapour pressure at STP	V_{stp}	Pa		ESRD 2014a
Molecular Weight	MW	g/mole		ESRD 2014a
Solubility	S	mg/L	5.8	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	-	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	$\mu g/m^3$	-	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	#DIV/0!	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	307	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	$\mu g/m^3$	307,400	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	#DIV/0!	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A

Description	Abbreviation	Units	Value	Reference/Comment
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	
Dimensionless Henry's Law Constant	H	Unitless	0.053	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B

Description	Abbreviation	Units	Value	Reference/Comment
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	0.053	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C

Description	Abbreviation	Units	Value	Reference/Comment
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	0.053	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone

Description	Abbreviation	Units	Value	Reference/Comment
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.23E-03	

Attenuation Coefficient

Description	Abbreviation	Units	Value	Reference/Comment
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	1.83E-02	
Alpha	Alpha	Unitless	1.94E-04	
Dilution Factor	DF	Unitless	5,149	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.12E-06	

Appendix B
Model for the Derivation of Commercial Soil Vapour Quality Guidelines

Table B-1 Default Soil Vapour Quality Guidelines Protective of Indoor Air Quality for Commercial buildings (Depths 0 to <100cm)

Chemical	Tolerable Concentration	Background Air	Allocation Factor	Attenuation Factor (alpha)(1)	Exposure Term	Bioattenuation Factor	Soil Vapour Quality Guideline [µg/m3]	
	µg/m3	µg/m3	Unitless	Unitless	Unitless	Unitless	Non-carcinogen	Carcinogen
Benzene	3	0	1	0.01	0.27	1		1092
Toluene	3800	44.2	0.5	0.01	0.27	1	683556	
Ethylbenzene	1000	7.5	0.5	0.01	0.27	1	180635	
Xylenes	180	1.82	0.5	0.01	0.27	1	32429	
1,2-DCA	0.4	0	1	0.01	0.27	1		146
Naphthalene	3	0.95	0.5	0.01	0.27	1	373	
Aliphatic C6-C8	18400	91.1	0.5	0.01	0.27	1	3332220	
Aliphatic >C8-C10	1000	38.8	0.5	0.01	0.27	1	174938	
Aromatic >C8-C10	200	37.5	0.5	0.01	0.27	1	29575	
Aliphatic >C10-C12	1000	0	0.5	0.01	0.27	1	182000	
Aromatic >C10-C12	200	0	0.5	0.01	0.27	1	36400	
Aliphatic >C12-C16	1000	0	0.5	0.01	0.27	1	182000	
Aromatic >C12-C16	200	0	0.5	0.01	0.27	1	36400	

(1) Default attenuation factor for sub-slab soil-gas sample (AEP 2016b)

For non-carcinogens (CCME 2014):

$$SVRG = \frac{(TC - C_a) \times AF \times BAF}{a \times ET}$$

For carcinogens (CCME 2014):

$$SVRG = \frac{RSC \times BAF}{a \times ET}$$

Table B-2 Input Variables for Indoor Vapour Inhalation

Required Input Variables	Land Use	Soil Type
	Commercial	Fine

Below Ground Surface Area of Building				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Building length	L_b	cm	2000	CCME 2014
Building width	W_b	cm	1500	CCME 2014
Building Area	A_b	cm^2	3.0E+06	CCME 2014

Flow Rate of Fresh air Into Building				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Building length	L_b	cm	2000	
Building width	W_b	cm	1500	
Building height	H_b	cm	300	CCME 2014
Indoor air exchange rate per hour	ACH	exch/hr	0.9	CCME 2014
Building ventilation rate	Q_b	cm^3/s	2.25E+05	CCME 2014

Pressure-driven Soil Gas Flow Rate From Subsurface Into Building				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Building length	L_b	cm	2.00E+03	
Building width	W_b	cm	1.50E+03	
Crack area	A_{crack}	cm^2	1846	CCME 2014
Building Area	A_b	cm^2	3.00E+06	
Soil gas flow rate	Q_{soil}	cm^3/s	16.7	CCME 2014

Soil Parameters for Site				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A moisture content	O_w^A	m^3-water / m^3-soil	0.167	CCME 2014
Stratum B moisture content	O_{wB}	m^3-water / m^3-soil		
Stratum C moisture content	O_w^C	m^3-water / m^3-soil		
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	CCME 2014
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil		
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil		
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	CCME 2014
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil		
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil		
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	CCME 2014
Stratum B soil dry bulk density	Pb^B	g/cm^3		
Stratum C soil dry bulk density	Pb^C	g/cm^3		
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm		
Stratum C thickness	S_c	cm		
Total thickness of vadose zone	L_t	cm	100	

Miscelaneous Attenuation Coefficient Variables				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Building floor thickness	L_{crack}	cm	11.25	CCME 2014
Building Area	A_b	cm^2	3.00E+06	

Exposure Variables				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Exposure term	ET	Unitless	0.27	CCME 2014

Volatilization Factor Parameters for Soil Vapour to Ambient Air				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Depth to subsurface soil vapour sample	L_s	cm	100	CCME 2014
Ambient air velocity in mixing zone	U_{air}	cm/s	400	CCME 2014
Width of source-zone area parallel to the wind direction	W	cm	3000	CCME 2014
Mixing zone height	M_{air}	cm	150	CCME 2014

Table B-3 Soil Vapour Guideline for Indoor Vapour Inhalation - Benzene

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	1,534,517	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	480.33	
	--	--	No	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	29,636,517	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	9,277	
	--	--	No	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.23	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	8.80E-02	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	9.80E-06	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RsC	mg/m^3	0.0030	ESRD 2014a
Allocation Factor	AF	Unitless	1	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	ESRD 2014a
Vapour pressure at STP	V_{stp}	Pa	12640	ESRD 2014a
Molecular Weight	MW	g/mole	78.11	ESRD 2014a
Solubility	S	mg/L	1780	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	398,270	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	$\mu g/m^3$	398,270,077	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	124,667	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	400,500	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	$\mu g/m^3$	400,500,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	125,365	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.088	
Diffusion coefficient in water	D_w	cm^2/s	9.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.225	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	7.44E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.088	
Diffusion coefficient in water	D_w	cm^2/s	9.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.225	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.088	
Diffusion coefficient in water	D_w	cm^2/s	9.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.225	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	7.44E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	7.44E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	3.22E-02	
Alpha	Alpha	Unitless	7.19E-05	
Dilution Factor	DF	Unitless	13,912	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	3.72E-06	

Table B-4 Soil Vapour Guideline for Indoor Vapour Inhalation - Toluene
Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	953,132,900	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	252,923	
	--	--	Yes	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	18,577,401,490	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	4,929,698	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.27	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	8.70E-02	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	8.60E-06	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0.0442	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	3.8	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	ESRD 2014a
Vapour pressure at STP	V_{stp}	Pa	3800	Health Canada 2009
Molecular Weight	MW	g/mole	92.14	Health Canada 2009
Solubility	S	mg/L	515	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	141,238	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	141,237,837	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	37,479	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	141,110	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	141,110,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	37,445	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.087	
Diffusion coefficient in water	D_w	cm^2/s	8.60E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.274	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	7.36E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.087	
Diffusion coefficient in water	D_w	cm^2/s	8.60E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.274	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.087	
Diffusion coefficient in water	D_w	cm^2/s	8.60E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.274	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	7.36E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	7.36E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	3.18E-02	
Alpha	Alpha	Unitless	7.17E-05	
Dilution Factor	DF	Unitless	13,944	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	3.68E-06	

Table B-5 Soil Vapour Guideline for Indoor Vapour Inhalation - Ethylbenzene
Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	258,789,686	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	59,693	
	--	--	Yes	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	5,694,754,186	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	1,313,554	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.36	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	7.50E-02	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0.0075	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	1	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	ESRD 2014a
Vapour pressure at STP	V_{stp}	Pa	1270	ESRD 2014a
Molecular Weight	MW	g/mole	106.00	ESRD 2014a
Solubility	S	mg/L	152	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	54,304	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	54,304,217	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	12,526	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	54,416	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	54,416,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	12,552	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.075	
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.358	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	6.34E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.075	
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.358	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.075	
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.358	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	6.34E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	6.34E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	2.74E-02	
Alpha	Alpha	Unitless	6.98E-05	
Dilution Factor	DF	Unitless	14,327	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	3.17E-06	

Table B-6 Soil Vapour Guideline for Indoor Vapour Inhalation - Xylenes

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	46,148,471	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	10,645	
	--	--	No	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	983,023,272	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	226,745	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.25	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	7.80E-02	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0.00182	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	0.18	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	ESRD 2014a
Vapour pressure at STP	V_{stp}	Pa	1070	ESRD 2014a
Molecular Weight	MW	g/mole	106.00	ESRD 2014a
Solubility	S	mg/L	198	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	45,752	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	$\mu g/m^3$	45,752,371	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	10,553	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	49,896	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	$\mu g/m^3$	49,896,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	11,509	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.078	
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.252	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	6.60E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.078	
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.252	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.078	
Diffusion coefficient in water	D_w	cm^2/s	7.80E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.252	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	6.60E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	6.60E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	2.85E-02	
Alpha	Alpha	Unitless	7.03E-05	
Dilution Factor	DF	Unitless	14,231	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	3.30E-06	

Table B-7 Soil Vapour Guideline for Indoor Vapour Inhalation - 1,2-DCA
Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	18,406	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	5	
	--	--	No	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	312,200	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	77	
	--	--	No	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.040	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	1.04E-01	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	9.90E-06	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RsC	mg/m^3	0.0004	ESRD 2014a
Allocation Factor	AF	Unitless	1	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	1	ESRD 2014a
Vapour pressure at STP	V_{stp}	Pa	10531.13385	EPI Suite
Molecular Weight	MW	g/mole	98.96	ESRD 2014a
Solubility	S	mg/L	8520	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	420,396	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	420,396,204	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	103,867	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	341,652	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	341,652,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	84,412	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.104	
Diffusion coefficient in water	D_w	cm^2/s	9.90E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.0401	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	8.80E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.104	
Diffusion coefficient in water	D_w	cm^2/s	9.90E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.0401	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.104	
Diffusion coefficient in water	D_w	cm^2/s	9.90E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.0401	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	8.80E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	8.80E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	3.80E-02	
Alpha	Alpha	Unitless	7.46E-05	
Dilution Factor	DF	Unitless	13,400	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	4.40E-06	

Table B-8 Soil Vapour Guideline for Indoor Vapour Inhalation - Naphthalene

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	55,423	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	11	
	--	--	No	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	1,494,012	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	285	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.020	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	5.90E-02	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	7.50E-06	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	9.50E-04	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RsC	mg/m^3	0.0030	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	1	ESRD 2014a
Vapour pressure at STP	V_{stp}	Pa	10.4	Health Canada 2009
Molecular Weight	MW	g/mole	128.00	Health Canada 2009
Solubility	S	mg/L	32	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	537	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	536,991	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	103	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	648	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	647,980	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	124	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.059	
Diffusion coefficient in water	D_w	cm^2/s	7.50E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.020441	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.99E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.059	
Diffusion coefficient in water	D_w	cm^2/s	7.50E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.020441	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.059	
Diffusion coefficient in water	D_w	cm^2/s	7.50E-06	
Dimensionless Henry's Law Constant	H	Unitless	0.020441	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.99E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.99E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	2.16E-02	
Alpha	Alpha	Unitless	6.73E-05	
Dilution Factor	DF	Unitless	14,855	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.50E-06	

Table B-9 Soil Vapour Guideline for Indoor Vapour Inhalation - F1 (C6-C8 Aliphatic)

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	5,063,354,384	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	1,237,990	Not applicable to fractions of hydrocarbons
	--	--	Yes	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	157,584,813,532	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	38,529,487	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	50	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	0.05	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0.09111	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	18.4	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	
Vapour pressure at STP	V_{stp}	Pa	6383	ESRD 2014a
Molecular Weight	MW	g/mole	100.00	ESRD 2014a
Solubility	S	mg/L	5.4	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	257,502	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	257,502,309	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	62,959	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	270,000	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	270,000,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	66,015	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	
Dimensionless Henry's Law Constant	H	Unitless	50	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	50	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	50	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.23E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	1.83E-02	
Alpha	Alpha	Unitless	6.58E-05	
Dilution Factor	DF	Unitless	15,195	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.11E-06	

Table B-10 Soil Vapour Guideline for Indoor Vapour Inhalation - F1 (C8-C10 Aliphatic)

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	265,818,721	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	49,994	Not applicable to fractions of hydrocarbons
	--	--	Yes	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	8,272,974,392	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	1,555,956	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	80	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	0.05	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0.03881	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	1	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	
Vapour pressure at STP	V_{stp}	Pa	638	ESRD 2014a
Molecular Weight	MW	g/mole	130.00	ESRD 2014a
Solubility	S	mg/L	0.43	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	33,475	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	33,475,300	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	6,296	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	34,400	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	34,400,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	6,470	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	
Dimensionless Henry's Law Constant	H	Unitless	80	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	80	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	80	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.23E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	1.83E-02	
Alpha	Alpha	Unitless	6.58E-05	
Dilution Factor	DF	Unitless	15,195	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.11E-06	

Table B-11 Soil Vapour Guideline for Indoor Vapour Inhalation - F1 (C8-C10 Aromatic)

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	44,953,179	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	9,159	Not applicable to fractions of hydrocarbons
	--	--	Yes	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	1,398,990,353	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	285,044	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.48	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	0.05	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0.03745	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	0.2	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	
Vapour pressure at STP	V_{stp}	Pa	638	ESRD 2014a
Molecular Weight	MW	g/mole	120.00	ESRD 2014a
Solubility	S	mg/L	65	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	30,900	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	30,900,277	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	6,296	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	31,200	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	31,200,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	6,357	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	
Dimensionless Henry's Law Constant	H	Unitless	0.48	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	0.48	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	0.48	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.23E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	1.83E-02	
Alpha	Alpha	Unitless	6.58E-05	
Dilution Factor	DF	Unitless	15,195	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.11E-06	

Table B-12 Soil Vapour Guideline for Indoor Vapour Inhalation - F2 (C10-C12 Aliphatic)

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	276,551,696	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	#DIV/0!	Not applicable to fractions of hydrocarbons
	--	--	Yes	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	8,607,013,533	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	#DIV/0!	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	120	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	0.05	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	1	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	
Vapour pressure at STP	V_{stp}	Pa		ESRD 2014a
Molecular Weight	MW	g/mole		ESRD 2014a
Solubility	S	mg/L	0.034	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	-	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	$\mu g/m^3$	-	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	#DIV/0!	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	4,080	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	$\mu g/m^3$	4,080,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	#DIV/0!	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	
Dimensionless Henry's Law Constant	H	Unitless	120	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	120	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	120	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.23E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	1.83E-02	
Alpha	Alpha	Unitless	6.58E-05	
Dilution Factor	DF	Unitless	15,195	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.11E-06	

Table B-13 Soil Vapour Guideline for Indoor Vapour Inhalation - F2 (C10-C12 Aromatic)

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	55,309,075	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	#DIV/0!	Not applicable to fractions of hydrocarbons
	--	--	Yes	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	1,721,065,597	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	#DIV/0!	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.14	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	0.05	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	0.2	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	
Vapour pressure at STP	V_{stp}	Pa		ESRD 2014a
Molecular Weight	MW	g/mole		ESRD 2014a
Solubility	S	mg/L	25	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	-	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	-	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	#DIV/0!	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	3,500	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	3,500,000	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	#DIV/0!	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	
Dimensionless Henry's Law Constant	H	Unitless	0.14	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	0.14	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	0.14	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.23E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	1.83E-02	
Alpha	Alpha	Unitless	6.58E-05	
Dilution Factor	DF	Unitless	15,195	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.11E-06	

Table B-14 Soil Vapour Guideline for Indoor Vapour Inhalation - F2 (C12-C16 Aliphatic)

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	276,551,701	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	#DIV/0!	Not applicable to fractions of hydrocarbons
	--	--	Yes	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	8,607,015,048	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	#DIV/0!	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	520	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	0.05	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	1	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	
Vapour pressure at STP	V_{stp}	Pa		ESRD 2014a
Molecular Weight	MW	g/mole		ESRD 2014a
Solubility	S	mg/L	0.00076	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	-	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	μg/m^3	-	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	#DIV/0!	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	395	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	μg/m^3	395,200	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	#DIV/0!	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	
Dimensionless Henry's Law Constant	H	Unitless	520	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	520	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	520	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.23E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	1.83E-02	
Alpha	Alpha	Unitless	6.58E-05	
Dilution Factor	DF	Unitless	15,195	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.11E-06	

Table B15 Soil Vapour Guideline for Indoor Vapour Inhalation - F2 (C12-C16 Aromatic)

Required Input Variables

Calculated Guidelines				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ug/m^3	55,306,998	CCME 2014
Tier 1 Soil Vapour Guideline at Source	C_{sv}	ppm	#DIV/0!	Not applicable to fractions of hydrocarbons
	--	--	Yes	guideline exceedance of maximum vapour concentration
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ug/m^3	1,720,511,869	
Tier 1 Outdoor Air Quality Guideline	C_{oa}	ppm	#DIV/0!	
	--	--	Yes	guideline exceedance of maximum vapour concentration

Chemical Properties				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Dimensionless Henry's Law Constant	H	Unitless	0.053	ESRD 2014a
Diffusion coefficient in air	D_a	cm^2/s	0.05	ESRD 2014a
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	Health Canada 2009
Background indoor air concentration	C_a	mg/m^3	0	ESRD 2014a or use default value of zero for carcinogens
Reference Concentration	RfC	mg/m^3	0.2	ESRD 2014a
Allocation Factor	AF	Unitless	0.5	ESRD 2014a or use default value of 1 for carcinogens
Bioattenuation Factor	BAF	Unitless	10	
Vapour pressure at STP	V_{stp}	Pa		ESRD 2014a
Molecular Weight	MW	g/mole		ESRD 2014a
Solubility	S	mg/L	5.8	ESRD 2014a
Maximum vapour concentration (NAPL Present)	C_{max}	mg/m^3	-	Health Canada 2010; Part VII
Maximum vapour concentration (NAPL Present)	C_{max}	$\mu g/m^3$	-	
Maximum vapour concentration (NAPL Present)	C_{max}	ppm	#DIV/0!	
Maximum vapour concentration (No NAPL Present)	C_{max}	mg/m^3	307	Health Canada 2010; Part VII
Maximum vapour concentration (No NAPL Present)	C_{max}	$\mu g/m^3$	307,400	
Maximum vapour concentration (No NAPL Present)	C_{max}	ppm	#DIV/0!	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer A				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	1.00E-05	
Dimensionless Henry's Law Constant	H	Unitless	0.053	
Stratum A volumetric moisture content	O_w^A	m^3-water / m^3-soil	0.167	
Stratum A volumetric vapour content	O_a^A	m^3-vapour / m^3-soil	0.303	
Stratum A soil dry bulk density	Pb^A	g/cm^3	1.4	
Stratum A soil total porosity	O_t^A	m^3-voids / m^3-soil	0.47	
Stratum A thickness	S_a	cm	100	
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer B				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	0.053	
Stratum B volumetric moisture content	O_w^B	m^3-water / m^3-soil	0	
Stratum B volumetric vapour content	O_a^B	m^3-vapour / m^3-soil	0	
Stratum B soil dry bulk density	Pb^B	g/cm^3	0	
Stratum B soil total porosity	O_t^B	m^3-voids / m^3-soil	0	
Stratum B thickness	S_b	cm	0	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	

Effective Vapour-phase Diffusion Coefficient Through Soil Layer C				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Diffusion coefficient in air	D_a	cm^2/s	0.05	
Diffusion coefficient in water	D_w	cm^2/s	0.00001	
Dimensionless Henry's Law Constant	H	Unitless	0.053	
Stratum C volumetric moisture content	O_w^C	m^3-water / m^3-soil	0	
Stratum C volumetric vapour content	O_a^C	m^3-vapour / m^3-soil	0	
Stratum C soil dry bulk density	Pb^C	g/cm^3	0	
Stratum C soil total porosity	O_t^C	m^3-voids / m^3-soil	0	
Stratum C thickness	S_c	cm	0	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	

Effective Overall Vapour-phase Diffusion Coefficient Through The Vadose Zone				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Stratum A effective diffusion coefficient	$D^{eff}A$	cm^2/s	4.23E-03	
Stratum B effective diffusion coefficient	$D^{eff}B$	cm^2/s	0.00E+00	
Stratum C effective diffusion coefficient	$D^{eff}C$	cm^2/s	0.00E+00	
Stratum A thickness	S_a	cm	100	
Stratum B thickness	S_b	cm	0	
Stratum C thickness	S_c	cm	0	
Total thickness of vadose zone	L_t	cm	100	
Overal effective diffusion coefficient	D^{eff}	cm^2/s	4.23E-03	

Attenuation Coefficient				
Description	**Abbreviation**	**Units**	**Value**	**Reference/Comment**
Indoor Air Attenuation Coefficients				
Diffusivity in cracks	D_{crack}	cm^2/s	1.83E-02	
Alpha	Alpha	Unitless	6.58E-05	
Dilution Factor	DF	Unitless	15,194	
Outdoor Air Attenuation Coefficients				
Volatilization factor for soil vapour to ambient air	$VF_{sv,amb}$	Unitless	2.12E-06	

Appendix C
Worked Example

The worked example outlined below is presented for the soil vapour quality guideline (SVQG) for benzene at a depth of 100cm that is protective of indoor air quality in a residential building on fine-textured soil. Appendix A presents the input values that were assumed for each model input variable and COPC required to calculate the SVQG.

Calculation of D_T^{eff} ***(Equation 1)***

$$D_T^{eff} = D^{air} \times \left(\frac{\theta_a^{\frac{10}{3}}}{n^2}\right) + \left(\frac{D^{water}}{H'}\right) \times \left(\frac{\theta_w^{\frac{10}{3}}}{n^2}\right)$$

Where:

D_T^{eff}	=	overall effective porous media diffusion coefficient [cm²/s]
D^{air}	=	pure component molecular diffusivity in air [cm²/s]
θ_a	=	air filled porosity [Unitless]
n	=	total porosity [Unitless]
D^{water}	=	pure component molecular diffusivity in water [cm²/s]
H'	=	Dimensionless Henry's Law constant [Unitless] at soil temperature (e.g., 15°C)
θ_w	=	moisture/water filled porosity [Unitless]

Example 1: Overall effective porous media diffusion coefficient for benzene

$$D_T^{eff} = 8.8E-02 \times \left(\frac{0.303^{\frac{10}{3}}}{0.47^2}\right) + \left(\frac{9.8E-06}{2.3E-01}\right) \times \left(\frac{0.167^{\frac{10}{3}}}{0.47^2}\right)$$

$$D_T^{eff} = 7.4E-03 cm^2/s$$

Calculation of D_{crack} ***(Equation 2)***

$$D_{crack} \approx D_{air} \times \left(\frac{n^{10/3}}{n^2}\right)$$

Where:

D_{crack}	=	effective vapour diffusion coefficient through the crack [cm²/s]
D_{air}	=	diffusion coefficient in air [cm²/s]
n	=	total porosity [Unitless]

Example 2: Effective vapour diffusion coefficient through the crack for benzene

$$D_{crack} \approx 8.8E-02 \times \left(\frac{0.47^{10/3}}{0.47^2}\right)$$

$$D_{crack} \approx 3.2E-02 cm^2/s$$

Dilution factor from soil gas to indoor air **(Equation 3)**

$$DF = \frac{1}{\alpha}$$

$$\alpha = \frac{\left(\frac{D_T^{eff}\ A_B}{Q_B L_T}\right)\exp\left(\frac{Q_{soil}\ L_{crack}}{D_{crack}\ A_{crack}}\right)}{exp\left(\frac{Q_{soil}\ L_{crack}}{D_{crack}\ A_{cract}}\right) + \left(\frac{D_T^{eff}\ A_B}{Q_B L_T}\right) + \left(\frac{D_T^{eff}\ A_B}{Q_{soil} L_T}\right)\left[exp\ \left(\frac{Q_{soil}\ L_{crack}}{D_{crack}\ A_{crack}}\right) - 1\right]}$$

Where:

DF	=	Dilution factor [Unitless]
α	=	attenuation coefficient [Unitless]
D_T^{eff}	=	effective porous media diffusion coefficient [cm²/s]
A_B	=	building area [cm²]
Q_B	=	building ventilation rate [cm³/s]
L_T	=	distance from contaminant source to foundation [cm]
Q_{soil}	=	volumetric flow rate of soil gas into the building [cm³/s]
L_{crack}	=	thickness of the foundation [cm]
D_{crack}	=	effective vapour diffusion coefficient through the crack [cm²/s]
A_{crack}	=	area of cracks through which the contaminant vapours enter [cm²]

Example 3: Attenuation coefficient of benzene for the dilution factor from soil gas to indoor air

$$\alpha = \frac{\left(\frac{7.4E-03 \times 2.7E+06}{7.5E+04 \times 100}\right)\exp\left(\frac{16.7 \times\ 11.25}{3.2E-02\ \times 994.5}\right)}{exp\left(\frac{16.7 \times\ 11.25}{3.2E-02\ \times 994.5}\right) + \left(\frac{7.4E-03\ \times 2.7E+06}{7.5E+04 \times 100}\right) + \left(\frac{7.4E-03 \times 2.7E+06}{16.7 \times 100}\right)\left[exp\ \left(\frac{16.7 \times\ 11.25}{3.2E-02\ \times 994.5}\right) - 1\right]}$$

$$\alpha = 2.1E-04$$

Volatilization Factor **(Equation 4)**

$$VF_{sv,amb} = \left(1 + \frac{L_s \times U_{air} \times M_{air}}{D_{eff} \times W}\right)^{-1}$$

Where:

$VF_{sv,amb}$	=	volatilization factor, subsurface soil vapour to ambient air (dimensionless)
D_T^{eff}	=	overall effective porous media diffusion coefficient [cm²/s]
L_s	=	depth to subsurface soil vapour sample (cm)
U_{air}	=	ambient air velocity in mixing zone (cm/s)
W	=	width of source-zone area parallel to the wind direction (cm)
M_{air}	=	mixing zone height (cm)

Example 4: Volatilization factor for benzene

$$VF_{sv,amb} = \left(1 + \frac{100 \times 400 \times 150}{7.4E-03 \times 3000}\right)^{-1}$$

$$VF_{sv,amb} = 3.7E - 06$$

The following equations were used to calculate $SVQG_{IAQ}$ for the indoor air inhalation pathway (CCME 2014):

Threshold chemical $$SVQG_{IAQ} = \frac{(TC - C_a) \times AF \times BAF}{\propto \times ET}$$ (Equation 5)

Non-threshold chemical $$SVQG_{IAQ} = \frac{(RsC) \times BAF}{\propto \times ET}$$ (Equation 6)

Similarly, the following equations were used to predict $SVQG_{OAQ}$ for the outdoor air inhalation pathway (CCME 2014):

Threshold chemical $$SVQG_{OAQ} = \frac{(TC - C_a) \times AF \times BAF}{VF_{sv,amb} \times ET}$$ (Equation 7)

Non-threshold chemical $$SVQG_{OAQ} = \frac{(RsC) \times BAF}{VF_{sv,amb} \times ET}$$ (Equation 8)

Where:

$SVQG_{IAQ}$	=	soil vapour quality guideline for the protection of indoor air quality [mg/m^3]
$SVQG_{OAQ}$	=	soil vapour quality guideline for the protection of outdoor air quality [mg/m^3]
TC	=	tolerable concentration or reference concentration [mg/m^3]
C_a	=	background indoor air concentration [mg/m^3]
AF	=	allocation factor [Unitless]
BAF	=	bioattenuation factor [Unitless]
α	=	attenuation factor calculated from Johnson and Ettinger (1991)
ET	=	exposure term [Unitless]
RsC	=	risk-specific concentration [mg/m^3]
$VF_{sv,amb}$	=	volatilization factor for subsurface soil to ambient air [Unitless]

Example 5: Soil vapour quality guideline for the protection of indoor air quality for benzene

$$SVQG_{IAQ} = \frac{(RsC) \times BAF}{\propto \times ET}$$

$$SVQG_{IAQ} = \frac{3.0E - 03 \times 10}{2.1E - 04 \times 1}$$

$$SVQG_{IAQ} = 1.5E + 02\ mg/m^3$$

Example 6: Soil vapour quality guideline for the protection of outdoor air quality for benzene

$$SVQG_{OAQ} = \frac{(RsC) \times BAF}{VF_{sv,amb} \times ET}$$

$$SVQG_{OAQ} = \frac{3.0E - 03 \times 10}{3.7E - 06 \times 1}$$

$$SVQG_{OAQ} = 8.1E + 03 mg/m^3$$

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MALL AREA

SITE

HOUNSFIELD HEIGHTS AREA

GENERAL SITE LOCATION

SCALE 1:30,000

0 0.5 1.0 1.5 km

SURROUNDING LAND USE

SCALE 1:10,000

0 100 200 300 m

LEGEND:

SITE BOUNDARY

CITY OF CALGARY BY-LAW ZONING

LAND USE DISTRICTS:

District	Code
RESIDENTIAL - CONTEXTUAL ONE DWELLING DISTRICT	R-C1
MULTI-RESIDENTIAL - CONTEXTUAL LOW-PROFILE DISTRICT	MC-1
MULTI-RESIDENTIAL - CONTEXTUAL GRADE-ORIENTED DISTRICT	MC-G
COMMERCIAL - CORRIDOR 2 DISTRCT	C-COR2
SPECIAL PURPOSE - SCHOOL, PARK, AND COMMUNITY RESERVE DISTRICT	S-SPR
SPECIAL PURPOSE - COMMUNITY INSTITUTION DISTRICT	S-CI
SPECIAL PURPOSE - COMMUNITY SERVICE DISTRICT	S-CS
SPECIAL PURPOSE - FUTURE URBAN DEVELOPMENT DISTRICT	S-FUD
DIRECT CONTROL DISTRICT	DC

NOTES:

1. CITY OF CALGARY ROAD MAP PROVIDED BY CANADIAN CARTOGRAPHICS CORPORATION, 2012.
2. LAND USE MAP PROVIDED BY THE CITY OF CALGARY.

ENGINEER

Clifton Associates

CLIENT

PROJECT

SOIL VAPOUR MONITORING PROGRAM
HOUNSFIELD HEIGHTS AND NORTH HILL MALL
CALGARY, ALBERTA

TITLE

SITE LOCATION
AND
SURROUNDING LAND USE PLAN

DESIGNED		SCALE	AS SHOWN	DATE	2016-01-21
DRAWN	RD	PROJECT NO.	CG2430.1 E04	FIG.	1
CHECKED		FILE NO.	CG2430.1-E4-01		

LEGEND:

SITE BOUNDARY

MALL AREA

16TH AVENUE NW

14TH AVENUE NW

17A STREET NW

19TH STREET NW

14TH STREET NW

10TH AVENUE NW

10TH AVENUE NW

HOUNSFIELD HEIGHTS AREA

NOTES:

1. AERIAL PHOTOGRAPH PROVIDED BY GOOGLE EARTH PRO. AIR PHOTO DATE: 2012.

0 50 100 150 200 250m

ENGINEER

Clifton Associates

CLIENT

PROJECT

SOIL VAPOUR MONITORING PROGRAM
HOUNSFIELD HEIGHTS AND NORTH HILL MALL
CALGARY, ALBERTA

TITLE

SITE LOCATION
AND
SURROUNDING PROPERTIES

DESIGNED		SCALE	1:5000	DATE	2016-01-21
DRAWN	RD	PROJECT NO.	CG2430.1 E04	FIG.	2
CHECKED		FILE NO.	CG2430.1-E4-02		

LEGEND

SITE BOUNDARY
PRE-EXISTING MONITORING WELL
EXTRACTION WELL
LRT TRACKS
FENCE LINE
LEGAL LINE
FORMER FACILITY/FEATURE
BUILDING
MONITORING WELL SCREENED THROUGH UNIT 1 - UPPER SILTY SAND
MONITORING WELL SCREENED THROUGH UNIT 2 - UPPER CLAYEY SILT
MONITORING WELL SCREENED THROUGH UNIT 3 - MIDDLE SANDY SILT
MONITORING WELL SCREENED THROUGH UNIT 4 - LOWER CLAYEY SILT
MONITORING WELL SCREENED THROUGH UNIT 5 - LOWER SILTY SAND AND GRAVEL
MONITORING WELL SCREENED THROUGH UNDETERMINED STRATA
PROPOSED SOIL VAPOUR MONITORING POINT — SV03
NESTED SOIL VAPOUR MONITORING POINT — SV26
ESTIMATED 30m RADIUS FOR POTENTIAL SOIL VAPOUR INTRUSION INVESTIGATION INTO A STRUCTURE AS RECOMMENDED BY 2010 HEALTH CANADA DOCUMENT.
PROPOSED LATERAL TRANSECT FOR SOIL VAPOUR PLUME DELINEATION
RESIDENTIAL
DETACHED GARAGE
SUB-SLAB SOIL VAPOUR POINT

UTILITY LINES & SYMBOLS

NATURAL GAS LINE
SANITARY SEWER
STORM SEWER
WATER
CATCH BASIN
FIRE HYDRANT
LIGHT STANDARD
MANHOLE
UTILITY POLE

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

0 10 20 30 40 50 m

PLOT SIZE 22x34

ENGINEER

Clifton Associates

CLIENT

PROJECT

(2014) SITE MANAGEMENT PLAN
HOUNSFIELD HEIGHTS AND NORTH HILL MALL
CALGARY, ALBERTA

TITLE

PROPOSED SOIL VAPOUR MONITORING POINTS

DESIGNED	SCALE 1:1000	DATE 2016-05-11
DRAWN CAH	PROJECT NO. CG2430	FIG. 3
CHECKED DB	FILE NO. CG2430.1E04	

FLUSH MOUNT
PROTECTIVE CASING
(4" CASTED ALUMINIUM)

GROUND
SURFACE
ELEVATION

CONCRETE (IF SPECIFIED)

STAINLESS STEEL VALVE

COARSE SAND
DRAINAGE LAYER

IMPLANT TUBING
(1/4" TEFLON)

BENTONITE PELLETS

BOREHOLE WALL

BENTONITE HYDRATED
BY DISTILLED WATER

SOIL VAPOUR IMLANT

SAND PACK

ENGINEER: Clifton Associates

CLIENT:

PROJECT NO.: CG2430.1 E04
FILE NO.: CG2430.1-E4-04.dwg
DATE: 2016-01-21

PROJECT: SOIL VAPOUR MONITORING PROGRAM
HOUNSFIELD HEIGHTS AND NORTH HILL MALL
CALGARY, ALBERTA

SCALE: NTS

TITLE:
PROPOSED SOIL VAPOUR PROBE INSTALLATION SCHEMATIC

DRAWING NO.: 4

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Address	1324-16 Street NW	1115-15 Street NW	1609-11 Avenue NW	1601-11 Avenue NW	1329-16 Street NW	1112-15 Street NW	1319-16 Street NW	1302-15 Street NW	1229-16A Street NW
Building Information									
Building Size	1650 sq ft main floor	4200 sq ft above grade	3250 sq ft above grade1050 w/o basement	850 sq ft	1800 sq ft	1150 sq ft	2600 sq ft	4000	1400
Building Type	brick bungalow	single family	wood frame single family	house	single family	bungalow	single family	house	house
Year of Construction	approx 1960	2012	1989	1940s	1950	unknown	1950s	1999	1910
Basement									
Present? Y/N	y	y	y	y	y	y	y	y	y
Finished	y	y	y	y	y	y		y	y
Unfinished									
Depth below grade?	8 ft	10 ft	4-5' walk out	7	6	?	7 ft	?	5 ft?
A full basement	y	y	y		y	y	y	y	y
A partial basement									
Visible Cracks?	n	n	n	y; shifting	y	y	y	n	y
Sump?	n	y	n	n	n	n	n	y	y
Crawl Space									
Crawlspace?	n	n	n	n	n	n	n	n	n
Earthen									
Concrete									
Gravel layer below?									
Water entering crawlspace?									
Visible Cracks?									
General									
Air conditioning unit?	n	y	y	y	n	n	n	y	n
Whole house fan?	n	y	y	n	n	n	n	y	y
Poorly growing vegetation?	y	n	y	y	n	y	n	n	n
Wet or soft areas of property?	n	n	n	n	n	n	n	y	y
Spring or a seep at the property?	n	n	n	y	n	n	n	y	y

Address	1634-11 Avenue NW	1116-15 Street NW	1301-15 Street NW	1604-11 Avenue NW	1225-16A Street NW	1327-15 Street NW	1520-10 Avenue NW	1318-16 Street NW
Building Information								
Building Size	1200	1550	1250	2140 sq ft	40x60 ft approx	1200 sq ft	5500 sq ft	approx 1400 sq ft
Building Type	single family residence	bungalow house	1 1/2 storey	2 storey	Bungalow	Bungalow	3 storeys	single family wood frame
Year of Construction	1996	1963	1941	1979	1950 approx	1956	2014	1947
Basement								
Present? Y/N	y	y	y	y	y	y	n	y
Finished	y		y	y	y	y		y
Unfinished								
Depth below grade?	8 ft	3'-6" (sloping lot)	approx 5 ft	6 ft front, 4 ft rear	6 ft approx	?		approx 6-7 ft
A full basement	t	y	y	y	y	y		y
A partial basement								under addition
Visible Cracks?	n	n	y	y	y	n		n
Sump?	n	n	n	y	y (in garage)	n	y	n
Crawl Space								
Crawlspace?	n	n	n	n	n	n	n	y
Earthen								y
Concrete								y
Gravel layer below?								n
Water entering crawlspace?								n
Visible Cracks?								n
General								
Air conditioning unit?	y	y	n	n	n	n	y	n
Whole house fan?	n	unsure	n	n	n	n	unsure	y (forced air furnace)
Poorly growing vegetation?	n	n	n	n	n	n	no response	n
Wet or soft areas of property?	n	n	n	n	n	n	n	n
Spring or a seep at the property?	n	n	n	n	n	n	not sure yet	n

Address	1332-16A Street NW	1124-16 Street NW	1316-15 Street NW	1320-15 Street NW	1312-16 Street NW	1507-11 Avenue NW	1610-11 Avenue N	1115-16A Street NW
Building Information								
Building Size	2500 sq ft approx	approx 4000 sq ft	2 storey	1 1/2 storey house	approx 2100 sq ft	Approx 2000 sq ft	1700 sq ft	2900 sq ft
Building Type	2 storey residence	2 storey	single detached	single detached	1 3/4 storey	frame	bungalow	singe family residential
Year of Construction	1950/1951	1988	1912	1948 +/-	Around 1913	Approx 1980	1955	1993
Basement								
Present? Y/N	y	y	y	y	y	y	y	y
Finished	y	y	y	y	y	y	y	
Unfinished								
Depth below grade?	4'2"	up to approx 9 ft	5 feet	6 ft	aprpox 8 ft	estimate 16 ft		8 ft
A full basement	y	y	y	y	y			y
A partial basement						y	y	
Visible Cracks?	n	n	n	n	y	y	n	n
Sump?	y	n	n	n	n	n	y	y
Crawl Space								
Crawlspace?	n	n	n	n	y	n	n	n
Earthen					y, floor			
Concrete					y, walls			
Gravel layer below?					unsure			
Water entering crawlspace?					n			
Visible Cracks?					n			
General								
Air conditioning unit?	y	n	n	n	y	n	y	y
Whole house fan?	unsure	y	y	y	y	y	unsure	y
Poorly growing vegetation?	n	n	n	n	n	y	n	n
Wet or soft areas of property?	n	n	n	n	n	n	n	n
Spring or a seep at the property?	n	n	n	n	n	n	n	n

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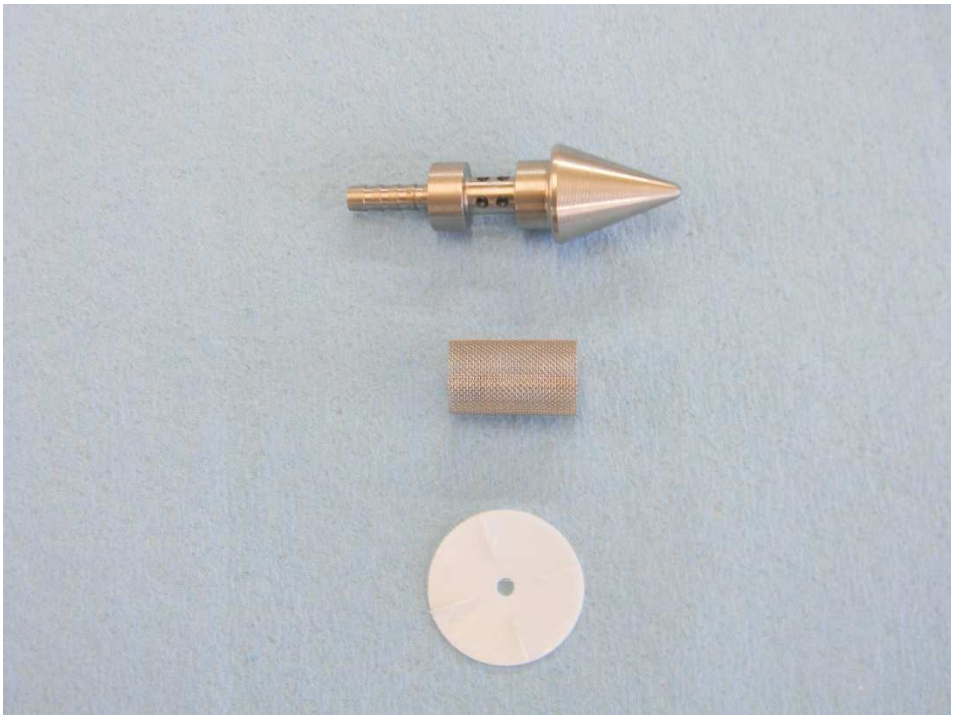
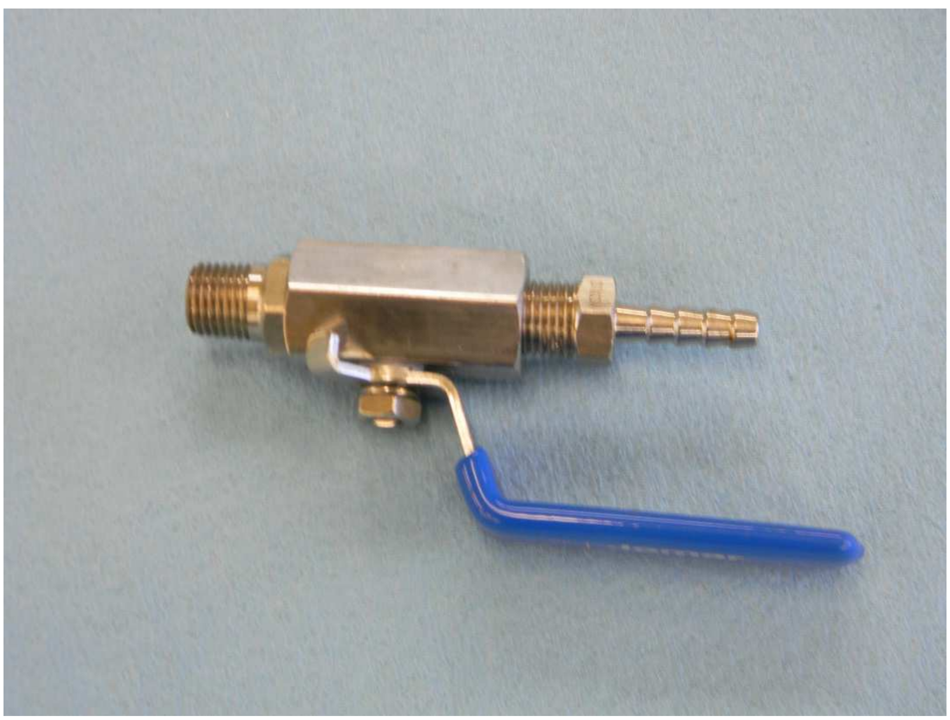
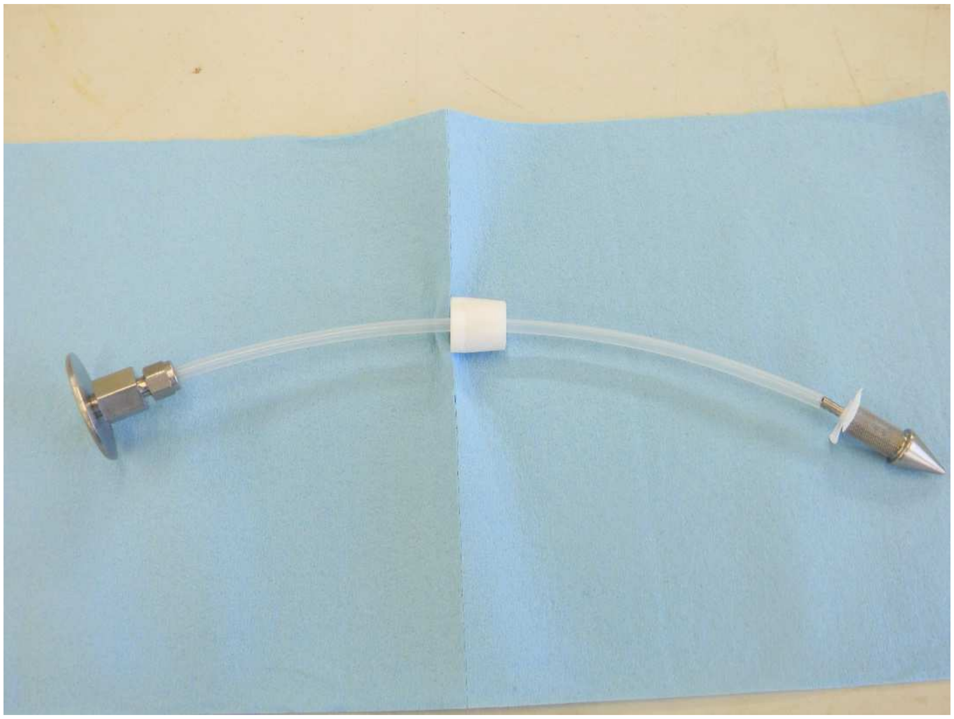


Picture #1 – An example of the stainless-steel soil vapour insert, PTFE umbrella, and stainless-steel mesh to be used for an installation of the soil vapour monitoring points



Picture #2- Stainless-steel valve to be installed at the top of the soil vapour monitoring assembly



Picture #3 – Soil vapour insert with attached PTFE sampling tubing

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2.0 QUALIFICATIONS AND EXPERIENCE OF PROJECT TEAM

Maxxam's Calgary Laboratory

The testing program will be coordinated out of our Calgary laboratory. The assigned project manager will ensure that all project details are executed (i.e. establish VOC parameters, delivery of SUMMA canisters and flow controllers, shipment to Clifton, receipt of samples, shipment of SUMMAs back to Maxxam-Mississauga, reporting, provision of EDDs, and any follow-up).

Maxxam's Mississauga Laboratory

The analysis of the soil vapour for Volatile Organic Compounds (VOCs) and other parameters will be conducted at Maxxam's largest environmental testing facility located in Mississauga, Ontario. This 90,000 square foot facility is state-of-art, and was designed to accommodate high sample volume flow and has the latest building science to provide a safe working environment for our employees.

2.1 Staff Education and Training

In Canada, Maxxam employs approximately 2200 scientists, technologists, IT specialists, QA specialists and a variety of support staff. Employees continually upgrade their skills through involvement in associations, attendance at seminars, education courses, and reading technical journals. This attendance, along with the new skills they master at Maxxam, is recorded on their respective training record. Maxxam offers a variety of methods for continuous learning and development. Areas of training include both job specific and cross-functional responsibilities. Maxxam's Quality System incorporates an extensive database for Standard Operating Procedures and Work Instructions, for which annual retraining is completed by every employee. Our service team members are additionally trained on analytical methods, along with hands-on experience in the laboratory.

Maxxam hereby certifies that all references to degrees or diplomas of our employees are true to the best of our knowledge. Verification of employee degrees/diplomas is available upon request.

2.2 Project Team

Maxxam is confident in its ability to continue to successfully execute this analytical program. With many years of direct experience, we possess in depth of knowledge of soil vapour sampling programs. As a result, we will avoid significant administration and setup costs including new processes, procedures, documentation, sampling and analytical programs.

Maxxam provides a high level of support comprised of our technical experts and project management resources with a solution-based focus. Four distinct groups within Maxxam's organizational structure will fulfill the specific requirements of this project: the Project Management Team, Scientific Services Team, Laboratory Operations Team and the Quality Assurance Team. Each of Maxxam's teams carries its own area of expertise, dedicated support staff and key account assignments. *Due to space limitations within this proposal, detailed resumes and descriptions of the roles, functions and qualifications of other key individuals of the Project Team can be provided upon request.*

2.3 Customer Service / Project Management

The Maxxam Team has significant project management experience and understands the need to deliver high quality service.

Dedicated Contact Person at Maxxam-Calgary: Jenelle Feller, Environmental Project Manager
Jenelle has three years' experience at Maxxam and was promoted to a Project Manager in February, 2014 and is now responsible for ensuring sample handling runs smoothly from the time of receipt at the lab, to when the final report is issued to the client. This includes liaising with both the laboratory and the client in regards to sample integrity, analysis requirements and information, sample container requirements and sampling best practices, laboratory operations, data reporting, turnaround time, and invoicing. For this program, her duties would include:

- Managing day to day project submissions to meet defined requirements at Maxxam-Calgary,
- Day to day resource for personnel submitting or tracking work in Calgary,
- Sampling supply logistics and delivery logistics in Calgary
- Reporting and invoicing responsibilities,
- Ensuring all specific requirements are met as defined in the scope of work in the final report and EDDs

The Maxxam Team has significant project management experience and understands the need to deliver high quality service.

Account Manager: Mr. Petro Oh, Business Development Manager Air Toxics and HRMS, has over ten years of experience working with various government agencies and consultants in the Calgary area related air and soil vapour sampling programs. Petro has over 30 years of experience in Air Toxics projects including six years of involvement with the Spyhill Landfill project. Petro has been a regular presenter at Air and Waste Management conferences on soil vapour collection across Canada. As well, he have conducted over 250 technical seminars detailing the science of sampling soil vapour and sub-slab gas and other air collection techniques. Petro will act as the Account Manager, and will be responsible for the ongoing success of the project. His duties would include:

- Overseeing data Integrity,
- Any field sampler training, if required,
- Annual Project Reviews,
- Day to day resource for personnel submitting work in Calgary,
- Overseeing sampling equipment logistics,
- Overseeing reporting and invoicing responsibilities,
- Ensuring all specific requirements are met as defined in the scope of work in the final report and EDDs.

Account Manager in Mississauga: Ms. Theresa Stephenson, Project Manager (PM), has more than 15 years of experience working with air and soil vapour related programs, and has solid business relationships with several consultants in the Calgary area. As Lead Project Manager, Theresa will be responsible for overall management of the day to day project needs, communication and coordination with Clifton and Maxxam-Calgary. Theresa has been the Project Manager for the Spyhill Landfill project for the last six years.

Roles include:

- Managing day to day project submissions to meet defined requirements received at Maxxam-Mississauga,
- Day to day resource for personnel submitting or tracking work in Mississauga,
- Sampling supply logistics and delivery logistics,
- Coordination with laboratory personnel to complete each job as required,
- Reporting responsibilities, compiling specific requirements are met as defined in the scope of work, final report and EDDs.

3.0 ANALYTICAL METHODS AND PROJECT LOGISTICS

3.1 Materials

Currently Maxxam **owns** over 1,700 SUMMA canisters and 2,000 flow controllers (set at various time durations). We send out 8,000 to 9,000 canister sets annually. With our capacity, Maxxam is able to reserve a number of canisters and flow controllers for this sampling program, if required. The canisters can be shipped to Maxxam-Calgary or directly to Clifton.

3.2 Sample Receipt and Login

SUMMA canister samples will be inspected upon receipt to identify any problems with sample labelling, sample condition and quantities collected.

Maxxam will send an email confirmation about the samples during the morning after the samples are received at the laboratory. The email confirmation will include the sample identification number, the requested test parameters and the laboratory job number assigned to each chain-of-custody.

3.3 Volatile Organic Compounds from SUMMA Canisters

The determination of Volatile Organic Compounds in samples sollected in SUMMA canisters using GC/MS is conducted in the Maxxam-Missisauga Volatiles Laboratory in accordance with Maxxam standard operating procedure BRL SOP-00304 (short version copy available). The primary reference is US EPA Method TO-15, "Determination of Volatile Organic Compounds (VOCs) in Air Collected In Specially Prepared Canisters And Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)", January 1999, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, 2nd Ed., EPA/625/R-96/010b.

While this method was designed to analyze ambient or indoor air samples, it can also be used to analyze soil vapour for TO15 parameters. Air or soil vapour is sampled into SUMMA canisters which have been previously cleaned and evacuated according to protocol outlined in Maxxam SOP BRL SOP-00306, "Cleaning Summa Canisters for Air Sampling. Canisters are attached to the analytical system". Water and CO2 vapour are removed by being trapped on a glass bead trap or an empty trap and a tenax trap.

The volatiles are concentrated by collection on a cryogenically cooled trap. The concentrated volatiles are thermally desorbed and carried onto a gas chromatographic column for separation of the component molecules. The molecules are then ionized and the ionized fragments are detected based on their mass to charge (m/z) ratio.

SUMMA Canister Preparation

Canisters are cleaned on an open manifold system as per BRL SOP-00306. One canister from each batch of canisters cleaned, to a maximum batch size of 16 canisters, is proofed using the analytical protocol outlined in Section 14.0 of BRL SOP-00304.

Sample Shipment and Information

The integrity of the canisters is checked as they arrive in the laboratory. Each canister should have a tag attached to it to identify the sample. This identity of the sample(s) is logged into the MaxxLIMS system under the appropriate job number. Samples are stored in the VOC laboratory prior to analysis. The laboratory should be made aware of the time of sampling, volume, sampling temperature and any anomalies encountered during sampling.

Typical List of VOC Parameters

Maxxam will report all analytical results upon completion of each sampling event. We will provide results in a summary report (PDF form) plus within an Electronic Data Deliverable (EDD) file format (many formats are available. Each analytical report will include the required quality control results and will describe any abnormalities that may have occurred during analysis.

Our standard list of VOC tests are given below. Maxxam can report all of the parameters indicated below or a selected sub-list:

Parameter Description	RDL (ppbv)
1,1,1-Trichloroethane	0.3
1,1,2,2-Tetrachloroethane	0.2
1,1,2-Trichloroethane	0.2
1,1-Dichloroethane	0.2
1,1-Dichloroethylene	0.3
1,2,4-Trichlorobenzene	2
1,2,4-Trimethylbenzene	0.5
1,2-Dichlorobenzene (ortho)	0.4
1,2-Dichloroethane	0.2
1,2-Dichloropropane	0.4
1,2-Dichlorotetrafluoroethane	0.2
1,3,5-Trimethylbenzene	0.5

Parameter Description	RDL (ppbv)
Ethylbenzene	0.2
Ethylene Dibromide	0.2
Heptane	0.3
Hexachlorobutadiene	3
n-Hexane	0.3
m / p-Xylene	0.4
Methyl Butyl Ketone (2-Hexanone)	2
Methyl Ethyl Ketone (2-Butanone)	3
Methyl Isobutyl Ketone	3.2
Methyl t-butyl ether (MTBE)	0.2
Methylene Chloride (Dichloromethane)	0.3
Naphthalene	2

1,3-Butadiene	0.5
1,3-Dichlorobenzene (meta)	0.4
1,4-Dichlorobenzene (para)	0.4
1,4-Dioxane	2
2,2,4-Trimethylpentane	0.2
2-propanol	3
2-Propanone (Acetone)	0.8
4-ethyltoluene	2.2
Benzene	0.2
Benzyl chloride	1
Bromodichloromethane	0.2
Bromoform	0.2
Bromomethane	0.2
Carbon Disulfide	0.5
Carbon Tetrachloride	0.3
Chlorobenzene	0.2
Chloroethane	0.3
Chloroform	0.2
Chloromethane	0.3
cis-1,2-Dichloroethylene	0.2
cis-1,3-Dichloropropene	0.2
Cyclohexane	0.2
Dibromochloromethane	0.2
Dichlorodifluoromethane	0.2
Ethanol	2.3

n-Butane	2
o-Xylene	0.2
Styrene	0.2
Tetrachloroethylene	0.2
Toluene	0.2
trans-1,2-Dichloroethylene	0.2
trans-1,3-Dichloropropene	0.2
Trichloroethylene	0.3
Trichlorofluoromethane (FREON 11)	0.2
Trichlorotrifluoroethane	0.2
Vinyl Chloride	0.2
Vinyl Acetate	0.2
Parameter Description	**RDL ug/m3**
Aliphatic >C5-C6	5
Aliphatic >C6-C8	5
Aliphatic >C8-C10	5
Aliphatic >C10-C12	5
Aliphatic >C12-C16	5
Aromatic >C7-C8 (TEX Excluded)	5
Aromatic >C8-C10	5
Aromatic >C10-C12	5
Aromatic >C12-C16	5
CCME F1	5
CCME F2	5

3.4 Organic Instrumentation for VOC Testing

Details about our current VOC instruments with capacities are listed below.

Instr. ID	Components	Manufacturer	Model #	Principal Analysis	Monthly VOC Sample Capacity
MSD 12	GC	Hewlett Packard	6890	TO14/15	250
	MS	Hewlett Packard	5973 MSD		
	A/S	Entech	7016CA		
	Concentrator	Entech	7100A		
MSD 14	GC	Hewlett Packard	6890	TO14/15	250
	MS	Hewlett Packard	5972		
	A/S	Entech	7016CA		
	Concentrator	Entech	7100A		
MSD 16	GC	Hewlett Packard	6890		
	MS	Hewlett Packard	5973 MSD	TO17, TO14/TO15	250
	Concentrator	Entech	7100		
MSD 17	GC	Hewlett Packard	689ON	TO14/15	250
	MSD	Hewlett Packard	5973N	-	
	A/S	Entech	7016CA		
	Concentrator	Entech	7100A		
MSD 51	GC	Hewlett Packard	7890A	TO14/15	250
	MSD	Hewlett Packard	5975C	-	
	A/S	Entech	7016CA		
	Concentrator	Entech	7100A		
MSD 53	GC	Hewlett Packard	7890A	TO14/15	250
	MSD	Hewlett Packard	5975C	-	
	A/S	Entech	7016CA		
	Concentrator	Entech	7100A		
Saturn 1	GC-FID	Varian	3800	Pre-screening only	Pre-screening only
Can Cleaning System		Entech	3100A		2200
Can Cleaning System		Entech	3100A		
Can Cleaning System		Entech	3108		
Can Cleaning System		XonTech			

4.0 QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

The QA/QC procedures routinely employed at Maxxam are described in this section. These procedures will more than meet the expectations of most regulatory groups in Canada. We will process a minimum of one blank and spike blank with every batch. As well, if the nature and quantity of the sample allows, we will include a lab matrix spike and lab duplicate.

4.1 Maxxam's Quality Policy

"To provide analytical results and services which consistently meet our customers' specified requirements through the implementation of a comprehensive quality management system."

This policy is designed to ensure our regulatory compliance through extensive internal and external audits, double blind studies and monthly quality improvement meetings. Quality is the cornerstone of our business. Senior management is ultimately responsible for ensuring that the quality policy is understood, implemented and monitored. Our Regional QA Managers maintain the process and report directly to the President of the company

4.2 Quality Management System

Our proven quality management system encompasses both quality assurance and quality control to ensure consistent delivery of high quality data to our clients. Our laboratories are accredited to ISO/IEC 17025 "General Requirements for the Competence of Testing and Calibration Laboratories", which is the global standard for laboratory quality management programs. Public safety, environmental impact and major financial decisions are routinely based on Maxxam's analytical data. Legal data defensibility is essential to these activities and is verified through a comprehensive quality control program.

4.3 Summary of Quality Control (QC) Parameters

The table below provides a summary of the routine QC parameters included with every batch of SUMMA canister samples tested at Maxxam-Mississauga. Detailed descriptions of each of the parameters tested are given in BRL SOP-00304.

Elements of Quality Control		
Element	**Frequency**	**Typical Limits – may vary on special tests**
Field QC		
Sample Containers	Batch proofed or individually certified	Non Detect
Traveling Blanks	Project Specific	<2 x RDL
Field Replicates	Project Specific	Project Specific
Run QC, All Methods		
Method Blanks	1 in 20 or 1/batch	<2 x RDL
Blank Spikes	1 in 20 or 1/batch	EPA limits or better
Matrix Spikes	1 in 20 or 1/batch	EPA limits or better
Replicate Analysis	1 in 20 or 1/batch	20%-50% RSD
Real Time Control Charts	Key parameters, all tests	± 3 SD, trend analysis
Organic QC		
Instrument Calibration	Multipoint	RSD ± 25%
Initial Calibration Verification	Daily (second source)	± 30% of initial
Continuing Cal. Verification	Verified every 24 hrs.	RF or RRF ± 30% of initial
Surrogate Standards	All samples, all organic analyses	EPA limits or better
Internal Standards (IS)	All Samples (method specific)	60% to 140% of IS
Standard Reference Material	As required (if available)	SRM limits
External QC		
Interlaboratory Comparisons	1/year	Top 10% overall, >95% acceptable
Maxxam Double Blind Program	2 x year (Inorganic, Organic, Food and Micro studies where applicable)	Statistical Limits
Internal QC Checks	As required	In house limits

5.0 ACCREDITATIONS

Maxxam Mississauga is accredited with the Standards Council of Canada (SCC) to ISO 17025 guidelines and is identified as Laboratory No. 97. The full SCC scope of environmental testing services (for the matrices soil, tissue, food, water and air samples) is updated periodically and the full scope is available at http://www.scc.ca/en/programs-services/laboratories. The Maxxam scope dated 02 June 2015 is presented separately from this proposal. Pages 16 to 18 of our SCC Scope specifically list all of the relevant VOCs in SUMMA test.

5.1 Audit for Accreditation

Details of our most recent external audits involving VOC testing on SUMMA canisters are available upon request or external confirmation can be obtained from:

Standard Council of Canada
Attn Sylvie Brisvenue
200-270 Albert St
Ottawa, ON K1P 6N7
Tel 1 613 238 3222
Email info@scc.ca

5.2 Performance Evaluation Program

As part of the accreditation procedure, Maxxam routinely participates in quality related programs. We participate in studies as arranged through ERA. Example study reports are available upon request. Maxxam generally scores at or close to 100% within the acceptance criteria set by ERA for VOC results.

SCOPE OF ACCREDITATION

Maxxam Analytics International Corporation
6740 Campobello Road
Mississauga, ON
L5N 2L8

Accredited Laboratory No. 97
(Conforms with requirements of CAN-P-1585, CAN-P-1587 , CAN-P-4E (ISO/IEC 17025:2005))

CONTACT: Ms. Anuradha Ramesh
TEL: +1 905 817 5700 ext.4161
FAX: +1 905 817 5777
EMAIL: aramesh@maxxam.ca

CLIENTS SERVED: All interested parties

FIELDS OF TESTING: Biological, Chemical/Physical

PROGRAM SPECIALTY AREA: Agriculture Inputs, Food, Animal Health and Plant Protection (PSA-AFAP) , Environmental, Environmental (OSDWA)

ISSUED ON: 2015-06-02

VALID TO: 2018-10-06

Note: Between May 16 and 18, 2015 food microbiology tests will be performed at both 6660 Campobello Road and 6740 Campobello Road. As of May 20, 2015 there will no longer be any food microbiology samples processed at 6740 Campobello Road (all food microbiological methods will be conducted at 6660 Campobello Road).
Note that neutron activation and radiological analyses are conducted at the Becquerel facility at 6790 Kitimat Road, Unit 4, Mississauga, Ontario L5N 5L9

NON METALLIC MINERALS AND PRODUCTS

Petroleum Refinery Products: (Including asphalt materials; petrochemicals; fuels and lubricants)
Fuels and Lubricants are performed at the following location:
Maxxam Analytics, PETROCHEMICAL LABORATORY
4141 Sladeview Crescent Unit 10
Mississauga, ON

TEST METHOD DEVELOPMENT & EVALUATION AND NON-ROUTINE TESTING

Note: Laboratories accredited under this Program Specialty Area have demonstrated that they meet

ISO/IEC 17025 requirements for routine testing under the same product classification as described below.

Chemical Analysis:

1. Development and validation of new testing methodology for the screening and determination of chemical compounds in food, water and environmental samples.
2. Development of testing methods for the assessment and validation of commercially available test kits for the screening and determination of mycotoxins, allergens and histamines in food, water and environmental samples.
3. Development and validation of mass spectral techniques in food, water and environmental samples.

Microbiology Analysis

1. Development and validation of analytical methods for detection, isolation, identification and characterization of microorganism including bacteria, yeast and molds in food, water and environmental samples.
2. Development, evaluation and validation of new test kits including commercial test kits for the detection and/or enumeration of microorganisms in food, water and environmental samples.

3. Modification, improvement and validation of published or existing methods for detection and/or enumeration of microorganisms in food, water and environmental samples.

4. Analysis of non-routine analytical methods for MPN in food borne pathogens; including but not limited to Salmonella, Shigella, Listeria species or Listeria monocytogenes, E.coli O157:H7, Campylobacter species or Campylobacter jejuni, Vibrio species or Vibrio parahaemolyticus, Vibrio vulnificus, Vibrio cholera, Enterobacter sakazakii

Procedures used for Test Method Development & Evaluation and Non-routine Testing:
COR WI-00122 Procedure for Compliance to CAN-P-1595
COR1SOP-00049: Enumeration of Foodborne Pathogens by MPN

ANIMAL AND PLANTS (AGRICULTURE)

Foods and Edible Products: (Human and Animal Consumption)

(Animal Tissue, Animal Derived Foods (Dairy, Honey, Eggs), Meat, Fish, Seafood, Fresh and Processed Fruit and Vegetables, Urine, Veal)

CAM SOP 00408	ICP OES-Metals in Air, Waters, Foods, Swabs, Solids, Paint and Sludge
	Calcium
	Chromium
	Copper
	Iron
	Magnesium
	Manganese

	Molybdenum
	Phosphorus
	Potassium
	Sodium
	Sulphur
	Zinc
CAM SOP 00440	Nitrate, Nitrite and TON in Waters, Solids, Sludge and Food by FIA
	Nitrate
	Nitrite
CAM SOP 00447	ICPMS Metals in Waters, Foods, Solids, Swabs and Biota
	Aluminum
	Arsenic
	Barium
	Boron
	Cadmium
	Calcium
	Chromium
	Copper
	Iron
	Lead
	Magnesium
	Manganese
	Nickel
	Phosphorus
	Potassium
	Selenium
	Sodium
	Tin
	Titanium
	Zinc
CAM SOP 00453	Mercury in Water, Solids, Sludge and Food by Cold Vapour A.A.
CAM SOP-00756	Perchlorate in Food by LCMSMS

(Fish and Seafood)

BRL SOP-00403	PCB Congeners (209 analytes) by HRGC HRMS in Food Product (Modified USEPA Method 1668, MOE Method DFPCB-E3418, and Environment Canada Method EPS1/RM)
BRL SOP-00410	Dioxins/Furans in Water, Soil, Food and Biota by HRGC HRMS (EPA 1613)
	1,2,3,4,6,7,8,9-C18-Dibenzofuran
	1,2,3,4,6,7,8,9-C18-Dibenzo-p-dioxin
	1,2,3,4,6,7,8-C17-Dibenzofuran
	1,2,3,4,6,7,8-C17-Dibenzo-p-dioxin
	1,2,3,4,7,8,9-C17-Dibenzofuran

	1,2,3,4,7,8-C16-Dibenzofuran
	1,2,3,4,7,8-C16-Dibenzo-p-dioxin
	1,2,3,6,7,8-C16-Dibenzofuran
	1,2,3,6,7,8-C16-Dibenzo-p-dioxin
	1,2,3,7,8,9-C16-Dibenzofuran
	1,2,3,7,8,9-C16-Dibenzo-p-dioxin
	1,2,3,7,8-C15-Dibenzofuran
	1,2,3,7,8-C15-Dibenzo-p-dioxin
	2,3,4,6,7,8-C16-Dibenzofuran
	2,3,4,7,8-C15-Dibenzofuran
	2,3,7,8-C14-Dibenzofuran
	2,3,7,8-C14-Dibenzo-p-dioxin
	H6CDD
	H6CDF
	H7CDD
	H7CDF
	O8CDD
	O8CDF
	P5CDD
	P5CDF
	PCDD/PCDF
	T4CDD
	T4CDF
BRL SOP-00423	PAH Compounds by HRGC/ HRMS in Food Products, Sediment and Water (Modified EPA 3540C, CARB 429)
	2-chloronapthalene
	2-Methyl napthalene
	Acenaphthene
	Acenaphthylene
	Anthracene
	Benzo(a)anthracene
	Benzo(a)pyrene
	Benzo(b)fluoranthene
	Benzo(e) pyrene
	Benzo(g,h,i)perylene
	Benzo(k)fluoranthene
	Bibenz(a,h)anthracene
	Chrysene
	Coronene
	Fluoranthene
	Fluorene
	Indeno(1,2,3-cd)pyrene
	Napthalene
	Perylene
	Phenanthrene

	Pyrene

(Food Chemistry - General)

BRL SOP-00408	PCB Congeners Analyses by HRGC/HRMS (modified EPA 1668A and 1668B) PCB Congeners (209 analytes)
BRL SOP-00410	Dioxins/Furans in Water, Soil (EPA 1613), Food and Biota (modified EPA 1613) by HRGC HRMS 1,2,3,4,6,7,8,9-C18-Dibenzofuran 1,2,3,4,6,7,8,9-C18-Dibenzo-p-dioxin 1,2,3,4,6,7,8-C17-Dibenzofuran 1,2,3,4,6,7,8-C17-Dibenzo-p-dioxin 1,2,3,4,7,8,9-C17-Dibenzofuran 1,2,3,4,7,8-C16-Dibenzofuran 1,2,3,4,7,8-C16-Dibenzo-p-dioxin 1,2,3,6,7,8-C16-Dibenzofuran 1,2,3,6,7,8-C16-Dibenzo-p-dioxin 1,2,3,7,8,9-C16-Dibenzofuran 1,2,3,7,8,9-C16-Dibenzo-p-dioxin 1,2,3,7,8-C15-Dibenzofuran 1,2,3,7,8-C15-Dibenzo-p-dioxin 2,3,4,6,7,8-C16-Dibenzofuran 2,3,4,7,8-C15-Dibenzofuran 2,3,7,8-C14-Dibenzofuran 2,3,7,8-C14-Dibenzo-p-dioxin H6CDD H6CDF H7CDD H7CDF O8CDD O8CDF P5CDD P5CDF PCDD/PCDF T4CDD T4CDF
BRL SOP-00423	PAH Compounds by HRGC/ HRMS in Food Products, Sediment and Water (modified EPA 3540C, CARB 429) - For Food Products only Acenaphthene Acenaphthylene

	Anthracene
	Benzo(a)anthracene
	Benzo(a)pyrene
	Benzo(b/j)fluoranthene
	Benzo(g,h,i)perylene
	Benzo(k)fluoranthene
	Chrysene
	Dinbenzo(a,h)anthracene
	Fluoranthene
	Fluorene
	Indeno(1,2,3-cd)pyrene
	Naphthalene
	Phenanthrene
	Pyrene
CAM SOP 00408	ICP OES-Metals in Air, Waters, Foods, Swabs, Solids, Paint and Sludge Only for: Calcium Copper Chromium Iron Magnesium Manganese Molybdenum Phosphorus Potassium Sodium Sulphur Zinc
CAM SOP 00413	Measurement of pH in Water, Soils and Food Samples
CAM SOP 00423	The Determination of Brookfield Viscosity in Food
CAM SOP 00449	Fluoride in Waters, Soil, Air, Vegitation and Food by ISE
CAM SOP 00700	Determination of Cholesterol in Foods, Feeds and Oils by GC/FID
CAM SOP 00701	Determination of Fat in Meat by Gravimetry
CAM SOP 00702	Determination of Fatty Acids in Fats and Oils by GC/FID
CAM SOP 00703	Determination of Sodium Chloride in Food and Feed Products by Titration
CAM SOP 00705	Determination of Fat in Foods using Soxhlet Extraction
CAM SOP 00706	Determination of Fat in Foods using Acid Hydrolysis
CAM SOP 00707	Total Dietary Fibre Soluble Fibre and Insoluble Fibre in Foods by Gravimetry
CAM SOP 00708	Determination of Sugars in Foods by Refractive Index
CAM SOP 00709	Vitamin A and B-Carotene in Food by HPLC
CAM SOP 00710	The Determination of Fat by the Modified Mojonnier Method in Milk, Cream, Milkshake Mix and Confectionary Products
CAM SOP 00711	Determination of Protein in Foods, Feeds and Edible Oils by Combustion
CAM SOP 00712	Vitamin E in foods, feeds, milk, and other dairy products by Capillary GC

CAM SOP 00713	Determination of Ash in Food and Food Products by Gravimetry
CAM SOP 00714	Determination of Acidity in Food and Food Products by Titration
CAM SOP 00715	Determination of Moisture and Total Solids in Food and Food Products by Gravimetry
CAM SOP 00716	Determination of Starch in Food by Spectrophotometry
CAM SOP 00717	Determination of Peroxide Value of Oils and Fats by Titration
CAM SOP 00718	Sulfites in Food and in Seafood by Gravimetry
CAM SOP 00719	Determination of Vitamin D-3 (Cholecalciferol) inFood Products by HPLC
CAM SOP 00722	The Determination of TBA Value in Foods by Spectrophotometry
CAM SOP 00724	Determination of Vitamin C in Complex Foodstuffs Using HPLC with Electrochemical Detector (Modified QFCL-001-01)
CAM SOP 00732	Determination of Water Activity in Food by Aqualab Water Activity Meter
CAM SOP 00734	Allergens in Foods and Swabs, Mycotoxin in Food using ELISA
CAM SOP 00739	Brix (Soluble Solids) in Foods, Juices and Honey by Refractometer
CAM SOP 00740	Sorbic and Benzoic Acids by HPLC in Food and Beverages
CAM SOP 00750	Determination of Total Folates (Vitamin B9) in Foods by Assay
CAM SOP 00751	Determination of Niacin (Vitamin B3) in Food by Assay
CAM SOP 00752	Determination of Pantothenic Acid (Vitamin B5) in Food by Assay
CAM SOP 00754	Determination of Cobalamin (Vitamin B12) in Food by Assay
CAM SOP 00755	Determination of Pyridoxine (Vitamin B6) in Foods by Microbiology Assay
CAM SOP 00874	Analysis of Melamine and Cyanuric Acid in Food by LC/MS/MS
CAM SOP 00882	Determination of Thiamine (Vitamin B1) in Foods by Fluorometry
CAM SOP 00884	Determination of Riboflavin (Vitamin B2) in Foods by Fluorometry
CAM SOP 00885	Analysis of Acrylamide in Food by LCMSMS
CAM SOP-00761	Total Dietary Fibre in Food
CAM SOP-00807	Determination of Perfluorinated Compounds in Food by LC/MS/MS
CAM SOP-00926	Determination of Amino Acids by HPLC
CAM SOP-00932	Nitrite and Nitrate in Meat and Food Products by HPLC

(Microbiological)

BAX® SYSTEM REAL- TIME PCR ASSAY STEC SUITE	The BAX ® SYSTEM REAL- TIME PCR ASSAY STEC SUITE
AOAC RI 050902	The DuPont Qualicon BAX® System Real- Time PCR Assay for Vibrio cholerae/parahaemolyticus/vulnificus
COR1SOP-00019	Enumeration of Coliforms, Faecal Coliforms and *E. Coli* in foods using the MPN Method (Modified MFHPB-19; option of standard 3-tube and 10-tube MPN method)
FDA BAM	Isolation and Identification of *Salmonella* in Food and Environmental Samples Following the FDA-BAM Method

MFHPB-10	Isolation of *Escherichia coli* O157:H7/NM from foods and environmental surface samples
MFHPB-18	Determination of the Aerobic Colony Count in Foods
MFHPB-19	Enumeration of Coliforms, Faecal Coliforms and of *E. coli* in Foods by using the MPN Method
MFHPB-20	Isolation and Identification of *Salmonella* from Foods and Environmental Samples
MFHPB-21	Enumeration of *Staphylococcus aureus* in Foods
MFHPB-22	Enumeration of Yeasts and Molds in Foods
MFHPB-23	Enumeration of *Clostridium perfringens* in Foods
MFHPB-27	Enumeration of *Escherichia coli* in Foods by the Direct Plating (DP) Method
MFHPB-30	Isolation of *Listeria monocytogenes* and *Listeria spp* from foods and environmental samples
MFHPB-31	Determination of Coliforms in Foods Using Violet Red Bile Agar
MFHPB-33	Enumeration of Total Aerobic Bacteria in Food Products and Food Ingredients Using 3M™ Petrifilm™ Aerobic Count Plates
MFHPB-34	Enumeration of *E. coli* and Coliforms in Food Products and Food Ingredients Using 3M™ Petrifilm™ E. coli Plates
MFHPB-35	Enumeration Of Coliforms In Food Products And Food Ingredients Using 3M™ Petrifilm™ Coliform Count Plates
MFLP-06	Detection of *SALMONELLA SPP*. in Foods using the 3MŽ Molecular Detection System Test Kit
MFLP-16	Detection of *Escherichia coli* O157:H7 in Foods ŒAssurance GDS for *E. coli* O157:H7 Gene Detection System
MFLP-21	Enumeration of *Staphylococcus aureus* in Foods and Environmental Samples Using 3M™ Petrifilm™ Staph Express Count (STX) Plates
MFLP-25	Isolation and Identification of *Shigella spp*. from Food
MFLP-28	The Qualicon Bax® System Method for the Detection of *Listeria Monocytogenes* in a Variety of Food
MFLP-29	The Qualicon Bax® System Method for the Detection of *Salmonella* in a Variety of Food and Environmental Samples
MFLP-30	The Dupont Qualicon Bax® System Method for the Detection of *E. coli* O157:H7 in Raw Beef and Fruit Juice
MFLP-33	Detection of *Listeria monocytogenes* in foods by the VIDAS LMO 2™method
MFLP-37	Part 1: Detection of Halophilic Vibrio Species in Seafood Part 2: Detection of Vibrio Cholerae
MFLP-38	Detection of *Salmonella spp*. from All Foods and Selected Environmental Surfaces using IQ-Check™ Salmonella Real-time PCR Test Kit
MFLP-39	Detection of *Listeria spp.* From Environmental Surfaces Using iQ-CheckTM *Listeria spp*. Real-Time PCR Test Kit
MFLP-42	Isolation and Enumeration of *Bacillus cereus* in Foods
MFLP-44	Enumeration of Aerobic and Anaerobic sporeformers
MFLP-46	Isolation of Thermophilic *Campylobacter* from Food
MFLP-49	

	Detection of *Salmonella* in Food Products by the VIDAS® UP Salmonella (SPT) Method
MFLP-65	MFLP-65 - Detection of staphylococcal enterotoxins in food products using the vidas® staph enterotoxin ii (set2), an elfa (enzyme linked fluorescent assay) technique
MFLP-74	Enumeration of Listeria monocytogenes in Foods
MFLP-76	The DuPont Qualicon BAX® System real time method for the detection of *E.coli* O157:H7 in raw beef trim and raw ground beef
MFLP-77	Detection of Listeria monocytogenes and other Listeria spp. in food products and environmental samples by the VIDAS® Listeria species Xpress (LSX) method
MFLP-83	Detection of Verotoxins VT 1 And VT 2 by The Merck Duopath® Verotoxin Kit
MFLP-9	Enumeration of *Enterobacteriaceae* Species in Food and Environmental Samples Using 3M™ Petrifilm™ Enterobacteriaceae Count Plates
MLG 4	FSIS Procedure for the Isolation and Identification of *Salmonella* from Meat, Poultry and Egg Products
MLG 4C	FSIS Procedure for the Use of the BAX System, PCR Assay for Screening *Salmonella* in Raw Meat, Carcass Sponge Samples, Whole Bird Rinses, Ready to Eat Meat and Poultry Products, and Pasteurized Egg Products
MLG41	Isolation, Identification,and Enumeration of *Campylobacter jejuni/coli/lari* from Poultry Rinse and Sponge Samples

Animal or Vegetable Fats and Oils and Their Cleavage Products; prepared edible fats; animal or vegetable waxes

Beverages, Spirits and Vinegar

CAM SOP-00739	Brix (Soluble Solids) in Foods, Juices and Honey by Refractometer
CAM SOP-00740	Sorbic and Benzoic Acids by HPLC in Food and Beverages

Dairy Products

See Animal Tissue, Animal Derived Foods (Dairy, Honey, Eggs), Meat, Fish, Seafood, Fresh and Processed Fruit and Vegetables, Urine, Veal

CAM SOP-00736	Determination of Undenatured Whey Protein Nitrogen in Non Fat Dry Milk by Spectrophotometry
CAM SOP-00737	Determination of Solubility Index by Volumetric Analysis
CAM SOP-00738	Determination of Scorched Particles Using Water Disc Method

Edible Fruits and Nuts

See Fresh and Processed Fruit and Vegetables

Edible Vegetables and Certain Roots and Tubers

See Fresh and Processed Fruit and Vegetables

Meat and Edible Meat Offal

(Meat and Meat Products (See Animal Tissue, Animal Derived Foods (Dairy, Honey, Eggs), Meat, Fish, Seafood, Fresh and Processed Fruit and Vegetables, Urine, Veal))

ENVIRONMENTAL AND OCCUPATIONAL HEALTH AND SAFETY

Environmental

(Soil/Sediment/Water/Air)

BQL SOP-00001	NEUTRON ACTIVATION Long Lived Isotopes which may include: Antimony Arsenic Barium Cerium Cesium Chromium Cobalt Europium Gold Hafnium Iron Lanthanum Lutetium Molybdenum Neodymium Nickel Rubidium Samarium Scandium Selenium Silver Sodium Tantalum Terbium Thorium Titanium Tungsten Uranium Ytterbium

	Zinc
	Zirconium
BQL SOP-00004	NEUTRON ACTIVATION Short-Lived Elements which may include:
	Aluminum
	Barium
	Bromine
	Calcium
	Chlorine
	Dysprosium
	Europium
	Fluorine
	Indium
	Iodine
	Magnesium
	Manganese
	Potassium
	Samarium
	Sodium
	Strontium
	Titanium
	Vanadium
BQL SOP-00005	DELAYED NEUTRON COUNTING for Uranium and U-235
BQL SOP-00006	ALPHA SPECTROMETRY
	Polonium-210
	Radium-224
	Radium-226 (OSDWA)
	Thorium-228
	Thorium-230
	Thorium-232
	Uranium-234
	Uranium-235
	Uranium-238
BQL SOP-00007	GAMMA SPECTROMETRY Natural Decay Chain Isotopes which may include Th-234, Th-230, Ra-226, Pb-210, U-235, Th-227, Ra-223, Ac-228, Ra-228 (OSDWA), Rn-222 (OSDWA), Pb-212, Pb-214, Bi-214, Tl-208 Synthetic Isotopes which may include Cs-137, Cs-134, I-131, Zn-65, Co-60, Mn-54, Am-241
BQL SOP-00008	GAS FLOW PROPORTIONAL COUNTING Gross Alpha Activity (OSDWA) Gross Beta Activity (OSDWA) Other radionuclides which may include Lead-210, (OSDWA) Radium-228 Strontium-90
BQL SOP-00009	LIQUID SCINTILLATION COUNTING which may include:
	Carbon-14

	Tritium (OSDWA)

Air

BQL-SOP-00010	Electret Ion Chamber Measurement for Radon-222
BRL SOP-00103	Metals by ICP/MS in Water, Soil, Air and Biota (Modified NIOSH 7300, 6009)
	Antimony
	Arsenic
	Barium
	Beryllium
	Bismuth
	Boron
	Cadmium
	Calcium
	Chromium
	Cobalt
	Copper
	Iron
	Lead
	Lithium
	Magnesium
	Manganese
	Molybdenum
	Nickel
	Phosphorus
	Potassium
	Selenium
	Silicon
	Silver
	Sodium
	Strontium
	Thallium
	Tin
	Titanium
	Tungsten
	Vanadium
	Zinc
BRL SOP-00104	Mercury by CVAAS in Water, Soil ,Air and Biota
	Mercury (Hg)
BRL SOP-00105	Anions by IC in Water, Soil and Air
	Bromide
	Chloride
	Fluoride
	Nitrite

	Phosphate
	Sulfate
BRL SOP-00106	Hexavalent Chromium by IC in Air
	Chromium VI
BRL SOP-00107	Ammonia in Air by IC (Based on EPA CTM-027, EPA Method 206)
	Ammonia (as NH4+)
BRL SOP-00108	Anions From Emission Sampling Trains by IC (Modified EPA 26/26A, EPA SW846 9057)
	Bromine
	Chlorine
	Fluorine
	Hydrogen Bromide
	Hydrogen Chloride
	Hydrogen Fluoride
	Hydrogen Iodide
	Iodine
	Nitric Acid
BRL SOP-00109	Gravimetric Determination of PM Emission from Stationary Sources and Air
	Particulates of Filters, Gravimetric
BRL SOP-00200	Semivolatiles Full Scan by GCMS in Water, Soil and Stack Gas Samples (Modified EPA SW846 8270C, 3510C, 3540C, 3640A, 0010)
	1,2,4-Trichlorobenzene
	1,2-Dichlorobenzene
	1,3-Dichlorobenzene
	1,4-Dichlorobenzene
	1-Chloronaphthalene
	1-Methylnaphthalene
	2,3,4,5-Tetrachlorophenol
	2,3,4,6-Tetrachlorophenol
	2,3,4-Trichlorophenol
	2,3,5,6-Tetrachlorophenol
	2,3,5-Trichlorophenol
	2,4,5-Trichlorophenol
	2,4,6-Trichlorophenol
	2,4-Dichlorophenol
	2,4-Dimethylphenol
	2,4-Dinitrophenol
	2,4-Dinitrotoluene
	2,6-Dichlorophenol
	2,6-Dinitrotoluene
	2-Chloronaphthalene
	2-Chlorophenol
	2-Methylnaphthalene

2-Methylphenol (o-Cresol)
2-Nitroaniline
2-Nitrophenol
3,3'-Dichlorobenzidine
3+4 Methylphenol (m+p-Cresol)
3-Nitroaniline
4,6-Dinitro-2-methylphenol
4-Bromophenyl Phenyl Ether
4-Chloro-3-Methylphenol
4-Chloroaniline
4-Chlorophenyl Phenyl Ether
4-Nitroaniline
4-Nitrophenol
5-Nitroancenphthene
Acenaphthene
Acenaphthylene
Aniline
Anthracene
Benzo (a) anthracene
Benzo (a) pyrene
Benzo (b) fluoranthene
Benzo (g,h,i) perylene
Benzo (k) fluoranthene
Benzoic Acid
Benzyl Alcohol
Benzyl Butyl Phthalate
Biphenyl
Bis (2-chloroethoxy)Methane
Bis (2-chloroethyl) Ether
Bis (2-chloroisopropyl) Ether
Bis (2-ethylhexyl) Phthalate
Camphene
Carbozole
Chrysene
Dibenzo (a,h) anthracene
Dibenzofuran
Diethyl Phthalate
Dimethyl Phthalate
Di-n-Butylphthalate
Di-n-Octylphthalate
Diphenylether
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene

	Hexachlorocyclopentadiene
	Hexachloroethane
	Indeno (1,2,3-cd) pyrene
	Indole
	Isophorone
	Naphthalene
	Nitrobenzene
	N-Nitrosodimethylamine (NDMA)
	N-Nitroso-di-N-Propylamine
	N-Nitrosodiphenylamine
	Pentachlorophenol
	Perylene
	Phenanthrene
	Phenol
	Pyrene
BRL SOP-00201	PAHs by SIM GCMS in Water, Soil and Air (Modified CARB 429)
	2-Methylnaphthalene
	Acenaphthene
	Acenaphthylene
	Anthracene
	Benzo (a) anthracene
	Benzo (a) pyrene
	Benzo (e) pyrene
	Benzo (g,h,i) perylene
	Benzo (k) fluoranthene
	Benzo(b) fluoranthene
	Chrysene
	Dibenzo (a,h) anthracene
	Fluoranthene
	Fluorene
	Indeno (1,2,3 cd) pyrene
	Naphthalene
	Perylene
	Phenanthrene
	Pyrene
BRL SOP-00211	Aldehydes, Ketones and Alcohols in Impingers by GC FID (Modified NCASI METHOD IM/CAN/WP-99.01)
	Acetone
	Acrolein
	Methanol
	Methyl ethyl ketone
	Methyl Isobutyl Ketone
	Phenol
	Propionaldehyde

BRL SOP-00300	Volatiles on Thermal Desorption Tubes in Air by GCMS (Modified T017)
	1,1,1-Trichloroethane
	1,1,2,2-Tetrachloroethane
	1,1,2-Trichloroethane
	1,1,2-Trichlorotrifluoroethane
	1,1,-Dichloroethene
	1,1-Dichloroethane
	1,2,4-Trichlorobenzene
	1,2,4-Trimethylbenzene
	1,2-Dibromoethane
	1,2-Dichloroethane
	1,2-Dichloroethene (cis)
	1,2-Dichloropropane
	1,2-Dichlorotetrafluoroethane
	1,3,5-Trimethylbenzene
	Benzene
	Bromomethane
	Carbon Tetrachloride
	Chlorobenzene
	Chloroform
	cis-1,3-Dichloropropene
	Dichlorodifluoromethane
	Ethyl Benzene
	Ethyl Chloride
	Hexachlorobutadiene
	m/p-xylene
	m-Dichlorobenzene
	Methyl chloride
	Methylene Chloride
	o-Dichlorobenzene
	o-xylene
	p-Dichlorobenzene
	Styrene
	Tetrachloroethene
	Toluene
	trans-1,3-Dichloropropene
	Trichloroethylene
	Trichlorofluoromethane
	Vinyl Chloride
BRL SOP-00304	Volatiles in Summa Canisters by GCMS (Modified EPA TO-14A AND TO-15)
	1,1,1-Trichloroethane
	1,1,2,2-Tetrachloroethane
	1,1,2-Trichloroethane

1,1-Dichloroethane
1,1-Dichloroethene
1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,2-Dichlorobezene
1,2-Dichloroethane
1,2-Dichloropropane
1,3,5-Trimethylbenzene
1,3-Butadiene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
1,4-Dioxane
2,2,4-Trimethypentane
2-Butanone (MEK)
2-Hexanone
2-Propanol
4-Ethyltoluene
4-Methyl-2-Pentanone
Acetone
Allyl Chloride
Benzene
Benzyl chloride
Bis (2-Chloroethyl) Ether
Bromodichloromethane
Bromoform
Bromomethane
Carbon Disulfide
Carbon Tetrachloride
Chlorobenzene
Chloroethane
Chloroform
Chloromethane
cis-1,2-Dichloroethene
cis-1,3-Dichloropropene
Cyclohexane
Dibromochloromethane
Dibromomethane
Dichlorodifluoromethane
Ethanol
Ethyl Acetate
Ethyl acrylate
Ethyl Benzene
Ethyl Bromide
Ethylene Dibromide
Halocarbon 113

	Halocarbon 114
	Heptane
	Hexachlorobutadiene
	Hexane
	Methyl Methacrylate
	Methyl Tertbutyl Ether
	Methylene Chloride
	m-xylene
	o-xylene
	Propene
	p-xylene
	Styrene
	Tetrachloroethene
	Tetrahydrofuran
	Toluene
	trans 1,2-Dichloroethene
	trans 1,3-Dichloropropene
	trans-1,2-Dichloropropene
	Trichloroethene
	Trichlorofluoromethane
	Vinyl Acetate
	Vinyl Bromide
	Vinyl Chloride
	Xylenes (total)
BRL SOP-00408	PCB Congener (209 Analytes) by HRGC HRMS in Water, Soil and Air (Modified EPA 1668A)
	Aluminum
	Antimony
	Arsenic
	Barium
	Beryllium
	Bismuth
	Boron
	Cadmium
	Calcium
	Chromium
	Cobalt
	Copper
	Iron
	Lead
	Lithium
	Magnesium
	Manganese
	Molybdenum
	Nickel

	Phosphorus Potassium Selenium Silicon Silver Sodium Strontium Sulphur Thallium Tin Titanium Vanadium Zinc

(PCDD/PCDF - Air)

BRL SOP-00404	Dioxins and Furans by HRGC HRMS in Air Samples (Modified EPA 40CFR PART 60 APP. A METHOD 23/23A) 1,2,3,4,6,7,8,9-C18-Dibenzofuran 1,2,3,4,6,7,8,9-C18-Dibenzo-p-dioxin 1,2,3,4,6,7,8-C17-Dibenzofuran 1,2,3,4,6,7,8-C17-Dibenzo-p-dioxin 1,2,3,4,7,8,9-C17-Dibenzofuran 1,2,3,4,7,8-C16-Dibenzofuran 1,2,3,4,7,8-C16-Dibenzo-p-dioxin 1,2,3,6,7,8-C16-Dibenzofuran 1,2,3,6,7,8-C16-Dibenzo-p-dioxin 1,2,3,7,8,9-C16-Dibenzofuran 1,2,3,7,8,9-C16-Dibenzo-p-dioxin 1,2,3,7,8-C15-Dibenzofuran 1,2,3,7,8-C15-Dibenzo-p-dioxin 2,3,4,6,7,8-C16-Dibenzofuran 2,3,4,7,8-C15-Dibenzofuran 2,3,7,8-C14-Dibenzofuran 2,3,7,8-C14-Dibenzo-p-dioxin H6CDD H6CDF H7CDD H7CDF O8CDD O8CDF P5CDD P5CDF PCDD/PCDF T4CDD

	T4CDF

(Volatiles - Air)

BRL SOP-00302	VOST Analyses by GCMS in Air (Modified EPA SW846 5041 A, 8260)
	1,1,1-Trichloroethane
	1,1,2,2-Tetrachloroethane
	1,1,2-Trichloroethane
	1,1-Dichloroethane
	1,2,3-Trichloropropane
	1,2-Dichlorobenzene
	1,2-Dichloroethane
	1,2-Dichloropropane
	1,3-Dichlorobenzene
	1,4-Difluorobenzene
	2-Butanone
	2-Hexanone
	4-Methyl-2-Pentanone
	Acetone
	Benzene
	Bromodichloromethane
	Bromoform
	Bromomethane
	Carbon Disulfide
	Carbon Tetrachloride
	Chlorobenzene
	Chlorodibromomethane
	Chloroethane
	Chloroform
	Chloromethane
	cis-1,2-Dichloroethylene
	cis-1,3-Dichloropropene
	Dichlorodifluoromethane
	Ethyl Benzene
	Ethylene Dibromide
	Iodomethane
	Methylene Chloride
	Styrene
	Tetrachloroethene
	Toluene
	Trans-1,2-Dichloroethylene
	Trans-1,3-Dichloropropene
	Trichloroethene
	Trichlorofluoromethane

	Vinyl Chloride
	Xylenes

Air Filter

CAM SOP-00408	ICP OES-Metals in Air, Waters, Foods, Swabs, Solids, Paint and Sludge
	Antimony
	Arsenic
	Barium
	Beryllium
	Bismuth
	Boron
	Cadmium
	Calcium
	Chromium
	Cobalt
	Copper
	Iron
	Lead
	Lithium
	Magnesium
	Manganese
	Molybdenum
	Nickel
	Phosphorus
	Potassium
	Selenium
	Silicon
	Silver
	Sodium
	Strontium
	Tin
	Titanium
	Total and Dissolved Metals
	Total and Dissolved Metals
	Total and Dissolved Metals
	Tungsten
	Vanadium
	Zinc

Biosolids

MICROBIOLOGY (Biosolids)

Oil

CAM SOP-00328	Polychlorinated Biphenyls in Oil Samples (PCBs) by GC/ECD Aroclor-1016 Aroclor-1221 Aroclor-1232 Aroclor-1242 Aroclor-1248 Aroclor-1254 Aroclor-1260 Aroclor-1262 Aroclor-1268 Total PCB

Paint

CAM SOP 00408	ICP OES-Metals in Air, Waters, Foods, Swabs, Solids, Paint and Sludge Aluminum Barium Beryllium Bismuth Cadmium Calcium Chromium Cobalt Copper Lead Magnesium Manganese Nickel Potassium Sodium Strontium Sulfur Vanadium Zinc
CAM SOP-00453	Mercury in Liquids, Soils, Swabs, Paint and Food by Cold Vapour A.A.

Solids

(Soil, Sediment, other environmental solids)

BRL SOP-00217	1,4 Dioxane in Water and Soil using Isotope Dilution by GCMS
BRL SOP-00406	Dioxins and Furans by HRGC HRMS in Water and Soil (Modified

	EPA SW846 8290)
	1,2,3,4,6,7,8,9-C18-Dibenzofuran
	1,2,3,4,6,7,8,9-C18-Dibenzo-p-dioxin
	1,2,3,4,6,7,8-C17-Dibenzofuran
	1,2,3,4,6,7,8-C17-Dibenzo-p-dioxin
	1,2,3,4,7,8,9-C17-Dibenzofuran
	1,2,3,4,7,8-C16-Dibenzofuran
	1,2,3,4,7,8-C16-Dibenzo-p-dioxin
	1,2,3,6,7,8-C16-Dibenzofuran
	1,2,3,6,7,8-C16-Dibenzo-p-dioxin
	1,2,3,7,8,9-C16-Dibenzofuran
	1,2,3,7,8,9-C16-Dibenzo-p-dioxin
	1,2,3,7,8-C15-Dibenzofuran
	1,2,3,7,8-C15-Dibenzo-p-dioxin
	2,3,4,6,7,8-C16-Dibenzofuran
	2,3,4,7,8-C15-Dibenzofuran
	2,3,7,8-C14-Dibenzofuran
	2,3,7,8-C14-Dibenzo-p-dioxin
	H6CDD
	H6CDF
	H7CDD
	H7CDF
	O8CDD
	O8CDF
	P5CDD
	P5CDF
	PCDD
	PCDF
	T4CDD
	T4CDF
BRL SOP-00408	PCB Congener (209 Analytes) by HRGC HRMS in Water, Soil and Air (Modified EPA 1668A)
	Aluminum
	Antimony
	Arsenic
	Barium
	Beryllium
	Bismuth
	Boron
	Cadmium
	Calcium
	Chromium
	Cobalt
	Copper
	Iron

	Lead
	Lithium
	Magnesium
	Manganese
	Molybdenum
	Nickel
	Phosphorus
	Potassium
	Selenium
	Silicon
	Silver
	Sodium
	Strontium
	Sulphur
	Thallium
	Tin
	Titanium
	Vanadium
	Zinc
CAM SOP 00449	Fluoride in Waters, Soil, Air, Vegitation and Food by ISE
CAM SOP-00226	Volatile Organic Compounds by Purge and GC/MS in Water, Leachates and Soil
	1,1,1,2-Tetrachloroethane
	1,1,1-Trichloroethane
	1,1,2,2-Tetrachloroethane
	1,1,2-Trichloroethane
	1,1-dichloroethane
	1,1-Dichloroethene
	1,2-Dibromoethane
	1,2-Dichlorobenzene
	1,2-Dichloroethane
	1,2-Dichloropropane
	1,3-Dichlorobenzene
	1,4-Dichlorobenzene
	2-Hexanone
	Acetone
	Benzene
	Bromodichloromethane
	Bromoform
	Bromomethane
	Carbon Tetrachloride
	Chlorobenzene
	Chloroethane
	Chloroform
	Chloromethane

	cis-1,2-Dichloroethene
	cis-1,3-Dichloropropene
	Dibromochloromethane
	Dichlorodifluoromethane
	Dichloroethane
	Ethylbenzene
	Hexane
	m/p-xylene
	Methyl Ethyl Ketone
	Methyl Isobutyl Ketone
	Methyl Tertbutyl Ether
	o-xylene
	Styrene
	Tetrachloroethene
	Toluene
	trans-1,2-Dichloroethene
	trans-1,3-Dichloropropene
	Trichloroethene
	Trichlorofluoromethane
	Vinyl Chloride
CAM SOP-00228	Volatile Organic Compounds by Headspace GC/MS in Water and Soil
	1,1,1,2-Tetrachloroethane
	1,1,1-Trichloroethane
	1,1,2,2-Tetrachloroethane
	1,1,2-Trichloroethane
	1,1-Dichloroethane
	1,1-Dichloroethene
	1,2-Dibromoethane
	1,2-Dichlorobenzene
	1,2-Dichloroethane
	1,2-Dichloropropane
	1,3-Dichlorobenzene
	2-Hexanone
	3-Dichlorobenzene
	Acetone
	Benzene
	Bromodichloromethane
	Bromoform
	Bromomethane
	Carbon Tetrachloride
	Chlorobenzene
	Chloroethane
	Chloroform
	Chloromethane

	cis-1,2-Dichloroethene
	cis-1,3-Dichloropropene
	Dibromochloromethane
	Dichlorodifluoromethane
	Dichloromethane
	Ethylbenzene
	Hexane
	m/p-xylene
	Methyl Ethyl Ketone
	Methyl Isobutyl Ketone
	Methyl Tertbutyl Ether
	o-xylene
	Styrene
	Tetrachloroethene
	Toluene
	trans-1,2-Dichloroethene
	trans-1,3-Dichloropropene
	Trichloroethene
	Trichlorofluoromethane
	Vinyl Chloride
CAM SOP-00301	Determination of Semivolatile Organics (Acid / Base Neutral Extractables) in Solid And Aqueous Samples Using GC/MS operating under both the Full Scan and Selected Ion Monitoring (SIM) Modes
	1,2,4-Trichlorobenzene
	1,2-Dichlorobenzene
	1,2-Diphenylhydrazine
	1,3-Dichlorobenzene
	1,4-Dichlorobenzene
	1-Methylnaphthalene
	2,3,4,5-Tetrachlorophenol
	2,3,4,6-Tetrachlorophenol
	2,3,4-Trichlorophenol
	2,3,5,6-Tetrachlorophenol
	2,3,5-Trichlorophenol
	2,3,6-Trichlorophenol
	2,3-Dichlorophenol
	2,4,5-Trichlorophenol
	2,4,6-Trichlorophenol
	2,4-Dichloro Phenol
	2,4-Dimethyl Phenol
	2,4-Dinitrophenol
	2,4-Dinitrotoluene
	2,5-Dichlorophenol
	2,6-Dichlorophenol

2,6-Dinitrotoluene
2-Chloronaphthalene
2-Chlorophenol
2-Methylnapthalene
2-Nitrophenol
3,3'-Dichlorobenzidene
3,4,5-Trichlorophenol
3,4-Dichlorophenol
3,5-Dichlorophenol
3-Chlorophenol
4,6-Dinitro-O-Cresol
4-Bromophenyl Phenyl Ether
4-Chloroaniline
4-Chlorophenol
4-Chlorophenyl Phenyl Ether
4-Nitrophenol
Acenaphthene
Acenaphthylene
Amytryne
Anthracene
Atrazine
Benzo (a) anthracene
Benzo (a) pyrene
Benzo (b) fluoranthene
Benzo (e) pyrene
Benzo (g,h,i) perylene
Benzo (k) fluoranthene
Biphenyl
Bis (2-Chloro Ethoxy) Methane
Bis (2-Chloro Ethyl) Ether
Bis (2-Chloro Isopropyl) Ether
Bis (2-ethylhexyl) Phthaltate
Butyl Benzyl Phthalate
Chrysene
Cyanazine
Diazinon
Dibenzo (a,h) anthracene
Diethyl Phthalate
Dimethyl Phthalate
Di-n-Butylphthalate
Di-n-Octylphthalate
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene

	Hexachlorocyclopentadiene
	Hexachloroethane
	Indeno (1,2,3 - cd) pyrene
	Isophorone
	m/p-cresol
	Malathion
	Metribuzin
	Naphthalene
	Nitrobenzene
	N-Nitrosodimethylamine
	N-Nitroso-Di-N Propyl Amine
	N-Nitroso-Diphenylamine/Diphenylamine
	o-Cresol
	Parathion Ethyl
	Parathion Methyl
	P-Chloro-M-Cresol
	pentachlorobenzene
	Pentachloro-phenol
	Phenanthrene
	Phenol
	Prometon
	Prometryn
	Prometryne
	Propazine
	Pyrene
	Quinoline
	Simazine
	Simetryn
	Terbutryn
CAM SOP-00307, CAM SOP-00309, CAM SOP-00317	Organochlorine Pesticides and PCBs in Solids, Water and Biological Materials by GC-ECD, Polychlorinated Biphenyls (PCBs) as Aroclors in Solid, Water, and Biological Samples by GC-ECD, and Neutral Chlorinated Hydrocarbons in Solid and Water by GC/ECD
	1,2,3,4-Tetrachlorobenzene
	1,2,3,5-Tetrachlorobenzene
	1,2,4,5-Tetrachlorobenzene
	1,2,4-Trichlorobenzene
	1,3,5-Trichlorobenzene
	2,4,5-Trichlorotoluene
	a-BHC
	a-Chlordane
	Aldrin
	Aroclor 1016
	Aroclor 1221
	Aroclor 1232

	Aroclor 1242
	Aroclor 1248
	Aroclor 1254
	Aroclor 1260
	Aroclor 1262
	Aroclor 1268
	b-BHC
	d-BHC
	Dieldrin
	Endosulfan I
	Endosulfan II
	Endosulfan Sulfate
	Endrin
	g-Chlordane
	Heptachlor
	Heptachlor Epoxide
	Hexachlorobenzene
	Hexachlorobutadiene
	Hexachlorocyclopentadiene
	Hexachloroethane
	Lindane
	Methoxychlor
	Mirex
	o,p' DDD
	o,p' DDE
	o,p'-DDT
	Octachlorostyrene
	Oxychlordane
	p,p'-DDD
	p,p'-DDE
	p,p'-DDT
	Pentachlorobenzene
	Total PCB
CAM SOP-00310 **(OSDWA)**	The Determination of Formaldehyde in Water and Soil by HPLC
CAM SOP-00315	Determination of CCME C6-C10 Hydrocarbons (F1) and BTEX in Soil and Water by Headspace-GC/MS/FID BTEX (Benzene, Toluene, Ethylbenzene, Xylenes) F1: C6-C10
CAM SOP-00316	The Determination of CCME Extractable Petroleum Hydrocarbons (F2-4) in Water and Soil by GC-FID F2: C10-C16 F3: C16-C34 F4: C34-C50 F4G
CAM SOP-00318	Determination Of Polynuclear Aromatic Hydrocarbons (PAHs) In

	Solid And Water Samples Using Selected Ion Monitoring (SIM) GCMS
	1-methylnaphthalene
	2-methylnaphthalene
	Acenaphthene
	Acenaphthylene
	Anthracene
	Benzo (a) anthracene
	Benzo (a) pyrene
	Benzo (b,j) fluoranthene
	Benzo (g,h,i) perylene
	Benzo (k) fluoranthene
	Chrysene
	Dibenzo (a,h) anthracene
	Fluoranthene
	Fluorene
	Indeno (1,2,3-cd) pyrene
	Naphthalene
	Phenanthrene
	Pyrene
CAM SOP-00320	The Determination of Nitroaromatics and Nitramines in Water and Soil Samples by HPLC
	1,3,5-Trinitrobenzene
	1,3-Dinitrobenzene
	2,4,6-Trinitrotoluene
	2,4-Dinitrotoluene
	2,6-Dinitrotoluene
	2-Amino-4,6-dinitrotoluene
	2-Nitrotoluene
	3,5-Dinitroaniline
	3-Nitrotoluene
	4-Amino-2,6-dinitrotoluene
	4-Nitrotoluene
	Hexahydro-1,3,5-trinitro-1,3,5-triazine
	Methyl-2,4,6-trinitrophenylnitramine
	Nitrobenzene
	Nitroglycerin
	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
	Pentaerythritol tetranitrite (PETN)
CAM SOP-00322	The Determination of Propylene Glycol, Ethylene Glycol and Diethylene Glycol in Liquids, Oils and solids by GC FID
	Diethylene Glycol
	Ethylene Glycol
	Propylene Glycol
CAM SOP-00323	Total Petroleum Hydrocarbons Soxhlet Extraction Method for Soil Sample

CAM SOP-00324	Oil and Grease Soxhlet Extraction Method for Soil Sample
CAM SOP-00327	Analysis of Diquat and Paraquat in Water by HPLC-UV Detector Using Aqueous Ionic Mobile Phase
	Diquat
	Paraquat
CAM SOP-00330	Determination of Phenoxy Acid Herbicides and related compounds in Aqueous and Solid Samples Using Selected Ion Monitoring (SIM) GC/MS
	2,4,5-T
	2,4,5-TP
	2,4-D
	2,4-DB
	2,4-DP (dichlorprop)
	3,5-dichlorobenzoic acid
	Acifluorfen
	Bentazon
	Chloramben
	DCPA Diacid
	Dicamba
	Dinoseb (DNBP)
	MCPA
	MCPP
	Pentachlorophenol
	Picloram
CAM SOP-00332	Determination of Chlorinated Phenols in Soil and Water Using Selected Ion Monitoring (SIM) GC/MS
	2,3,4,5-Tetrachlorophenol
	2,3,4,6-Tetrachlorophenol
	2,3,4-Trichlorophenol
	2,3,5,6-Tetrachlorophenol
	2,3,5-Trichlorophenol
	2,3,6-Trichlorophenol
	2,3-Dichlorophenol
	2,4,5-Trichlorophenol
	2,4,6-Trichlorophenol
	2,4-Dichlorophenol
	2,4-Dimethylphenol
	2,4-Dinitrophenol
	2,5-Dichlorophenol
	2,6-Dichlorophenol
	2-Chlorophenol
	2-Nitrophenol
	3,4,5-Trichlorophenol
	3,4-Dichlorophenol
	3,5-Dichlorophenol
	4,6-Dinitro-2-methylphenol

	4-Chloro-3-Methylphenol
	4-Chlorophenol
	4-Nitrophenol
	m/p-Cresol
	o-Cresol
	Pentachlorophenol
	Phenol
CAM SOP-00407	Determination of Phosphorus (all forms) in Waters by Colorimetry (FIA); parameters Orthophosphate, Hydrolyzable Phosphorus, Total Phosphorus
CAM SOP-00408	ICP OES- Metals in Air, Waters, Foods, swabs, Solids, Paint and Sludge
	Aluminum
	Antimony
	Arsenic
	Barium
	Beryllium
	Bismuth
	Boron
	Cadmium
	Calcium
	Chromium
	Cobalt
	Copper
	Iron
	Lead
	Lithium
	Magnesium
	Manganese
	Molybdenum
	Nickel
	Phosphorus
	Potassium
	Selenium
	Silicon
	Silver
	Sodium
	Strontium
	Sulphur
	Thallium
	Tin
	Titanium
	Vanadium
	Zinc
CAM SOP-00413	Measurement of pH in Water, Soils and Food Samples

CAM SOP-00414	Electrical Conductivity in Waters and Sludge, Soil Extracts
CAM SOP-00432	Ignitability of Solids
CAM SOP-00435	Anions in Soil, Water and Air by Ion Chromatography
	Bromide
	Chloride
	Fluoride
	Nitrate
	Nitrite (NO2)
	PO4
	Sulfate
CAM SOP-00436	Hexavalent Chromium by IC in Water and Soil
CAM SOP-00440	Nitrate, Nitrite and TON in Waters, Solids, Sludge and Food by FIA
	Nitrate
	Nitrite
CAM SOP-00441	Ammonia in Waters Biosolids and Soil Samples by Colourimetry
	Ammonia
CAM SOP-00444	Analysis of Phenolics in Water and Soil Colorimetric Automated 4-AAP
	Phenolics
CAM SOP-00445	Determination of Moisture Content Solids by Gravimetry
CAM SOP-00447	ICPMS Metals in Waters, Foods, Solids and Biota Total and Dissolved Metals
	Aluminum
	Antimony
	Arsenic
	Barium
	Beryllium
	Bismuth
	Boron
	Cadmium
	Calcium
	Chromium
	Cobalt
	Copper
	Iron
	Lead
	Lithium
	Magnesium
	Manganese
	Mercury
	Molybdenum
	Nickel
	Phosphorus
	Potassium

	Selenium
	Silver
	Sodium
	Strontium
	Tellurium
	Thallium
	Thorium
	Tin
	Titanium
	Tungsten
	Uranium
	Vanadium
	Zinc
	Zirconium
CAM SOP-00453	Mercury in Water, Solids, Sludge and Food by Cold Vapour A.A.
CAM SOP-00454 **(OSDWA)**	TKN Determination in Waters, Solids, Sludge by Micro-Colourimetry
	Total Kjeldahl Nitrogen
CAM SOP-00457 **(OSDWA)**	Analysis of Cyanide in Waters and Solids by Colourimetry
	Cyanide (SAD)
	Free Cyanide
CAM SOP-00461	Analysis of Ortho-Phosphate in Water and Soil by Micro-Colourimetry
	Phosphate
CAM SOP-00463 **(OSDWA)**	Determination of Chloride in Water and Soil by MicroColourimetry
CAM SOP-00464 **(OSDWA)**	Sulphate Determination in Water and Soils by Automated Turbidimetry
CAM SOP-00467	Particle Size Distribution Sieve Analysis in Soil
CAM SOP-00468	TOC and TC in Solids by Furnace Combustion
	Total Carbon
	Total Organic Carbon
CAM SOP-00894	Determination of Perfluorinated Compounds in Water and Soil By LC-MS-MS
	PFBS (Perfluorobutanesulfonate)
	PFHxS (Perfluorohexanesulfonate)
	PFBA (Perfluorobutanoic acid)
	PFDA (Perfluorodecanoic acid)
	PFDoA (Perfluorododecanoic acid)
	PFHpA (Perfluoroheptanoic acid)
	PFHxA (Perfluorohexanoic acid)
	PFNA (Perfluorononanoic acid)
	PFOA (Perfluoro-n-Octanoic Acid)
	PFOS (Perfluoro-1-Octanesulfonate)
	PFOSA (Perfluorooctanesulfonamide)

	PFPeA (Perfluoropentanoic acid)
	PFUnA (Perfluoroundecanoic acid)

(SWABS)

CAM SOP-00309	Polychlorinated Biphenyls (PCBs) as Aroclors in Solid, Water, and Biological Samples by GC-ECD
	Aroclor 1016
	Aroclor 1221
	Aroclor 1232
	Aroclor 1242
	Aroclor 1248
	Aroclor 1254
	Aroclor 1260
	Aroclor 1262
	Aroclor 1268
CAM SOP-00408	ICP OES- Metals in Air, Waters, Foods, swabs, Solids, Paint and Sludge
	Aluminum
	Antimony
	Arsenic
	Barium
	Beryllium
	Bismuth
	Boron
	Cadmium
	Calcium
	Chromium
	Cobalt
	Copper
	Iron
	Lead
	Magnesium
	Manganese
	Molybdenum
	Nickel
	Phosphorus
	Potassium
	Selenium
	Silver
	Sodium
	Strontium
	Sulphur
	Tin
	Titanium

Vanadium
Zinc

Waste
(Leachates)

BRL SOP-00400	Nitrosamines Analysis in Water and Soil by HRGC HRMS
	N−Nitroso−di−n−butylamine
	N−Nitroso−di−n−propylamine
	N−Nitrosodiethylamine
	N−Nitrosodimethylamine
	N−Nitrosoethylmethylamine
	N−Nitrosomorpholine
	N−Nitrosopiperidine
	N−Nitrosopyrrolidine
BRL SOP-00410	Dioxin and Furans in Water, Leachates, Soil, Food and Biota by HRGC HRMS (EPA 1613)
	1,2,3,4,6,7,8,9-Cl8-Dibenzofuran
	1,2,3,4,6,7,8,9-Cl8-Dibenzo-p-dioxin
	1,2,3,4,6,7,8-Cl7-Dibenzofuran
	1,2,3,4,6,7,8-Cl7-Dibenzo-p-dioxin
	1,2,3,4,7,8,9-Cl7-Dibenzofuran
	1,2,3,4,7,8-Cl6-Dibenzofuran
	1,2,3,4,7,8-Cl6-Dibenzo-p-dioxin
	1,2,3,6,7,8-Cl6-Dibenzofuran
	1,2,3,6,7,8-Cl6-Dibenzo-p-dioxin
	1,2,3,7,8,9-Cl6-Dibenzofuran
	1,2,3,7,8,9-Cl6-Dibenzo-p-dioxin
	1,2,3,7,8-Cl5-Dibenzofuran
	1,2,3,7,8-Cl5-Dibenzo-p-dioxin
	2,3,4,6,7,8-Cl6-Dibenzofuran
	2,3,4,6,7,8-Cl6-Dibenzofuran
	2,3,4,7,8-Cl5-Dibenzofuran
	2,3,7,8-Cl4-Dibenzofuran
	2,3,7,8-Cl4-Dibenzo-p-dioxin
	H6CDD
	H6CDF
	H7CDD
	H7CDF
	O8CDD
	O8CDF
	P5CDD
	P5CDF
	PCDD
	PCDF

	T4CDD
	T4CDF
CAM SOP-00226	Volatile Organic Compounds by Purge and GC/MS in Water, Leachates and Soil
	1,1,1,2-Tetrachloroethane
	1,1,1-Trichloroethane
	1,1,2,2-Tetrachloroethane
	1,1,2-Trichloroethane
	1,1-dichloroethane
	1,1-Dichloroethene
	1,2-Dibromoethane
	1,2-Dichlorobenzene
	1,2-Dichloroethane
	1,2-Dichloropropane
	1,3-Dichlorobenzene
	1,4-Dichlorobenzene
	2-Hexanone
	Acetone
	Benzene
	Bromodichloromethane
	Bromoform
	Bromomethane
	Carbon Tetrachloride
	Chlorobenzene
	Chloroethane
	Chloroform
	Chloromethane
	cis-1,2-Dichloroethene
	cis-1,3-Dichloropropene
	Dibromochloromethane
	Dichlorodifluoromethane
	Dichloroethane
	Ethylbenzene
	Hexane
	m/p-xylene
	Methyl Ethyl Ketone
	Methyl Isobutyl Ketone
	Methyl Tertbutyl Ether
	o-xylene
	Styrene
	Tetrachloroethene
	Toluene
	trans-1,2-Dichloroethene
	trans-1,3-Dichloropropene
	Trichloroethene

	Trichlorofluoromethane
	Vinyl Chloride
CAM SOP-00301	Determination of Semivolatile Organics (Acid / Base Neutral Extractables) in Solid And Aqueous Samples Using GC/MS operating under both the Full Scan and Selected Ion Monitoring (SIM) Modes
	Anthracene
	1,2,4-Trichlorobenzene
	1,2-Dichlorobenzene
	1,2-Diphenylhydrazine
	1,3-Dichlorobenzene
	1,4-Dichlorobenzene
	1-Methylnaphthalene
	2,3,4,5-Tetrachlorophenol
	2,3,4,6-Tetrachlorophenol
	2,3,4-Trichlorophenol
	2,3,5,6-Tetrachlorophenol
	2,3,5-Trichlorophenol
	2,3,6-Trichlorophenol
	2,3-Dichlorophenol
	2,4,5-Trichlorophenol
	2,4,6-Trichlorophenol
	2,4-Dichloro Phenol
	2,4-Dimethyl Phenol
	2,4-Dinitrophenol
	2,4-Dinitrotoluene
	2,5-Dichlorophenol
	2,6-Dichlorophenol
	2,6-Dinitrotoluene
	2-Chloronaphthalene
	2-Chlorophenol
	2-Methylnapthalene
	2-Nitrophenol
	3,3'-Dichlorobenzidene
	3,4,5-Trichlorophenol
	3,4-Dichlorophenol
	3,5-Dichlorophenol
	3-Chlorophenol
	4,6-Dinitro-O-Cresol
	4-Bromophenyl Phenyl Ether
	4-Chloroaniline
	4-Chlorophenol
	4-Chlorophenyl Phenyl Ether
	4-Nitrophenol
	Acenaphthene

Acenaphthylene
Amytryne
Atrazine
Benzo (a) anthracene
Benzo (a) pyrene
Benzo (b) fluoranthene
Benzo (e) pyrene
Benzo (g,h,i) perylene
Benzo (k) fluoranthene
Biphenyl
Bis (2-Chloro Ethoxy) Methane
Bis (2-Chloro Ethyl) Ether
Bis (2-Chloro Isopropyl) Ether
Bis (2-ethylhexyl) Phthaltate
Butyl Benzyl Phthalate
Chrysene
Cyanazine
Diazinon
Dibenzo (a,h) anthracene
Diethyl Phthalate
Dimethyl Phthalate
Di-n-Butylphthalate
Di-n-Octylphthalate
Fluoranthene
Fluorene
for Pentachlorobenzene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno (1,2,3 - cd) pyrene
Isophorone
m/p-cresol
Malathion
Metribuzin
Naphthalene
Nitrobenzene
N-Nitrosodimethylamine
N-Nitroso-Di-N Propyl Amine
N-Nitroso-Diphenylamine/Diphenylamine
o-Cresol
Parathion Ethyl
Parathion Methyl
P-Chloro-M-Cresol
Pentachloro-phenol

	Phenanthrene
	Phenol
	Prometon
	Prometryn
	Prometryne
	Propazine
	Pyrene
	Quinoline
	Simazine
	Simetryn
	Terbutryn
CAM SOP-00305	Analysis of Glyphosate in Water, Leachates and Soil by HPLC
CAM SOP-00306	Analysis of Diuron, Guthion, and Temephos in Water by HPLC Diuron Guthion (azinphos-methyl) Temephos
CAM SOP-00307, CAM SOP-00309, CAM SOP-00317	Organochlorine Pesticides and PCBs in Solids, Water and Biological Materials by GC-ECD, Polychlorinated Biphenyls (PCBs) as Aroclors in Solid, Water, and Biological Samples by GC-ECD, and Neutral Chlorinated Hydrocarbons in Solid and Water by GC/ECD
	1,2,3,4-Tetrachlorobenzene
	1,2,3,5-Tetrachlorobenzene
	1,2,4,5-Tetrachlorobenzene
	1,2,4-Trichlorobenzene
	1,3,5-Trichlorobenzene
	2,4,5-Trichlorotoluene
	a-BHC
	a-Chlordane
	Aldrin
	Aroclor 1016
	Aroclor 1221
	Aroclor 1232
	Aroclor 1242
	Aroclor 1248
	Aroclor 1254
	Aroclor 1260
	Aroclor 1262
	Aroclor 1268
	b-BHC
	d-BHC
	Dieldrin
	Endosulfan I
	Endosulfan II
	Endosulfan Sulfate
	Endrin

	g-Chlordane
	Heptachlor
	Heptachlor Epoxide
	Hexachlorobenzene
	Hexachlorobutadiene
	Hexachlorocyclopentadiene
	Hexachloroethane
	Lindane
	Methoxychlor
	Mirex
	o,p' DDD
	o,p' DDE
	o,p'-DDT
	Octachlorostyrene
	Oxychlordane
	p,p'-DDD
	p,p'-DDE
	p,p'-DDT
	Pentachlorobenzene
	Total PCB
CAM SOP-00315	Determination of CCME C6-C10 Hydrocarbons (F1) and BTEX in Soil and Water by Headspace-GC/MS/FID BTEX (Benzene, Toluene, Ethylbenzene, Xylenes) F1: C6-C10
CAM SOP-00316	The Determination of CCME Extractable Petroleum Hydrocarbons (F2-4) in Water and Soil by GC-FID F2: C10-C16 F3: C16-C34 F4: C34-C50 F4G
CAM SOP-00318	Determination Of Polynuclear Aromatic Hydrocarbons (PAHs) In Solid And Water Samples Using Selected Ion Monitoring (SIM) GCMS
	1-methylnaphthalene
	2-methylnaphthalene
	Acenaphthene
	Acenaphthylene
	Anthracene
	Benzo (a) anthracene
	Benzo (a) pyrene
	Benzo (b,j) fluoranthene
	Benzo (g,h,i) perylene
	Benzo (k) fluoranthene
	Chrysene
	Dibenzo (a,h) anthracene
	Fluoranthene

	Fluorene
	Indeno (1,2,3-cd) pyrene
	Naphthalene
	Phenanthrene
	Pyrene
CAM SOP-00411	Nitrilotriacetic Acid (NTA) in Water by UV-Vis Spectroscopy
CAM SOP-00440	Nitrate, Nitrite and TON in Waters, Solids, Sludge and Food by FIA
	Nitrate
	Nitrite
CAM SOP-00447	ICPMS Metals in Waters, Foods, Solids, Swabs and Biota
	Aluminum
	Arsenic
	Barium
	Boron
	Cadmium
	Calcium
	Chromium
	Copper
	Iron
	Lead
	Magnesium
	Manganese
	Nickel
	Phosphorus
	Potassium
	Selenium
	Sodium
	Tin
	Titanium
	Zinc
CAM SOP-00449	Fluoride in Waters, Soil, Air, Vegetation and Food by ISE.
	Fluoride
CAM SOP-00453	Mercury in Water, Solids, Sludge and Food by Cold Vapour A.A.
CAM SOP-00457	Analysis of Cyanide in Waters and Solids by Colourimetry Cyanide (SAD) Free Cyanide

Water (Inorganic)

CAM SOP-00326 **(OSDWA)**	Determination of Total Oil and Grease, Petroleum Hydrocarbons (heavy), Mineral Oil and Grease and Animal and Vegetable Oil and Grease in Water by Gravimetry
	Mineral, Animal and Vegetable Oil and Grease

	Petroleum Hydrocarbons (Heavy - F4G)
	Total Oil and Grease
CAM SOP-00407 **(OSDWA)**	Determination of Total Phosphorus in Waters by Colorimetry (FIA)
	Hydrolysed phosphorus
	Ortho-phosphate
	Total Phosphorus
CAM SOP-00408	ICP OES-Metals in Air, Waters, Foods, Swabs, Solids, Paint and Sludge
	Aluminum
	Antimony
	Arsenic
	Barium
	Beryllium
	Bismuth
	Boron
	Cadmium
	Calcium
	Chromium
	Cobalt
	Copper
	Iron
	Lead
	Magnesium
	Manganese
	Molybdenum
	Nickel
	Phosphorus
	Potassium
	Selenium
	Silicon
	Silver
	Sodium
	Strontium
	Sulfur
	Thallium
	Tin
	Uranium
	Vanadium
	Zinc
	Zirconium
CAM SOP-00409	Colourimetric Determination of Iron in Water
CAM SOP-00410	Colorimetric Determination of Tannin and Lignin in liquid samples
CAM SOP-00411 (OSDWA)	Nitrilotriacetic Acid (NTA) in Water by UV-Vis Spectroscopy

CAM SOP-00412 **(OSDWA)**	Spectrophotometric Determination of Colour in Water Samples
	Color
CAM SOP-00413 **(OSDWA)**	Measurement of pH in Water, Soils and Food Samples
CAM SOP-00414 **(OSDWA)**	Electrical Conductivity in Waters and Sludge, Soil Extracts
CAM SOP-00416 **(OSDWA)**	COD in Water by Colorimetry
	COD (Chemical Oxygen Demand)
CAM SOP-00417 **(OSDWA)**	Nephelometric Measurement of Turbidity in Water
	Turbidity
CAM SOP-00425	Determination of Free or Total Chlorine in Water by HACH Colorimetry
	Free chlorine
	Total chlorine
CAM SOP-00427 **(OSDWA)**	Determination of Biochemical Oxygen Demand in Waters by D.O. Meter
	BOD (5 day)
	CBOD (5 day)
CAM SOP-00428 **(OSDWA)**	Determination of Solids in Water, Solid and Semisolid (biosolid, sludge) Samples by Gravimetry
	Fixed and Volatile Solids
	Total Dissolved Solids
	Total Suspended Solids
CAM SOP-00431 (OSDWA)	Organic Acids in Water by Ion Chromatography
	Acetic Acid
	Butyric Acid
	Formic Acid
	Propionic Acid
CAM SOP-00433 **(OSDWA)**	Determination of Inorganic Carbon in Water by IR Detection
	DIC - Dissolved Inorganic Carbon
	TIC-Total Inorganic Carbon
CAM SOP-00435 **(OSDWA)**	Anions in Food, Soil, Water and Air by Ion Chromatography
	Bromide
	Chloride
	Sulfate
CAM SOP-00436 **(OSDWA)**	Hexavalent Chromium by IC in Water and Soil
	Hexavalent Chromium (CrVI)
CAM SOP-00440 **(OSDWA)**	Nitrite, Nitrate and TON in Waters, Solids, Sludge and Food by FIA
	Nitrate plus Nitrite

	Nitrite
CAM SOP-00441 **(OSDWA)**	Ammonia in Waters Biosolids and Soil Samples by Colourimetry
	Ammonia
CAM SOP-00444 **(OSDWA)**	Analysis of Phenolics in Water and Soil-Colorimetric Automated 4-AAP
	Total Phenolics
CAM SOP-00446 **(OSDWA)**	Organic Carbon Analysis in Waters by Combustion and IR Detection
	DOC ŒDissolved Organic Carbon
	TOC ŒTotal Organic Carbon
CAM SOP-00447 **(OSDWA)**	ICPMS Metals in Waters, Foods, Solids and Biota Metals
	Aluminum
	Antimony
	Arsenic
	Barium
	Beryllium
	Bismuth
	Boron
	Cadmium
	Calcium
	Chromium
	Cobalt
	Copper
	Iron
	Lead
	Lithium
	Magnesium
	Manganese
	Molybdenum
	Nickel
	Potassium
	Selenium
	Silicon
	Silver
	Sodium
	Strontium
	Tellurium
	Thallium
	Thorium
	Tin
	Titanium
	Tungsten
	Uranium
	Vanadium

	Zinc
	Zirconium
CAM SOP-00448	Alkalinity in Waters by PC-Titrate.
	Alkalinity (pH 4.5)
CAM SOP-00449 **(OSDWA)**	Fluoride in Waters, Soil, Air and Food by ISE
CAM SOP-00451 **(OSDWA)**	Determination of Perchlorate in Water and Soil by LC/MS/MS
CAM SOP-00453 **(OSDWA)**	Mercury in Waters, Solids, Sludge, and Food by Cold Vapour A.A.
CAM SOP-00454 **(OSDWA)**	TKN Determination in Waters, Solids, Sludge by Micro-Colourimetry
	Total Kjeldahl Nitrogen
CAM SOP-00455 **(OSDWA)**	Sulphide Determination in Water by Ion Selective Electrode
CAM SOP-00457 **(OSDWA)**	Analysis of Cyanide in Waters and Solids by Colourimetry
	Cyanide (SAD)
	Free Cyanide
CAM SOP-00458	Measurement of Total Residual Chlorine in Water by Amperometric Titration
CAM SOP-00459 (OSDWA)	UV Transmittance (Percent T) at 254 nm in Water and Wastewater by UV-VIS Spectroscopy
	% Transmittance
CAM SOP-00461 **(OSDWA)**	Analysis of Ortho-Phosphate in Water and Soil by Micro-Colourimetry
CAM SOP-00463 **(OSDWA)**	Determination of Chloride in Water and Soil by MicroColourimetry
CAM SOP-00464 **(OSDWA)**	Sulphate Determination in Water and Soils by Automated Turbidimetry
CAM SOP-00473	Colourimetric Determination of Thiocyanate in Liquid Samples
CAM SOP-00938	Total Kjeldahl Nitrogen in Waters (TKN) from Colorimetric TN and NO2/NO3

Water (Microbiology)

CAM SOP-00508 **(OSDWA)**	Enumeration of Pseudomonas Aeruginosa in Water with the Membrane Filtration Technique
	Pseudomonas Aeruginosa
CAM SOP-00511 **(OSDWA)**	Enumeration of Fecal Streptococcus and Enterococcus in Water with the Membrane Filtration Technique
	Enterococcus
	Fecal Streptococcus
CAM SOP-00512 **(OSDWA)**	Heterotrophic Plate Count in Water and Wastewater using the Pour Plate and Membrane Filtrations Techniques
	Heterotrophic Plate Count (HPC)
	Heterotrophic Plate Count (MF)

CAM SOP-00514 **(OSDWA)**	Detection of Coliforms, Fecal Coliforms, E.coli, Aeromonas, S.Aureus and P.Aeruginosa in Water with the Presence/Absence Technique
	Escherichia coli (E. coli)
	Fecal Coliforms
	Total Coliforms
CAM SOP-00551 **(OSDWA)**	Enumeration of Coliform and E.coli in Potable Water Using Membrane Filtration and DC Agar
	Background
	Escherichia coli (E. coli)
	Total Coliforms
CAM SOP-00552 **(OSDWA)**	Enumeration of Coliform, Fecal Coliform and E.coli in Water and Environmental Samples Using Mendo, mFC-RA and mFC-BCIG Agar and of E.coli in Biosolids using mFC-BCIG Agar
	Background Counts
	Escherichia coli (E. coli)
	Fecal Coliforms
	Total Coliforms
CAM SOP-00581 (OSDWA)	Detection of Coliforms and E.coli in Water by Presence/Absence Technique
	Escherichia coli (E. coli)
	Total Coliforms

Water (Organic)

BRL SOP-00217 **(OSDWA)**	1,4-Dioxane in Water and Soil Using Isotope Dilution by GCMS
BRL SOP-00400 **(OSDWA)**	Nitrosamines Analysis in Water and Soil by HRGC HRMS
	N−Nitrosodiethylamine
	N−Nitrosodimethylamine
	N−Nitrosoethylmethylamine
	N−Nitrosomorpholine
	N−Nitrosopiperidine
	N−Nitrosopyrrolidine
	N-Nitroso-di-n-butylamine
	N-Nitroso-di-n-propylamine
BRL SOP-00408 **(OSDWA)**	
	209 Congeners
BRL SOP-00410 **(OSDWA)**	Dioxin and Furans in Water, Leachates, Soil, Food and Biota by HRGC HRMS (EPA 1613)
	1,2,3,4,6,7,8,9-Cl8-Dibenzofuran
	1,2,3,4,6,7,8,9-Cl8-Dibenzo-p-dioxin
	1,2,3,4,6,7,8-Cl7-Dibenzofuran
	1,2,3,4,6,7,8-Cl7-Dibenzo-p-dioxin

	1,2,3,4,7,8,9-Cl7-Dibenzofuran
	1,2,3,4,7,8-Cl6-Dibenzofuran
	1,2,3,4,7,8-Cl6-Dibenzo-p-dioxin
	1,2,3,6,7,8-Cl6-Dibenzofuran
	1,2,3,6,7,8-Cl6-Dibenzo-p-dioxin
	1,2,3,7,8,9-Cl6-Dibenzofuran
	1,2,3,7,8,9-Cl6-Dibenzo-p-dioxin
	1,2,3,7,8-Cl5-Dibenzofuran
	1,2,3,7,8-Cl5-Dibenzo-p-dioxin
	2,3,4,6,7,8-Cl6-Dibenzofuran
	2,3,4,7,8-Cl5-Dibenzofuran
	2,3,7,8-Cl4-Dibenzofuran
	2,3,7,8-Cl4-Dibenzo-p-dioxin
	H6CDD
	H6CDF
	H7CDD
	H7CDF
	O8CDD
	O8CDF
	P5CDD
	P5CDF
	PCDD
	PCDF
	T4CDD
	T4CDF
BRL SOP-00412 **(OSDWA)**	Geosmin and 2-MIB in Water by HRGC HRMS
	2-Methylisoborneol
	Geosmin
CAM SOP-00219	Analysis of Dissolved Methane and Other Gases in Water by GC/FID Headspace
	Acetylene
	Carbon Dioxide
	Ethane
	Ethylene
	Methane (OSDWA)
	Propane
	Propylene
CAM SOP-00226 **(OSDWA)**	Volatile Organic Compounds by Purge and Trap GC/MS in Water and Soil
	1- Butanol
	1,1,1,2-Tetrachloroethane
	1,1,1-Trichloroethane
	1,1,2,2-Tetrachloroethane
	1,1,2-Trichloroethane

1,1,2-Trichlorotrifluoroethane
1,1-Dichloroethane
1,1-dichloroethylene
1,2,3 - Trichlorobenzene
1,2,3 - Trichloropropane
1,2,3 - Truimethylbenzene
1,2,4 - Trichlorobenzene
1,2,4 - Trimethylbenzene
1,2-dichlorobenzene
1,2-dichloroethane
1,2-Dichloropropane
1,3,5 - Trichlorobenzene
1,3,5 - Trimethylbenzene
1,3-Dichlorobenzene
1,4-dichlorobenzene
1-Propanol
2-Butanol
2-Chloroethyl vinyl ether
2-Hexanone
Acetaldehyde
Acetone (2-Propanone)
Acrolein
Acrylonitrile
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Butyl acetate
Butyl acrylate
Carbon disulfide
Carbon Tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
Chloroform
Chloromethane
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Cyclohexane
Dichlorodifluoromethane
Dichloromethane
Dicyclopentadiene
Diethyl ether
Diisopropyl ether
Ethanol

	Ethyl acetate Ethyl acrylate Ethylbenzene Ethylene dibromide Hexane Isobutanol Isopropanol Isopropyl acetate m/p-xylene Methyl acetate Methyl acrylate Methyl Ethyl Ketone Methyl isobutyl Ketone Methyl methacrylate Methyl t-butyl ether Naphthalene o-xylene Propyl acetate Styrene Tert-Butanol Tetrachloroethylene Tetrahydrofuran Toluene trans-1,2-Dichloroethylene trans-1,3-Dichloropropene Trichloroethylene Trichlorofluoromethane Vinyl acetate Vinyl Chloride
CAM SOP-00228 **(OSDWA)**	Volatile Organic Compounds by Headspace GC/MS in Water and Soil (Headspace Analysis) 1- Butanol 1,1,1,2-Tetrachloroethane 1,1,1-Trichloroethane 1,1,2,2-Tetrachloroethane 1,1,2-Trichloroethane 1,1,2-Trichlorotrifluoroethane 1,1-Dichloroethane 1,1-dichloroethylene 1,2,3 - Trichlorobenzene 1,2,3 - Trichloropropane 1,2,3 - Truimethylbenzene 1,2,4 - Trichlorobenzene 1,2,4 - Trimethylbenzene

1,2-dichlorobenzene
1,2-dichloroethane
1,2-Dichloropropane
1,3,5 - Trichlorobenzene
1,3,5 - Trimethylbenzene
1,3-Dichlorobenzene
1,4-dichlorobenzene
1-Propanol
2-Butanol
2-Chloroethyl vinyl ether
2-Hexanone
Acetaldehyde
Acetone (2-Propanone)
Acrolein
Acrylonitrile
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Butyl acetate
Butyl acrylate
Carbon disulfide
Carbon Tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
Chloroform
Chloromethane
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Cyclohexane
Dichlorodifluoromethane
Dichloromethane
Dicyclopentadiene
Diethyl ether
Diisopropyl ether
Ethanol
Ethyl acetate
Ethyl acrylate
Ethylbenzene
Ethylene dibromide
Hexane
Isobutanol
Isopropanol
Isopropyl acetate

	Isopropylbenzene
	m/p-xylene
	Methyl acetate
	Methyl acrylate
	Methyl Ethyl Ketone
	Methyl isobutyl Ketone
	Methyl methacrylate
	Methyl t-butyl ether
	Naphthalene
	o-xylene
	Propyl acetate
	Styrene
	Tert-Butanol
	Tetrachloroethylene
	Tetrahydrofuran
	Toluene
	trans-1,2-Dichloroethylene
	trans-1,3-Dichloropropene
	Trichloroethylene
	Trichlorofluoromethane
	Vinyl acetate
	Vinyl Chloride
CAM SOP-00301 **(OSDWA)**	Determination of Semivolatile Organics Acid/Base Neutral Extractables) in Solid and Aqueous Samples Using GC/MS operating under both the Full Scan and Selected Ion Monitoring (SIM) Modes
	1,2,4-Trichlorobenzene
	1,2-Dichlorobenzene
	1,2-Diphenylhydrazine
	1,3-Dichlorobenzene
	1,4-Dichlorobenzene
	1-Methylnaphthalene
	2,3,4,5-Tetrachlorophenol
	2,3,4,6-tetrachlorophenol
	2,3,4-Trichlorophenol
	2,3,5,6-Tetrachlorophenol
	2,3,5-Trichlorophenol
	2,3,6-Trichlorophenol
	2,3-Dichlorophenol
	2,4,5-TP
	2,4,5-Trichlorophenol
	2,4,5-trichlorophenoxyacetic acid
	2,4,6-trichlorophenol
	2,4-dichlorophenol
	2,4-dichlorophenoxyacetic acid

2,4-Dimethyl Phenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,5-Dichlorophenol
2,6-Dichlorophenol
2,6-Dinitrotoluene
2-Chloronaphthalene
2-Chlorophenol
2-Methylnaphthalene
2-Nitrophenol
3,3'-Dichlorobenzidene
3,4,5-Trichlorophenol
3,4-Dichlorophenol
3,5-Dichlorophenol
3-Chlorophenol
4,6-Dinitro-o-Cresol
4-Bromophenyl Phenyl Ether
4-Chloroaniline
4-Chlorophenol
4-Chlorophenyl Phenyl Ether
4-Nitrophenol
Acenaphthene
Acenaphthylene
Alachlor
Aldicarb
Ametryn
Anthracene
Atrazine
Bendiocarb
Benzo (a) anthracene
Benzo (a) pyrene
Benzo (b) fluoranthene
Benzo (e) pyrene
Benzo (g,h,i) perylene
Benzo (k) fluoranthene
Biphenyl
Bis (2-Chloro Ethoxy)Methane
Bis (2-Chloro Ethyl) Ether
Bis (2-Chloro Isopropyl) Ether
Bis (2-ethylhexyl) Phthalate
Bromoxynil
Butyl Benzyl Phthalate
Carbaryl
Carbofuran
Chlordane (a,g)

Chlorpyrifos (ethyl)
Chrysene
Cyanazine
Des-ethylatrazine
Diazinon
Dibenzo (a,h) anthracene
Dicamba
Diclofop-methyl (as free acid)
Diethyl Phthalate
Dimethoate
Dimethyl Phthalate
Di-n-Butylphthalate
Di-n-Octylphthalate
Dinoseb
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno (1,2,3 - cd) pyrene
Isophorone
m,p-cresol
Malathion
Methoxychlor
Methyl Parathion
Metolachlor
Metribuzin
Naphthalene
Nitrobenzene
N-Nitroso-di-n-Propyl Amine
N-Nitroso-Diphenylamine/Diphenylamine
o-Cresol
Oxychlordane
p,p'-DDD
p,p'-DDE
Parathion (ethyl)
p-chloro-m-cresol
Pentachlorobenzene
Pentachlorophenol
Phenanthrene
Phenol
Phorate
Picloram
Prometon

	Prometryne
	Propazine
	Pyrene
	quinoline
	Simazine
	Simetryn
	Terbufos
	Terbutryn
	Triallate
	Trifluralin
CAM SOP-00305 **(OSDWA)**	Analysis of Glyphosate in Water and Soil by HPLC
CAM SOP-00306 **(OSDWA)**	Analysis of Diuron, Guthion, and Temephos in Water by HPLC
	Diuron
	Guthion (azinphos-methyl)
	Temephos
CAM SOP-00307, CAM SOP-00309, CAM SOP-00317 (OSDWA)	Organochlorine Pesticides and PCBs in Solids, Water and Biological Materials by GC-ECD, Polychlorinated Biphenyls (PCBs) as Aroclors in Solid, Water, and Biological Samples by GC-ECD, and Neutral Chlorinated Hydrocarbons in Solid and Water by GC/ECD
	1,2,3,4-tetrachlorobenzene
	1,2,3,5-Tetrachlorobenzene
	1,2,3-Trichlorobenzene
	1,2,4,5-Tetrachlorobenzene
	1,2,4-Trichlorobenzene
	1,3,5-Trichlorobenzene
	2,4,5-Trichlorotoluene
	A - BHC
	a - Chlordane
	Aldrin
	Aroclor 1262
	Aroclor-1016
	Aroclor-1221
	Aroclor-1232
	Aroclor-1242
	Aroclor-1248
	Aroclor-1254
	Aroclor-1260
	Aroclor-1268
	b-BHC
	d-BHC
	Dieldrin
	Endosulfan I
	Endosulfan II

	Endosulfan Sulfate
	Endrin
	Endrin Aldehyde
	Endrin Ketone
	g - Chlordane
	Heptachlor
	Heptachlor Epoxide
	Hexachlorobenzene
	Hexachlorobutadiene
	Hexachlorocyclopentadiene
	Hexachloroethane
	Lindane (gamma-BHC)
	Methoxychlor
	Mirex
	O,p'-DDD
	O,p'-DDE
	O,p'-DDT
	Octachlorostyrene
	Oxychlordane
	p,p' - DDT
	p,p' Methoxychlor
	p,p'-DDD
	p,p'-DDE
	Pentachlorobenzene
	Total PCBs
CAM SOP-00310 **(OSDWA)**	The Determination of Formaldehyde in Water and Soil by HPLC
CAM SOP-00313	Analysis of 4-Nonylphenol and Nonylphenol Ethoxylates in Water by HPLC
	4-Nonylphenol
	Total Nonylphenol Ethoxylates
CAM SOP-00315 **(OSDWA)**	Determination of CCME C6-C10 Hydrocarbons (F1) and BTEX in Soil and Water by Headspace GC/MS/FID
	Benzene
	Ethylbenzene
	F1: C6-C10
	m/p-xylene
	o-xylene
	Toluene
CAM SOP-00316 **(OSDWA)**	Determination of CCME Extractable Petroleum Hydrocarbons (F2-4) in Water and Soil by GC/FID
	F2: C10-C16
	F3: C16-C34
	F4: C34-C50
CAM SOP-00318	Determination Of Polynuclear Aromatic Hydrocarbons (PAHs) In Solid And Water Samples Using Selected Ion Monitoring (SIM)

	GCMS
	1-methylnaphthalene
	2-methylnaphthalene
	Acenaphthene
	Acenaphthylene
	Anthracene
	Benzo (a) anthracene
	Benzo (a) pyrene
	Benzo (b,j) fluoranthene
	Benzo (g,h,i) perylene
	Benzo (k) fluoranthene
	Chrysene
	Dibenzo (a,h) anthracene
	Fluoranthene
	Fluorene
	Indeno (1,2,3-cd) pyrene
	Naphthalene
	Phenanthrene
	Pyrene
CAM SOP-00320 **(OSDWA)**	The Determination of Nitroaromatics and Nitramines in Water and Soil Samples by HPLC
	1,3,5-Trinitrobenzene
	1,3-Dinitrobenzene
	2,4,6-Trinitrotoluene
	2,4-Dinitrotoluene
	2,6-Dinitrotoluene
	2-Amino-4,6-dinitrotoluene
	2-Nitrotoluene
	3,5-Dinitroaniline
	3-Nitrotoluene
	4-Amino-2,6-dinitrotoluene
	4-Nitrotoluene
	Hexahydro-1,3,5-trinitro-1,3,5-triazine
	Methyl-2,4,6-trinitrophenylnitramine
	Nitrobenzene
	Nitroglycerin
	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
	Pentaerythritol tetranitrite (PETN)
CAM SOP-00322 **(OSDWA)**	The Determination of Propylene Glycol, Ethylene Glycol and Diethylene Glycol in Liquids, Oils and solids by GC/FID
	Diethylene glycol
	Ethylene glycol
	Propylene glycol
CAM SOP-00327 **(OSDWA)**	Analysis of Diquat and Paraquat in Water by HPLC-UV Detector Using Aqueous Ionic Mobile Phase

	Diquat
	Paraquat
CAM SOP-00330	Determination of Phenoxy Acid Herbicides and related compounds in Aqueous and Solid Samples Using Selected Ion Monitoring (SIM) GC/MS
	2,4,5-T
	2,4,5-TP
	2,4-D
	2,4-DB
	2,4-DP (dichlorprop)
	3,5-dichlorobenzoic acid
	Acifluorfen
	Bentazon
	Chloramben
	DCPA Diacid
	Dicamba
	Dinoseb (DNBP)
	MCPA
	MCPP
	Pentachlorophenol
	Picloram
CAM SOP-00332	Determination of Chlorinated Phenols in Soil and Water Using Selected Ion Monitoring (SIM) GC/MS
	2,3,4,5-Tetrachlorophenol
	2,3,4,6-Tetrachlorophenol
	2,3,4-Trichlorophenol
	2,3,5,6-Tetrachlorophenol
	2,3,5-Trichlorophenol
	2,3,6-Trichlorophenol
	2,3-Dichlorophenol
	2,4,5-Trichlorophenol
	2,4,6-Trichlorophenol
	2,4-Dichlorophenol
	2,4-Dimethylphenol
	2,4-Dinitrophenol
	2,5-Dichlorophenol
	2,6-Dichlorophenol
	2-Chlorophenol
	2-Nitrophenol
	3,4,5-Trichlorophenol
	3,4-Dichlorophenol
	3,5-Dichlorophenol
	4,6-Dinitro-2-methylphenol
	4-Chloro-3-Methylphenol
	4-Chlorophenol

	4-Nitrophenol
	m/p-Cresol
	o-Cresol
	Pentachlorophenol
	Phenol
CAM SOP-00411	
	Nitrilotriacetic Acid (NTA) in Water by UV-Vis Spectroscopy
CAM SOP-00413	Measurement of pH in Water, Soils and Food Samples
CAM SOP-00414	Electrical Conductivity in Waters and Sludge, Soil Extracts
CAM SOP-00435	
	Anions in Food, Soil, Water and Air by Ion Chromatography
	Bromide
	Chloride
	Fluoride
	Nitrate
	Nitrite (NO2)
	PO4
	Sulfate
CAM SOP-00440	
	Nitrate
	Nitrate, Nitrite and TON in Waters, Solids, Sludge and Food by FIA
	Nitrite
CAM SOP-00447	ICPMS Metals in Waters, Foods, Solids, Swabs and Biota
	Aluminum
	Arsenic
	Barium
	Boron
	Cadmium
	Calcium
	Chromium
	Copper
	Iron
	Lead
	Magnesium
	Manganese
	Nickel
	Phosphorus
	Potassium
	Selenium
	Sodium
	Tin
	Titanium
	Zinc
CAM SOP-00457	

	Analysis of Cyanide in Waters and Solids by Colourimetry
	Cyanide (SAD)
	Free Cyanide
CAM SOP-00883	Determination of Morpholine in Water Using LC/MS/MS
CAM SOP-00894	Determination of Perfluorinated Compounds in Water and Soil By LC-MS-MS
	PFBS (Perfluorobutanesulfonate)
	PFBA (Perfluorobutanoic acid)
	PFDA (Perfluorodecanoic acid)
	PFDoA (Perfluorododecanoic acid)
	PFHpA (Perfluoroheptanoic acid)
	PFHxA (Perfluorohexanoic acid)
	PFHxS (Perfluorohexanesulfonate)
	PFNA (Perfluorononanoic acid)
	PFOA (Perfluoro-n-Octanoic Acid)
	PFOS (Perfluoro-1-Octanesulfonate)
	PFOSA (Perfluorooctanesulfonamide)
	PFPeA (Perfluoropentanoic acid)
	PFUnA (Perfluoroundecanoic acid)

Occupational Health and Safety:

CAM SOP-00209	Analysis of Percent Level Carbon Dioxide in Medical Gases
CAM SOP-00223	Analysis of percent Level Helium in Compressed Breathing Gases

(Compressed Breathing Air Systems - Z180.1, Z275.1, CAN/CSA Z275.2)

CAM SOP-00200	Analysis of Oxygen, Nitrogen, Carbon Dioxide, Carbon Monoxide and Methane in Compressed Breathing and Medical Gases
CAM SOP-00201	Analysis of Halogenated Hydrocarbon Compounds in Compressed Breathing Gases
CAM SOP-00202	Total Non-methane Hydrocarbons in Compressed Breathing and Medical Gases
CAM SOP-00204	C2-C4 Hydrocarbons in Compressed Breathing Gases
CAM SOP-00205	Analysis of Water, Water Vapour and Odour in Compressed Breathing Gases
CAM SOP-00206	Determining Oil Particulates and Condensates in Compressed Breathing Gases
CAM SOP-00221	Analysis of Nitrogen Oxides (NOx) in Gases
CAM SOP-00223	Analysis of Percent Level Helium in Compressed Breathing Gases

(Medical Gases - CAN/CSA Z10083, CAN/CSA Z7396.1)

CAM SOP-00200	Analysis of Oxygen, Nitrogen, Carbon Dioxide, Carbon Monoxide and Methane in Compressed Breathing and Medical Gases
CAM SOP-00201	

	Analysis of Halogenated Hydrocarbon Compounds in Compressed Breathing Gases
CAM SOP-00202	Total Non-methane Hydrocarbons in Compressed Breathing and Medical Gases
CAM SOP-00203	Analysis of Nitrogen Oxide in Compressed Gases
CAM SOP-00204	C2-C4 Hydrocarbons in Compressed Breathing and Medical Gases
CAM SOP-00205	Analysis of Water, Water Vapour and Odour in Compressed Breathing Gases
CAM SOP-00206	Determining Oil Particulates and Condensates in Compressed Breathing and Medical Gases
CAM SOP-00208	Analysis of Sulphur Dioxide in Medical Gases
CAM SOP-00209	Analysis of Percent Level Carbon Dioxide in Medical Gases
CAM SOP-00210	Analysis of Oxygen by Paramagnetic Analyser in Compressed Breathing Gases
CAM SOP-00216	Analysis of Percent Level Medical Nitrous Oxide

METALLIC ORES AND PRODUCTS

Concentrates, Metallic Liquors and Other Process Products:

Refer to major sub-heading: **Mineral Analysis Testing**

Mineral Analysis Testing

(Ores and Rocks: Mineral Assaying Soil/Sediment Precious Metals)

BQL SOP-00001

NEUTRON ACTIVATION
Long Lived Isotopes which may include:
Antimony
Arsenic
Barium
Cerium
Cesium
Chromium
Cobalt
Europium
Gold
Hafnium
Iron
Lanthanum
Lutetium
Molybdenum
Neodymium
Nicke
Rubidium
Samarium

	Scandium Selenium Silver Sodium Tantalum Terbium Thorium Titanium Tungsten Uranium Ytterbium Zinc Zirconium
BQL SOP-00002	NEUTRON ACTIVATION Platinum Group Elements with Nickel-Sulphide Fire Assay Pre-Concentration which may include Os Ir Pd Pt Rh Ru
BQL SOP-00003	PROMPT GAMMA ACTIVATION Boron by Prompt-Gamma
BQL SOP-00004	NEUTRON ACTIVATION Short-Lived Elements which may include: Aluminum Barium Bromine Calcium Chlorine Dysprosium Europium Fluorine Indium Iodine Magnesium Manganese Potassium Samarium Sodium Strontium Titanium Vanadium
BQL SOP-00005	DELAYED NEUTRON COUNTING for Uranium and U-235

BQL SOP-00007	GAMMA SPECTROMETRY in SOLIDS Natural Decay Chain Isotopes which may include: Natural Decay Chain Isotopes which may include Th-234, Th-230, Ra-226, Pb-210, U-235, Th-227, Ra-223, Ac-228, Ra-228, Pb-212, Rn-222, Pb-214, Bi-214 Synthetic Isotopes which may include Cs-137, Cs-134, I-131, Zn-65, Co-60, Mn-54

NON METALLIC MINERALS AND PRODUCTS

Petroleum Refinery Products: (Including asphalt materials; petrochemicals; fuels and lubricants)

Fuels and Lubricants

ASTM D0092	Flash and Fire Points by Cleveland Open Cup Tester (SLA SOP 00010)
ASTM D0093	Flash Point by Pensky-Martens Closed Cup Tester (SLA SOP-00029)
ASTM D0130	Corrosiveness to Copper from Petroleum Products by Copper Strip Test (SLA SOP-00031)
ASTM D0445	Kinematic Viscosity of Transparent and Opaque Liquids (SLA SOP 00028)
ASTM D0482	Ash from Petroleum Products (SLA SOP-00117)
ASTM D0524	Ramsbotton Carbon Residue Of Petroleum Products (SLA SOP-00113)
ASTM D0611	Aniline Point and Mixed Aniline Point of Petroleum Products and Hydrocarbon Solvents (SLA SOP-00023)
ASTM D0664	Acid Number of Petroleum Products by Potentiometric Titration (SLA SOP-00054)
ASTM D0721	Oil Content of Petroleum Waxes (SLA SOP-00034)
ASTM D0874	Sulfated Ash from Lubricating Oils and Additives (SLA SOP-00013)
ASTM D0892 (IP146 Alternative)	Foaming Characteristics of Lubricating Oils (SLA SOP-00012)
ASTM D0974	Acid and Base Number by Color Indicator Titration (SLA SOP-00017)
ASTM D1218	Refractive Index and Refractive Dispersion of Hydrocarbon Liquids (SLA SOP-00064)
ASTM D1298	Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method (SLA SOP-00056)
ASTM D1401	Water Separability of Petroleum Oils and Synthetic Fluids (SLA SOP-00018)
ASTM D1500	ASTM Color of Petroleum Products (ASTM Color Scale) (SLA SOP-00063)

ASTM D1796	Water and Sediment in Fuel Oils by the Centrifuge Method (SLA SOP 00001)
ASTM D2896	Base Number of Petroleum Products by Potentiometric Perchloric Acid Titration (Procedure B) (SLA SOP00005)
ASTM D2983	Low-Temperature Viscosity of Lubricants Measured by Brookfield Viscometer (SLA SOP 00024)
ASTM D4052	Density and Relative Density of Liquids by Digital Density Meter (SLA SOP-00019)
ASTM D4294	Sulphur in Petroleum and Petroleum Products by Energy Dispersive X-ray Fluorescence Spectrometry (SLA SOP-00026)
ASTM D4629	Trace Nitrogen in Liquid Petroleum Hydrocarbons by Syringe/Inlet Oxidative Combustion and Chemiluminescence Detection (SLA SOP-00115)
ASTM D4951	Determination of Additive Elements in Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (SLA SOP-00111)
ASTM D5185	Determination of Additive Elements, Wear Metals, and Contaminants in used Lubricating Oils and Determination of Selected Elements in Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (SLA SOP-00114)
ASTM D5293	Apparent Viscosity of Engine Oils and Base Stocks Between -5° and -35° C by Using the Auto Cold- Cranking Simulator (SLA SOP-00057)
ASTM D5453	Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Oil, Diesel Engine Oil, and Engine Oil by Ultraviolet Fluorescence (SLA SOP-00106)
ASTM D5771	Cloud Point of Petroleum Products (Optical Detection Stepped Cooling Method) (SLA SOP-00119)
ASTM D5950	Pour Point of Petroleum Products (Automatic Tilt Method)(SLA SOP-00030)
ASTM D6304	Determination of Water in Petroleum Products, Lubricating Oils and Additives by Coulometric Karl Fisher Titration (SLA SOP-00112)

Notes:

CAN-P-4E (ISO/IEC 17025): General Requirements for the Competence of Testing and Calibration Laboratories (ISO/IEC 17025: 2005)
CAN-P-1587: Requirements for the Accreditation of Agricultural Inputs, Food, Animal Health and Plant protection Testing Laboratories
CAN-P-1585: Requirements for the Accreditation of Environmental Testing Laboratories
APHA: American Public Health Association ŒStandard Methods for the Examination of Water and Wastewater
"OSDWA" indicates the appendix is used for the analysis of Ontario drinking water samples, which is subject to the rules and related regulations under the Ontario "Safe Drinking Water Act" (2002)
ASTM: American Society for Testing and Materials
SLA SOP: Subject Laboratory In-House Test Method

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