SNC·LAVALIN

Risk Management Plan

Central Park, 171 Bay Street North, Hamilton, Ontario
City of Hamilton

September 15, 2021
699597

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Executive Summary

The Environment and Geoscience business unit of SNC-Lavalin was retained by the City of Hamilton (the City) to prepare an updated Risk Management Plan the property located at 171 Bay Street North, Central Park in Hamilton, Ontario (the "site"). Previous Environmental Site Assessment work, including Risk Assessment and supplemental Site assessment work was carried out by SNC-Lavalin to assess the soil, groundwater and soil vapour quality at the Site, in anticipation of planned redevelopment of the Site. The Risk Assessment identified potential unacceptable risks to human and ecological health.

Risk modelling and analysis presented in the Risk Assessment identified potential unacceptable risks to human and ecological health. The Risk Management Measures (RMMs) discussed are designed to mitigate potential unacceptable risks associated with the following exposure pathways, environmental media and contaminants:

- Park Visitor (public)
  - **Surface Soil Direct Contact (ingestion and dermal contact)**
  - **Outdoor Air Inhalation from a Surface Soil Source**
- Long-Term Outdoor Worker (e.g. landscape or maintenance worker)
  - **Surface Soil Direct Contact (ingestion and dermal contact)**
- Subsurface Worker (e.g. landscape or maintenance worker)
  - **Surface Soil Direct Contact (ingestion and dermal contact and inhalation of particulates)**
  - **Subsurface Soil Direct Contact (ingestion and dermal contact and inhalation of particulates)**
  - **Trench Vapour Inhalation from a Surface Soil Source**
  - **Trench Vapour Inhalation from a Subsurface Soil Source**
  - **Incidental Direct Contact with Shallow Groundwater (ingestion and dermal contact)**
- Off-Site Residents (e.g. neighbouring residential property)
  - **Indoor Air Inhalation of Volatile COCs from a Groundwater Source**
- Off-Site Commercial Office Worker (e.g. neighbouring commercial property)
  - **Indoor Air Inhalation from a Groundwater Source**
- Ecological Receptors
  - **Direct ecological contact with contaminated surface soil**

The RMMs proposed herein have been developed to be protective of potential future park visitor receptors, off-site commercial and residential receptors, subsurface workers as well as ecological receptors. As a key assumption of the risk assessment was the application of a stratified soil approach, stratified soil conditions must be maintained.

Accordingly, the following RMMs are incorporated in this RMP:

- Carry out remedial excavation of surface soil with concentrations of benzene greater than 29.3 µg/g in the vicinity of BH-19-17 and complete verification sampling to mitigate outdoor inhalation risks;
- Install barrier to site soil (soil/fill cap or hard cap) across the entire property to mitigate direct contact with contaminated soil for park visitors, long term outdoor workers, and ecological receptors;

- Implement a soil and groundwater management plan and health and safety plan to mitigate risks from exposure to groundwater, surface soil or subsurface soil, including trench vapour inhalation for subsurface workers.
- Implement an engineered groundwater migration mitigation system near portions of the northern property boundary to mitigate migration of contaminated groundwater that poses risks to off-site down-gradient residential and commercial receptors through inhalation of volatile COC in indoor air from a groundwater source.
- implementation of the soil management plan to restrict disturbance and relocation of impacted subsurface soil when excavation occurs and ensure stratified conditions are maintained at the RA Property).

The RMM listed herein are required to reduce exposure to COCs in soil, groundwater and vapour to levels at which no unacceptable risks are anticipated and/or to render the exposure pathways inoperable. The following details are included as it pertains to the RMMs described.

The localized remedial excavation at BH-19-17 is estimated to cover an area of approximately 18.5 m^2 and extend to a depth of approximately 2 metre below ground surface (m bgs) to account for a volume of approximately 37 m^3.

Site regrading to install the soft and hard fill caps is required. It is estimated that approximately 6,700 m^3 of existing soil will need to be cut for accepting the fill cap. Assuming that a limited volume of soil would be reused at the site approximately 7,200 m^3 of fill will be required to bring the surface to the required grade to accept the fill cap across the site. Approximately 13,600 m^3 of material will be required for construction of the fill cap.

An engineered system should be implemented as an RMM to control groundwater movement at the property boundary and mitigate indoor air risks associated with migration of potentially impacted groundwater to off-site, down gradient residential and commercial properties.

The groundwater mitigation system should allow impacted groundwater to be treated in a manner that it would meet the Table 3 SCS at the property boundary. Suitable in-situ or ex-situ treatment alternatives may be implemented. The preliminary design of one alternative, a groundwater recovery trench is presented here. is.

The groundwater recovery trench will extend approximately 90 m along the northern property boundary, installed to approximately 12 m deep to intercept the deeper silty clay or clay layer and install a suitable infiltration drainage pipe, connected to two well risers and two “clean-out” ports. The trench will be separated from the surrounding site soil by a non-woven mesh geotextile and backfilled with clear stone. At surface the upper 0.5 m will consist of compacted fill material (forming part of the site fill cap) underlain by a 0.15 m thick sub-base of compacted granular material. Where the trench intersects existing Site utilities, an area equivalent to that of the utility trench plus 0.5 m on all sides will be backfilled with compacted clay or unshrinkable cement fill to prevent or minimize a preferential pathway connection between the utility trench and the groundwater recovery trench material. One extraction well riser will be constructed along the eastern extent of the trench and one well riser will be constructed west of the utility crossing.

Groundwater extraction volume calculation results indicate that the dewatering zone of influence is estimated to be approximately 11 m from the groundwater recovery trench. The typical daily water extraction volume is expected to be approximately 46,500 L. Although the expected daily water extraction volume, is estimated to be less than 50,000 L per day, the system may be classified as a pump and treat system and there may be periods where it exceeds 50,000 L/day, it is recommended that a factor of safety be applied to the typical daily extraction volume and permit to take water (PTTW) be obtained from the MECP on that basis.

Discharge from the groundwater recovery trench will be connected to the receiving sanitary line. If Hamilton Water requires pre-treatment, suitable treatment units which may consist of bag or carbon filters would also need to be incorporated. The system will be controlled by an electrical control panel connected to level switches within the pumping wells and over pressure safety monitors switches within the system. A secure, above ground structure to house this equipment is recommended and could be installed along the northern property line between Sheaffe Street and Caroline Street North. Based on the Site characterization studies, the contaminants of concern that may require treatment include sediment (for turbidity) and volatile organic compounds. PAHs were identified in the soil and groundwater at the site.

Future utility services shall be installed in trenches with aggregate and/or soil meeting the meeting the MECP Table 3 SCS to a minimum depth 500 mm below and 500 mm laterally from the limits of the services. Where a utility is to be installed in an area of heavy impact and potential free-phase contamination, additional mitigations are proposed to decrease risks of residual contamination impacting or migrating along the utility.

Administrative requirements included as part of the RMMs include the following provisions:

- Groundwater in or under the Property shall not be used as a source of potable water and no wells shall be installed on the RA Property for the purposes of obtaining potable water.
- A site specific health and safety plan should be developed and implemented during all intrusive, below-grade construction activities potentially coming in contact with or exposing site soil or groundwater.
- Following implementation of the cap, the health and safety plan is only required to be implemented when excavation will extend below the cap.
- Prior to site redevelopment, before any activities that have the potential to disturb soil are initiated, the site area shall be fenced off to secure the site from unauthorized access to prevent visitors/the public from contact with contamination.
- Any potential future growing of vegetation/plants for human consumption would require the plants to be grown in raised planting beds with imported clean potting soil and a separation textile installed at the base of the raised bed. Growing material should be sourced from commercial or otherwise approved suppliers. Soil sourced at the RA Property should not be used in raised beds.
- The fill cap or hard cap shall be maintained indefinitely.
- The soil and groundwater management plans, health and safety plan and site fencing shall be required for the RA Property during any activities potentially in contact with or exposing site soils and/or groundwater for as long as the COCs are present at the Property.
- The groundwater migration mitigation system shall be operated indefinitely or until it has been demonstrated that groundwater at the RA Property meets either the applicable generic SCSs or SSTLs.
- An inspection and maintenance program should be prepared and implemented to ensure the continuing integrity of the fill cap or hard cap as long as the COCs are present on the Site.

- A monitoring and sampling program should be developed and implemented to monitor the effectiveness of the engineered groundwater migration mitigation system.

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1. Introduction and Background

The Environment and Geoscience business unit of SNC-Lavalin was retained by the City of Hamilton (the City) to prepare an updated Risk Management Plan the property located at 171 Bay Street North, Central Park in Hamilton, Ontario (the "site") (Figures 1 and 2). Previous Environmental Site Assessment work (SNC-Lavalin, 2019a), including Risk Assessment (SNC-Lavalin, 2019b) and supplemental Site assessment work (SNC-Lavalin, 2020) was carried out by SNC-Lavalin to assess the soil, groundwater and soil vapour quality at the Site, in anticipation of planned redevelopment of the Site. The Risk Assessment identified potential unacceptable risks to human and ecological health.

A Risk Management Plan (RMP) was included with the 2019 Risk Assessment carried out by SNC-Lavalin, however, the RMP relied on assumptions about the extent of contaminants along the property boundaries and whether off-site soil vapour impacts may be occurring as a result of concentrations of contaminants in groundwater on the Site. Accordingly, a supplemental soil, soil vapour and groundwater investigation was completed by SNC-Lavalin in 2020. The supplemental investigation was completed to assess shallow soil quality in the vicinity of BH-19-17, update groundwater quality data on which proposed Risk Management Measure were based and assess soil vapour quality at the property boundary.

This updated RMP was completed in accordance with the SNC-Lavalin proposal dated June 26, 2019 to assess/delineate the area around BH-19-17 and assess the groundwater and soil vapour conditions to refine the design of the proposed Risk Management Measure (RMM).

2. Risk Management Plan

2.1. Risks Identified by Risk Assessment

Risk modelling and analysis presented in the Risk Assessment (SNC-Lavalin, 2019b) identified potential unacceptable risks to human and ecological health. The RMMs discussed in the following sections are designed to mitigate potential unacceptable risks associated with the following exposure pathways, environmental media and contaminants:

- Park Visitor (public)
  - **Surface Soil Direct Contact (ingestion and dermal contact)** – benzene, PHC F2-F3, PAHs (acenaphthylene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[ghi]perylene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluoranthene, indeno[1,2,3-cd]pyrene, 1- and 2-Methylnaphthalene, pyrene), metals (antimony, arsenic, cadmium, copper, lead, and zinc).
  - **Outdoor Air Inhalation from a Surface Soil Source** – benzene.
- Long-Term Outdoor Worker (e.g. landscape or maintenance worker)
  - **Surface Soil Direct Contact (ingestion and dermal contact)** – benzene, PAHs (acenaphthylene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[ghi]perylene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluoranthene,

indeno[1,2,3-cd]pyrene, and pyrene), metals (antimony, arsenic, cadmium, copper, lead, and zinc).

- Subsurface Worker (e.g. landscape or maintenance worker)
  - **Surface Soil Direct Contact (ingestion and dermal contact and inhalation of particulates)** – PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, and dibenz[a,h]anthracene) and metals (antimony, arsenic, cadmium, copper, lead, and zinc)
  - **Subsurface Soil Direct Contact (ingestion and dermal contact and inhalation of particulates)** – PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, fluoranthene, indeno[1,2,3-cd]pyrene, and 1-2-methylnaphthalene), metals (arsenic and lead)
  - **Trench Vapour Inhalation from a Surface Soil Source** – benzene, toluene, xylenes, PHC F1 and F2, styrene, PAHs (acenaphthylene, naphthalene) and mercury
  - **Trench Vapour Inhalation from a Subsurface Soil Source** – benzene, ethylbenzene, xylenes, PHC F1 and F2, trichloroethylene, vinyl chloride, naphthalene, and mercury
  - **Incidental Direct Contact with Shallow Groundwater (ingestion and dermal contact)** – Benzene, PHC F2 and F3, PAHs (acenaphthene, acenaphthylene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, indeno[1,2,3-cd]pyrene, naphthalene)

- Off-Site Residents (e.g. neighbouring residential property)
  - **Indoor Air Inhalation of Volatile COCs from a Groundwater Source** – benzene, toluene, ethylbenzene, xylenes, PHC F1 and F2, styrene, trichloroethylene, and vinyl chloride, PAHs (acenaphthene, acenaphthylene, fluorene, and naphthalene), and mercury

- Off-Site Commercial Office Worker (e.g. neighbouring commercial property)
  - **Indoor Air Inhalation from a Groundwater Source** – benzene

- Ecological Receptors
  - **Direct ecological contact with contaminated surface soil** – cyanide EC, SAR, antimony, arsenic, HWS boron, cadmium, copper, lead, zinc, benzene, xylenes, styrene, PHC F1-F4, and PAHs

The described risks are depicted in a conceptual site model in Figure 3.

It is noted that although indoor air inhalation of volatile COCs from a groundwater source indicates potential risk from several PAHs, however, only naphthalene of which was included in the soil vapour sampling program. This is considered appropriate since naphthalene is the only PAH that has a health-base indoor air criteria listed in Appendix IV in MECP Soil Vapour intrusion Assessment Guidance (MOE, 2013), for the evaluation of indoor air contamination resulting from subsurface vapour intrusion at brownfields sites. As such, it was determined that naphthalene can be used as a surrogate for the evaluation of indoor air inhalation risk of PAHs.

Additionally, for mercury, the compound was carried in the RA as a result of a single elevated RDL for one soil sample and there have been no detectable concentrations of mercury in groundwater at the Site, as such it is not considered a contaminant of concern. Further rationale is provided to rule out risk associated with mercury in that, although elemental mercury is volatile, almost all soil mercury is not elemental, therefore, mercury is assumed to be non-volatile in the absence of evidence of an elemental mercury release.

The RMMs proposed herein have been developed to be protective of potential future park visitor receptors, off-site commercial and residential receptors, subsurface workers as well as ecological receptors. As a key assumption of the risk assessment was the application of a stratified soil approach, stratified soil conditions must be maintained.

2.2. Areas Requiring Risk Management Measures

RMMs are required in areas where soil and/or groundwater quality exceeds the applicable site specific target levels (SSTLs).

Surface Soil

Surface soil impacts posing risks are prevalent across the majority of the RA Property. Historically, the site has been subject to extensive infilling and there is heterogenous fill material though out the site. Due to the heterogeneous nature of subsurface conditions, detailed delineation of impacts was not feasible and instead assessment activities were developed to investigate areas with the expected maximum concentrations of contaminants of concern for the purpose of assessing risk. Figure 4 indicates locations where surface soil sample concentrations were greater than the HH-SSTLs protective of Park Visitors, Long-Term Outdoor Workers, Off-Site Residents, and Off-Site Commercial Workers evaluated in the HHRA.

The need for a RMM to address surface soil risks is primarily driven by the human health risks (e.g. surface soil concentrations exceeding the HH-SSTLs). There was only one sampling location (BH-01-17) where the shallow soil conditions met the HH-SSTLs but exceeded an E-SSTL based on an elevated sodium adsorption ratio (SAR) value. At all other surface soil locations where ecological risks are present, human health risks are also present. As such, where a RMM will be applied to address the human health risk in surface soil, it will also address the ecological risk.

Outdoor Inhalation (Soil)

The outdoor inhalation risk to Park Visitors from benzene exposure in shallow soil is calculated from a single sampling location (SS-2 at BH-19-17 at 0.8 to 1.4 m bgs) with a benzene concentration that is significantly higher (141 µg/g) than concentrations for both surface and subsurface soil in the remainder of the RA Property (ranging from <0.0068 µg/g to 2.7 µg/g in surface soil and <0.0068 µg/g to 27.5 µg/g in subsurface soil). Subsequent soil sampling during November 2019 revealed that soil in the vicinity of BH-19-17 meets the Table 5 Surface soil standards as well as the HH-SSTL, accordingly the RMM proposed below includes that this localized area be remediated, and verification sampling be carried out during park redevelopment.

Figure 5 indicates all locations where subsurface soil sample concentrations were greater than the HH-SSTLs protective of subsurface workers. Subsurface soil impacts posing risks to subsurface workers are prevalent over the majority of the RA Property. Due to the heterogenous nature of the fill, it was considered unlikely that the limits of contamination could be reasonably determined, and surface soil impacts posing unacceptable risk to subsurface workers are interpreted to extend across the majority of the RA Property. The RMMs discussed below to address risks to trench workers from surface and subsurface soil will therefore apply across the whole site area.

Direct Contact (Groundwater)

A summary of groundwater impacts posing risks to subsurface workers is presented in Figure 6. Impacted groundwater posing risks is located in the north central portion of the RA Property and at an isolated area in the eastern portion of the RA Property (MW-101). Significant trench work will be associated with the site re-development as the City is planning to replace the existing sewers and water main which run through the RA Property from north to south (south of Caroline Street North) and east-west connecting to Harriet Street, Mill Street and Railway Street. The RMMs discussed below to address groundwater risks to subsurface workers will apply throughout the site where contact with groundwater is present, and is expected to be most prevalent in the northern section of the RA Property adjacent to the benzene/PHC/PAH groundwater impacts in shallow groundwater in that area.

Inhalation of Vapours (Soil and/or Groundwater)

The risk assessment identified potentially unacceptable risks associated with the inhalation of indoor air at off-site residential or commercial properties or on-site utility trench excavation areas impacted by volatile contaminants sourced from contaminated soil and/or groundwater, at locations were HH-SSTLs, protective of Inhalation of Indoor Air, were exceeded. The areas where groundwater concentrations exceed the HH-SSTLs protective of Inhalation of Indoor Air at off-site residential and commercial properties are shown in Figure 7 and Figure 8, respectively. No enclosed buildings designed to be occupied will be constructed on site.

There are groundwater impacts in the north central portion of the RA Property, with several volatile parameters presenting potentially unacceptable risk to down gradient, off site residential areas north of the RA Property (along Caroline Street North) and a second area with groundwater impacts in the west central portion of the RA Property which was based primarily on chlorinated solvent impacts (namely TCE) presenting potential elevated risk to the off-site cross-gradient residential area west of the RA Property (north of Harriet Street).

This potential risk was further evaluated through a more direct line of evidence, through the evaluation of soil vapour samples. Soil vapour analytical results were compared to health based indoor air criteria, adjusted by attenuation factors for residential or commercial land uses, as appropriate depending on the adjacent land use.

At the time the RA was completed, one round of soil vapour sampling had been completed, and it was conservatively inferred that vapour mitigation risk management measures may be required along several property boundaries. To refine the required risk management measures additional soil vapour data was collected in 2018, and with an expanded soil vapour probe network in 2019 and 2020 (SNC-Lavalin, 2020). The results of the additional assessment indicated that increased vapour risk to residential receptors was detected at only one location SVP18-04 (situated away from the property boundary), with vapour samples from soil vapour probes installed closer to the property limits/off-site receptors meeting the adjusted health based indoor air criteria . No increased risk to commercial receptors was identified. Consequently, the only risk management measure required to mitigate unacceptable risk to off-site receptors comprises mitigating the migration of groundwater from the area of the site where an unacceptable vapour risk was identified.

The groundwater migration mitigation risk management measure will not mitigate potential risks associated with contamination that may have already migrated from the site, however, as noted above,

soil vapour sampling completed at the north property limit (SVP19-03 and SVP18-01) did not identify an unacceptable risk at the property limit.

3. Proposed Risk Management Measures

The following sections presents the proposed RMMs to mitigate the risks identified above.

To mitigate off-site groundwater migration and inhalation of indoor air impacts off-site to the north, a groundwater migration mitigation system can be designed to extend along the northern property boundary (SNC-Lavalin, 2020). The areas where groundwater concentrations exceed the HH-SSTLs protective of Inhalation of Indoor Air for off-site commercial properties are shown in Figure 8. Groundwater impacts are present in the north central portion of the RA Property with benzene concentrations presenting risk to the down gradient off site commercial property north of the RA Property (along Caroline Street North).

Based on the current soil, groundwater and soil vapour data (SNC-Lavalin 2019a and 2020), RMMs will be required to address risks to the down-gradient residential and commercial receptors to the north (along Caroline Street North).

Accordingly, the following RMMs are incorporated in this RMP:

- Carry out remedial excavation of surface soil with concentrations of benzene greater than 29.3 µg/g in the vicinity of BH-19-17 and complete verification sampling to mitigate outdoor inhalation risks;
- Install barrier to site soil (soil/fill cap or hard cap) across the entire property to mitigate direct contact with contaminated soil for park visitors, long term outdoor workers, and ecological receptors;
- Implement a soil and groundwater management plan and health and safety plan to mitigate risks from exposure to groundwater, surface soil or subsurface soil, including trench vapour inhalation for subsurface workers.
- Implement an engineered groundwater migration mitigation system near portions of the northern property boundary to mitigate migration of contaminated groundwater that poses risks to off-site down-gradient residential and commercial receptors through inhalation of volatile COC in indoor air from a groundwater source.
- implementation of the soil management plan to restrict disturbance and relocation of impacted subsurface soil when excavation occurs and ensure stratified conditions are maintained at the RA Property).

The scope of the planned re-development of the RA Property includes utility replacement/construction and as such, trench blocks are to be installed during construction work as an additional risk management measure to mitigate the potential for utility trenches to serve as preferential migration pathways for soil vapours and groundwater.

Given the assumptions and receptors considered in the RA, administrative controls also apply to the RA Property and are described further in Section 3.5. These include restrictions for groundwater use, buildings and growing of plants/vegetation for human consumption, as well as requirements for fencing during re-development work.

The RMM listed herein are required to reduce exposure to COCs in soil, groundwater and vapour to levels at which no unacceptable risks are anticipated and/or to render the exposure pathways inoperable.

3.1. Localized remedial excavation in the vicinity of BH-19-17

Based on the findings of the 2018 Phase II ESA (SNC-Lavalin, 2019a) and the supplemental investigation completed in 2020 (SNC-Lavalin, 2020) it is required to carry out remedial excavation in the immediate vicinity of BH-19-17. It is proposed that excavation extents be bounded by test pit locations TP19-02, TP19-03, TP19-04 and TP19-05. Delineation of the benzene exceedance is incomplete at the eastern extent. Accordingly, it is required that verification sampling be carried out at the excavation extents to ensure remaining site surface soil meet the HH-SSTL for benzene at this location. Should verification samples not meet the required HH-SSTL, it is required that the excavation be extended until concentrations of benzene in confirmation soil samples analysed from the floors and walls of the completed excavation are less than the HH-SSTL.

The estimated extent of benzene impacted soil at BH-19-17 is shown in Figure 9 The estimated volume for excavation is as follows:

Location	Area (m^2)	Thickness (m)	Volume (m^3)
BH-19-17	18.5	2	37

Verification samples should be collected at a frequency equal to or greater than that described in Schedule E, Table 3 of (Minimum Confirmation Sampling Requirements for Excavation) in O. Reg 153/04.

Following excavation, where benzene concentrations meet the HH-SSTL the excavation can be backfilled with imported clean fill which meets applicable HH-SSTL or Table 5 surface soil standards, and finished with a 0.5 m fill cap. As described in Section 2.1, stratified soil conditions must be maintained at the site and 1.5 m of soil must be maintained over the subsurface soil.

Finally, any excavated surface soils in this area which have been confirmed by testing to meet the HH-SSTL but exceed Table 5 surface soil standards, may only be reused on-site provided they are overlain a minimum of 1.5 m clean material and fill cap.

The remedial excavation shall be supervised by a Qualified Person (as defined by O. Reg. 153/04) and the results of the excavation program documented in a report.

3.2. Barrier to Site Soils

As the future use of the site is parkland use, a barrier is required to mitigate human and ecological receptors coming into direct contact with site soils. The barrier can be comprised of a hard cap or soft (fill) cap, to be compatible with the park design and should be implemented in conjunction with park redevelopment. The cap design has been revised since the Risk Assessment, based on additional consideration of the protection provided by the barriers. As described in the Section 2.2, the cap is required across the whole site (Figure 4).

Inspection and maintenance are required to ensure the integrity of the cap is maintained. Details of the required inspection and maintenance program are described in Section 5.1.

The minimum requirements to establish a barrier to site soils as outlined below (and illustrated in Figure 10) are intended to mitigate direct contact exposure risk to humans (excluding subsurface workers whose exposure is managed through health and safety planning) and ecological receptors. Consideration in the design was given to the requirements of the MGRA model risk management approach (MOECC, 2016a) as well as alternate capping approaches from other jurisdictions described in the RA (Section 5.4.2.2 of SNC-Lavalin, 2019b).

Areas where a hard cap or soft (fill) cap will be installed are illustrated on Figure 11. Figures documenting the installation of the cap should be prepared at the conclusion of the redevelopment program.

3.2.1. Hard Cap

In areas of the site where the park design calls for 'hardscape' (e.g. paved areas, concrete surfaced play areas such as basket ball courts, walkways consisting of asphalt, etc.), the barrier to site soils shall consist of a layer of clean fill above the impacted site soils consisting of a minimum thickness of 0.15 m of compacted granular or sub-base material, as appropriate, followed by a minimum thickness of 0.075 m (75 mm) of concrete, asphalt or acceptable hard, cured-in-place, surface finish at grade. A suitable geotextile marker layer shall be placed between the subsoil and the base of the hard cap.

A schematic design of a typical hard cap cross-section is presented on Figure 10.

3.2.2. Soft (Fill) Cap

In areas of the site that will be 'soft scaped' (e.g. play areas and grassed and landscaped areas) a soft or fill cap shall be installed. The soft cap will typically be composed suitable surface finishes (e.g. soft or rubberized playground floor, grass sod, engineered wood fiber and/or decomposed granite as appropriate) followed by a layer of soil and a marker layer. The soil layer will:

- Provide a barrier and isolate contaminated soil from direct contact by site receptors; and,
- Facilitate growth of vegetation at the site to improve aesthetics and minimize erosion.

It is required that a geotextile marker layer be installed across areas that will require mitigation against animal burrowing or to limit rooting of trees and shrubs (e.g. areas landscaped with trees and/or shrubs, dog park areas) into contaminated soil.

In vegetated areas where deep rooted plants are not planned to be present, considering that a 50 cm soil cap is anticipated to provide adequate plant community protection from contaminated soil, the geotextile primary purpose is as a visual indicator to demarcate contaminated soil from clean soil. The geotextile is not needed to provide a physical barrier to root penetration, therefore a number of permeable material options are available including geogrids.

Accordingly, across the majority of the redeveloped park (e.g. grassed or sports fields), where geotextile will not be required, the Soft (fill) cap will be completed with a suitable alternative, e.g. a geogrid, to serve as a warning indicator to individuals excavating on the property and to individuals performing cap integrity observations.

Schematic designs of a typical soft (fill) cap cross-section with geotextile and a soft (fill) cap with geogrid are presented on Figure 10.

Based on the redevelopment plan for the Site the areas where a soft (fill) cap with geotextile, a soft (fill) cap with geogrid, and a hard cap is required are presented in Figure 11.

3.2.2.1. Soft (fill) cap specifications

The thickness of the soft (fill) cap layer is to be at least 0.5 m and composed of a vegetated topsoil layer and a clean soil layer which meets the soil quality standards for the site MECP Table 3 SCS for coarse textured soil in residential/parkland land use setting). The rationale for the thickness of the soft (fill) cap layer is provided below.

The cap serves to make the human direct contact exposure route inoperable by preventing contact with contaminated soils during normal activities conducted by park visitors and long-term maintenance workers. Considering that these activities do not cause significant soil disturbance under normal site use, conceptually, only a nominal thickness of soil is required to render this pathway inoperable. However, applying a 0.5 m soil cap allows for a factor of safety for minor disturbance of surface soil without exposing human receptors to contaminated soil. By incorporating an isolation layer (geotextile) or visual marker layer, a significant decrease in cap thickness and potential exposure of contaminated soil would be readily apparent and corrective action (cap repair) can be implemented.

The thickness of the soft (fill) cap layer to mitigate ecological risks is based on the following considerations:

- The representative depth where exposure to plants and soil invertebrates may occur is the top 30 cm (based on the recommended sampling depth relevant to exposure in Suter, 2007);
- A US EPA (2015) meta-analysis study identified the soil zone of highest biological activity for soil-dwelling ecological receptors based on invertebrate density, microbial biomass and density, root biomass and root production to be 25 to 30 cm and low and essentially no difference in activity at depths greater than 50 cm. The study evaluated both grassland and forest environment types;
- The natural root distribution of most trees is present within the top 40 cm of soil (Watson and Himelick, 1992);
- In temperate grasslands, forests and crop lands, the majority of root biomass is in the upper 30 cm of the soil (52-83%, Jackson et al, 1996). An updated analysis using the same data and new data by Schenk and Jackson (2002) identified a 95th percentile meadow root depth of 40 cm and a 95th percentile cool temperate forest root depth 104 cm; and
- The MECP MGRA includes a 'Hard Cap or Fill Cap Barrier (1.0 m specified greater thickness) risk management measure' for all property uses, however, no rationale is provided for this thickness, accordingly it is inferred that there is no reason to believe a 0.5 m cap will not make the human direct contact route inoperable. Further, this barrier (specified in the MGRA) does not require the inclusion of a marker layer, whereas the barrier proposed for the site will serve as visual indicator of an area requiring repair.
- The frequency of cap inspection may be adjusted to be more frequent during higher park use periods and following high rainfall or seasonal events.

  Further, regulatory agencies recommend or have accepted cap thicknesses of less than 1 m as follows:
    - The German Soil Protection Ordinance (BBODSCHV, 1999 in Meuser, 2013) provides recommended minimum thicknesses of clean soil caps intended to exclude human direct contact risks. These are 35 cm in playgrounds (with a geotextile barrier below the soil cap) and 10 to 35 cm in vegetated parks which do not experience digging activities;

- A 60 cm to 90 cm (2 to 3 foot) cap is typically considered acceptable in the US for non-residential contaminated areas (US EPA, 2010). The rationale for this depth does not seem to be readily available; and
- The Ontario Ministry of Environment, Conservation and Parks has accepted use of 50 cm soft caps at contaminated sites (for example CPU 0371-8TYQMY, for parkland use), which is shallower than RSC based requirements, with the incorporation of a geotextile in the cap design (consistent with the cap design detailed for the Site).

Based on these regulatory agencies' approach, it can be inferred that, in the absence of ground disturbance, or with the addition of a physical layer such as a geotextile, a soil cap of as little as 10 cm in thickness serves to disrupt the receptor pathway.

For consideration of ecological receptors, a soil cap depth in excess of 30 cm and up to approximately 40 cm may be considered suitable to maintain invertebrate communities and shallow rooted plant species and a cap thickness greater than approximately 50 cm may provide little additional benefit in terms of mitigating direct contact exposure based on US EPA (2015) data.

The selection of a soil cap thickness though needs to consider both necessary root depth requirements to allow for proper plant health and support and moisture storage requirements when a geotextile is part of the cap design. A 50 cm soil cap with geotextile barrier is potentially not suitable for areas with deep rooted plant species such as many trees and some shrubs where insufficient support may leave trees vulnerable to blow-over and cap depth may provide insufficient moisture storage (since deeper rooting is restricted by the recommended geotextile) to maintain tree and shrub plant health in the summer.

As a result, a 50 cm soil cap is recommended for the site and in areas where deep rooting plants are planted, their root balls must be placed in an excavation and surrounded on all sides by a soil layer no less than 0.5 m thick, MECP Table 3 SCS for coarse textured soil in residential/parkland land use setting.

3.2.3. Maintenance of Stratified Conditions

Where the re-development design does not allow a grade adjustment of +0.5 m, a grade lowering would first be required to accommodate a fill cap, or accept a hard cap as required. If the existing grade is to be lowered before the cap is installed, the thickness of the cap must be proportionally increased from the minimum of 0.5 m by an amount equal to the lowering of the initial grade, to a maximum of imported fill thickness of 1.5 m in order to maintain the stratified soil conditions assessed in the Risk Assessment. Excavated surface soils may be reused on-site provided they are also capped by the minimum 0.5 m fill cap or hard cap in accordance with the soil management plan for the RA Property.

3.2.4. Cut and Fill Volumes

Based on the existing grade plan, as surveyed (received from the City of Hamilton) and the proposed final grade based on the park redevelopment plan, the following cut and fill requirements are estimated as indicated in Appendix A.

As stratified site condition standards need to be maintained, any potential reuse of excavated material at the site should be cognizant of the final elevation of its final placement and should not be less than 1.5m bgs (final grade). It is estimated that approximately 6,700 m^3 of existing soil will need to be cut for accepting the fill cap. Assuming that a limited volume of soil would be reused at the site approximately 7,200 m^3 of fill will be required to bring the surface to the required grade to accept the fill cap across the site. Approximately 13,600 m^3 of material will be required for construction of the fill cap. Any imported

material to be used for capping purposes shall be either crusher run aggregate (e.g. Granular A or B) or soil material otherwise certified to meet the SSTLs or Table 3 Standards for parkland use. The SSTLs are specified in the Risk Assessment and an excerpt of the SSTL tables from the Risk Assessment report (SNC-Lavalin 2019b) are included in Appendix A.

3.2.5. Imported Capping Material Soil Texture

It is understood that the City wishes to reuse soil from a current stockpile present at the Site to supplement fill requirements at the Site. Some or all of this stockpile may be used during installation of utilities at the Site, remaining soil may be used for capping material.

Soil grain size distribution samples were collected of the soil stockpile designated to be used as capping material. The soil was brought from nearby Churchill Park in west Hamilton. Based on the results of the grain size distribution by sieve and hydrometer, the soil samples can be classified as fine textured with between 92 to 96% of particles, by mass, smaller than 0.075 mm in diameter, and corresponds to soil type of clay and silty clay.

The fine textured material affects the soil's infiltration rate, which determines how much and how quickly precipitation can be taken in by the soil. If the rate of precipitation exceeds the infiltration rate, ponding and surface runoff may occur. Where topographic gradient permits runoff without causing erosion, a higher clay content may be acceptable. However, in locations where very low topographic gradient is present, e.g. in the vicinity of the sports field, it is desirable to achieve infiltration suitable to avoid surface ponding and runoff.

Soil texture of the capping material should consist of suitably graded material, typically with a clay percentage less than 30%, which will allow appropriate drainage and infiltration of precipitation and limit formation of puddles. It is desirable to have a surface infiltration of 9 to 15 mm/hr, similar to that of silt loam. The final infiltration rate and required soil texture should be assessed by a landscape architect and incorporated in the park design.

3.3. Soil Management Plan

A soil management plan (SMP) should be implemented during any activities which may potentially come in contact with or expose site soils. The SMP will be implemented to minimize exposure to COCs and to ensure that soil placed on the RA Property (re-used or imported) meets appropriate stratified SCSs or SSTLs. This plan shall be developed by and overseen by a Qualified Person as described under O. Reg. 153/04 and include, but not be limited to, the following components:

- Dust control measures and prevention of soils tracking by vehicles and personnel from the Site, including wetting of soil with potable water, reduced speeds for on-Site vehicles, tire washing stations and restricting work in high wind conditions.
- Management of excavated materials to minimize exposure to and migration of contaminated soil, including cleaning equipment, placement of materials for stockpiling on designated areas lined and covered with polyethylene sheeting, bermed and fenced to prevent access, runoff control to minimize contact and provisions for discharge to sanitary sewers or other approved treatment.
- The development and implementation of protocols for assessing soil excavated at, brought to or removed from the RA Property.
- Protocols and procedures to ensure the placement of excavated or imported soil meets the appropriate depth-specific standards.

- Storm water management measures to control the potential transport of COCs off-Site during on-Site construction/redevelopment activities. This shall include, but to not be limited to, silt fences and filter socks on catch-basins and utility covers as necessary.
- Characterization of excavated materials requiring off-site disposal, such that disposal as a waste will be in accordance with the provisions of O. Reg. 347, as amended, made under the Act.
- Record keeping including, but not to limited to, dates and duration of work, weather and Site conditions, location and depth of excavation and soil placement activities, dust control measures, stockpile management and drainage, all soil and groundwater characterization results, names of the Qualified Persons, contractors, haulers and receiving Sites for any excavated soils/materials or contaminated groundwater removed from the property and any complaints received relating to Site activities.

3.4. Groundwater Management Plan

A groundwater management plan should be developed and implemented to describe management handling and disposal requirements for groundwater encountered during excavation associated with re-development work (notably utility upgrades/replacements) or implementation/installation of any RMMs (e.g. the engineered groundwater mitigation system).

Based on details of the proposed work, an evaluation should be completed to determine if a Permit to Take Water may be required to handle the volumes of groundwater expected within the excavations. During rain events, run-off and rainfall should also be diverted away from any open excavations. Record keeping for groundwater management can be done in coordination with the SMP's record keeping requirements listed in Section 3.3.

3.5. Groundwater Migration Mitigation System

An engineered system should be implemented as an RMM to control groundwater movement at the property boundary and mitigate indoor air risks associated with migration of potentially impacted groundwater to off-site, down gradient residential and commercial properties.

The groundwater mitigation system should allow impacted groundwater to be treated in a manner that it would meet the Table 3 SCS at the property boundary. Suitable in-situ or ex-situ treatment alternatives may be considered. The preliminary design of one alternative, a groundwater recovery trench, is presented here as . The location of the groundwater mitigation system at the northern property boundary allows for connection of discharge to the sanitary sewer alignment along Sheaffe street. It is anticipated that Hamilton Sewer Use Bylaw requirements may necessitate treatment of the collected groundwater prior to discharge. As this is a City collection system discharging to a City receiver, obtaining input and clarification on pre-treatment expectations from the Hamilton Water Division of the City's Public Works Department is recommended.

3.5.1. Groundwater Recovery Trench

Based on the findings of the preceding work including the Phase II ESA and supplemental subsurface investigations, sufficient data were collected to prepare a design for the proposed groundwater recovery trench. The design of the groundwater recovery trench is documented in Appendix B.

It is proposed to construct a groundwater recovery trench aligned perpendicular to the direction of groundwater flow, down gradient of the area where maximum concentrations of contaminants of concern

have been detected in groundwater, extending the full depth of the upper fill layers in the vicinity of the northern property boundary. It is proposed to advance a trench to approximately 12 m deep to intercept the deeper silty clay or clay layer and install a suitable infiltration drainage pipe, connected to two well risers and two “clean-out” ports. The trench will be separated from the surrounding site soil by a non-woven mesh geotextile and backfilled with clear stone. At surface the upper 0.5 m will consist of compacted fill material (forming part of the site fill cap) underlain by a 0.15 m thick sub-base of compacted granular material. Drawings depicting the trench design are provided in Appendix B, with a discussion of the design provided below.

Where the trench intersects existing Site utilities, an area equivalent to that of the utility trench plus 0.5 m on all sides will be backfilled with compacted clay or unshrinkable cement fill to prevent or minimize a preferential pathway connection between the utility trench and the groundwater recovery trench material. If required, steel separating plates can be installed to separate the trench-block low permeability backfill from the clear stone backfill.

One extraction well riser will be constructed along the eastern extent of the trench and one well riser will be constructed west of the utility crossing.

For the purpose of calculating the groundwater extraction volume, the following assumptions were made based on the available information:

- The open cut method (with a temporary shoring system) will be used to facilitate the construction/installation of the trench (i.e., excavation walls will be approximately vertical).;
- The target groundwater level is approximately 5 m from the bottom of the trench;
- The base of the water bearing zone is assumed to be at the bottom of the trench excavation.;
- The majority of the groundwater drawdown will occur within the sand, silty sand fill; and
- The water bearing zone is considered to be unconfined.

The target groundwater level may be adjusted based on the observations of the groundwater monitoring program following commissioning of the system and the observed gradients north of the trench. A gradient towards the south is required to be achieved between the northern property boundary and the trench.

Input parameters for dewatering evaluation are summarized in Table 4.1.

Table 4.1: Input Parameters for Trench Dewatering Evaluation

Parameters	Groundwater Recovery Trench
Length and width of excavation (m)	Approximately 90 m long by approximately 2 m wide
Bottom of excavation (mbgs)	Ranging from 10 to 12 (approximately 78 m asl to 81 m asl)
Initial groundwater level (mbgs)	1.9 (approximately 87 m asl)
Target groundwater level (mbgs)	4.9 (approximately 84.5 m asl)
Groundwater drawdown (m)	3
Hydraulic conductivity (m/s)	1.1×10^{-6} (most conservative on site)

The details of the groundwater extraction volume calculation, including input parameters, equations and results are provided in Appendix B. A summary of the dewatering evaluation is presented in Table 4.2

Table 4.2: Dewatering Evaluation Results

	Trench (Approximately 90 m)
Radius of Influence (m)	10.6
Typical daily dewatering volume (L/day)	46,500

The results indicate that the dewatering zone of influence was estimated to be approximately 11 m from the groundwater recovery trench. The typical daily water extraction volume is expected to be approximately 46,500 L and is based on the extraction of groundwater under the assumptions listed in Table 1, with no additional variations included.

Although the expected daily water extraction volume, is estimated to be less than 50,000 L per day, the system may be classified as a pump and treat system and there may be periods where it exceeds 50,000 L/day, it is recommended that a factor of safety be applied to the typical daily extraction volume and permit to take water (PTTW) be obtained from the MECP on that basis.

Based on the requirement to obtain a permit to take water, a permit application may be submitted prior to construction and amended following construction and commissioning of the groundwater control system, once calibrated pumping and discharge volumes have been established.

3.5.2. Groundwater treatment and discharge

The groundwater recovery trench will be equipped with at least two groundwater extraction wells that connect directly into the perforated drainage pipe. Each extraction well should be equipped with a submersible pump connected to an above-ground control panel, flow meter and discharge lines connected to the receiving sanitary line. If Hamilton Water requires pre-treatment, suitable treatment units which may consist of bag or carbon filters would also need to be incorporated. The system will be controlled by an electrical control panel connected to level switches within the pumping wells and over pressure safety monitors switches within the system.

A secure, above ground structure to house this equipment is recommended and could be installed along the northern property line between Sheaffe Street and Caroline Street North.

It is assumed that a City of Hamilton discharge permit will be required to permit discharge to the sanitary sewer and will confirm the discharge criteria. Based on the Site characterization studies, the contaminants of concern that may require treatment include sediment (for turbidity) and volatile organic compounds. PAHs were identified in the soil and groundwater at the site, however the City of Hamilton Sanitary and Storm Sewer Use Bylaw does not provide criteria for PAHs. A summary of the groundwater quality sample results for the site compared against the City of Hamilton Sanitary and Storm Sewer Use Bylaw is included in Table B.1.

3.5.3. Operation and Monitoring

A groundwater monitoring and sampling program and effluent sampling program will be required to meet the Hamilton Sewer Use Bylaw permit conditions and demonstrate the performance of the groundwater recovery trench and monitor ongoing groundwater conditions (see Section 5.2).

3.6. Underground Utility Services and Trench Blocks

Future utility services shall be installed in trenches with aggregate and/or soil meeting the meeting the MECP Table 3 SCS for coarse textured soil in residential/parkland land use setting to a minimum depth 500 mm below and 500 mm laterally from the limits of the services. This RMM is meant to limit utility contact with contaminated soil and decrease a utility workers exposure to contaminated materials during potential future repair work. Trench fill material is to be installed into, and covered by, non-woven mesh geotextile to mitigate contact with existing site soils and limit migration of fines into granular trench backfill material.

Where a utility is to be installed in an area of heavy impact and potential free-phase contamination, additional mitigations are proposed to decrease risks of residual contamination impacting or migrating along the utility. The following options are proposed:

- Over excavating of impacted soil and backfilling with clean material
- Installation of non-permeable liner, e.g. geosynthetic clay liner
- Consider rerouting of utility to mitigate contact with impacted site soil

Where existing or new services intersect groundwater, low permeability trench blocks should be installed across the trench channel. Trench blocks are proposed to be installed in utility trenches at intervals required to mitigate vapour migration and allow infiltration of groundwater which may accumulate in trench material, as well as mitigate migration of groundwater from un-impacted to impacted areas and off-site. Trench blocks are to be constructed of 750 mm compacted clay, installed directly into the surrounding soil material.

Additional details on locations and spacing of trench blocks in support of the City's planned utility upgrade project were provided in a Memorandum to the City dated April 9, 2019 (SNC Lavalin, 2019c).

3.7. Administrative Controls

3.7.1. Prohibit Installation of Potable Wells

Groundwater in or under the Property shall not be used as a source of potable water and no wells shall be installed on the RA Property for the purposes of obtaining potable water.

Since maintaining existing wells would interfere with construction works it is proposed that all existing monitoring wells be abandoned/decommissioned prior to the start of re-development construction. Wells should be decommissioned in accordance Ontario Regulation (O. Reg.) 903 by a licensed well contractor. A new, refined network of fewer monitoring wells should be installed following completion of the re-development work (as described in Section 5.2).

3.7.2. Building Prohibition

No habitable buildings shall be constructed on the RA Property. It is anticipated that any treatment unit can be housed within a pre-constructed, heated and insulated, concrete bungalow or pump-house enclosure. As the building will require only infrequent access and short term access it is not included in this prohibition.

3.7.3. Health and Safety Requirements

A site specific health and safety plan should be developed and implemented during all intrusive, below-grade construction activities potentially coming in contact with or exposing site soil or groundwater. The City should ensure that the health and safety plan consider the following:

- all relevant information concerning the presence of, human exposure to, and risk posed by, the COCs through dermal contact, soil or ground water ingestion and inhalation of soil particles or vapour that may be present at the Property including information in the RA;
- all relevant information, measures and procedures concerning protection of the persons from exposure to the COCs and the precautions to be taken when undertaking intrusive activities, including the supervision of workers, occupational hygiene requirements, use of personal protective equipment, provision of air flow augmentation in excavations or other areas or situations of minimal air ventilation, and other protective measures and procedures as appropriate;
- all relevant information concerning the presence and significance of the RMMs and requirements which are being, or have been, implemented at the Site; and,
- the procedures and timing for implementing emergency response and contingency measures and procedures, including contact information, in the event of a health and safety incident.

The health and safety plan should be prepared in accordance with applicable Ministry of Labour health and safety regulations, shall address any potential risks identified in the RA. The health and safety plan shall evaluate any proposed project activities and require appropriate action as stipulated under the Occupational Health and Safety Act, as amended, including, if needed notification to the local Ministry of Labour office that the Site contains contaminated soil and ground water.

Implementation of the health and safety plan shall be overseen by persons qualified to review the provisions of the plan with respect to the proposed site work and conduct daily inspections. The Owner shall retain a copy of the plan.

Following implementation of the cap, the health and safety plan is only required to be implemented when excavation will extend below the cap.

3.7.4. Site Fencing Requirements

Prior to site redevelopment, before any activities that have the potential to disturb soil are initiated, the site area shall be fenced off to secure the site from unauthorized access to prevent visitors/the public from contact with contamination. Gates should be secured with locks when construction personnel are not present. Evidence of entry of unauthorized personnel should be recorded, and if this is found to occur frequently, security personnel should be recruited to monitor the site during off-hours.

Following redevelopment, fencing is only required if excavation will occur below the soil cap (or as required for other purposes).

3.7.5. Restrictions on Plants/Vegetation for Human Consumption

Any potential future growing of vegetation/plants for human consumption would require the plants to be grown in raised planting beds with imported clean potting soil and a separation textile installed at the base of the raised bed. Growing material should be sourced from commercial or otherwise approved suppliers. Soil sourced at the RA Property should not be used in raised beds.

4. Duration of Risk Management Measures

The fill cap and hard cap shall be maintained indefinitely.

The soil and groundwater management plans, health and safety plan and site fencing shall be required for the RA Property during any activities potentially in contact with or exposing site soils and/or groundwater for as long as the COCs are present at the Property.

The groundwater migration mitigation system shall be operated indefinitely or until it has been demonstrated that groundwater at the RA Property meets either the applicable generic SCSs or SSTLs. The groundwater monitoring program will be conducted indefinitely or until there is sufficient data to support the recovery system is operating as designed.

All other RMMs shall be maintained indefinitely.

5. Requirements for Monitoring and Maintenance

5.1. Barrier to Site Soils

An inspection and maintenance program should be prepared and implemented to ensure the continuing integrity of the fill cap or hard cap as long as the COCs are present on the Site. The inspection program should include training of regular park maintenance staff to report any signs of deterioration observed during the course of regular park maintenance, additionally, formal inspections should be carried out at a regular intervals, e.g. on a monthly basis during periods of no snow cover, but at a minimum, semi-annual (spring and fall) inspections should be scheduled. If deficiencies are identified during routine park maintenance a formal inspection should be carried out to verify the cap integrity.

In the event of deficiencies including any breaches of the hard or soft (fill) cap, deterioration of soft (fill) cap, visible erosion gullies or any loss of integrity of the cap contingency measures shall be implemented including temporary site fencing and timely repair of the affected areas to the original design specifications.

Inspection, deficiencies, and repairs should be recorded in a logbook maintained by the City.

5.2. Groundwater Migration Mitigation System

A monitoring and sampling program should be developed and implemented to monitor the effectiveness of the engineered groundwater migration mitigation system. A monitoring well network illustrated in Figure 12 should be established, with wells installed upgradient and downgradient of the groundwater control or treatment system. Groundwater samples should be collected from monitoring wells and analysed for COCs to assess effectiveness in mitigating contaminant migration. An appropriate performance monitoring for the engineered groundwater mitigation system (interceptor trench) would include measuring hydraulic heads and gradients, ground-water flow directions and rates, pumping rates, discharge volumes and effluent quality. Should an alternate mitigation approach be selected, an appropriate performance monitoring program, relative to the approach, should be developed. These data should be evaluated to ensure compliance with discharge requirements, to interpret effectiveness at mitigating groundwater migration and to identify whether enhancements are required.

6. Closure

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7. References

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SNC-Lavalin, 2019b. Human Health and Ecological Risk Assessment and Risk Management Plan, Central Park, City of Hamilton, Ontario. June 26, 2019

SNC-Lavalin, 2019c. Memorandum - Central Park, Hamilton - Soil and Groundwater Management Consideration During Utility Works. Dated April 9, 2019

SNC-Lavalin, 2020: Supplemental Site Assessment (2019 and 2020): Soil, Soil Vapour, Groundwater Monitoring and Sampling Program, Central Park, City of Hamilton, Ontario. May 4, 2020

Certificate of Property Use (CPU) no. 0371-8TYQMY (CPU) to the City of Ottawa for Zone C of the property currently known as Lansdowne Park & Sylvia Holden Commemorative Park, located at 945-1015 Bank Street, City of Ottawa, Ontario. Note: The 50 cm cap area applies throughout the remaining vegetated or hard covered areas of the Former Eastern Landfill and not the heirloom orchard

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TABLES

TABLE :

Groundwater Analytical Results
Central Park, Hamilton, ON

Sample Location			Table 5[2]	MW-101	MW-102	MW-103	MW-104	MW-115	MW-116	MW-201	MW-202	MW-203	MW-205	MW-01-17	MW-09-17	MW-18-17	BH-17-17	MW18-01	MW18-02	MW18-03	MW18-04	MW18-05	MW18-07	MW18-08	MW18-09	MW18-14	MW18-16	MW18-17	MW18-23	MW18-24	MW18-25	MW18-26	MW18-27	MW18-28	MW18-29	MW18-30
Laboratory Sample ID			Standard	L2163169-5	L2163993-2	L2163169-2	L2162292-1	L2163169-4	L2163993-3	L2162292-8	L2164646-2	L2164646-1	L2163169-1	L2163169-6	L2163169-3	L2163993-1	L2171531-1	L2162292-5	L2162292-6	L2173188-1	L2161100-4	L2162292-3	L2162292-7	L2161100-1	L2161100-2	L2162292-4	L2161100-3	L2161100-5	L2162292-2	L2170681-1	L2170681-2	L2170681-3	L2170681-4	L2171531-2	L2171531-3	L2173188-2
SNC-Lavalin Sample ID			CG	MW-101	MW-102	MW-103	MW-104	MW-115	MW-116	MW-201	MW-202	MW-203	MW-205	MW-01-17	MW-09-17	MW-18-17	BH-17-17	MW18-01	MW18-02	MW18-03	MW18-04	MW18-05	MW18-07	MW18-08	MW18-09	MW18-14	MW18-16	MW18-17	MW18-23	MW18-24	MW18-25	MW18-26	MW18-27	MW18-28	MW18-29	MW18-30
Sampling Date (yyyy/mm/dd)				2018/09/11	2018/09/12	2018/09/11	2018/09/10	2018/09/11	2018/09/12	2018/09/10	2018/09/13	2018/09/13	2018/09/11	2018/09/11	2018/09/11	2018/09/12	2018/09/25	2018/09/10	2018/09/10	2018/09/07	2018/09/07	2018/09/10	2018/09/10	2018/09/07	2018/09/07	2018/09/10	2018/09/07	2018/09/07	2018/09/10	2018/09/24	2018/09/24	2018/09/24	2018/09/24	2018/09/25	2018/09/25	2018/09/27
Parameter	RDL	Units																																		
Dissolved Metals																																				
Antimony	0.10	µg/L	20,000	< 0.10	0.20	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	1.3	< 1.0	< 1.0	< 1.0	0.65	-	< 1.0	< 1.0	< 1.0	< 1.0	-	< 1.0	-	< 1.0	< 1.0	-	-	1.4	< 1.0	-	< 0.10
Arsenic	1.0	µg/L	1,900	4.53	5.39	< 1.0	< 1.0	7.4	1.1	< 1.0	-	1.1	< 1.0	< 1.0	< 1.0	2.3	19.9	< 1.0	< 1.0	1.39	-	< 1.0	< 1.0	9.1	2.8	-	17.8	-	6.0	< 1.0	-	-	16.9	2.8	-	3.28
Barium	1.0	µg/L	29,000	391	26.5	79.1	389	239	101	82.4	-	11.5	65.7	74.4	162	72.5	272	115	75.1	51.7	-	100	86.4	191	178	-	138	-	253	63.5	-	-	193	228	-	216
Beryllium	0.10	µg/L	67	< 0.10	< 0.10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.10	-	< 1.0	< 1.0	< 1.0	< 1.0	-	< 1.0	-	< 1.0	< 1.0	-	-	< 1.0	< 1.0	-	< 0.10
Boron	10	µg/L	45,000	229	204	290	450	280	1,930	1,050	-	< 100	970	210	200	260	230	< 100	290	402	-	310	220	440	410	-	620	-	370	290	-	-	450	270	-	61
Cadmium	0.010	µg/L	2.7	< 0.010	< 0.010	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	-	< 0.050	< 0.050	< 0.050	< 0.050	0.167	< 0.050	< 0.050	< 0.050	< 0.010	-	< 0.050	< 0.050	< 0.050	0.056	-	< 0.050	-	< 0.050	0.118	-	-	< 0.050	< 0.050	-	< 0.010
Chromium (total)	0.50	µg/L	810	< 0.50	< 0.50	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	-	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 0.50	-	< 5.0	< 5.0	< 5.0	< 5.0	-	< 5.0	-	< 5.0	< 5.0	-	-	< 5.0	< 5.0	-	< 0.50
Cobalt	0.10	µg/L	66	0.75	0.22	< 1.0	< 1.0	< 1.0	1.1	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	3.7	< 1.0	< 1.0	1.8	< 0.10	-	< 1.0	< 1.0	< 1.0	2.7	-	1.2	-	1.3	1.8	-	-	< 1.0	< 1.0	-	0.52
Copper	0.20	µg/L	87	0.38	1.01	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	-	< 2.0	< 2.0	< 2.0	< 2.0	9.5	< 2.0	< 2.0	< 2.0	1.13	-	< 2.0	< 2.0	< 2.0	3.3	-	< 2.0	-	< 2.0	< 2.0	-	-	< 2.0	< 2.0	-	< 0.20
Lead	0.050	µg/L	25	< 0.050	0.073	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0.067	-	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	-	< 0.50	< 0.50	-	-	< 0.50	< 0.50	-	< 0.050
Mercury	0.010	µg/L	0.29	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010	< 0.010	< 0.010	-	< 0.010	-	< 0.010	< 0.010	-	-	< 10[1]	< 0.010	-	< 0.010
Molybdenum	0.050	µg/L	9,200	0.489	3.32	0.51	< 0.50	< 0.50	45.0	27.1	-	1.77	39.6	< 0.50	< 0.50	21.9	< 0.50	1.11	1.01	20.5	-	0.52	< 0.50	3.43	3.89	-	4.94	-	2.16	0.83	-	-	3.47	< 0.50	-	1.22
Nickel	0.50	µg/L	490	0.81	1.77	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	-	< 5.0	< 5.0	< 5.0	< 5.0	11.2	< 5.0	< 5.0	< 5.0	0.87	-	< 5.0	< 5.0	< 5.0	6.1	-	< 5.0	-	< 5.0	< 5.0	-	-	< 5.0	< 5.0	-	0.53
Selenium	0.050	µg/L	63	1.22	0.327	1.22	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	4.35	6.22	< 0.50	< 0.50	2.39	0.64	0.248	-	0.78	0.82	< 0.50	12.6	-	< 0.50	-	< 0.50	< 0.50	-	-	0.60	< 0.50	-	0.171
Silver	0.050	µg/L	1.5	< 0.050	< 0.050	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.050	-	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	-	< 0.50	< 0.50	-	-	< 0.50	< 0.50	-	< 0.050
Sodium	500	µg/L	2,300,000	130,000	15,200	218,000	492,000	451,000	310,000	256,000	-	24,000	256,000	492,000	333,000	369,000	361,000	303,000	269,000	83,200	-	758,000	438,000	252,000	320,000	-	106,000	-	442,000	322,000	-	-	55,500	265,000	-	72,900
Thallium	0.010	µg/L	510	< 0.010	< 0.010	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.023	-	< 0.10	< 0.10	< 0.10	< 0.10	-	< 0.10	-	< 0.10	< 0.10	-	-	< 0.10	< 0.10	-	< 0.010
Uranium	0.10	µg/L	420	0.372	1.73	1.31	< 0.10	< 0.10	4.38	4.44	-	0.96	3.27	1.33	1.57	4.76	< 0.10	1.52	2.01	1.58	-	0.80	0.78	0.59	2.51	-	0.77	-	2.97	2.07	-	-	1.15	< 0.10	-	0.405
Vanadium	0.50	µg/L	250	< 0.50	< 0.50	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	-	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	1.00	-	< 5.0	< 5.0	< 5.0	< 5.0	-	< 5.0	-	< 5.0	< 5.0	-	-	< 5.0	< 5.0	-	< 0.50
Zinc	1.0	µg/L	1,100	< 1.0	192	< 10	< 10	< 10	11	47	-	**2,420**	20	< 10	< 10	< 10	< 10	< 10	< 10	1.5	-	< 10	< 10	< 10	< 10	-	< 10	-	< 10	< 10	-	-	< 10	10	-	< 1.0
Petroleum Hydrocarbon (PHC) Fractions																																				
PHC F1	25	µg/L	750	51	< 25	< 25	< 64	< 67	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	270	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	670	< 3,600[1]	**1,380**	**790**	165
PHC F2	100	µg/L	150	**210**	< 100	< 100	**12,700**	**7,460**	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	**20,400**	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	150	< 100	< 100	< 100	< 100	**610**	**16,600**	**33,900**	**28,200**	**24,000**	**230**
PHC F3	250	µg/L	500	< 250	< 250	< 250	**550**	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 500	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	500	< 1,000[1]	**890**	< 500	< 250
PHC F4	250	µg/L	500	< 250	< 250	< 250	< 500	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 500	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 500	< 1,000[1]	< 500	< 500	< 250
Volatile Organic Compounds																																				
Acetone	30	µg/L	130,000	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	32	< 30	< 30	35	73	< 30	< 30	83	< 30	-	202	< 30	-	< 30	< 30	< 30	< 30	< 30
Benzene	0.50	µg/L	44	< 0.50	< 0.50	< 0.50	**195**	**318**	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	**374**	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	2.85	**215**	**17,100**	**1,510**	**1,110**	< 0.50
Bromodichloromethane	2.0	µg/L	85,000	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	-	< 2.0	< 2.0	-	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Bromoform	5.0	µg/L	380	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	-	< 5.0	< 5.0	-	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Bromomethane	0.50	µg/L	5.6	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Carbon Tetrachloride	0.20	µg/L	0.79	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	-	< 0.20	< 0.20	-	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chlorobenzene	0.50	µg/L	630	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 8.0	< 5.5	< 0.50	< 0.50	< 0.50
Chloroform	1.0	µg/L	2.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.3	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-	< 1.0	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromochloromethane	2.0	µg/L	82,000	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	-	< 2.0	< 2.0	-	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Dichlorobenzene, 1,2- (o-DCB)	0.50	µg/L	4,600	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Dichlorobenzene, 1,3- (m-DCB)	0.50	µg/L	9,600	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Dichlorobenzene, 1,4- (p-DCB)	0.50	µg/L	8	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Dichlorodifluoromethane	2.0	µg/L	4,400	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	-	< 2.0	< 2.0	-	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Dichloroethane, 1,1-	0.50	µg/L	320	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Dichloroethane, 1,2-	0.50	µg/L	1.6	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Dichloroethylene, 1,1-	0.50	µg/L	1.6	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Dichloroethylene, cis-1,2-	0.50	µg/L	1.6	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	0.84	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Dichloroethylene, trans-1,2-	0.50	µg/L	1.6	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Dichloropropane, 1,2-	0.50	µg/L	16	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Dichloropropene, 1,3-	0.50	µg/L	5.2	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.67	< 0.50	< 0.50	< 0.50
Dichloropropene, cis-1,3-	0.30	µg/L	na	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	-	< 0.30	< 0.30	-	< 0.30	< 0.60	< 0.30	< 0.30	< 0.30
Dichloropropene, trans-1,3-	0.30	µg/L	na	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	-	< 0.30	< 0.30	-	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30
Ethylbenzene	0.50	µg/L	2,300	< 0.50	< 0.50	< 0.50	41.9	121	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	195	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0.90	391	504	413	436	2.27
Ethylene Dibromide (Dibromoethane, 1,2-)	0.20	µg/L	0.25	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	-	< 0.20	< 0.20	-	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Hexane (n)	0.10	µg/L	51	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0.56	< 0.50	< 0.50	< 0.50	1.12	< 0.50	< 0.50	< 0.50	0.72	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0.73	< 0.50	-	< 0.50	< 0.50	-	< 0.55	3.08	< 0.50	< 0.50	< 0.10
Methyl Ethyl Ketone	20	µg/L	470,000	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	-	< 20	< 20	-	< 20	< 20	< 20	< 20	< 20
Methyl Isobutyl Ketone	20	µg/L	140,000	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	-	< 20	< 20	-	< 20	< 20	< 20	< 20	< 20
Methyl t-butyl ether (MTBE)	2.0	µg/L	190	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	-	< 2.0	< 2.0	-	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Methylene Chloride	5.0	µg/L	610	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	-	< 5.0	< 5.0	-	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Styrene	0.50	µg/L	1,300	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	2.84	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	180	1.85	< 0.50	< 0.50
Tetrachloroethane, 1,1,1,2-	0.50	µg/L	3.4	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Tetrachloroethane, 1,1,2,2-	0.50	µg/L	3.2	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Tetrachloroethylene	0.50	µg/L	1.6	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Toluene	0.50	µg/L	18,000	< 0.50	< 0.50	< 0.50	48.6	3.97	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0.50	< 0.50	0.55	70.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	3.63	5.55	4.300	687	12.3	< 0.50
Trichloroethane, 1,1,1-	0.50	µg/L	640	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Trichloroethane, 1,1,2-	0.50	µg/L	4.7	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Trichloroethylene	0.50	µg/L	1.6	< 0.50	< 0.50	**1.64**	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	**2.95**	0.56	0.64	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	**17.6**	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Trichlorofluoromethane	5.0	µg/L	2,500	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	-	< 5.0	< 5.0	-	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Vinyl Chloride	0.50	µg/L	0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	-	< 0.50	< 0.50	-	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Xylenes	0.50	µg/L	4,200	< 0.50	< 0.50	< 0.50	139	56.4	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	468	< 0.50	< 0.50	< 0.50	<

Table B.2: Maximum Measured Groundwater Concentrations and City of Hamilton Sanitary and Stormwater By-Law Discharge Limits
Central Park, Hamilton, ON

Contaminant	Units	[1]Hamilton Sanitary by-law Critera	[1]Hamilton Stormwater by-law Criteria	Min RDL	Maximum Measured Concentration	Sample Name	Sampling Location
General Chemistry							
Chloride	mg/L	na	1,500	0.1	908	MW-104	MW-104
Cyanide (CN-)	mg/L	na	na	0.002	0.007	MW-104	MW-104
Electrical Conductivity	µS/cm	na	na	2	4070	MW-104	MW-104
Nitrate as N	mg/L	na	na	0.25	1.86	MW-103	MW-103
Nitrite as N	mg/L	na	na	0.25	<1	NA	NA
pH	pH	(5.5 - 9.5)	(5.5 - 9.5)	-	8.53	MW-102	MW-102
Total Suspended Solids	mg/L	15	350	10	**33**	MW-115	MW-115
Dissolved Metals							
Antimony	µg/L	na	5,000	0.1	1.4	MW18-27	MW18-27
Arsenic	µg/L	na	1,000	1	24.7	MW-102	MW-102
Barium	µg/L	na	na	1	458	MW-101	MW-101
Beryllium	µg/L	na	na	0.1	3.4	MW-104	MW-104
Boron	µg/L	na	na	10	1930	MW-116	MW-116
Cadmium	µg/L	1,000	700	0.01	0.2	MW-18-17	MW-18-17
Chromium (Total)	µg/L	1,000	na	0.5	12.4	MW-104	MW-104
Chromium (VI)	µg/L	na	na	0.5	5	MW-104	MW-104
Cobalt	µg/L	na	5,000	0.1	3.7	MW-18-17	MW-18-17
Copper	µg/L	1,000	2,000	0.2	9.5	MW-18-17	MW-18-17
Lead	µg/L	1,000	2,000	0.05	0.5	MW-102	MW-102
Mercury	µg/L	na	10	0.01	< 10	BH18-27	BH18-27
Molybdenum	µg/L	na	1,000	0.05	53.8	MW-102	MW-102
Nickel	µg/L	1,000	2,000	0.5	11.2	MW-18-17	MW-18-17
Selenium	µg/L	na	1,000	0.05	12.6	MW18-09	MW18-08
Silver	µg/L	na	5,000	0.05	< 0.5	NA	NA
Sodium	µg/L	na	na	1000	758000	MW18-05	MW 18-04
Thallium	µg/L	na	na	0.01	0.3	MW18-03	MW18-02
Uranium	µg/L	na	na	0.1	16.8	MW-102	MW-102
Vanadium	µg/L	na	5,000	0.5	14.3	MW-102	MW-102
Zinc	µg/L	3,000	3,000	1	2420	MW-203	MW-203
Petroleum Hydrocarbon (PHC) Fractions							
PHC F1 - BTEX	µg/L	na	na	25	3600	MW18-28	MW 18-277
PHC F1	µg/L	na	na	25	23700	MW18-27	MW 18-26
PHC F2	µg/L	na	na	100	33900	MW18-27	MW 18-26
PHC F3	µg/L	na	na	100	2300	MW-104	MW-104
PHC F4	µg/L	na	na	100	< 1,000	MW18-27	MW18-27
Total Hydrocarbons (C6-C50)	µg/L	na	na	370	57600	MW18-27	MW 18-26

See footnotes on last lage.

Table B.2: Maximum Measured Groundwater Concentrations and City of Hamilton Sanitary and Stormwater By-Law Discharge Limits
Central Park, Hamilton, ON

Contaminant	Units	[1]Hamilton Sanitary by-law Critera	[1]Hamilton Stormwater by-law Criteria	Min RDL	Maximum Measured Concentration	Sample Name	Sampling Location
Volatile Organic Compounds							
Acetone	µg/L	na	na	1	202	MW18-23	MW18-23
Benzene	µg/L	na	10	0.2	17100	MW18-27	MW18-27
Bromodichloromethane	µg/L	na	na	0.2	< 2	NA	NA
Bromoform	µg/L	na	na	0.1	< 5	NA	NA
Bromomethane	µg/L	na	na	0.2	< 2	NA	NA
Carbon Tetrachloride	µg/L	na	na	0.2	< 2	NA	NA
Chlorobenzene	µg/L	na	na	0.1	< 8	NA	NA
Chloroform	µg/L	na	40	0.2	< 2	MW18-01	MW18-01
Dibromochloromethane	µg/L	na	na	0.1	< 2	NA	NA
Dichlorobenzene, 1,2- (o-DCB)	µg/L	na	50	0.1	< 1	NA	NA
Dichlorobenzene, 1,3- (m-DCB)	µg/L	na	na	0.1	< 1	MW-101	MW-101
Dichlorobenzene, 1,4- (p-DCB)	µg/L	na	80	0.1	< 1	NA	NA
Dichlorodifluoromethane	µg/L	na	na	0.2	< 2	NA	NA
Dichloroethane, 1,1-	µg/L	na	na	0.3	< 3	NA	NA
Dichloroethane, 1,2-	µg/L	na	na	0.2	< 2	MW-104	MW-104
Dichloroethylene, 1,1-	µg/L	na	na	0.3	< 3	NA	NA
Dichloroethylene, cis-1,2-	µg/L	na	4,000	0.2	< 2	MW18-24	MW18-24
Dichloroethylene, trans-1,2-	µg/L	na	na	0.2	< 2	NA	NA
Dichloropropane, 1,2-	µg/L	na	na	0.2	< 2	NA	NA
Dichloropropane, 1,3-	µg/L	na	na	0.3	< 3	NA	NA
Dichloropropene, 1,3-	µg/L	na	na	0.5	< 0.67	NA	NA
Dichloropropene, cis-1,3-	µg/L	na	na	0.3	< 0.6	NA	NA
Dichloropropene, trans-1,3-	µg/L	na	140	0.3	< 0.3	NA	NA
Ethylbenzene	µg/L	na	160	0.1	504	MW18-27	MW18-27
Ethylene Dibromide (Dibromoethane, 1,2-)	µg/L	na	na	0.1	< 1	NA	NA
Hexane (n)	µg/L	na	na	0.1	3.08	MW18-27	MW18-27
Methyl Ethyl Ketone	µg/L	na	na	1	21	MW-203	MW-203
Methyl Isobutyl Ketone	µg/L	na	na	1	< 20	NA	NA
Methyl t-butyl ether (MTBE)	µg/L	na	na	0.2	< 2	NA	NA
Methylene Chloride (Dichloromethane)	µg/L	na	2,000	0.3	< 5	NA	NA
Styrene	µg/L	na	na	0.1	180	MW18-27	MW18-27
Tetrachloroethane, 1,1,1,2-	µg/L	na	na	0.1	< 1	NA	NA
Tetrachloroethane, 1,1,2,2-	µg/L	na	1,400	0.1	< 1	NA	NA
Tetrachloroethylene	µg/L	na	1,000	0.2	< 2	MW-203	MW-203
Toluene	µg/L	na	16	0.2	4300	MW18-27	MW18-27
Trichloroethane, 1,1,1-	µg/L	na	na	0.3	3	NA	NA
Trichloroethane, 1,1,2-	µg/L	na	na	0.2	< 2	NA	NA
Trichloroethylene	µg/L	na	400	0.2	17.6	MW18-24	MW18-24
Trichlorofluoromethane	µg/L	na	na	0.4	< 5	NA	NA
Vinyl Chloride	µg/L	na	na	0.17	< 1.7	NA	NA
Xylenes	µg/L	na	1,400	0.2	1960	MW18-27	MW18-27
Xylenes, m+p-	µg/L	na	na	0.4	1320	MW18-27	MW18-27
Xylenes, o-	µg/L	na	na	0.3	641	MW18-27	MW18-27
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	µg/L	na	na	0.02	646	MW18-26	MW18-26
Acenaphthylene	µg/L	na	na	0.02	61.2	MW18-27	MW18-27
Anthracene	µg/L	na	na	0.02	19.6	MW18-27	MW18-27
Benzo(a)anthracene	µg/L	na	na	0.02	3.78	MW 18-277	MW18-27
Benzo(a)pyrene	µg/L	na	na	0.01	2.36	MW 18-277	MW18-27
Benzo(b)fluoranthene	µg/L	na	na	0.02	2.73	MW 18-277	MW18-27
Benzo(g,h,i)perylene	µg/L	na	na	0.02	1.12	MW 18-277	MW18-27
Benzo(k)fluoranthene	µg/L	na	na	0.02	1.05	MW 18-277	MW18-27
Chrysene	µg/L	na	na	0.02	2.75	MW 18-277	MW18-27
Dibenzo(a,h)anthracene	µg/L	na	na	0.02	0.302	MW 18-277	MW18-27
Fluoranthene	µg/L	na	na	0.02	30.1	MW 18-277	MW18-27
Fluorene	µg/L	na	na	0.02	251	MW18-27	MW18-27
Indeno(1,2,3-cd)pyrene	µg/L	na	na	0.02	1.46	MW 18-277	MW18-27
Methylnaphthalene, 1-	µg/L	na	na	0.02	733	MW18-27	MW18-27
Methylnaphthalene, 2-	µg/L	na	na	0.02	1150	MW18-27	MW18-27
Methylnaphthalene, 1- & 2-	µg/L	na	na	0.028	1890	MW18-27	MW18-27
Naphthalene	µg/L	na	na	0.05	39900	MW 18-27	MW18-27
Phenanthrene	µg/L	na	na	0.02	202	MW18-27	MW18-27
Pyrene	µg/L	na	na	0.02	18.3	MW 18-277	MW18-27

See footnotes on last lage.

Table B.2: Maximum Measured Groundwater Concentrations and City of Hamilton Sanitary and Stormwater By-Law Discharge Limits
Central Park, Hamilton, ON

Contaminant	Units	[1]Hamilton Sanitary by-law Critera	[1]Hamilton Stormwater by-law Criteria	Min RDL	Maximum Measured Concentration	Sample Name	Sampling Location
Polychlorinated Biphenyls							
Arochlor 1242	µg/L	na	na	0.02	< 0.2	NA	NA
Arochlor 1248	µg/L	na	na	0.02	< 0.2	NA	NA
Arochlor 1254	µg/L	na	na	0.02	< 0.2	NA	NA
Arochlor 1260	µg/L	na	na	0.02	< 0.2	NA	NA
Total Polychlorinated Biphenyl	µg/L	na	1	0.04	< 0.4	NA	NA

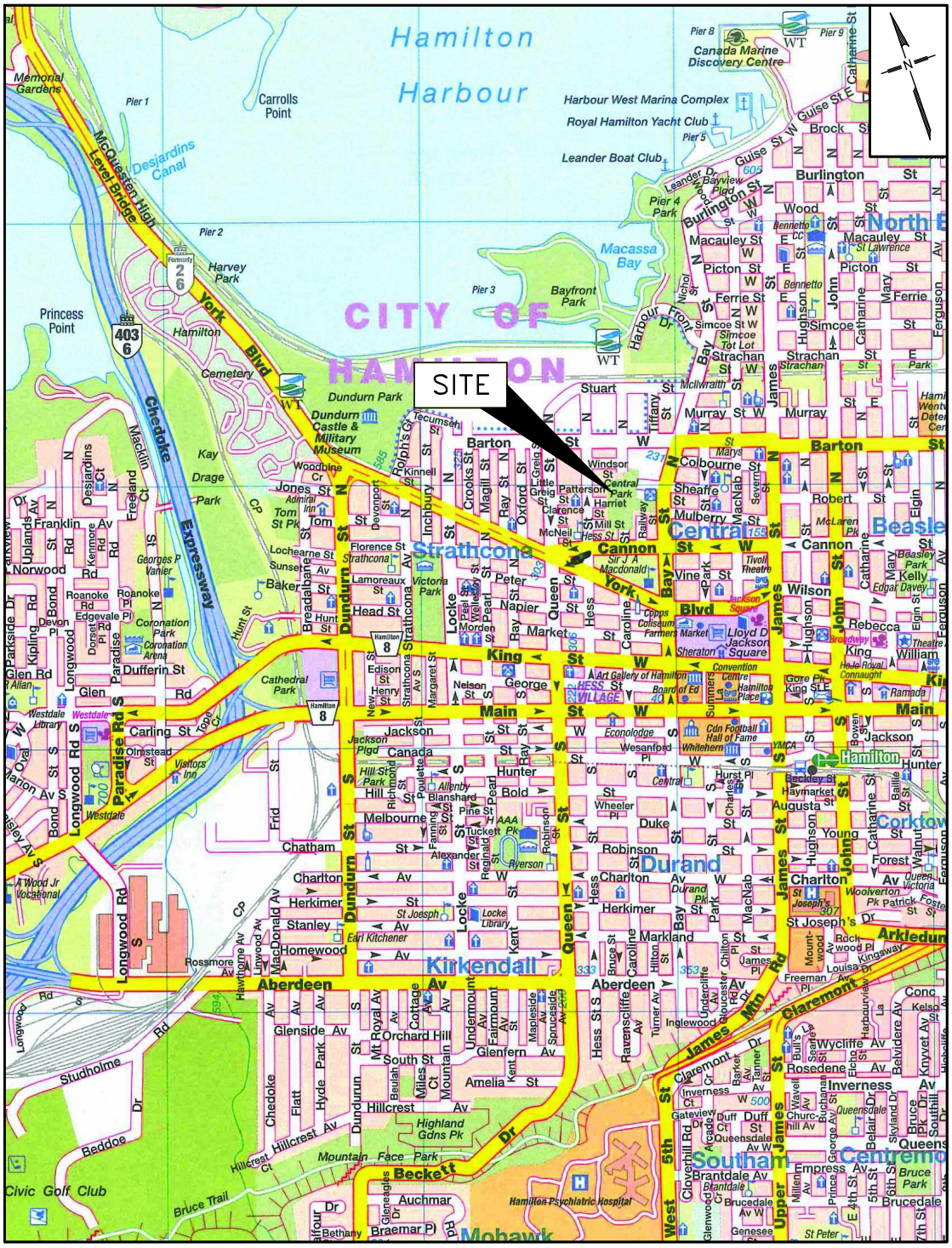
Footnotes:

Additional terms may be defined within the body of SNC-Lavalin's report.
RDL - Reportable Detection Limit, unless otherwise noted
< - Denotes concentration less than indicated detection limit
"-" - Not analyzed
na - Not applicable
µg/L - micrograms per litre
µS/cm - microSiemens per centimetre
mg/L - milligrams per litre

BOLD	Concentration greater than City of Hamilton Sanitary Sewer Discharge limits
SHADED	Concentration greater than City of Hamilton Storm Sewer Discharge limits

[1] City of Hamilton By-Law No. 14-090 - Section 4 - Discharges to Sanitary and Combined Sewers

FIGURES


SITE
Hamilton Harbour
CITY OF HAMILTON
Canada Marine Discovery Centre
Harbour West Marina Complex
Royal Hamilton Yacht Club
Leander Boat Club
Macassa Bay
Bayfront Park
Carrolls Point
Desjardins Canal
Princess Point
Harvey Park
Dundurn Park
Dundurn Castle & Military Museum
Cathedral Park
Coronation Park
Mountain Face Park
Highland Gdns Pk
Civic Golf Club
Hamilton Psychiatric Hospital
Strathcona
Durand
Kirkendall
Mohawk
Southam
Centremo
Beasle
Corktow
Arkledun
Hamilton
Central
Burlington
North E
Barton
King
Main
Aberdeen
Beckett
Claremont
James Mtn Rd
Dundurn St
Queen St
Locke St
James St
John St
Bay St
Wellington St
Hess Village
Jackson Square
Lloyd D Jackson Square
Coliseum
Convention Centre
Hamilton Place
Art Gallery of Hamilton
Board of Ed
Cdn Football Hall of Fame
Tivoli Theatre
Copps Coliseum
Farmers Market
Sheraton
Ramada
Hotel Royal Connaught
Gore Pk
Bruce Trail
Chedoke Expressway
McQuesten High Level Bridge
York Blvd
Paradise Rd
Longwood Rd S
Mountain Hwy
Upper James
West 5th St
Hunt St
Macklin St
Freeland Ct
Desjardins Ct
Kay Drage Park
Georges P Vanier
Westdale Library
Visitors Inn
Studholme Dr
Beddoe Dr
Hillcrest Av
Mt Royal Av
Orchard Hill
Glenside Av
Glenfern Av
Amelia St
Hillcrest
Chatham
Charlton Av
Herkimer
Stanley Av
Homewood Av
Rossmore Av
Aberdeen Av
Melbourne St
Hill St
Jackson St
Canada
Hunter
Bold
Wellington St
Burlington St
Macauley St
Picton St
Ferrie St
Simcoe St W
Strachan St
Stuart St
Murray St W
Barton St
Cannon St
Vine St
Wilson St
Rebecca St
King St
William St
Main St
Jackson St
Augusta St
Young St
Forest
Charlton Av
St Joseph's Dr
Rosedene Av
Inverness Av
Brantdale Av
Brucedale Av
Queensdale Av
Claremont Dr
Inglewood Dr
Wycliffe Av
Mountain Hwy
Upper James
Mohawk
Beckett Dr
Auchmar Rd
Braemar Pl
Bethany
Genesee
St Peter
Brucedale
Queens
Bruce Park
Belmont Pk
Knyvet Av
Belvidere Av
Harbourview Pl
Queen Victoria
Woolverton Pk
Patrick St
Foster
Walnut St
Ferguson
Catharine St
Mary St
Elgin St
Beasley Park
Kelly
Edgar Davey
Rebecca St
Hughson St
Bay St
Wellington St
Hess St
Queen St
Dundurn St
Locke St
James St
John St
Catharine St
Ferguson
Victoria Park
Pearl St
Napier St
Market
Caroline St
Hess St
Queen St
Bay St
Wellington

SCALE 1:1,000

0 20 40m

LEGEND

- INFERRED BURIED METAL OBJECT (AS DEFINED BY OTHERS, AZIMUTH, 2013)
- UNUSUAL SOIL CONDITIONS (AS DEFINED BY OTHERS, AZIMUTH, 2013)
- PHASE TWO STUDY AREA
- PROPERTY LINE
- INFRASTRUCTURE
- EXISTING BUILDING
- FENCE LINE
- EXISTING COMBINED STORM AND SANITARY SEWER
- EXISTING GAS SERVICE
- EXISTING HYDRO SERVICE
- EXISTING TELEPHONE SERVICE
- EXISTING WATER SERVICE
- EXISTING STORM SERVICE
- EXISTING SANITARY SERVICE

NOTE(S):
1. SCALE AND SITE INFRASTRUCTURE LOCATIONS ARE APPROXIMATE
2. INFORMATION ON THIS FIGURE MAY BE LOST IF IT IS PRINTED, PHOTOCOPIED OR FAXED IN OTHER THAN ITS ORIGINAL SIZE AND COLOURS
3. 'm' : METRES

SOURCE(S):
1. CITY OF HAMILTON, PUBLIC WORKS DEPARTMENT, SHEAFFE STREET, DRAWING No. 16–H–103, MARCH 30, 2017
2. CITY OF HAMILTON, PUBLIC WORKS DEPARTMENT, CANNON STREET WEST, DRAWING No. 16–H–104, MARCH 30, 2017
3. CITY OF HAMILTON, PUBLIC WORKS DEPARTMENT, RAILWAY STREET, DRAWING No. 16–H–105, SHEETS 1 AND 2, MARCH 30, 2017
4. CITY OF HAMILTON, PUBLIC WORKS DEPARTMENT, RAILWAY STREET, DRAWING No. 16–H–105, MARCH 30, 2017
5. CITY OF HAMILTON, PUBLIC WORKS DEPARTMENT, CAROLINE STREET NORTH, DRAWING No. 16–H–106, SHEETS 1 AND 2 MARCH 30, 2017
6. CITY OF HAMILTON, PUBLIC WORKS DEPARTMENT, HARRIET STREET, DRAWING NO. 16–H–107, MARCH 30, 2017
7. CITY OF HAMILTON, PUBLIC WORKS DEPARTMENT, MILL STREET, DRAWING No. 16–H–108, MARCH 30, 2017

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Client/Location: CITY OF HAMILTON CENTRAL PARK, HAMILTON, ON		Title: SITE LAYOUT	
Project No: 669597	Filename: 008F02_669597	Date: MAY 2020	Dwg No: FIGURE 2
Drawn: AG	Verified: SA	Project Manager: LB	

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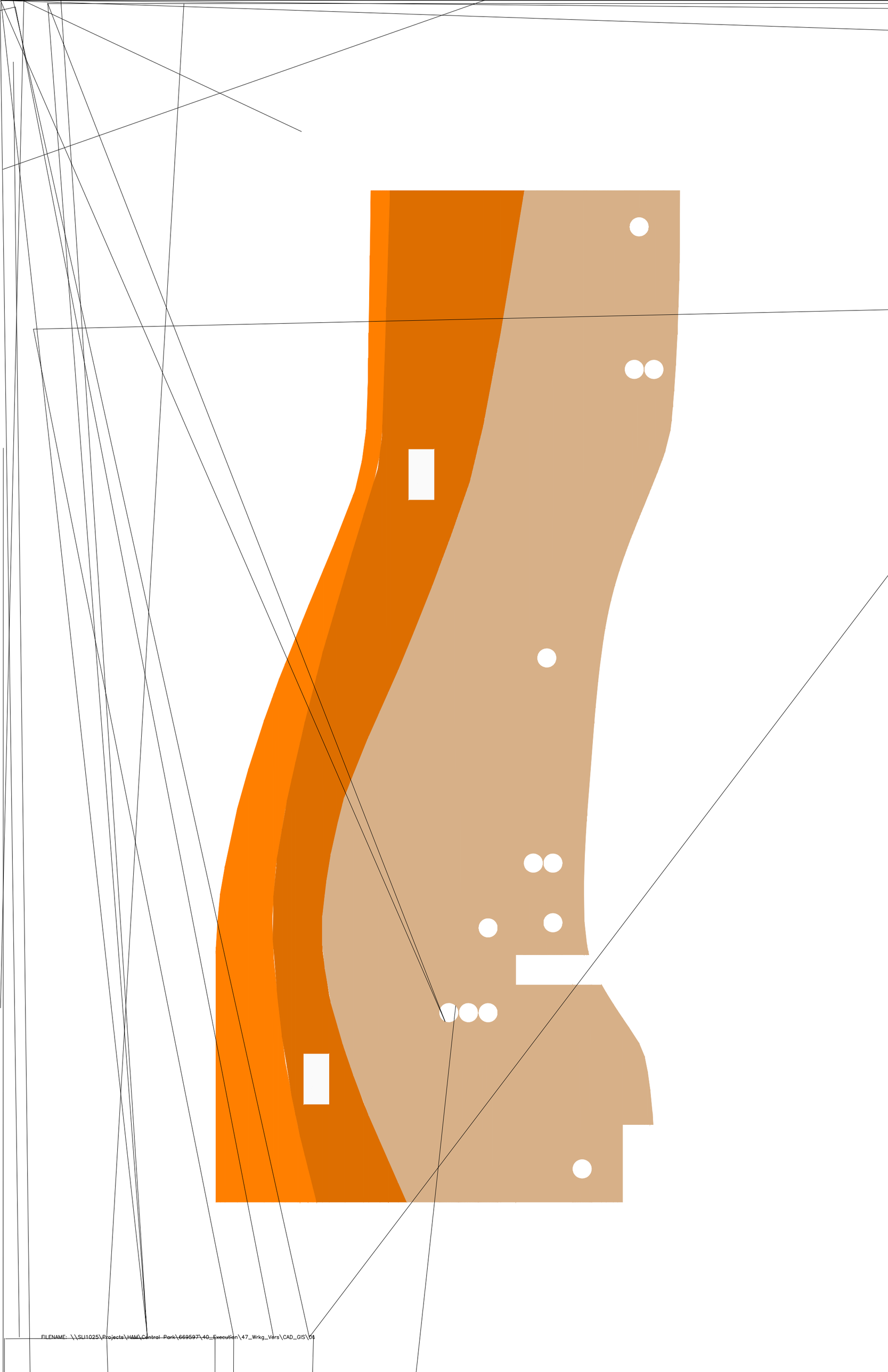

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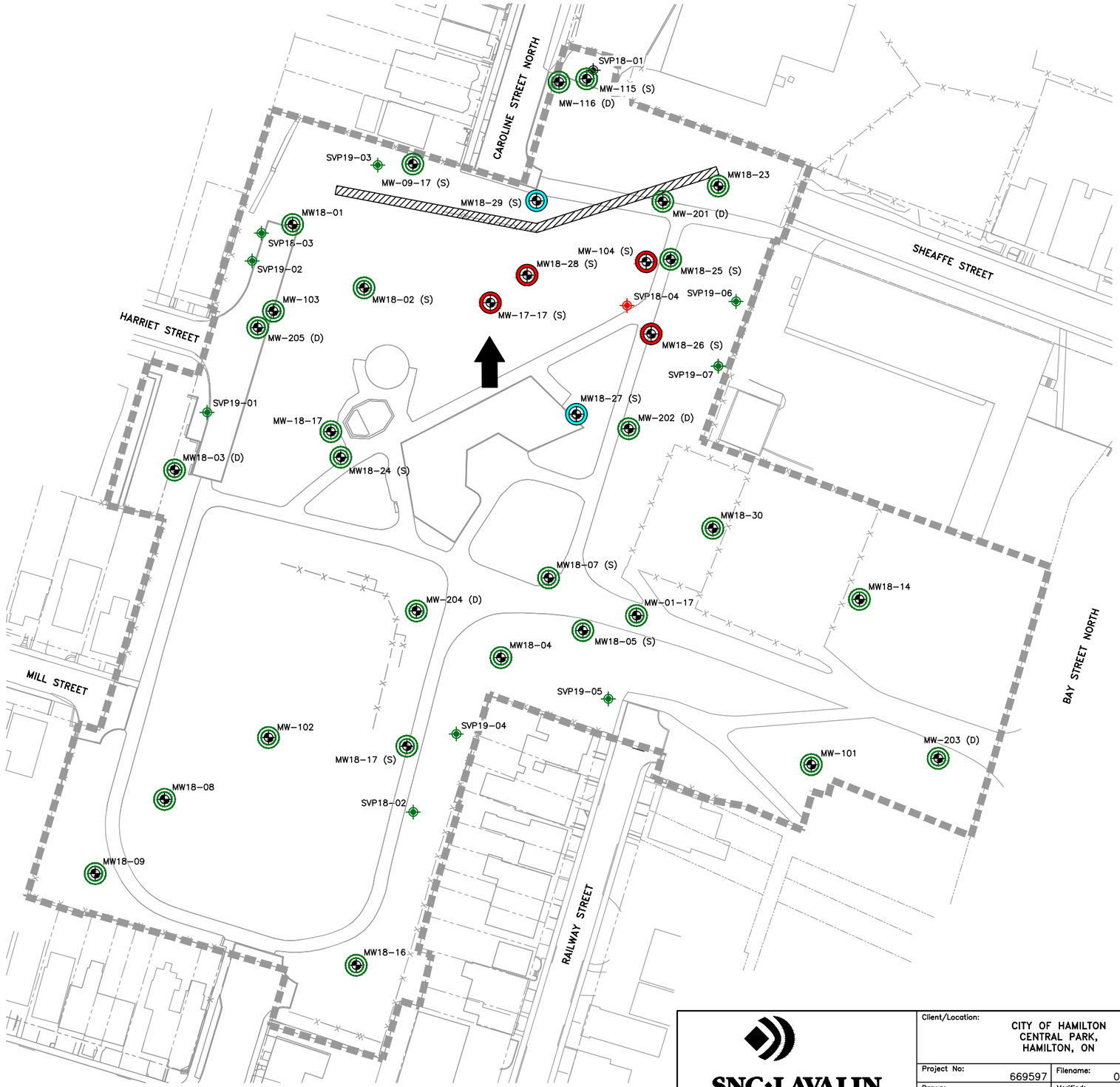

LEGEND

- MONITORING WELL
- SOIL VAPOUR PROBE
- RA PROPERTY
- PROPERTY LINE
- INFRASTRUCTURE
- EXISTING BUILDING
- FENCE LINE
- GROUNDWATER MITIGATION SYSTEM
- INTERPRETED SHALLOW HORIZONTAL GROUNDWATER FLOW
- NO RISK TO INDOOR AIR IDENTIFIED BASED ON SOIL VAPOUR CONCENTRATIONS FROM SAMPLING EVENT, SHOWN IN GREEN
- RISK (BENZENE) TO INDOOR AIR IDENTIFIED BASED ON SOIL VAPOUR CONCENTRATIONS FROM SAMPLING EVENT, SHOWN IN RED
- LOCATION WHERE MOST RECENT GROUNDWATER SAMPLE MET HH-SSTL FOR ALL PARAMETERS THAT WERE ANALYSED, SHOWN IN GREEN
- LOCATION WHERE MOST RECENT GROUNDWATER SAMPLE EXCEEDED HH-SSTL FOR BENZENE
- LOCATION WHERE MOST RECENT GROUNDWATER SAMPLE EXCEEDED HH-SSTL FOR ALL PARAMETERS, SHOWN IN RED
- (S) INDICATES SHALLOW WATER TABLE (DEPTH TO WATER TABLE <3mbg)
- (D) INDICATES DEEPER SCREENED WELL
- HH-SSTL HUMAN HEALTH-SITE SPECIFIC TARGET LEVEL PROTECTIVE OF INHALATION OF INDOOR AIR AT OFF-SITE COMMERCIAL PROPERTIES

NOTE(S):
1. SCALE AND SITE INFRASTRUCTURE LOCATIONS ARE APPROXIMATE
2. INFORMATION ON THIS FIGURE MAY BE LOST IF IT IS PRINTED, PHOTOCOPIED OR FAXED IN OTHER THAN ITS ORIGINAL SIZE AND COLOURS

SNC·LAVALIN

Client/Location: CITY OF HAMILTON CENTRAL PARK, HAMILTON, ON		Title: SUMMARY OF GROUNDWATER RESULTS EXCEEDING HUMAN HEALTH SPECIFIC TARGET LEVEL (OFF-SITE COMMERCIAL)	
Project No: 669597	Filename: 008F08_669597	Date: MAY 2020	Dwg No: FIGURE 8
Drawn: AG	Verified: SA	Project Manager: LB	

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NOTE(S):
1. SCALE AND SITE INFRASTRUCTURE LOCATIONS ARE APPROXIMATE
2. INFORMATION ON THIS FIGURE MAY BE LOST IF IT IS PRINTED, PHOTOCOPIED OR FAXED IN OTHER THAN ITS ORIGINAL SIZE AND COLOURS

SNC·LAVALIN

Client/Location: CITY OF HAMILTON CENTRAL PARK, HAMILTON, ON		Title: PROPOSED REMEDIAL EXCAVATION	
Project No: 669597	Filename: 008F09_669597	Date: MAY 2020	Dwg No: FIGURE 9
Drawn: AG	Verified: LB	Project Manager: LB	

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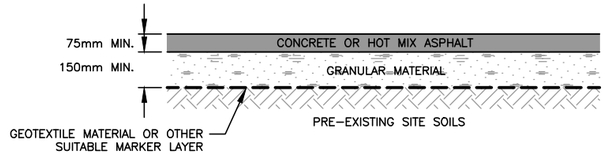
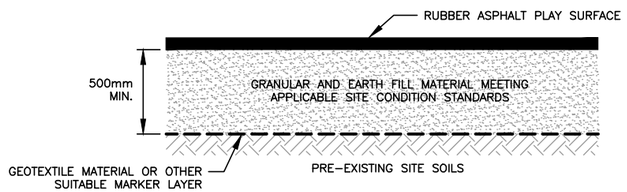
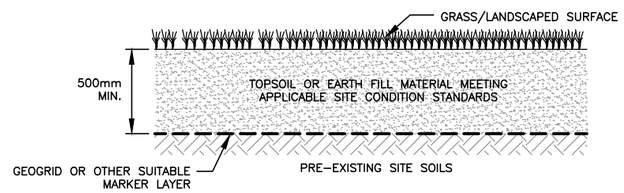
FILL CAP/HARD CAP



DETAIL 1 – WALKWAYS, ACCESS ROADS AND PAVED PARKING AREAS
NOT TO SCALE

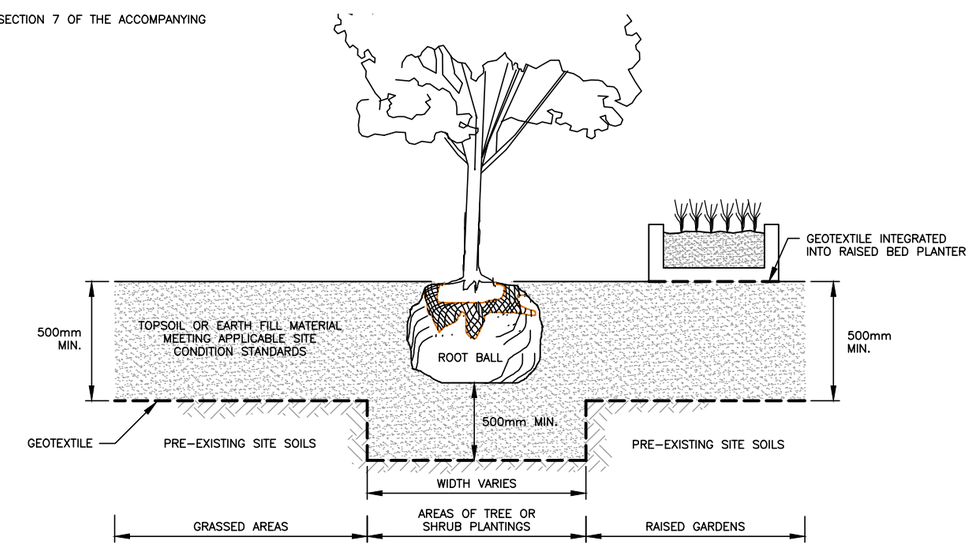


DETAIL 2a – PLAY AREAS
NOT TO SCALE



DETAIL 2b – GRASS/LANDSCAPED AREAS
NOT TO SCALE

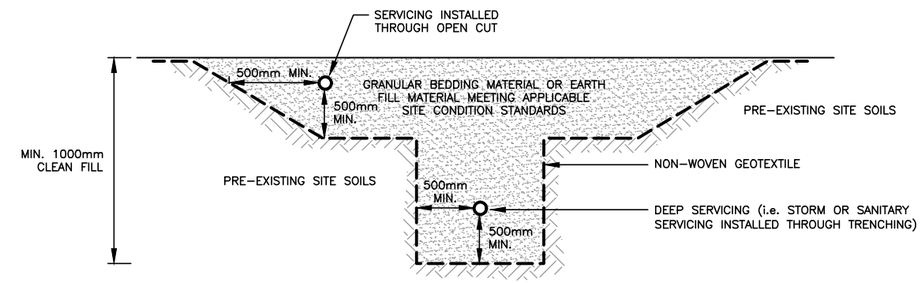
NOTE(S):
1. SOIL MATERIALS USED IN CONSTRUCTING THE FILL CAP AND HARD CAP SHALL MEET THE TABLE 3 SITE CONDITION STANDARDS.
2. REFER TO SECTION 7 OF THE ACCOMPANYING REPORT.



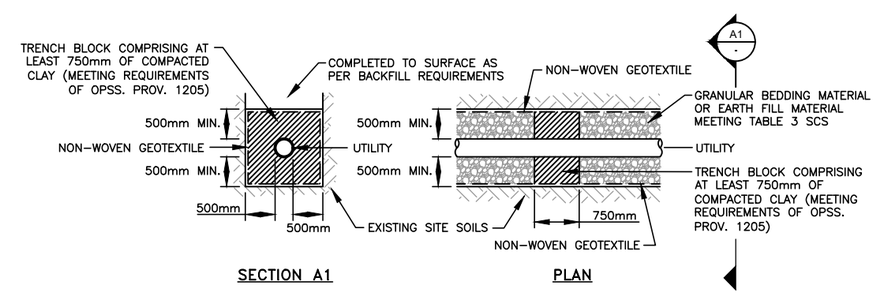
DETAIL 3 – LANDSCAPED AREAS WITH DEEP ROOTING PLANTS
NOT TO SCALE

NOTE(S):
1. SCALE AND SITE INFRASTRUCTURE LOCATIONS ARE APPROXIMATE
2. INFORMATION ON THIS FIGURE MAY BE LOST IF IT IS PRINTED, PHOTOCOPIED OR FAXED IN OTHER THAN ITS ORIGINAL SIZE AND COLOURS

FUTURE SITE SERVICES AND TRENCH BLOCKS



DETAIL 4 – SITE SERVICING
NOT TO SCALE



DETAIL 5 – TRENCH BLOCK
NOT TO SCALE

SNC·LAVALIN

Client/Location: CITY OF HAMILTON CENTRAL PARK, HAMILTON, ON		Title: SCHEMATIC OF RISK MANAGEMENT MEASURES	
Project No: 669597	Filename: 008F10_669597	Date: MARCH 2021	Dwg No: FIGURE 10
Drawn: DM/AG	Verified: AM	Project Manager: LB	

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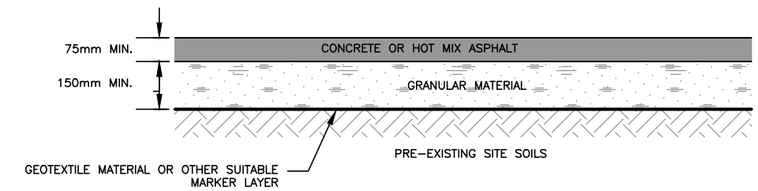
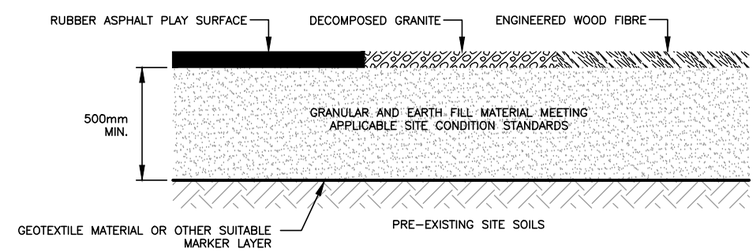
NOTE:
AREAS TO BE PLANTED WITH TREES AND DEEP ROOTING SHRUBS TO BE COMPLETED WITH SOFT (FILL) CAP AND GEOTEXTILE.

LEGEND
- RA PROPERTY
- PROPERTY LINE
- INFRASTRUCTURE
- EXISTING BUILDING
- FENCE LINE
- EXISTING TREES TO BE PRESERVED
- PROPOSED TREE
- SOFT (FILL) CAP WITH GEOTEXTILE
- SOFT (FILL) CAP WITH GEOGRID
- HARD CAP

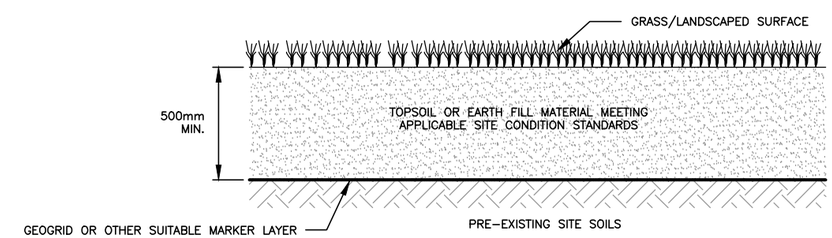
NOTE(S):
1. SCALE AND SITE INFRASTRUCTURE LOCATIONS ARE APPROXIMATE
2. INFORMATION ON THIS FIGURE MAY BE LOST IF IT IS PRINTED, PHOTOCOPIED OR FAXED IN OTHER THAN ITS ORIGINAL SIZE AND COLOURS
3. 'm' : METRES



HARD CAP
NOT TO SCALE



SOFT CAP (FILL) WITH GEOTEXTILE
NOT TO SCALE



SOFT CAP (FILL) WITH GEOGRID
NOT TO SCALE

SNC·LAVALIN

Client/Location: CITY OF HAMILTON CENTRAL PARK, HAMILTON, ON		Title: AREAS WHERE HARD CAP AND SOFT (FILL) CAP ARE REQUIRED	
Project No: 669597	Filename: 008F11_669597	Date: MARCH 2021	Dwg No: FIGURE 11
Drawn: DM	Verified: LB	Project Manager: LB	

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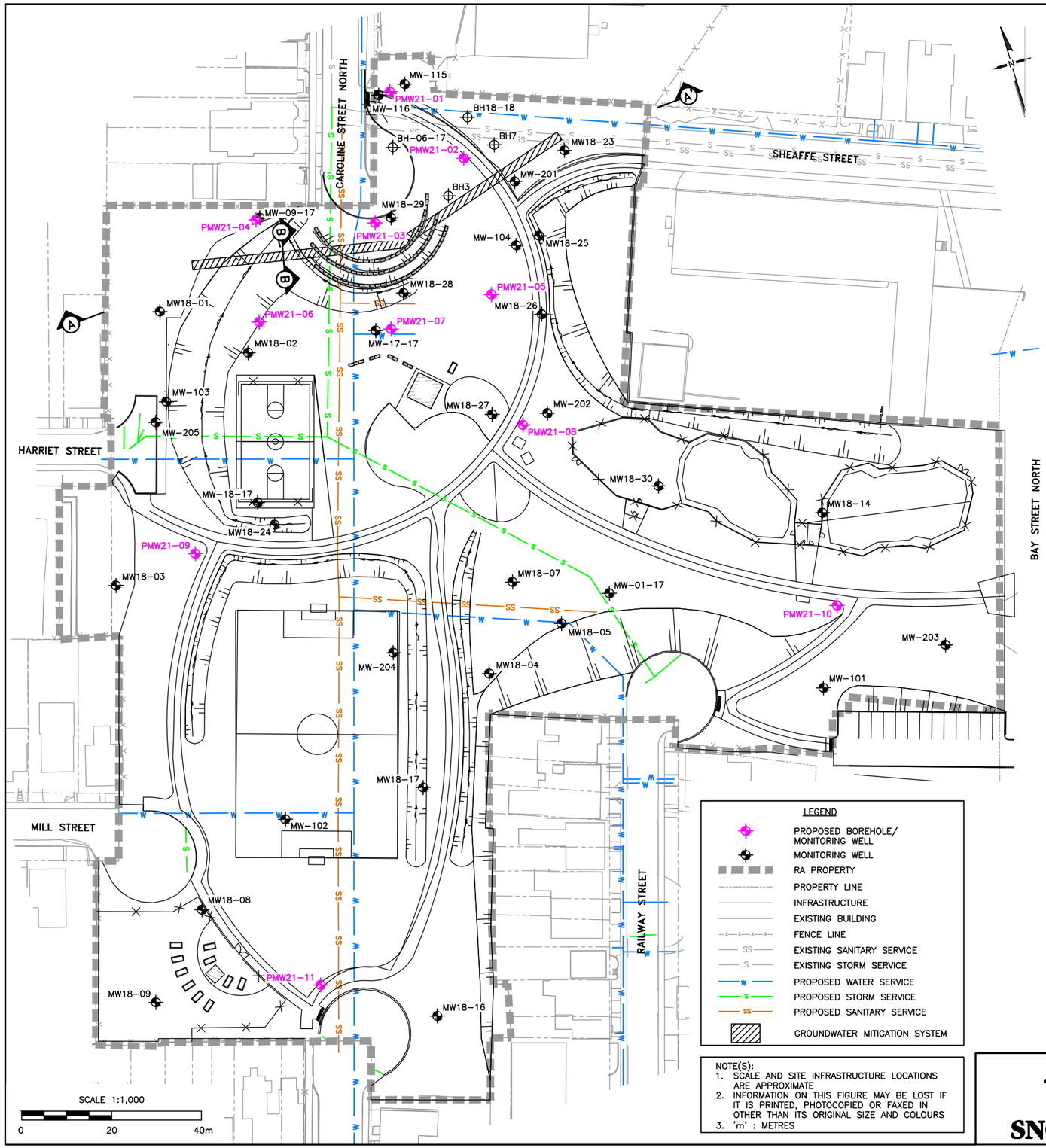
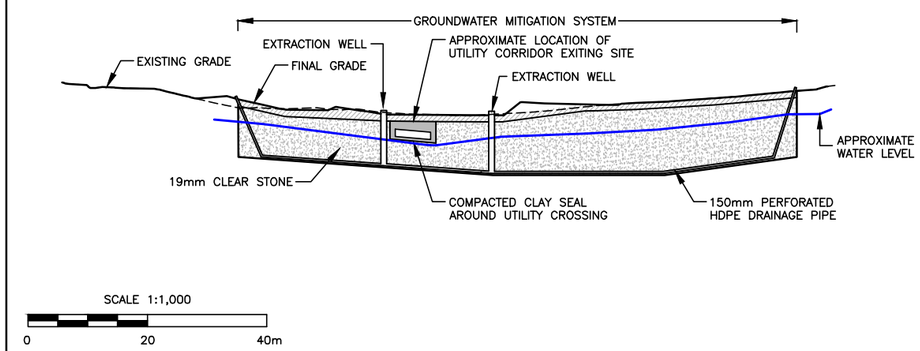


LEGEND

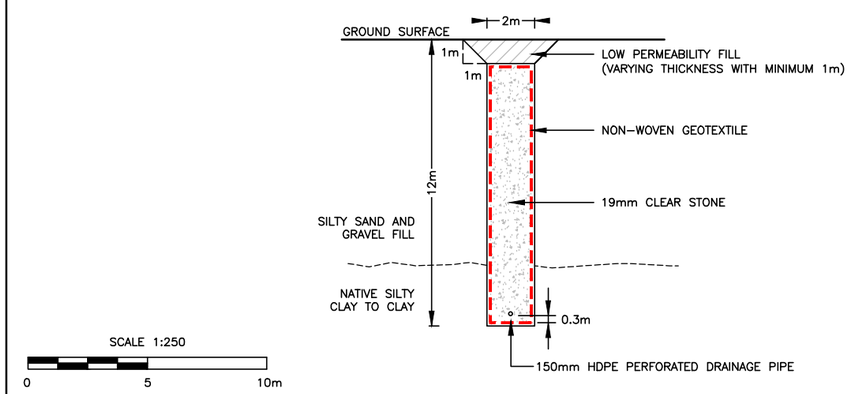
- PROPOSED BOREHOLE/ MONITORING WELL
- MONITORING WELL
- RA PROPERTY
- PROPERTY LINE
- INFRASTRUCTURE
- EXISTING BUILDING
- FENCE LINE
- EXISTING SANITARY SERVICE
- EXISTING STORM SERVICE
- PROPOSED WATER SERVICE
- PROPOSED STORM SERVICE
- PROPOSED SANITARY SERVICE
- GROUNDWATER MITIGATION SYSTEM

NOTE(S):
1. SCALE AND SITE INFRASTRUCTURE LOCATIONS ARE APPROXIMATE
2. INFORMATION ON THIS FIGURE MAY BE LOST IF IT IS PRINTED, PHOTOCOPIED OR FAXED IN OTHER THAN ITS ORIGINAL SIZE AND COLOURS
3. 'm' : METRES

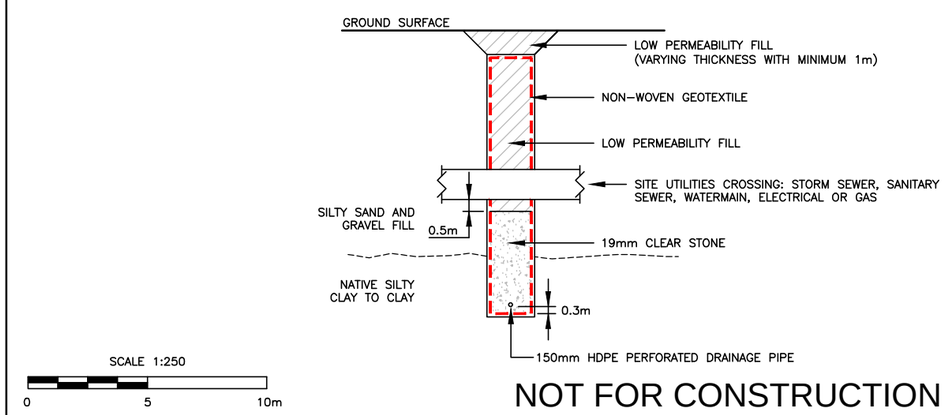
TYPICAL LONGITUDINAL CROSS SECTION A–A'



TYPICAL CROSS SECTION OF GROUNDWATER MITIGATION SYSTEM (B–B')



TYPICAL CROSS SECTION AT UTILITY CROSSING



NOT FOR CONSTRUCTION

SNC·LAVALIN

Client/Location: CITY OF HAMILTON CENTRAL PARK, HAMILTON, ON			Title: PROPOSED GROUNDWATER MONITORING AND SAMPLING NETWORK
Project No: 669597	Filename: 008F12_669597	Date: MARCH 2021	Dwg No: FIGURE 12
Drawn: AG	Verified: LB	Project Manager: LB	

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APPENDIX A

6 RA Conclusions and Recommendations

6.1 Recommended Site Specific Target Levels Protective of Human Health

Based on the results of the risk assessment, final human health SSTLs (HH-SSTLs) have been identified in Table 6.1 (Surface Soil), Table 6.2 (Groundwater Along the Property Boundary), Table 6.3 (Surface and Subsurface Soil Applicable to Trench Worker), and Table 6.4 (Groundwater Applicable to Trench Worker). Table 6.1 presents the lowest surface soil SSTLs based on four (4) operable exposure pathways associated with surface soil COCs for the human receptors including Park Visitors, Long-Term Outdoor Workers, Off-Site Residents, and Off-Site Commercial Workers evaluated in HHRA. Table 6.2 presents the groundwater SSTLs based on the inhalation of indoor air exposure pathway for Off-Site Residents and Off-Site Commercial Workers located at the hydraulic downgradient off-Site properties adjacent to the RA Property. Table 6.3 presents soil SSTLs for Subsurface Workers. The surface and subsurface soil SSTLs are based on the direct contact with soil exposure pathway and inhalation of trench air originating from surface soil and subsurface soil exposure pathways. Table 6.4 presents groundwater SSTLs for Subsurface Workers, groundwater SSTLs were based on inhalation of trench air originating from groundwater. The Human Health SSTLs represent the higher value between the calculated HH-RBCs identified in Section 4.4.2 and the MECP generic SCSs; MECP Free Phase threshold or ½ Solubility were also used to identify the HH-RBCs that were above the free phase threshold and ½ of solubility limit for soil and groundwater, respectively. As such, the final HH-SSTL was not identified at a concentration below the MECP SCS and/or above the free phase threshold or ½ of solubility limit. Table 6.3 recommended SSTLs were all based on MECP (MOE 2011a) Table 3 or Table 5 for surface soil and subsurface soil SCS as the calculated HH-RBCs are all below the MECP (MOE 2011a) Table 3 and Table 5 SCS. As such, free phase threshold values are not provided in Table 6.3.

Table 6.1 Final Surface Soil Site Specific Target Levels (SSTLs) Protective of Human Health (Park Visitors, Long-Term Outdoor Workers, Off-Site Residents, and Off-Site Commercial Workers)

COC	Site Maximum Concentration (µg/g)	Lowest Soil RBC (µg/g)	MOE Table 3 SCS (µg/g)	MOE Free Phase Threshold (µg/g)	Final HH-SSTLs Surface Soil (µg/g)
BTEX					
Benzene	169.2	8	0.21	5000	8
PHCs					
PHC F2	6588	2730	98	2700	2700
PHC F3	13560	5010	300	5800	5010
PHC F4	6204	5280	2800	6900	5280
PAHs					
Acenaphthylene	12	5.96	0.15	2900	6.0
Benz[a]anthracene	104.4	0.6	0.5	7600	0.6
Benzo[a]pyrene	76.8	0.06	0.3	7600	0.3
Benzo[b]fluoranthene	90	0.6	0.78	7600	0.8
Benzo[ghi]perylene	30	5.96	6.6	7600	6.6
Benzo[k]fluoranthene	43.2	0.6	0.78	7600	0.8
Chrysene	90	5.96	7	7700	7
Dibenz[a,h]anthracene	13.2	0.06	0.1	7600	0.1
Fluoranthene	324	5.96	0.69	7600	5.96
Indeno[1,2,3-cd]pyrene	34.8	0.6	0.38	7600	0.6

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COC	Site Maximum Concentration (µg/g)	Lowest Soil RBC (µg/g)	MOE Table 3 SCS (µg/g)	MOE Free Phase Threshold (µg/g)	Final HH-SSTLs Surface Soil (µg/g)
Methlynaphthalene, 2-(1-)	74.4	62.34	0.99	3600	62.34
Pyrene	264	59.57	78	7700	78
Metals & Inorganics					
Antimony	63.12	6.51	7.5	8000	7.5
Arsenic	51.6	0.78	18	12000	18
Cadmium	54.96	0.6	1.2	18000	1.2
Copper	8880	519.21	140	NA	519
Lead	4920	4.18	120	24000	120
Zinc	49920	4884	340	15000	4884
PCBs					
Polychlorinated Biphenyls	1.92	0.31	0.35	5000	0.35

NA- Not Available

Table 6.2 Final Groundwater Human Health SSTLs Protective of Inhalation of Indoor Air at Off-Site Properties

COCs	Maximum Groundwater Concentration (µg/L)	RBC GW (µg/L)	MOE Table 7 GW SCS (µg/L)	MOE Free Phase Threshold	Final HH-SSTLs Groundwater (µg/L)
Residential Scenario					
VOCs					
Benzene	20520	0.11	0.5	900000	0.5
Toluene	5160	192	320	260000	320
Ethylbenzene	605	31	54	85000	54
Xylene Mixture	2352	27	72	53000	72
PHCs					
PHC F1	4320	3.48	420	1900	420
PHC F2	40680	5.87	150	150	150
VOCs					
Styrene	216	24.18	43	160000	43
Trichloroethylene	21	0.07	0.5	640000	0.5
Vinyl Chloride	3	0.01	0.5	4400000	0.5
PAHs					
Acenaphthene	775	6.79	17	2000	17
Acenaphthylene	73	0.99	1	8100	1
Naphthalene	27480	2.14	7	16000	7
Metals & Inorganics					
Mercury	12	0.002	0.1	30	0.1
Commercial Scenario					
Benzene	20520	23.6	44	900000	44

Table 6.3 Final Soil Human Health SSTLs for the Protection of Subsurface Workers

COCs	Maximum Soil Concentrations (µg/g)	Lowest RBC_{Soil} (µg/g)	MOE Generic SCS (µg/g)	Final Soil SSTLs (µg/g)
Surface Soil			**MOE Generic Table 3 SCS**	
BTEX				
Benzene	169	0.5	0.21	0.5
Toluene	246	82.6	68	82.6

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COCs	Maximum Soil Concentrations (µg/g)	Lowest RBC_{Soil} (µg/g)	MOE Generic SCS (µg/g)	Final Soil SSTLs (µg/g)
Surface Soil			**MOE Generic Table 3 SCS**	
Xylene Mixture	403	11.6	26	26
PHCs				
PHC F1	1104	21.1	55	55
PHC F2	6588	19.6	98	98
VOCs				
Styrene	162	4.9	0.7	4.9
PAHs				
Acenaphthylene	99	6.5	7.9	7.9
Benz[a]anthracene	104	31.1	0.5	31.1
Benzo[a]pyrene	77	3.1	0.3	3.1
Benzo[b]fluoranthene	90	31.1	0.78	31.1
Benzo[k]fluoranthene	43	31.1	0.78	31.1
Dibenz[a,h]anthracene	13	3.1	0.1	3.1
Naphthalene	65	0.01	0.6	0.6
Metals & Inorganics				
Antimony	63	54.6	7.5	54.6
Arsenic	52	40.5	18	40.5
Cadmium	55	6.9	1.2	6.9
Copper	8880	4887	140	4887
Lead	4920	38.2	120	120
Zinc	49920	40961	340	40961
Mercury	7	0.01	0.27	0.27
Subsoil			**MOE Generic Table 5 SCS**	
BTEX				
Benzene	33	0.2	0.21	0.21
PHCs				
PHC F1	216	11.4	55	55
PHC F2	15840	65.5	98	98
VOCs				
Trichloroethylene	3	0.08	0.061	0.06
Vinyl Chloride	0.3	0.01	0.02	0.02
PAHs				
Benz[a]anthracene	240	31.1	0.96	31.1
Benzo[a]pyrene	120	3.1	0.3	3.1
Benzo[b]fluoranthene	180	31.1	0.96	31.1
Benzo[k]fluoranthene	95	31.1	0.96	31.1
Dibenz[a h]anthracene	14	3.1	0.1	3.1
Fluoranthene	792	311.3	9.6	311.3
Indeno[1 2 3-cd]pyrene	62	31.1	0.96	31.1
Methlynaphthalene, 2-(1-)	845	487	34	487
Naphthalene	3036	0.0016	0.65	0.65
Metals & Inorganics				
Arsenic	120	40.5	18	40.5
Mercury	49	0.06	0.27	0.27

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Table 6.4 Final Groundwater Human Health SSTLs for the Protection of Subsurface Workers

COCs	Maximum Groundwater (µg/L)	Lowest RBC_{GW} (µg/L)	MOE Table 7 SCS	½ of Solubility	Final Shallow Groundwater SSTLs (µg/L)
BTEX					
Benzene	20500	469	0.5	900000	469
PHCs					
PHC F2	40680	334	150	150	150
PHC F3	2760	251	500	4.90E-08	251
PAHs					
Acenaphthene	775	571	17	2000	571
Acenaphthylene	73	55	1	81000	55
Benzo[a]pyrene	0.91	0.04	0.81	0.81	0.81
Benzo[b]fluoranthene	11.68	0.67	0.75	0.75	0.75
Benzo[k]fluoranthene	0.64	0.4	0.4	0.4	0.4
Indeno[1 2 3-cd]pyrene	0.56	0.2	0.2	0.095	0.2
Naphthalene	27500	917	7	16000	917

6.2 Recommended Site-Specific Target Levels Protective of Ecological Health

Based on the results of the qualitative and quantitative ecological health risk assessment, RA Property E-SSTLs for surface soil COCs for the protection of ecological receptors were identified in Table 6.5. The TRVs for plants/soil organisms and mammals/birds incorporated MEP adjustment factors of 1.9 and 1,000, respectively. Although the calculated ERs exceeded the targeted ER of 1 for a number of COCs in risk characterization, risk based concentrations for the protection of ecological receptors were not calculated, as the MEP adjusted component values were applied in the secondary screening of COCs and were used to determine the E-SSTLs. Table 6.5 presents the surface soil E-SSTLs represent the higher value between the MEP adjusted component values and the MECP generic SCSs; MECP Free Phase threshold were also used to identify the E-SSTLs that were above the free phase threshold for soil. As such, the final E-SSTL was not identified at a concentration below the MECP SCS and/or above the free phase threshold. No groundwater E-SSTLs were calculated as there is no unacceptable risk identified for downgradient surface water aquatic life.

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Table 6.5 Ecological Site Specific Target Levels (E-SSTLs) - Surface Soil

Parameter	Units	Table 3 Generic SCS R/P/I GC [1]	Site Maximum Concentration	EPC (1.2xMaximum)	Ontario Soil Background (Table 1)	Plants& Soil Org. R/P/I_CG_NPG [2]	MEP (1.9x) is Applied	Mammals & Birds. R/P/I_CG_NPG [2]	MEP (1,000x) is Applied	MOE Free Phase Threshold (µg/g)	Final E-SSTL	RMM Required?
General Chemistry												
Cyanide (WAD)	µg/g	0.051	2.3	2.8	0.051	0.9	1.71	0.11	110	240000	1.7	YES
Electrical Conductivity	mS/cm	0.7	2880	3456	0.57	0.7	1.33	na	na	na	1.3	YES
Sodium Adsorption Ratio	None	5 [5]	109	130.8	2.4	5	9.5	na	na	na	9.5	YES
Total Metals												
Antimony	µg/g	7.5	52.6	63.1	1.3	20	38	25	25000	8000	38	YES
Arsenic	µg/g	18	43.0	51.6	18	20	38	51	51000	12000	38	YES
Boron (Hot Water Soluble)	µg/g	1.5	3.6	4.4	0.5	1.5	2.85	na	na	5000	3	YES
Cadmium	µg/g	1.2	45.8	55.0	1.2	12	22.8	1.9	1900	18000	23	YES
Copper	µg/g	140	7400	8880	92	140	266	770	770000	na	266	YES
Lead	µg/g	120	4100	4920	120	250	475	32	32000	24000	475	YES
Zinc	µg/g	340	41600	49920	290	400	760	340	340000	15000	760	YES
BTEX												
Benzene	µg/g	0.21	141	169	0.02	25	47.5	370	370000	5000.00	47.5	YES
Xylenes	µg/g	3.1	336	403	0.05	95	180.5	96	96000	2300	180.5	YES
PHCs												
PHC F1	µg/g	55	920	1104	25	210	399	na	na	1700	399	YES
PHC F2	µg/g	98	5490	6588	10	150	285	na	na	2700	285	YES
PHC F3	µg/g	300	11300	13560	240	300	570	na	na	5800	570	YES
PHC F4 (silica gel)	µg/g	2,800	5170	6204	120	2800	5320	na	na	6900	5320	YES
VOCs												
Styrene	µg/g	0.7	0.05	162	0.05	17	32.3	370[b]	370000	3500	32.3	YES
PAHs												
Anthracene	µg/g	0.67	100	120	0.16	2.5	4.75	38000	38000000	2700	4.8	YES
Benzo(a)anthracene	µg/g	0.5	87	104	0.36	0.5	0.95	6.2[e]	6200	7600	0.95	YES
Benzo(a)pyrene	µg/g	0.3	64	76.8	0.3	20	38	1600	1600000	7600	38	YES
Benzo(b)fluoranthene	µg/g	0.78	75	90	0.47	7.6	14.44	6.2[e]	6200	7600	14.4	YES
Benzo(g,h,i)perylene	µg/g	6.6	25	30	0.68	6.6	12.54	1.1[d]	1100	7600	12.5	YES
Benzo(k)fluoranthene	µg/g	0.78	36	43.2	0.48	7.6	14.44	6.2[e]	6200	7600	14.4	YES
Chrysene	µg/g	7	75	90	2.8	7	13.3	6.2[e]	6200	7700	13.3	YES
Fluoranthene	µg/g	0.69	270	324	0.56	50	95	0.69	690	7600	95	YES
Fluorene	µg/g	62	64	76.8	0.12	ncv	55.1[a]	15.4[f]	15400	2800	55.1	YES
Indeno(1,2,3-cd)pyrene	µg/g	0.38	29	34.8	0.23	0.38	0.722	1.1[d]	1100	7600	0.7	YES
Methylnaphthalene, 1- & 2-	µg/g	0.99 [3]	62	74.4	0.59	ncv	55.1[a]	100[c]	100000	3600	55.1	YES
Naphthalene	µg/g	0.6	54.2	65.0	0.09	0.6	1.14	380	380000	2800	1.1	YES
Phenanthrene	µg/g	6.2	310	372	0.69	6.2	11.78	2700	2700000	2300	11.8	YES
Pyrene	µg/g	78	220	264	1	ncv	34.2[b]	4700	4700000	7700	34.2	YES

All terms defined within the body of SNC-Lavalin's report.
µg/g - micrograms per gram, dry weight basis
ncv - No component value
ns - No MECP MOE (2011b) standard
na - Not applicable
mS/cm - milliSiemens per centimetre
[1] Table 3 full depth site condition standards in a non-potable groundwater condition for residential/parkland/institutional property use (R/I/I), coarse textured surface soils (MOE, 2011b)
[2] Soil components for Table 3 full depth site condition standards in a non-potable groundwater condition for residential/parkland/institutional property use (R/I/I), coarse textured surface soils (MOE, 2011b). Soil component values were selected for the protection of ecological health based on residential parkland land use, plant & soil organisms, mammals & birds, soil leaching to groundwater and migrating to surface water (S-GW3).
[3] Standard applies to both 1- and 2- methylnaphthalene, with the provision that if both are detected the sum of the two must not exceed the standard. Individual isomer is not carried forward for evaluation as the methylnaphthalene, 1-,2- is retained for further evaluation.
[a] 29 µg/g is the US EPA (2007) Eco-SSL protective of soil invertebrates for LMW-PAHs that do not have Plants & Soil Org. component values from MOE, 2011b.
[b] 18 µg/g is the US EPA Eco-SSL (2007) protective of soil invertebrates for HMW-PAHs that do not have Plants & Soil Org. component values from MOE, 2011b.
[c] 100µg/g is the US EPA Eco-SSL protective of mammals for LMW-PAHs (acenaphthylene and 1,2-methylnaphthalene) that do not have Mammals & Birds component values from MOE, 2011b.
[d] 1.1µg/g is the US EPA Eco-SSL protective of mammals for HMW-PAHs (benzo(g,h,i)perylene, dibenzo(a,h)anthracene and indeno[1,2,3-cd]pyrene) that do not have Mammals & Birds component values from MOE, 2011b.
[e] 6.2 µg/g is the CCME soil and food ingestion (SQG) pathway guideline for the protection of mammals and birds for benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene.
[f] 15.4 µg/g is the CCME soil and food ingestion (SQG) pathway guideline for the protection of mammals and birds for benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene.

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