REMEDIAL ACTION PLAN
COLLINS BAY INSTITUTION FORMER LANDFILL 1 (CSC ID 441-L02) & LANDFILL 3 (CSC ID 441-L03) KINGSTON, ONTARIO

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA / CORRECTIONAL SERVICES CANADA

ENVIRONMENT & WATER

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FINAL REPORT

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EXECUTIVE SUMMARY

The Environment & Water business unit of SNC-Lavalin Inc. (SNC-Lavalin) was retained by Public Works and Government Services Canada (PWGSC) on behalf of Correctional Service Canada (CSC) to prepare a Remedial Action Plan (RAP) in support of the site closure of Former Landfills 1 and 3 located at the Collins Bay Institution in Kingston, Ontario. The RAP is part of a work program with the ultimate objective of providing PWGSC/CSC with suitable documentation to select a method of closing the landfills in a manner that will address issues identified during previously completed Site Specific Risk Assessments (SSRAs; SNC-Lavalin, 2013a, 2013b and 2014a), as well as meeting at least minimum acceptable closure standards that are warranted incorporating consideration of the age of the waste and proximity of receptors.

The remedial option presented in the RAP was selected following the completion of Remedial Options Evaluations (ROEs) for each of the landfills (SNC-Lavalin, 2014b and 2014c). A combined option involving excavation and removal of the waste at Landfill 3, transportation to Landfill 1 for re-grading, capping and closure was selected as the preferred alternative by PWGSC and CSC based on recommendations in the ROE reports. The remedial activities associated with this option generally include:

- Excavation and transfer of buried waste materials located at Landfill 3 to Landfill 1
- Collection of verification soil samples from the completed excavation
- Waste re-grading and compaction at Landfill 1
- Supply and installation of a Geosynthetic Clay Liner (GCL) over the re-graded waste at Landfill 1
- Locally (Kingston area) sourced soil cover to be placed above liner, compacted and shaped to final grades
- Minimal re-grading/ditchwork around capped landfill to ensure surface water run-off from the surrounding areas, and runoff generated from the landfill is directed away from cap
- Seeding and rehabilitation of the former Landfill 3 area as additional wetland area
- Hydro-seeding of final cap over Landfill 1 and any other site areas affected by the construction
- Implementation of a long term post-closure care program including inspections, maintenance and an environmental monitoring program at Landfill 1

The proposed remediation program will be completed on federally owned lands and will therefore be federally regulated. No provincial permits will be sought for the proposed work program. Potential off-site impacts that would be subject to provincial regulation (i.e. to surface water or air) are not anticipated. Excavation water will be managed through containment on-site or through off-site disposal at approved facilities therefore no permits or approvals for sewer discharges will be sought. A Temporary Entrance Permit would be required from the City of Kingston to allow for establishment of an additional gate entrance off Front Road.

Site specific target levels (SSTL) were identified for Landfill 3 for use as remediation objectives and/or clean-up criteria for soil and sediment to assist with verification sampling to be completed following excavation of Landfill 3 wastes. Areas that the reinstated ground surface is interpreted as being above the static groundwater table will be considered terrestrial land and the results of soil sample analysis would be compared to SSTLs for surface soil. For areas that the reinstated ground surface may be below the static groundwater table, the classification will be wetland, and results would be compared to sediment SSTLs.

A site-specific Environmental Protection Plan (EPP) will be prepared prior to commencement of the site closure works to identify specific measures to address potential hazards to the environment including:

- Impacts to potential species at risk (SAR) and/or other wildlife present at the site (based on an SAR avoidance plan)
- Surface water run-off and/or erosion of site soil to adjacent surface water courses
- Handling of potentially impacted groundwater in excavations
- Spill hazards

The RAP outlines minimum requirements for these environmental protection measures. The RAP also outlines management measures for the control of litter, odours, noise and mud or dust at the site during remedial activities.

Soil brought to the site will be adequately sourced, tested and approved from off-site sources. Imported soils for use as backfill and topsoil at the former Landfill 3 will be required to meet the site specific restoration criteria described above. It is proposed that any imported soils for use in the cover materials at Landfill 1 should meet the MOE Table 3 Generic Site Condition Standards in a Non-Potable Groundwater Condition (O. Reg. 153/04, as amended) for a commercial/industrial property.

Stormwater management measures during construction works will include at a minimum light duty silt fence barriers and straw bales. A double installation of silt fencing is planned at the excavation site (Landfill 3) and a single installation of silt fencing is planned at the landfill capping work site (Landfill 1).

The PWGSC consultant will provide full-time contactor supervision and contract administration throughout remediation works and prepare a Site Closure Report following completion of the construction work. PWGSC and CSC have proposed commencing the remediation activities in the Fall of 2014. It is anticipated that construction activities will take approximately 5 to 6 weeks to complete.

Requirements for long term post-closure care activities at Landfill 1 will include regular site inspections, cover application and re-vegetation for the capped landfill to correct for the effects of settlement and/or erosion if noted, maintenance of ditches and/or monitoring wells and continuation of the environmental monitoring program for groundwater and landfill gas monitoring, until it can be demonstrated that concentrations of contaminants are stabilized at relatively low levels (preferably below regulatory criteria) over at least a two (2) year period. Semi-annual groundwater monitoring and sampling is recommended for the first two (2) years following installation of the landfill cap with annual monitoring and sampling required for subsequent years (to a maximum of up to 20 years for cost estimating purposes).

An estimate for the total lifecycle cost of the RAP described herein is on the order of [redacted]

Costs for remediation activities (or capital works) associated with the RAP are estimated to be on the order of [redacted] Costs are distributed between approximately [redacted] for contractor costs, [redacted] for consultant project management and supporting services and a [redacted] contingency (for potential hazardous waste disposal, import of additional fill, change orders, etc.). Long-term costs for post-closure care are estimated to be on the order of [redacted]

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1 INTRODUCTION

The Environment & Water business unit of SNC-Lavalin Inc. (SNC-Lavalin) was retained by Public Works and Government Services Canada (PWGSC) on behalf of Correctional Service Canada (CSC) to prepare a Remedial Action Plan (RAP) in support of the site closure of Former Landfills 1 and 3 located at the Collins Bay Institution in Kingston, Ontario.

The RAP was prepared in accordance with the SNC-Lavalin proposal 128705-03.002 dated October 7, 2013 (Revision 4) which was prepared in response to the Statement of Work (SOW) dated September 25, 2013 as well as various email correspondence and discussions between the PWGSC and SNC-Lavalin project managers.

1.1 Objective and Scope of Work

As stated in the SOW and the SNC-Lavalin proposal, the RAP is part of a work program with the ultimate objective of providing PWGSC/CSC with suitable documentation to select a method of closing the landfills in a manner that will address issues identified during previously completed Site Specific Risk Assessments (SSRAs; SNC-Lavalin, 2013a, 2013b and 2014a), as well as meeting at least minimum acceptable closure standards that are warranted incorporating consideration of the age of the waste and proximity of receptors.

The remedial option presented in the RAP was selected following the completion of Remedial Options Evaluations (ROEs) for each of the landfills (SNC-Lavalin, 2014b and 2014c). The remedial options considered alternatives to close each of the landfills independently of each other and in conjunction with each other. The objective of the RAP is to provide a detailed outline of all remediation activities so that detailed design drawings and specifications can be prepared to support the project tendering process. In accordance with the requirements of the SOW, the work program presented in the RAP is comprehensive, cost effective and promotes sustainable remediation. This report also includes conceptual preliminary design level drawings for the landfill closure works and a detailed cost estimate for implementation.

1.2 Site Description

Landfill 1 and 3 are located in the south and central portions of the Collins Bay Institution property. The institution is a minimum security federal penitentiary owned and operated by CSC. The land is owned by the Government of Canada under the jurisdiction of CSC. Figures 1 and 2 identify the locations of the sites in Kingston, Ontario and within the Collins Bay Institution. The sites are identified by the following federal identification numbers:

- Landfill 1 - DFRP 12272, CSC ID 441-L02, Federal Contaminated Site Identifier 00024662
- Landfill 3 - DFRP 12272, CSC ID 441-L03, Federal Contaminated Site Identifier 00012990

Both sites are currently vacant. Land uses adjacent to Landfill 1 include:

- Agricultural lands used for farming of cash crops such as hay to the west and north as well as a private institutional access road immediately north of the landfill
- A municipal road (Front Road) to the south and industrial manufacturing plant (DuPont Canada) fronting the opposite side of the road
- An untraveled road (Highbanks Road) and lands owned and operated by the Cataraqui Creek Conservation Authority (CRCA) including a provincially significant wetland to the east

The existing topography in the vicinity of Landfill 1 (Figure 3) is generally flat and at approximately the same elevation as surrounding lands. An existing drainage feature located north of the fill area directs surface runoff towards a seasonally wet area northeast of the landfill area. A ditch is also present south of the fill area running along the north side of Front Road. Previous investigations identified a maximum fill thickness of 7.6 m at this landfill in an area corresponding to a former quarry location. Construction and demolition waste in combination with waste soil and limestone are the predominantly reported landfill materials at Landfill 1.

Existing land uses adjacent to Landfill 3 include:

- A private institutional access road immediately west of the landfill
- Seasonally wet wetlands and an ephemeral stream identified as part of the provincially significant wetland complex to the southwest, south and east
- Agricultural lands used for farming of cash crops to the north and northwest

The existing topography within the Landfill 3 area (Figure 4) is generally flat and similar in elevation to the surrounding lands to the north and northwest. The site slopes gently towards wetlands. An ephemeral stream is present south of the site and a smaller drainage feature is also present north of the fill area. Previous investigations identified a maximum thickness of 3.5 m of waste material in the fill area at this landfill. Construction/demolition waste and soil fill are the predominantly reported landfill materials. Manure may also have been spread at this landfill prior to construction of a nearby manure composting facility.

1.3 Remediation Project Overview

Independent landfill closure alternatives for the two (2) landfills were considered in the ROE including several different capping options as well as excavation and off-site disposal of wastes. A combined option involving excavation and removal of the waste at Landfill 3, transportation to Landfill 1 for re-grading, capping and closure was also considered and compared to the two preferred alternatives selected from the independent closure options.

Based on recommendations in the ROE reports, the preferred alternative selected by PWGSC and CSC for detailed description in the RAP was the combined option described above. The remedial activities associated with this option generally include:

- Excavation and transfer of buried waste materials located at Landfill 3 to Landfill 1
- Collection of verification soil samples from the completed excavation
- Waste re-grading and compaction at Landfill 1
- Supply and installation of a Geosynthetic Clay Liner (GCL) over the re-graded waste at Landfill 1
- Locally (Kingston area) sourced soil cover to be placed above liner, compacted and shaped to final grades
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- Seeding and rehabilitation of the former Landfill 3 area as additional wetland area
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- Implementation of a long term post-closure care program including inspections, maintenance and an environmental monitoring program at Landfill 1

1.4 Report Structure

The RAP presented in this report has been divided into three (3) main sections. General considerations for site closure works are described in Section 2. Construction and other remediation work activities are described in Section 3 and post-closure care requirements are described in Section 4. Section 5 includes detailed cost estimates for the landfill closure program. Preliminary design level drawings are referenced throughout the report and are attached at the end of the report.

2 GENERAL SITE CLOSURE CONSIDERATIONS

2.1 Regulating Authorities

Since the landfills are located on federally owned lands, planned on-site activities will be federally regulated. Remediation works will be conducted in accordance with federal statutes and regulations, addressing provincial/municipal requirements as appropriate.

Due to federal exemptions, an Ontario Ministry of the Environment (MOE) Environmental Compliance Approval (ECA) for the landfill closure works is not required and thus no provincial applications or other permits will be obtained. Similarly, although the adjacent lands to the east are Provincially Significant Wetlands, a permit is not required from the Cataraqui Creek Conservation Authority (CRCA) provided all works occur on the federal property. Notwithstanding this, PWGSC and CSC provided a draft version of this RAP to the CRCA for comment and will provide the final version for reference.

Correspondence from the CRCA to CSC has indicated that they are supportive of removal of the waste and restoration of the excavation at Landfill 3 as potential future wetland as it will provide a number of benefits, including the re-establishment of conditions that likely existed prior to the development of the landfill. It will allow CRCA an opportunity to compensate for wetland losses elsewhere in the city of Kingston and will result in an expansion to the local floodplain volume. The CRCA anticipates that the wetland will naturally develop within the reinstated area without intervention, however they have offered to provide CSC with suggestions as to how the habitat could be improved beyond a baseline expansion should they wish to do so (T. Beaubiah, Biologist, CRCA, personal communication, April 3, 2014).

Potential off-site impacts (i.e. to surface water or air, or during transportation of contaminated material) would fall under MOE jurisdiction. However, as discussed in greater detail in later sections of this report, off-site impacts resulting from the proposed remediation activities are not anticipated. Potential off-site impacts will also be addressed in an Environmental Effects Evaluation (EEE) and contractor Environmental Protection Plan (EPP).

The project type is not listed as a project exempted from Department of Fisheries and Oceans (DFO) permit requirements, therefore a permit from DFO may be required. On this basis, PWGSC and CSC provided a draft version of the RAP for DFO for review. CSC received comments from DFO on the draft report in a letter dated April 5, 2014 from Tara Bortoluzzi, Fisheries Expert. Recommendations from DFO's comments were incorporated into the final version of this report.

A municipal permit to allow direct truck access to Front Road will also be required from the municipality.

2.2 *Restoration Criteria*

2.2.1 Soil Restoration Criteria

Previous risk assessment work at both landfill sites (SNC-Lavalin, 2013a; SNC-Lavalin 2013b) identified only shallow soil impacts as having the potential to pose unacceptable risks to site receptors. In each case, those shallow soil impacts demonstrating unacceptable risk based on a human health risk assessment were limited in extent to the shallow soils overlying the waste materials. These risks will be addressed as the proposed remediation activities will involve either; 1. Complete removal of the soil with the noted impacts (as at Landfill 3 in conjunction with waste removal); or, 2. Capping over the impacted soil (as at Landfill 1).

No potential risks to ecological receptors were identified at Landfill 1. At Landfill 3, potential risks to ecological receptors (terrestrial invertebrates and plants) were identified in the marsh area east of the waste (based on concentrations of metals and PAHs in soil/sediment). Given the level of uncertainty with the original screening level ecological risk assessment, implementation of remedial activities to address potential risks in the marsh areas was not recommended as it was deemed possible that remedial actions would lead to greater disruption to the ecological receptors than currently existed.

Further, the samples collected in this area, being from a seasonally wet marsh area, may have been subjected to naturally present reducing conditions which can result in an accumulation of metals and organics which would not have been related to the presence of the landfill.

Potential risks to aquatic receptors were re-evaluated in a subsequent sediment study (SNC-Lavalin, 2014) which demonstrated no unacceptable risks from the landfill based on a weight of evidence evaluation. This further suggests that potential disruption of aquatic receptors should be avoided.

Site specific target levels (SSTLs) were identified for Landfill 3 for use as remediation objectives and/or clean-up criteria for soil and sediment to assist with verification sampling to be completed following excavation of Landfill 3 wastes (as described in Section 3.3.6).

Areas that the reinstated ground surface is interpreted as being above the static groundwater table will be considered terrestrial land and the results of soil sample analysis would be compared to SSTLs for surface soil. For areas that the reinstated ground surface may be below the static groundwater table, the classification will be wetland, and results would be compared to sediment SSTLs.

SSTLs for soil and sediment are provided in Appendix A along with the rationale for their identification. SSTLs were identified for metals, benzene, toluene, ethylbenzene and xylenes (BTEX), petroleum hydrocarbon fractions (PHC F1 to F4), polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs).

Figure 5 presents a summary of existing conditions immediately below the landfill waste. Although limited sampling at this depth was completed as part of previous investigations, results generally indicate that conditions immediately below the waste should meet the SSTLs.

2.2.2 Groundwater Restoration Criteria

Although it may take some time for conditions to fully renaturalize following excavation of the waste at former Landfill 3, the removal of the source of impacts (waste) is anticipated to result in improvements to groundwater conditions over time with no long term residual impacts to be managed. On this basis, groundwater restoration criteria are not required for Landfill 3 and no post-closure environmental groundwater monitoring is being proposed for that site.

In the previously completed risk assessment work, no risks were identified based on groundwater conditions at Landfill 1, however it was recommended that a monitoring and sampling program be implemented to validate the results of the risk assessment and establish a database of pre-construction site conditions at the Landfill. Groundwater sampling was completed at Landfill 1 in the fall of 2013 and additional events are planned for Spring and Summer 2014 prior to the construction work. The waste from Landfill 3 that will be moved to Landfill 1 will result in an additional potential source for groundwater impacts at the Landfill 1 site. Although the waste will be situated well above the water table and will be subsequently covered by a relatively impermeable cap, it is possible that leachate generated from the wastes while the water content depletes may temporarily increase the contaminant loading. A post-closure groundwater monitoring program is recommended, as described in later sections of this report.

Groundwater restoration criteria for the Landfill 1 site will be based on the risk-based screening levels used in the previously completed SSRA. Groundwater results would first be compared to generic federal and provincial regulatory criteria, then compared to previous site maxima used in the SSRA, and should the values be greater than these, the results would further be compared to screening levels from the SSRA to determine whether results of the SSRA remain valid.

2.3 Final Contour Plans

The completed landfill cap feature at Landfill 1 will appear as a slightly raised oblong shaped mound sloping downward in all directions. The landfill cap is designed to promote drainage off of the landfill while utilizing side slopes intended to both minimize erosion of the cover (not too steep) and the potential for ponding due to differential settlement (not too flat). Any small areas of localized depressions and/or grade reversal caused by settlement can be minimized through a conscientious final cover inspection program, particularly in the years immediately following closure.

The final contours at Landfill 1 are illustrated in Figure 5. The final landform following final cover placement will have a peak elevation on the order of 82 m above sea level (masl) compared to typical surrounding grades of 78 to 79 masl. The central top cap of the landfill area will typically be sloped at 20H:1V (5%). Side slopes of the mound will have a maximum slope of 4H:1V (25%). These slopes are consistent with generally acceptable standards (Ontario Regulation 232/98 requires that final slopes meet a minimum of 20H:1V and a maximum of

4H:1V) and are shallow enough that they will not result in a health and safety risk to anyone walking on the mound.

In addition to the final contours, a series of ditches around the mound will be used to intercept and divert surface water runoff from the surrounding properties. The ditching features will reduce infiltration into the soils surrounding the waste mound and therefore reduce leachate generation as well as minimize the potential for water ponding at the site.

Following waste excavation at Landfill 3, minimal backfill will be placed at the west end of the excavation to establish a moderate slope (3H:1V) down to the floor of the excavation. The majority of the excavated area will be situated at or below the water table and will be left to renaturalize as wetland. The proposed final contours for this area are shown in Figure 7. No ditching work and/or ongoing monitoring to maintain grades are proposed for this area.

2.4 Site Access

During construction activities associated with closure works, access to the landfill sites would be via gate access from Front Road. There are currently two (2) existing gates, one in the southeast corner of Landfill 1 and another approximately 400 m west of Landfill 1. The entrance at the southeast corner of Landfill 1 is not ideal as it opens onto the landfill where the capping work will be completed. The western entrance is situated further away for the two (2) landfill sites and therefore would require significant driving across parts of the CSC property. It is therefore recommended that a third, temporary access point be established immediately west of Landfill 1. A guard or commissionaire would control access through any of the gates used during the construction work. A bike lane is present on the north side of Front Road so careful consideration of both bicycle and vehicular traffic flow on Front Road will be required when entering or leaving the site.

The Commissionaire assigned to the project will note vehicle movement into and out of the area. Only authorized companies will be allowed on-site. The lead contractor will provide a list of subcontractors that will be working on the site and/or making deliveries to the site. Companies that do not appear on the list would be turned away. The tender documents will outline additional specific procedures, including daily sign-in and sign-out procedures for the project, yet to be determined by CSC.

Given that the landfill sites are part of the Collins Bay Institution property, public access would not be permitted during, or after completion of the closure works. Inadvertent or trespasser access by the public is therefore unlikely and therefore the Landfill 1 site does not need to be secured with fencing and an entrance gate as would be typical for other closed landfills. During closure works, some existing fencing surrounding the landfill sites may need to be removed. While it will be at the discretion of PWGSC and CSC as to whether fencing around the former landfills that is removed is re-instated as part of the closure works, re-establishing the fence around the landfill is recommended to prevent farming from encroaching on the restored areas and to block farm equipment from using the area as a turnaround area, each of which would result in damage to the completed landfill cap.

2.5 Environmental Protection

A site-specific Environmental Protection Plan (EPP) will be prepared by the selected contractor prior to commencement of the site closure works in order to identify specific measures to address the following potential hazards to the environment:

- Impacts to potential species at risk (SAR) and/or other wildlife present at the site
- Surface water run-off and/or erosion of site soil to adjacent surface water courses
- Handling of potentially impacted groundwater in excavations
- Spill hazards

The EPP will also address any mitigation measures identified from the Environmental Effects Evaluation (EEE) to be completed by CSC to comply with the Canadian Environmental Assessment Act, 2012.

2.5.1 Wildlife Protection

The objective of the wildlife management portion of the EPP is to avoid wildlife mortality as a direct consequence of construction activities and avoid any negative impacts on protected species, their habitats or breeding and feeding activities.

Vehicle movements with be restricted to construction areas and access roads to avoid harassment of animals. All animals including birds will be allowed to passively disperse from roads and work areas. Contractors will install fencing around open excavations and hazards where appropriate to prevent wildlife from entering the work areas.

A list of SAR species with the potential to be present at or near the work areas will be developed and made available for contractor education. Photographs of potential SAR species will be provided during an initial orientation, and remain available on-site to assist in identification. Should a SAR or its critical habitat be encountered, the project SAR biologist will be contacted to determine appropriate mitigation measures to avoid destruction, injury or interference with the species, its residence and/or its habitat (e.g., through sighting, timing or design changes). If a suspected SAR is observed on site, a GPS location will be recorded and photographs will be taken (if possible) to verify the species observed. PWGSC/CSC will be notified immediately if a confirmed SAR is observed on site, or if subsequent investigations result in the belief that a SAR has been on the site.

Based on the previous completed risk assessments, which included searches of the Ministry of Natural Resources (MNR) Natural Heritage Information Centre database, as well as details from a 2004 report on the adjacent sections of the Little Cataraqui Creek Wetland (Kingston Field Naturalists, 2004), and correspondence from DFO, the following SAR may be present in the vicinity of the site:

Community	Species
Mammals	Grey Fox
Birds	Common Nighthawk, Black Tern, Red-Shouldered Hawk, Short-Eared Owl, Least Bittern
Reptiles	Snapping Turtle, Blanding's Turtle, Spiny Softshell, Northern Map Turtle, Milksnake
Invertebrates	Monarch Butterfly
Fish	American Eel (under consideration for SAR ranking)

The vegetation at the two (2) landfill sites consists of various grasses and weeds. According to the 2004 Kingston Field Naturalists report, no locally significant plants were identified within the landfill site areas. Shallow marshlands are adjacent to the south and west of Landfill 3. A stand of deciduous trees is also present immediately east of Landfill 1. Details of wetland protection measures are provided in the following section. It is anticipated that the mature trees at the eastern edge of Landfill 1 will be protected and that where possible the landfill cap will be restricted from encroaching beneath the crown to prevent shallow root damage. Existing vegetation will be maintained to the best extent possible so that overall disturbance to habitat is minimized.

2.5.2 Surface Water Protection

Specific mitigation measures for surface water protection will include the following (at a minimum):

- Maintain appropriate separation distances between equipment and watercourses or wetlands
- Minimize the operational footprint as much as is practical or alter location of temporary workspaces
- Parking areas, temporary workspaces lay-down areas, etc. shall not be located within 10 m of the high water mark of wetland or watercourses
- All reasonable precautions will be taken to prevent the release of deleterious substances into watercourses (i.e. installation of sediment and erosion control measures)
- Equipment shall be refuelled and serviced in areas where spills or wash water will not directly enter any watercourse
- Equipment operating within 10 m of any watercourse will be free of external grease and oil
- Washing of vehicles and/or equipment is not to take place at the site except if required prior to entering municipal roads. Appropriate mitigation measures, including collection of wash water will be required
- Washing of vehicles and/or equipment within 100 m of watercourses or water-bodies will be strictly prohibited
- Water generated from excavation dewatering activities or other operations cannot be discharged directly into a watercourse or water-body and will be tested prior to disposal
- Equipment and/or vehicles will not ford water-bodies during construction activities

- Surface water drainages and contours must be retained or re-established post-construction

The contractor will be required to prepare and submit an Erosion and Sediment Control Plan for the construction work that mimimizes risk of sedimentation of the waters of Little Cataraqui Creek during all phases of the work. The Erosion and Sediment Control Plan will comply with DFO's "Measures to Avoid Causing Harm to Fish and Fish Habitat" (available at http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html) and will include (at a minimum):

- Installation of effective erosion and sediment control measures before starting work to prevent sediment from entering the water body
- Measures for managing water flowing onto the site, as well as water being pumped/diverted from the site such that sediment is filtered out prior to the water entering a waterbody
- Regular inspection and maintenance of erosion and sediment control measures and structures during the course of construction
- Repairs to erosion and sediment control measures and structures if damage occurs
- Removal of non-biodegradable erosion and sediment control materials once the site has stabilized post-construction

While completing work at the Landfill 3 site, additional caution should be taken to prevent surface soils and waste materials from entering the adjacent wetland area. Further details specifically related to surface water protection during excavation work at Landfill 3 and details for management of water in the excavation is described later is in this report.

2.5.3 Spill Prevention

As part of the EPP and Site Specific Health and Safety Plan (discussed in Section 5.5), the contractor will be responsible for establishing spill prevention and spill response procedures. The procedures to prevent a chemical, fuel, hydraulic oil, lubricant and other hazardous substance release on or around the site are to be implemented by all sub-contractors. This may involve (as noted previously) the use of a designated fuelling area, if practical. The contractor will be responsible for any fuel or chemical spilled on the work site, including the clean-up and disposal of all materials and shall ensure sufficient spill response equipment is available at the site to respond to spills on land or water. At a minimum all heavy equipment shall be equipped with spill response equipment capable of cleaning up any volume that may be generated from that equipment. In accordance with the Institution's Contractor Health, Safety & Security requirements (CSC, 2013), the contractor will be required to contact the Control or Security Liaison Officer and the Chief of Plant Maintenance at the institution in the event of any spill. An Environmental Incident Report (CSC Form 1265-03) will also be completed by the contractor and submitted to the Chief Facility Management.

2.6 Litter Control

During excavation of wastes at Landfill 3, transport, and placement at Landfill 1 there is potential for windblown litter to be dispersed at the landfills and surrounding area. Given that the majority of wastes are construction and demolition wastes, the amount of litter is anticipated to be less than would be typical for municipal solid waste which contains significant quantities of paper and plastic products. Litter control measures should include regular inspection of the work area and surrounding lands to collect litter. It is not anticipated that haul trucks will require mandatory covering during transport, but it should be considered as a litter control remedy that can be utilized depending on the type of waste encountered and the wind conditions.

Litter control measures will be significantly reduced once the waste has been re-compacted at Landfill 1 and should not be required once the GCL has been placed.

2.7 Odour Control

Since the majority of wastes are construction and demolition wastes, it is not anticipated that significant odours will be generated during excavation and transport of wastes from Landfill 3 or placement at Landfill 1. If wastes causing odours are identified, odours will be minimized by quickly covering this waste with other incoming material.

2.8 Mud and Dust Control

In wet weather, mud on vehicles and equipment leaving the construction site may be of concern. As all works will be completed within the site, and work will be restricted in adverse weather conditions (e.g. heavy rain events), related impacts are assumed to be minimal. The contractor will be required to have a street sweeper on call in the event that the roads require cleaning.

If dust impacts are noticeable during closure activities (typically during hot, dry conditions), these can be reduced through watering and the use of approved dust suppressants. Waste oils are not to be used. Roads can be cleaned regularly to control both dust and low vehicle speeds should be enforced to further aid in reducing possible dust impacts.

Dust created by wind erosion of cover soils on the landfill cap will be reduced through the early establishment of a vegetative cover.

2.9 Noise Control

While a detailed study of noise impacts from landfill closure activities on surrounding land uses has not been carried out, the relative remoteness of the site to the more developed areas in Kingston coupled with the restricted access to the site should address the potential for complaints in this regard. Heavy equipment and trucks required during closure activities should be maintained in a good state of repair and not be permitted on-site without suitable mufflers. Pre-consultation with the nearby developments on the south side of Front Road should also be considered by way of a letter notifying of the planned construction work. If required, daily work schedules can be altered or restricted to minimize complaints.

2.10 Post-Closure Care

It is recommended that following landfill closure works some site activities will continue to be carried out at the capped Landfill 1 as part of the site's long term care. These post-closure care activities will include:

- Regular site inspections
- Cover application and re-vegetation for the capped landfill to correct for the effects of settlement and/or erosion if noted
- Maintenance of ditches and/or monitoring wells
- Continuation of environmental monitoring programs, such as those for groundwater and landfill gas monitoring, until it is deemed no longer necessary

Detailed descriptions of these activities are provided in Section 4 of this report.

The environment at the former Landfill 3 may take some time to return to pre-landfill conditions following excavation and removal of the wastes, however on the basis that the source of impacts will be removed from this area, no post-closure care related activities would be required.

3 REMEDIATION ACTIVITIES

3.1 Monitoring Well Abandonment

Both landfill sites currently have existing monitoring wells situated within or around the waste that are used to monitor leachate and conditions in the underlying groundwater. Selected wells at each site are currently being monitored and sampled as part of an ongoing work program to establish a suitable database of pre-construction site conditions. Since many of the existing wells are redundant, and maintaining all of the wells would interfere with construction works it is proposed that all existing monitoring wells be abandoned/decommissioned prior to the start of construction. Wells should be decommissioned in accordance Ontario Regulation (O. Reg.) 903 by a licensed well contractor. A new, smaller network of fewer monitoring wells should be installed following completion of the recapping works (as described in Section 4).

3.2 Construction Set-Up

A construction work lay-down area will need to be established prior to the start of construction activities as a staging area for the delivery of selected materials and parking of equipment. The equipment that may be required includes 1 or 2 excavators, 3 to 4 rock trucks, a sheepsfoot compactor, a smooth roller compactor, heavy bulldozer, trim bulldozer, hydroseeder, water truck (for dust suppression on as required basis) and GCL installation equipment. As noted previously a street sweeper may be provided as needed or made available at an on-call basis.

An appropriately sized lay-down would measure approximately 30 m x 30 m. Figure 8 illustrates the potential areas outside of the landfill sites that may be affected by the construction works and shows two (2) potential staging areas have been identified, including an existing pad located west of the landfills (designated at the manure composting area) that is not currently in use. The option adjacent to Landfill 1 is preferred over the compost pad however, as it is closer to the work sites and would limit the time and distance required to mobilize equipment and materials which would assist in minimizing dust related impacts.

3.3 Waste Excavation (Landfill 3)

3.3.1 Estimated Extent of Waste

The original estimated volume of waste at Landfill 3 was re-evaluated in the ROE in an attempt to provide a more accurate quantity. Previous approximations developed during site investigations were based on a 9,110 m^2 waste disposal footprint with the maximum depth of 3.5 m being applied across the entire area. This was seen as being appropriately conservative as at the time, when recapping in place was the only alternative under consideration and resulted in a total estimated waste volume of 31,885 m^3. The revised quantity was calculated using a 3D interpretation of the waste volume based on actual existing ground surface and “bottom of waste” elevations as reported in borehole and test pit information. The revised value from this analysis is on the order of 19,170 m^3 of buried waste at Landfill 3. It is notable that the “bottom of waste” elevations appear to be slightly lower than the surface of the existing wetland areas, however, they do represent a more probable representation of the pre-landfill ground surface as illustrated in Figure 7. Nonetheless, to ensure conservative cost estimates were included, a 10% contingency was added to the revised volume resulting in a total waste volume estimate of 21,090 m^3).

Any visible debris identified in the adjacent wetland and/or ephemeral stream south of the landfill should also be removed. Appropriate surface water and sediment protection measures should be utilized for this work and are described in Section 3.3.5 below.

3.3.2 Asbestos Waste Management

The wastes at Landfill 3 are expected to consist predominantly of construction/demolition waste and soil fill. Typical for the materials used in that period, construction/demolition wastes including asbestos containing materials (ACMs) may be encountered. In particular, it is expected that potential ACM roofing materials from a decommissioned old barn on the CSC property may be found. These materials can be re-located as planned to Landfill 3. Potential ACMs will be handled only by heavy equipment with no hand work (or workers) in proximity to the materials. Water should be used as needed to reduce fragmenting and air-borne issues. Once placed at Landfill 1, the potential ACMs should prioritized for re-burial, again with appropriate care taken to prevent creating airborne issues. Additional details for asbestos management will be included in the contractor specifications. For costing purposes, the contractor will be notified that they should assume that these materials will be present and incorporate plans to execute the work accordingly.

3.3.3 Hazardous Waste Management

Hazardous wastes and/or materials are not anticipated to be found within the excavated wastes from Landfill 3. If encountered, hazardous wastes will be disposed off-site. Based on contractor input, the estimated cost/tonne for hazardous waste handling, transport and disposal has been estimated as being on the order of [redacted] The cost has only been included as part of the project contingency allowance as hazardous wastes are not expected.

During the works, the contractor will be required to provide proof that they have submitted an appropriate number of samples from the excavated waste for waste classification analysis, including analysis of bulk parameters and Toxicity Characterization Leaching Procedure (TCLP) testing to confirm that relocated wastes may be considered non-hazardous. This is primarily to ensure that hazardous wastes are not being inappropriately handled and/or relocated at the site. Waste classification analyses on soil cuttings from work programs previously completed at Landfill 3 showed that those materials were non-hazardous.

3.3.4 Excavation Water Management

The depth to the natural water table in the area of excavation typically ranges from approximately 1.0 m to 2.5 m below ground surface (bgs). Due to shallow groundwater conditions, some water seepage into the excavation is expected, however, not at levels which for a non-federal site would require an MOE Permit to Take Water. Maximum rates on the order of 100 L/d to 5,000 L/d are expected. To prevent nearby surface water from entering the excavation, the excavation should be completed such that a land plug or residual berm is left as an isolation measure between the working face and the wetland or waters of Little Cataraqui Creek. The material comprising the berm would be last material removed as part of the excavation. If the berm or isolation measure is non-permeable (e.g. silt/clay), care will be taken to ensure water levels on the freshly excavated side are not significantly greater than those of Little Cataraqui Creek prior to removal, to prevent a sudden influx of water.

Based on existing groundwater conditions at Landfill 3, the groundwater seeping into the excavation may be leachate impacted and has the potential to have elevated concentrations of parameters such as metals and polycyclic aromatic hydrocarbons (PAHs) and therefore may not be suitable for immediate discharge to the ground surface or wetland upon dewatering of the excavation. Water could be disposed off site by a MOE licensed carrier at a MOE licensed facility. For the purposes of off-site disposal, any water collected may be classified as waste code 263L (miscellaneous organic waste).

Alternately, since water seeping into the excavation is also likely to come from un-impacted areas surrounding the current limits of waste, pumped water could also be contained in either a designated pooling/collection area/sump within the excavation or in a holding tank outside of the excavation and a sample submitted for laboratory analysis to confirm that water meets Provincial Water Quality Objectives (PWQO) and CCME Freshwater Aquatic Life (FWAL) criteria prior to discharge. The water sample would be analysed for BTEX, PHCs, PAHs, metals and general water chemistry parameters at a minimum. Depending on the nature of the excavated wastes, additional parameters for potential contaminants may be added. If water does not meet discharge criteria, off-site disposal is recommended.

There is a significant distance between the site and an appropriate manhole receiver. Additional permitting would also be required via the municipality and possibly MOE to arrange for sewer disposal. As a result, discharge to municipal sewers is not considered a viable option during site remediation.

If water meets surface water criteria, it may be discharged on-site provided it is diverted away from the creek to a vegetated area and/or through additional filtering structures to ensure removal of suspended sediment. Discharge water entering the creek should be generally free of silt or other deleterious materials.

During rain events, run-off and rain fall should be diverted away from any open excavations. Due to the size of the excavation, it is unlikely that the excavation can be covered during these events and as such rain water accumulation in the excavation will need to be managed by the same methods as described above. When possible, the contractor may cover the excavation to prevent the accumulation of water in opened sections.

3.3.5 Surface Water and Sediment Protection Measures

Surface water and sediment protection measures will be taken to prevent impacts from construction work on the adjacent marsh/wetland areas. Measures will comply with DFO's "Measures to Avoid Causing Harm to Fish and Fish Habitat" (available at http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html). A double line of silt fencing will be set-up around the work area. If retention of surface water is required, straw bales will also be used. This is particularly important when completing the excavation immediately adjacent to the wetlands and/or scraping observed surface debris from the wetland and/or ephemeral stream area. Silt fences may also be supported by straw bales to help keep them upright.

Throughout the course of excavation work, best attempts should be made to ensure surface grades are sloped to drain run-off away from the exposed wastes. Best attempts should be made to minimize the disturbed areas to reduce the potential for erosion.

Additional details on stormwater water management are provided in Section 3.7.

3.3.6 Soil Sampling

Sampling of the walls and floors of the completed excavation will be conducted by the environmental consultation supervising excavation actitivities to document soil conditions at the excavation limits. Discrete soil samples will be collected in a grid pattern from the floor and walls of the excavation using a trowel and/or the excavator bucket. Floor samples will be collected in an approximately 10 m by 10 m grid pattern. Wall samples will be collected every 10 m along the walls at staggered depths spaced 1 m apart vertically. Recovered samples will be divided into two (2) portions: one for possible laboratory analysis and the second for field logging/screening. Samples will be inspected and logged for soil type, moisture, colour, structure, texture and visual evidence of impact. Headspace vapours will be screened using a Gastech Model 1238 ME organic vapour meter (OVM). A representative number of samples, based on approximately one (1) sample submitted for every ten (10) samples screened will be submitted for laboratory analysis of metals, BTEX, PHC F1 to F4, PAHs and PCBs. Analytical results will be compared to the SSTLs as described in Section 2.2. For areas to be reinstated as terrestrial land, results of soil sample analysis would be compared to SSTLs for surface soil. For areas reinstated as wetland, results would be compared to sediment SSTLs.

Should results of the verification sampling program indicate soil concentrations at levels above the SSTLs for soil or sediment (as applicable), depending on the extent of impacts and through consultation with PWGSC and CSC, the impacts will either be removed through additional excavation and collection of new verification soil samples or covered through the placement of additional clean fill above impacts. Backfilling (Landfill 3)

Backfill materials in the west part of the excavation (Figure 7) may be any locally sourced clean-fill materials that are available.

The supplier of imported fill shall provide results of any environmental testing completed on fill materials including results of bulk parameter and TCLP testing. The consultant overseeing construction works will also be required to routinely screen incoming fill and shall submit an appropriate number of samples for analysis of appropriate parameters to ensure fill materials meet the Site Specific Soil Restoration Criteria (as described in Section 2.2).

The portion of the excavation that is situated above the water table (i.e. the area that will not be restored as wetland) will be covered with topsoil and hydro-seeded. Compaction is this area will not be required to meet specific compaction standards since this area is anticipated to remain vacant and re-naturalize following backfilling. Minor areas subject to surface water ponding will not create a concern.

3.4 Waste Transport

As noted, it is estimated that on the order of 21,090 m^3 of wastes will be excavated and transported to Landfill 1 via Quarry Road which connects the sites. The road is described as a gravel road primarily used by tractors and/or other farm equipment. Some reinforcement of the road (such as placement of additional gravel) may be required to facilitate the frequent truck traffic between the landfills. The south end of this road (near Landfill 1) is particularly known to be soft and will need reinforcement prior to the anticipated truck traffic.

Trucks will either back into the work area for loading and exit in a forward direction, completing a 3-point turn, or if loaded while parallel to the site, will use a turn area further from the excavation. As shown in Figure 8, the truck turning area near Landfill 3 is proposed to be situated within the 30 m buffer north of the landfill (an area not currently used for farming) in order to minimize impacts on nearby farmland. The turning areas at Landfill 1 will be situated within the general waste fill area.

3.5 Cover Placement (Landfill 1)

3.5.1 Waste Placement and Re-grading

The existing ground surface at Landfill 1 will be initially scarified to assist in bonding between the incoming material and the existing material and reduce the risk of a slip failure along the side slopes. Waste will be unloaded from transport vehicles onto a designated area then pushed into place, spread and compacted. The area where waste is unloaded, moved, and compacted is known as the working face. The working face will be constantly changing as wastes are placed and the base grades for the cover system are established. The working face at any given time should be limited to a small and distinct area to allow better control of potential litter dispersal and to allow for good compaction.

Once compacted and graded, the surface should be rolled with a smooth-drum compactor such that it is generally firm and unyielding with no abrupt elevation changes (protrusions greater than 12 mm in height) or voids. Where needed, waste material can be covered with an interim cover of filter cloth or a thin layer of on-site soils to prevent wind-blown litter and reduce infiltration through the wastes. This interim protective cover will also serve to smooth out any rough spots or voids to protect the GCL from damage.

The final base grades may need to be adjusted based on actual volumes of relocated wastes. Should more or less waste be relocated than anticipated in design drawings, the top elevations of the mound shall be reduced or raised slightly to accommodate the change.

3.5.2 Geosynthetic Clay Liner (GCL) Placement

A GCL constructed of a thin layer of processed clay (bentonite) fixed between two sheets of a geotextile will be installed over graded wastes by approved contractors. The specific GCL proposed for use is a Bentofix Scrim Reinforced Non-woven Liner (SRNWL) consisting of a needle-punched, thermally reinforced composite with a core of natural sodium bentonite clay between two durable geotextiles layers. The top layer is a staple fiber nonwoven (NW) geotextile while the bottom layer is a scrim reinforced nonwoven (SR NW) geotextile.

A needle punched GCL was preferred over a glued or adhesive bonded GCL due to the expected grade of side slopes and minimal preparation of the subgrade below the waste. The SRNWL described above is recommended for moderate to steep slope installation where the subgrade conditions may be rough in nature (such as for this case where the GCL is intended to be placed directly above smoothed wastes). The SRNWL is also appropriate for sites with moderate to high load applications where increased internal shear strength is required, although this may not be specifically needed at this site.

The GCL will be delivered to the site in large 5 m wide rolls. Each roll, when laid out over the waste, would cover an area approximately 5 m wide and 45 m long. Considering that extra material is required for overlaps (approximately 0.3 m wide) and anchors during installation, it is estimated that approximately 21,175 m^2 of GCL will be required. This estimate includes the total surface area to be capped (estimated at 19,250 m^2) as well as an additional 10% for overlaps, anchors and wastage. To help protect the GCL rolls once delivered to the site (and prior to deployment), they should be stored on wooden pallets to prevent direct contact with the ground, and heavy, waterproof tarps should be placed over the GCL rolls to protect them from precipitation, using sandbags or other appropriate anchors to help keep the tarps in place over the rolls.

GCLs will be joined by overlapping panels, without sewing or mechanically connecting pieces together. Loose bentonite powder is to be placed on the area of overlap to provide a seal. The specification documents that will be prepared prior to tender will include procedures for shipping and storing materials, as well as performing acceptance testing on delivered materials. The specifications will also address methods for joining panels and repairing sections. To prevent premature hydration of the GCL, it should be covered with its subsequent soil layer before a rainfall or snowfall occurs.

3.5.3 Soil Cover Placement and Re-vegetation

A soil cover layer will be placed above the GCL to function as the erosion protection layer and infiltration layer (to maintain water content to support vegetation above and hydrate the bentonite below). A minimum thickness of 0.3 m of cover soil is recommended over the GCL to provide sufficient confining stress, eliminate the potential for seam separation and prevent damage from heavy equipment. A 0.3 m cover is generally accepted as adequate to prevent damage from for tracked equipment, however if heavier traffic areas or haul roads are ever anticipated for the site, greater thicknesses are recommended. Given that the Kingston area is not prone to drought-like conditions, the 0.3 m cover soil is assessed as being likely to retain enough moisture to prevent significant dehydration and cracking of the GCL on a long term basis.

To address potential difficulties in installation and ensure a minimum of 0.3 m of cover is maintained between equipment tires/tracks and the GCL at all times (as recommended by ASTM D 6102), it is proposed that the 0.3 m cover soil be constructed of a single imported material. A silty sand topsoil has been recommended for this purpose. The cover soil should be free of sharp-edged particles or other foreign objects that could damage the GCL including roots, vegetation, debris, stones or clods over 25 mm in size. Material will be compacted with a smooth roller to achieve acceptable dry density prior to application of hydroseed. Moisture content of fill materials should be maintained within 2% of optimum to attain the required compaction density.

The use of additional tools (i.e. netting or hay) to retain the topsoil along the steeper slopes is recommended to reduce erosion while the vegetative layer is being established.

The volume of final cover soil will be on the order of 5,800 m^3. Material for the soil cover will need to be adequately sourced, tested and approved from off-site sources. For the cover material at Landfill 1, the consultant overseeing construction works will be required to routinely screen incoming fill and shall submit an appropriate number of samples for analysis of appropriate parameters to ensure fill materials meet the MOE Table 3 Generic Site Condition Standards in a Non-Potable Groundwater Condition (O. Reg. 153/04, as amended) for a commercial/industrial property. The Table 3 standards are considered sufficiently protective of proposed land use. In addition, periodic TCLP analyses should be provided from the material provider.

Hydro-seeding shall be carried out as soon as practical to all areas disturbed by the remedial work. The vegetated cover should generally be reinstated by hydro-seeding using hydraulic seeder or mulcher in accordance with OPSS 572 as amended by Special Provision 572S01 or carrying out seeding and placing of mulch protection manually. Unless otherwise requested, the tender should specify the use of "Table Land Grass Mixture" as supplied by the OSC (Ontario Seed Company) or equivalent for hydro-seeding to conform to OPSS 572 as amended. Local input from the CRCA should be obtained to determine if they have an alternate preferred seeding mix, in particular for the disturbed area near Landfill 3 as it may be more advantageous to incorporate wetland/marsh type community species.

Hydro-seed applied in the late fall may not grow and take root immediately, however only one application is anticipated as the hydro-seed will typically do well and take root the following Spring.

3.6 Stormwater Management

Throughout construction activities, perimeter ditching will be established to divert stormwater flows away from work areas. At the excavation area (Landfill 3), stormwater runoff generated at the properties north and west of the former waste mound will be intercepted via ditching and directed to the wetland area to the east. At Landfill 1, surface run-off from adjacent lands will be directed to the existing ditches north of the waste mound (flowing towards wetlands) and south of the waste mound (ditch along Front Road).

Light duty silt fence barriers should be utilized at a minimum during construction and should conform to OPSS 577.07.02.02. A double installation of silt fencing is planned at the excavation site (Landfill 3) and a single installation of silt fencing is planned at the landfill capping work site (Landfill 1).

If deemed necessary in the ditching to reduce flow rates, straw bale flow checks shall be constructed of a double row of bales butted tightly together and conform to OPSS 577.07.04.01. Equivalent, commercially available products may also be considered.

3.7 Site Restoration

Following construction of the cap, all areas affected or disturbed during the course of the work should be restored and/or reinstated to match adjacent surface elevations and/or the surface condition existing before the work.

4 POST CLOSURE ACTIVITIES

4.1 Environmental Monitoring

The purpose of the low permeability landfill cap is to prevent or reduce infiltration through cover materials and buried wastes thereby limiting ongoing leachate generation. A reduction in the moisture content of the waste may also eventually serve to reduce the waste to below optimum habitat conditions for methanogenic bacteria, reducing the site's methane generation rate (but also conversely prolonging the period of methane generation). Although few issues related to the presence of the original Landfill 1 itself have been identified and the consolidation of wastes from Landfill 3 at the Landfill 1 location are not anticipated to worsen conditions in the medium to long term, an environmental monitoring program is recommended. Best management practices would suggest that a post-closure monitoring program should be completed regularly until a suitable database has been established that indicates potential trends or emergent issues following the disturbance to the area during construction have been identified and assessed. Generally an extended period of meeting acceptable groundwater quality results below relevant generic or site specific criteria in the monitoring wells would provide suitable rationale to discontinue monitoring.

4.1.1 Leachate and Groundwater Management

At present, Landfill 1 is maintained as a natural attenuation landfill for which no leachate containment or collection systems have been incorporated. Leachate is generated following infiltration of surface water (precipitation) which interacts with the buried waste, typically by dissolving metals or organics. Landfill leachate then seeps into the underlying or adjacent subsurface environment where it undergoes various natural mechanisms which aid in reducing its strength (e.g., advection, diffusion, dispersion, adsorption, biodegradation and dilution).

Currently, any leachate generated is expected to percolate into the underlying soils, and then flow laterally to the east and northeast according to local groundwater flow gradients in the shallow groundwater table. Based on existing groundwater quality sampling, and water level data leachate appears to be removed at a rate similar to its generation rate (i.e. there is no significant leachate mounding or stagnation areas that would allow leachate impacted water to concentrate.) The installation of a landfill cover is anticipated to lead to changes in surface permeability and a reduction in infiltration. The local groundwater flow pattern is expected to generally continue as at present, with only minor decreases in inflow directly under the capped area.

At a minimum, the long term groundwater monitoring network should comprise one well through the "centre" of the mound (to act as a leachate strength source monitor), with one well up-gradient and one down-gradient and one or two other wells installed to ensure adequate spatial coverage is maintained. Figure 9 shows a potential layout of a post-closure monitoring well network.

Semi-annual groundwater monitoring and sampling is recommended for the first two (2) years following installation of the landfill cap. It is estimated that annual monitoring and sampling will also be required for subsequent years. The work program during each event would include measurement of water levels in wells and collection of samples for laboratory analysis of previously identified contaminants of concern at each of the former landfill sites. These include BTEX, PHC F1 to F4, PAHs) and PCBs. General chemistry parameters should also be analysed to identify potential changes in groundwater chemistry and indicator parameters associated with landfill leachate.

As noted previously, the program would be expected to run until it can be demonstrated that concentrations of contaminants had stabilized at relatively low levels (preferably below regulatory criteria) over at least a two (2) year period.

4.1.2 Landfill Gas Management

No methane control systems are utilized at the Landfill 1 site. There is a low potential for subsurface migration of landfill gas before it is vented to the atmosphere, in particular due to the drops in elevation to the east, west and north of the mound. Further, since wastes have been reported as being predominantly related to construction and demolition debris, rather than typical domestic organic waste, this site has a correspondingly lower than typical methane production rate. Following installation of the landfill cap, the ability of the methane to vent will be reduced, however it is likely to result only in enhanced horizontal migration to beyond the extent of the cap, where it would again vent naturally.

No manholes or other subsurface structures where methane could theoretically migrate to and accumulate in were identified in the road allowance south of the site and given the very localized nature of methane detections during previous landfill monitoring events, this is considered unlikely to occur even if they were present. Nonetheless a buffer area within the corrections facility property of approximately 30 m (based on a rule of thumb of three times the maximum thickness of the capped wastes; estimated at 10 m once wastes from Landfill 3 are added) is recommended around the fill area as an exclusion zone in which is it proposed that no structures should be erected without proper venting precautions.

Monitoring of methane and other landfill gases would be completed regularly following landfill closure in conjunction with groundwater monitoring and sampling conditions at the same estimated frequency as described above.

4.2 Inspections

Site inspections should be conducted on a regular basis following the closure works, to ensure that that cap and ditching is maintained in good working order. Inspections will check for:

- Leachate springs or breakouts
- Ponded water and inadequate surface drainage
- Final cover erosion and settlement
- Condition of vegetation

Inspections may be completed by CSC staff. It is proposed that inspections be completed monthly for the first year following installation or until vegetation is established and the contractor has been given contractual release from warranty. Following this, the works should continue to be inspected on a quarterly basis by institutional maintenance staff (and following any extreme weather events) thereafter for a total of 10 years have passed and the soil cover and vegetation is assumed to have become established to a mature level. Upon completion of the project, the consultant responsible for supervision of construction works can provide training to CSC staff on how to conduct inspections and provide a field checklist to be used during inspections.

4.3 Maintenance

General maintenance would be related to repairs to the cap due to erosion in the short term following installation and/or maintenance and general repairs to monitoring wells if they are maintained for future use. For cost estimating purposes, it was assumed that minor repairs or maintenance to the cap may be required in the first five (5) years following installation due to settlement, erosion or other weather/seasonal effects.

Some additional, minimal long term site maintenance restrictions should be imposed, mostly as they relate to maintaining the efficacy of the landfill cap as currently described in this document (i.e. do not permit motorized vehicles on the finished cap). Other, similar restrictions, such as planting of deep rooting trees, or other activities that might damage the cap and/or create preferential flow pathways for leachate and landfill gas should generally be avoided. As such, placing signs and/or stakes that indicate the limit of the cap may be considered. Alternatively, using the surface water swales that surround the refined mound as limits might be a more efficient manner of achieving the same result.

5 PROJECT ADMINISTRATION

5.1 Insurance

The consultant and contractors retained by PWGSC as well as any subcontractors shall pay all contributions to the Workers Safety and Insurance Board (WSIB) of Ontario to cover any employees involved in any aspects of the Work. PWGSC's consultant and contractor shall be responsible for promptly reporting all accidents, environmental incidents, injuries and safety incidents to government authorities, as required by law.

The consultant, contractor and any subcontractors shall maintain, at all times during the term of the work, and for a minimum of 12 months following the completion date, general liability insurance and automobile liability insurance in amounts as requested by PWGSC.

5.2 Permits, Inspections and Utility Clearance

The proposed remediation program will be completed on federally owned lands and will therefore be federally regulated. No provincial ECAs or permits will be sought for the proposed work program. Potential off-site impacts that would be subject to provincial regulation (i.e. to surface water or air) are not anticipated. Excavation water will be managed through containment on-site or through off-site disposal at approved facilities therefore no permits or approvals for sewer discharges will be sought. A Temporary Entrance Permit would be required from the City of Kingston to allow for establishment of an additional gate entrance off Front Road.

The PWGSC retained contractor will be responsible to obtain any municipal or other permits, inspections and utility clearances and post any notices of project required by local, provincial and federal agencies for the work described herein.

5.3 Schedule

PWGSC and CSC have proposed commencing the remediation activities in the Fall of 2014. It is anticipated that construction activities will take approximately 5 to 6 weeks to complete. Consultation with contractors has demonstrated that this work schedule is feasible but may not allow for considerable contingency for potential weather or logistical delays. These delays would be due to unusual or unforeseeable conditions such as inclement weather (rain, snow, etc.) for an extended period of time or legitimately unforeseeable equipment or supplier issues.

If inclement weather or other unforeseen issues cause significant schedule delays, construction activities can continue into winter months (December and January) with the exception of placement of the hydro-seed, as long as it is ensured that snow accumulations are not incorporated into the cap, and incoming soil is not frozen beyond workability or to the point that it is likely to damage (i.e. perforate) the GCL during compaction. Following placement of the GCL and soil cover (if done in winter months), construction activities would be suspended for the 2014-2015 year. Temporary measures (such as netting or straw cover) may be applied at that time to protect the soil cover from erosion over the winter months and during the spring melt. In Spring 2016, additional soil cover may be brought to site to complete repair work as needed followed by hydro-seeding of the cap.

As noted earlier in this report, consideration for the scheduling of construction works will consider potential impacts to SAR and SAR habitat. Turtle hibernating season is noted to be from mid-October to April. Through mitigation measures identified in an EPP prepared prior to the work, potential turtle hibernating areas will be protected. Based on the anticipated work schedule, no other direct impacts to SAR or SAR habitat are anticipated.

The project is also scheduled outside of spring and summer spawning seasons for fish species and times likely for barrier breach or high waters according to DFO's Southern Region Restricted Activity timing windows.

Given the current understanding of the waste constituents (in particular the low organics composition) post-closure care activities are anticipated to be required for a maximum of twenty (20) years following construction.

5.4 Contract Administration and Site Supervision

Following award of the contract, PWGSC's consultant should provide full-time supervision of site remediation activities and contract administration which will include the following services:

- Review tender documents to fully understand the contractor's obligations under the Contract and provide assistance during the tendering process including preparation of addenda and review of tender results
- Participate in pre-construction project Kick-off Meeting and subsequent construction meetings to be held at the site. Record issues and decisions and prepare and distribute minutes to all attendees
- Ensure all mandatory documents (including Health and Safety plans, EPP, Spills Action Plans, etc.) are submitted by the contractor prior to initiating site work and that all such documents are reviewed and approved by the consultant
- Monitor and report on work progress / problems on a weekly basis and ensure any problems noted are maintained in future reports until the successful completion / resolution of the problem
- Maintain day-to-day (or as scheduled, such as weekly) contact with the PWGSC Departmental Representative throughout the contract

- Continue to review Contractor's Site Specific Health and Safety Plan and Environmental Protection Measures and their implementation throughout the project. Verify and ensure Contractor's staff follow safety requirements, including sign-in sign-out management procedures
- Ensure Contractor completed project preparation activities, including but not limited to arranging utility locates, site surveys, obtaining permits and other related activities
- Measure and verify all quantities, dimensions, location of excavations, manifests, tipping fees, and maintain accumulative totals versus authorized totals and As-Built drawings
- Directing and documenting the excavation of wastes from Landfill 3 to ensure the full extent of wastes are removed
- Directing the management of contaminated excavation water and verification that unless it meets quality standards allowing direct release, contaminated water has been sent to a facility licensed in accordance with the MOE via a hauler licensed to transport the liquid
- Monitor dust control and mud tracking control measures and their implementation
- Investigate any change orders requested by the Contractor and if warranted, make recommendations to the PWGSC Departmental Representative to process and Contract Notifications for change in the original scope of work
- Identify and verify the source and quality of all imported fill and other soil
- Ensure that Contractor maintains a minimum compaction of the sub grade based on tender recommendations via measurements of proctor density where required
- Verify measurement of final quantities of the project with the contractor
- Ensure site is restored to pre-work conditions or better
- Ensure that any/all shop drawing are submitted for review and approval
- Prepare reports during the work including records of any contaminated soil or wastes removed with verification of the Contractor, the date of removal, the results of sample analysis, field notes, site plans, and colour photographs of the site before, during and after completion of the project
- Complete the final construction report including contractor supplied as-built drawings that have been reviewed and verified
- Review all submitted invoices and change orders by the Contractor for accuracy of noted quantities and progress of work including supporting documentation for all expenses and make recommendations for payment
- Prepare interim and final deficiency reports
- Provide conclusions and recommendations for any future monitoring work or otherwise requested work at the site, and prepare a Final Closure Report

- Prepare minutes of Construction meetings and prepare agendas during implementation period

In addition to environmental consultant staff hours for supervision, management and reporting of remedial activities, geotechnical services (for soil analysis, *in situ* compaction testing and supervision) will also be required.

5.5 Health and Safety Plan

The PWGSC contractor will be required to develop and implement a site specific health and safety plan during the remediation work program. This plan will consider potential hazards associated with typical excavation and earthwork construction activities (e.g. unstable soil, use of heavy equipment, vibrations, noise, etc.), and site specific issues including the potential for worker contact with wastes (including potential ACMs and hazardous wastes) and contaminated soil and groundwater, the potential for odours from waste excavation, and the potential for impacting surface water runoff. The site specific health and safety plan shall also be required to comply with the site's Contractor Health, Safety & Security requirements (CSC, 2013).

Worker personal protective equipment (PPE), appropriate to the tasks at hand, will at a minimum include steel toed safety boots, hard hat, fluorescent safety vests, gloves and possibly respiratory protection. Safety glasses with side shields and hearing protection will be made available, as required. If soil sample results indicate it is necessary, additional PPE will be selected for use at the site.

5.6 Reporting

5.6.1 Landfill Closure Works

Following completion of the construction work, the PWGSC consultant will prepare a Site Closure Report documenting closure activities. The report will include as-constructed site drawings, site photos, daily and weekly reports, proof of measurement and verification of all earthwork related quantities, manifests for disposal (as applicable) and laboratory analysis and certificates. The PWGSC Project Management Tools Site Closure Report Module will also be used as reference for the closure report format and contents. The closure report will include the following items (at a minimum):

- Introduction
- A summary of the remedial design (including selection of remedial options and design modifications)
- A summary of the work conducted
- A description of all accepted Change Orders, with justification
- A description o f health and safety incidents and near misses
- A Cost of Services form showing estimated quantities, actual quantities, and reason for variance.

- A Gantt Chart of the proposed and actual remediation schedule
- As-built Drawings
- Appendices (including permits, contract, pre-work and post-work site inspection reports, progress meeting notes, contractor's daily record sheets, contractor's daily reports, quality assurance and quality control reports, field memos, quantity records and photographs)
- Signed statement that all work was completed in an appropriate manner and in compliance with contract terms and conditions.

5.6.2 Post-Closure Care

The results of the sampling programs at Landfill 1 will be included in a summary letter report prepared following each sampling event. Reports will be prepared as summary reports and are not expected to include detailed description of methodology. Some interpretation or discussion (e.g. trend analysis) of the results would be included to comment on potential changes in conditions compared to pre-closure conditions. Groundwater quality will be assessed by comparing analytical results to the selected restoration criteria.

6 COST ESTIMATES

An estimate for the total lifecycle cost of the RAP described herein is on the order of [redacted] A detailed estimate for implementation of the RAP is provided in Table 1.

6.1 Remediation Activities

Costs for remediation activities (or capital works) associated with the RAP are estimated to be on the order of [redacted] Costs are distributed between approximately [redacted] for contractor costs, [redacted] for consultant project management and supporting services and a [redacted] contingency (for potential hazardous waste disposal, import of additional fill, change orders, etc.).

6.2 Post-Closure Care

Long-term costs for post-closure care are estimated to be on the order of [redacted] Long term costs are presented as the net present value based on inflation and deflation rates presented in Table 2. A breakdown of the proposed environmental monitoring program costs [redacted] is provided in Table 3.

7 REFERENCES

Kingston Field Naturalists, 2004. Report on Little Cataraqui Creek Wetland, West Side, Front Road to Bath Road, Kingston, Ontario.

SNC-Lavalin Inc. (SNC-Lavalin), 2013a. Site Specific Risk Assessment, Frontenac Institution Former Landfill 3 (CSC ID 441-L03), Kingston, Ontario. Prepared for Public Works and Government Services Canada/Correctional Service Canada. December 6, 2013.

SNC-Lavalin, 2013b. Site Specific Risk Assessment, Frontenac Institution Former Landfill 1 (CSC ID 441-L02), Kingston, Ontario. Prepared for Public Works and Government Services Canada/Correctional Service Canada. December 6, 2013.

SNC-Lavalin, 2014a. Sediment Weight of Evidence Evaluation, CSC Frontenac Institution Former Landfill 3 (CSC ID 441-L03), Kingston, Ontario. Prepared for Public Works and Government Services Canada/Correctional Service Canada. March 31, 2014.

SNC-Lavalin, 2014b. Remedial Options Evaluation, Frontenac Institution Former Landfill 1 (CSC ID 441-L02), Kingston, Ontario. Prepared for Public Works and Government Services Canada/Correctional Service Canada. March 28, 2014.

SNC-Lavalin, 2014c. Remedial Options Evaluation, Frontenac Institution Former Landfill 3 (CSC ID 441-L03), Kingston, Ontario. Prepared for Public Works and Government Services Canada/Correctional Service Canada. March 28, 2014.

8 DISCLAIMER

The statements made in this report are based solely on the information obtained to date as part of the above referenced study. SNC-Lavalin has used its professional judgement in assessing this information and formulating its opinion and recommendations. New information may result in a change in this opinion. The mandate at SNC-Lavalin is to perform the tasks prescribed by the Client with the due diligence of the profession. No other warranty or representation, expressed or implied, as to the accuracy of the information or recommendations is included or intended in this report. The results of this study should in no way be construed as a warranty that the subject property is free from any and all contamination.

SNC-Lavalin disclaims any liability or responsibility to any person or party, other than the party to whom this report is addressed, for any loss, damage, expense, fine, or penalty which may arise or result from the use of any information or recommendations contained in this report. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the sole responsibility of the third party.

Submitted by:

SNC-LAVALIN INC.
ENVIRONMENT & WATER

LICENSED PROFESSIONAL ENGINEER
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July 23/14
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
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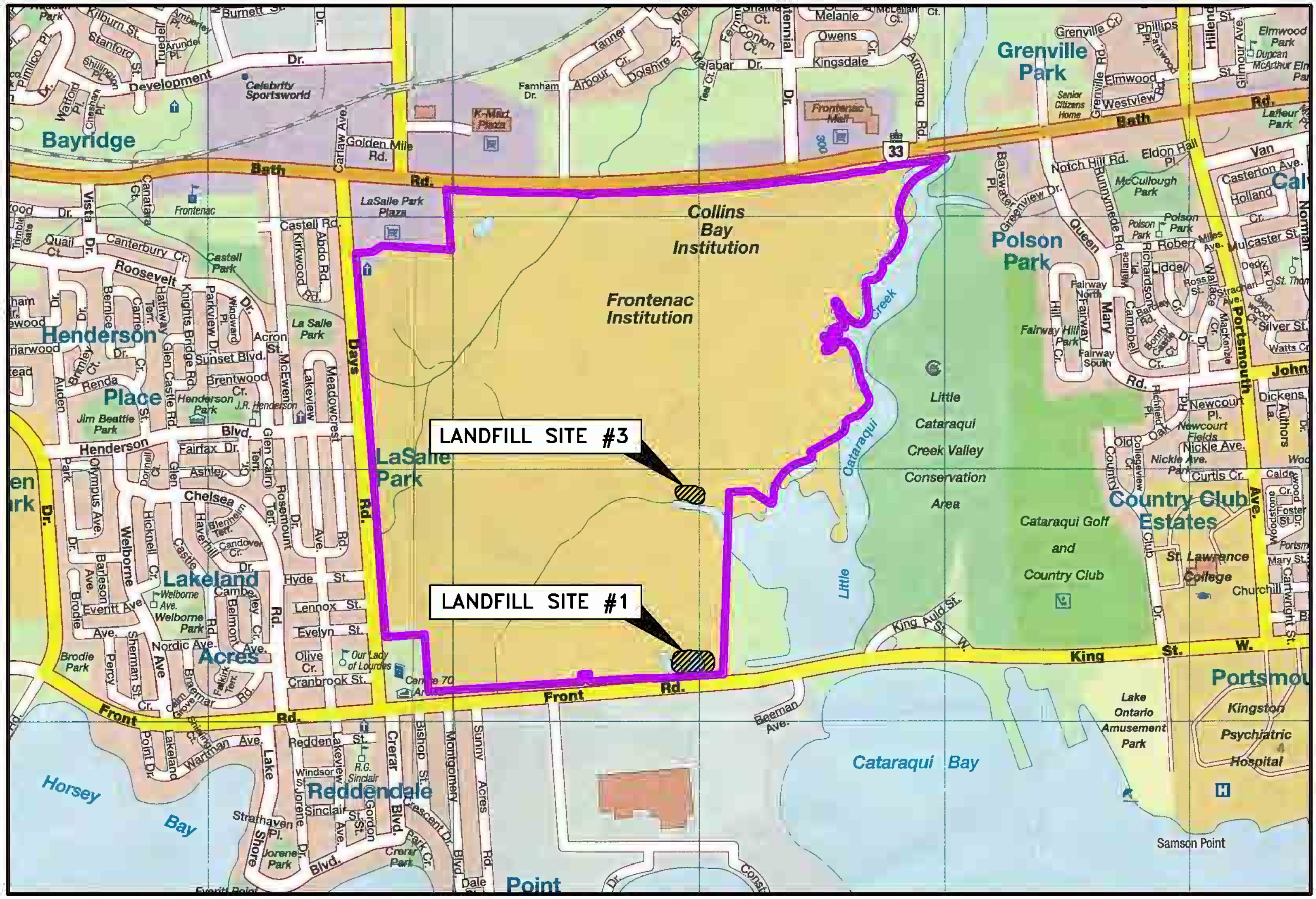
Project Engineer

Darren Dickson, M.A.Sc., P.Eng.
Senior Engineer

Mark Foerster, P.Geo.
Regional Manager

FIGURES



N

LEGEND

INSTITUTION PROPERTY

SCALE 1:25000

0 500 1000m

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. MAPART PUBLISHNG, KINGSTON ROAD MAP

SNC·LAVALIN

Client/Location: PWGSC/CSC COLLINS BAY INSTITUTION FORMER LANDFILLS 1 & 3 KINGSTON, ONTARIO		Title: SITE LOCATION	
Project No: 615406/615415	Filename: 003F01_615406	Date: APRIL 2014	Dwg No: FIGURE 1
Drawn: DM	Verified: AM	Project Manager: DD	

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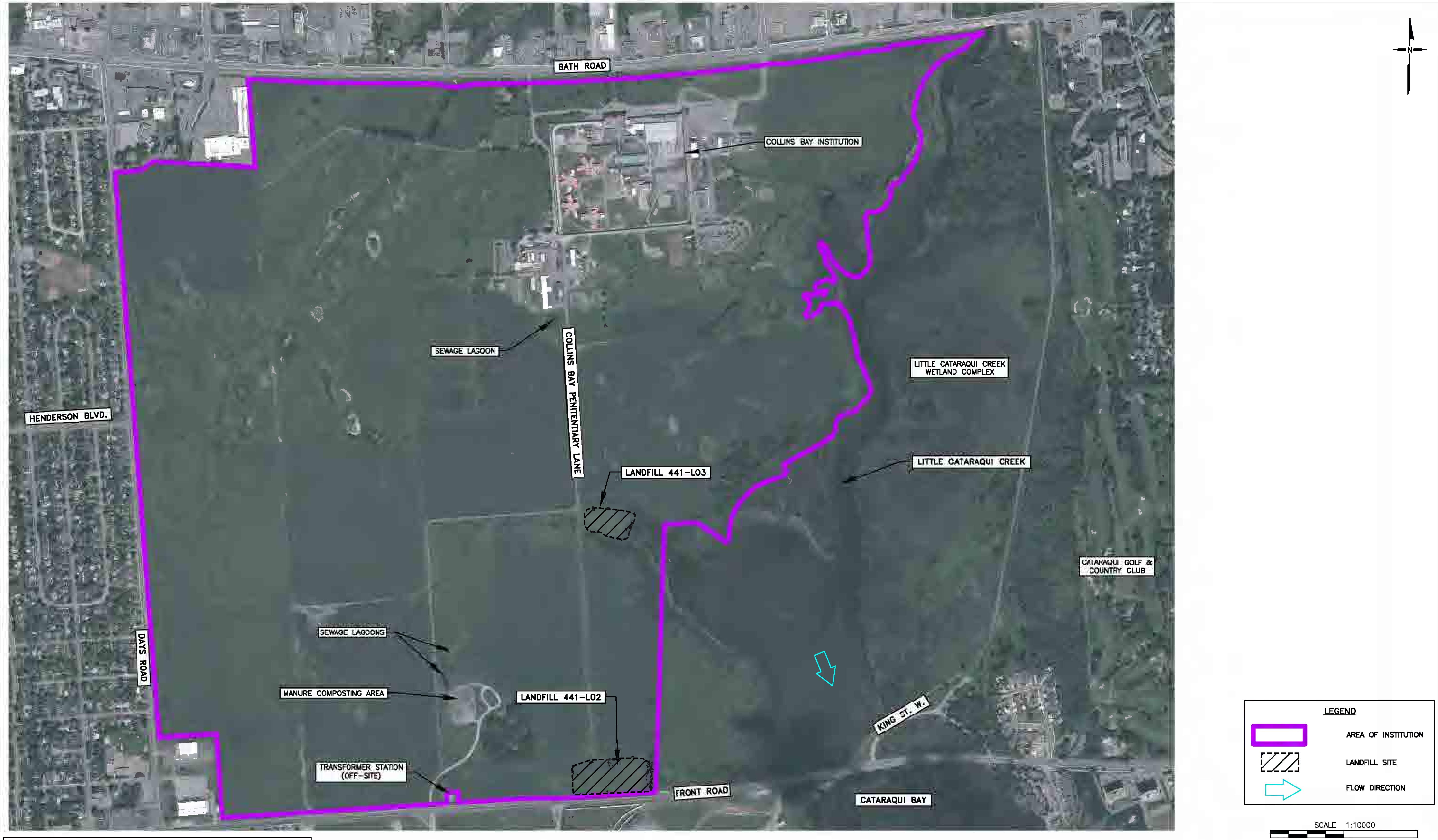

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1. SCALE AND SITE INFRASTRUCTURE LOCATIONS ARE APPROXIMATE
2. INFORMATION ON THIS FIGURE MAY BE LOST IF IT IS PRINTED, PHOTOCOPIED OR FAXED IN OTHER THAN ITS ORIGINAL SIZE AND COLOURS
3. 'm' : METRES

SOURCE(S):
1. GOOGLE EARTH IMAGE, AUGUST, 2011

SNC·LAVALIN

Client/Location: PWGSC/CSC COLLINS BAY INSTITUTION FORMER LANDFILLS 1 & 3 KINGSTON, ONTARIO		Title: SITE LOCATIONS WITHIN FRONTENAC FACILITY	
Project No: 615406/615415	Filename: 003F02_615406	Date: APRIL 2014	Dwg No: FIGURE 2
Drawn: DM	Verified: AM	Project Manager: DD	

PAGE FORMAT: 11x17

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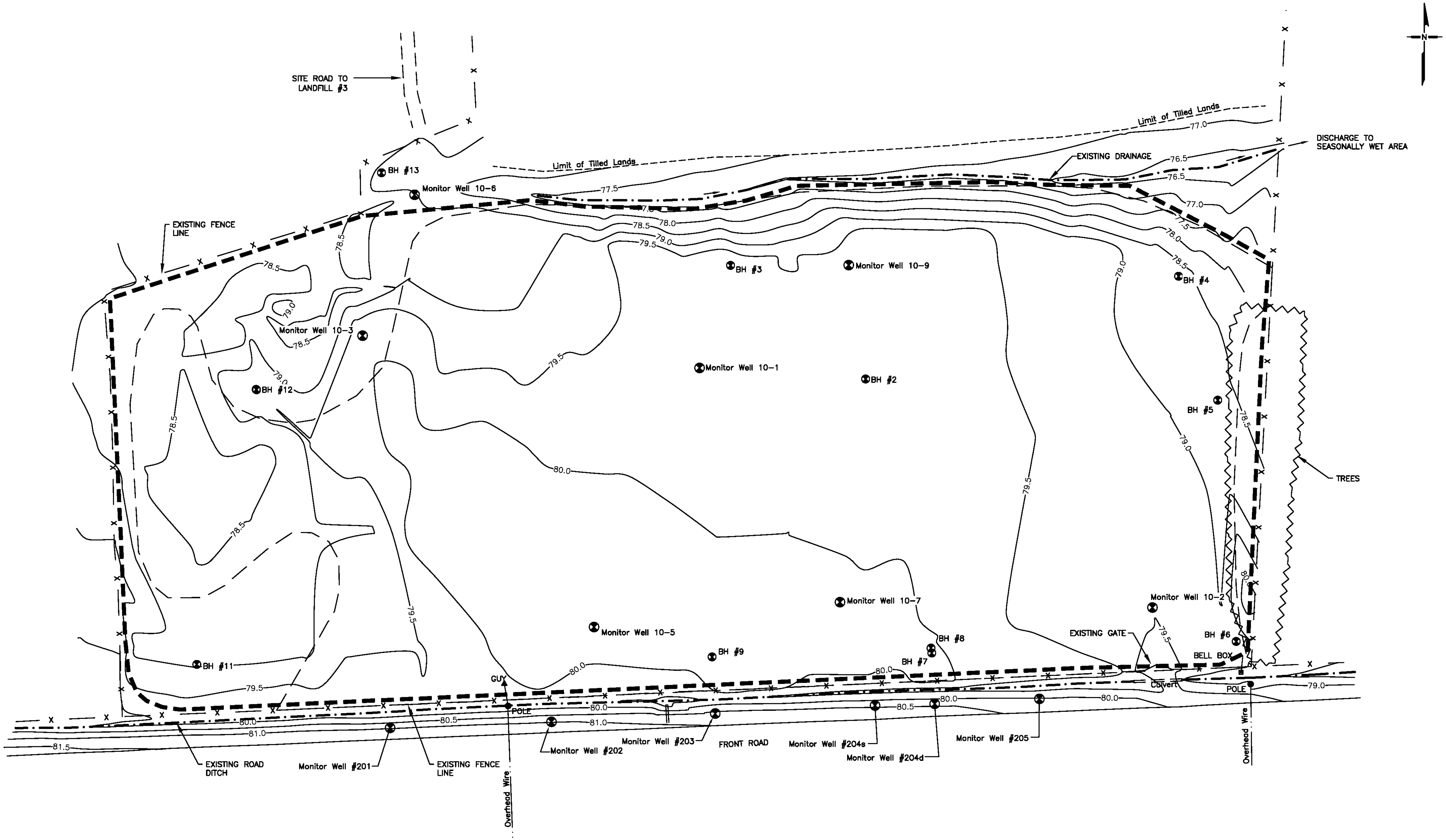

NOTE(S):
1. SCALE AND SITE INFRASTRUCTURE LOCATIONS ARE APPROXIMATE
2. INFORMATION ON THIS FIGURE MAY BE LOST IF IT IS PRINTED, PHOTOCOPIED OR FAXED IN OTHER THAN ITS ORIGINAL SIZE AND COLOURS
3. 'm' : METRES

SOURCE(S):
1. TOPOGRAPHIC SKETCH, HOPKINS, CORMIER & CHITTY SURVEYING CONSULTANTS INC, KINGSTON, ONTARIO, NOVEMBER 2012

LEGEND

- BOREHOLE/MONITORING WELL
- 76.0 EXISTING CONTOUR (m)
- LIMIT OF ADDTIONAL FILLING/ REGRADING
- LIMIT OF EXISTING WASTE (ESTIMATED)
- EXISTING DRAINAGE

SNC·LAVALIN	Client/Location: PWGSC/CSC COLLINS BAY INSTITUTION FORMER LANDFILLS 1 & 3 KINGSTON, ONTARIO		Title: SITE PLAN AND EXISTING CONDITIONS - LANDFILL #1	
	Project No: 615406/615415	Filename: 003F03_615406	Date: APRIL 2014	Dwg No: FIGURE 3
	Drawn: DM	Verified: AM	Project Manager: DD	

PAGE FORMAT: 11x17

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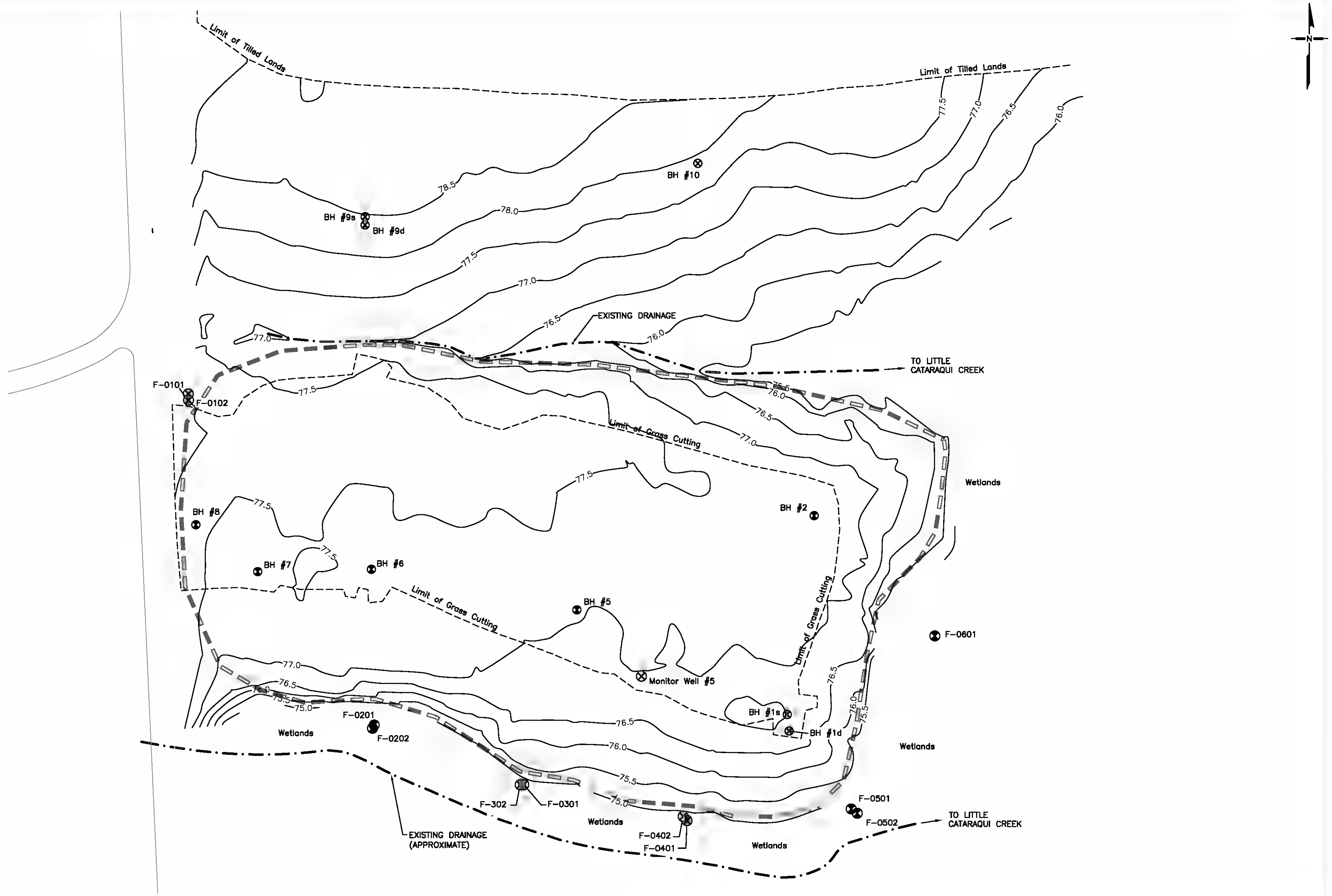

LEGEND

⊗	BOREHOLE/MONITORING WELL
—— 76.0 ——	EXISTING CONTOUR (m)
▬ ▬ ▬	LIMIT OF ADDTIONAL FILLING/ REGRADING
—·—·—	EXISTING DRAINAGE

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. TOPOGRAPHIC SKETCH, HOPKINS, CORMIER & CHITTY SURVEYING CONSULTANTS INC, KINGSTON, ONTARIO, NOVEMBER 2012

SNC·LAVALIN

PWGSC/CSC
COLLINS BAY INSTITUTION FORMER LANDFILLS 1 & 3
KINGSTON, ONTARIO

SITE PLAN AND EXISTING CONDITIONS – LANDFILL #3

APRIL 2014

FIGURE 4

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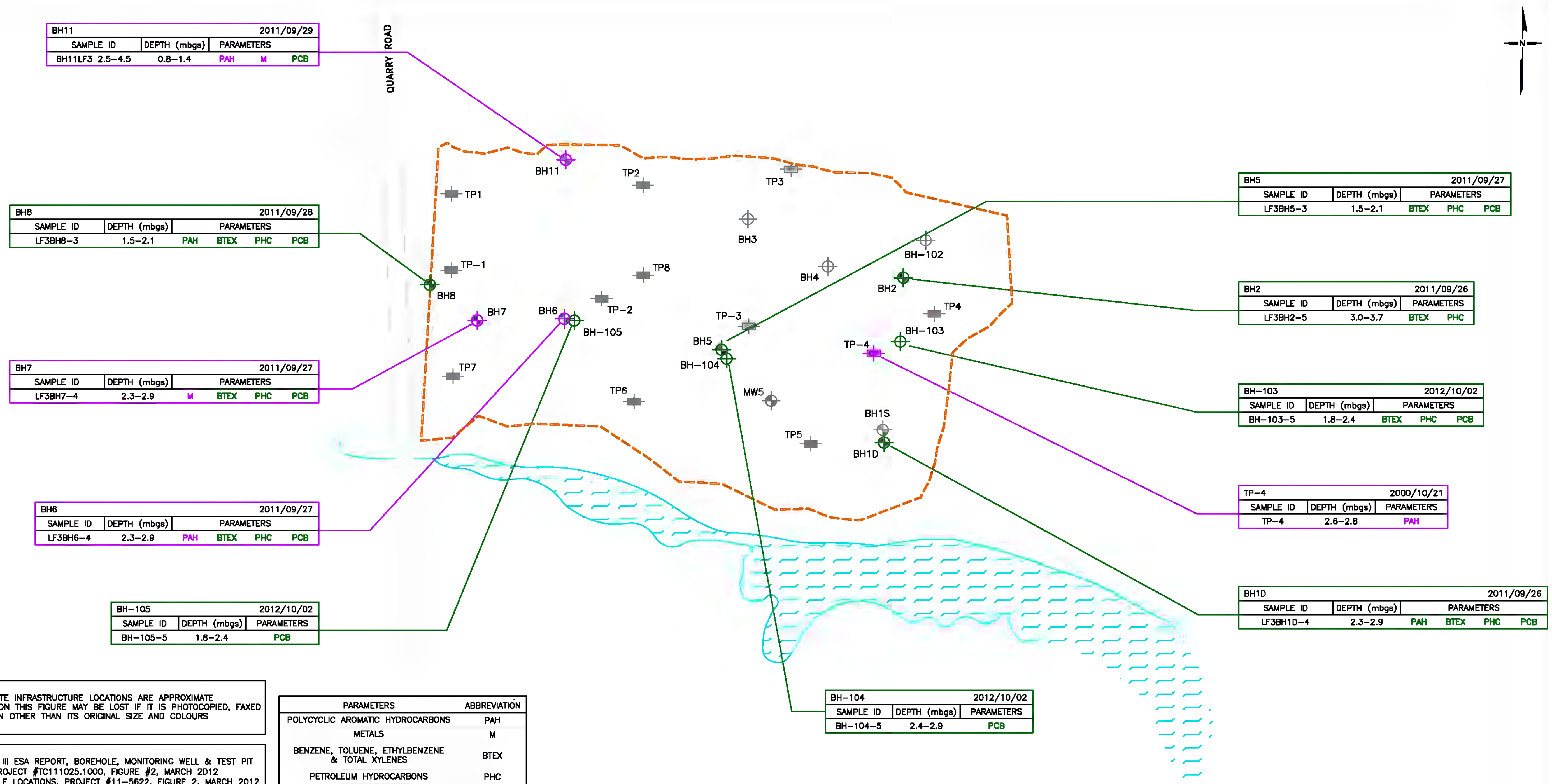

NOTE(S):
1. SCALE AND SITE INFRASTRUCTURE LOCATIONS ARE APPROXIMATE
2. INFORMATION ON THIS FIGURE MAY BE LOST IF IT IS PHOTOCOPIED, FAXED OR PRINTED IN OTHER THAN ITS ORIGINAL SIZE AND COLOURS
3. "m" : METRES

SOURCE(S):
1. AMEC, PHASE III ESA REPORT, BOREHOLE, MONITORING WELL & TEST PIT LOCATIONS, PROJECT #TC111025.1000, FIGURE #2, MARCH 2012
2. DILLON, SAMPLE LOCATIONS, PROJECT #11–5622, FIGURE 2, MARCH 2012
3. HISTORICAL AIR PHOTO, SEPTEMBER 2011

PARAMETERS	ABBREVIATION
POLYCYCLIC AROMATIC HYDROCARBONS	PAH
METALS	M
BENZENE, TOLUENE, ETHYLBENZENE & TOTAL XYLENES	BTEX
PETROLEUM HYDROCARBONS	PHC
POLYCHORINATED BIPHENYLS	PCB

LEGEND

APPROXIMATE LIMITS OF WASTE

EDGE OF WATER BODY (CREEK, RIVER, ETC.)

BOREHOLE

BOREHOLE/MONITORING WELL

TEST PIT

NOT ANALYSED AND/OR NO SAMPLE IMMEDIATELY BELOW WASTE

SOIL SAMPLE SATISFIES SITE SPECIFIC SOIL AND SEDIMENT RESTORATION CRITERIA

SOIL SAMPLE EXCEEDS SEDIMENT RESTORATION CRITERIA AND MEETS SOIL RESTORATION CRITERIA

SOIL SAMPLE EXCEEDS SEDIMENT AND SOIL RESTORATION CRITERIA

GREEN — GREEN COLOURED PARAMETER MEETS SITE SPECIFIC SOIL AND SEDIMENT RESTORATION CRITERIA

PURPLE — PURPLE COLOURED PARAMETER EXCEEDS SITE SPECIFIC SEDIMENT RESTORATION CRITERIA AND MEETS SOIL RESTORATION CRITERIA

RED — RED COLOURED PARAMETER EXCEEDS SITE SPECIFIC SOIL AND SEDIMENT CRITERIA RESTORATION

SCALE 1:1000
0 20 40m

SNC·LAVALIN

Client/Location: PWGSC/CSC COLLINS BAY INSTITUTION FORMER LANDFILLS 1 & 3 KINGSTON, ONTARIO

Title: SOIL CONDITIONS IMMEDIATELY BELOW WASTES – LANDFILL #3

Project No.: 615406/615415	Filename: 003F05_615415	Date: APRIL 2014	Dwg No.: FIGURE 5
Drawn: DM	Verified: AM	Project Manager: DD	

PAGE FORMAT: 17x22

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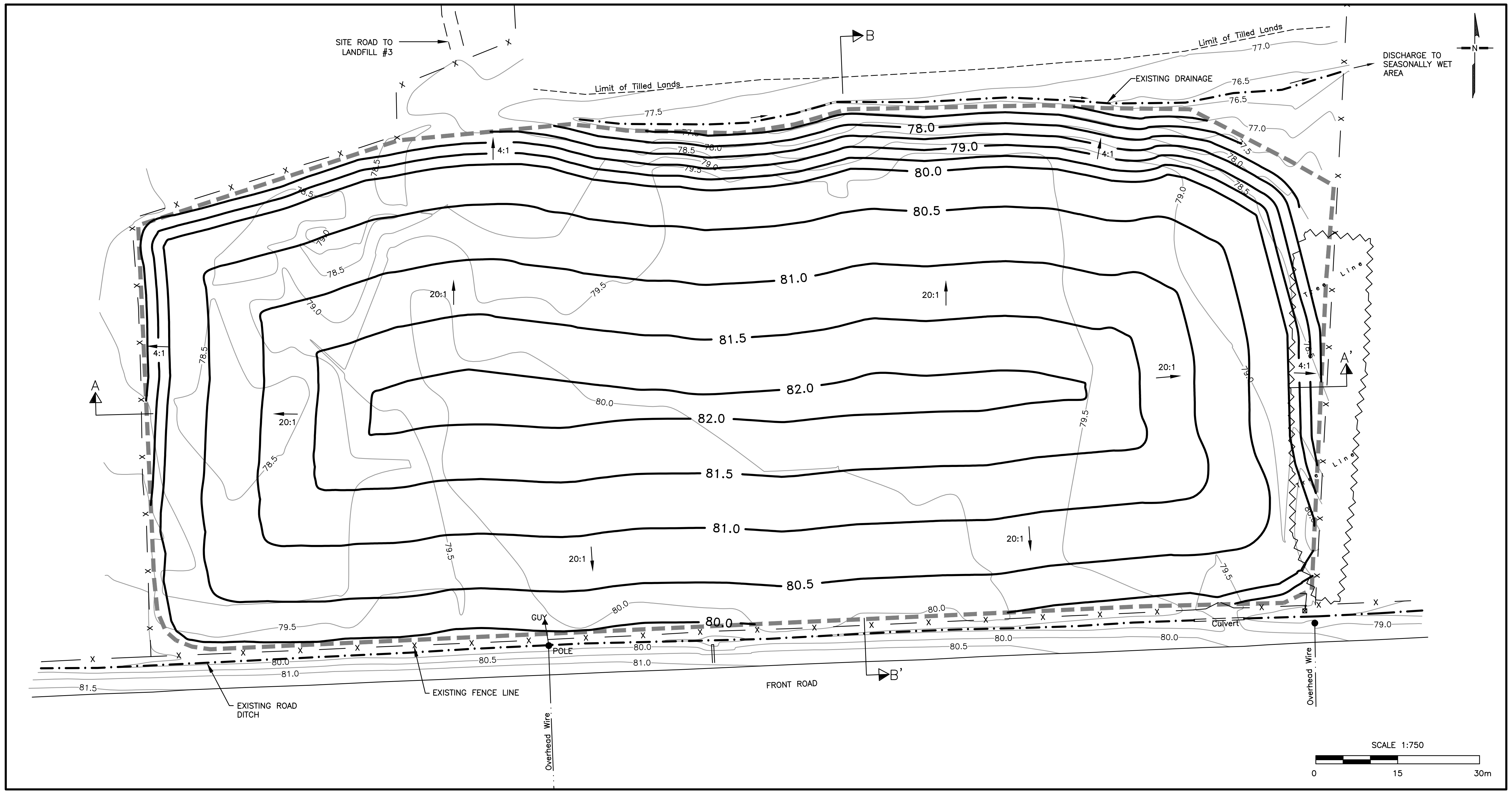
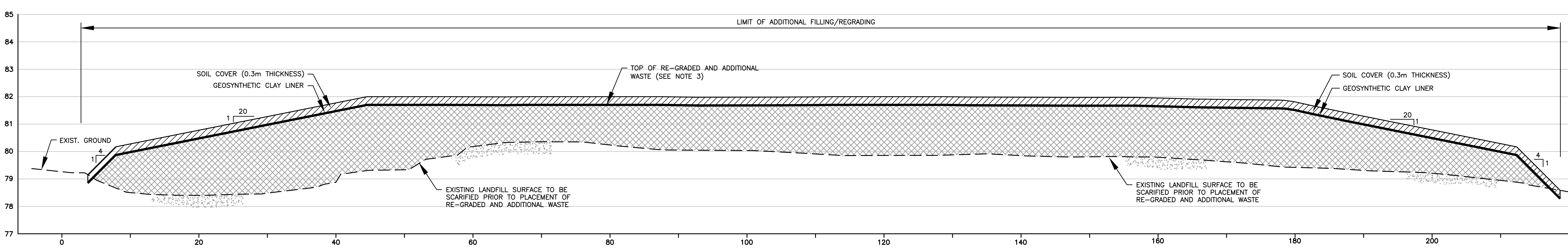
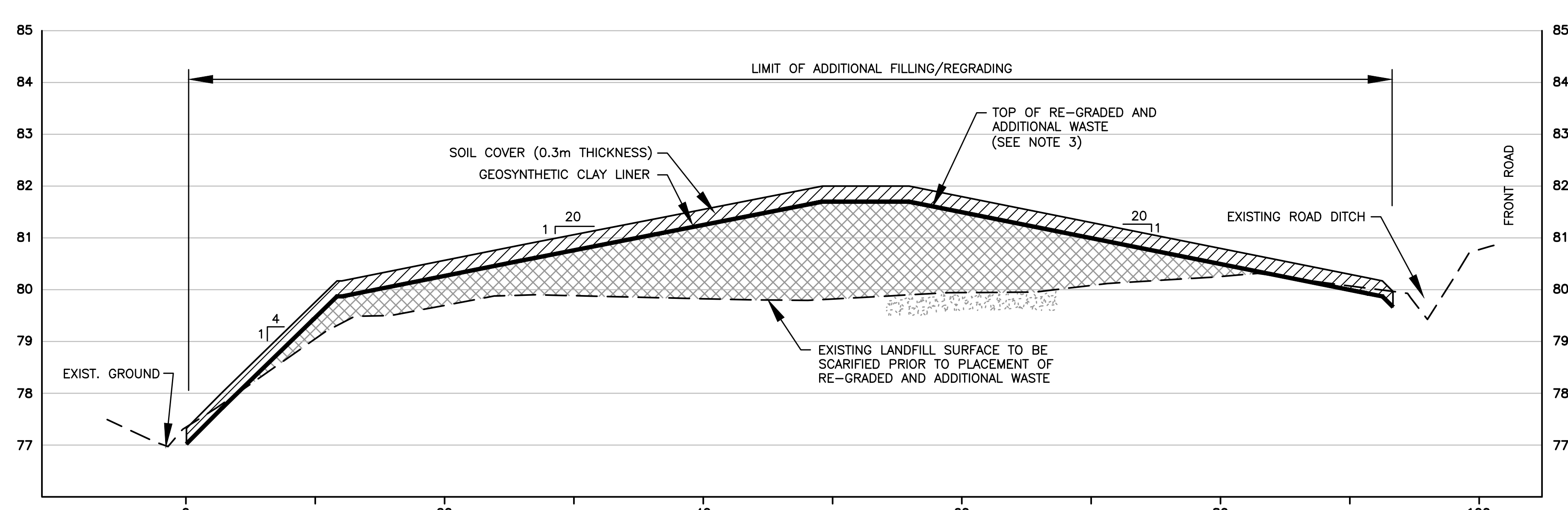




CROSS SECTION A-A'
HORIZONTAL SCALE (m) – 1:400



CROSS SECTION B-B'
HORIZONTAL SCALE (m) – 1:400

LEGEND

- 76.0 — EXISTING CONTOUR (m)
- LIMIT OF ADDITIONAL FILLING/ RE-GRADING
- EXISTING DRAINAGE
- 81.0 — FINAL COVER CONTOUR (m)

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. RE-GRADED WASTE WILL CONSIST OF APPROX. 500^3 OF WASTES (MOVED/RE-GARDED FROM OTHER AREAS OF LANDFILL) AND APPROX. 19,115m^3 OF WASTE MATERIALS IMPORTED FROM LANDFILL #3 (TOTAL APPROX. 19,620m^3)
4. 'm' : METRES

SOURCE(S):
1. TOPOGRAPHIC SKETCH, HOPKINS, CORMIER & CHITTY SURVEYING CONSULTANTS INC, KINGSTON, ONTARIO, NOVEMBER 2012

HOR. SCALE 1:500
0 5 10
VERT. SCALE 1:125
0 1.25 2.5

SNC·LAVALIN

Client/Location: PWGSC/CSC COLLINS BAY INSTITUTION FORMER LANDFILLS 1 & 3 KINGSTON, ONTARIO		Title: FINAL CONTOURS (LANDFILL CAP) – LANDFILL 1	
Project No: 615406/6415415	Filename: 001F06_615406	Date: APRIL 2014	Dwg No: FIGURE 6
Drawn: DM	Verified: AM	Project Manager: DD	

PAGE FORMAT: 11x17

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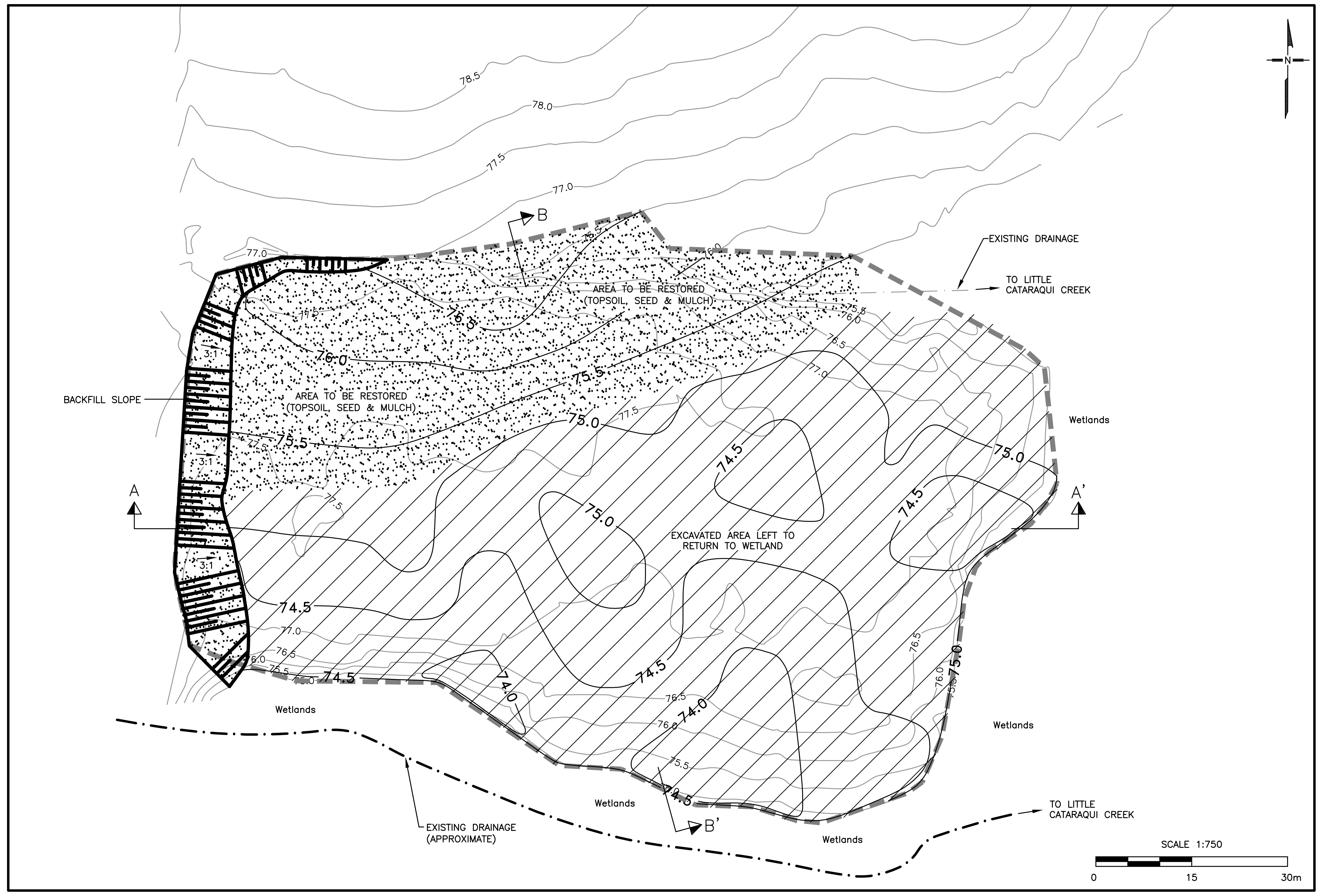
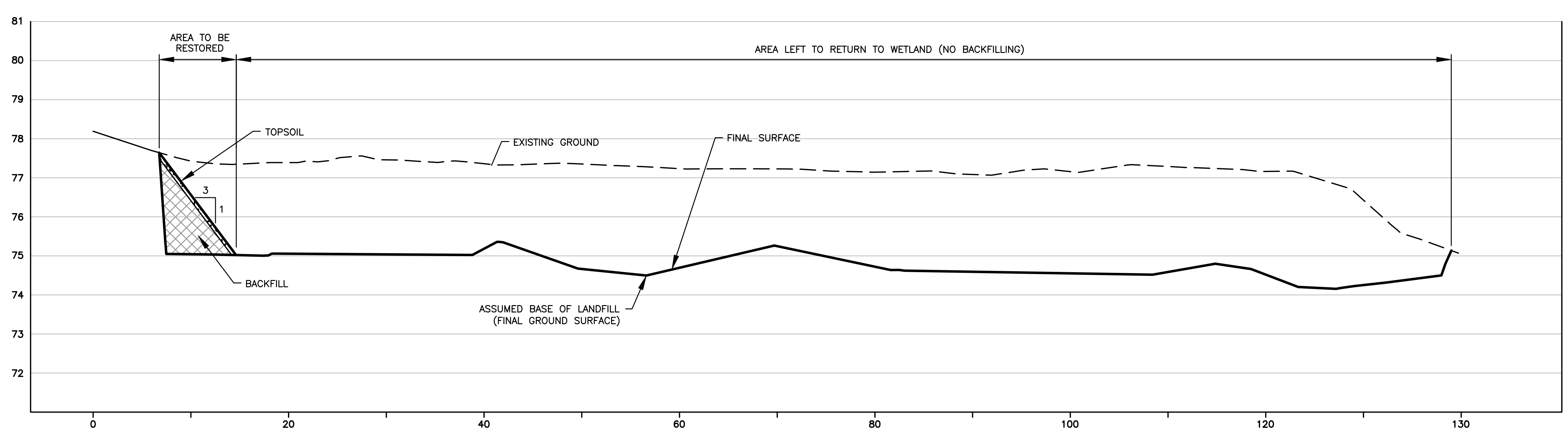
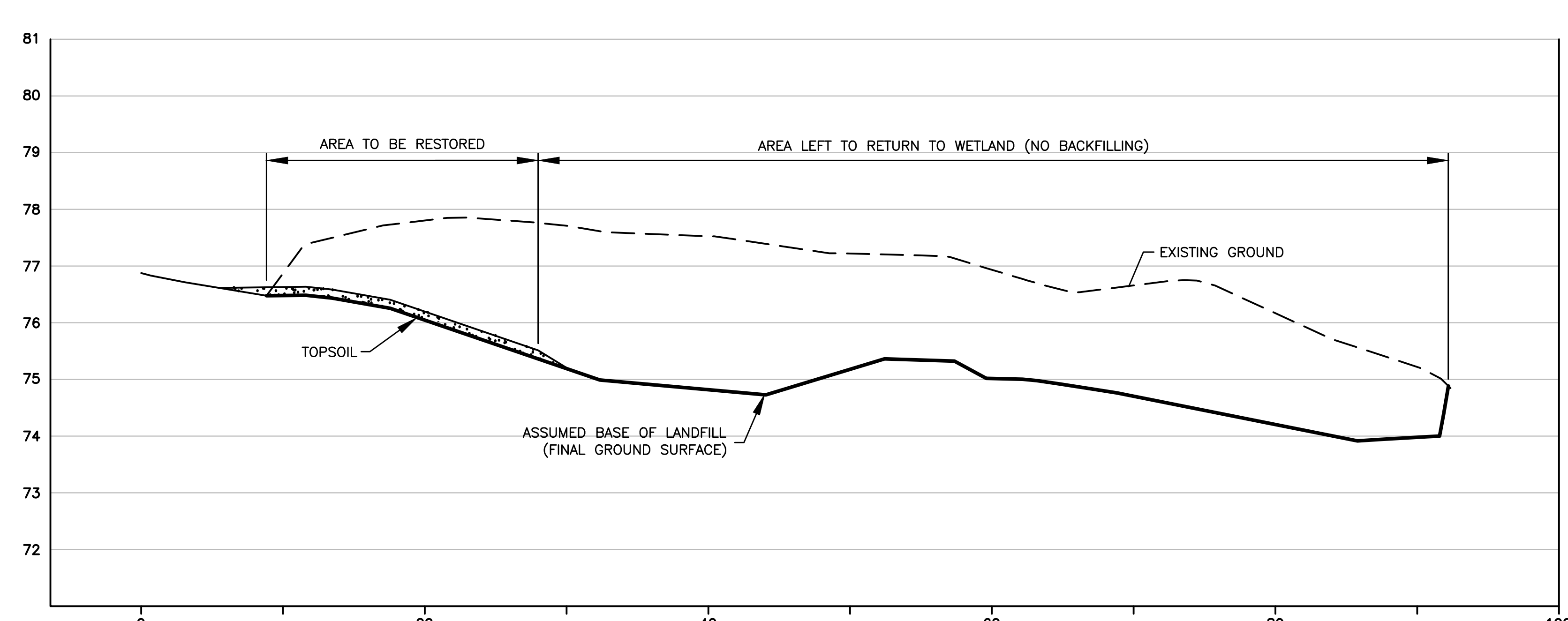




CROSS SECTION A-A'
HORIZONTAL SCALE (m) – 1:400



CROSS SECTION B-B'
HORIZONTAL SCALE (m) – 1:400

LEGEND

- 76.0 — EXISTING CONTOUR (m)
- LIMIT OF ADDTIONAL FILLING/ RE-GRADING
- EXISTING DRAINAGE
- 74.0 — FINAL CONTOUR (m) LIMIT OF EXCAVATION
- AREA TO BE RESTORED
- AREA TO BE RETORED TO WETLAND

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. ADDITIONAL FILL INCLUDING TOP SOIL WILL BE SUPPLIED BY IMPORTED MATERIALS (APPROX. 590m³)
4. 'm' : METRES

SOURCE(S):
1. TOPOGRAPHIC SKETCH, HOPKINS, CORMIER & CHITTY SURVEYING CONSULTANTS INC, KINGSTON, ONTARIO, NOVEMBER 2012

HOR. SCALE 1:500
0 5 10
VERT. SCALE 1:125
0 1.25 2.5

SNC·LAVALIN

Client/Location: PWGSC/CSC COLLINS BAY INSTITUTION FORMER LANDFILLS 1 & 3 KINGSTON, ONTARIO		Title: FINAL CONTOURS (EXPANDED WETLAND AREA) – LANDFILL 3	
Project No: 615406/615415	Filename: 003F07_615406	Date: APRIL 2014	Dwg No: FIGURE 7
Drawn: DM	Verified: AM	Project Manager: DD	

PAGE FORMAT: 11x17

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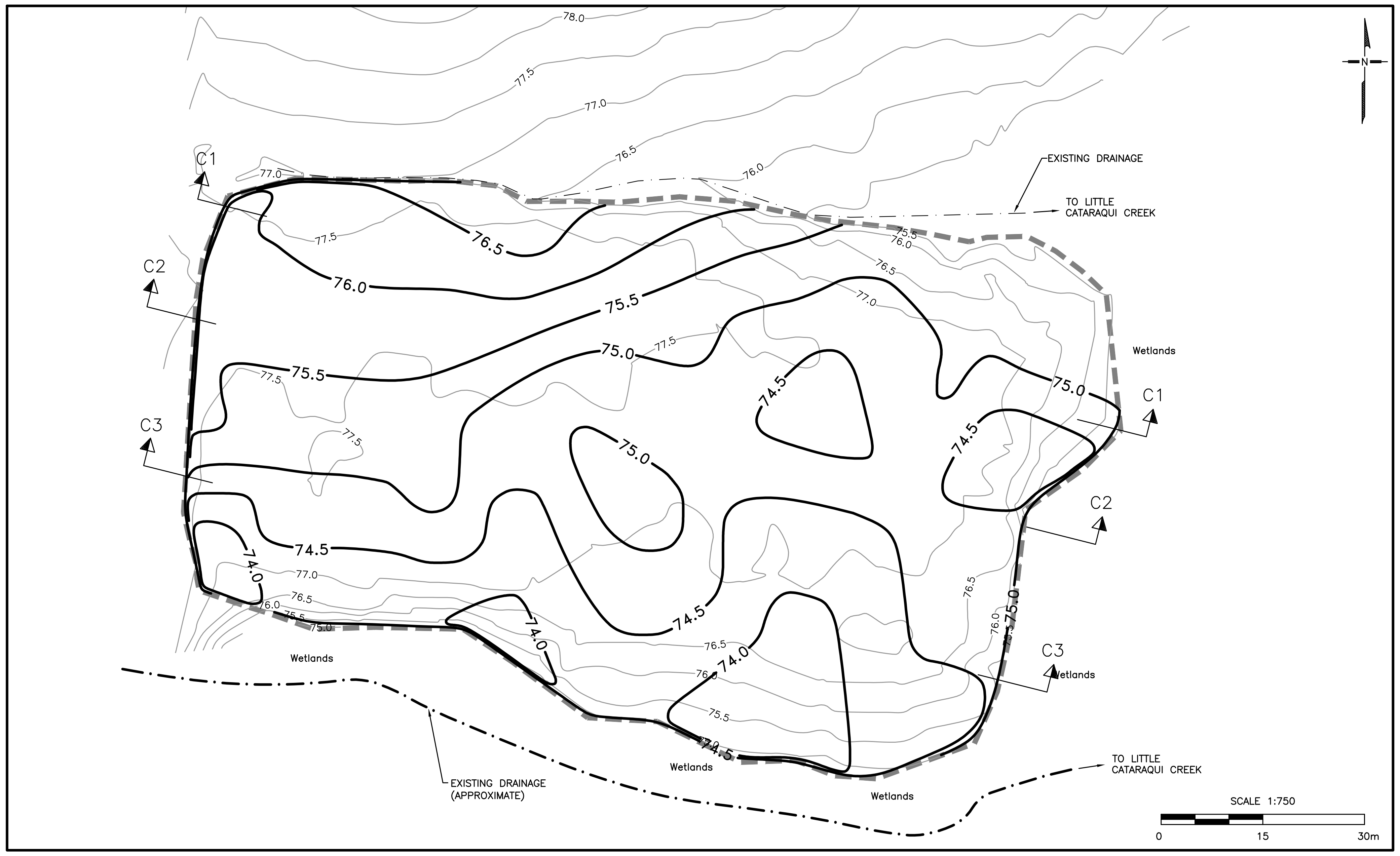

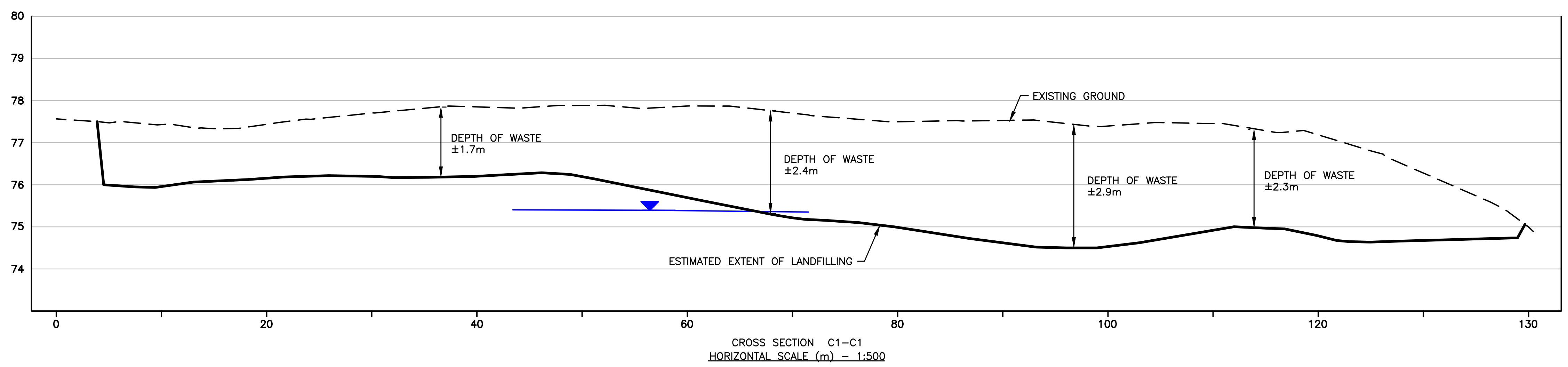

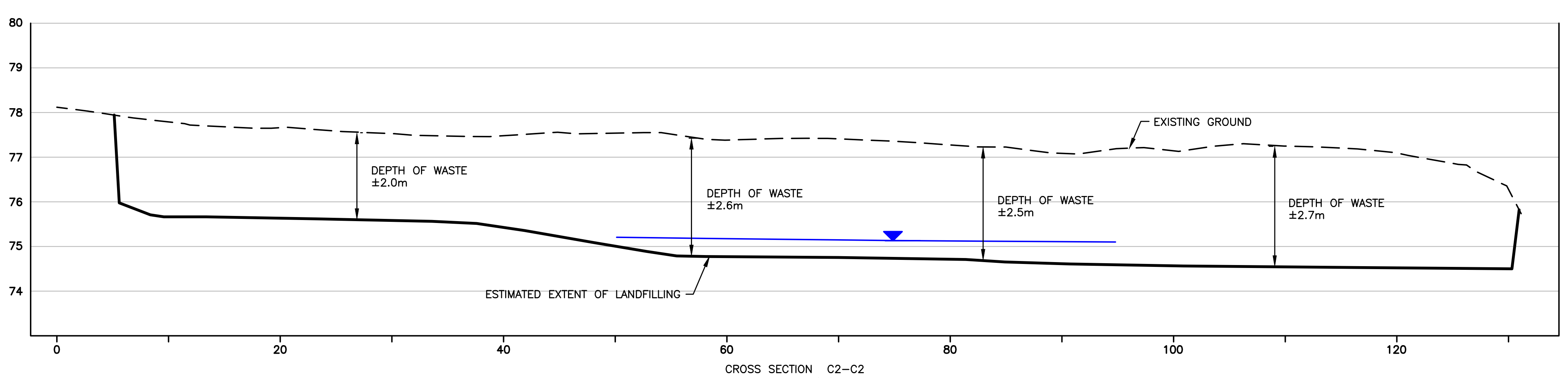

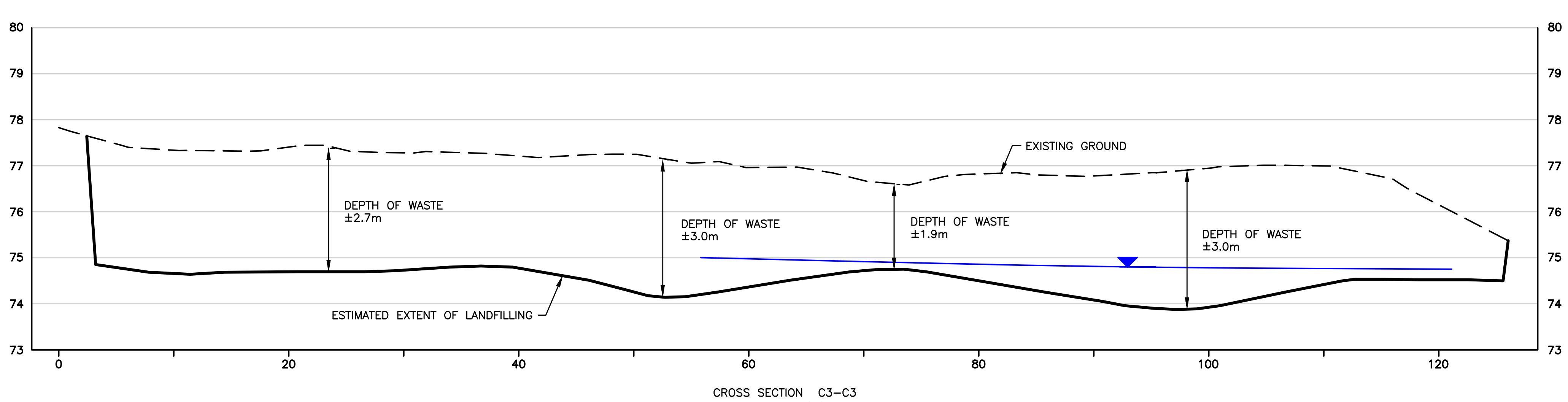

LEGEND

76.0 EXISTING CONTOUR (m)
ESTIMATED LIMIT OF WASTE
EXISTING DRAINAGE
81.0 ESTIMATED BASE OF LANDFILL CONTOUR (m)
WATER LEVEL (OCTOBER 21, 2013)

NOTE(S):
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2. INFORMATION ON THIS FIGURE MAY BE LOST IF IT IS PRINTED, PHOTOCOPIED OR FAXED IN OTHER THAN ITS ORIGINAL SIZE AND COLOURS
3. ADDITIONAL FILL INCLUDING TOP SOIL WILL BE SUPPLIED BY IMPORTED MATERIALS (APPROX. 8,500m^3)
4. 'm' : METRES

HOR. SCALE 1:500
0 5 10
VERT. SCALE 1:125
0 1.25 2.5

SNC·LAVALIN

Client/Location: PWGSC/CSC
COLLINS BAY INSTITUTION FORMER LANDFILLS 1 & 3
KINGSTON, ONTARIO

Title: EXTENT OF EXCAVATION – LANDFILL 3

Project No: 615406/615415
Filename: 003F08_615406
Date: APRIL 2014
Dwg No: FIGURE 8
Drawn: DM
Verified: AM
Project Manager: DD

PAGE FORMAT: 17x22

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SCALE APPROX. 1:4000

0 80 160m

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. BACKGROUND IMAGE GOOGLE EARTH, IMAGE DATE AUGUST 2011

SNC·LAVALIN

Client/Location: PWGSC/CSC COLLINS BAY INSTITUTION FORMER LANDFILLS 1 & 3 KINGSTON, ONTARIO		Title: SITE ACCESS AND LANDS AFFECTED BY CLOSURE WORKS	
Project No: 615406/615415	Filename: 003F09_615406	Date: APRIL 2014	Dwg No: FIGURE 9
Drawn: DM	Verified: AM	Project Manager: DD	

FILENAME: \\SLI1025\Projects\PWGSC\CSC Frontenac LFs\615406\4.0 Execution\4.7 Working Versions\4.7.3 CAD_GIS\003\003F09_615406.dwg

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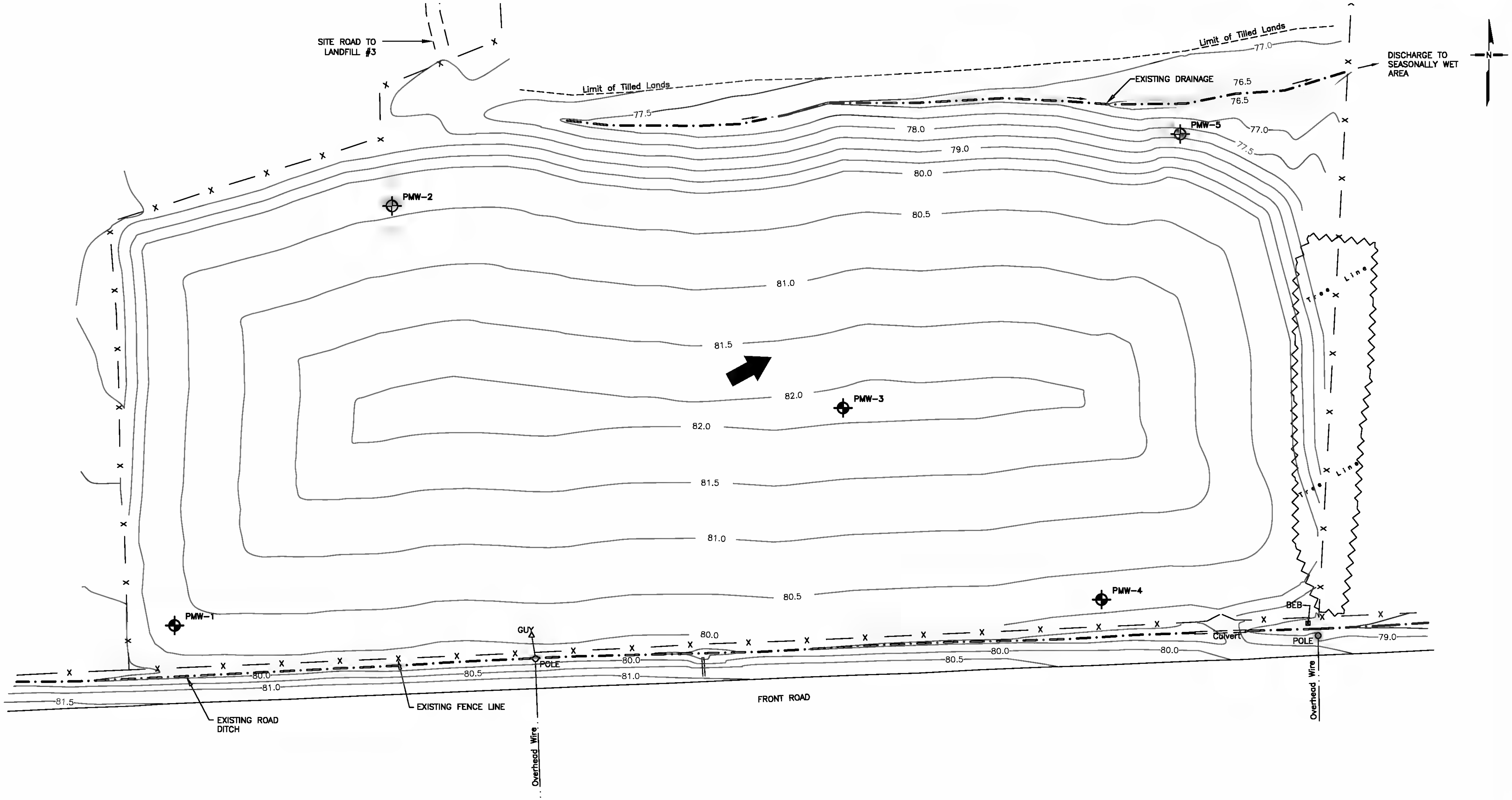

SCALE 1:750

0 15 30m

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. TOPOGRAPHIC SKETCH, HOPKINS, CORMIER & CHITTY SURVEYING CONSULTANTS INC, KINGSTON, ONTARIO, NOVEMBER 2012

LEGEND
- PROPOSED MONITORING WELL
- APPROXIMATE GROUNDWATER FLOW DIRECTION
- EXISTING DRAINAGE

SNC·LAVALIN

PWGSC/CSC
COLLINS BAY INSTITUTION FORMER LANDFILLS 1 & 3
KINGSTON, ONTARIO

Filename:

POST-CLOSURE
MONITORING WELL NETWORK

MARCH 2014

FIGURE 10

PAGE FORMAT: 11x17

FILENAME: \\SLI1025\Projects\PWGSC\CSC Frontenac LFs\615406\4.0 Execution\4.7 Working Versions\4.7.3 CAD_GIS\003\003F10_615406.dwg

TABLES (Omitted)

APPENDIX A

Site Specific Target Levels for Surface Soil and Sediment at Landfill 3

Site Specific Target Levels (SSTLs) for Surface Soil and Sediment at Landfill 3

Soil Restoration Criteria

SSTLs for human receptors and for mammalian and avian receptors were calculated using a simplified back-calculation approach based on the ratio between the target risk level and calculated risk for each receptor due to an exposure point concentration in a given medium. For the purpose of SSTL calculation, a target risk level of 1 is used to derive SSTLs for mammalian and avian receptors and a target risk level of 0.2 (for non-carcinogenic chemicals) or 1×10^{-5} (for carcinogenic chemicals) is used to derive human health SSTLs. The SSTL calculation approach is as follows:

$$SSTL_{x-y} = EPC_x \times \frac{TargetRisk_{x-y}}{CalculatedRisk_{x-y}}$$

Equation 1

where:

$SSTL_{x\text{-}y}$ = Site specific target level calculated for chemical x and receptor y (mg/kg or mg/L);

EPC_x = Exposure point concentration for chemical x (mg/kg or mg/L);

Target $Risk_{x\text{-}y}$ = Target risk level for chemical x and receptor y (unitless); and,

Calculated $Risk_{x\text{-}y}$ = Calculated risk level for chemical x and receptor y (unitless).

Calculated risk and EPCx values were obtained from SNC-Lavalin (2013a).

Mammal and bird SSTLs for chemicals which were not quantitatively evaluated in the Landfill 3 site specific risk assessment (SNC-Lavalin, 2013a) were obtained from the Ontario Ministry of Environment (MOE, 2011) mammal and bird soil standard component. Terrestrial plant and soil invertebrate SSTLs were selected from the following list toxicity based benchmarks:

- Canadian Council of Ministers of the Environment – Commercial land Use - ecological soil contact guideline (CCME, 1999 as updated; CCME, 2008; CCME, 2010);
- Ontario Ministry of Environment and Energy – Commercial/Industrial Land Use –plant/soil invertebrate standard component (MOE, 2011);
- Efroymson et al. (1997a) soil invertebrate (earthworm) and (1997b) phytotoxicity data;
- Efroymson et al., 1997b (phytotoxicity benchmarks); and,
- US EPA (2010a) Ecological Soil Screening Levels.

The lowest of the human health, mammal/bird and invertebrate/plant benchmark or SSTL was selected for restoration criteria. The restoration criteria were cross checked against MOE (2011) background soil concentrations to ensure that the final restoration criteria were not set lower than background. The final site specific clean-up criteria are provided in Table A.1. Typically, the soil SSTLs represent either terrestrial plant/soil invertebrate protective benchmarks or background soil concentrations.

Sediment Restoration Criteria

SSTLs for mammalian and avian receptors were calculated using the simplified back-calculation approach identified in Equation 1. For the purpose of SSTL calculation, an ecological target risk level of 1 has been used. The calculated risk and EPCx values were obtained from SNC-Lavalin (2013a).

Toxicity based ecological (aquatic life) criteria for sediment were selected from the following hierarchal list:

- Canadian Council of Ministers of the Environment – Freshwater Interim Sediment Quality Guidelines (ISQGs) - (CCME, 1999 as updated);
- Ontario Ministry of Environment and Energy – Low Effects Level Sediment Quality Guidelines (MOE, 2008);
- Thompson et al (2005) – Sediment-Based Low Effects Level criteria;
- United States Environmental Protection Agency Generic Screening Levels (US EPA, 2006); and,
- Atlantic Partnership in RBCA Implementation (APIRI, 2012) –Sediment Ecological Screening Levels for Typical Sediments (modified total petroleum hydrocarbon (TPH) fractions were recalculated to CCME PHC fractions F1 to F3 based on CCME (2008) PHC apportionments and an average fraction of organic carbon (fOC) for the Site of 1%).

A human health sediment criterion protective of biomagnification risk associated with fish ingestion was calculated for one detectable parameter, consisting of PCBs. The criterion is calculated as follows:

$$SSTL_{PCB-HH-fishingest} = fOC \times \frac{\left[\dfrac{(TRV \times BW \times TR)}{IR_{fish}}\right]}{(BSAF \times f_{lipid})} \qquad \text{Equation 2}$$

Where:

fOC = fraction organic carbon in sediment (g/OC/g sediment dry weight) = 0.0078;

TRV = PCB toxicity reference value (µg/kg body weight per day) = 0.13;

BW = Receptor bodyweight (kg) = 16.5 for a toddler;

TR = Target risk level (unitless) = 0.2;

IR_{fish} = Fish ingestion rate (g/day fresh weight) adjusted to 10% of the intake value to represent site caught related ingestion rate = 5.6;

BSAF = Sediment to biota partition factor (g OC/g lipid) = 4; and,

f_{lipid} = Fillet portion fish lipid fraction (unitless) = 0.0182.

Equation input values are consistent with those used in SNC-Lavalin (2013a).

The lowest of the criteria identified above (mammal/bird, aquatic life, human health fish ingestion (PCB) was selected as the restoration criteria following a final cross check against the background concentration. This final check was completed to avoid setting a sediment SSTL below a level which cannot be feasibly managed.

Site-specific background concentrations for sediment were calculated using data collected from reference stations as part of the sediment Weight-of-Evidence evaluation approach in the SSRA addendum (SNC-Lavalin, 2014). Specifically, the 97.5 percentile concentrations was calculated and selected as the site-specific background concentration. ProUCL (2010b) version 4.1 was used to complete a goodness-of-fit test on the analytical data for each analysed chemical to determine whether the data satisfied assumptions applicable to a series of potential distribution types (i.e. normally, lognormally or follows a gamma distribution). Additionally, since distribution goodness-of-fit tests on data sets with non-detectable values can be unreliable, non-parametric 97.5 percentile calculation was accomplished by ProUCL with the aid of the Kaplan-Meier nonparametric method in these situations.

The majority of the background concentrations based on the 97.5 percentiles calculated using ProUCL exceeded the maximum concentrations detected in the site background sediment data set. ProUCL appears to fit the data to a model distribution based on the data and then extrapolates based on the model if necessary to identify the 97.5 percentile. In this case, the right tail of the fitted distribution extends beyond the maximum concentrations where the higher percentiles (95%, 97.5%, 99%) are likely to fail. This likely occurs when the data set is relatively small and there is a small coefficient of variation (i.e. the dispersion of the data is small). In cases where the 97.5 percentile exceeded the maximum detected concentration, the maximum concentration was identified as site background sediment conditions.

In a number of cases a 97.5 percentile concentration could not be calculated due to lack of data or a chemical was non-detectable at the reference locations. Chemicals for a which a background concentration could not be established consist of benzene, toluene, ethylbenzene, total xylenes, a limited number of polycyclic aromatic hydrocarbons, tin and chromium(VI).

Site-specific remediation objectives and/or clean-up criteria for sediment are presented in Table A.1.

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TABLE A.1 **RESTORATION CRITERIA**
CSC Collins Bay Institution, Former Landfill No.3
Kingston, Ontario

	Sediment Restoration Criteria µg/g	Reference	Soil Restoration Criteria µg/g	Reference
Antimony	2	USEPA Region III	40	MOE 2011 Comm/Indust Coarse Soil Plant + Invertebrate Component
Arsenic	5.9	CCME ISQG	18	MOE 2011 Table 1
Barium	180	97.5 percentile of Background concentration	620	ECO SSTL
Beryllium	0.68	97.5 percentile of Background concentration	8	MOE 2011 Comm/Indust Coarse Soil Plant + Invertebrate Component
Boron (total)	13	97.5 percentile of Background concentration	120	MOE 2011 Soil Contact
Cadmium	2.653	97.5 percentile of Background concentration	22	CCME 1999 Eco Soil Contact
Chromium (total)	37.3	CCME ISQG	87	CCME 1999 Eco Soil Contact
Chromium (VI)	nc		1.4	CCME 1999 Eco Soil Contact
Cobalt	50	MOE LEL	80	MOE 2011 Comm/Indust Coarse Soil Plant + Invertebrate Component
Copper	35.7	CCME ISQG	92	MOE 2011 Table 1
Lead	35	CCME ISQG	600	CCME 1999 Eco Soil Contact
Mercury	0.17	CCME ISQG	50	CCME 1999 Eco Soil Contact
Molybdenum	13.8	Thompson LEL	40	MOE 2011 Comm/Indust Coarse Soil Plant + Invertebrate Component
Nickel	23.4	Thompson LEL	50	CCME 1999 Eco Soil Contact
Selenium	1.9	Thompson LEL	2.9	CCME 1999 Eco Soil Contact
Silver	1	USEPA Region III	40	MOE 2011 Comm/Indust Coarse Soil Plant + Invertebrate Component
Thallium	0.2	97.5 percentile of Background concentration	3.6	CCME 1999 Eco Soil Contact
Uranium	104.4	Thompson LEL	2000	CCME 1999 Eco Soil Contact
Vanadium	35.2	Thompson LEL	130	CCME 1999 Eco Soil Contact
Zinc	140	97.5 percentile of Background concentration	360	CCME 1999 Eco Soil Contact
Acenaphthene	0.00671	CCME ISQG	29	US EPA 2007 - LMW Soil Invertebrates
Acenaphthylene	0.00587	CCME ISQG	29	US EPA 2007 - LMW Soil Invertebrates
Anthracene	0.0469	CCME ISQG	32	CCME 1999 Eco Soil Contact
Benzo(a)anthracene	0.0778	97.5 percentile of Background concentration	1	MOE 2011 Comm/Indust Coarse Soil Plant + Invertebrate Component
Benzo(a)pyrene	0.0801	97.5 percentile of Background concentration	72	CCME 1999 Eco Soil Contact
Benzo(b)fluoranthene	0.168	97.5 percentile of Background concentration	29	US EPA 2007 - LMW Soil Invertebrates
Benzo(g,h,i)perylene	0.0714	97.5 percentile of Background concentration	13	CCME 1999 Eco Soil Contact
Benzo(k)fluoranthene	0.0517	97.5 percentile of Background concentration	15	CCME 1999 Eco Soil Contact
Chrysene	0.128	97.5 percentile of Background concentration	14	MOE 2011 Comm/Indust Coarse Soil Plant + Invertebrate Component
Dibenzo(a,h)anthracene	0.00622	CCME ISQG	18	US EPA 2007 - LMW Soil Invertebrates
Fluoranthene	0.429	97.5 percentile of Background concentration	180	CCME 1999 Eco Soil Contact
Fluorene	0.0212	CCME ISQG	30	Efroymson et al. 1997 - Earthworm Toxicity
Indeno(1,2,3-cd)pyrene	0.0683	97.5 percentile of Background concentration	0.76	MOE 2011 Comm/Indust Coarse Soil Plant + Invertebrate Component
Methylnaphthalene, 1-	nc		29	US EPA 2007 - LMW Soil Invertebrates
Methylnaphthalene, 2-	0.0616	97.5 percentile of Background concentration	29	US EPA 2007 - LMW Soil Invertebrates
Naphthalene	0.0346	CCME ISQG	22	MOE 2011 Comm/Indust Coarse Soil Plant + Invertebrate Component
Phenanthrene	0.168	97.5 percentile of Background concentration	12	MOE 2011 Comm/Indust Coarse Soil Plant + Invertebrate Component
Pyrene	0.293	97.5 percentile of Background concentration	18	US EPA 2007 - HMW Soil Invertebrates
BaP TPE	nc		5.3	CCME, 2008 - human health
Benzene	1.2	Apiri, 2012	180	CCME 2004 Eco Soil Contact
Toluene	1.4	Apiri, 2012	250	CCME 2004 Eco Soil Contact
Ethylbenzene	1.2	Apiri, 2012	300	CCME 2004 Eco Soil Contact
Total Xylenes	1.3	Apiri, 2012	350	CCME 2004 Eco Soil Contact
PHC F1[1]	12.30	Apiri, 2012	320	CCME 2008 Eco Soil Contact
PHC F2[1]	9.84	Apiri, 2012	260	CCME 2008 Eco Soil Contact
PHC F3	606.5	97.5 percentile of Background concentration	1700	CCME 2008 Eco Soil Contact
PHC F4	240	97.5 percentile of Background concentration	3300	CCME 2008 Eco Soil Contact
Total PCBs	0.138	97.5 percentile of Background concentration	1.1	Eco SSTL
Aroclor 1254	0.099	97.5 percentile of Background concentration	nc	
Aroclor 1260	0.049	97.5 percentile of Background concentration	nc	

1 criteria calculated assuming 1% TOC

General Background Statistics for Full Data Sets

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	97.5%
Coverage	90%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Aluminum

General Statistics

Total Number of Observations	10	Number of Distinct Observations	4
Tolerance Factor	2.647		

Raw Statistics		**Log-Transformed Statistics**	
Minimum	11000	Minimum	9.306
Maximum	15000	Maximum	9.616
Second Largest	15000	Second Largest	9.616
First Quartile	12250	First Quartile	9.413
Median	13000	Median	9.473
Third Quartile	14500	Third Quartile	9.58
Mean	13100	Mean	9.474
SD	1524	SD	0.117
Coefficient of Variation	0.116		
Skewness	0.0283		

Warning: There are only 4 Distinct Values in this data

There are insufficient Distinct Values to perform some GOF tests and bootstrap methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values to compute bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10-15 or more observations for accurate and meaningful bootstrap results.

Background Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.866	Shapiro Wilk Test Statistic	0.869
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97.5% UTL with 90% Coverage	17134	97.5% UTL with 90% Coverage	17756
97.5% UPL (t)	16716	97.5% UPL (t)	17194
90% Percentile (z)	15053	90% Percentile (z)	15130
95% Percentile (z)	15607	95% Percentile (z)	15788
97.5% Percentile (z)	16087	97.5% Percentile (z)	16382
99% Percentile (z)	16645	99% Percentile (z)	17101
Gamma Distribution Test		**Data Distribution Test**	
k star	57.11	Data appear Normal at 5% Significance Level	

Theta Star	229.4		
MLE of Mean	13100		
MLE of Standard Deviation	1733		
nu star	1142		
A-D Test Statistic	0.618	Nonparametric Statistics	
5% A-D Critical Value	0.724	90% Percentile	15000
K-S Test Statistic	0.213	95% Percentile	15000
5% K-S Critical Value	0.266	99% Percentile	15000
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	15000
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	15000
90% Percentile	15365	97.5% Percentile Bootstrap UTL with 90% Coverage	15000
95% Percentile	16075	97.5% BCA Bootstrap UTL with 90% Coverage	15000
99% Percentile	17466	97.5% UPL	15000
97.5% Percentile	16709	97.5% Chebyshev UPL	23081
97.5% WH Approx. Gamma UPL	17011	Upper Threshold Limit Based upon IQR	17875
97.5% HW Approx. Gamma UPL	17054		
97.5% WH Approx. Gamma UTL with 90% Coverage	17516		
97.5% HW Approx. Gamma UTL with 90% Coverage	17572		

Arsenic

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	5
Tolerance Factor	2.647		
Raw Statistics		Log-Transformed Statistics	
Minimum	1.5	Minimum	0.405
Maximum	2.3	Maximum	0.833
Second Largest	2	Second Largest	0.693
First Quartile	1.8	First Quartile	0.588
Median	1.8	Median	0.588
Third Quartile	1.95	Third Quartile	0.667
Mean	1.84	Mean	0.603
SD	0.222	SD	0.119
Coefficient of Variation	0.121		
Skewness	0.66		
Background Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.904	Shapiro Wilk Test Statistic	0.917
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
97.5% UTL with 90% Coverage	2.428	97.5% UTL with 90% Coverage	2.504
97.5% UPL (t)	2.367	97.5% UPL (t)	2.423
90% Percentile (z)	2.125	90% Percentile (z)	2.129
95% Percentile (z)	2.205	95% Percentile (z)	2.223

97.5% Percentile (z)	2.275	97.5% Percentile (z)	2.307
99% Percentile (z)	2.357	99% Percentile (z)	2.41
Gamma Distribution Test		Data Distribution Test	
k star	54.83	Data appear Normal at 5% Significance Level	
Theta Star	0.0336		
MLE of Mean	1.84		
MLE of Standard Deviation	0.248		
nu star	1097		
A-D Test Statistic	0.574	Nonparametric Statistics	
5% A-D Critical Value	0.724	90% Percentile	2.03
K-S Test Statistic	0.262	95% Percentile	2.165
5% K-S Critical Value	0.266	99% Percentile	2.273
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	2.233
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	2.3
90% Percentile	2.165	97.5% Percentile Bootstrap UTL with 90% Coverage	2.3
95% Percentile	2.267	97.5% BCA Bootstrap UTL with 90% Coverage	2.3
99% Percentile	2.467	97.5% UPL	2.3
97.5% Percentile	2.358	97.5% Chebyshev UPL	3.295
97.5% WH Approx. Gamma UPL	2.401	Upper Threshold Limit Based upon IQR	2.175
97.5% HW Approx. Gamma UPL	2.407		
97.5% WH Approx. Gamma UTL with 90% Coverage	2.474		
97.5% HW Approx. Gamma UTL with 90% Coverage	2.481		

Barium

General Statistics

Total Number of Observations	10	Number of Distinct Observations	6
Tolerance Factor	2.647		
Raw Statistics		Log-Transformed Statistics	
Minimum	130	Minimum	4.868
Maximum	180	Maximum	5.193
Second Largest	180	Second Largest	5.193
First Quartile	152.5	First Quartile	5.027
Median	170	Median	5.136
Third Quartile	170	Third Quartile	5.136
Mean	162	Mean	5.082
SD	16.87	SD	0.109
Coefficient of Variation	0.104		
Skewness	-0.91		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.876	Shapiro Wilk Test Statistic	0.862
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
97.5% UTL with 90% Coverage	206.6	97.5% UTL with 90% Coverage	215.1
97.5% UPL (t)	202	97.5% UPL (t)	208.8
90% Percentile (z)	183.6	90% Percentile (z)	185.3
95% Percentile (z)	189.7	95% Percentile (z)	192.8
97.5% Percentile (z)	195.1	97.5% Percentile (z)	199.6
99% Percentile (z)	201.2	99% Percentile (z)	207.7
Gamma Distribution Test		Data Distribution Test	
k star	67.66	Data appear Normal at 5% Significance Level	
Theta Star	2.394		
MLE of Mean	162		
MLE of Standard Deviation	19.69		
nu star	1353		
A-D Test Statistic	0.668	Nonparametric Statistics	
5% A-D Critical Value	0.724	90% Percentile	180
K-S Test Statistic	0.295	95% Percentile	180
5% K-S Critical Value	0.266	99% Percentile	180
Data follow Appx. Gamma Distribution at 5% Significance Level		97.5% Percentile	180
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	180
90% Percentile	187.7	97.5% Percentile Bootstrap UTL with 90% Coverage	180
95% Percentile	195.7	97.5% BCA Bootstrap UTL with 90% Coverage	180
99% Percentile	211.3	97.5% UPL	180
97.5% Percentile	202.8	97.5% Chebyshev UPL	272.5
97.5% WH Approx. Gamma UPL	206.2	Upper Threshold Limit Based upon IQR	196.3
97.5% HW Approx. Gamma UPL	206.8		
97.5% WH Approx. Gamma UTL with 90% Coverage	211.8		
97.5% HW Approx. Gamma UTL with 90% Coverage	212.6		

Beryllium

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	10
Tolerance Factor	2.647		
Raw Statistics		Log-Transformed Statistics	
Minimum	0.51	Minimum	-0.673
Maximum	0.68	Maximum	-0.386
Second Largest	0.67	Second Largest	-0.4
First Quartile	0.553	First Quartile	-0.593
Median	0.575	Median	-0.553
Third Quartile	0.633	Third Quartile	-0.458
Mean	0.589	Mean	-0.534
SD	0.0593	SD	0.1
Coefficient of Variation	0.101		
Skewness	0.342		
Background Statistics			
Normal Distribution Test		Lognormal Distribution Test	

Shapiro Wilk Test Statistic	0.941	Shapiro Wilk Test Statistic	0.948
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
97.5% UTL with 90% Coverage	0.746	97.5% UTL with 90% Coverage	0.764
97.5% UPL (t)	0.73	97.5% UPL (t)	0.743
90% Percentile (z)	0.665	90% Percentile (z)	0.667
95% Percentile (z)	0.687	95% Percentile (z)	0.691
97.5% Percentile (z)	0.705	97.5% Percentile (z)	0.713
99% Percentile (z)	0.727	99% Percentile (z)	0.74
Gamma Distribution Test		Data Distribution Test	
k star	77.61	Data appear Normal at 5% Significance Level	
Theta Star	0.00759		
MLE of Mean	0.589		
MLE of Standard Deviation	0.0669		
nu star	1552		
A-D Test Statistic	0.265	Nonparametric Statistics	
5% A-D Critical Value	0.724	90% Percentile	0.671
K-S Test Statistic	0.152	95% Percentile	0.676
5% K-S Critical Value	0.266	99% Percentile	0.679
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	0.678
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	0.68
90% Percentile	0.676	97.5% Percentile Bootstrap UTL with 90% Coverage	0.68
95% Percentile	0.703	97.5% BCA Bootstrap UTL with 90% Coverage	0.68
99% Percentile	0.756	97.5% UPL	0.68
97.5% Percentile	0.727	97.5% Chebyshev UPL	0.978
97.5% WH Approx. Gamma UPL	0.738	Upper Threshold Limit Based upon IQR	0.753
97.5% HW Approx. Gamma UPL	0.739		
97.5% WH Approx. Gamma UTL with 90% Coverage	0.757		
97.5% HW Approx. Gamma UTL with 90% Coverage	0.759		

Boron

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	8
Tolerance Factor	2.647		
Raw Statistics		Log-Transformed Statistics	
Minimum	7.8	Minimum	2.054
Maximum	13	Maximum	2.565
Second Largest	12	Second Largest	2.485
First Quartile	8.55	First Quartile	2.146
Median	10.1	Median	2.309
Third Quartile	11.75	Third Quartile	2.463
Mean	10.15	Mean	2.302
SD	1.858	SD	0.183
Coefficient of Variation	0.183		

Skewness	0.202		
Background Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.905	Shapiro Wilk Test Statistic	0.908
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97.5% UTL with 90% Coverage	15.07	97.5% UTL with 90% Coverage	16.25
97.5% UPL (t)	14.56	97.5% UPL (t)	15.45
90% Percentile (z)	12.53	90% Percentile (z)	12.65
95% Percentile (z)	13.21	95% Percentile (z)	13.52
97.5% Percentile (z)	13.79	97.5% Percentile (z)	14.32
99% Percentile (z)	14.47	99% Percentile (z)	15.32
Gamma Distribution Test		**Data Distribution Test**	
k star	23.33	Data appear Normal at 5% Significance Level	
Theta Star	0.435		
MLE of Mean	10.15		
MLE of Standard Deviation	2.101		
nu star	466.6		
A-D Test Statistic	0.508	**Nonparametric Statistics**	
5% A-D Critical Value	0.724	90% Percentile	12.1
K-S Test Statistic	0.201	95% Percentile	12.55
5% K-S Critical Value	0.266	99% Percentile	12.91
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	12.78
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	13
90% Percentile	12.92	97.5% Percentile Bootstrap UTL with 90% Coverage	13
95% Percentile	13.84	97.5% BCA Bootstrap UTL with 90% Coverage	13
99% Percentile	15.67	97.5% UPL	13
97.5% Percentile	14.66	97.5% Chebyshev UPL	22.32
97.5% WH Approx. Gamma UPL	15.09	Upper Threshold Limit Based upon IQR	16.55
97.5% HW Approx. Gamma UPL	15.17		
97.5% WH Approx. Gamma UTL with 90% Coverage	15.76		
97.5% HW Approx. Gamma UTL with 90% Coverage	15.87		
Cadmium			
General Statistics			
Total Number of Observations	10	Number of Distinct Observations	10
Tolerance Factor	2.647		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	0.54	Minimum	-0.616
Maximum	2.9	Maximum	1.065
Second Largest	1.8	Second Largest	0.588
First Quartile	0.72	First Quartile	-0.329

Median	0.78	Median	-0.249
Third Quartile	0.893	Third Quartile	-0.114
Mean	1.067	Mean	-0.0775
SD	0.731	SD	0.509
Coefficient of Variation	0.685		
Skewness	2.204		

Background Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.662	Shapiro Wilk Test Statistic	0.796
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
97.5% UTL with 90% Coverage	3.002	97.5% UTL with 90% Coverage	3.563
97.5% UPL (t)	2.801	97.5% UPL (t)	3.098
90% Percentile (z)	2.004	90% Percentile (z)	1.777
95% Percentile (z)	2.269	95% Percentile (z)	2.139
97.5% Percentile (z)	2.5	97.5% Percentile (z)	2.511
99% Percentile (z)	2.768	99% Percentile (z)	3.026
Gamma Distribution Test		Data Distribution Test	
k star	2.636	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.405		
MLE of Mean	1.067		
MLE of Standard Deviation	0.657		
nu star	52.72		
A-D Test Statistic	1.238	Nonparametric Statistics	
5% A-D Critical Value	0.73	90% Percentile	1.91
K-S Test Statistic	0.348	95% Percentile	2.405
5% K-S Critical Value	0.268	99% Percentile	2.801
Data not Gamma Distributed at 5% Significance Level		97.5% Percentile	2.653
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	2.9
90% Percentile	1.948	97.5% Percentile Bootstrap UTL with 90% Coverage	2.9
95% Percentile	2.325	97.5% BCA Bootstrap UTL with 90% Coverage	2.9
99% Percentile	3.15	97.5% UPL	2.9
97.5% Percentile	2.687	97.5% Chebyshev UPL	5.855
97.5% WH Approx. Gamma UPL	2.937	Upper Threshold Limit Based upon IQR	1.151
97.5% HW Approx. Gamma UPL	2.968		
97.5% WH Approx. Gamma UTL with 90% Coverage	3.264		
97.5% HW Approx. Gamma UTL with 90% Coverage	3.322		

Calcium

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	8
Tolerance Factor	2.647		
Raw Statistics		Log-Transformed Statistics	

Minimum	45000	Minimum	10.71
Maximum	74000	Maximum	11.21
Second Largest	73000	Second Largest	11.2
First Quartile	52500	First Quartile	10.87
Median	54500	Median	10.91
Third Quartile	67000	Third Quartile	11.11
Mean	58300	Mean	10.96
SD	10371	SD	0.172
Coefficient of Variation	0.178		
Skewness	0.708		
Background Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.836	Shapiro Wilk Test Statistic	0.863
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
97.5% UTL with 90% Coverage	85753	97.5% UTL with 90% Coverage	90704
97.5% UPL (t)	82907	97.5% UPL (t)	86519
90% Percentile (z)	71592	90% Percentile (z)	71706
95% Percentile (z)	75359	95% Percentile (z)	76333
97.5% Percentile (z)	78628	97.5% Percentile (z)	80587
99% Percentile (z)	82428	99% Percentile (z)	85833
Gamma Distribution Test		Data Distribution Test	
k star	25.87	Data appear Lognormal at 5% Significance Level	
Theta Star	2254		
MLE of Mean	58300		
MLE of Standard Deviation	11462		
nu star	517.4		
A-D Test Statistic	0.818	Nonparametric Statistics	
5% A-D Critical Value	0.724	90% Percentile	73100
K-S Test Statistic	0.316	95% Percentile	73550
5% K-S Critical Value	0.266	99% Percentile	73910
Data not Gamma Distributed at 5% Significance Level		97.5% Percentile	73775
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	74000
90% Percentile	73387	97.5% Percentile Bootstrap UTL with 90% Coverage	74000
95% Percentile	78345	97.5% BCA Bootstrap UTL with 90% Coverage	74000
99% Percentile	88223	97.5% UPL	74000
97.5% Percentile	82818	97.5% Chebyshev UPL	126231
97.5% WH Approx. Gamma UPL	85085	Upper Threshold Limit Based upon IQR	88750
97.5% HW Approx. Gamma UPL	85417		
97.5% WH Approx. Gamma UTL with 90% Coverage	88710		
97.5% HW Approx. Gamma UTL with 90% Coverage	89169		

Chromium

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	6
Tolerance Factor	2.647		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	24	Minimum	3.178
Maximum	36	Maximum	3.584
Second Largest	35	Second Largest	3.555
First Quartile	28	First Quartile	3.332
Median	31	Median	3.434
Third Quartile	34.25	Third Quartile	3.533
Mean	30.4	Mean	3.405
SD	4.351	SD	0.148
Coefficient of Variation	0.143		
Skewness	-0.299		
Background Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.916	Shapiro Wilk Test Statistic	0.904
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97.5% UTL with 90% Coverage	41.92	97.5% UTL with 90% Coverage	44.5
97.5% UPL (t)	40.72	97.5% UPL (t)	42.74
90% Percentile (z)	35.98	90% Percentile (z)	36.38
95% Percentile (z)	37.56	95% Percentile (z)	38.38
97.5% Percentile (z)	38.93	97.5% Percentile (z)	40.21
99% Percentile (z)	40.52	99% Percentile (z)	42.44
Gamma Distribution Test		**Data Distribution Test**	
k star	36.65	Data appear Normal at 5% Significance Level	
Theta Star	0.83		
MLE of Mean	30.4		
MLE of Standard Deviation	5.022		
nu star	732.9		
A-D Test Statistic	0.406	**Nonparametric Statistics**	
5% A-D Critical Value	0.724	90% Percentile	35.1
K-S Test Statistic	0.174	95% Percentile	35.55
5% K-S Critical Value	0.266	99% Percentile	35.91
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	35.78
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	36
90% Percentile	36.99	97.5% Percentile Bootstrap UTL with 90% Coverage	36
95% Percentile	39.1	97.5% BCA Bootstrap UTL with 90% Coverage	36
99% Percentile	43.29	97.5% UPL	36
97.5% Percentile	41	97.5% Chebyshev UPL	58.9
97.5% WH Approx. Gamma UPL	41.94	Upper Threshold Limit Based upon IQR	43.63
97.5% HW Approx. Gamma UPL	42.12		
97.5% WH Approx. Gamma UTL with 90% Coverage	43.47		
97.5% HW Approx. Gamma UTL with 90% Coverage	43.7		

Cobalt

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	9
Tolerance Factor	2.647		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	5.5	Minimum	1.705
Maximum	9.2	Maximum	2.219
Second Largest	8.8	Second Largest	2.175
First Quartile	7.075	First Quartile	1.956
Median	7.9	Median	2.067
Third Quartile	8.625	Third Quartile	2.154
Mean	7.67	Mean	2.026
SD	1.186	SD	0.164
Coefficient of Variation	0.155		
Skewness	-0.596		
Background Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.951	Shapiro Wilk Test Statistic	0.928
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97.5% UTL with 90% Coverage	10.81	97.5% UTL with 90% Coverage	11.69
97.5% UPL (t)	10.48	97.5% UPL (t)	11.18
90% Percentile (z)	9.19	90% Percentile (z)	9.351
95% Percentile (z)	9.621	95% Percentile (z)	9.925
97.5% Percentile (z)	9.995	97.5% Percentile (z)	10.45
99% Percentile (z)	10.43	99% Percentile (z)	11.1
Gamma Distribution Test		**Data Distribution Test**	
k star	30.37	Data appear Normal at 5% Significance Level	
Theta Star	0.253		
MLE of Mean	7.67		
MLE of Standard Deviation	1.392		
nu star	607.4		
A-D Test Statistic	0.311	**Nonparametric Statistics**	
5% A-D Critical Value	0.724	90% Percentile	8.84
K-S Test Statistic	0.164	95% Percentile	9.02
5% K-S Critical Value	0.266	99% Percentile	9.164
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	9.11
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	9.2
90% Percentile	9.499	97.5% Percentile Bootstrap UTL with 90% Coverage	9.2
95% Percentile	10.09	97.5% BCA Bootstrap UTL with 90% Coverage	9.2
99% Percentile	11.27	97.5% UPL	9.2

97.5% Percentile	10.63	97.5% Chebyshev UPL	15.44
97.5% WH Approx. Gamma UPL	10.9	Upper Threshold Limit Based upon IQR	10.95
97.5% HW Approx. Gamma UPL	10.96		
97.5% WH Approx. Gamma UTL with 90% Coverage	11.33		
97.5% HW Approx. Gamma UTL with 90% Coverage	11.41		

Copper

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	5
Tolerance Factor	2.647		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	30	Minimum	3.401
Maximum	34	Maximum	3.526
Second Largest	34	Second Largest	3.526
First Quartile	32	First Quartile	3.466
Median	33	Median	3.497
Third Quartile	33	Third Quartile	3.497
Mean	32.5	Mean	3.481
SD	1.269	SD	0.0396
Coefficient of Variation	0.0391		
Skewness	-0.815		
Background Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.903	Shapiro Wilk Test Statistic	0.898
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97.5% UTL with 90% Coverage	35.86	97.5% UTL with 90% Coverage	36.07
97.5% UPL (t)	35.51	97.5% UPL (t)	35.68
90% Percentile (z)	34.13	90% Percentile (z)	34.17
95% Percentile (z)	34.59	95% Percentile (z)	34.66
97.5% Percentile (z)	34.99	97.5% Percentile (z)	35.1
99% Percentile (z)	35.45	99% Percentile (z)	35.61
Gamma Distribution Test		**Data Distribution Test**	
k star	500.7	Data appear Normal at 5% Significance Level	
Theta Star	0.0649		
MLE of Mean	32.5		
MLE of Standard Deviation	1.452		
nu star	10013		
A-D Test Statistic	0.517	**Nonparametric Statistics**	
5% A-D Critical Value	0.724	90% Percentile	34
K-S Test Statistic	0.263	95% Percentile	34
5% K-S Critical Value	0.266	99% Percentile	34
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	34

Assuming Gamma Distribution		97.5% UTL with 90% Coverage	34
90% Percentile	34.37	97.5% Percentile Bootstrap UTL with 90% Coverage	34
95% Percentile	34.93	97.5% BCA Bootstrap UTL with 90% Coverage	34
99% Percentile	35.97	97.5% UPL	34
97.5% Percentile	35.41	97.5% Chebyshev UPL	40.81
97.5% WH Approx. Gamma UPL	35.62	Upper Threshold Limit Based upon IQR	34.5
97.5% HW Approx. Gamma UPL	35.63		
97.5% WH Approx. Gamma UTL with 90% Coverage	35.99		
97.5% HW Approx. Gamma UTL with 90% Coverage	36.01		

Iron

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	7
Tolerance Factor	2.647		
Raw Statistics		Log-Transformed Statistics	
Minimum	14000	Minimum	9.547
Maximum	21000	Maximum	9.952
Second Largest	21000	Second Largest	9.952
First Quartile	16250	First Quartile	9.696
Median	18500	Median	9.825
Third Quartile	20500	Third Quartile	9.927
Mean	18100	Mean	9.794
SD	2558	SD	0.145
Coefficient of Variation	0.141		
Skewness	-0.288		

Background Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.916	Shapiro Wilk Test Statistic	0.915
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
97.5% UTL with 90% Coverage	24872	97.5% UTL with 90% Coverage	26356
97.5% UPL (t)	24170	97.5% UPL (t)	25325
90% Percentile (z)	21378	90% Percentile (z)	21607
95% Percentile (z)	22308	95% Percentile (z)	22780
97.5% Percentile (z)	23114	97.5% Percentile (z)	23849
99% Percentile (z)	24051	99% Percentile (z)	25155
Gamma Distribution Test		Data Distribution Test	
k star	37.66	Data appear Normal at 5% Significance Level	
Theta Star	480.6		
MLE of Mean	18100		
MLE of Standard Deviation	2949		
nu star	753.2		

A-D Test Statistic	0.368	Nonparametric Statistics	
5% A-D Critical Value	0.724	90% Percentile	21000
K-S Test Statistic	0.177	95% Percentile	21000
5% K-S Critical Value	0.266	99% Percentile	21000
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	21000
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	21000
90% Percentile	21968	97.5% Percentile Bootstrap UTL with 90% Coverage	21000
95% Percentile	23209	97.5% BCA Bootstrap UTL with 90% Coverage	21000
99% Percentile	25659	97.5% UPL	21000
97.5% Percentile	24322	97.5% Chebyshev UPL	34856
97.5% WH Approx. Gamma UPL	24869	Upper Threshold Limit Based upon IQR	26875
97.5% HW Approx. Gamma UPL	24975		
97.5% WH Approx. Gamma UTL with 90% Coverage	25763		
97.5% HW Approx. Gamma UTL with 90% Coverage	25900		

Lead

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	10
Tolerance Factor	2.647		
Raw Statistics		Log-Transformed Statistics	
Minimum	21	Minimum	3.045
Maximum	40	Maximum	3.689
Second Largest	39	Second Largest	3.664
First Quartile	28.75	First Quartile	3.358
Median	33	Median	3.496
Third Quartile	37.25	Third Quartile	3.617
Mean	32.2	Mean	3.453
SD	6.356	SD	0.213
Coefficient of Variation	0.197		
Skewness	-0.552		
Background Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.946	Shapiro Wilk Test Statistic	0.92
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
97.5% UTL with 90% Coverage	49.02	97.5% UTL with 90% Coverage	55.47
97.5% UPL (t)	47.28	97.5% UPL (t)	52.32
90% Percentile (z)	40.35	90% Percentile (z)	41.48
95% Percentile (z)	42.65	95% Percentile (z)	44.82
97.5% Percentile (z)	44.66	97.5% Percentile (z)	47.93
99% Percentile (z)	46.99	99% Percentile (z)	51.81
Gamma Distribution Test		Data Distribution Test	
k star	18.28	Data appear Normal at 5% Significance Level	
Theta Star	1.762		

MLE of Mean	32.2		
MLE of Standard Deviation	7.532		
nu star	365.5		
A-D Test Statistic	0.32	Nonparametric Statistics	
5% A-D Critical Value	0.725	90% Percentile	39.1
K-S Test Statistic	0.15	95% Percentile	39.55
5% K-S Critical Value	0.266	99% Percentile	39.91
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	39.78
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	40
90% Percentile	42.15	97.5% Percentile Bootstrap UTL with 90% Coverage	40
95% Percentile	45.51	97.5% BCA Bootstrap UTL with 90% Coverage	40
99% Percentile	52.26	97.5% UPL	40
97.5% Percentile	48.55	97.5% Chebyshev UPL	73.83
97.5% WH Approx. Gamma UPL	50.16	Upper Threshold Limit Based upon IQR	50
97.5% HW Approx. Gamma UPL	50.64		
97.5% WH Approx. Gamma UTL with 90% Coverage	52.66		
97.5% HW Approx. Gamma UTL with 90% Coverage	53.28		

Magnesium

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	10
Tolerance Factor	2.647		
Raw Statistics		Log-Transformed Statistics	
Minimum	4700	Minimum	8.455
Maximum	7400	Maximum	8.909
Second Largest	7300	Second Largest	8.896
First Quartile	5850	First Quartile	8.674
Median	6200	Median	8.732
Third Quartile	7000	Third Quartile	8.852
Mean	6230	Mean	8.727
SD	904.4	SD	0.15
Coefficient of Variation	0.145		
Skewness	-0.258		
Background Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.94	Shapiro Wilk Test Statistic	0.932
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
97.5% UTL with 90% Coverage	8624	97.5% UTL with 90% Coverage	9171
97.5% UPL (t)	8376	97.5% UPL (t)	8802
90% Percentile (z)	7389	90% Percentile (z)	7474
95% Percentile (z)	7718	95% Percentile (z)	7893
97.5% Percentile (z)	8003	97.5% Percentile (z)	8274
99% Percentile (z)	8334	99% Percentile (z)	8741

Gamma Distribution Test		Data Distribution Test	
k star	35.62	Data appear Normal at 5% Significance Level	
Theta Star	174.9		
MLE of Mean	6230		
MLE of Standard Deviation	1044		
nu star	712.4		
A-D Test Statistic	0.313	Nonparametric Statistics	
5% A-D Critical Value	0.724	90% Percentile	7310
K-S Test Statistic	0.165	95% Percentile	7355
5% K-S Critical Value	0.266	99% Percentile	7391
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	7378
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	7400
90% Percentile	7600	97.5% Percentile Bootstrap UTL with 90% Coverage	7400
95% Percentile	8041	97.5% BCA Bootstrap UTL with 90% Coverage	7400
99% Percentile	8912	97.5% UPL	7400
97.5% Percentile	8436	97.5% Chebyshev UPL	12153
97.5% WH Approx. Gamma UPL	8632	Upper Threshold Limit Based upon IQR	8725
97.5% HW Approx. Gamma UPL	8671		
97.5% WH Approx. Gamma UTL with 90% Coverage	8950		
97.5% HW Approx. Gamma UTL with 90% Coverage	9001		

Manganese

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	10
Tolerance Factor	2.647		
Raw Statistics		Log-Transformed Statistics	
Minimum	370	Minimum	5.914
Maximum	540	Maximum	6.292
Second Largest	530	Second Largest	6.273
First Quartile	412.5	First Quartile	6.022
Median	455	Median	6.119
Third Quartile	507.5	Third Quartile	6.229
Mean	458	Mean	6.119
SD	61.25	SD	0.135
Coefficient of Variation	0.134		
Skewness	-0.0202		
Background Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.926	Shapiro Wilk Test Statistic	0.927
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
97.5% UTL with 90% Coverage	620.1	97.5% UTL with 90% Coverage	649.6
97.5% UPL (t)	603.3	97.5% UPL (t)	626

90% Percentile (z)	536.5	90% Percentile (z)	540.2
95% Percentile (z)	558.7	95% Percentile (z)	567.4
97.5% Percentile (z)	578	97.5% Percentile (z)	592
99% Percentile (z)	600.5	99% Percentile (z)	622.1
Gamma Distribution Test		Data Distribution Test	
k star	43.08	Data appear Normal at 5% Significance Level	
Theta Star	10.63		
MLE of Mean	458		
MLE of Standard Deviation	69.78		
nu star	861.6		
A-D Test Statistic	0.38	Nonparametric Statistics	
5% A-D Critical Value	0.724	90% Percentile	531
K-S Test Statistic	0.172	95% Percentile	535.5
5% K-S Critical Value	0.266	99% Percentile	539.1
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	537.8
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	540
90% Percentile	549.4	97.5% Percentile Bootstrap UTL with 90% Coverage	540
95% Percentile	578.5	97.5% BCA Bootstrap UTL with 90% Coverage	540
99% Percentile	635.8	97.5% UPL	540
97.5% Percentile	604.5	97.5% Chebyshev UPL	859.2
97.5% WH Approx. Gamma UPL	617.2	Upper Threshold Limit Based upon IQR	650
97.5% HW Approx. Gamma UPL	619.3		
97.5% WH Approx. Gamma UTL with 90% Coverage	638.1		
97.5% HW Approx. Gamma UTL with 90% Coverage	640.8		

Mercury

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	10
Tolerance Factor	2.647		
Raw Statistics		Log-Transformed Statistics	
Minimum	0.067	Minimum	-2.703
Maximum	0.11	Maximum	-2.207
Second Largest	0.098	Second Largest	-2.323
First Quartile	0.0783	First Quartile	-2.548
Median	0.0875	Median	-2.437
Third Quartile	0.0955	Third Quartile	-2.349
Mean	0.0874	Mean	-2.447
SD	0.0129	SD	0.149
Coefficient of Variation	0.147		
Skewness	0.13		
Background Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.977	Shapiro Wilk Test Statistic	0.977
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97.5% UTL with 90% Coverage	0.121	97.5% UTL with 90% Coverage	0.128
97.5% UPL (t)	0.118	97.5% UPL (t)	0.123
90% Percentile (z)	0.104	90% Percentile (z)	0.105
95% Percentile (z)	0.109	95% Percentile (z)	0.11
97.5% Percentile (z)	0.113	97.5% Percentile (z)	0.116
99% Percentile (z)	0.117	99% Percentile (z)	0.122
Gamma Distribution Test		**Data Distribution Test**	
k star	35.71	Data appear Normal at 5% Significance Level	
Theta Star	0.00245		
MLE of Mean	0.0874		
MLE of Standard Deviation	0.0146		
nu star	714.1		
A-D Test Statistic	0.206	**Nonparametric Statistics**	
5% A-D Critical Value	0.724	90% Percentile	0.0992
K-S Test Statistic	0.161	95% Percentile	0.105
5% K-S Critical Value	0.266	99% Percentile	0.109
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	0.107
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	0.11
90% Percentile	0.107	97.5% Percentile Bootstrap UTL with 90% Coverage	0.11
95% Percentile	0.113	97.5% BCA Bootstrap UTL with 90% Coverage	0.11
99% Percentile	0.125	97.5% UPL	0.11
97.5% Percentile	0.118	97.5% Chebyshev UPL	0.172
97.5% WH Approx. Gamma UPL	0.121	Upper Threshold Limit Based upon IQR	0.121
97.5% HW Approx. Gamma UPL	0.122		
97.5% WH Approx. Gamma UTL with 90% Coverage	0.126		
97.5% HW Approx. Gamma UTL with 90% Coverage	0.126		

Molybdenum

General Statistics

Total Number of Observations	10	Number of Distinct Observations	6
Tolerance Factor	2.647		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	0.5	Minimum	-0.693
Maximum	0.76	Maximum	-0.274
Second Largest	0.7	Second Largest	-0.357
First Quartile	0.5	First Quartile	-0.693
Median	0.53	Median	-0.635
Third Quartile	0.638	Third Quartile	-0.451
Mean	0.577	Mean	-0.562
SD	0.0958	SD	0.158
Coefficient of Variation	0.166		
Skewness	1.004		

Background Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.814	Shapiro Wilk Test Statistic	0.823
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
97.5% UTL with 90% Coverage	0.831	97.5% UTL with 90% Coverage	0.866
97.5% UPL (t)	0.804	97.5% UPL (t)	0.829
90% Percentile (z)	0.7	90% Percentile (z)	0.698
95% Percentile (z)	0.735	95% Percentile (z)	0.739
97.5% Percentile (z)	0.765	97.5% Percentile (z)	0.777
99% Percentile (z)	0.8	99% Percentile (z)	0.823
Gamma Distribution Test		Data Distribution Test	
k star	30.37	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.019		
MLE of Mean	0.577		
MLE of Standard Deviation	0.105		
nu star	607.4		
A-D Test Statistic	0.838	Nonparametric Statistics	
5% A-D Critical Value	0.724	90% Percentile	0.706
K-S Test Statistic	0.292	95% Percentile	0.733
5% K-S Critical Value	0.266	99% Percentile	0.755
Data not Gamma Distributed at 5% Significance Level		97.5% Percentile	0.747
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	0.76
90% Percentile	0.715	97.5% Percentile Bootstrap UTL with 90% Coverage	0.76
95% Percentile	0.759	97.5% BCA Bootstrap UTL with 90% Coverage	0.76
99% Percentile	0.848	97.5% UPL	0.76
97.5% Percentile	0.8	97.5% Chebyshev UPL	1.205
97.5% WH Approx. Gamma UPL	0.82	Upper Threshold Limit Based upon IQR	0.844
97.5% HW Approx. Gamma UPL	0.822		
97.5% WH Approx. Gamma UTL with 90% Coverage	0.852		
97.5% HW Approx. Gamma UTL with 90% Coverage	0.855		

Nickel

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	7
Tolerance Factor	2.647		
Raw Statistics		Log-Transformed Statistics	
Minimum	16	Minimum	2.773
Maximum	22	Maximum	3.091
Second Largest	22	Second Largest	3.091
First Quartile	18.25	First Quartile	2.904
Median	20	Median	2.996
Third Quartile	21	Third Quartile	3.045
Mean	19.6	Mean	2.97

SD	2.066	SD	0.109
Coefficient of Variation	0.105		
Skewness	-0.556		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.93	Shapiro Wilk Test Statistic	0.92
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97.5% UTL with 90% Coverage	25.07	97.5% UTL with 90% Coverage	26
97.5% UPL (t)	24.5	97.5% UPL (t)	25.24
90% Percentile (z)	22.25	90% Percentile (z)	22.41
95% Percentile (z)	23	95% Percentile (z)	23.32
97.5% Percentile (z)	23.65	97.5% Percentile (z)	24.13
99% Percentile (z)	24.41	99% Percentile (z)	25.11
Gamma Distribution Test		**Data Distribution Test**	
k star	67.38	Data appear Normal at 5% Significance Level	
Theta Star	0.291		
MLE of Mean	19.6		
MLE of Standard Deviation	2.388		
nu star	1348		
A-D Test Statistic	0.358	**Nonparametric Statistics**	
5% A-D Critical Value	0.724	90% Percentile	22
K-S Test Statistic	0.192	95% Percentile	22
5% K-S Critical Value	0.266	99% Percentile	22
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	22
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	22
90% Percentile	22.72	97.5% Percentile Bootstrap UTL with 90% Coverage	22
95% Percentile	23.69	97.5% BCA Bootstrap UTL with 90% Coverage	22
99% Percentile	25.58	97.5% UPL	22
97.5% Percentile	24.55	97.5% Chebyshev UPL	33.13
97.5% WH Approx. Gamma UPL	24.96	Upper Threshold Limit Based upon IQR	25.13
97.5% HW Approx. Gamma UPL	25.02		
97.5% WH Approx. Gamma UTL with 90% Coverage	25.64		
97.5% HW Approx. Gamma UTL with 90% Coverage	25.73		

Phosphorous

General Statistics

Total Number of Observations	10	Number of Distinct Observations	5
Tolerance Factor	2.647		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	810	Minimum	6.697
Maximum	1100	Maximum	7.003

Second Largest	1100	Second Largest	7.003
First Quartile	832.5	First Quartile	6.724
Median	935	Median	6.838
Third Quartile	1075	Third Quartile	6.979
Mean	949	Mean	6.848
SD	124.1	SD	0.13
Coefficient of Variation	0.131		
Skewness	0.191		
Background Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.832	Shapiro Wilk Test Statistic	0.836
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
97.5% UTL with 90% Coverage	1278	97.5% UTL with 90% Coverage	1330
97.5% UPL (t)	1244	97.5% UPL (t)	1283
90% Percentile (z)	1108	90% Percentile (z)	1113
95% Percentile (z)	1153	95% Percentile (z)	1167
97.5% Percentile (z)	1192	97.5% Percentile (z)	1216
99% Percentile (z)	1238	99% Percentile (z)	1276
Gamma Distribution Test		Data Distribution Test	
k star	45.78	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	20.73		
MLE of Mean	949		
MLE of Standard Deviation	140.3		
nu star	915.7		
A-D Test Statistic	0.751	Nonparametric Statistics	
5% A-D Critical Value	0.724	90% Percentile	1100
K-S Test Statistic	0.242	95% Percentile	1100
5% K-S Critical Value	0.266	99% Percentile	1100
Data follow Appx. Gamma Distribution at 5% Significance Level		97.5% Percentile	1100
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	1100
90% Percentile	1133	97.5% Percentile Bootstrap UTL with 90% Coverage	1100
95% Percentile	1191	97.5% BCA Bootstrap UTL with 90% Coverage	1100
99% Percentile	1305	97.5% UPL	1100
97.5% Percentile	1243	97.5% Chebyshev UPL	1762
97.5% WH Approx. Gamma UPL	1268	Upper Threshold Limit Based upon IQR	1439
97.5% HW Approx. Gamma UPL	1272		
97.5% WH Approx. Gamma UTL with 90% Coverage	1310		
97.5% HW Approx. Gamma UTL with 90% Coverage	1315		
Potassium			
General Statistics			
Total Number of Observations	10	Number of Distinct Observations	6

Tolerance Factor	2.647		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	1200	Minimum	7.09
Maximum	2100	Maximum	7.65
Second Largest	2000	Second Largest	7.601
First Quartile	1800	First Quartile	7.496
Median	1900	Median	7.55
Third Quartile	1975	Third Quartile	7.588
Mean	1790	Mean	7.475
SD	299.8	SD	0.189
Coefficient of Variation	0.167		
Skewness	-1.395		

Background Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.795	Shapiro Wilk Test Statistic	0.755
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97.5% UTL with 90% Coverage	2584	97.5% UTL with 90% Coverage	2907
97.5% UPL (t)	2501	97.5% UPL (t)	2760
90% Percentile (z)	2174	90% Percentile (z)	2247
95% Percentile (z)	2283	95% Percentile (z)	2406
97.5% Percentile (z)	2378	97.5% Percentile (z)	2554
99% Percentile (z)	2487	99% Percentile (z)	2736
Gamma Distribution Test		**Data Distribution Test**	
k star	23.81	Data do not follow a Discernable Distribution (0.05)	
Theta Star	75.16		
MLE of Mean	1790		
MLE of Standard Deviation	366.8		
nu star	476.3		
A-D Test Statistic	1.158	**Nonparametric Statistics**	
5% A-D Critical Value	0.724	90% Percentile	2010
K-S Test Statistic	0.336	95% Percentile	2055
5% K-S Critical Value	0.266	99% Percentile	2091
Data not Gamma Distributed at 5% Significance Level		97.5% Percentile	2078
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	2100
90% Percentile	2273	97.5% Percentile Bootstrap UTL with 90% Coverage	2100
95% Percentile	2433	97.5% BCA Bootstrap UTL with 90% Coverage	2100
99% Percentile	2752	97.5% UPL	2100
97.5% Percentile	2577	97.5% Chebyshev UPL	3754
97.5% WH Approx. Gamma UPL	2651	Upper Threshold Limit Based upon IQR	2238
97.5% HW Approx. Gamma UPL	2676		
97.5% WH Approx. Gamma UTL with 90% Coverage	2769		
97.5% HW Approx. Gamma UTL with 90% Coverage	2799		

Selenium

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	5
Tolerance Factor	2.647		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	0.84	Minimum	-0.174
Maximum	1.1	Maximum	0.0953
Second Largest	1.1	Second Largest	0.0953
First Quartile	0.993	First Quartile	-0.00754
Median	1.05	Median	0.0477
Third Quartile	1.1	Third Quartile	0.0953
Mean	1.03	Mean	0.0262
SD	0.0867	SD	0.0882
Coefficient of Variation	0.0841		
Skewness	-1.169		
Background Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.795	Shapiro Wilk Test Statistic	0.783
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97.5% UTL with 90% Coverage	1.259	97.5% UTL with 90% Coverage	1.296
97.5% UPL (t)	1.236	97.5% UPL (t)	1.265
90% Percentile (z)	1.141	90% Percentile (z)	1.149
95% Percentile (z)	1.173	95% Percentile (z)	1.187
97.5% Percentile (z)	1.2	97.5% Percentile (z)	1.22
99% Percentile (z)	1.232	99% Percentile (z)	1.26
Gamma Distribution Test		**Data Distribution Test**	
k star	103.4	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.00996		
MLE of Mean	1.03		
MLE of Standard Deviation	0.101		
nu star	2069		
A-D Test Statistic	0.93	**Nonparametric Statistics**	
5% A-D Critical Value	0.724	90% Percentile	1.1
K-S Test Statistic	0.298	95% Percentile	1.1
5% K-S Critical Value	0.266	99% Percentile	1.1
Data not Gamma Distributed at 5% Significance Level		97.5% Percentile	1.1
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	1.1
90% Percentile	1.162	97.5% Percentile Bootstrap UTL with 90% Coverage	1.1
95% Percentile	1.202	97.5% BCA Bootstrap UTL with 90% Coverage	1.01
99% Percentile	1.28	97.5% UPL	1.1
97.5% Percentile	1.238	97.5% Chebyshev UPL	1.598
97.5% WH Approx. Gamma UPL	1.254	Upper Threshold Limit Based upon IQR	1.261

97.5% HW Approx. Gamma UPL	1.257		
97.5% WH Approx. Gamma UTL with 90% Coverage	1.282		
97.5% HW Approx. Gamma UTL with 90% Coverage	1.286		

Silver

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	6
Tolerance Factor	2.647		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	0.2	Minimum	-1.609
Maximum	0.26	Maximum	-1.347
Second Largest	0.25	Second Largest	-1.386
First Quartile	0.203	First Quartile	-1.597
Median	0.22	Median	-1.514
Third Quartile	0.248	Third Quartile	-1.396
Mean	0.225	Mean	-1.496
SD	0.0232	SD	0.102
Coefficient of Variation	0.103		
Skewness	0.3		

Background Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.878	Shapiro Wilk Test Statistic	0.879
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97.5% UTL with 90% Coverage	0.286	97.5% UTL with 90% Coverage	0.294
97.5% UPL (t)	0.28	97.5% UPL (t)	0.286
90% Percentile (z)	0.255	90% Percentile (z)	0.255
95% Percentile (z)	0.263	95% Percentile (z)	0.265
97.5% Percentile (z)	0.27	97.5% Percentile (z)	0.274
99% Percentile (z)	0.279	99% Percentile (z)	0.284
Gamma Distribution Test		**Data Distribution Test**	
k star	73.95	Data appear Normal at 5% Significance Level	
Theta Star	0.00304		
MLE of Mean	0.225		
MLE of Standard Deviation	0.0262		
nu star	1479		
A-D Test Statistic	0.553	**Nonparametric Statistics**	
5% A-D Critical Value	0.724	90% Percentile	0.251
K-S Test Statistic	0.178	95% Percentile	0.256
5% K-S Critical Value	0.266	99% Percentile	0.259
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	0.258
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	0.26

90% Percentile	0.259	97.5% Percentile Bootstrap UTL with 90% Coverage	0.26
95% Percentile	0.27	97.5% BCA Bootstrap UTL with 90% Coverage	0.26
99% Percentile	0.29	97.5% UPL	0.26
97.5% Percentile	0.279	97.5% Chebyshev UPL	0.377
97.5% WH Approx. Gamma UPL	0.284	Upper Threshold Limit Based upon IQR	0.315
97.5% HW Approx. Gamma UPL	0.284		
97.5% WH Approx. Gamma UTL with 90% Coverage	0.291		
97.5% HW Approx. Gamma UTL with 90% Coverage	0.292		

Sodium

General Statistics

Total Number of Observations	10	Number of Distinct Observations	8
Tolerance Factor	2.647		

Raw Statistics		**Log-Transformed Statistics**	
Minimum	380	Minimum	5.94
Maximum	520	Maximum	6.254
Second Largest	500	Second Largest	6.215
First Quartile	445	First Quartile	6.098
Median	470	Median	6.153
Third Quartile	495	Third Quartile	6.204
Mean	465	Mean	6.138
SD	40.62	SD	0.0908
Coefficient of Variation	0.0874		
Skewness	-0.864		

Background Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.948	Shapiro Wilk Test Statistic	0.927
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97.5% UTL with 90% Coverage	572.5	97.5% UTL with 90% Coverage	589.2
97.5% UPL (t)	561.4	97.5% UPL (t)	574.7
90% Percentile (z)	517.1	90% Percentile (z)	520.5
95% Percentile (z)	531.8	95% Percentile (z)	537.9
97.5% Percentile (z)	544.6	97.5% Percentile (z)	553.6
99% Percentile (z)	559.5	99% Percentile (z)	572.3
Gamma Distribution Test		**Data Distribution Test**	
k star	97.08	Data appear Normal at 5% Significance Level	
Theta Star	4.79		
MLE of Mean	465		
MLE of Standard Deviation	47.19		
nu star	1942		
A-D Test Statistic	0.314	**Nonparametric Statistics**	
5% A-D Critical Value	0.724	90% Percentile	502

K-S Test Statistic	0.161	95% Percentile	511
5% K-S Critical Value	0.266	99% Percentile	518.2
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	515.5
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	520
90% Percentile	526.4	97.5% Percentile Bootstrap UTL with 90% Coverage	520
95% Percentile	545.3	97.5% BCA Bootstrap UTL with 90% Coverage	520
99% Percentile	581.8	97.5% UPL	520
97.5% Percentile	561.9	97.5% Chebyshev UPL	731.1
97.5% WH Approx. Gamma UPL	569.7	Upper Threshold Limit Based upon IQR	570
97.5% HW Approx. Gamma UPL	570.9		
97.5% WH Approx. Gamma UTL with 90% Coverage	582.9		
97.5% HW Approx. Gamma UTL with 90% Coverage	584.3		

Strontium

General Statistics

Total Number of Observations	10	Number of Distinct Observations	9
Tolerance Factor	2.647		
Raw Statistics		Log-Transformed Statistics	
Minimum	600	Minimum	6.397
Maximum	900	Maximum	6.802
Second Largest	880	Second Largest	6.78
First Quartile	635	First Quartile	6.454
Median	665	Median	6.5
Third Quartile	810	Third Quartile	6.693
Mean	713	Mean	6.558
SD	117	SD	0.157
Coefficient of Variation	0.164		
Skewness	0.851		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.814	Shapiro Wilk Test Statistic	0.834
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
97.5% UTL with 90% Coverage	1023	97.5% UTL with 90% Coverage	1069
97.5% UPL (t)	990.6	97.5% UPL (t)	1024
90% Percentile (z)	862.9	90% Percentile (z)	862.2
95% Percentile (z)	905.5	95% Percentile (z)	912.9
97.5% Percentile (z)	942.3	97.5% Percentile (z)	959.3
99% Percentile (z)	985.2	99% Percentile (z)	1016
Gamma Distribution Test		Data Distribution Test	
k star	30.75	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	23.19		
MLE of Mean	713		

MLE of Standard Deviation	128.6		
nu star	615		
A-D Test Statistic	0.841	**Nonparametric Statistics**	
5% A-D Critical Value	0.724	90% Percentile	882
K-S Test Statistic	0.266	95% Percentile	891
5% K-S Critical Value	0.266	99% Percentile	898.2
Data follow Appx. Gamma Distribution at 5% Significance Level		97.5% Percentile	895.5
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	900
90% Percentile	881.9	97.5% Percentile Bootstrap UTL with 90% Coverage	900
95% Percentile	936.8	97.5% BCA Bootstrap UTL with 90% Coverage	900
99% Percentile	1046	97.5% UPL	900
97.5% Percentile	986.2	97.5% Chebyshev UPL	1479
97.5% WH Approx. Gamma UPL	1011	Upper Threshold Limit Based upon IQR	1073
97.5% HW Approx. Gamma UPL	1014		
97.5% WH Approx. Gamma UTL with 90% Coverage	1051		
97.5% HW Approx. Gamma UTL with 90% Coverage	1055		

Thallium

General Statistics

Total Number of Observations	10	Number of Distinct Observations	4
Tolerance Factor	2.647		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	0.12	Minimum	-2.12
Maximum	0.2	Maximum	-1.609
Second Largest	0.2	Second Largest	-1.609
First Quartile	0.17	First Quartile	-1.772
Median	0.175	Median	-1.743
Third Quartile	0.18	Third Quartile	-1.715
Mean	0.169	Mean	-1.792
SD	0.0281	SD	0.183
Coefficient of Variation	0.166		
Skewness	-1.079		

Warning: There are only 4 Distinct Values in this data

There are insufficient Distinct Values to perform some GOF tests and bootstrap methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values to compute bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10-15 or more observations for accurate and meaningful bootstrap results.

Background Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.815	Shapiro Wilk Test Statistic	0.774
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
97.5% UTL with 90% Coverage	0.243	97.5% UTL with 90% Coverage	0.27
97.5% UPL (t)	0.236	97.5% UPL (t)	0.257
90% Percentile (z)	0.205	90% Percentile (z)	0.211
95% Percentile (z)	0.215	95% Percentile (z)	0.225
97.5% Percentile (z)	0.224	97.5% Percentile (z)	0.239
99% Percentile (z)	0.234	99% Percentile (z)	0.255
Gamma Distribution Test		Data Distribution Test	
k star	24.99	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.00676		
MLE of Mean	0.169		
MLE of Standard Deviation	0.0338		
nu star	499.7		
A-D Test Statistic	1.031	Nonparametric Statistics	
5% A-D Critical Value	0.724	90% Percentile	0.2
K-S Test Statistic	0.336	95% Percentile	0.2
5% K-S Critical Value	0.266	99% Percentile	0.2
Data not Gamma Distributed at 5% Significance Level		97.5% Percentile	0.2
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	0.2
90% Percentile	0.214	97.5% Percentile Bootstrap UTL with 90% Coverage	0.2
95% Percentile	0.228	97.5% BCA Bootstrap UTL with 90% Coverage	0.2
99% Percentile	0.257	97.5% UPL	0.2
97.5% Percentile	0.241	97.5% Chebyshev UPL	0.353
97.5% WH Approx. Gamma UPL	0.248	Upper Threshold Limit Based upon IQR	0.195
97.5% HW Approx. Gamma UPL	0.25		
97.5% WH Approx. Gamma UTL with 90% Coverage	0.259		
97.5% HW Approx. Gamma UTL with 90% Coverage	0.261		

Uranium

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	9
Tolerance Factor	2.647		
Raw Statistics		Log-Transformed Statistics	
Minimum	0.68	Minimum	-0.386
Maximum	1.4	Maximum	0.336
Second Largest	1.2	Second Largest	0.182
First Quartile	0.735	First Quartile	-0.308
Median	0.845	Median	-0.17
Third Quartile	0.93	Third Quartile	-0.0726
Mean	0.9	Mean	-0.133
SD	0.235	SD	0.239
Coefficient of Variation	0.261		
Skewness	1.32		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.851	Shapiro Wilk Test Statistic	0.899
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97.5% UTL with 90% Coverage	1.521	97.5% UTL with 90% Coverage	1.648
97.5% UPL (t)	1.457	97.5% UPL (t)	1.543
90% Percentile (z)	1.201	90% Percentile (z)	1.189
95% Percentile (z)	1.286	95% Percentile (z)	1.297
97.5% Percentile (z)	1.36	97.5% Percentile (z)	1.399
99% Percentile (z)	1.446	99% Percentile (z)	1.526
Gamma Distribution Test		**Data Distribution Test**	
k star	13.07	Data appear Normal at 5% Significance Level	
Theta Star	0.0689		
MLE of Mean	0.9		
MLE of Standard Deviation	0.249		
nu star	261.4		
A-D Test Statistic	0.51	**Nonparametric Statistics**	
5% A-D Critical Value	0.725	90% Percentile	1.22
K-S Test Statistic	0.213	95% Percentile	1.31
5% K-S Critical Value	0.266	99% Percentile	1.382
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	1.355
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	1.4
90% Percentile	1.23	97.5% Percentile Bootstrap UTL with 90% Coverage	1.4
95% Percentile	1.345	97.5% BCA Bootstrap UTL with 90% Coverage	1.4
99% Percentile	1.578	97.5% UPL	1.4
97.5% Percentile	1.45	97.5% Chebyshev UPL	2.437
97.5% WH Approx. Gamma UPL	1.506	Upper Threshold Limit Based upon IQR	1.223
97.5% HW Approx. Gamma UPL	1.515		
97.5% WH Approx. Gamma UTL with 90% Coverage	1.593		
97.5% HW Approx. Gamma UTL with 90% Coverage	1.605		

Vanadium

General Statistics

Total Number of Observations	10	Number of Distinct Observations	6
Tolerance Factor	2.647		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	23	Minimum	3.135
Maximum	32	Maximum	3.466
Second Largest	31	Second Largest	3.434
First Quartile	25	First Quartile	3.219
Median	27	Median	3.293
Third Quartile	30	Third Quartile	3.401
Mean	27.3	Mean	3.3

SD	3.433	SD	0.127
Coefficient of Variation	0.126		
Skewness	0.0111		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.876	Shapiro Wilk Test Statistic	0.874
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97.5% UTL with 90% Coverage	36.39	97.5% UTL with 90% Coverage	37.9
97.5% UPL (t)	35.45	97.5% UPL (t)	36.6
90% Percentile (z)	31.7	90% Percentile (z)	31.88
95% Percentile (z)	32.95	95% Percentile (z)	33.38
97.5% Percentile (z)	34.03	97.5% Percentile (z)	34.74
99% Percentile (z)	35.29	99% Percentile (z)	36.39
Gamma Distribution Test		**Data Distribution Test**	
k star	48.9	Data appear Normal at 5% Significance Level	
Theta Star	0.558		
MLE of Mean	27.3		
MLE of Standard Deviation	3.904		
nu star	978.1		
A-D Test Statistic	0.651	**Nonparametric Statistics**	
5% A-D Critical Value	0.724	90% Percentile	31.1
K-S Test Statistic	0.253	95% Percentile	31.55
5% K-S Critical Value	0.266	99% Percentile	31.91
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	31.78
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	32
90% Percentile	32.41	97.5% Percentile Bootstrap UTL with 90% Coverage	32
95% Percentile	34.02	97.5% BCA Bootstrap UTL with 90% Coverage	32
99% Percentile	37.19	97.5% UPL	32
97.5% Percentile	35.47	97.5% Chebyshev UPL	49.79
97.5% WH Approx. Gamma UPL	36.16	Upper Threshold Limit Based upon IQR	37.5
97.5% HW Approx. Gamma UPL	36.27		
97.5% WH Approx. Gamma UTL with 90% Coverage	37.31		
97.5% HW Approx. Gamma UTL with 90% Coverage	37.45		

Zinc

General Statistics

Total Number of Observations	10	Number of Distinct Observations	5
Tolerance Factor	2.647		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	100	Minimum	4.605
Maximum	140	Maximum	4.942

Second Largest	130	Second Largest	4.868
First Quartile	110	First Quartile	4.7
Median	115	Median	4.744
Third Quartile	127.5	Third Quartile	4.848
Mean	117	Mean	4.756
SD	13.37	SD	0.114
Coefficient of Variation	0.114		
Skewness	0.334		

Background Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.932	Shapiro Wilk Test Statistic	0.934
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
97.5% UTL with 90% Coverage	152.4	97.5% UTL with 90% Coverage	157.1
97.5% UPL (t)	148.7	97.5% UPL (t)	152.3
90% Percentile (z)	134.1	90% Percentile (z)	134.5
95% Percentile (z)	139	95% Percentile (z)	140.2
97.5% Percentile (z)	143.2	97.5% Percentile (z)	145.3
99% Percentile (z)	148.1	99% Percentile (z)	151.5
Gamma Distribution Test		**Data Distribution Test**	
k star	60.26	Data appear Normal at 5% Significance Level	
Theta Star	1.942		
MLE of Mean	117		
MLE of Standard Deviation	15.07		
nu star	1205		
A-D Test Statistic	0.357	**Nonparametric Statistics**	
5% A-D Critical Value	0.724	90% Percentile	131
K-S Test Statistic	0.202	95% Percentile	135.5
5% K-S Critical Value	0.266	99% Percentile	139.1
Data appear Gamma Distributed at 5% Significance Level		97.5% Percentile	137.8
Assuming Gamma Distribution		97.5% UTL with 90% Coverage	140
90% Percentile	136.7	97.5% Percentile Bootstrap UTL with 90% Coverage	140
95% Percentile	142.8	97.5% BCA Bootstrap UTL with 90% Coverage	140
99% Percentile	154.9	97.5% UPL	140
97.5% Percentile	148.3	97.5% Chebyshev UPL	204.6
97.5% WH Approx. Gamma UPL	150.9	Upper Threshold Limit Based upon IQR	153.8
97.5% HW Approx. Gamma UPL	151.3		
97.5% WH Approx. Gamma UTL with 90% Coverage	155.3		
97.5% HW Approx. Gamma UTL with 90% Coverage	155.7		


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Canada

Environmental Effects Evaluation (EEE) Report

Sections 67 of the

Canadian Environmental Assessment Act, 2012

Site Closure of Former Landfills 1 and 3
Collins Bay Institution, 1455 Bath Road, PO Box 7500, Kingston, Ontario

PWGSC Project No.: R.058456.001

Source: GoogleMaps

Prepared by
Public Works and Government Services Canada –
Environmental Services, Toronto, Ontario

June 3, 2014

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PART A: PROJECT INFORMATION

Project Title:	Remediation of Former Landfills 1 and 3
Project Location:	Collins Bay Institution, Kingston, Ontario
Lead Federal Authority:	Correctional Services Canada
Lead Authority contact:	Danielle Currie, Correctional Services Canada
Other FA's:	
EEE Assessor contact:	Lee Chan, Public Works and Government Services Canada
PWGSC Project Number:	R.058456.001
Client contact:	Danielle Currie, Correctional Services Canada

PART B: SCOPE OF PROJECT

B.1 Project Description

The proposed project involves the transfer of solid wastes from Landfill 3 (LF3) to Landfill 1 (LF1), both of which are located in the central and southern parts of Collins Bay Institution's property. While they are referred to as "Landfills", essentially they are waste dumps, disposal sites with no engineered features. The institution is located on federal property and is owned and operated by Correctional Services Canada. Historically, disposal of waste materials at LF3 occurred roughly between 1948 and 1989. Wastes included construction debris, concrete, rebar, brick, asphalt, plastic, wood, cinders, paper, soil fill, debris from a demolished dairy barn (potentially containing asbestos containing materials (ACMs)) and possibly furnace slag. The barn was previously demolished by fire, thus the waste from the structure consists of combusted debris. Previous studies have determined the maximum waste fill thickness (depth) of LF3 to be 3.5 metres (m). The estimated total waste volume was determined to be 21,090 m^3. The former landfill is currently vacant and is covered with soil and vegetation. The activity of the project involves the excavation and transfer of wastes to LF1, which would in turn be graded and capped. LF3 will then be allowed to re-vegetate naturally and parts of it will potentially integrate naturally with the adjacent wetland. Previous studies have determined the maximum waste fill thickness (depth) of LF1 to be 7.6 m. Waste materials in this LF are mostly comprised of construction and demolition wastes as well as waste soils and limestone.

Project Phase	Project Components	
	Core Project Components	**Ancillary Works Other Projects & Activities**
Mobilization and Preparation	• Locate utility lines within project area. • Erosion and sediment control. • Install temporary access road and entrance on the north side of Front Road and approximately 200 m west of the east entrance to LF1. • Establish three (3) sections of pull over lanes. • Establish (30m x 30m) lay down at end of temporary access road for staging and equipment parking (1 – 2 excavators, 3-4 rock trucks, 1 sheep foot compactor, 1 smooth roller compactor, 1 heavy bulldozer, 1 trim bulldozer, 1 hydro seeder, 1 water truck and GCL installation equipment). • Removal of approximately two dozen existing trees from the project area. Other trees will be tagged to indicate that they are to remain. • Scarification of the surface of LF1. • Installation of construction facilities.	• Improvements to existing haul road between LFs 1 and 3 such as the preparation of 3 vehicular pull-offs on east side of existing access road between LFs1 and 3 to allow vehicular passing. • Relocation of existing hydro support pole at LF1. • Decommissioning of existing monitoring wells at LFs 1 and 3.
Excavation and Transfer	• Excavation and removal of approximately 21,090 m^3 of buried waste materials from LF3 and transportation to LF1 via Quarry Road that connects the two LFs. • Placement of wastes over LF1.	• Collection and analysis of soil samples from walls of completed excavation at LF3. • Excavation and backfilling activities coordinated to accommodate 72 hour laboratory turnaround time for sample analysis. • Dewatering of excavation.

Capping and Closure	• Waste re-grading and compaction at LF1. • Installation of Geosynthetic Clay Liner (GCL) over the re-graded waste at LF1. • Source locally-supplied (Kingston area) soil cover. Analytical testing of granular and topsoil fill to ensure environmental standards are met. • Transportation and placement of topsoil cover above GCL. Compacted and shaped to final grades. • Transportation and placement of limited fill and topsoil in LF3 excavation. • Hydro seeding with Ontario Seed Company (OSC) native seed shoreline mix, and rehabilitation of the former LF3 area as additional wetland area. • Hydro-seeding of final cap over LF1 with OSC native seed.	• Minimal backfilling with imported fill at LF3 and re-grading level with existing road to the west with a shallow downward slope to the east towards adjacent wetland areas. • Re-grading or ditch work around capped LF1 to direct surface water run-off away from the cap. • Restoration and hydro seeding of any other disturbed areas. • Topsoil would be stockpiled in the laydown area, or in the area immediately north of Landfill 1, or in the area immediately north of Landfill 3. • Planting of replacement trees that are native to the region. • Demobilization of contractor equipment and personnel.
Post-Closure Care Program	Inspections and as-required maintenance of LF1 on a long-term basis. This includes: • Cover application and re-vegetation for the capped landfill to correct for settlement or erosion. • Maintenance of ditches or monitoring wells. • Semi-annual groundwater sampling. • Landfill gas monitoring.	New network of monitoring wells to be installed following the completion of recapping.

Source: Specification, Landfill Closure Works, CSC Collins Bay Institution, Landfills 1 and 3, Kingston, Ontario, version 2014-04-18

B.2 Scheduling

The project is proposed to commence in September of 2014 and is anticipated to take approximately six (6) weeks to complete. In the event of inclement weather or other unforeseen issues, construction activities would continue into December and January. This timeline includes the following works:

- Site Setup, Temporary Facilities and Well Abandonment
- Waste Excavation at Landfill 3 and Relocation to Landfill 1
- Landfill Cover Placement at Landfill 1
- Final Grading, Hydroseeding, Site Restoration and Cleaning

In the event that snow has accumulated, construction activities will be delayed until spring 2015. If the GCL and soil cover has been implemented, a temporary netting or straw cover will be used to protect the soil cover for the duration of the winter season and until the spring thaw. At that time, additional soil cover may be applied as repair measures followed by the hydro-seeding of the cap.

The scheduling of the project considers potential adverse impacts to Species-at-Risk (SAR) habitat and SAR individuals. For example, turtle hibernation season is understood to be from mid-October to April. Accordingly, with the current proposed schedule, no other adverse impacts to SAR habitat or SAR are anticipated.

B.3 Regulatory

The below table summarizes regulations that are applicable to this project.

Act/Regulation	Applicability
Species-at-Risk Act (2003)	Protects species listed under Schedule 1 that may occur. Critical habitats of "Threatened" or "Endangered"-listed species are also protected.
Migratory Birds Convention Act (1994)	Protects migratory birds by prohibiting killing, removal of eggs, disturbance of nests or their destruction. Breeding times generally are between May 1st and August 1st and construction activities should be timed to avoid this period.
Transportation of Dangerous Goods Act (1992)	Pertain to the appropriate handling of fuels, toxic wastes and other hazardous material involved in this project to prevent accidental releases into the ground or water.
Canadian Fertilizer Act	Regulates the composition, handling and application of materials that would be used during hydro-seeding of the capped LF.
Canada Labour Code, Canada Occupational Safety and Health Regulations, Part X – Hazardous Substances ***Occupational Health and Safety Act Revised 1990*** ***Regulations for Construction Projects, O.Reg. 213/91***	Worker health and safety are regulated under these regulations since work at the site will involve contact with: • Construction and demolition waste in combination with waste soil and limestone in LF1, • Construction and demolition waste and soil fill in LF3, and; • Potentially with asbestos-containing building materials, PCB-containing materials and free liquids.
Revised Regulations of Ontario 1990, Regulation 347 "General Waste Management"	Stipulates appropriate management and disposal of solid wastes.
Ontario Water Resources Act, Ontario Regulation (O.Reg. 903)	Decommissioning of monitoring wells must be undertaken by a licensed well contractor.

As the project will be undertaken only on federal property and no potential off-site environmental impacts are anticipated, no provincial permits will be required. Any effluent produced as a result of this project shall be managed on-site through containment or off-site disposal at approved facilities, therefore no permits or approvals for municipal sewer discharges will be pursued.

No Fisheries Act permit from the Department of Fisheries and Oceans Canada (DFO) is required as the project is to occur above the high-water mark and it is therefore unlikely that fish or fish habitat will be adversely impacted. DFO's stance on permitting is further detailed in it correspondence in Section D3.

A SARA permit is not required since no potential SAR is anticipated to be impacted by the project and no critical habitat for any SAR has been identified at or near the project site.

PART C: SCOPE OF EVALUATION

C.1 Environmental Setting

Collins Bay Institution is a minimum security federal penitentiary that comprises of twenty-six (26) buildings and is owned and operated by Correctional Services Canada (CSC). The penitentiary fronts 1455 Bath Road, Kingston, Ontario and the buildings are concentrated in the northern most section of the entire property. The central and southern sections of the property are comprised of mostly agricultural and vacant lands. LFs 1 and 3 are located within the south and central sections of the property which are vacant. Figure 1 shows the location of both landfills in relation to the buildings.

The surrounding land use of the landfills is described as the following.

Surrounding land use of LF1:

- To the west and north: agricultural lands used for farming of cash crops such as hay and a institutional access road immediately north.
- To the south: Front Road (a city road) and a DuPont Canada industrial manufacturing plant fronting the opposite side of the road.
- To the east: Highbanks Road (an unused road) and lands owned and operated by the Cataraqui Region Conservation Authority (CRCA) which includes a provincially significant wetland (PSW). LF1 is located approximately 250 m west of the western shoreline of the Little Cataraqui Creek. Wetlands surrounding the Creek are considered to be associated with the PSW but the PSW's exact boundaries are not well defined. The PSW boundary is located approximately 80 m east of CSC property.

Surrounding land use of LF3:

- To west: a institutional access road
- Immediately to the southwest, south, west and east: seasonally wet wetlands and an ephemeral stream that have been identified as being associated with the PSW.
- To the north and northwest: agricultural lands used for farming of cash crops

C.2 Physical Environment

LF1 is located just north of Front Road on the southern part of the institution property and 250 metres west of the western shoreline of Little Cataraqui Creek. The LF was formerly a quarry with an area of 1.7 hectares. Waste materials include concrete, brick, asphalt, coal, cinder, plastic, wood, rebar, metal and paint chips mixed with soil and limestone backfill. The materials are covered with soil and vegetation, however these were visible near the perimeters of the LF. The LF is generally flat and is of similar elevation as the surrounding area.

The geology of the area generally consists of undifferentiated carbonate and clastic sedimentary rock exposed at surface or covered by a discontinuous layer of overburden. Native soils consist of primarily silt with varying sand content and clay. Groundwater occurs within a range of 2.6 metres below ground surface (mbgs) and 3.5 mbgs and flows north east toward the Little Cataraqui Creek.

LF3 is located on the west shore of Little Cataraqui Creek. The area within which LF3 is located is generally flat and of similar elevation as the areas of the northern part of the property. The central part of the LF is flat. The LF site slopes towards creeks that are located south and east and the surface of the sloped sections of the LF is uneven. Waste materials located at LF3 consists of construction debris, concrete, rebar, brick, asphalt, plastic, wood, cinders, paper, soil fill, debris from a demolished dairy barn, including potential ACMs and possibly furnace slag. The LF surface consists of soil and vegetation which is fragmented with waste materials visible at the surface at many locations.

As with LF1 the geology of LF3 consists of undifferentiated carbonate and clastic sedimentary rock exposed at surface or covered by a discontinuous layer of overburden. Native soils are composed of sandy or silty clay overlying silt or silty sand. Groundwater depth ranges between 1.5 mbgs to 2.4 mbgs and flows south southwest.

At both LFs, no anthropogenic structures other than the monitoring wells (eleven (11) associated with LF1 and twenty-four (24) within the vicinity of LF3), and an existing Bell box, pole and guy wire, and fence along the south side of LF3 exist.

C.3 Biological Environment

The vegetation at LF1 consists of grass with taller grasses along the perimeter of the in-filled area. A drainage ditch runs along the south of the LF and adjacent to Front Road. Northeast of the northeast part of the in-filled area lies a low lying area that becomes wet seasonally. Cattails exist within this low lying area and mature trees lie along the eastern boundary of the LF.

Vegetation at LF3 consists primarily of grasses within the central part, while the perimeter areas consist of a mixture of tall grasses and cattails. A small creek, referred to as “Southeast Tributary”, flows west to east immediately south of LF3 and into the Little Cataraqui Creek. Shallow marsh areas lie to the south and west of LF3.

Wetlands surrounding Little Cataraqui Creek are associated with the PSW which is situated approximately 80 metres east of the CSC property. These areas are referred to as the Little Cataraqui Marsh which is part of the Little Cataraqui Creek Wetland Complex.

Species-at-Risk

An ecological study by the Kingston Field Naturalists in 2004 identified the Little Cataraqui Creek as a PSW, 292 species of plants, 13 species of mammal, 64 species of birds (plus 35 migrant species), 19 species of fish, 15 herptile species, and 13 species of odonates. Three locally rare species of plant were identified as well as 5 Ontario species-at-risk (SAR). The above study and site specific risk assessments conducted for the LFs identified several SAR that potentially could occur near the project site which are listed below. SNC reported that only the Grey Fox (“Threatened” under Schedule 1 of SARA) was actually observed. Historical observations of both federal and provincially-listed SAR at the project site are tabled below.

Taxonomy	Species-at-Risk (all listed under Schedule 1, SARA)
Mammals	Grey Fox
Birds	Common Nighthawk, Black Tern, Red-Shouldered Hawk, Short-Eared Owl, Least Bittern
Reptiles	Snapping Turtle, Blanding’s Turtle, Spiny Softshell, Northern Map Turtle, Milksnake
Invertebrates	Monarch Butterfly

While there is the presence of potentially suitable habitat, a SARA permit is not required for this project as no critical habitat has been identified on or near the project site for any of the above-tabled SAR. Also, most of the SAR are listed as “Special Concern” whose habitat is not afforded protection under SARA. The American Eel was also identified in the Little Cataraqui Creek, however, it is yet to be listed under SARA and therefore no protection is afforded. This on the other hand does not reduce the due diligence of undertaking measures in avoiding incidental harm to individuals identified as belonging to a SAR nor does it reduce the importance of avoiding adverse impacts to the aquatic habitat of the Creek. Mitigation measures for the protection of wildlife and their habitats (both terrestrial and aquatic) are in Tables 2.1 and 2.2.

Although wildlife (including SAR) may traverse across the LFs, their occurrence is not anticipated during the project period since the activities are planned for the Fall of 2014 and the presence of heavy equipment should cause wildlife to avoid the general area.

C.4 Socio-economic Environment

The property has been owned by the federal government and operated as a correctional institution since 1930. Minimum security inmates have used the property for agricultural operations including crop growing and harvesting and livestock tending. This has ceased and since 2010 has been leased to a local farmer for cash crop agriculture.

C.5 Scoping

This environmental effects evaluation considers the full range of project / environment interactions and the environmental factors that could be affected by the project as defined above and the significance of related effects after mitigation. The environmental effects of a project to be considered include at a minimum, but are not limited to those described under subsection 5(1) and 5(2) of CEAA 2012. The environmental effects considered under this report include:

- Fish
- Species-at-Risk
- Migratory Birds
- Health and Socio-Economic
- Water (surface, ground, drainage)
- Soil Quality (surface, sub-surface)

Table 1: Potential Project / Environment Interactions Matrix : Remediation of Former Landfill 3, Collins Bay Institution, Ontario

P = Potential Effect of Project on Environment;' - ' = No Interaction

	As per Section 5(1)			*Section 5(1c) Aboriginal Interest*				*Section 5(2)*			*Due Diligence*			
Project Phase / Physical Work/Activity	*Fish (Fisheries Act)*	*Aquatic Species (SARA)*	*Birds (MBCA)*	*Health and Socio economic*	*Physical and cultural heritage*	*Land use*	**HAPA Significance*	*Health and Socio economic*	*Physical and cultural heritage*	*HAPA Significance*	*Water (ground surface, drainage, etc.*	*Birds / Wildlife*	*Soil*	*Terrestrial Species (SARA)*
Construction														
Mobilization and Preparation	***P***	***P***	***P***	-	-	-	-	***P***	-	-	***P***	***P***	***P***	***P***
Transfer of Wastes from LF3 to LF1	***P***	***P***	***P***	-	-	-	-	***P***	-	-	***P***	***P***	***P***	***P***
Capping and Closure of LF1	***P***	***P***	***P***	-	-	-	-	***P***	-	-	***P***	***P***	***P***	***P***
Post-Closure Care Program	-	***P***	***P***	-	-	-	-	***P***	-	-	-	***P***	-	***P***

*HAPA –*structure, site or thing that is of historical, archaeological, paleontological or architectural significant*

Table 2.1 – 2.6: Potential Project / Valued Ecosystem Interactions and Mitigation Measures

<table>
<tr><td colspan="6">Table 2.1 Valued Ecosystem Component - Fish (Fisheries Act)</td></tr>
<tr><td colspan="6">Potential Effect: Harmful effects to fish.</td></tr>
<tr><td colspan="2">Potential Interaction</td><td colspan="4">Mitigation Measures</td></tr>
<tr><td colspan="2">Project activities may result in debris/material entering a nearby freshwater environment. Suspended material will adversely affect fish (impair gills, cover eggs) as well as habitat.

Contamination of surface water from temporarily stored material to be used for establishment of lay down areas.

Contamination of surface water from potential run-off of soils/debris during excavation and deposition activities. This potentially can be exacerbated by heavy precipitation.</td><td colspan="4">• Maintain adequate separation distances between equipment and watercourses or wetlands. Minimize operational footprint as much as practical or change location of temporary workspaces. Parking areas, temporary workspaces lay-down areas are not be located within 10 metres of the high water mark of wetlands or watercourses.
• Erosion control measures (ie. silt fencing, etc.) must be undertaken to prevent the inadvertent release of any debris, waste, or fill material into the adjacent aquatic environments. Erosion control measures are to remain in place until vegetation is re-established and/or all exposed soils (that have been placed over LF1) are stabilized. Work must be scheduled to avoid periods of heavy precipitation.
• If any such entry occurs, the material must be removed immediately and managed appropriately.
• Ensure that vehicles and machinery do not operate between the LFs and the wetland or ford over water bodies during construction.
• The exposed soil area must be minimized by limiting the area that is exposed at one time and by limiting the time that any one area is exposed. All stockpiled materials must be covered and/or dyked to prevent erosion and release of sediment laden water. Exposed soil should be hydro seeded or sodded to ensure soil stabilization as the final step of remediation for this project.
• Machinery must be checked for leakage of lubricants or fuel and must be in good working order. Refueling must be done at least 30 m from any water body and on an impermeable surface. Basic petroleum spill clean-up equipment must be on-site. All spills or leaks must be promptly contained, cleaned up and reported to the 24-hour environmental emergencies reporting system (1-800-268-6060).
• Excavation to be executed to establish a berm at the water’s edge effectively separating Little Cataraqui Creek from the initial stage of the excavated area. In the event excavated area must be de-watered, test diverted water against applicable criteria for suitability for discharge. Discharge away from the Creek onto a vegetated area. Any water entering the Creek is to be free of silt or other deleterious materials. Ensure water levels within excavation are reduced relative to that of the Creek in order to avoid sudden influx of water into the Creek upon removal of berms.
• Project will not occur within a water body however it is to be conducted outside of spring spawning season which is generally between March to August for fish species previously identified in the Creek.
• Surface water drainages and contours must be retained or re-established post-construction.</td></tr>
<tr><td>Magnitude</td><td colspan="2">Reversibility</td><td>Geographic Extent</td><td>Duration</td><td>Frequency</td></tr>
<tr><td>Small</td><td colspan="2">Reversible</td><td>Immediate</td><td>Medium-term</td><td>Intermittant</td></tr>
<tr><td>Residual Effects:</td><td colspan="5">Insignificant</td></tr>
</table>

Monitoring:	If dewatering is required from LF3, sample diverted water from the LF to determine if parameters are below Provincial Water Quality Objectives (PWQO) and the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (FAL).
Comments: .	

Table 2.2 Valued Ecosystem Component – Species-at-Risk (SARA) (applies to terrestrial SAR as well as non-SAR wildlife)				
Potential Effect: Incidental Mortality of Wildlife				
Potential Interaction	**Mitigation Measures**			
Heavy equipment or workers may inadvertently harm individuals of SAR/wildlife which may be present within the project area	• Distribute color photos and descriptions of SAR that has occurred in the region and may potentially occur during the project to the contractor and workers. Instruct all parties involved in project to stop work if a SAR or other wildlife species is encountered within project area. Upon an encounter, record location using Global Positioning System (GPS) and photograph. Contact PWGSC representative. • All detected animals including birds shall be allowed to passively disperse from roads and work areas. • Vehicle movements to be restricted to construction areas and access roads to avoid inadvertent harassment of wildlife. • Barriers such as fencing shall be installed around excavations and other hazards where appropriate to prevent intrusion of wildlife into work areas.			
Magnitude	**Reversibility**	**Geographic Extent**	**Duration**	**Frequency**
Small	Reversible	Immediate	Medium-Term	Intermittent
Residual Effects:	Insignificant			
Monitoring:	None required			
Comments: Initial operation of heavy equipment would result in movement, noise and vibration which would cause wildlife to retreat from areas of laydown, LFs and other areas anticipated to be disturbed or utilized by construction activities before commencement. Ongoing operation of such machinery should cause wildlife to refrain from entering affected areas thus the risk of inadvertent harm is decreased or nullified. This includes terrestrial/aquatic wildlife species such as herptiles.				

<table>
<tr><td colspan="6">Table 2.3 Valued Ecosystem Component – Migratory Birds (MBCA)</td></tr>
<tr><td colspan="6">Potential Effect: Incidental Mortality of Migratory Birds</td></tr>
<tr><td colspan="2">Potential Interaction</td><td colspan="4">Mitigation Measures</td></tr>
<tr><td colspan="2">Heavy equipment or workers may inadvertently harm, kill, or disturb individuals of a migratory bird species that may nest within areas (or close proximity) of remedial activities.</td><td colspan="4">Conduct remedial activities outside of migratory bird breeding period (between May 1 – August 1).
If work is not conducted outside of this window, a biologist should confirm presence or absence of nests in the areas of laydown, LFs and other areas anticipated to be disturbed by construction activities. Prior to staging and/or construction activities. If nests are detected work will have to cease within a reasonable radius buffer of the nest.</td></tr>
<tr><td>Magnitude</td><td colspan="2">Reversibility</td><td>Geographic Extent</td><td>Duration</td><td>Frequency</td></tr>
<tr><td>Small</td><td colspan="2">Reversible</td><td>Immediate</td><td>Medium-Term</td><td>Intermittent</td></tr>
<tr><td colspan="2">Residual Effects:</td><td colspan="4">Insignificant</td></tr>
<tr><td colspan="2">Monitoring:</td><td colspan="4">None required</td></tr>
<tr><td colspan="6">Comments:
In addition to the mitigation measures, the presence of heavy equipment should cause migratory birds to refrain from entering let alone nest within or in close proximity to affected areas thus the risk of inadvertent harm is decreased or nullified. This is most probable if such work has already commenced prior to the start of the breeding season.</td></tr>
</table>

<table>
<tr><td colspan="6">Table 2.4 Valued Ecosystem Component – Health and Socio economics</td></tr>
<tr><td colspan="6">Potential Effect: Exposure to Contaminated soils and Hazardous Wastes, Effects on Adjacent Neighbors to Noise, Impacts on Adjacent Farms, Aesthetics</td></tr>
<tr><td colspan="2">Potential Interaction</td><td colspan="4">Mitigation Measures</td></tr>
<tr><td colspan="2">Persons present on project site during remedial activities may be exposed to hazards.</td><td colspan="4">
Remediation activities must be conducted by qualified contractor to meet applicable health and safety regulations.
Workers who may come in contact with hazards must be provided with and use appropriate personal protective equipment.
Site access must be restricted to authorized workers only.
Dust suppression measures must be applied to prevent fugitive dust. Suspected ACM-containing roofing materials should be kept wet to avoid fibre release into the air during remediation.
Upon any unexpected health and safety issue, hazard or condition, work shall cease immediately and a departmental representative immediately advised.
Heavy equipment shall be well maintained and use adequate mufflers. Activities emitting excessive noise shall be restricted to daytime operations and shall adhere to municipal noise by-laws. Daily work schedules to be altered or restricted to minimize noise complaints as needed.
Completion of remedial activities should not be delayed unnecessarily so as to minimize period of unaesthetic construction sites.
Remedial activities are not to encroach on adjacent farms in which crops are actively being raised.
</td></tr>
<tr><td>Magnitude</td><td colspan="2">Reversibility</td><td>Geographic Extent</td><td>Duration</td><td>Frequency</td></tr>
<tr><td>Small</td><td colspan="2">Reversible</td><td>Immediate</td><td>Medium-Term</td><td>Intermittent</td></tr>
<tr><td colspan="2">Residual Effects:</td><td colspan="4">Insignificant</td></tr>
<tr><td colspan="2">Monitoring:</td><td colspan="4">None required</td></tr>
<tr><td colspan="6">Comments: While workers may be exposed to hazards, the exposure can be limited through the use of appropriate personal protective equipment and restricting site access to authorized workers only. In addition, workers must follow the Provincial Occupational Health and Safety Act and any other appropriate legislation, regulations, guidelines, or best-management practices.</td></tr>
</table>

<table>
<tr><td colspan="5">Table 2.5 Valued Ecosystem Component - Water</td></tr>
<tr><td colspan="5">Potential Effect: Groundwater contamination</td></tr>
<tr><td colspan="2">Potential Interaction</td><td colspan="3">Mitigation</td></tr>
<tr><td colspan="2">Contamination of groundwater from temporarily stored material from excavation activities.</td><td colspan="3">A liner should be placed at any temporary storage site prior to placement of waste and/or contaminated soil.
Deleterious substances (wastes, soil, granular or other construction-related materials) shall be prevented from entering nearby water systems. Rubbish and waste materials are not to be buried on-site. Waste or volatile materials, such as mineral spirits, oil or paint thinner are not to be disposed onto the ground or watercourses. Waste materials are to be disposed off-site in accordance with Ontario Regulations 347, General Waste Management to Ministry of Environment-approved disposal facilities.
Machinery must be checked for leakage of lubricants or fuel and must be in good working order. Refueling must be done at least 30 m from any water body and on an impermeable surface. Basic petroleum spill clean-up equipment must be on-site. All spills or leaks must be promptly contained, cleaned up and reported to the 24-hour environmental emergencies reporting system (1-800-268-6060).</td></tr>
<tr><td>Magnitude</td><td>Reversibility</td><td>Geographic Extent</td><td>Duration</td><td>Frequency
Significance</td></tr>
<tr><td>Small</td><td>Reversible</td><td>Immediate</td><td>Short-term</td><td>Once</td></tr>
<tr><td>Residual Effects:</td><td colspan="4">Insignificant</td></tr>
<tr><td>Monitoring:</td><td colspan="4">None required</td></tr>
<tr><td colspan="5">Comments:</td></tr>
</table>

Table 2.6 Valued Ecosystem Component - Soil (Surface and Subsurface) Quality				
Potential Effect: Erosion and contamination of soils.				
Potential Interaction	**Mitigation**			
Disturbance to soil from heavy equipment use (including during the removal of existing trees). Increased soil disturbance within the area of work for the duration of the remedial activities. Contamination of soil from temporarily stored material during soil remediation activities.	• Contaminated soil originating from LF3 that must be stored at any time during construction period, must be stored for the shortest time possible, covered, and/or deposited into LF1 as soon as possible. • All contaminated soil placed in LF1 must be capped with clean fill and hydro seeded to allow vegetation to establish to ensure there is no access to contaminated soil. • Work must be scheduled to avoid periods of heavy precipitation. Erosion control structures (ie. temporary matting, geotextile filter fabric, etc.) are to be used, as appropriate, to prevent erosion and release of sediments and/or sediment laden water during the construction phase. These structures are to be left in place until vegetation is re-established and/or all exposed soils are stabilized. • The exposed soil area must be minimized by limiting the area that is exposed at one time and by limiting the time that any one area is exposed. During construction period, all stockpiled soil must be covered and/or dyked to prevent erosion and release of sediment laden water. During restoration after completion of the project, exposed soil is to be replanted or sodded to ensure soil stabilization. This includes areas where trees have been removed and where no replacement trees are planned. • Trees in the project area that are to remain will be identified and specific protection barriers will be installed where required prior to construction. • Machinery must be checked for leakage of lubricants or fuel and must be in good working order. Basic petroleum spill clean-up equipment must be on-site and procedures to prevent chemical, fuel, hydraulic oil, lubricant and other hazardous substances release are to be followed by all sub-contractors. All spills or leaks must be promptly contained, cleaned up and reported to the 24-hour environmental emergencies reporting system (1-800-268-6060). The Control or Security Liaison Officer and the Chief of Plant Maintenance of the institution must be contacted in the event of any spill.			
Magnitude	**Reversibility**	**Geographic Extent**	**Duration**	**Frequency**
Small	Reversible	Immediate	Short-term	Once
Residual Effects:	Insignificant			
Monitoring:	None required			
Comments: Remedial activities could result in the mobilization of on-site contaminated soils, especially during precipitation events. Such runoff events are likely to be of short duration and confined to the project site. The implementation of effective mitigation measures can reduce such effects to insignificant levels.				

PART D: COMMUNICATIONS

D.1 Consideration of Public Concerns

During March and April of 2014, CSC conferred with the **Cataraqui Region Conservation Authority (CRCA)** and communicated the intention of not backfilling LF3 after excavation of wastes. Mr. Tom Beaubiah, Biologist representing the CRCA expressed the Authority's support in an April 3rd, 2014 e-correspondence to Ms. Currie Danielle of CSC stating:

- Not backfilling LF3 would promote the restoration of wetland habitat which likely existed prior to the site being used for waste disposal;
- The increased volume resulting from the planned excavation would benefit the CRCA and the City of Kingston in that opportunities for wetland expansion have been sought to compensate for incremental infilling from City projects; and,
- An expansion/restoration of wetlands would support objectives of an agreement between CSC, EC and the CRCA. Within the agreement, the wetland of the Little Cataraqui Creek is recognized by all three parties and provides an avenue for its maintenance and improvement.

Due to the above, there is no potential for public concern. Public consultation was therefore not deemed necessary as part of this screening.

A record of public participation determination and record of relevant correspondences are in **Appendix B**.

D.2 Aboriginal Interest

PWGSC evaluated the proposed closure of LFs 1 and 3 at Collins Bay Institution to determine if the environmental effects will likely result in a significant adverse environmental effect upon aboriginal interests. The area involved in this project is limited within federal property that is owned and managed by CSC and is not on a reserve or near a First Nation land. CSC has confirmed that no First Nations interest has been expressed with respect to the property. An e-mail correspondence is attached in **Appendix B**. Hence, no communications with an aboriginal community related to this project have transpired or are planned.

D.3 Government Co-ordination

Federal and provincial authorities likely to have an interest in the project were consulted by CSC, prior to the environmental effects evaluation. A project description was distributed to the Department of Fisheries and Oceans Canada (DFO) upon which expert support advice was provided in an April 5th, 2014 correspondence from Dr. Tara Bortoluzzi, Fisheries Biologist, FCSAP Expert Support of DFO and addressed to Ms. Danielle Currie of CSC.

Information regarding best management practices and management options was detailed in the correspondence which were subsequently considered and incorporated into the environmental effects evaluation. This included information from DFO's website which detailed measures aimed at preventing harm to fish. At the time of this evaluation, no further co-ordination with this or other federal or provincial authority had transpired or was deemed necessary.

PART E: ENVIRONMENTAL EFFECTS EVALUATION CONCLUSION

Potential impacts of this project may be associated with the following environmental aspects: fish, SAR, wildlife, surface water/groundwater, worker health and safety, and soils. It is reasonable to conclude that with appropriate mitigation measures in place and best management practices, environmental effects will be of short duration and the potential zone of influence will be confined to the immediate vicinity.

PART F: ACCURACY AND COMPLIANCE MONITORING

Site monitoring for this project should be undertaken as a measure to ensure conformance of activities with mitigation measures. This is suggested as a wetland recognized for its significance is immediately located adjacent to the site.

PART G: DETERMINATION

The federal authority is required to provide a determination of the significance of environmental effects as a result of this project. The decision outlined below is based on the interpretation of environmental effects and mitigation measures described in Part D of this report.

Project Name: Site Closure of Former Landfills 1 and 3
PWGSC Project #: R.058456.001
Location: Collins Bay Institution, Kingston, Ontario

The Federal Authority has evaluated the project for significant adverse environmental effects as required under Section 67 of *Canadian Environmental Assessment Act (CEAA), 2012*. On the basis of this evaluation, the department has determined that the decision opposite the "X" applies to the proposed project.

___ Project not likely to cause significant adverse environmental effects - proceed.

X Project not likely to cause significant adverse environmental effects with mitigation - proceed using mitigative measures as determined.

___ Inadequate information available - further study and assessment is required.

___ Project likely to cause significant adverse environmental effects that cannot be justified in the circumstances - project will not proceed.

___ Project likely to cause significant adverse environmental effects that may be justified in the circumstances - refer to the Governor in Council for decision.

PART H: SIGNATURE

This document summarizes the results of an environmental effects (EE) evaluation related to the above project that has been performed and completed by the Federal Authority in accordance with the *Canadian Environmental Assessment Act, 2012.*

Evaluator: ______________________ Date: 2014 JUNE 3

Lee Chan, Environmental Specialist, Environmental Services, PWGSC Ontario Region

The above has completed this environmental effects evaluation (EEE) report to the best of their ability and knowledge, and ensures that it meets the requirement of the Canadian Environmental Assessment Act, 2012.

Project Manager: ______________________ Date: 2014 June 5

Danielle Currie, Environmental Protection Program, Correctional Services Canada

The above has read and understood this environmental effects evaluation (EEE) report and acknowledges responsibility for ensuring the implementation of mitigation measures and for ensuring the design and implementation of 'accuracy and compliance monitoring', if any, identified in this report.

PART I: REFERENCES

Currie, Danielle, CSC. E-mail correspondence: *590-10: 441-L03 Remediation of historic dumpsite at Collins Bay Institution.* April 3, 2014, 1:41pm.

DFO. *Measures to Avoid Causing Harm to Fish and Fish Habitat*. http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html Accessed April 25, 2014.

MacFadden, Allison, SNC Lavalin. E-mail correspondence : *Re : CSC Collins Bay*. February 26, 2014, 2 :02pm.

Ontario Freshwater Fishes Life History Database. http://www.ontariofishes.ca/home.htm Accessed May 30, 2014.

Questions for CSC_Mar 31, 2014_ Collins Bay Landfill Remediation Work final, Landfill Closure Works – CSC Collins Bay Landfills 1&3. Word document.
SARA registry. http://www.sararegistry.gc.ca/species/schedules_e.cfm?id=1. Accessed April 17, 2014.

SNC Lavalin Environment, 2013. *Revised Draft, Site Specific Risk Assessment, Collins Bay Institution, Former Landfill 1 (441-L02).* May 24, 2013.

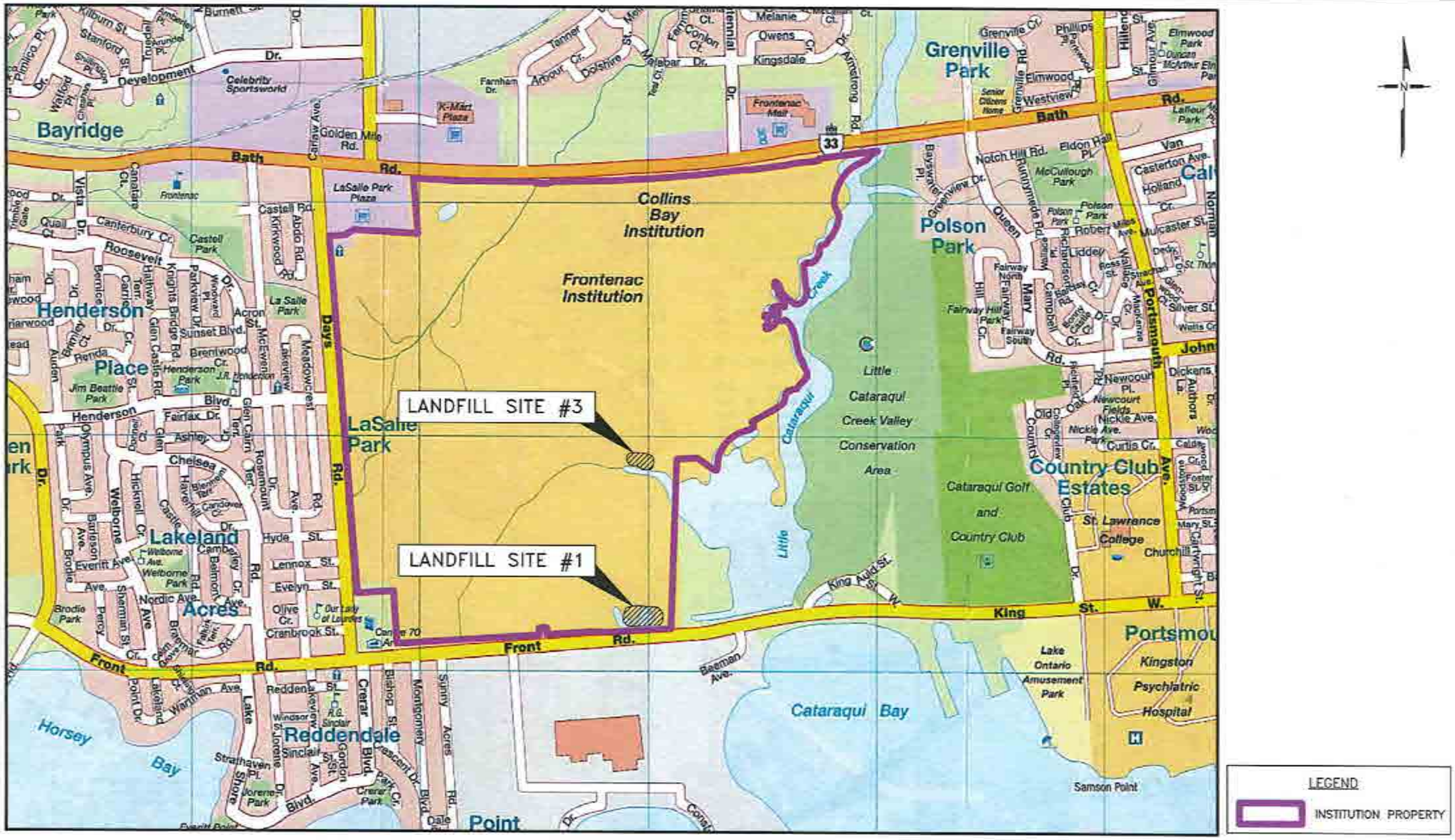
SNC Lavalin Environment, 2013. *Revised Draft, Site Specific Risk Assessment, Collins Bay Institution, Former Landfill 3 (441-L03)*. May 24, 2013.

SNC Lavalin Environment and Water, 2014. *Revised Draft, Remedial Action Plan, Collins Bay Institution Former Landfill 1 (CSC ID 441-L02) & Landfill 3 (CSC ID 441-L03), Kingston, Ontario*. April 21, 2014.

SNC Lavalin for Public Works and Government Services Canada. Specifications, Landfill Closure Works, CSC Collins Bay Institution, Landfills 1 & 3, Kingston, Ontario. R.058456.001/002. 2014-04-08.

SNC Lavalin for Public Works and Government Services Canada. Drawings, Landfill Closure Works, CSC Collins Bay Institution, Landfills 1 & 3, Kingston, Ontario. R.058456.001/002. 2014-04-08.

APPENDIX A
FIGURES



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. MAPART PUBLISHNG, KINGSTON ROAD MAP

SNC·LAVALIN

Client/Location: PWGSC CSC FRONTENAC LANDFILL 1 & 3 KINGSTON, ONTARIO		Title: SITE LOCATION	
Project No: 615406/615415	Filename: 021F01_615406	Date: MARCH 2014	Dwg No: FIGURE 1
Drawn: DM	Verified: AM	Project Manager: DD	

FILENAME: P:\PWGSC\CSC Frontenac LF's\615406\4.0 Execution\4.7 Working Versions\4.7.3 CAD_GIS\002\002F01_615406.dwg

PAGE FORMAT: 8.5x11

APPENDIX B

RECORD OF PUBLIC PARTICIPATION DETERMINATION
AND RELEVANT CORRESPONDENCES

Record of Public Participation Determination

Stage of work plan: Early planning phase of screening (pre-scoping)

Is there an indication that…	Describe potential indication and issues	Consider public participation?	
there is an existing or likely public interest in the type, location or potential effects of the project?		□ Yes	√ No
There are members of the public with a history of being involved in past proposed projects in the area?		□ Yes	√No
the project has the potential to generate conflict between environmental and social or economic values of concern to the public?		☐ Yes	√No
the project may be <u>perceived</u> as having the potential for significant adverse environmental effects? [1]		☐ Yes	√No
there is potential to learn from community ecological? knowledge or Aboriginal traditional knowledge?		□ Yes	√No
there is uncertainty about potential direct and indirect environmental effects or the significance of identified effects?		☐ Yes	√No
the project has been or will be subject to other public participation processes that would meet the objectives of the Ministerial Guideline http://www.ceaa.gc.ca/013/006/ministerial_guideline_e.htm		□ Yes	√ No
there is any other reason why public participation is or is not appropriate?		□ Yes	√No

As a result of the scan above, is public participation under CEAA appropriate in the circumstances?

□ Yes √ No

Additional comments to support determination:

---

[1] *Environmental Effect as per the definition in CEAA (2012) is*
- *Changes to the environment to components of the environment that are within the legislative authority of Parliament (fish as defined by the Fisheries Act, aquatic species under the Species at Risk Act, and migratory birds as defined in the Migratory Birds Convention Act (1994)*
- *Changes to the environment that occur on federal lands, or inter-provincially or outside of Canada.*
- *The effect of any change on health and socio-economic condition, physical and cultural heritage, use of resources for traditional purposes and structures of historical significance are limited with respect to Aboriginal peoples.*

Lee Chan

From:	MacFadden, Allison [Allison.MacFadden@snclavalin.com]
Sent:	February-26-14 2:02 PM
To:	Currie Danielle (NHQ-AC); Sue-Jin An; Dickson, Darren
Cc:	Mohammad Murtaza; Roy Dennis (ONT)
Subject:	RE: CSC- Frontenac
Attachments:	Sample SAR Descriptions.pptx; Contractor Orientation CBI and FI Final December 2012.docx; Site Access from Front Road.pdf

Hi all,

Thanks so much for those clarifications Danielle.

We will review the SAR report you provided. The 2013 risk assessments also identified several potential SAR for the area (based on NHIC search). Based on site observations however, only 1 may have actually been seen at the site to date (the Grey Fox). We're proposing an "avoidance" approach for potential SAR. Avoidance measures to be implemented during construction activities will be described in the RAP. It may be as simple as workers in supervisory positions being aware of potential SAR and having a binder on-site with photos of species and descriptions of their habitat and contact numbers of who to call if any are encountered (see attached for a sample document we prepared for another project).

I have just a few additional questions as we're working on the RAP:

- Could CSC confirm if all construction work is required to follow the same procedures as in the attached contractor H&S requirements or would the construction work follow modified procedures?
- There is an existing access gate off Front Rd in the southeast corner of Landfill 1 as well as well as an entrance approximately 300 m west of Landfill 1. Could CSC advise if we are limited to using only these access points or if it be possible to install another gate to make a temporary access point between the two existing gates? As shown in the attached map, an additional entrance might be helpful because the gate in the southeast corner opens right up to the landfill (where capping will be done). A City permit may be required to establish a temporary "private entrance" off Front Road for this gate, but a permit may also be required for the gate at the southeast corner since it doesn't appear to be a regularly used gate.
- Finally, does CSC have a site plan showing areas that are currently leased to farmers? We would like to consider avoiding these areas when selecting possible lay-down or truck turn around areas. It will also help us determine how much of the leased area may be impacted by those construction activities so that we can advise CSC.

Thanks,

Allison

Allison MacFadden, ***P. Eng.***
Project Engineer
Environment & Water

Tel.: 416-635-5882 x 55831

SNC-Lavalin Inc.

From: Currie Danielle (NHQ-AC) [mailto:Danielle.Currie@csc-scc.gc.ca]
Sent: February 26, 2014 1:01 PM
To: Sue-Jin An; Dickson, Darren; MacFadden, Allison
Cc: Mohammad Murtaza; Roy Dennis (ONT)
Subject: RE: CSC- Frontenac

Good Afternoon Sue, Allison and Darren,

CSC has done work in and around the creek before, so I can confirm that land ownership does indeed trump the wetland requirements. The province does not need to be engaged, nor do we need any permits from the Cataraqui Regional Conservation Authority (CRCA).

I have spoken to my contact at the CRCA (Tom Beaubiah) and he agreed to being involved in this project from a technical guidance perspective. He seemed overall onboard with what we are doing (the CA is familiar with the 441-L03 site), including the possibility of not backfilling the site. Obviously it is a bit difficult for him to comment on any specifics, but I told him that I will forward him the RAP once we get it. I also mentioned that we would like to involve the CRCA in the decision making process as to whether or not we should backfill the excavation.

I did discuss with him how we could follow the spirit of the permitting process without actually getting the permit or being bound by the decisions of the CRCA. He said they typically review the plans to ensure that there are no natural hazards, no negative impact on the flood plain and no interference with the wetland. I agree with Darren that most of what they want in terms of plans (e.g. erosion and runoff control) are thing we are already planning on doing. I will send him all of our plans and our Environmental Effect Evaluation to make sure that the CA has an opportunity to comment. I will also follow up with him to see if the CA has any best practices that we can work into the project.

As for SAR, I have attached a report that was done 10 years ago that describes what species were identified near the site. Tom also mentioned that we should look into the possible presence of turtles (especially snapping turtles, eastern musk turtle and northern map turtle) on/around the landfill. He mentioned that the province has some information (likely online) about these species and what mitigation measures we can put in place to protect them.

We also briefly discussed timing windows for the area, which are:

- Avoid any work in-water from March 15-July 1 (this doesn't really apply to us)
- Water in Lake Ontario (and therefore the Little Cataraqui Creek) is at its highest in mid-June and holds steady until Labour Day.
- Water is at its lowest around thanksgiving. This will likely work in our favour.
- Mid-October to April is turtle hibernating season. This may impact us.

As for DFO requirements, it seems the new Fisheries Act eliminates the relationship between DFO and CAs, so the CRCA is not able to provide us much help on that front. I have spoken to both DFO Expert Support (Jody Willis) and DFO Permitting (Tracy Allison) and it seems like, based on their new system of "self-assessment", we are not required to get a permit from them for this work. This is because the majority of the work will occur above the high-water mark, the site is poor/not fish habitat (and therefore it is unlikely that there will be any harm to fish or fish habitat), and the work we are doing will actually have a net benefit on the wetland. As well, any backfilling we are doing isn't really considered infilling as the area fish habitat to begin with (as it is above the high-water mark). Obviously we will still need to put in place all the mitigation measures to ensure that we don't have a Fisheries Act violation, but it seems like we don't need to apply for a Fisheries Act permit. I am working on figuring out how we can officially document our "self assessment" and I will let you know shortly how to proceed. Because this proposed option is much more in DFO's territory than the original option of capping the landfill, and because the CRCA no longer provides services on behalf of DFO, I am going to pass the RAP through DFO-Expert Support to make sure they have no major problems with our project.

I hope this provides some clarification. Please let me know if there is anything else that needs clarification.

Danielle

Danielle Currie
Junior Environmental Officer| Agente junior de l'environnement
Environmental Protection Programs | Programmes de la protection de l'environnement
Technical Services, NHQ | Services techniques, AC
Correctional Service Canada | Service Correctionnel Canada
340 Laurier Avenue West | 340 avenue Laurier ouest
Ottawa, Ontario K1A 0P9
Tel. | Tél. : (613) 995-0256
E-mail | Courriel : Danielle.Currie@csc-scc.gc.ca

From: Sue-Jin An [mailto:Sue-Jin.An@pwgsc-tpsgc.gc.ca]
Sent: Tuesday, February 25, 2014 6:02 PM
To: 'Dickson, Darren'
Cc: 'MacFadden, Allison'; Mohammad Murtaza; Currie Danielle (NHQ-AC)
Subject: RE: CSC- Frontenac

Thanks for the email, Darren.

Sorry, I was away from the office for a few days, I didn't remember our consultant's name properly...!!

WRT not requiring a permit/plan... I do recall that we discussed this over the phone. I recently went online and saw that they had a planning/permitting process for works near provincially significant wetlands. But in our case, does the land ownership status trump the wetland requirements? Does that mean the province need not be engaged? Danielle was planning to touch base with the CA on leaving the depression at Landfill 3, with that in mind, I thought it would be an opportunity to resolve many of these questions.

The SAR section in the RA did identify some species which were recorded by NHIC to be in the area (according to the Landfill 3 RA). However, it is possible the information is rather old or prone to inaccuracies... As you've said, the BMPs, scheduling of works, and monitoring would address most of the likely mitigation requirements. However, the CA may have more update to date and site specific information, as well as guidance on mitigation measures. They can also advise you on your question regarding the preferred seeding mix as well.

WRT the fisheries act requirements, the site may be considered a poor habitat and with the changes to the regs, I'm not certain on the process that would need to be followed. Don't they need to be engaged to make this determination? I've seen CA's process to include triggers for DFO and province involvement, but again without having reviewed this CA's administrative controls in place, I can't be sure.

These are some of the questions that I had. Just want to minimize any last minute surprises... ☺

Darren, Allison, and Danielle, please let me know your thoughts. ☺

Thank you.
Sue
PWGSC, 416-512-5287

From: Dickson, Darren [mailto:Darren.Dickson@snclavalin.com]
Sent: February-25-14 4:45 PM
To: Sue-Jin An; Currie Danielle (NHQ-AC); MacFadden, Allison

Cc: Mohammad Murtaza
Subject: RE: CSC- Frontenac

Hi Sue,

As per your first paragraph Allison confirmed with the CA (without identifying the site specifically) that if you are completing all of the work on CSC property you don't need permits from them.

I think more importantly would be to get their input (if not approval) regarding whether any imported soil for any over-excavated area would be required or even desirable, and secondly to see if they have a recommended/preferred seeding mix for reinstating areas that have had work near the wetland...

In my experience obtaining the CA approvals relates to preparing adequate monitoring and mitigation plans (sediment, reinstatement) coupled with using practices designed to minimize impacts in the first place. We intend to do this regardless. The other issue relates to timing of the works such that it will have limited to no impact on SAR, high quality breeding/spawning areas (during breeding/spawning seasons), or migration. As we have generally determined that this is low quality habitat (ephemerally wet and more likely to be dryish during the work period) and it was indicated that we don't have SAR in the area, we are likely okay here too...

Allison, anything I've missed?

Darren Dickson, ***M.A.Sc., P.Eng.***
Group Leader
Environment & Water

Hamilton Area Office: 905.332.5338

SNC-Lavalin Inc.

From: Sue-Jin An [mailto:Sue-Jin.An@pwgsc-tpsgc.gc.ca]
Sent: February 25, 2014 3:49 PM
To: Currie Danielle (NHQ-AC); MacFadden, Allison; Dickson, Darren
Cc: Mohammad Murtaza
Subject: RE: CSC- Frontenac

Hello,

Since the entire area is owned by CSC, the group consensus I had heard over the phone was that no environmental provincial permits would be required in this case. However, since the work is being undertaken very close to and possibly in the provincially significant wetlands, shouldn't we consider the requirements set up by the CA for working in this area?

Danielle, you mentioned contacting the CA for their information. I think it would be advisable to touch base with them to identify and understand their process and requirement, even if we may not be required to file a permit. That way, we'd be able to follow the Best Management Practices, and processes that CA would recommend. We feel it would be advisable to abide by the spirit of the process at least...

What are your thoughts on this? Allison and Darryl?

Thank you.

Sue

From: Sue-Jin An [mailto:Sue-Jin.An@pwgsc-tpsgc.gc.ca]
Sent: February 13, 2014 12:20 PM
To: MacFadden, Allison; Dickson, Darren
Cc: 'Currie Danielle (NHQ-AC)'; Mohammad Murtaza
Subject: CSC- Frontenac

Allison and Darren,

It looks like Excavation from LF3 and disposal at LF1 seems to be preferred option under the best/refined case scenario. However, considering the construction is planned to start in September, and we find out mid-construction, there is deeper waste, or weather has not been cooperating, could you please identify where at the construction stage we can cut off (sort of like a mini-milestone) for the construction work for that year? Just in case the work runs to the next year (and this would bring the cost over the 765K easily), could you please identify where we can cut off the work safely for that year without creating a big mess for us to clean up and re-work the year after... Could you please provide this detail in the table for CSC?
This risk is minimized if we undertake each landfill construction individually.

Thank you for the call today.

Regards,
Sue-Jin

Sue-Jin An, P.Eng.
Senior Environmental Specialist
Environmental Services | Services de l'environnement
Public Works and Government Services Canada - Ontario Region | Travaux publics et Services gouvernementaux Canada - Région de l'Ontario
4900 Yonge St., Toronto ON M2N 6A6 | 4900, rue Yonge, Toronto ON M2N 6A6
Sue-Jin.An@pwgsc-tpsgc.gc.ca
Telephone | Téléphone 416-512-5287
Facsimile | Télécopieur 416-590-8284
Government of Canada | Gouvernement du Canada

Lee Chan

From:	Lee Chan
Sent:	May-16-14 10:36 AM
To:	Suzanne LaPerrière
Subject:	FYI only: Frontenac LFs 1 and 3 - EEE draft report questions, response from A McFadden of SNC Lavalin
Categories:	Frontenac 3E

Hi Suzanne;

FYI only. SNC has responded to my technical inquiries.

Please feel free to delete.

Thanks,

Lee Chan
Environmental Specialist | Spécialiste en environnement
Environmental Services | Services de l'environnement

From: MacFadden, Allison [mailto:Allison.MacFadden@snclavalin.com]
Sent: May-15-14 5:02 PM
To: Currie Danielle (NHQ-AC); Sue-Jin An
Cc: Lee Chan; Martin Bouwma; Mohammad Murtaza; Dickson, Darren
Subject: RE: Frontenac LFs 1 and 3 - EEE draft report questions

Hi all,

I have indicated responses below in **red.**

Allison

Allison MacFadden, ***P. Eng.***
Project Engineer
Environment & Water

Tel.: 416-635-5882 x 55831

SNC-Lavalin Inc.

From: Currie Danielle (NHQ-AC) [mailto:Danielle.Currie@csc-scc.gc.ca]
Sent: May 14, 2014 9:24 AM
To: Sue-Jin An
Cc: Lee Chan; Martin Bouwma; MacFadden, Allison; Mohammad Murtaza
Subject: RE: Frontenac LFs 1 and 3 - EEE draft report questions

Hello Sue-Jin,

To my knowledge, there is no aboriginal interests in this property.

Danielle

Danielle Currie
Environmental Protection Programs | Programmes de la protection de l'environnement
Correctional Service Canada | Service Correctionnel Canada
Tel. | Tél. : (613) 995-0256

From: Sue-Jin An [mailto:Sue-Jin.An@pwgsc-tpsgc.gc.ca]
Sent: Tuesday, May 13, 2014 5:25 PM
To: 'MacFadden, Allison'; Currie Danielle (NHQ-AC); Mohammad Murtaza; Lee Chan; Martin Bouwma
Subject: RE: Frontenac LFs 1 and 3 - EEE draft report questions

Folks,
We're in the process of completing the Environment Effects Evaluation, and have the following questions for SNC and CSC. (Lee, I have one question for you below which would help us answer the question you've posed)
I've started on some of the answers already and I would like your input to complete the response. Could you please take a moment to address the questions below?

Thank you, folks!

Sue
PWGSC, 416-512-5287

From: Lee Chan
Sent: May-13-14 4:45 PM
To: Sue-Jin An
Subject: Frontenac LFs 1 and 3 - EEE draft report questions

Hi Sue;

As mentioned earlier, below are some questions that I hope would help make a good report for your requirements:

- Is Danielle Currie the CSC PM? Or should it be Corinna? ***Danielle Currie is the PM.***
- Would the topsoil be stockpiled on or near the site before application over for LF1 or would it be transported in as needed and immediately laid over LF1 and within the LF3 excavation? ***We will likely be stockpiling topsoil. Do we have an idea of where they will be stockpiled, SNC? Options for stockpiling of topsoil would be 1. the laydown area, 2. the area immediately north of Landfill 1, or 3. the area immediately north of Landfill 3. These areas are currently not used by the farmer leasing the property. Only topsoil removed for the construction of temporary facilities (road and law down areas) can be reused, so there is an expectation that topsoil to backfill at Landfill 3 (only where needed) and to use in the cover at Landfill 1 will all need to imported from off-site sources. The imported topsoil may also be temporarily stockpiled in the areas noted above.***
- Would the SAR assessment report (2013) by Danielle be handy? (Sorry I did not see it attached in Allison's e-mail in your S drive). I would like to review it. Also there is another SAR assessment done by Kingston Field Naturalists (2004). Could this please be forwarded as well? ***There is no SAR assessment report which was generated in 2013. The 2013 report that Allison is referring in the email is the site specific risk assessment report (2013). The site specific risk assessment reports***

(for LF1 and LF3) are available in the share drive. 2004 KFN report has been uploaded to the share drive and is now in the same folder for your review.

- What exactly is physically involved in the establishment of the lay down area and access road improvements? Would any vegetated areas be potentially cleared? I'm trying to determine potential interaction with the nearby wetlands, etc. ***There will likely be some vegetation and topsoil removal for access road improvements, establishing lay down areas, and etc.. The stripped stockpiled topsoil will be used for later restoration of the areas. There would likely be some granular material placement and grading to improve and maintain the haul road. There may be(?) some grading of the temporary laydown area if needed (yes, we anticipate some build up of the grade to allow road/site entrance to meet elevation of Front Road). There will also be decommissioning of wells on LF1 and LF3. There will likely be some fence removal as well. + Tree removal (in the footprints of Landfills 1&3) Please add any further detail I may have missed. Drawing C-03 shows the temporary truck access turning area, and construction laydown area as well. What about the pull over lanes, what are the anticipated prep work required for the pull over lanes? Pull over lanes will widen the road in a few areas (closer to the south end of the road through since the north end is elevated above surrounding areas and would require too much fill). Following the site visit in April, we determined that the truck turning area where proposed was not feasible since there is a steep drop-off the side of the road to the west. A truck turning area will be relocated a little further north (in the area north of Landfill 3) and could require only a little imported fill to level out the area.***
- Would the silt fencing be placed only on the sides of the LFs that face the wetlands or would these fully encompass the LFs? ***Silt fencing is planned on the side that faces the wetlands in LF3. There is also silt fencing planned for LF1 as well. You can see the silt fencing configurations on Drawing C-03 in the 50% design. Also, the rows of silt fencing at Landfill 3 are going to move out a little further into the wetland (about 5 -10 m) in the next drawing submission (99% complete) to allow for removal of some surface debris in the wetland right at the edges of the landfill.***
- During the excavation of LF3, this would be executed in such a way that a temporary berm would be established between the LF's excavation and the adjacent wetland. Is this in addition to the silt fencing that would be in place? ***Yes.(SNC please confirm) Yes the berm is the material that is the at the furthest east and south edges of the excavation and it is the last material to be removed. The silt fencing will be situated about 5-10 m beyond this berm.***
- One measure to avoid incidental intrusion of certain SAR into the project area is the use of fencing (eg. silt fencing). Is this a feasible measure from this project's perspective? ***Partial silt fencing is already planned for LF1 and LF3. Based on current information about potential SAR, additional controls are not anticipated but they would be considered and implemented as instructed by our SAR specialist if any SAR are observed., Lee: to avoid incidental intrusion, does it require complete fencing around the construction sites?***
- We should confirm with CSC that there is definitely no aboriginal interests on this property (just to be sure). ***I will inquire with CSC. Danielle, could you please respond?***

I am available to discuss or the comments can simply be added in an e-reply.

Very much appreciate any input.

Thank you and best regards,

Lee Chan
Environmental Specialist | Spécialiste en environnement
Environmental Services | Services de l'environnement

APPENDIX C
FEDERAL COORDINATION CORRESPONDENCES

Fisheries and Oceans Canada
Pêches et Océans Canada

Central and Arctic Region
501 University Crescent
Winnipeg, Manitoba
R3T 2N6

Region du Centré et de l 'Artique
501 University Crescent
Winnipeg, Manitoba
R3T 2N6

Your file *Votre référence*

Our file *Notre référence* 12-HCAA-CA4-01638

Sent Via Email

April 5, 2014

Danielle Currie
Environmental Officer
Correctional Service Canada
340 Laurier Avenue West
Ottawa, Ontario K1A 0P9

Dear Ms. Currie,

Subject: Fisheries and Oceans Canada Review of the Draft Report titled "Remedial Action Plan, Frontenac Institution Former Landfill 1 (CSC ID 441-L02) & Landfill 3 (CSC ID 441-L03) Kingston, Ontario" (March 2014).

In response to a request from Correctional Services Canada received March 10, 2014, attached is a summary of Fisheries and Oceans Canada (DFO) Federal Contaminated Sites Action Plan (FCSAP) Expert Support review of the Draft Report titled "Remedial Action Plan, Frontenac Institution Former Landfill 1 (CSC ID 441-L02) & Landfill 3 (CSC ID 441-L03) Kingston, Ontario," dated March 7, 2014, by SNS Lavalin Inc.. The review was completed as part of our role as an Expert Support under the Federal Contaminated Sites Action Plan program (FCSAP). Please find our comments attached.

If you have any questions, please contact Tara Bortoluzzi at our Winnipeg office at 204-983-8908 by fax at 204-984-2404 or by email at Tara.Bortoluzzi@dfo-mpo.gc.ca.

Yours Sincerely,

T Bortoluzzi

Tara Bortoluzzi, Ph.D.
Fisheries Biologist
FCSAP Expert Support

Cc: Maria Petrou, Environment Canada

Canada

FCSAP DFO Expert Support Review of CSC Remedial Action Plan, Frontenac Institution Former Landfill 1 (CSC ID 441-L02) & Landfill 3 (CSC ID 441-L03) Kingston, Ontario. Draft

Site: Frontenac Institution Kingston, ON

Report title: "Remedial Action Plan, Frontenac Institution Former Landfill 1 (CSC ID 441-L02) & Landfill 3 (CSC ID 441-L03) Kingston, Ontario" (March 2014). Draft

Date reviewed: April 3, 2014

Reviewed by: Jody Willis and Tara Bortoluzzi, Expert Support, DFO

DFO Expert Support was invited to provide feedback on the chosen remedial option for Landfill 3. DFO Expert Support did not have an opportunity to comment on the previous primary phase of assessment and therefore were not able to provide up front input to the custodian on the ecological risk assessment where DFO interests and concerns regarding risk to fish and fish habitat are considered relevant to the planning of the remediation and risk management measures.

At this stage, DFO Expert Support advice is limited to providing information regarding best practices and management options for the chosen remedial action so that risks to fish and fish habitat are eliminated or minimized and ensuring that the choosen remedial actions are consistent with federal environmental policies and management objectives.

Executive Summary

The purpose of a Remedial Action Plan (RAP) is to outline the plan to bring about the restoration or clean-up of a site. Soil brought in as fill is intended to meet the MOE Table 3 Generic Site Condition Standards in a Non-Potable Groundwater Condition (O. Reg. 153/04, as amended) for a parkland property. Contaminants were found at levels higher than criteria at the borehole/monitoring wells on the southern boundary of landfill 3 and may therefor constitute a continuing source. Please determine the applicability of using the O. Reg. 153/04 soil standards at this specific site. Please consider the use of Table 9. Generic Site Condition Standards for Use within 30 m of a Water Body in a Non-Potable Groundwater Condition to account for the proximity of landfill 3 to the Little Cateraqui Creek. DFO supports the Cateraqui Region Conservation Authority interest in having all contaminated materials removed, followed by wetland renaturalization. Should this option be pursued please ensure that measures to avoid causing harm to fish and fish habitat, http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html, are incorporated into the remedial action plan.

The executive summary specifies that construction activities associated with the removal of contaminated soils and backfill with clean soils will take approximately 5 weeks to complete. From a fisheries protection perspective, it would be beneficial to initiate this work outside of the fisheries timing windows due to the potential for barrier breach and high waters. Please refer to the following link and give consideration to the Southern Region Restricted Activity timing windows http://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/on-eng.html.

2.1 Regulating Authorities

The RAP report states that "a permit from the Department of Fisheries and Oceans (DFO) is likely not required since the majority of the work will occur above the high-water mark and is unlikely to result in harm to fish or fish habitat…." It is suggested that to increase the confidence in the custodian's decision, a record of the Fisheries Protection Program self-assessment exercise found here http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html, is attached as an addendum to document decision points.

2.2.1 Soil Restoration Criteria

Please specify which aquatic receptors were included in the Ecological Risk Assessment (ERA) at Landfill 3. Please describe the evaluation method used to determine that remediation activities within the contaminated marsh areas would result in unacceptable significant negative impacts to the aquatic receptors and habitat.

It is recommended that in the event that the excavated area at Landfill 3 is not backfilled with clean soil "(potentially at the request of the CSC and/or Cateraqui Region Conservation Area to allow the excavated area to develop as additional wetland area)", confirmatory soil samples should be collected to the vertical and horizontal extents of the contaminated soils prior to renaturalization as wetland.

2.2.2 Groundwater Restoration Criteria

Please provide the rationale for why groundwater restoration criteria are not required for Landfill 3.

2.5 Environmental Protection

The RAP suggests that a site-specific Environmental Protection Plan (EPP) will be prepared prior to commencement of works. The option of renaturalizing the landfill 3 area to wetland involves the removal of contaminated soils to the waters edge. DFO supports this initiative however is concerned with the potential impacts to fish and fish habitat associated with excavation in areas where fine sediments are encountered and enter into the water column. The suspended material can aggravate the gills of fish and smother fish eggs and fish habitat, as they move through the water column. The regional DFO Species at Risk Coordinator has confirmed that the Little Cataraqui Creek area is under consideration for listing related to the American Eel. This information increases the sensitivity rating of the potential receptors.

Please ensure that the measures to avoid causing harm to fish and fish habitat, http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html, are incorporated into the remedial action plan. Specifically:

- To protect local fish populations during their spawning and nursery periods, all in-water work should occur at times specified by the Ontario Ministry of Natural Resources http://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/on-eng.html.
- The excavation work should be staged so that the landfill soils within the boundaries roughly outlined in Figures 4, 6 and 7 are excavated first, leaving a land plug or isolation measures in tact up to the waters edge, separating the waters of Little Cateraqui Creek from the first stage of the excavation area.
    - If the isolated excavated area has to be de-watered, water being pumped out should be tested against criteria and if suitable for discharge, diverted away from the creek to a vegetated area and/or through additional filtering structures. The silt/clay laden water should be pumped far enough away from the water so that there is adequate time and distance to filter the water. Water entering the creek should be free of silt or other deleterious materials.
    - The isolation measures at the waters' edge should be left in place until the land plug is excavated and the exposed areas stabilized.
    - If isolation measures are non-permeable, care should be taken to ensure water levels on the freshly excavated side are equal to those of Little Cateraqui Creek prior to removal.

DFO concurs with the intent to dispose of water not meeting discharge criteria off-site as outlined in the RAP.

Please note that silt fencing with nylon mesh netting reinforcing the regular, woven plastic strand material has been known to entangle large-bodied snakes and should be avoided if these animals are suspected to occur in the area.

Thank you for the opportunity to review the RAP for the Frontenac Institution Former Landfill 3 (CSC ID 441-L03) in Kingston, Ontario. DFO Expert Support input is provided to help in ensuring remedial actions will not be detrimental to fisheries resources and to ensure that endpoints are established to determine success of remedial actions.

References:

Ontario Ministry of the Environment (OMOE). 2011. Rational for the Development of Soil and Ground Water Standards for use at Contaminated Sites in Ontario, April 15, 2011, PIBS 7386c01.

Fisheries and Oceans Canada, Measures to Avoid Causing Harm to Fish and Fish Habitat, http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html.

APPENDIX D
DEFINITIONS AND METHODOLOGIES

Environment (defined in *S.2(1)*) – the components of the Earth, and includes land, water and air, including all layers of the atmosphere; and all organic and inorganic matter and living organisms (and the interacting natural systems of those).

Environmental Effects (defined in *S.5(1)* – 5.(1) For the purposes of this Act, the environmental effects that are to be taken into account in relation to an act or thing, a physical activity, a designated project or a project are

(a) a change that may be caused to the following components of the environment that are within the legislative authority of Parliament:

(i) fish as defined in section 2 of the Fisheries Act and fish habitat as defined in subsection 34(1) of that Act,
(ii) aquatic species as defined in subsection 2(1) of the Species at Risk Act,
(iii) migratory birds as defined in subsection 2(1) of the Migratory Birds Convention Act, 1994, and
(iv) any other component of the environment that is set out in Schedule 2;

(b) a change that may be caused to the environment that would occur:
(i) on federal lands,
(ii) in a province other than the one in which the act or thing is done or where the physical activity, the designated project or the project is being carried out, or
(iii) outside Canada; and
(c) with respect to aboriginal peoples, an effect occurring in Canada of any change that may be caused to the environment on
(i) health and socio-economic conditions,
(ii) physical and cultural heritage,
(iii) the current use of lands and resources for traditional purposes, or
(iv) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

(2) However, if the carrying out of the physical activity, the designated project or the project requires a federal authority to exercise a power or perform a duty or function conferred on it under any Act of Parliament other than this Act, the following environmental effects are also to be taken into account:
(a) a change, other than those referred to in paragraphs (1)(a) and (b), that may be caused to the environment and that is directly linked or necessarily incidental to a federal authority's exercise of a power or performance of a duty or function that would permit the carrying out, in whole or in part, of the physical activity, the designated project or the project; and
(b) an effect, other than those referred to in paragraph (1)(c), of any change referred to in paragraph (a) on
(i) health and socio-economic conditions,
(ii) physical and cultural heritage, or
(iii) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

Schedule 2 (3) The Governor in Council may, by order, amend Schedule 2 to add or remove a component of the environment.

Federal Authority (defined in *S.2(1)*) – a Minister of the Crown in right of Canada; an agency of the Government of Canada or a parent Crown corporation, as defined in subsection 83(1) of the *Financial Administration Act (FAA);* or any department or departmental corporation that is set out in Schedule I or II to the FAA.

Federal lands (defined in *S.2(1)*) – defined as follows:

- lands that belong to Her Majesty in right of Canada, or that Canada has power to dispose of, and all waters on and airspace above those lands, other than lands under the administration and control of the Commissioner of Yukon, the Northwest Territories or Nunavut;
- the internal waters of Canada, in any area of the sea not within a province;
- the territorial sea of Canada in any area of the sea not within a province;
- the exclusive economic zone of Canada, and the continental shelf of Canada; and
- reserves, surrendered lands and any other lands that are set apart for the use and benefit of a band and that are subject to the *Indian Act*, and all waters on and airspace above those reserves or lands.

Mitigation measures (defined in *S. 2(1)*) – measures for the elimination, reduction or control of the adverse environmental effects of a designated project, and includes restitution for any damage to the environment cause by those effects through replacement, restoration, compensation or any other means.

Project (defined in *S. 66*) – a physical activity that is carried out in relation to a physical work and is not a designated project.

Valued Ecosystem Component (defined on Agency - www.ceaa.gc.ca/default.asp?lang=En&n=B7CA71391&offset=3#v) - The environmental element of an ecosystem that is identified as having scientific, social, cultural, economic, historical, archaeological or aesthetic importance.

The value of an ecosystem component may be determined on the basis of cultural ideals or scientific concern. Valued ecosystem components that have the potential to interact with project components should be included in the assessment of environmental effects.

Methodology

The environmental effects evaluation methodology used in this report focuses the evaluation on those environmental components of greatest concern. The Valued Ecological Components (VECs) most likely to be affected by the project as described are indicated in **Table 1.** VECs were selected based on ecological importance to the existing environment (above), the relative sensitivity of environmental components to project influences and their relative social, cultural or economic importance. The potential impacts resulting from these interactions are described below.

Evaluation of Environmental Effects

The VECs selected in Table 1 are addressed in Tables 2.1 through 2.16* in the EEE. The residual effects of the project on the environment are defined. Similarly, the physical works/activities and required mitigation measures are detailed and the significance of residual (post-mitigation) effects is estimated.

The following ratings are based on:

- **information provided by the proponent;**
- **a review of project related activities;**
- **an appraisal of the environmental setting, and identification of resources at risk;**
- **the identification of potential impacts within the temporal and spatial bounds; and**
- **personal knowledge and professional judgment of the assessor.**

The significance of project related impacts was determined in consideration of their frequency, the duration and geographical extent of the effects, magnitude relative to natural or background levels, and whether the effects are reversible or are positive or negative in nature. These criteria are indicated in Table 2.

Table 3. Assessment Criteria for Determination of Significance.

Magnitude	Magnitude, in general terms, may vary among Issues, but is a factor that accounts for size, intensity, concentration, importance, volume and social or monetary value. It is rated as compared with background conditions, protective standards or normal variability.	
	Small	Relative to natural or background levels
	Moderate	Relative to natural or background levels
	Large	Relative to natural or background levels
Reversibility	Reversible	Effect can be reversed
	Irreversible	Effects are permanent
Geographic Extent	Immediate	Confined to project site
	Local	Effects beyond immediate project site but not regional in scale
	Regional	Effects on a wide scale
Duration	Short Term	Between 0 and 6 months in duration
	Medium Term	Between 6 months and 2 years
	Long Term	Beyond 2 years
Frequency	Once	Occurs only once
	Intermittent	Occurs occasionally at irregular intervals
	Continuous	Occurs on a regular basis and regular intervals

APPENDIX E

MITIGATION TABLE

Valued Ecosystem Component	Environmental Mitigation Measure	Implementation Schedule/Date	Person/Title/ Firm Responsible	Compliance (Task Complete – Yes or No/Date) If No, provide reason
Fish	• Maintain adequate separation distances between equipment and watercourses or wetlands. Minimize operational footprint as much as practical or change location of temporary workspaces. Parking areas, temporary workspaces lay-down areas are not be located within 10 metres of the high water mark of wetlands or watercourses. • Erosion control measures (ie. silt fencing, etc.) must be undertaken to prevent the inadvertent release of any debris, waste, or fill material into the adjacent aquatic environments. Erosion control measures are to remain in place until vegetation is re-established and/or all exposed soils (that have been placed over LF1) are stabilized. Work must be scheduled to avoid periods of heavy precipitation. • If any such entry occurs, the material must be removed immediately and managed appropriately. • Ensure that vehicles and machinery do not operate between the LFs and the wetland or ford over water bodies during construction. • The exposed soil area must be minimized by limiting the area that is exposed at one time and by limiting the time that any one area is exposed. All stockpiled materials must be covered and/or dyked to prevent erosion and release of sediment laden water. Exposed soil should be hydro seeded or sodded to ensure soil stabilization as the final step of remediation for this project. • Machinery must be checked for leakage of lubricants or fuel and must be in good working order. Refueling must be done at least 30 m from any water body and on an impermeable surface. Basic petroleum spill clean-up equipment must be on-site. All spills or leaks must be promptly contained, cleaned up and reported to the 24-hour environmental emergencies reporting system (1-800-268-6060). • Excavation to be executed to establish a berm at the water's edge effectively separating Little Cataraqui Creek from the initial stage of the excavated area. In the event excavated area must be de-watered, test diverted water against applicable criteria for suitability for discharge. Discharge away from the Creek onto a vegetated area. Any water entering the Creek is to be free of silt or other deleterious materials. Ensure water levels within excavation are reduced relative to that of the Creek in order to avoid sudden influx of water into the Creek upon removal of berms. • Project will not occur within a water body however it is to be conducted outside of spring spawning season which is generally between March to			

Valued Ecosystem Component	Environmental Mitigation Measure	Implementation Schedule/Date	Person/Title/ Firm Responsible	Compliance (Task Complete – Yes or No/Date) If No, provide reason
	August for fish species previously identified in the Creek. • Surface water drainages and contours must be retained or re-established post-construction.			
SAR and non-SAR Wildlife	• Distribute color photos and descriptions of SAR that has occurred in the region and may potentially occur during the project to the contractor and workers. Instruct all parties involved in project to stop work if a SAR or other wildlife species is encountered within project area. Upon an encounter, record location using Global Positioning System (GPS) and photograph. Contact PWGSC representative. • All detected animals including birds shall be allowed to passively disperse from roads and work areas. • Vehicle movements to be restricted to construction areas and access roads to avoid inadvertent harassment of wildlife. • Barriers such as fencing shall be installed around excavations and other hazards where appropriate to prevent intrusion of wildlife into work areas.			
Migratory Birds	• Conduct remedial activities outside of migratory bird breeding period (between May 1 – August 1). • If work is not conducted outside of this window, a biologist should confirm presence or absence of nests in the areas of laydown, LFs and other areas anticipated to be disturbed by construction activities. Prior to staging and/or construction activities. If nests are detected work will have to cease within a reasonable radius buffer of the nest.			
Health and Socio-economics	• Remediation activities must be conducted by qualified contractor to meet applicable health and safety regulations. • Workers who may come in contact with hazards must be provided with and use appropriate personal protective equipment. • Site access must be restricted to authorized workers only. • Dust suppression measures must be applied to prevent fugitive dust. Suspected ACM-containing roofing materials should be kept wet to avoid fibre release into the air during remediation. • Upon any unexpected health and safety issue, hazard or condition, work shall cease immediately and a departmental representative immediately advised. • Heavy equipment shall be well maintained and use adequate mufflers.			

Valued Ecosystem Component	Environmental Mitigation Measure	Implementation Schedule/Date	Person/Title/ Firm Responsible	Compliance (Task Complete – Yes or No/Date) If No, provide reason
	Activities emitting excessive noise shall be restricted to daytime operations and shall adhere to municipal noise by-laws. Daily work schedules to be altered or restricted to minimize noise complaints as needed. • Completion of remedial activities should not be delayed unnecessarily so as to minimize period of unaesthetic construction sites. • Remedial activities are not to encroach on adjacent farms in which crops are actively being raised.			
Water	• A liner should be placed at any temporary storage site prior to placement of waste and/or contaminated soil. • Deleterious substances (wastes, soil, granular or other construction-related materials) shall be prevented from entering nearby water systems. Rubbish and waste materials are not to be buried on-site. Waste or volatile materials, such as mineral spirits, oil or paint thinner are not to be disposed onto the ground or watercourses. Waste materials are to be disposed off-site in accordance with Ontario Regulations 347, General Waste Management to Ministry of Environment-approved disposal facilities. • Machinery must be checked for leakage of lubricants or fuel and must be in good working order. Refueling must be done at least 30 m from any water body and on an impermeable surface. Basic petroleum spill clean-up equipment must be on-site. All spills or leaks must be promptly contained, cleaned up and reported to the 24-hour environmental emergencies reporting system (1-800-268-6060).			
Soil (Surface and Sub-surface) Quality	• Contaminated soil originating from LF3 that must be stored at any time during construction period, must be stored for the shortest time possible, covered, and/or deposited into LF1 as soon as possible. • All contaminated soil placed in LF1 must be capped with clean fill and hydro seeded to allow vegetation to establish to ensure there is no access to contaminated soil. • Work must be scheduled to avoid periods of heavy precipitation. Erosion control structures (ie. temporary matting, geotextile filter fabric, etc.) are to be used, as appropriate, to prevent erosion and release of sediments and/or sediment laden water during the construction phase. These structures are to be left in place until vegetation is re-established and/or all exposed soils are stabilized. • The exposed soil area must be minimized by limiting the area that is exposed at one time and by limiting the time that any one area is			

Valued Ecosystem Component	Environmental Mitigation Measure	Implementation Schedule/Date	Person/Title/ Firm Responsible	Compliance (Task Complete – Yes or No/Date) If No, provide reason
	exposed. During construction period, all stockpiled soil must be covered and/or dyked to prevent erosion and release of sediment laden water. During restoration after completion of the project, exposed soil is to be replanted or sodded to ensure soil stabilization. This includes areas where trees have been removed and where no replacement trees are planned. • Trees in the project area that are to remain will be identified and specific protection barriers will be installed where required prior to construction. • Machinery must be checked for leakage of lubricants or fuel and must be in good working order. Refueling must be done at least 30 m from any water body and on an impermeable surface. Basic petroleum spill clean-up equipment must be on-site. All spills or leaks must be promptly contained, cleaned up and reported to the 24-hour environmental emergencies reporting system (1-800-268-6060).			

NOTES: ____

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Environmental Assessment Mitigation Monitoring Report Form Completed By:

Name: ____ Title: ____

Company: ____ Phone No.: ____

Signature: ____ Date: ____

PAVEMENT INVESTIGATION

Haul Road Assessment
Collins Bay Penitentiary Lane
Kingston, Ontario

O/FILE : 14-2150-03

June 20, 2014

Revised:July 24, 2014

Distribution :
Ms. Allison MacFadden, P.Eng. – SNC-Lavalin Inc. 1 copy PDF

SNC • LAVALIN

Public Works and Government Services Canada and Correctional Services Canada c/o
SNC-Lavalin Inc.
20 DeBoers Drive, Suite 200
Burlington, ON L7L 5H4

Pavement Investigation Report

Haul Road Assessment
Collins Bay Penitentiary Lane
Kingston, Ontario

LICENSED PROFESSIONAL ENGINEER
7/25/14
V. AURILIO
PROVINCE OF ONTARIO

Dylan Hill, B.Eng., E.I.T.
Geotechnical Project Coordinator
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Manager, Pavement Engineering Services
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O/File : 14-2150-03
Date : June 20, 2014
Revised: July 24, 2014

Distribution :
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LIST OF APPENDICES

Note 1: This report contains 14 pages and 9 appendices.

1.0 INTRODUCTION

*DBA Engineering Ltd. (*DBA*)* was retained by SNC-Lavalin Inc. (Client) on behalf of Public Works and Government Services Canada (PWGSC) and Correctional Services Canada (CSC) to carry out a pavement investigation for the proposed material haul road to be located on a portion of Collins Bay Penitentiary Lane, in Kingston, Ontario (Site).

The objectives of this assessment are:

- To secure soil information/data (obtained from test pit locations) about the site that could affect the design and performance of the proposed haul road; and
- To prepare a pavement assessment report addressing recommendations for any improvements to the existing roadway to accommodate traffic for the proposed project.

The report is prepared with the condition that all designs are in accordance with applicable standards and codes, regulations of authorities having jurisdiction, and good engineering practice. Further, the recommendations and opinions in this report are applicable only to the proposed project.

On-going liaison with *DBA* during the final design and construction phase of the project is recommended to ensure that the recommendations in this report are applicable and/or correctly interpreted and implemented. Also, any queries concerning the pavement aspects of the proposed project should be directed to *DBA* for further elaboration and/or clarification.

This report has been prepared solely and exclusively for the Client for the purpose mentioned above and it is subject to the limitations stated in Appendix 1. All changes to the proposed project should be submitted to *DBA* to ensure the pertinence of the recommendations. It must also be noted that the scope of this mandate was solely limited to geotechnical investigation and did not include the environmental aspects of the soils.

Contractors and others involved in the construction of this project are advised to make an independent assessment of the subsoil and groundwater conditions for the purpose of establishing quantities, schedules, and construction techniques. The contractor is responsible for the field operations including the work schedule and the equipment selection. DBA cannot be held responsible for faulty work and poor equipment selection and unexpected work resulting from poorly understood soil conditions.

2.0 PROJECT AND SITE DESCRIPTION

We understand that the proposed project consists of the removal of approximately 32,000m^3 of waste from a landfill site located south of Collins Bay and Frontenac Institutions, on Collins Bay Penitentiary Road, and transporting this material to another landfill location located approximately 600m to the south. We understand that proposed transportation of material will take place on an existing granular access road, using either standard tandem or tri-axel dump trucks or off-road articulated rock trucks, and will begin in fall months (i.e late September to early October). The duration of the work is expected to be six (6) weeks.

The area under investigation is currently a granular access road, surrounded by agricultural field areas on all sides. A wetland area is located at the far north-east of the existing roadway. We understand the existing road has primarily been used by Correctional Services Canada staff for site patrol and for occasional access by farming equipment to adjacent agricultural field areas.

In general, the topography of the road surface was found to be generally flat from the south end of the roadway, for approximately 400m northward, then sloping gently downward towards the north for the remaining extent of the road. Very shallow ditching was present along the existing road at the south side of the site, however with adjacent agricultural land approximately 1.5m higher than the roadway surface for approximately 225m from the southern limit of the road, northward. For the remaining approximately 400m, the existing roadway was observed to be higher than surrounding lands, with generally deeper ditching.

The topography along the access road was surveyed by Josselyn Engineering Inc. at approximately 20m intervals, and provided to DBA, and can be found presented in Appendix 7 of this report.

A Site Location Plan is presented in Appendix 2 of this report. As well, several site photos are presented in Appendix 8 of this report.

3.0 METHOD OF INVESTIGATION

3.1 Fieldwork

3.1.1 General Remarks

Prior to field activities, public utility clearances were obtained, and a private utility locator was retained in order to verify excavation locations were clear of buried utilities.

All field activities were undertaken on May 30, 2014, under the constant supervision of DBA technical staff. A representative of the Client was on site during field operations.

3.1.2 Equipment

A total of three (3) test pits, identified as TP1, TP2 and TP3, were advanced with rubber tracked mini-excavator. All test pits were advanced through existing roadway granular materials, to expose native subgrade soils, or to a maximum depth of 1.2m, whichever was less.

Subsequent to the completion of test pit activities, all test pits were backfilled.

3.1.3 Sampling and In-Situ Testing

Hand grab samples were collected of roadway granular materials and subgrade soils at each test pit location. The in-situ shear strength of native soils was estimated using a handheld penetrometer. In addition, Lightweight Deflectometer (LWD) testing was performed on both existing granular materials and subgrade soils, as per ASTM E2583. Detailed results of the LWD testing can be seen presented as Appendix 5 of this report.

3.1.4 Test Pit Locations/Elevations

All test pits were excavated within the existing roadway area, with TP1 located at the north, TP2 in the middle area, and TP3 at the south section of the haul road.

Ground surface elevations at test pit locations were surveyed as a part of the aforementioned topographic survey performed by Josselyn Engineering Inc. and provided to DBA.

A Test Pit Location Plan is presented in Appendix 3 of this report.

4.0 SUBSOIL CONDITIONS

4.1 General Remarks

The soil descriptions given in this report and the test pit logs are based on current geotechnical practice, as per the *Canadian Foundation Engineering Manual, 4th Edition*.

The subsoil conditions encountered generally consisted of a sandy gravel fill with trace silt and clay, overlying silt and clay with trace sand subgrade, however this silt and clay subgrade was found to be reworked material in TP1.

Details of the subsurface conditions encountered are presented on the individual test pit logs attached to this report as Appendix 4. It is emphasized however, that the soil types, their sequence, thickness and physical properties may vary between test pits and samples both vertically and horizontally. The encountered subsoil conditions are summarized as follows:

4.2 Fill Materials

Fill materials were observed in all test pits, directly at surface. This fill material was generally found to consist of sandy gravel with trace silt and trace clay. This material was found to be approximately 0.6, 0.4 and 0.5m in thickness in test pits TP1, TP2 and TP3, respectively. This fill material was light brownish grey in colour in test pit TP1, and grey in test pits TP2 and TP3. The fill material was observed to be in a damp condition in test pit TP1, and in a moist condition in test pits TP2 and TP3. Traces of ash and cinders were also noted in test pit TP1 at approximately 0.5m below existing grades.

Silt and clay fill with trace sand was observed at a depth of 0.6m below existing grades in TP1, underlying the sandy gravel fill, and extended to the termination of the test pit at 1.2m. This material was observed to be brown in colour, and in a damp condition, becoming moist with depth (measured moisture contents of 25.3%).

4.3 Native Silt and Clay

A native silt and clay with some sand was observed underlying fill soils in both test pits TP2 and TP3. This material was found to be mottled greyish brown in colour, and was observed to be in a moist condition (measured moisture contents of between 25-30%). This consistency of this material was assessed to be very stiff, with penetrometer readings of between 4.0-4.5kg/cm^2 on the exposed subgrade surface.

5.0 GROUNDWATER

A detailed groundwater study was not undertaken as a part of this scope of work. However, water levels were observed in open test pits upon completion of excavation, and prior to backfilling. No groundwater was observed in test pits TP1 and TP2. Very light seepage was noted in test pit TP3 at the fill-clay interface, but terminated after several minutes.

It should be noted that the groundwater levels can fluctuate greatly and be located at different elevations depending on the seasonal and the atmospheric conditions – i.e. heavy rains, spring thaw, dry spells, etc.

6.0 LABORATORY

6.1 General

All samples collected in the field were transported to DBA's materials testing laboratory in Kingston, Ontario. Visual soil classifications made in the field were verified by peer review in the lab. The following laboratory testing was carried out:

- Natural moisture content was measured on all retrieved subgrade samples;
- Grain size analysis of all retrieved upper fill soils;
- Atterberg Limits testing on subgrade soils in test pit TP3;
- Standard Proctor testing on subgrade soils in test pit TP1; and
- California Bearing Ratio testing on subgrade soils in test pit TP1.

Detailed results of all laboratory testing are presented in Appendix 6 of this report.

Samples will be retained for a minimum period of three (3) months following the issuance of this report, unless otherwise notified by the Client.

7.0 DISCUSSION AND RECOMMENDATIONS

7.1 General Remarks

Based on our understanding of the proposed project as described in Section 2.0, the following are considered to be the most notable issues at this site:

- Southern Portion of Existing Road - Adequate Ditching and Drainage: surrounding lands in the southern portion of the existing roadway were observed to be up to 1.5m higher than existing grades at road elevation, with little to no ditching of significance in place. Upon discussion with Correctional Service Canada staff members at the time of the site visit, we understand that this portion of the road is prone to flooding during wet seasonal periods. *Adequate ditching and positive drainage away from the road embankment is critical for proper performance of the granular pavement structure.* New ditching which will provide positive drainage away from the roadway embankment would be required in this area in order to provide positive drainage. It is recommended that where possible, ditches extend at least 0.5m below the bottom of any pavement sub-base. The use of synthetic reinforcement is also recommended in this area in order to provide additional overall strengthening of the new pavement structure, and would be especially important if high water conditions are present in some areas (i.e. if adequate drainage is not possible).

7.2 Design Considerations

7.2.1 Design Inputs

Based on the results of the field investigation, LWD testing and laboratory testing, a soaked CBR of 6.0% for the subsoil encountered in TP1, and a resilient modulus of 25MPa were utilized as a part of our design calculations. As well, based on our understanding of the proposed project, a proposed timeframe for completion of approximately six (6) weeks, and the use of either standard tandem/tri-axel dump trucks or articulated off-road rock trucks for haulage of material, we would expect a minimum daily traffic load of 100 trips in each direction for standard dump trucks, or 30 trips in each direction for rock trucks.

7.2.2 US DOT Granular Pavement Design

The US Department of Transportation ten-step iterative method for determination of thickness of granular surfaced roads[1] was also utilized to determine road base thickness for this project, given the design parameters determined. This method assumes a thickness, and then determines an expected damage due to serviceability and rutting criteria which are calculated. Iterations are performed until the thickness that yields at or nearest a 100% damage value (i.e. optimum) is selected.

For our model, a 1.0" rutting depth was considered. This depth was chosen due to the fact that drainage in the poor performing south end of the road is questionable, and to generally avoid or mitigate any concerns with the existing soils becoming overly wet during the fall months (even with new ditching). Also, taken into consideration was the observation that the resilient modulus values obtained were quite low for the given soil types over all.

According to this methodology, 300mm of new Granular A would provide an appropriate section to accommodate the proposed traffic. If an increased rutting depth is utilized, a thinner section could be provided, however it should be understood that increased maintenance and poor performance during construction could potentially result.

A nomograph illustrating the design results based on the chosen inputs can be seen attached as Appendix 9 of this report.

7.2.3 Granular Base Equivalency Method

The Granular Base Equivalency (GBE) concept equates the strength of various pavement materials in terms of their thickness. GBE thickness is the required overall structural pavement thickness expressed in terms of an equivalent thickness of Granular A.

The average existing granular material section, based on test pits TP1, TP2 and TP3 would be 500mm of gravelly sand, overlying a silt and clay subgrade. Treating the existing gravelly sand with an equivalency factor of 0.5, the GBE would be 250. Based on 100% truck traffic and the

[1] Skorseth, K.: Gravel Roads – Maintenance and Design Manual : US Department of Transportation, November 2010

existing soils on site, an estimated appropriate GBE for 100 return trips per day would be 550. Therefore, according to the GBE design methodology, the addition of approximately 300mm of new Granular A would provide an appropriate section to accommodate the proposed traffic.

It should be noted that this method does consider the long term. According to our understanding, this road will be utilized by a small volume of regular traffic on a continual basis beyond the timeframe of the proposed hauling project. This method was used for comparison.

7.2.4 Synthetic Reinforcement

The use of synthetic reinforcement, more commonly known as 'geogrid', should be considered at the south extent of the existing road, in the existing poor performing areas (i.e. extending approximately 200-250m northward). This is especially important if adequate drainage to a positive outlet may not be available at all times (i.e. during high return period precipitation events). It is recommended that a biaxial geogrid be specified. Geosynthetic manufacturers are best suited to comment as to exactly which of their products would be most suitable for each situation - however, for reference, Terrafix TBX1500, TBX2000 or similar would be suitable for this application.

7.2.5 Recommended New Pavement Thickness

Based on the results of the above mentioned design methodologies, we recommend the placement of an additional 300mm of new Granular A material over the entire roadway structure in order to accommodate the proposed traffic loading for this project.

For the proposed pull-outs, grades can be raised using materials meeting Ontario Provincial Standard Specification (OPSS) Select Subgrade Material (SSM) specifications. The pavement structure in these areas should consist of should consist of a minimum of 300mm of Granular 'B' Type I or II material, underlying a minimum of 300mm of Granular A.

7.2.6 Maintenance

Some ongoing maintenance of the road following project completion may be required, especially if seasonal flooding continues in the south portion of the road. Generally speaking, this would involve re-grading and/or reshaping of the driving surface and replacement of lost aggregate on a periodic basis.

7.3 Construction Considerations

7.3.1 Site Preparation

As mentioned above, installation of ditching in order to provide positive drainage away from the roadway embankment in the southern portion of the Site is imperative to any roadway structure in this area performing adequately.

We recommend that all brush, topsoil and other organics be stripped from the existing roadway surface and shoulder areas. The exposed granular surface should then be proof rolled under heavy construction equipment (minimum 10,000kg) under the supervision of qualified geotechnical personnel. Subsequent to proof rolling, identified weak areas should be sub-excavated to stable subgrade material and replaced with Granular B Type II, and compacted to 100% of that material's Standard Proctor Maximum Dry Density (SPMDD). It should be noted that any sub-excavated areas must be provided with positive drainage upon replacement with new material.

Following the proof rolling examination, depressions and undulations must be eliminated to permit quick drainage. The existing granular surface should be graded with a minimum 3% crossfall towards ditches.

7.3.2 Placement of New Granular Materials

Upon preparation of the existing granular sub-base to receive new material, geogrid should be placed at the south end of the roadway as per the manufacturer's specific instructions, under the supervision of qualified geotechnical personnel or the manufacturer's representative. All new granular material should be placed and graded with a minimum 3% crossfall towards ditches, and subsequently compacted to 100% of its SPMDD.

For construction of new embankments, SSM should be placed in maximum lifts of 0.3m, and compacted using suitable compaction equipment to a minimum of 98% of their SPMDD.

8.0 CLOSURE

The recommendations provided in this report are based on subsoil data obtained at the test locations. Experience indicates that the subsoil and groundwater conditions can vary significantly between and beyond the sounding locations. For this reason, the recommendations given in this report are subject to a field verification of the subsoil conditions at the time of construction.

Should any site condition encountered differ from those at the tested locations or any changes in the project, we request that we be notified immediately in order to permit reassessment of our recommendations.

We trust that this report contains all of the information required at this time. If you have any questions regarding this report, or if we can be of further assistance on this project, please contact us.

A P P E N D I X 1

REPORT LIMITATIONS

(1 page)

REPORT LIMITATIONS

The conclusions and recommendations given in this report are based on information determined at the test locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test locations may differ from those encountered at the test locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during the construction to confirm that the subsurface conditions across the site do not deviate materially from those encountered in the test pits.

The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report relating to potential construction problems and possible methods of construction are intended only for the guidance of the designer. The number of test pits may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

The benchmark and elevations mentioned in this report were obtained strictly for use by this office in the geotechnical design of the project. They should not be used by any other party for any other purpose.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. *DBA* accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

APPENDIX 2

SITE LOCATION PLAN

(1 page)

NOTES

1. ALL SITE FEATURES ARE APPROXIMATE
2. DRAWING SHOULD BE READ IN CONJUNCTION WITH DBA REPORT No.: 14-2150-03

CLIENT: **SNC-LAVALIN**	DWN BY: DH CHK'D BY: VA	TITLE **SITE LOCATION PLAN**	DATE: **JUNE 2014**
DBA ENGINEERING LTD. 1164 Clyde Court Kingston, Ontario K7P 2E4	DATUM: - SCALE: NTS	PROJECT **PAVEMENT INVESTIGATION PROPOSED HAUL ROAD** Collins Bay Penitentiary Lane, Kingston ON	PROJECT NO: **14-2150-03** FIGURE No. **1**

APPENDIX 3

TEST PIT LOCATION PLAN

(1 page)

LEGEND

TP1 - Test Pit

NOTES

1. ALL SITE FEATURES ARE APPROXIMATE
2. DRAWING SHOULD BE READ IN CONJUNCTION WITH DBA REPORT No.: 14-2150-03

CLIENT: **SNC-LAVALIN**	DWN BY: DH CHK'D BY: VA	TITLE **TEST PIT LOCATION PLAN**	DATE: **JUNE 2014**
DBA ENGINEERING LTD. 1164 Clyde Court Kingston, Ontario K7P 2E4	DATUM: - SCALE: NTS	PROJECT **PAVEMENT INVESTIGATION PROPOSED HAUL ROAD** Collins Bay Penitentiary Lane, Kingston ON	PROJECT NO: **14-2150-03** FIGURE No. **2**

A P P E N D I X 4

RECORD OF TEST PITS

(3 pages)

RECORD OF TEST PIT No. TP1

Project Number:	14-2150-03	Drilling Location:	North extent of existing road	Logged by:	MM
Project Client:	PWGSC/CSC c/o SNC-Lavalin	Drilling Method:		Compiled by:	MM
Project Name:	Haul Road Assessment	Drilling Machine:		Reviewed by:	DH
Project Location:	Collins Bay Correctional Institution	Date Started: Jun 30, 14	Date Completed: Jun 30, 14	Revision No.:	0

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Local Ground Surface Elevation: 79.4 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT ● DCPT; MTO Vane*: △ Intact ▲ Remould; Nilcon Vane*: ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12; △ Soil Vapour Reading parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); Plastic W_P — W — W_L Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS
	light brownish grey **FILL** - sandy gravel, trace silt, trace clay damp becoming greyish black trace ash and cinders 78.8	GS	1				79				
	0.6 brown **FILL** - silt and clay, trace sand damp, becoming moist with depth 78.2	GS	2			1			o25		
	1.2 end of test pit										

DBA Engineering Limited
370 Steelcase Road East
Markham, Ontario L3R 1G2
Tel: 1-800-819-8833
Fax: 905-940-8508

No freestanding groundwater measured in open borehole on completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commisioned and the accompanying'Notes to Record of Boreholes'.

Scale: 1 : 21

RECORD OF TEST PIT No. TP2

DBA

Project Number:	14-2150-03	Drilling Location:	Middle of existing road	Logged by:	MM
Project Client:	PWGSC/CSC c/o SNC-Lavalin	Drilling Method:		Compiled by:	MM
Project Name:	Haul Road Assessment	Drilling Machine:		Reviewed by:	DH
Project Location:	Collins Bay Correctional Institution	Date Started:	Jun 30, 14 Date Completed: Jun 30, 14	Revision No.:	0

LITHOLOGY PROFILE | SOIL SAMPLING | FIELD TESTING | LAB TESTING

FIELD TESTING: Penetration Testing: ○ SPT ● DCPT; MTO Vane*: △ Intact ▲ Remould; Nilcon Vane*: ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING: ★ Rinse pH Values 2 4 6 8 10 12; △ Soil Vapour Reading parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); W_P W W_L Plastic Liquid 20 40 60 80

Local Ground Surface Elevation: 79.6 m

Lithology Plot	DESCRIPTION	Elev. / Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	INSTRUMENTATION INSTALLATION	COMMENTS
	grey **FILL** - sandy gravel, trace silt, trace clay moist	79.3 / 0.4	GS	1								
	mottled greyish brown **SILTY AND CLAY** - some sand very stiff moist	79.0 / 0.7	GS	2				79		30		
	end of test pit											

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No freestanding groundwater measured in open borehole on completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commisioned and the accompanying'Notes to Record of Boreholes'.

Scale: 1 : 21

RECORD OF TEST PIT No. TP3

DBA

Project Number:	14-2150-03	Drilling Location:	South extent of existing road	Logged by:	MM
Project Client:	PWGSC/CSC c/o SNC-Lavalin	Drilling Method:		Compiled by:	MM
Project Name:	Haul Road Assessment	Drilling Machine:		Reviewed by:	DH
Project Location:	Collins Bay Correctional Institution	Date Started:	Jun 30, 14 Date Completed: Jun 30, 14	Revision No.:	0

LITHOLOGY PROFILE | SOIL SAMPLING | FIELD TESTING | LAB TESTING

Field testing legend: Penetration Testing: ○ SPT ● DCPT; MTO Vane*: △ Intact ▲ Remould; Nilcon Vane*: ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80

Lab testing legend: ★ Rinse pH Values 2 4 6 8 10 12; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); W_P W W_L Plastic Liquid 20 40 60 80

Local Ground Surface Elevation: 78.4 m

Lithology Plot	DESCRIPTION	Elev./Depth	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	INSTRUMENTATION INSTALLATION	COMMENTS
	grey **FILL** - sandy gravel, trace silt, trace clay moist	77.9	GS	1				78				
	mottled greyish brown **SILTY AND CLAY** - some sand very stiff moist	0.5 / 77.6	GS	2						25		
	end of test pit	0.8										

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No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 21

APPENDIX 5

LIGHTWEIGHT DEFLECTOMETER TEST RESULTS

(10 pages)

GROUPE QUALITAS INC.
3420 Saint-Joseph Blvd. East
Montreal, Quebec
Canada H1X 1W6
www.qualitas.qc.ca

Telephone: 514-331-6913

June 9, 2014

Mr. Dylan Hill, B. Eng., E.I.T.
Geotechnical Project Coordinator
DBA Engineering Ltd
1164, Clyde Court
Kingston, ON K7P 2E4

Our file n°: CR-1926
Reference n°: rap-001

Subject: LWD tests
Collins Bay Penitentiary haul road
Your reference N° K-00393

Dear Mr. Hill,

You will find enclosed the soil resilient moduli measured on May 30, 2014 at 3 locations along the Collins Bay Penitentiary haul road. Tests were completed at the surface of the gravel road and at the subgrade level in 3 tests pits excavated by DBA Engineering Ltd. The soil resilient moduli were determined through the measurement of deflection using a Lightweight Weight Deflectometer (LWD). The equipment used for the evaluation complies with standard ASTM E2583 "Standard test method for Measuring Deflections with a Light Weight Deflectometer".

For each test point, the soil resilient modulus (M_R) under the loading plate was calculated with the following Boussinesq relation:

$$M_R = \left[\frac{2\left(1 - \mu^2\right) pa}{d} \right]$$

where

MR soil resilient modulus
µ Poisson coefficient (0.35 was used for all tests)
p applied pressure below the plate
a loading plate radius
d measured deflection under the loading plate.

Detailed results are presented in Appendix 2 and summarized in Table 1. Photographs are presented in Appendix 1.

TABLE 1

TEST PIT	DEPTH	AVERAGE RESILIENT MODULUS (MPa)
TP-1	surface	101
	-0.70 m below the surface	20
TP-2	surface	24
	-0.42 m below the surface	30
TP-3	surface	47
	-0.50 m below the surface	327 [1]

(1) Resilient modulus measured 500 mm below the surface in TP-3 is too high for a fine grained soil.

As mentioned in Table 1, the resilient modulus measured 500 mm below the surface in TP-3 is too high for a fine grained soil. Time history curves for all drops show an untypical peak deflection. Since resilient modulus is high for all drops at different heights, boulder or something else may be present at shallow depth. This value should be used with caution or rejected.

We trust that this report contains all the information required, we remain at your disposal if we can be of further assistance on this project.

GROUPE QUALITAS INC.

André Contant, P.Eng., M.A.Sc.

Gilles Bertrand
Senior manager
AC/ac

(This report is composed of 10 pages and cannot be reproduced without Groupe Qualitas inc. authorization).

APPENDIX 1

PHOTOGRAPHS

(3 PAGES)

TEST PIT 3

TEST PIT 2

TEST PIT 1

APPENDIX 2

SOIL RESILIENT MODULUS

(3 PAGES)

Test number:	1	Test at surface		Poisson coef:	0,35
Test location:	TP-3	Loading plate radius (mm) :	150		

Test number	Date (dd/mm/yyyy)	hour	Stress (kPa)	Load (kN)	Deflection (µm)	Modulus (MPa)
1	30/05/2014	10:42:05	36,3	2,6	223	43
2	30/05/2014	10:48:26	70,4	5,0	394	47
3	30/05/2014	10:49:22	70,2	5,0	393	47
4	30/05/2014	10:50:11	113,6	8,0	644	46
					Average	**47**

Test number:	2	-0.50 m below the surface		Poisson coef:	0,35
Test location:	TP-3	Loading plate radius (mm) :	150		

Test number	Date (dd/mm/yyyy)	hour	Stress (kPa)	Load (kN)	Deflection (µm)	Modulus (MPa)
1	30/05/2014	11:45:25	29,4	2,1	23	330
2	30/05/2014	11:46:40	29,2	2,1	26	293
3	30/05/2014	11:47:58	61,3	4,3	42	387
4	30/05/2014	11:50:44	64,1	4,5	49	345
5	30/05/2014	11:52:04	113,3	8,0	83	360
6	30/05/2014	11:52:57	116,3	8,2	101	303
7	30/05/2014	11:53:49	112,5	8,0	108	274
					Average	**327**

Test number:	3	Test at surface		Poisson coef:	0,35
Test location:	TP-2	Loading plate radius (mm) :	150		

Test number	Date (dd/mm/yyyy)	hour	Stress (kPa)	Load (kN)	Deflection (µm)	Modulus (MPa)
1	30/05/2014	12:18:51	34,8	2,5	502	18
3	30/05/2014	12:20:40	37,0	2,6	449	22
4	30/05/2014	12:21:24	36,7	2,6	444	22
5	30/05/2014	12:22:42	63,4	4,5	702	24
6	30/05/2014	12:23:29	64,2	4,5	725	23
7	30/05/2014	12:24:23	108,5	7,7	1050	27
8	30/05/2014	12:25:18	107,2	7,6	1069	26
					Average	**24**

Test number:	4	-0.42 m below the surface		Poisson coef:	0,35
Test location:	TP-2	Loading plate radius (mm) :	150		

Test number	Date (dd/mm/yyyy)	hour	Stress (kPa)	Load (kN)	Deflection (µm)	Modulus (MPa)
1	30/05/2014	12:48:47	35,8	2,5	262	36
2	30/05/2014	12:49:45	35,8	2,5	237	40
3	30/05/2014	12:51:15	63,0	4,5	515	32
4	30/05/2014	12:52:31	63,1	4,5	527	32
5	30/05/2014	12:53:43	94,7	6,7	886	28
6	30/05/2014	12:54:40	93,6	6,6	918	27
7	30/05/2014	12:55:37	95,2	6,7	947	27
8	30/05/2014	12:57:05	94,0	6,6	986	25
					Average	**30**

Test number:	5	Test at surface		Poisson coef: 0,35
Test location:	TP-1	Loading plate radius (mm) :	150	

Test number	Date (dd/mm/yyyy)	hour	Stress (kPa)	Load (kN)	Deflection (µm)	Modulus (MPa)
1	30/05/2014	13:35:15	37,2	2,6	89	110
2	30/05/2014	13:36:43	36,9	2,6	87	111
3	30/05/2014	13:38:35	67,0	4,7	175	101
4	30/05/2014	13:39:52	66,1	4,7	172	101
5	30/05/2014	13:41:06	101,3	7,2	275	97
6	30/05/2014	13:42:45	102,5	7,2	278	97
					Average	**101**

Test number:	6	-0.70 m below the surface		Poisson coef: 0,35
Test location:	TP-1	Loading plate radius (mm) :	150	

Test number	Date (dd/mm/yyyy)	hour	Stress (kPa)	Load (kN)	Deflection (µm)	Modulus (MPa)
1	30/05/2014	14:05:48	35,1	2,5	469	20
2	30/05/2014	14:06:52	35,1	2,5	465	20
3	30/05/2014	14:08:24	62,4	4,4	817	20
4	30/05/2014	14:09:10	63,1	4,5	834	20
5	30/05/2014	14:10:45	93,7	6,6	1207	20
6	30/05/2014	14:11:38	94,8	6,7	1232	20
					Average	**20**

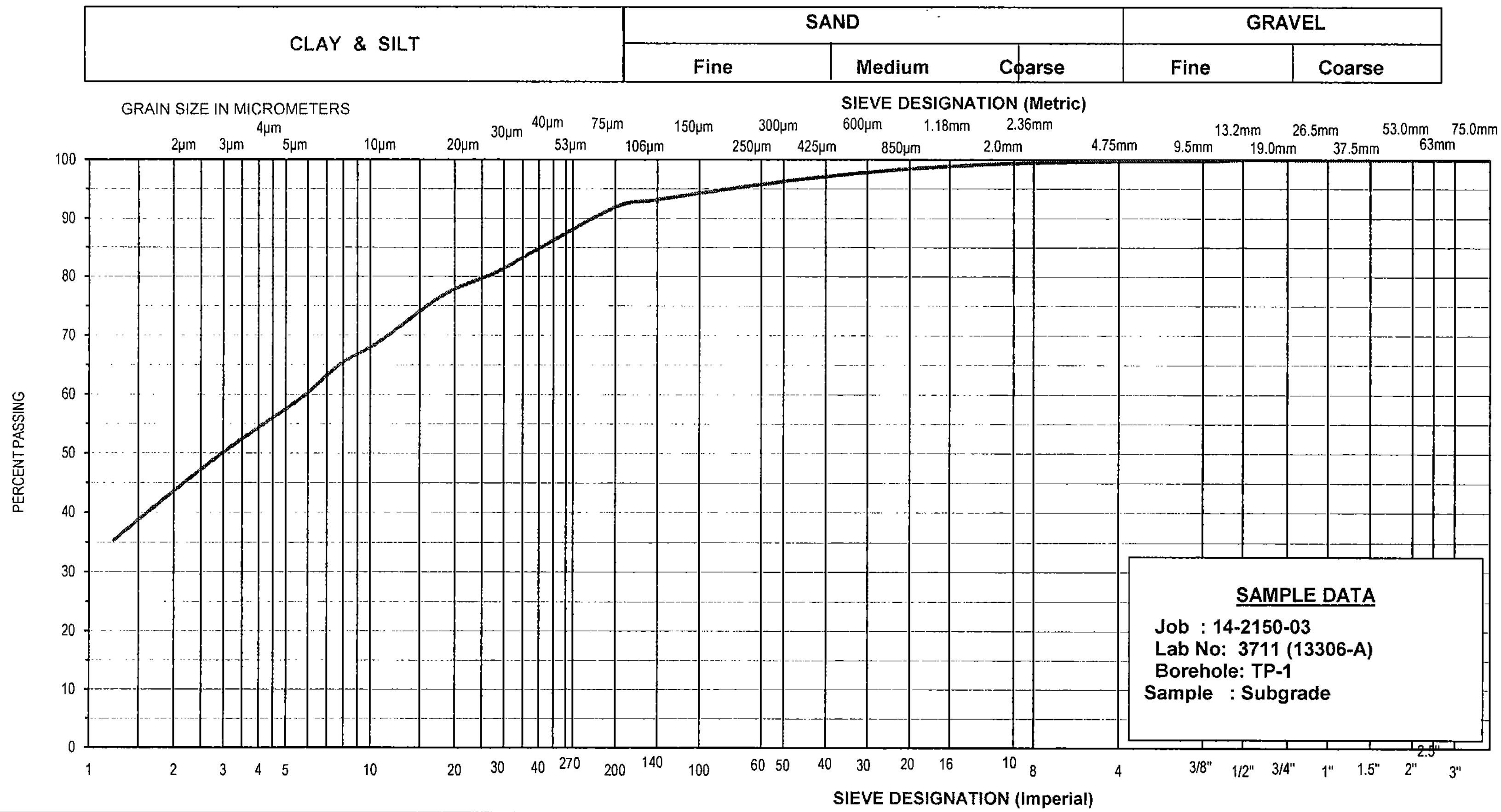
APPENDIX 6

LABORATORY RESULTS

(9 pages)

DBA ENGINEERING LTD.

UNIFIED SOIL CLASSIFICATION SYSTEM

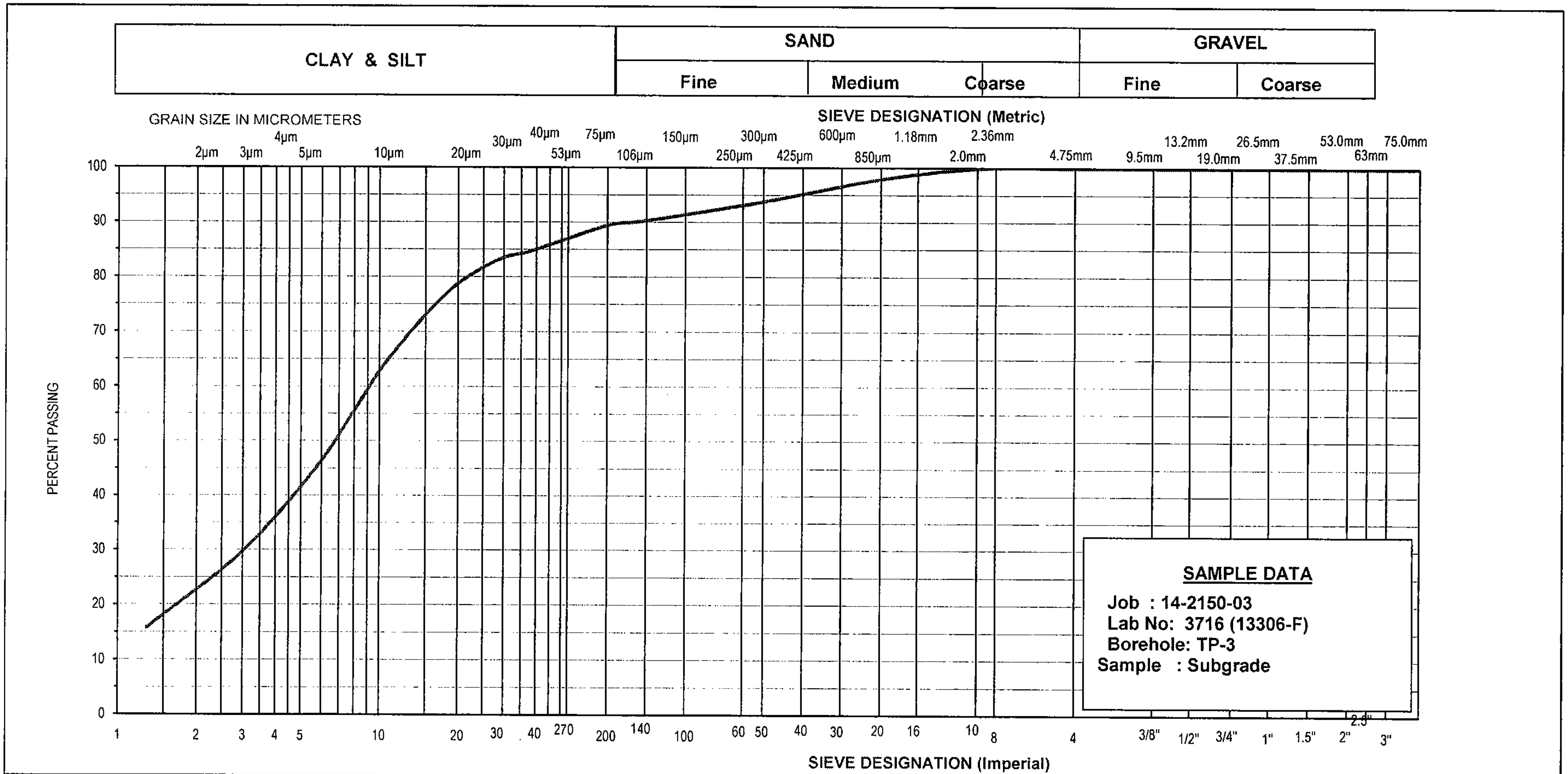


% +3"	% Gravel		% Sand			% Fines	
	Course	Fine	Course	Medium	Fine	Silt	Clay
	0	0	0	2	6	48	44

DBA ENGINEERING LTD. 401 Hanlan Road Vaughan, Ontario L4L 3T1	**GRAIN SIZE DISTRIBUTION**	**Client: SNC Lavalin** **Project : Haul Road Assessment**
	SILT AND CLAY **trace sand**	**Location: TP-1, Subgrade** **Date: June 2014**

DBA ENGINEERING LTD.

UNIFIED SOIL CLASSIFICATION SYSTEM



% +3"	% Gravel		% Sand			% Fines	
	Course	Fine	Course	Medium	Fine	Silt	Clay
	0	0	0	5	6	66	23

DBA ENGINEERING LTD. 401 Hanlan Road Vaughan, Ontario L4L 3T1	**GRAIN SIZE DISTRIBUTION**	**Client: SNC Lavalin** **Project : Haul Road Assessment**
	SILT **with clay, some sand**	**Location: TP-3, Subgrade** **Date: June 2014**

401 Hanlan Road
Vaughan, Ontario L4L 3T1
Tel: (905) 851-0090
Toll Free: 1-800-819-8833
Fax: (905) 851-0091

DBA ENGINEERING LTD.

Grain Size Analysis Test Report

Project No.: 14-2150-03 **Project Description:** Geotechnical Investigation-Haul Road Ass **Date:** Jun 11, 2014

Project Location:

Contract No.:

SAMPLE DATA

Material: Granular Base

Date Sampled: May 30, 2014

Time Sampled:

Sample Type: Shovel

Sample Location: TP 1

Lot: **Sublot:**

Source: N/A

Sampled By: Technician

LAB DATA

Lab No.: **3712** **Date Tested:** Jun 09, 2014

Specification: OPSS 1010, Granular B Type I

PARTICLE ANALYSIS

TEST	Sample	Specification
Percent Crushed:		
% Asphalt Coated:		30
% Flat and Elongated		

WASH PASS 0.075mm

TEST	Sample	Specs
Wash Pass 0.075 mm:		
FINENESS MODULUS	5.08	

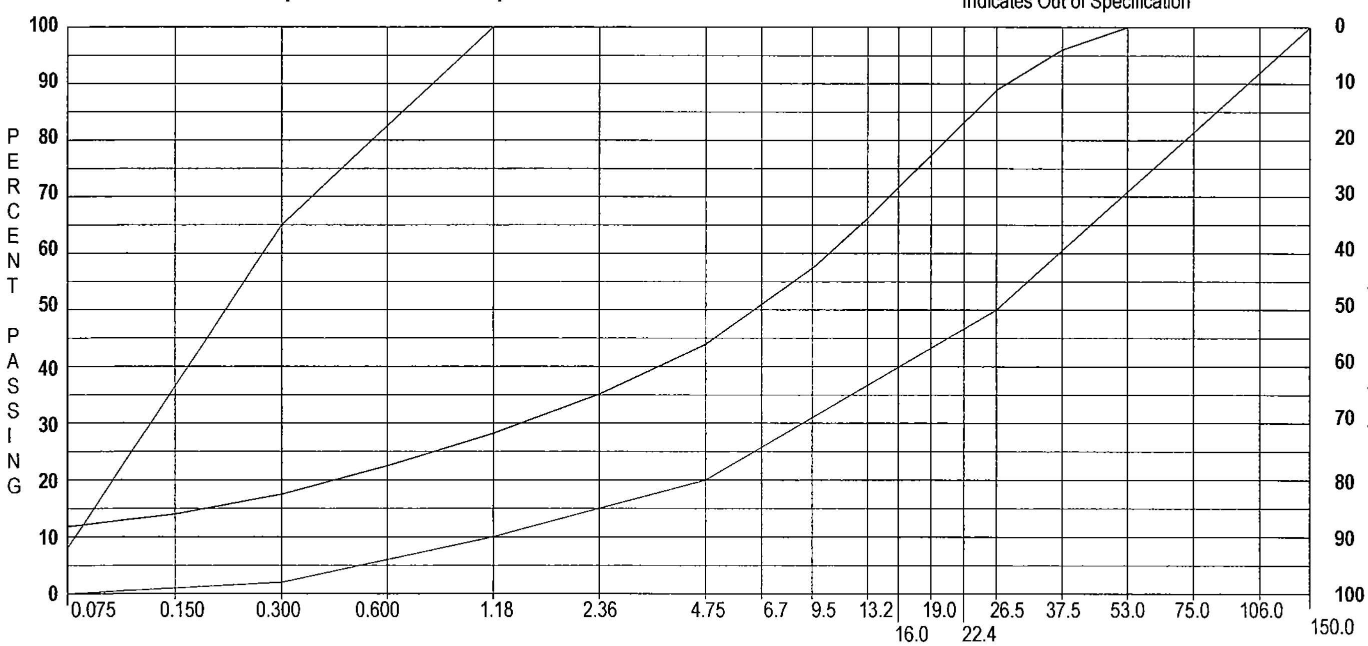
Grain Size Analysis

Sieve Sizes (mm)	Percent Passing	
	Sample	Specification
150.0	**100**	100 - 100
106.0	**100**	-
75.0	**100**	-
53.0	**100**	-
37.5	**96**	-
26.5	**88.9**	50 - 100
22.4		-
19.0	**77.3**	-
16.0	**71.7**	-
13.2	**66.2**	-
9.5	**57.7**	-
6.7		-
4.75	**43.9**	20 - 100
2.36	**35.1**	-
1.18	**28.2**	10 - 100
0.600	**22.5**	-
0.300	**17.5**	2 - 65
0.150	**14**	-
0.075	**11.8***	0 - 8

* Indicates Out of Specification

Comments:

Sample: ______ **Specs:** ______



Project Manager: Murray McClelland

DBA ENGINEERING LTD.
401 Hanlan Road
Vaughan, Ontario L4L 3T1
Tel: (905) 851-0090
Toll Free: 1-800-819-8833
Fax: (905) 851-0091

Grain Size Analysis Test Report

Project No.: 14-2150-03 **Project Description:** Geotechnical Investigation-Haul Road Ass **Date:** Jun 11, 2014

Project Location: **Contract No.:**

SAMPLE DATA

Material: Granular Base
Date Sampled: May 30, 2014
Time Sampled:
Sample Type: Shovel
Sample Location: TP 2
Lot: **Sublot:**
Source: N/A
Sampled By: Technician

LAB DATA

Lab No.: **3714** **Date Tested:** Jun 09, 2014

Specification: OPSS 1010, Granular B Type I

PARTICLE ANALYSIS

TEST	Sample	Specification
Percent Crushed:		
% Asphalt Coated:		30
% Flat and Elongated		

WASH PASS 0.075mm

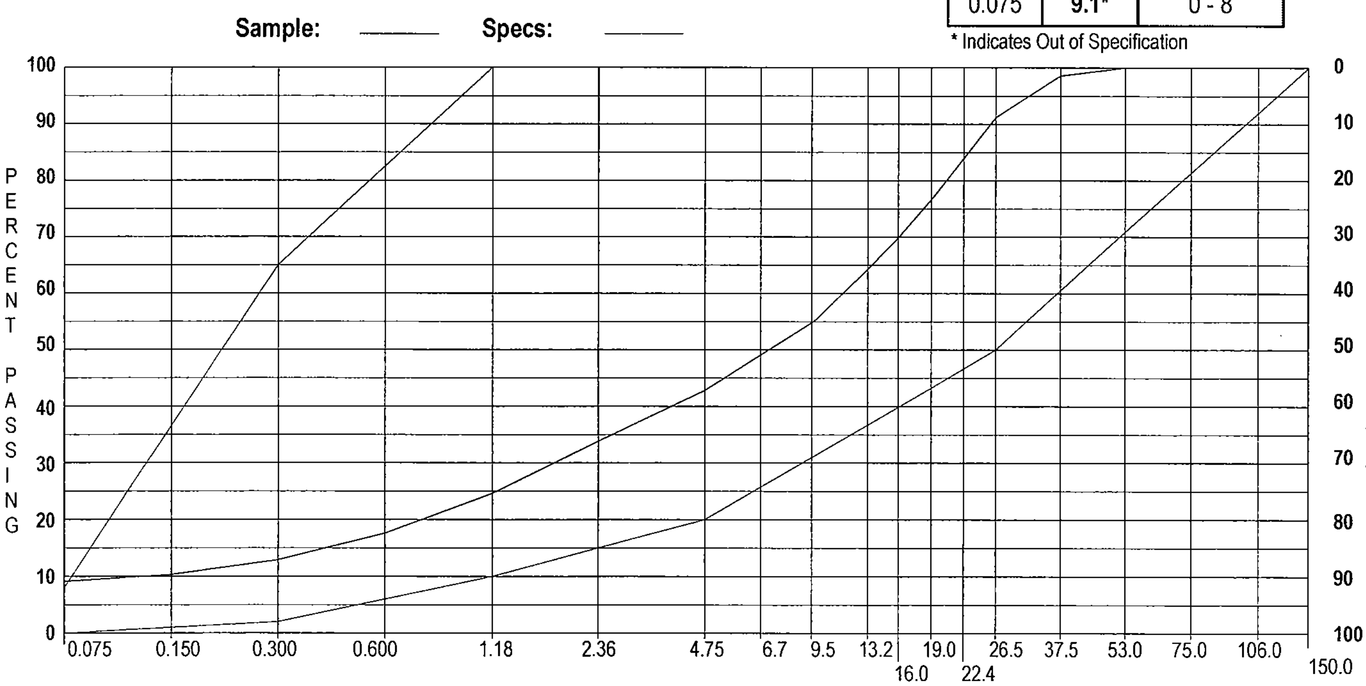
TEST	Sample	Specs
Wash Pass 0.075 mm:		
FINENESS MODULUS	5.28	

Comments:

Grain Size Analysis

Sieve Sizes (mm)	Percent Passing	
	Sample	Specification
150.0	**100**	100 - 100
106.0	**100**	-
75.0	**100**	-
53.0	**100**	-
37.5	**98.6**	-
26.5	**91.2**	50 - 100
22.4		-
19.0	**76.6**	-
16.0	**69.9**	-
13.2	**64.3**	-
9.5	**55.1**	-
6.7		-
4.75	**42.8**	20 - 100
2.36	**33.8**	-
1.18	**24.6**	10 - 100
0.600	**17.6**	-
0.300	**12.9**	2 - 65
0.150	**10.3**	-
0.075	**9.1***	0 - 8

* Indicates Out of Specification



Project Manager: Murray McClelland

DBA ENGINEERING LTD.

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Fax: (905) 851-0091

Grain Size Analysis Test Report

Project No.: 14-2150-03 **Project Description:** Geotechnical Investigation-Haul Road Ass **Date:** Jun 11, 2014

Project Location:

Contract No.:

SAMPLE DATA

Material: Existing Material

Date Sampled: May 30, 2014

Time Sampled:

Sample Type: Shovel

Sample Location: TP 3, 0' - 1'6"

Lot: **Sublot:**

Source: N/A

Sampled By: Technician

LAB DATA

Lab No.: **3715** **Date Tested:** Jun 09, 2014

Specification: OPSS 1010, Granular B Type I

Grain Size Analysis

Sieve Sizes (mm)	Percent Passing	
	Sample	Specification
150.0	**100**	100 - 100
106.0	**100**	-
75.0	**86.4**	-
53.0	**80.2**	-
37.5	**77.1**	-
26.5	**70.8**	50 - 100
22.4		-
19.0	**60.1**	-
16.0	**56.2**	-
13.2	**52.8**	-
9.5	**47.6**	-
6.7		-
4.75	**35.9**	20 - 100
2.36	**28**	-
1.18	**21.3**	10 - 100
0.600	**16.4**	-
0.300	**13.1**	2 - 65
0.150	**11.1**	-
0.075	**9.9***	0 - 8

* Indicates Out of Specification

PARTICLE ANALYSIS

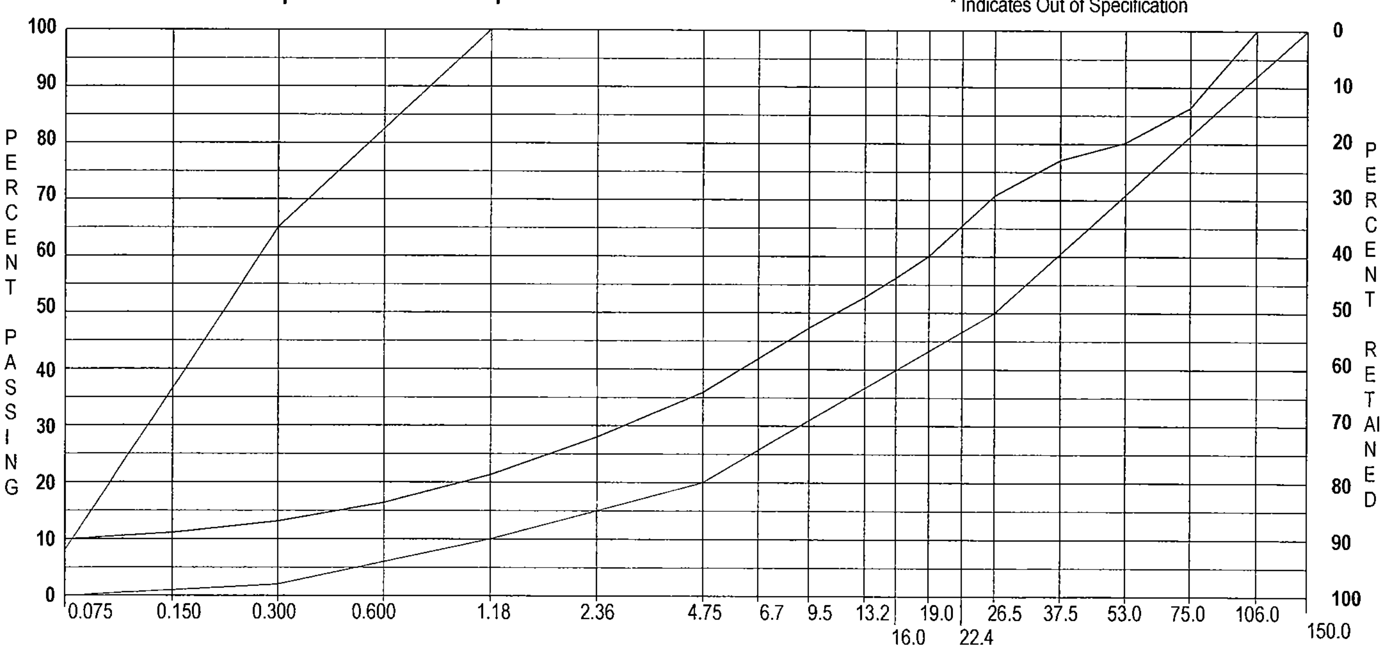
TEST	Sample	Specification
Percent Crushed:		
% Asphalt Coated:		30
% Flat and Elongated		

WASH PASS 0.075mm

TEST	Sample	Specs
Wash Pass 0.075 mm:		
FINENESS MODULUS	5.89	

Comments:

Sample: ______ **Specs:** ______



Project Manager: Murray McClelland

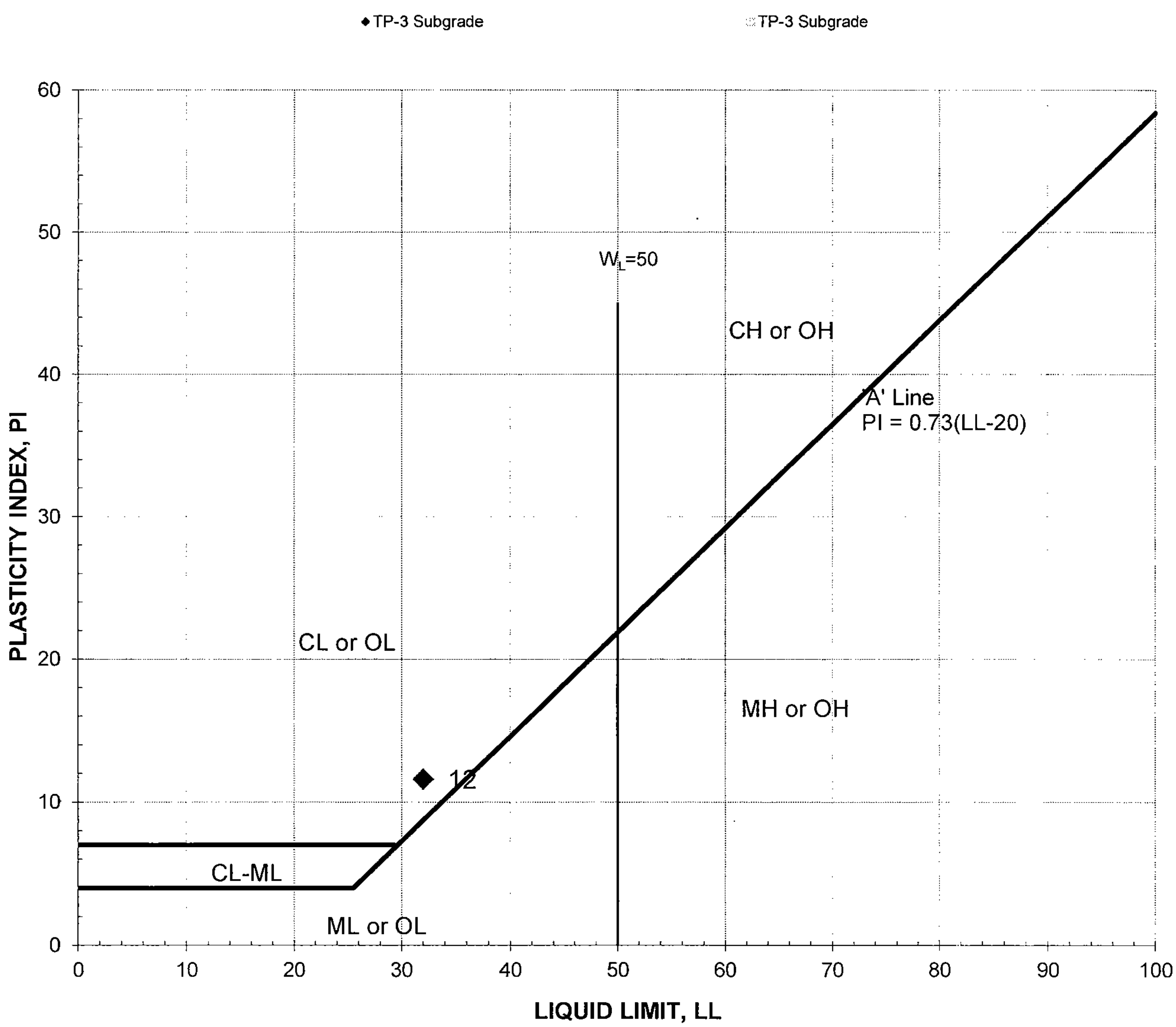
DBA ENGINEERING LTD.

PLASTICITY CHART

Job # :	14-2150-03	**Lab #** :	3716(13306F)
Project Client:	SNC Lavalin	**Technician** :	UC
Project :	Haul Road Assessment	**Supervisor** :	KJ
Location :	TP-3, Subgrade	**Date** :	06/10/14

TEST RESULTS

Specimen #	Sample #	Depth	LL%	PL%	PI	Fines	W%	Classification	Remarks
TP-3	Subgrade		32	20	12		25	CL	



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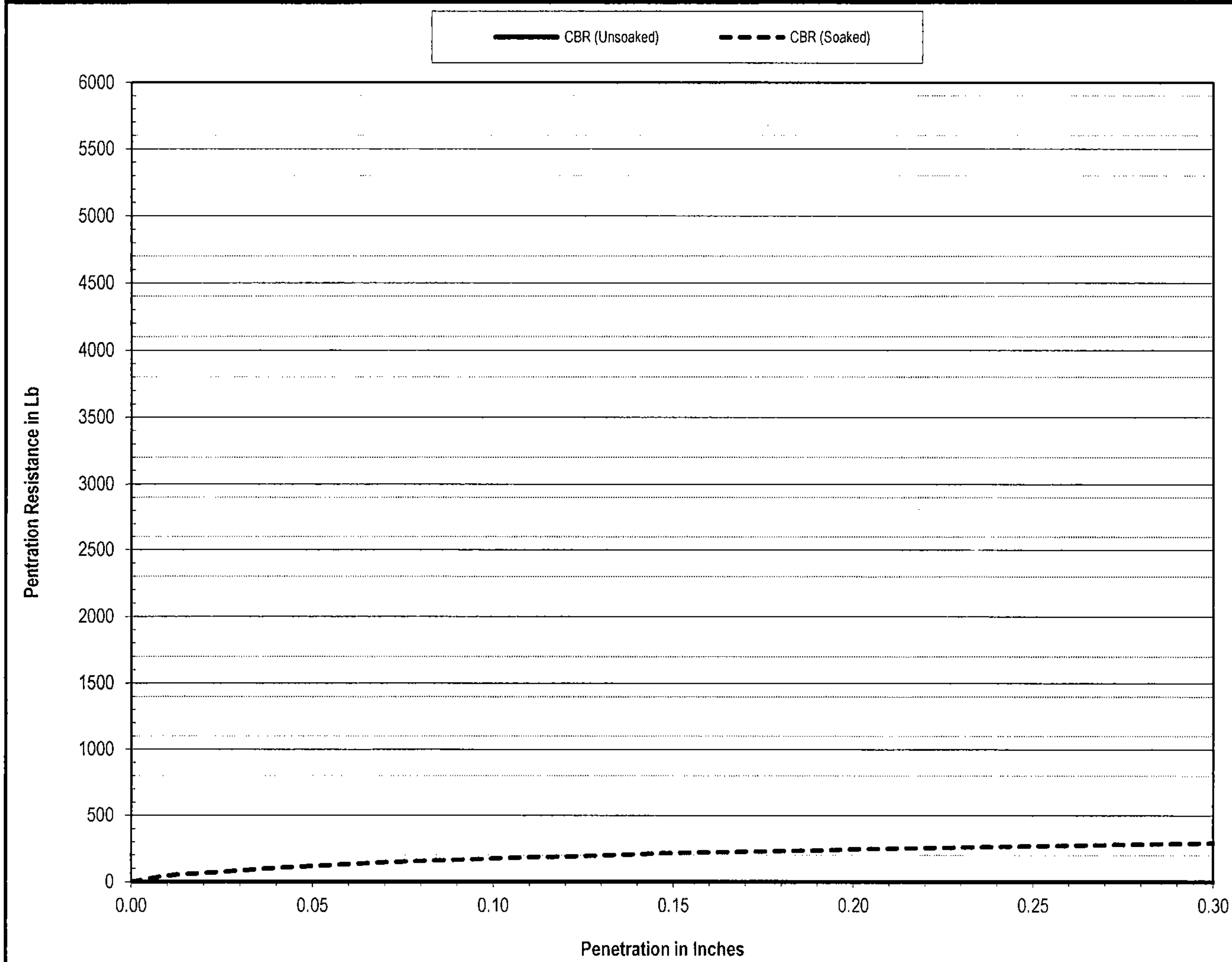
CALIFORNIA BEARING RATIO TEST (ASTM D1883)



SAMPLE DATA

Project No : 14-2150-03
Lab No. : 3711 (13306-A)
Sample : Subgrade
Samp Date: May 30 2014
Borehole : TP 1
Depth : N/A

CBR TEST RESULTS

Unsoaked CBR Value (%) with Zero Correction	:	-
Soaked CBR Value (%) with Zero Correction	:	6
Swell (%)	:	1.14
Max Dry Density (kg/m^3)	:	1640
OMC (%)	:	21.4

DBA ENGINEERING LTD.
401 Hanlan Road,
Vaughan ON, L4L 3T1

Client :	SNC Lavalin Inc.
Project :	Haul Road Assessment
Location:	TP 1
Date :	June 13 2014

-

DHILLON BURLEIGH & ASSOCIATES
Civil, Pavement, Geo, Environmental and Materials
Consulting Engineers
401 Hanlan Road
Vaughan ON, L4L 3T1
Tel: (905) 851-0090 Fax (905) 851-0091

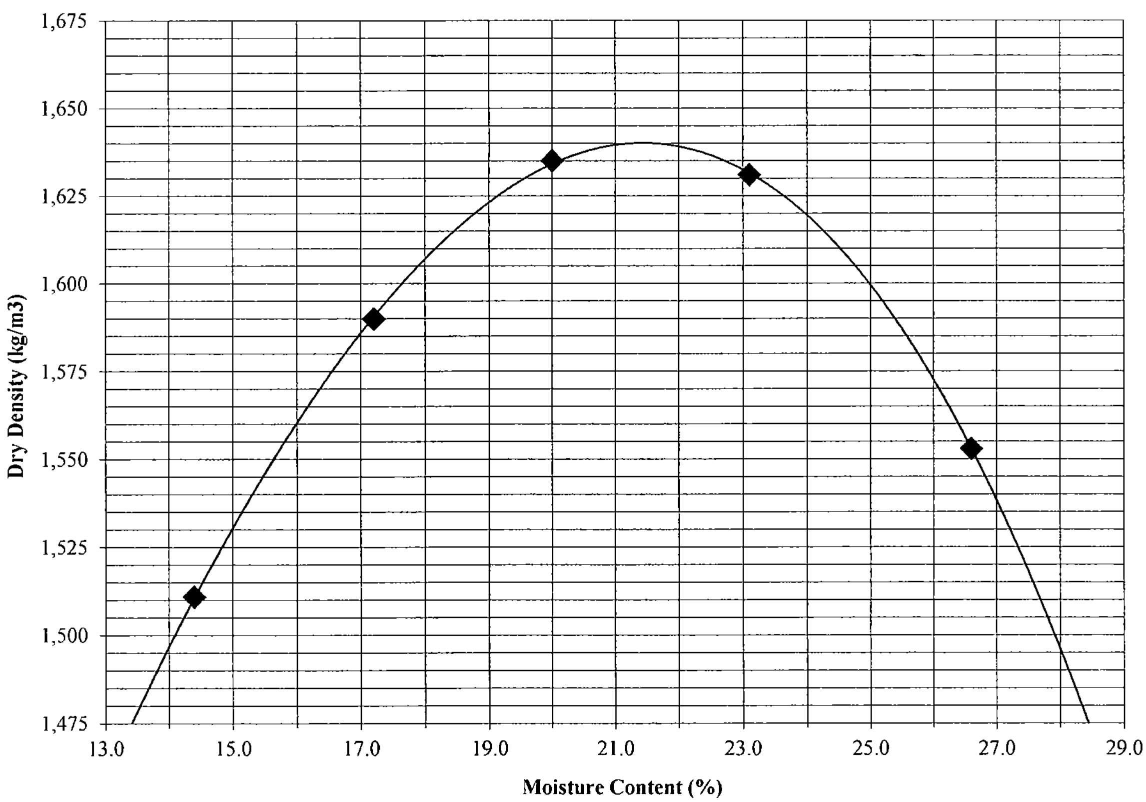
STANDARD PROCTOR REPORT (LS-706)

CLIENT:	**SNC Lavalin Inc.**	**LAB NO.:**	**3711 (13306-A)**
PROJECT NAME:	Haul Road Assessment	**DATE:**	June 6 2014
SAMPLE DESCRIPTION:	Subgrade	**PROJECT NO.:**	**14-2150-03**
MATERIAL SUPPLIER:	N/A	**SAMPLE DATE:**	May 30 2014
SAMPLE LOCATION:	TP 1	**SAMPLED BY:**	Technician

TRIAL NUMBER	1	2	3	4	5	6
DRY DENSITY (kg/m^3)	1,511	1,590	1,635	1,631	1,553	
MOISTURE CONTENT (%)	14.4	17.2	20.0	23.1	26.6	

MAX. DRY DENSITY 1,640 kg/m^3

OPTIMUM MOISTURE CONTENT: 21.4 %



DBA ENGINEERING LTD.

Civil, Pavement, GEO, Environmental and Materials Engineers

401, Hanlan Road
Vaughan, Ontario, Canada L4L 3T1
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Toll Free: 1-800-819-8833
Fax: 905-851-0091
www.dbaeng.com

Moisture Content

(LS -701)

Project No. : 14-2150-03

Date Tested: June 6 2014

Project Name : SNC - Haul Road Assessment

Lab No. : 3711, 3713, 3716

Source/Location : TP 1, 2, 3

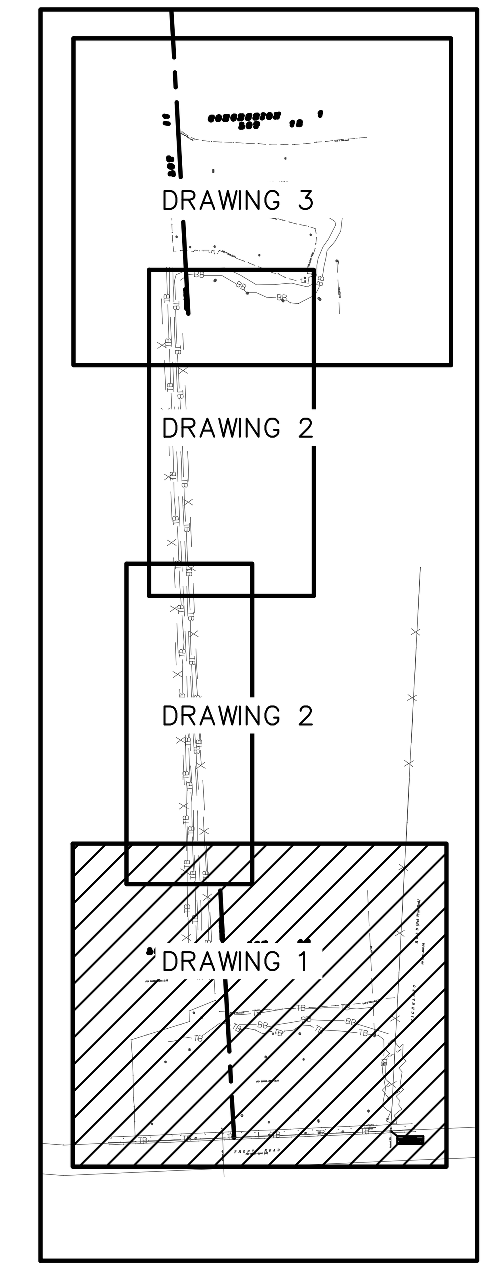
Material : Subgrade

Lab # / Sample	Mass of Sample Wet & Tare (g)	Mass of Sample Dry & Tare (g)	Mass of Water (g)	Mass of Dry Soil (g)	Mass of Tare (g)	Moisture Content (%)
3711 (13306-A) / TP 1	412.3	347.9	64.4	256.2	91.7	25.1
3713 (13306-C) / TP 2	511.3	416.2	95.1	319.4	96.8	29.8
3716 (13306-F) / TP 3	410.8	344.8	66.0	260.8	84.0	25.3

A P P E N D I X 7

SITE TOPOGRPAHIC SURVEY BY OTHERS

(3 pages)



LEGEND

+76.45 ELEVATION	TOPOGRAPHIC INFORMATION PROVIDED BY HOPKINS, CORMIER & CHITTY SURVEYING CONSULTANTS INC. ONTARIO LAND SURVEYORS NOVEMBER 2012.
+76.45/GS DESCRIPTION ELEVATION	TOPOGRAPHIC INFORMATION OBTAINED BY JOSSELYN ENGINEERING INC. MAY 2014.
	FENCE LINE
℄ DITCH	DITCH
TB	TOP OF BANK
BB	BOTTOM OF BANK
	LOT LINE
	EDGE OF GRAVEL
	MONITOR WELL
78.40/test_pit-3 TP — TEST PIT NUMBER, GROUND ELEVATION	TEST PIT LOCATION

No.	By	Date	Revision	Checked

Josselyn Engineering Inc.

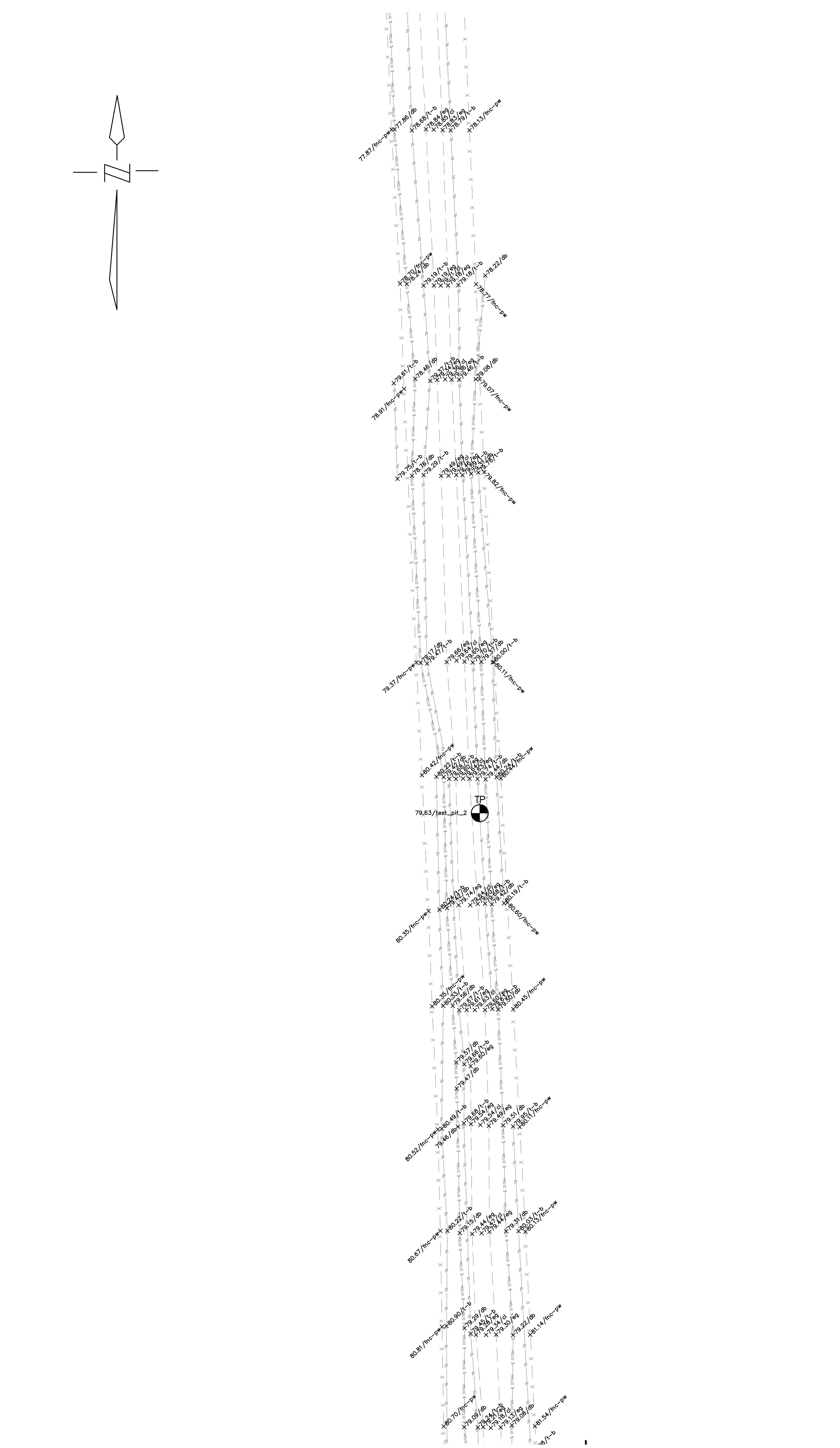
1225 GARDINERS ROAD
SUITE 105
KINGSTON, ONTARIO K7P 2R9
TEL : 613-634-9278
FAX : 613-634-9138
E-MAIL :mjosselyn@josselyn.ca

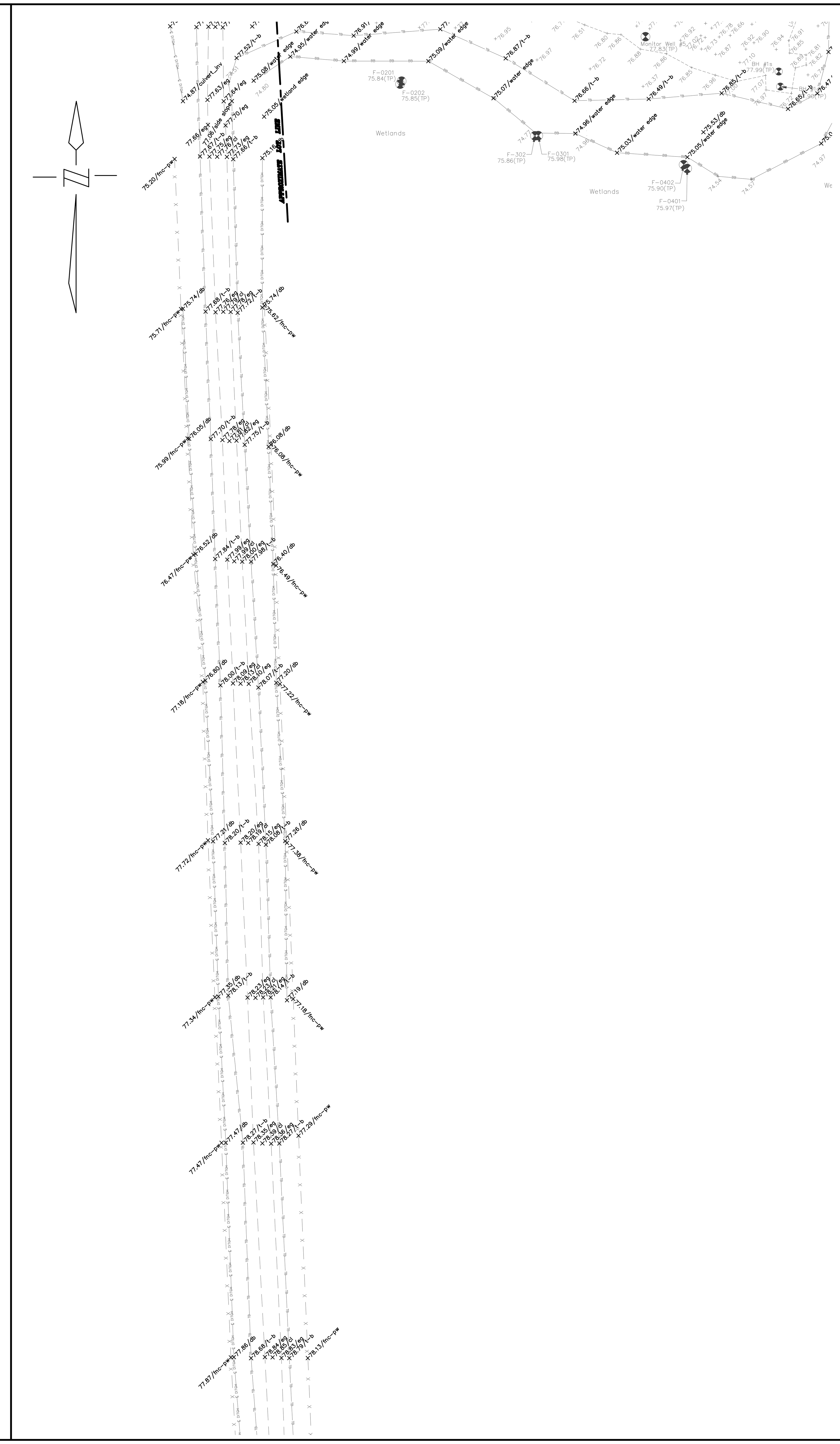
OWNER: CORRECTIONAL SERVICE CANADA

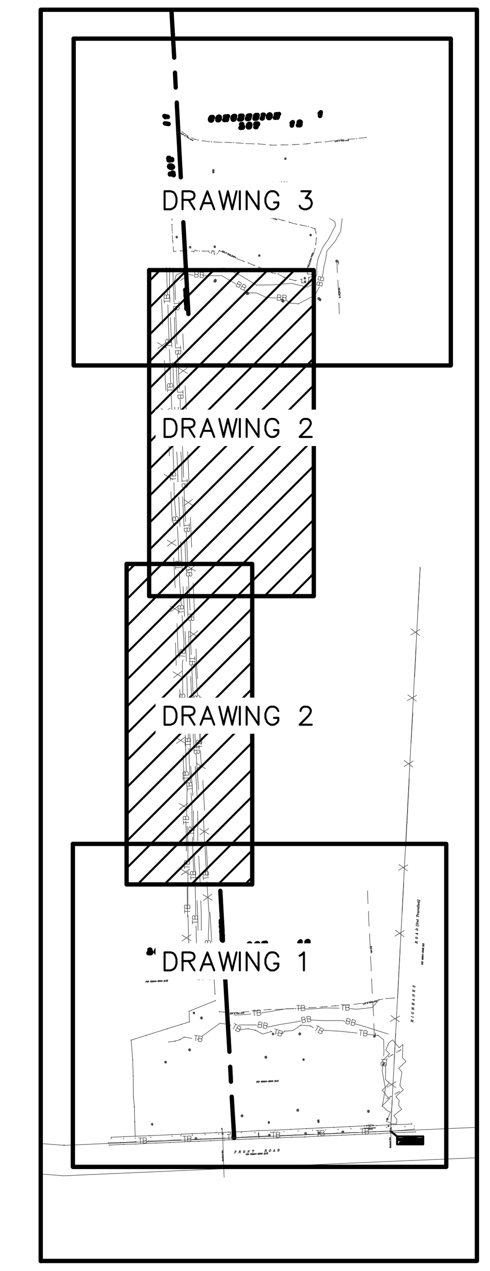
PROJECT: COLLINS BAY

DRAWING TITLE: EXISTING CONDITIONS PLAN 1

Designed By: M.J.	Date: JUNE 6, 2014.	Project No.	Drawing No.
Drawn By: N.B.		1274	1
Checked By: M.J.	Scale: 1:500		







LEGEND

ELEVATION — TOPOGRAPHIC INFORMATION PROVIDED BY HOPKINS, CORMIER & CHITTY SURVEYING CONSULTANTS INC. ONTARIO LAND SURVEYORS NOVEMBER 2012.

DESCRIPTION / ELEVATION — TOPOGRAPHIC INFORMATION OBTAINED BY JOSSELYN ENGINEERING INC. MAY 2014.

FENCE LINE

DITCH

TOP OF BANK

BOTTOM OF BANK

LOT LINE

EDGE OF GRAVEL

MONITOR WELL

78.40/test_pit-3 TP — TEST PIT NUMBER — GROUND ELEVATION — TEST PIT LOCATION

No.	By	Date	Revision	Checked

Josselyn Engineering Inc.

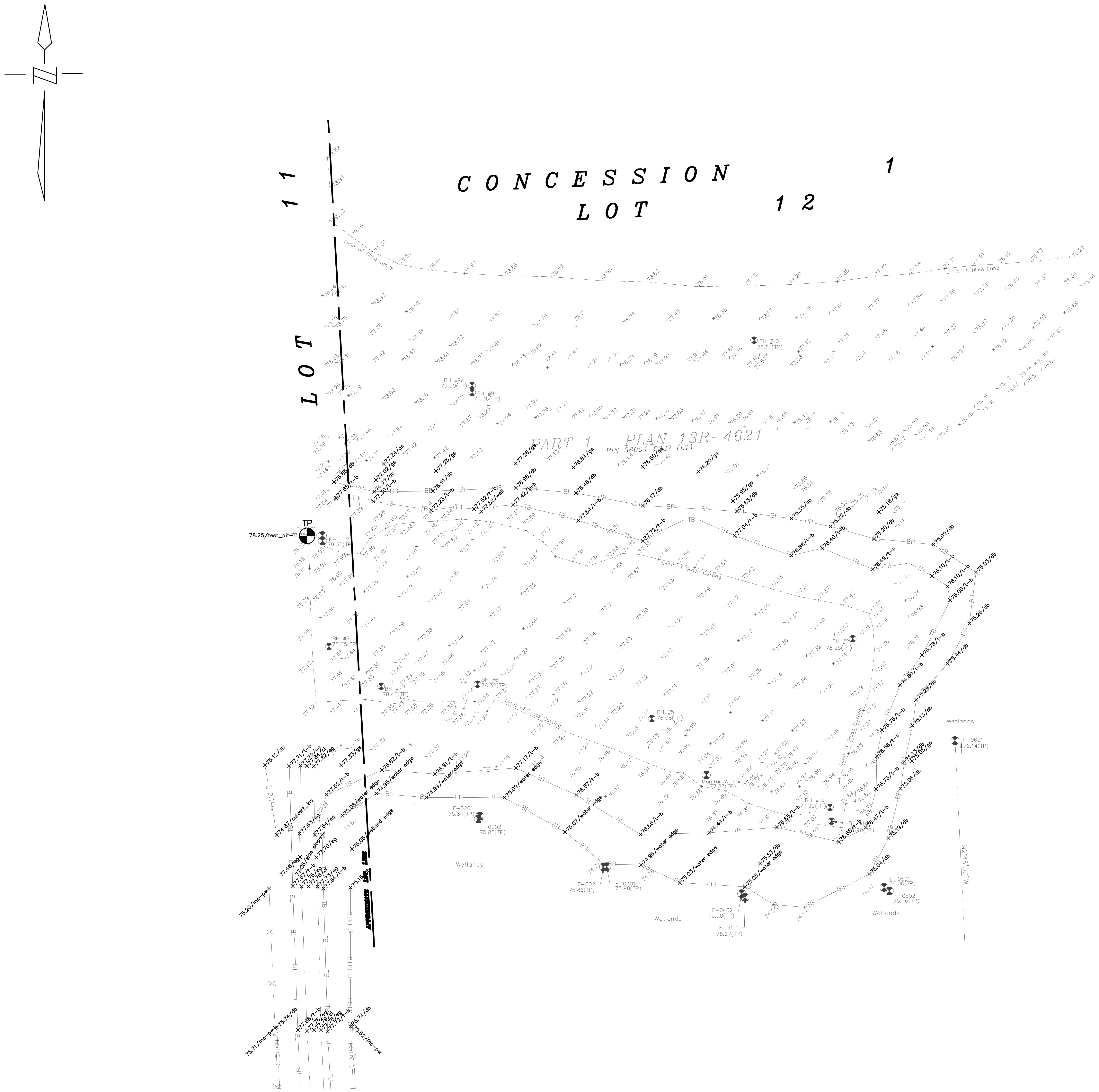
1225 GARDINERS ROAD
SUITE 105
KINGSTON, ONTARIO K7P 2R9
TEL : 613-634-9278
FAX : 613-634-9138
E-MAIL :mjosselyn@josselyn.ca

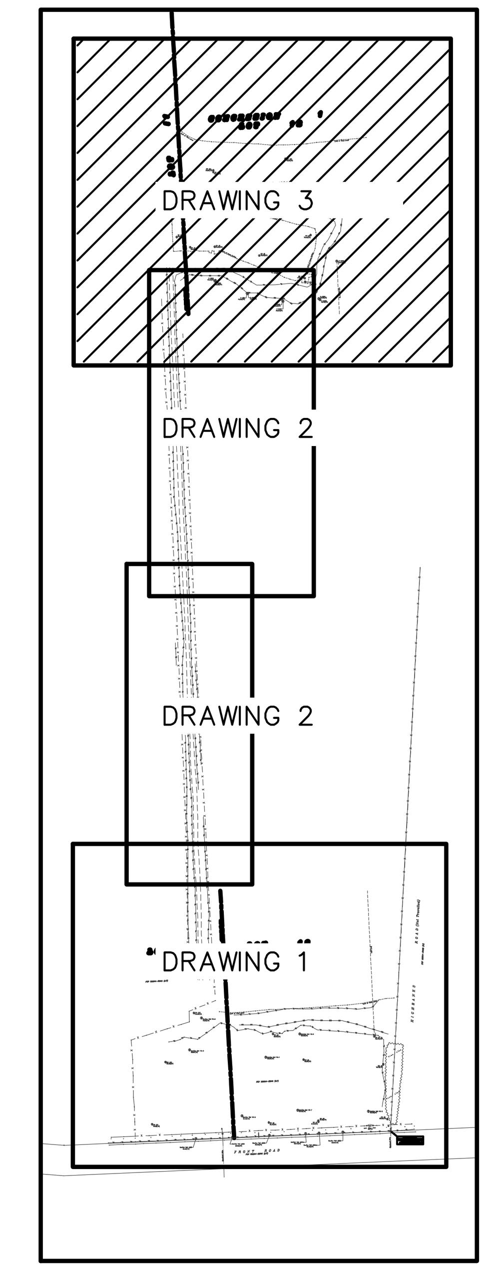
OWNER: CORRECTIONAL SERVICE CANADA

PROJECT: COLLINS BAY

DRAWING TITLE: EXISTING CONDITIONS PLAN 2

Designed By: M.J.	Date: JUNE 6, 2014	Project No. 1274	Drawing No. 2
Drawn By:	Scale: 1:500		
Checked By: M.J.			





LEGEND

ELEVATION — TOPOGRAPHIC INFORMATION PROVIDED BY HOPKINS, CORMIER & CHITTY SURVEYING CONSULTANTS INC. ONTARIO LAND SURVEYORS NOVEMBER 2012.

DESCRIPTION / ELEVATION — TOPOGRAPHIC INFORMATION OBTAINED BY JOSSELYN ENGINEERING INC. MAY 2014.

FENCE LINE

DITCH

TOP OF BANK

BOTTOM OF BANK

LOT LINE

EDGE OF GRAVEL

MONITOR WELL

78.40/test_pit-3 — TEST PIT NUMBER — GROUND ELEVATION — TEST PIT LOCATION

No.	By	Date	Revision	Checked

Josselyn Engineering Inc.

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TEL : 613-634-9278
FAX : 613-634-9138
E-MAIL :mjosselyn@josselyn.ca

OWNER: CORRECTIONAL SERVICE CANADA

PROJECT: COLLINS BAY

DRAWING TITLE: EXISTING CONDITIONS PLAN 3

Designed By: M.J.	Date: JUNE 6, 2014.	Project No.	Drawing No.
Drawn By: N.B.		1261	3
Checked By: M.J.	Scale: 1:500		

APPENDIX 8

SITE PHOTO LOG

(2 pages)

Figure 1 – North extent of road, looking south

Figure 2 – Approximately midpoint of road, looking south

Figure 3 – Poor performing area, approximately 100m from end of road

APPENDIX 9

DESIGN NOMOGRAPH

(1 page)

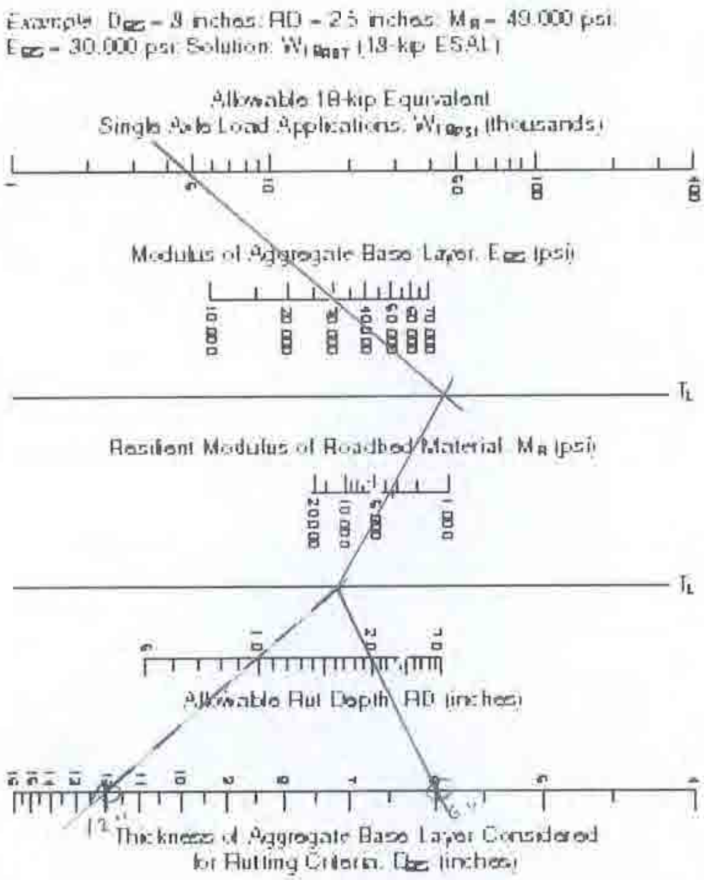

Figure 12: Design Chart for Aggregate-Surfaced Roads Considering Allowable Rutting. (39) From *AASHTO Guide for Design of Pavement Structures*. Copyright 1993, by the American Association of State Highway and Transportation Officials, Washington, D.C. Used by permission.

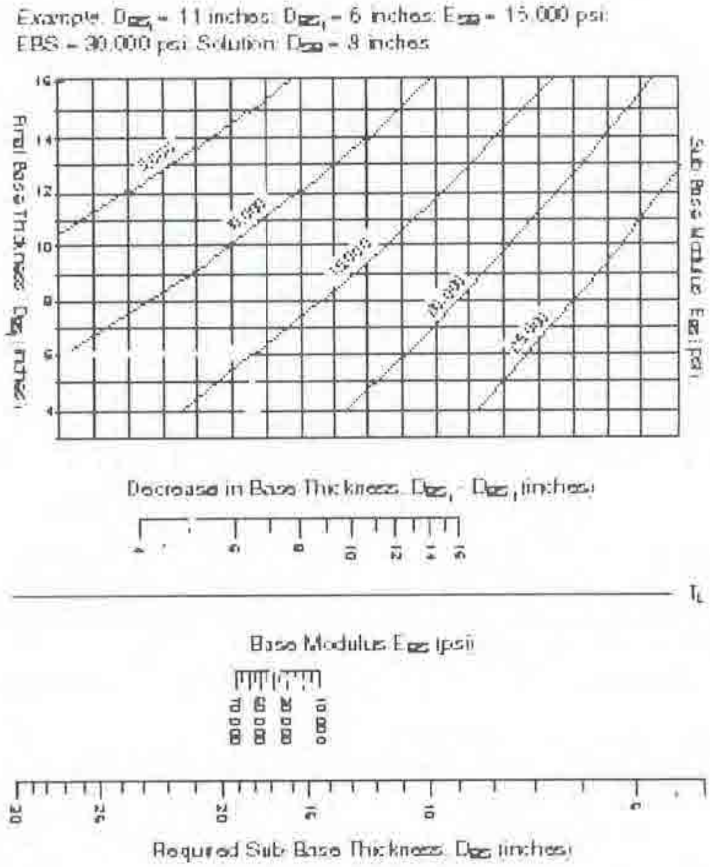

Figure 13: Chart to Convert a Portion of the Aggregate Base Layer Thickness to an Equivalent Thickness of Sub-base. (39) From *AASHTO Guide for Design of Pavement Structures*. Copyright 1993, by the American Association of State Highway and Transportation Officials, Washington, D.C. Used by permission.

Step 5: Determine allowable 18-kip EASL traffic for serviceability criteria. For each trial base thickness the allowable W_{18} ESAL can be calculated from the serviceability base nomograph of Figure 11. For example, the 11-inch trial thickness yields the following allowable W_{18} for the above stated criteria: W_{18} = 400,000 for Winter season, 10,000 for Spring/Thaw season, 32,000 for Spring/Fall season, and 90,000 for Summer season as shown in the table of the 2nd trial. These values are recorded in column 5 of Table 4.

Step 6: Determine allowable 18-kip EASL traffic for rutting criteria. For each trial base thickness the allowable W18 ESAL can be calculated from the rutting depth-base nomograph of Figure 12. From the nomograph, W_{18} = 80,000 for Winter season, 7,300 for Spring/Thaw season, 23,000 for Spring/Fall season, and 38,000 for Summer season as shown in the table of the 1st trial. These values are recorded in column 7 of Table 4.

Step 7: Determine seasonal damage (serviceability and rutting criteria). The seasonal values of damages are calculated for serviceability criteria by dividing the projected seasonal traffic (column 4) by allowable traffic in that season (column 5). The corresponding damage for the serviceability criteria is then calculated as (Damage) = 8,750/400,000 = 0.022 and recorded in column 6 as shown in the table of the 1st trial. The same procedure is applied for rutting criteria where the seasonal damages are calculated by dividing column 4 by column 7 and recorded in column 8 as: [Damage = 8,750/80,000 = 0.109].

Step 8: Determine average base thickness. Once the total damages for both serviceability and rutting criteria are completed for the four trial thicknesses, two curves are developed as shown in Figure 14. The first curve represents the relationship between serviceability failure and base thickness (D_{BS}) and the other curve represent rutting failure and base thickness. Average base thickness for each damage criteria is determined by interpolating the corresponding base thickness value for a total damage of 1.0. From Figure 5 these values are $\bar{D}_{BS}$ = 12.9 inches for rutting criteria and $\bar{D}_{BS}$ = 10.6 inches for serviceability criteria. In this example rutting governs, so the design base thickness should be 13 inches.

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Kingston (Ontario)
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BOREHOLE LOGS

CSC Collins Bay Landfill 1 (CSC ID 441-L02)

Kingston, Ontario

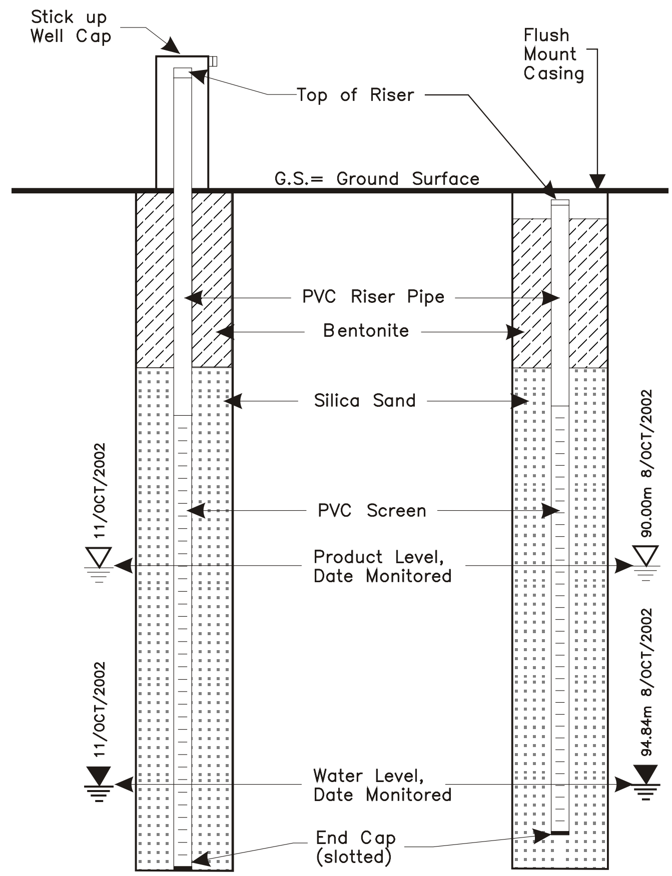
SNC•LAVALIN Environment

BOREHOLE LOG LEGEND

SAMPLING

- SPLIT SPOON SAMPLE
- AUGER SAMPLE
- DIRECT PUSH OR CONTINUOUS SOIL SAMPLE
- SAMPLE SUBMITTED FOR LABORATORY ANALYSIS
- BEDROCK CORE
- DAYLIGHTED HOLE SAMPLE
- GRAB SAMPLE
- AIR ROTARY/ TRI–CONE

WELL INSTALLATION



GRAPHIC LOG

WELL MATERIALS

SILICA SAND, FILL, GRAVEL, GROUT, SAND AND GRAVEL FILL, BENTONITE, CONCRETE, PEA GRAVEL

NATIVE SOILS

SANDY CLAY, SANDY SILT, CLAYEY SAND, TOPSOIL, CLAY, SILT, SAND, GRAVEL, PEAT, TILL, SILTY CLAY, CLAYEY SILT, SILTY SAND, SANDY GRAVEL

FILL

ASPHALT, CONCRETE, GRAVEL, SAND, SILTY SAND, SILT, CLAY, PAVEMENT, MIXED DEBRIS, SOD, SANDY TOPSOIL AND GRAVEL, PAVEMENT PIECES, BOULDERS, SAND & GRAVEL, CLAYEY SAND, SANDY CLAY

BEDROCK

UNDIFFER–ENTIATED ROCK, LIMESTONE, SANDSTONE, GRANITE, SHALE, WEATHERED SHALE, IGNEOUS, META–MORPHIC, SEDIMENTARY, VOLCANIC

FILE NAME: LEGEND_BH_SEP–2012.CDR

SNC•LAVALIN Environment

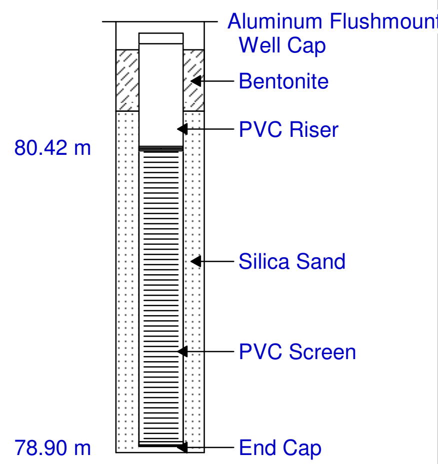
Borehole/Monitoring Well ID: BH-201 (MW-201)

Project No.: 12317A
Client: PWGSC
Location: CSC Frontenac Landfill No. 1
Date Completed: October 18, 2012
Site Datum: Geodetic

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 10.8 cm
Monitoring Well Diameter: 5.1 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 7822DT
Well Casing: Aluminum Flushmount
Well Screen: PVC Schedule 40 Slot 10
OVM: GasTech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	81.10
0–2.5 ft	NA	BH-201-1		<5	50		SAND and GRAVEL FILL dry to moist, dark brown, loose	
2.5–5 ft	NA	BH-201-2	◆	<5	50			80.00
5–7.2 ft	NA	BH-201-3	◆	<5	65		clayey SAND dry to moist, dark brown, compact, with fractured limestone bedrock	79.00
							End of borehole at 2.2 m bgs. Refusal at bedrock.	78.00 / 77.00 / 76.00



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ Sample submitted for laboratory analysis.

Borehole/Monitoring Well ID: BH-202 (MW-202)

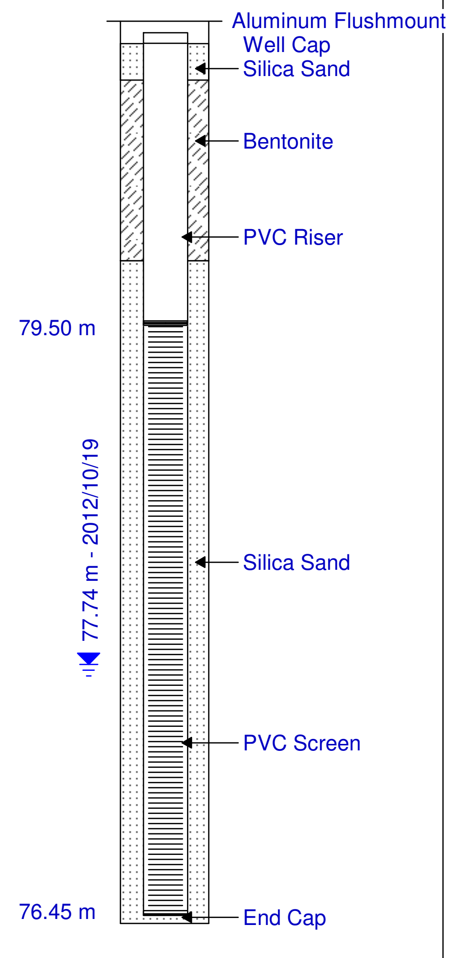
SNC·LAVALIN Environment

Project No.: 12317A
Client: PWGSC
Location: CSC Frontenac Landfill No. 1
Date Completed: October 19, 2012
Site Datum: Geodetic

SLE Supervisor: E. Kelly
Drilling Method: Direct Push / Air Hammer
Borehole Diameter: 10.8 cm / 7.6 cm
Monitoring Well Diameter: 5.1 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe/Geomachine
Well Casing: Aluminum Flushmount
Well Screen: PVC Schedule 40 Slot 10
OVM: GasTech 1238 ME

DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
0							Ground Surface	81.05
0–0.5	NA	BH-202-1		<5	28		SAND and GRAVEL FILL dry to moist, dark brown	
0.5–1.0	NA	BH-202-2	◆	<5	28		clayey SAND dry to moist, dark brown, compact, with fractured limestone bedrock	80.00
1.0–1.2	NA	BH-202-3	◆	<5	28		TILL fractured limestone bedrock	
1.2–3.0	NA	NA		NA	NA		bedrock refusal at 1.8 m bgs no sample	79.00
							End of borehole at 4.6 m bgs.	



Depth scale: ft 0–18; m 0–5. Elevation scale: 81.05, 80.00, 79.00, 78.00, 77.00, 76.00.

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ Sample submitted for laboratory analysis.

SNC•LAVALIN Environment

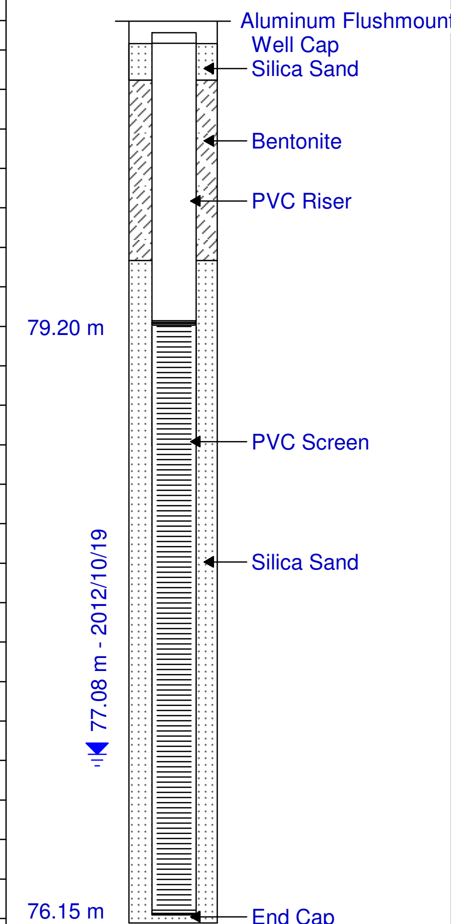
Borehole/Monitoring Well ID: BH-203 (MW-203)

Project No.: 12317A
Client: PWGSC
Location: CSC Frontenac Landfill No. 1
Date Completed: October 19, 2012
Site Datum: Geodetic

SLE Supervisor: E. Kelly
Drilling Method: Direct Push / Air Hammer
Borehole Diameter: 10.8 cm / 7.6 cm
Monitoring Well Diameter: 5.1 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe/Geomachine
Well Casing: Aluminum Flushmount
Well Screen: PVC Schedule 40 Slot 10
OVM: GasTech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
0 / 0							Ground Surface	80.75
0–2.5 ft	NA	BH-203-1	◆	<5	67		SAND and GRAVEL FILL dry to moist, dark brown clayey SAND moist, light brown, loose	80.00
2.5–5 ft / 1 m	NA	BH-203-2	◆	<5	67		silty SAND light brown, loose, trace clay wet	
5–15 ft / 2–4 m	NA	NA		NA	NA		bedrock refusal at 1.6 m bgs no sample	79.00 78.00 77.00
15–18 ft / 5 m							End of borehole at 4.6 m bgs.	76.00



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ Sample submitted for laboratory analysis.

BH-203-99 duplicate of BH-203-2.

SLE 4

Borehole/Monitoring Well ID: BH-204D (MW-204D)

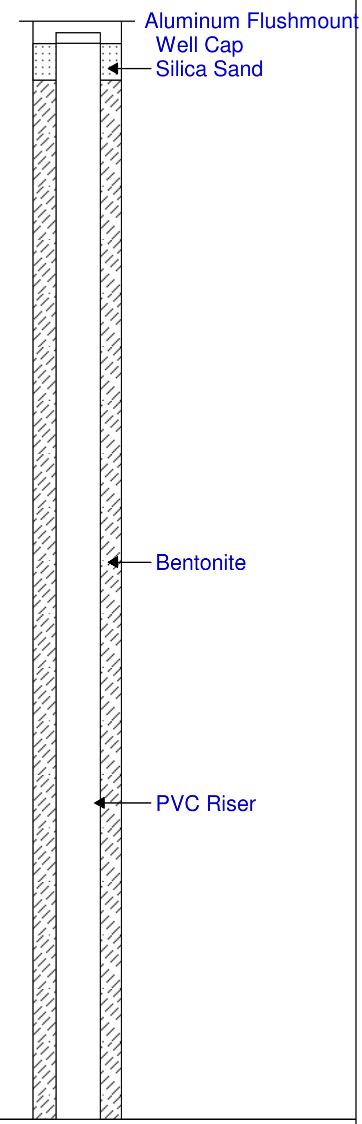
SNC•LAVALIN Environment

Project No.: 12317A
Client: PWGSC
Location: CSC Frontenac Landfill No. 1
Date Completed: October 19, 2012
Site Datum: Geodetic

SLE Supervisor: E. Kelly
Drilling Method: Direct Push / Air Hammer
Borehole Diameter: 10.8 cm / 7.6 cm
Monitoring Well Diameter: 5.1 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geomachine100
Well Casing: Aluminum Flushmount
Well Screen: PVC Schedule 40 Slot 10
OVM: GasTech 1238 ME

DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	DESCRIPTION	ELEVATION (m)
						Ground Surface	80.45
0	NA	BH-204D-1		<5	52	SAND and GRAVEL FILL moist, dark brown, loose	
						clayey SAND moist to wet, dark brown, soft, mottled	80.00
1	NA	BH-204D-2	◆	<5	52		
	NA	BH-203D-3	◆	<5	64	silty SAND wet, light brown, soft, trace clay; no clay	79.00
2						bedrock refusal at 2.1 m bgs no sample	78.00
3							77.00
4							76.00
5						possible fractures	75.00



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ Sample submitted for laboratory analysis.

BH-204D-99 duplicate of BH-204D-2.

SLE 4

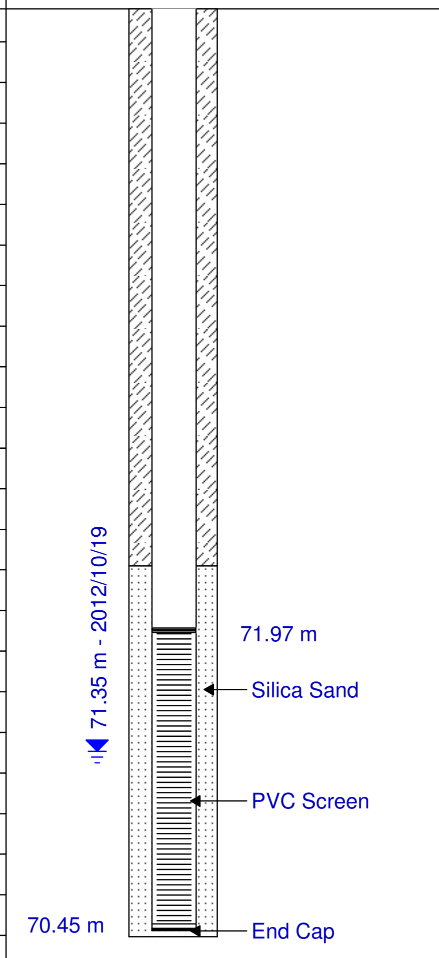
Borehole/Monitoring Well ID: BH-204D (MW-204D)

Project No.: 12317A
Client: PWGSC
Location: CSC Frontenac Landfill No. 1
Date Completed: October 19, 2012
Site Datum: Geodetic

SLE Supervisor: E. Kelly
Drilling Method: Direct Push / Air Hammer
Borehole Diameter: 10.8 cm / 7.6 cm
Monitoring Well Diameter: 5.1 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geomachine100
Well Casing: Aluminum Flushmount
Well Screen: PVC Schedule 40 Slot 10
OVM: GasTech 1238 ME

DEPTH	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
19								
20	6	NA	NA	NA	NA			
21								74.00
22								
23	7							
24								73.00
25								
26	8							
27							possible fractures	
28								72.00
29								
30	9							
31								71.00
32								
33	10						End of borehole at 10.0 m bgs.	
34								70.00
35								
36								



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ Sample submitted for laboratory analysis.

SNC•LAVALIN Environment

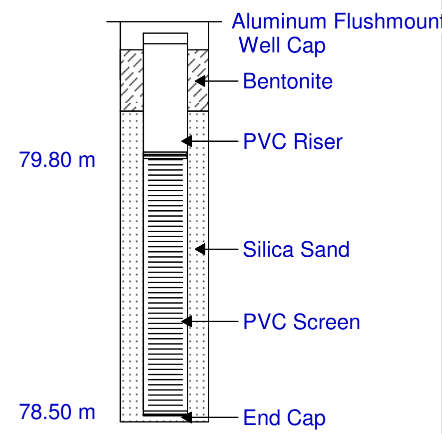
Borehole/Monitoring Well ID: BH-204S (MW-204S)

Project No.: 12317A
Client: PWGSC
Location: CSC Frontenac Landfill No. 1
Date Completed: October 18, 2012
Site Datum: Geodetic

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 10.8 cm
Monitoring Well Diameter: 5.1 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 7822DT
Well Casing: Aluminum Flushmount
Well Screen: PVC Schedule 40 Slot 10
OVM: GasTech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	80.50
0–0.5 m	NA	BH-204S-1		<5	48		SAND and GRAVEL FILL moist, dark brown, loose clayey SAND moist to wet, dark brown, soft, mottled	80.00
0.5–1.0 m	NA	BH-204S-2	◆	<5	48		silty SAND wet, light brown, soft, trace clay	
1.0–1.5 m	NA	BH-204S-3	◆	10	25			79.00
2 m							End of borehole at 2.0 m bgs. Refusal at bedrock.	78.00
								77.00
								76.00
18 ft								75.00



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

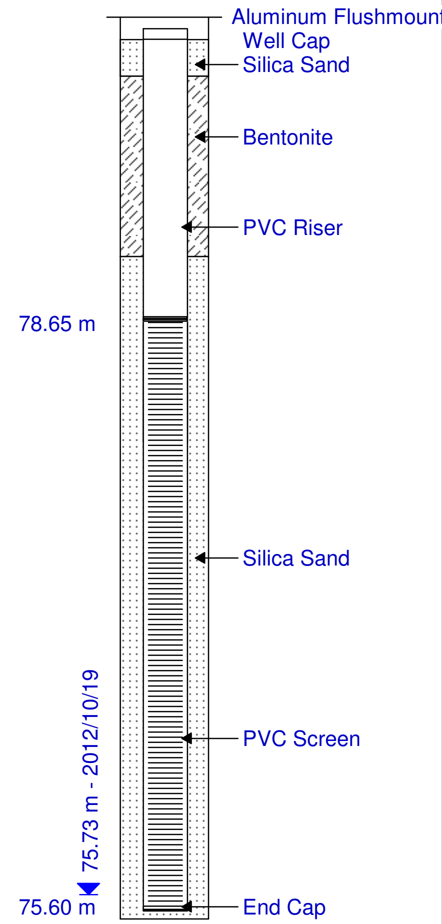
◆ Sample submitted for laboratory analysis.

Borehole/Monitoring Well ID: BH-205 (MW-205)

SNC•LAVALIN Environment

Project No.: 12317A	**SLE Supervisor:** E. Kelly	**Drilling Company:** Strata Soil Inc.
Client: PWGSC	**Drilling Method:** Direct Push / Air Hammer	**Drilling Equipment:** Geoprobe/Geomachine
Location: CSC Frontenac Landfill No. 1	**Borehole Diameter:** 10.8 cm / 7.6 cm	**Well Casing:** Aluminum Flushmount
Date Completed: October 19, 2012	**Monitoring Well Diameter:** 5.1 cm	**Well Screen:** PVC Schedule 40 Slot 10
Site Datum: Geodetic		**OVM:** GasTech 1238 ME

DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
0							Ground Surface	80.20
0–0.5	NA	BH-205-1	◆	<5	57		SAND and GRAVEL FILL moist, dark brown, loose; clayey SAND moist to wet, dark brown, soft, mottled, slight oxidation	
0.5–1.0	NA	BH-205-2		<5	57		silty SAND wet, light brown, soft, trace clay	
1.0–1.2	NA	BH-205-3		<5	100			
1.2–1.4	NA	BH-205-4	◆	<5	100			
1.4–3.0	NA	NA		NA	NA		fractured limestone bedrock; bedrock refusal at 2.1 m bgs no sample	
3.0							End of borehole at 4.6 m bgs.	



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ Sample submitted for laboratory analysis.

SLE 4

amec

RECORD OF BOREHOLE No BH2

Project Client: PWGSC
Location: Frontenac Institution, Landfill 1, Collins Bay, Ontario
Logged By: DN

Project Number: TC111025.1000
Borehole Type & Drilling Equipment: 200 mm Dia. Hollow Stem Augering, Track Mounted Drill CME-55
Compiled By: ZF

Project Datum: NA
Date: September 19, 2011
Checked By: SG

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	REMARKS
0.0	brown Clay **FILL** trace to some silt, sands, gravel dry to damp	1	AU			
		2	SS	33	10	
		3	SS	59	6	BH2 5-7 - submitted for Metals.
	grey black staining	4	SS	25	5	BH2 7.5-9.5 - submitted for PAH.
	damp to moist	5	SS	50	8	BH2 10-12 - submitted for PHC F1-F4 and BTEX.
	moist to wet	6	SS	16	12	
4.4	**BEDROCK (ROCK)**					BH2 23-25 - submitted for Metals.
7.6	grey **CLAY** wet	7	SS	16	50+	BH2 25-27 - submitted for PAH. -Slight PAH-like odour
8.2	grey limestone **BEDROCK**					-Hydrocarbon odour -Sulfur odour

Combustible Organic Vapour (RKI Eagle 2), ppm: nd (samples 1, 2, 5, 6)

DYNAMIC CONE PENETRATION TEST; STANDARD PENETRATION TEST (SPT) 10 20 30 40; Combustible Organic Vapour, % LEL 20 40 60 80; DEPTH (m) 1–9; G.W. CONDITION; ELEVATION (m); WELL INSTALLATION; STRAT PLOT

amec

RECORD OF BOREHOLE No BH2

Project Client: PWGSC
Location: Frontenac Institution, Landfill 1, Collins Bay, Ontario
Logged By: DN

Project Number: TC111025.1000
Borehole Type & Drilling Equipment: 200 mm Dia. Hollow Stem Augering, Track Mounted Drill CME-55
Compiled By: ZF

Project Datum: NA
Date: September 19, 2011
Checked By: SG

SOIL PROFILE			SAMPLES									DYNAMIC CONE PENETRATION TEST □ / STANDARD PENETRATION TEST (SPT) ■	Combustible Organic Vapour, % LEL ▲ (20 40 60 80) / (RKI Eagle 2) Combustible Organic Vapour, ppm ● (20 40 60 80)	REMARKS
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	DEPTH (m)	G.W. CONDITION	ELEVATION (m)	WELL INSTALLATION		10 20 30 40		
11.0	**End of Borehole** Measured ground water depth on –, 2011: – mbgs Well Detail: 50 mm PVC shed 40 (9.47 m - 10.99 m) with sand pack (8.84 m - 10.99 m), bentonite plug above sand, capped with flush threaded joints screw-on flat end cap.													

amec

RECORD OF BOREHOLE No BH3

Project Client: PWGSC
Location: Frontenac Institution, Landfill 1, Collins Bay, Ontario
Logged By: DN

Project Number: TC111025.1000
Borehole Type & Drilling Equipment: 200 mm Dia. Hollow Stem Augering, Track Mounted Drill CME-55
Compiled By: ZF

Project Datum: NA
Date: September 20, 2011
Checked By: SG

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	SPT	Combustible Organic Vapour, ppm (RKI Eagle 2)	REMARKS
0.0	Grassed Surface brown **CLAY** with silt, trace sands, gravel, asphalt, red brick fragments, damp	1	AU				nd	
	abundant limestone frgaments in matrix	2	SS	16	7	7	25	
1.5	grey-brown **SILT** trace to some clay, organics, damp	3	SS	75	10	10	nd	BH3 5-7 - submitted for Metals.
		4	SS	75	8	8	25	BH3 7.5-9.5 - submitted for PAH, PHC F1-F4 and BTEX.
3.0	**BEDROCK** 6" seam 6" seam							
6.1	**End of Borehole**							

Measured ground water depth on –, 2011: – mbgs

Well Detail:
50 mm PVC shed 40
(4.57 m - 6.10 m)
with sand pack (3.96 m - 6.10 m),
bentonite plug above sand,
monument casing at grade with
j-plug on top.

Chart headings: DEPTH (m) 1–6; G.W. CONDITION; ELEVATION (m); WELL INSTALLATION; DYNAMIC CONE PENETRATION TEST □; STANDARD PENETRATION TEST (SPT) ■ 10 20 30 40; Combustible Organic Vapour, % LEL ▲ 20 40 60 80; (RKI Eagle 2) Combustible Organic Vapour, ppm ● 20 40 60 80; STRAT PLOT

amec

RECORD OF BOREHOLE No BH4

Project Client: PWGSC
Location: Frontenac Institution, Landfill 1, Collins Bay, Ontario
Logged By: DN

Project Number: TC111025.1000
Borehole Type & Drilling Equipment: 200 mm Dia. Hollow Stem Augering, Track Mounted Drill CME-55
Compiled By: ZF

Project Datum: NA
Date: September 20, 2011
Checked By: SG

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	RECOVERY (%)	"N" VALUE	Combustible Organic Vapour, ppm (RKI Eagle 2)	REMARKS
0.0	Grassed Surface brown Silt **FILL** with some clay, trace sands, gravel, red brick fragments damp	1	AU			nd	BH4 0-2.5 - submitted for Metals.
	Clay	2	SS	41	7	25	
		3	SS	41	6	25	
	moist to damp	4	SS	25	3	25	BH4 7.5-9.5 - submitted for PHC F1-F4 and BTEX.
3.1	**BEDROCK**	5	SS	100	50+	25	
6.1	**End of Borehole**						

Column headings: STRAT PLOT; DEPTH (m); G.W. CONDITION; ELEVATION (m); WELL INSTALLATION; DYNAMIC CONE PENETRATION TEST □; STANDARD PENETRATION TEST (SPT) ■ (10 20 30 40); Combustible Organic Vapour, % LEL ▲ (20 40 60 80); (RKI Eagle 2) Combustible Organic Vapour, ppm ● (20 40 60 80)

End of Borehole

Measured ground water depth on –, 2011: – mbgs

Well Detail:
50 mm PVC shed 40
(4.57 m - 6.10 m)
with sand pack (3.96 m - 6.10 m),
bentonite plug above sand,
monument casing at grade with
j-plug on top.

amec

RECORD OF BOREHOLE No BH5

Project Client: PWGSC
Location: Frontenac Institution, Landfill 1, Collins Bay, Ontario
Logged By: DN

Project Number: TC111025.1000
Borehole Type & Drilling Equipment: 200 mm Dia. Hollow Stem Augering, Track Mounted Drill CME-55
Compiled By: ZF

Project Datum: NA
Date: September 20, 2011
Checked By: SG

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	RECOVERY (%)	"N" VALUE	Combustible Organic Vapour (RKI Eagle 2), ppm	REMARKS
0.0	Grassed Surface dark grey to black granular Silt/Clay **FILL** mixed with sand/gravel and sand/gravel size crushed asphalt dense packed, damp	1	AU			nd	BH5 0-2.5+DUPS-1 - submitted for Metals.
	brown Clay/Silt mixed with 50 granular limestone trace asphalt	2	SS	25	29	nd	
	abundant granular limestone (sand, gravel) some red brick fragments	3	SS		11	nd	BH5 5-7 - submitted for PAH.
2.3	grey **CLAY** with silt, trace sand, gravel and grey limestone chips, moist	4	SS		4	nd	
2.9	**BEDROCK** 4" seam						BH5 9-10 - submitted for PHC F1-F4 and BTEX.
6.1	**End of Borehole**						

Chart scales: Dynamic Cone Penetration Test □; Standard Penetration Test (SPT) ■: 10, 20, 30, 40. Combustible Organic Vapour, % LEL ▲: 20, 40, 60, 80. Combustible Organic Vapour, ppm ●: 20, 40, 60, 80. Depth (m): 1–6.

Measured ground water depth on –, 2011: – mbgs

Well Detail:
50 mm PVC shed 40
(4.57 m - 6.10 m)
with sand pack (3.96 m - 6.10 m),
bentonite plug above sand,
monument casing at grade with
j-plug on top.

amec

RECORD OF BOREHOLE No BH6

Project Client: PWGSC
Location: Frontenac Institution, Landfill 1, Collins Bay, Ontario
Logged By: DN

Project Number: TC111025.1000
Borehole Type & Drilling Equipment: 200 mm Dia. Hollow Stem Augering, Track Mounted Drill CME-55
Compiled By: ZF

Project Datum: NA
Date: September 21, 2011
Checked By: SG

ELEV DEPTH (m)	DESCRIPTION (SOIL PROFILE)	SAMPLE NUMBER	TYPE	RECOVERY (%)	"N" VALUE	SPT	Combustible Organic Vapour, ppm (RKI Eagle 2)	REMARKS
0.0	Grassed Surface dark brown Silt/Clay **FILL** trace sands, gravel, concrete with rebar, organics damp	1	AU				nd	BH6 0-2.5 - submitted for Metals.
1.0	buff **SILT** indistinct fluvial structures dry to damp — moist at tip	2	SS	100	18	■	nd	
		3	SS	62	20	■	nd	BH6 6.5-7.5 - submitted for PAH, PHC F1-F4 and BTEX.
2.3	loose limestone **BEDROCK** — fractured zone — fractured zone — fractured zone							
7.6	**End of Borehole**							

Graph scales: DYNAMIC CONE PENETRATION TEST □; STANDARD PENETRATION TEST (SPT) ■ (10, 20, 30, 40); Combustible Organic Vapour, % LEL ▲ (20, 40, 60, 80); (RKI Eagle 2) Combustible Organic Vapour, ppm ● (20, 40, 60, 80). Columns: STRAT PLOT, DEPTH (m), G.W. CONDITION, ELEVATION (m), WELL INSTALLATION.

Measured ground water depth on –, 2011: – mbgs

Well Detail:
50 mm PVC shed 40
(6.10 m - 7.62 m)
with sand pack (5.49 m - 7.62 m),
bentonite plug above sand,
monument casing at grade with
j-plug on top.

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RECORD OF BOREHOLE No BH7

Project Client: PWGSC
Location: Frontenac Institution, Landfill 1, Collins Bay, Ontario
Logged By: DN

Project Number: TC111025.1000
Borehole Type & Drilling Equipment: 200 mm Dia. Hollow Stem Augering, Track Mounted Drill CME-55
Compiled By: ZF

Project Datum: NA
Date: September 21, 2011
Checked By: SG

ELEV DEPTH (m)	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	TYPE	RECOVERY (%)	"N" VALUE	Combustible Organic Vapour, ppm (RKI Eagle 2)	REMARKS
0.0	brown **SILT** trace clay, sands, gravel damp	1	AU			nd	
0.8	brown to brown-grey Clay/Silt **FILL** abundant limestone fragments (sand/gravel size) brick damp	2	SS	100	25	nd	BH7 2.5-4.5 - submitted for Metals.
	grey to grey-brown	3	SS	62	15	nd	
	dark grey with trace to some sands trace gravel, brick moist to wet	4	SS	25	3		
	brown-grey to grey Clay / asphalt, gravel	5	SS	75	20	nd	-Strong PAH-like odour
	grey, fine-medium Sand trace gravel wet	6	SS		8		BH7 12.5-14.5+DUPS-4 - submitted for PAH, PHC F1-F4 and BTEX. -PAH-like odour
	dark grey mix of Clay, Silt and Sand trace gravel, wood, organics	7	SS	13	5	nd	-PAH-like odour
	dark grey Clay/Silt with sands, limestone, wood	8	SS	16	20	nd	-PAH-like odour
	dark grey-black Silt with some clay, trace to some sands, limestone fragments wet	9	SS	13	50+		BH7 22.5-24.5+DUPS-3 - submitted for PAH. -PAH-like odour
7.5	**BEDROCK**						

Column headings also printed: STRAT PLOT; DEPTH (m); G.W. CONDITION; ELEVATION (m); WELL INSTALLATION; DYNAMIC CONE PENETRATION TEST □; STANDARD PENETRATION TEST (SPT) ■ 10 20 30 40; Combustible Organic Vapour, % LEL ▲ 20 40 60 80; (RKI Eagle 2) Combustible Organic Vapour, ppm ● 20 40 60 80.

Depth scale (m): 1, 2, 3, 4, 5, 6, 7, 8, 9

RECORD OF BOREHOLE No BH7

Project Client:	PWGSC	Location:	Frontenac Institution, Landfill 1, Collins Bay, Ontario	Logged By:	DN
Project Number:	TC111025.1000	Borehole Type & Drilling Equipment:	200 mm Dia. Hollow Stem Augering, Track Mounted Drill CME-55	Compiled By:	ZF
Project Datum:	NA	Date:	September 21, 2011	Checked By:	SG

SOIL PROFILE			SAMPLES								DYNAMIC CONE PENETRATION TEST □ / STANDARD PENETRATION TEST (SPT) ■ (10 20 30 40)	Combustible Organic Vapour, % LEL ▲ (20 40 60 80) / (RKI Eagle 2) Combustible Organic Vapour, ppm ● (20 40 60 80)	REMARKS
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	DEPTH (m)	G.W. CONDITION	ELEVATION (m)	WELL INSTALLATION			
10.7	**End of Borehole** Measured ground water depth on –, 2011: – mbgs Well Detail: 50 mm PVC shed 40 (9.14 m - 10.67 m) with sand pack (8.53 m - 10.67 m), bentonite plug above sand, monument casing at grade with j-plug on top.												

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RECORD OF BOREHOLE No BH8

Project Client: PWGSC
Location: Frontenac Institution, Landfill 1, Collins Bay, Ontario
Logged By: DN

Project Number: TC111025.1000
Borehole Type & Drilling Equipment: 200 mm Dia. Hollow Stem Augering, Track Mounted Drill CME-55
Compiled By: ZF

Project Datum: NA
Date: September 21, 2011
Checked By: SG

ELEV DEPTH (m)	DESCRIPTION (SOIL PROFILE)	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	DEPTH (m)	G.W. CONDITION	ELEVATION (m)	WELL INSTALLATION	DYNAMIC CONE PENETRATION TEST / STANDARD PENETRATION TEST (SPT) 10 20 30 40	Combustible Organic Vapour, % LEL 20 40 60 80 / (RKI Eagle 2) Combustible Organic Vapour, ppm 20 40 60 80	REMARKS
0.0	brown **SILT** trace clay, sands, gravel damp												Stratigraphy inferred from BH7
0.8	brown to brown-grey Clay/Silt **FILL** abundant limestone fragments (sand/gravel size) brick damp — grey to grey-brown — dark grey with trace to some sands trace gravel, brick moist to wet — brown-grey to grey Clay — asphalt, gravel — grey, fine-medium Sand trace gravel wet — dark grey mix of Clay, Silt and Sand trace gravel, wood, organics						1 2 3 4 5 6						
6.1	**End of Borehole** Measured ground water depth on –, 2011: – mbgs Well Detail: 50 mm PVC shed 40 (4.57 m - 6.10 m) with sand pack (3.96 m - 6.10 m), bentonite plug above sand, monument casing at grade with j-plug on top.												

amec

RECORD OF BOREHOLE No BH9

Project Client: PWGSC	Location: Frontenac Institution, Landfill 1, Collins Bay, Ontario		Logged By: DN
Project Number: TC111025.1000	Borehole Type & Drilling Equipment: 200 mm Dia. Hollow Stem Augering, Track Mounted Drill CME-55		Compiled By: ZF
Project Datum: NA	Date: September 22, 2011		Checked By: SG

SOIL PROFILE / SAMPLES / DYNAMIC CONE PENETRATION TEST ☐ / STANDARD PENETRATION TEST (SPT) ■ (10 20 30 40) / Combustible Organic Vapour, % LEL ▲ (20 40 60 80) / (RKI Eagle 2) Combustible Organic Vapour, ppm ● (20 40 60 80)

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	Combustible Organic Vapour, ppm	REMARKS
0.0	brown Clay **FILL** with silt, trace sands, crushed limestone damp	1	AU			nd	
		2	SS	50	12	nd	
	Clay/Silt trace sands, some gravel (limestone) asphalt, red brick and coal fragments Clay damp to moist	3	SS	33	15		BH9 5-7 - submitted for Metals.
		4	SS	50	17	nd	
	weathered concrete damp						
	crushed Limestone	5	SS		39	nd	
	No recovery	6	SS				
	dark grey to black Clay/Silt with trace sands, trace to some limestone gravel, wood fragments wet	7	SS		3	nd	BH9 15-17 - submitted for PAH, PHC F1-F4 and BTEX. -Organic odour
	dark grey to grey-black Silt	8	SS	33	17		BH9 17.5-19.5 - submitted for Metals.
		9	SS	50	9	nd	-PAH-like odour
6.7	**End of Borehole**						

Measured ground water depth on –, 2011: – mbgs

Well Detail:
50 mm PVC shed 40 (4.57 m - 6.10 m) with sand pack (3.96 m - 6.10 m), bentonite plug above sand, monument casing at grade with j-plug on top.

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RECORD OF BOREHOLE No BH11

Project Client: **PWGSC** | Location: **Frontenac Institution, Landfill 1, Collins Bay, Ontario** | Logged By: **DN**

Project Number: **TC111025.1000** | Borehole Type & Drilling Equipment: **200 mm Dia. Hollow Stem Augering, Track Mounted Drill CME-55** | Compiled By: **ZF**

Project Datum: **NA** | Date: **September 22, 2011** | Checked By: **SG**

ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	DEPTH (m)	G.W. CONDITION	ELEVATION (m)	WELL INSTALLATION	DYNAMIC CONE PENETRATION TEST □ / STANDARD PENETRATION TEST (SPT) ■ (10 20 30 40)	Combustible Organic Vapour, % LEL ▲ (20 40 60 80) / (RKI Eagle 2) Combustible Organic Vapour, ppm ● (20 40 60 80)	REMARKS
0.0	dark brown **CLAY** trace to some silt, sand and gravel damp		1	AU								nd	BH11 0-2.5+DUPS-6 - submitted for Metals.
	grey with gravel (limestone)		2	SS	16	4	1				■	nd	
1.5	**BEDROCK**						2						
	wet						3						
							4						
4.6	**End of Borehole** Measured ground water depth on –, 2011: – mbgs Well Detail: 50 mm PVC shed 40 (3.05 m - 4.57 m) with sand pack (2.44 m - 4.57 m), bentonite plug above sand, monument casing at grade with j-plug on top.												

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RECORD OF BOREHOLE No BH12

Project Client: PWGSC	Location: Frontenac Institution, Landfill 1, Collins Bay, Ontario		Logged By: DN
Project Number: TC111025.1000	Borehole Type & Drilling Equipment: 200 mm Dia. Hollow Stem Augering, Track Mounted Drill CME-55		Compiled By: ZF
Project Datum: NA	Date: September 23, 2011		Checked By: SG

Legend: Dynamic Cone Penetration Test □; Standard Penetration Test (SPT) ■ (scale 10, 20, 30, 40); Combustible Organic Vapour, % LEL ▲ (scale 20, 40, 60, 80); (RKI Eagle 2) Combustible Organic Vapour, ppm ● (scale 20, 40, 60, 80)

ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	DEPTH (m)	Combustible Organic Vapour, ppm	REMARKS
0.0	Grassed Surface dark brown Clay **FILL** trace silt, sands, gravel, roots, organics; damp		1	AU				nd	
			2	SS		10	1		
	brown		3	SS	84	12	2		BH12 5-7 - submitted for PAH and Metals. DUPS-7 - submitted for PAH
	grey; moist to wet		4	SS	33	6		nd	BH12 7.5-9.5 - submitted for PHC F1-F4 and BTEX.
	with limestone gravel; wet		5	SS		3	3		
3.8	**BEDROCK**		6	SS		50+	4		
4.3	**End of Borehole**								

Measured ground water depth on –, 2011: – mbgs

Well Detail:
50 mm PVC shed 40
(1.22 m - 4.27 m)
with sand pack (0.91 m - 4.27 m), bentonite plug above sand, capped with flush threaded joints screw-on flat end cap.

Column headings also printed: G.W. CONDITION; ELEVATION (m); WELL INSTALLATION

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RECORD OF BOREHOLE No BH13

Project Client: **PWGSC** | Location: **Frontenac Institution, Landfill 1, Collins Bay, Ontario** | Logged By: **DN**

Project Number: **TC111025.1000** | Borehole Type & Drilling Equipment: **200 mm Dia. Hollow Stem Augering, Track Mounted Drill CME-55** | Compiled By: **ZF**

Project Datum: **NA** | Date: **September 23, 2011** | Checked By: **SG**

ELEV DEPTH (m)	SOIL PROFILE – DESCRIPTION	SAMPLES – NUMBER	TYPE	RECOVERY (%)	"N" VALUE	DEPTH (m)	DYNAMIC CONE PENETRATION TEST □ / STANDARD PENETRATION TEST (SPT) ■ (10 20 30 40)	Combustible Organic Vapour, % LEL ▲ (20 40 60 80) / (RKI Eagle 2) Combustible Organic Vapour, ppm ● (20 40 60 80)	REMARKS
0.0	Grassed Surface brown-buff **CLAY** trace to some silt, sands moist	1	AU					nd	
0.6	brown-buff **SILT** trace clay, sands damp to moist	2	SS	100	22	1	■	nd	BH13 0.5-4.5 - submitted for PAH, PHC F1-F4, BTEX and Metals.
1.5	**BEDROCK** saturated					2 3 4			
4.6	**End of Borehole** Measured ground water depth on –, 2011: – mbgs Well Detail: 50 mm PVC shed 40 (3.05 m - 4.57 m) with sand pack (2.44 m - 4.57 m), bentonite plug above sand, monument casing at grade with j-plug on top.								

BOREHOLE/MONITORING WELL #: BH/MW-10-1

BOREHOLE LOG

Project No: 2020-1004
Project: Phase II ESA, Frontenac Institution Former Landfill #1 (CSC-ID: 441-L02)
Client: Public Works and Government Services Canada for Correctional Service of Canada
Well Location: Centre Portion of Reported Landfill Footprint (375894m E, 4897474m N)

Stickup: 0.54 m
GS Elevation: 99.03
Water Level: 1.92 mbgs (December 21, 2010)
Water Level Elevation: 97.11 masl
Bottom of Well Depth: 6.70 mbgs

SUBSURFACE PROFILE			SAMPLE							Well Completion Details
Description	Depth (mbgs)		Sample ID	Type	Blow Count	Sample Recovery	Organic Vapour Reading (ppm)	Combustible Vapour Reading (ppm)	Submitted for Lab Analysis	
Ground Surface	99.030 / 0.000									
Sandy Silt Compact grading to very loose, brown, dry grading to moist, sandy silt with some gravel. No odours.			S1	SS	5-10-15-8		0.1	0		
			S2	SS	6-8-10-12		0.0	0		
			S3	SS	9-10-15-11		0.0	0		
Paint chips from 1.83 to 2.44 m.			S4	SS	4-5-1-1		0.2	0	*	
			S5	SS	1-2-1-1		1.2	0	*	
Cinder from 2.44 to 3.66 m.			S6	SS	1-1-1-1		1.0	0	*	
			S7	SS	2-1-2-2		0.8	0	*	
	94.153 / 4.877		S8	SS	3-2-2-2		0.6	0		
Clayey Silt Soft, dark grey, wet, clayey silt. No odours, plastic pieces from 4.88 to 5.49 m.			S9	SS	4-2-1-2		0.2	0		
Cinder from 5.49 to 6.10 m.			S10	SS	2-3-1-2		0.1	0	*	
Wood pieces from 6.10 to 6.70 m. Auger refusal on presumed bedrock at 6.70 m.	92.324 / 6.706		S11	SS	5-1-2-3		0.1	0		
End of Borehole										

Notes
GS - Ground surface
masl - Metres above sea level
mbgs - Metres below ground surface
ppm - Parts per million
SS - Soil sample

Drilled By: G.E.T Drilling Limited
Drill Method: CME-55 Truck, Hollow Stem Augers
Drill Date: December 13, 2010

Logged By: K.Williams
Log Prepared By: K.Williams
Checked By: A.Fantin

Note: Any decisions/actions made by a third party based on this log are the sole responsibilty of the third party. Franz Environmental Inc. accepts no liability for third party desisions/actions made based on this log.

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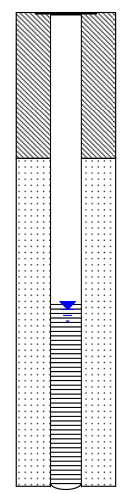
BOREHOLE/MONITORING WELL #: BH/MW-10-2

BOREHOLE LOG

Project No: 2020-1004
Project: Phase II ESA, Frontenac Institution Former Landfill #1 (CSC-ID: 441-L02)
Client: Public Works and Government Services Canada for Correctional Service of Canada
Well Location: Southeast Portion of Reported Landfill Footprint (375831m E, 4897477m N)

Stickup: 0.88 m
GS Elevation: 98.57
Water Level: 2.48 mbgs (December 21, 2010)
Water Level Elevation: 96.10 masl
Bottom of Well Depth: 3.96 mbgs

SUBSURFACE PROFILE				SAMPLE							
Depth (m)	Symbol	Description	Depth (mbgs)	Sample ID	Type	Blow Count	Sample Recovery	Organic Vapour Reading (ppm)	Combustible Vapour Reading (ppm)	Submitted for Lab Analysis	Well Completion Details
		Ground Surface	98.570 0.000								
0.0–1.83		***Sandy Silt*** Loose grading to very loose, brown, dry grading to wet, sandy silt. No odours or staining.		S1	SS	2-5-4-2		0.6	15	*	
				S2	SS	1-2-1-1		0.2	5	*	
			96.741 1.829	S3	SS	1-2-2-2		0.4	5	*	
1.83–3.96		Large boulder from 1.83 to 3.96 m.		S4	SS	2-36-35-10		NS	NS		
				S5	SS	1-1-1-1		NS	NS		
				S6	SS	1-2-3-4		NS	NS		
		Auger refusal on presumed bedrock at 3.96 m.	94.608 3.962	S7	SS	2-4-1-1		NS	NS		
		End of Borehole									



Depth scale (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0

Notes
GS - Ground Surface
masl - Metres above sea level
mbgs - Metres below ground surface
NS - No sample
ppm - Parts per million
SS - Soil sample

Drilled By: G.E.T Drilling Limited
Drill Method: CME-55 Truck, Hollow Stem Augers
Drill Date: December 14, 2010

Logged By: K.Williams
Log Prepared By: K.Williams
Checked By: A.Fantin

Note: Any decisions/actions made by a third party based on this log are the sole responsibilty of the third party. Franz Environmental Inc. accepts no liability for third party desisions/actions made based on this log.

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BOREHOLE/MONITORING WELL #: BH/MW-10-3

BOREHOLE LOG

Project No: 2020-1004

Project: Phase II ESA, Frontenac Institution Former Landfill #1 (CSC-ID: 441-L02)

Client: Public Works and Government Services Canada for Correctional Service of Canada

Well Location: Northwest Portion of Reported Landfill Footprint (375982m E, 4897427m N)

Stickup: 0.88 m

GS Elevation: 99.15 masl

Water Level: 1.85 mbgs (December 20, 2010)

Water Level Elevation: 97.30 masl

Bottom of Well Depth: 4.88 mbgs

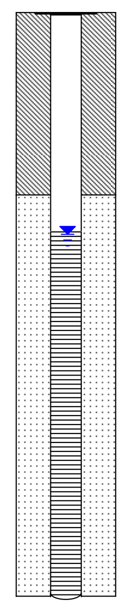
SUBSURFACE PROFILE

Depth (m)	Description	Depth (mbgs)
0.0	Ground Surface	99.150 0.000
0.0–4.88	***Sandy Silt*** Compact grading to very loose, brown grading to grey, dry grading to wet, sandy silt with some rock fragments. No odours or staining. Auger refusal on presumed bedrock at 4.88 m.	94.273 4.877
	End of Borehole	

SAMPLE

Sample ID	Type	Blow Count	Sample Recovery	Organic Vapour Reading (ppm)	Combustible Vapour Reading (ppm)	Submitted for Lab Analysis
S1	SS	10-11-8-6		0.8	15	*
S2	SS	7-10-5-6		0.4	0	*
S3	SS	8-10-10-9		0.1	0	
S4	SS	9-8-8-7		0.1	0	
S5	SS	6-5-3-3		0.2	0	*
S6	SS	2-1-1-2		1.0	20	*
S7	SS	2-2-2-2		0.8	5	
S8	SS	3-4-4-2		0.2	0	

Well Completion Details



Depth (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0

Notes:
GS - Ground surface
masl = Metres above sea level
mbgs = Metres below ground surface
ppm = Parts per million
SS = Soil sample

Drilled By: G.E.T Drilling Limited

Drill Method: CME-55 Truck, Hollow Stem Augers

Drill Date: December 14, 2010

Logged By: K.Williams

Log Prepared By: K.Williams

Checked By: A.Fantin

Note: Any decisions/actions made by a third party based on this log are the sole responsibilty of the third party. Franz Environmental Inc. accepts no liability for third party desisions/actions made based on this log.

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BOREHOLE/MONITORING WELL #: BH/MW-10-5

BOREHOLE LOG

Project No: 2020-1004
Project: Phase II ESA, Frontenac Institution Former Landfill #1 (CSC-ID: 441-L02)
Client: Public Works and Government Services Canada for Correctional Service of Canada
Well Location: South Portion of Reported Landfill Footprint (375873m E, 4897421m N)

Stickup: 0.84 m
GS Elevation: 99.70 masl
Water Level: 2.53 mbgs (December 21, 2010)
Water Level Elevation: 97.17 masl
Bottom of Well Depth: 3.96 mbgs

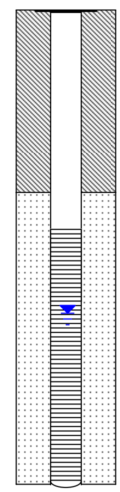
SUBSURFACE PROFILE

Depth (m)	Description	Depth (mbgs)
	Ground Surface	99.700
0.0	***Sandy Silt*** Compact grading to very loose, brown grading to grey, dry grading to wet, sandy silt. No odours.	0.000
~2.0	Plastic pieces from 1.83 to 2.44 m.	
~3.0	Cinder from 3.05 to 3.66 m.	
~3.8	Auger refusal on presumed bedrock at 3.96 m.	95.738 3.962
	End of Borehole	

SAMPLE

Sample ID	Type	Blow Count	Organic Vapour Reading (ppm)	Combustible Vapour Reading (ppm)	Submitted for Lab Analysis
S1	SS	10-10-12-8	0.1	0	
S2	SS	8-10-9-9	0.1	0	
S3	SS	6-5-3-4	0.2	0	
S4	SS	4-4-3-3	0.5	0	*
S5	SS	1-1-2-1	0.6	0	*
S6	SS	1-1-1-1	0.4	0	*
S7	SS	2-1-50 for 0"	0.1	0	

Well Completion Details



Notes
GS - Ground surface
masl - Metres above sea level
mbgs - Metres below ground surface
ppm - Parts per million
SS - Soil sample

Drilled By: G.E.T Drilling Limited
Drill Method: CME-55 Truck, Hollow Stem Augers
Drill Date: December 14, 2010

Logged By: K.Williams
Log Prepared By: K.Williams
Checked By: A.Fantin

Note: Any decisions/actions made by a third party based on this log are the sole responsibilty of the third party. Franz Environmental Inc. accepts no liability for third party desisions/actions made based on this log.

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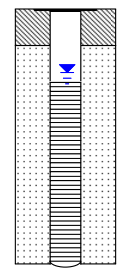
BOREHOLE/MONITORING WELL #: BH/MW-10-6

BOREHOLE LOG

Project No: 2020-1004
Project: Phase II ESA, Frontenac Institution Former Landfill #1 (CSC-ID: 441-L02)
Client: Public Works and Government Services Canada for Correctional Service of Canada
Well Location: West of Quarry Road (375837m E, 4897511m N)

Stickup: 0.84 m
GS Elevation: 97.63 masl
Water Level: 0.53 mbgs (December 20, 2010)
Water Level Elevation: 97.10 masl
Bottom of Well Depth: 2.13 mbgs

SUBSURFACE PROFILE			SAMPLE							
Depth (m)	Description	Depth (mbgs)	Sample ID	Type	Blow Count	Sample Recovery	Organic Vapour Reading (ppm)	Combustible Vapour Reading (ppm)	Submitted for Lab Analysis	Well Completion Details
	Ground Surface	97.630 0.000								
0.0–2.13	***Sandy Silt*** Loose grading to very loose, brown, dry grading to wet, sandy silt. No odours or staining.		S1	SS	8-5-3-3		0.2	0	*	
			S2	SS	3-2-1-2		0.3	0	*	
			S3	SS	2-1-1-1		0.2	5	*	
	Auger refusal on presumed bedrock at 2.13 m.	95.496 2.134	S4	SS	2-1-50 for 0"		0.1	0	*	
	End of Borehole									



Notes
GS - Ground surface
masl - Metres above sea level
mbgs - Metres below ground surface
ppm - Parts per million
SS - Soil sample

Drilled By: G.E.T Drilling Limited
Drill Method: CME-55 Truck, Hollow Stem Augers
Drill Date: December 15, 2010

Logged By: K.Williams
Log Prepared By: K.Williams
Checked By: A.Fantin

Note: Any decisions/actions made by a third party based on this log are the sole responsibilty of the third party.
Franz Environmental Inc. accepts no liability for third party desisions/actions made based on this log.

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BOREHOLE/MONITORING WELL #: BH/MW-10-7

BOREHOLE LOG

Project No: 2020-1004
Project: Phase II ESA, Frontenac Institution Former Landfill #1 (CSC-ID: 441-L02)
Client: Public Works and Government Services Canada for Correctional Service of Canada
Well Location: South Central Portion of Reported Landfill Footprint (375919m E, 4897429m N)

Stickup: 0.86 m
GS Elevation: 99.65 masl
Water Level: 2.41 mbgs (December 21, 2010)
Water Level Elevation: 97.24 masl
Bottom of Well Depth: 7.31 mbgs

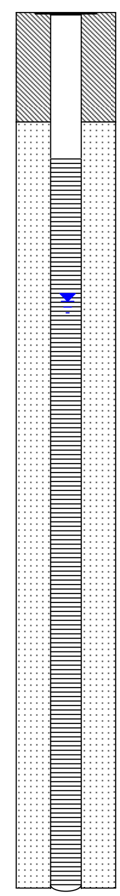
SUBSURFACE PROFILE

Depth (m)	Description	Depth (mbgs)
0.0	Ground Surface	99.650 / 0.000
0.0–7.3	***Sandy Silt*** Compact grading to very loose, brown, dry grading to wet, sandy silt. No odours.	
~2.1	Plastic pieces from 1.83 to 2.44 m.	
~4.7	Cinder from 3.05 to 7.31 m.	
~7.3	Auger refusal on presumed bedrock at 7.31 m.	92.335 / 7.315
	End of Borehole	

SAMPLE

Sample ID	Type	Blow Count	Organic Vapour Reading (ppm)	Combustible Vapour Reading (ppm)	Submitted for Lab Analysis
S1	SS	5-6-7-5	0.1	0	*
S2	SS	6-7-7-6	0.1	0	*
S3	SS	4-4-3-3	0.2	0	
S4	SS	3-2-2-2	0.2	0	
S5	SS	2-1-1-2	0.6	0	*
S6	SS	1-2-3-3	0.4	0	*
S7	SS	1-1-1-1	0.2	0	
S8	SS	1-2-1-1	0.1	0	
S9	SS	1-1-1-1	1.0	0	
S10	SS	2-1-2-3	1.2	0	
S11	SS	3-2-1-3	1.9	0	*
S12	SS	2-2-1-2	1.0	0	*

Well Completion Details



Notes
GS - Ground surface
masl - Metres above sea level
mbgs - Metres below ground surface
ppm - Parts per million
SS - Soil sample

Drilled By: G.E.T Drilling Limited
Drill Method: CME-55 Truck, Hollow Stem Augers
Drill Date: December 15, 2010

Logged By: K.Williams
Log Prepared By: K.Williams
Checked By: A.Fantin

Note: Any decisions/actions made by a third party based on this log are the sole responsibilty of the third party. Franz Environmental Inc. accepts no liability for third party desisions/actions made based on this log.

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BOREHOLE/MONITORING WELL #: BH/MW-10-9

BOREHOLE LOG

Project No: 2020-1004

Project: Phase II ESA, Frontenac Institution Former Landfill #1 (CSC-ID: 441-L02)

Client: Public Works and Government Services Canada for Correctional Service of Canada

Well Location: North Portion of Reported Landfill Footprint (375924m E, 4897489m N)

Stickup: 0.82 m

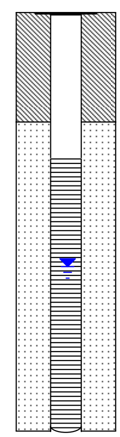
GS Elevation: 99.09 masl

Water Level: 2.12 mbgs (December 21, 2010)

Water Level Elevation: 96.97 masl

Bottom of Well Depth: 3.51 mbgs

SUBSURFACE PROFILE				SAMPLE								
Depth (m)	Symbol	Description	Depth (mbgs)	Sample ID	Type	Blow Count	Sample Recovery	Organic Vapour Reading (ppm)	Combustible Vapour Reading (ppm)	Submitted for Lab Analysis	Well Completion Details	Depth (m)
		Ground Surface	99.090 0.000									
0.0–3.5		***Sandy Silt*** Compact grading to very loose, brown, dry grading to wet, sandy silt. No odours or staining.		S1	SS	3-8-3-3		0.1	0	*		
				S2	SS	2-3-9-4		0.1	0	*		
				S3	SS	2-3-4-4		0.4	5	*		
		Metal debris from 1.83 to 2.44 m.		S4	SS	3-2-2-1		0.6	0	*		
				S5	SS	2-1-1-1		0.1	0	*		
		Auger refusal on presumed bedrock at 3.51 m.	95.585 3.505	S6	SS	3-2-3-50 for 0"		0.2	0			
		End of Borehole										



Depth scale (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0

Notes
GS - Ground surface
masl - Metres above sea level
mbgs - Metres below ground surface
ppm - Parts per million
SS - Soil sample

Drilled By: G.E.T Drilling Limited

Drill Method: CME-55 Truck, Hollow Stem Augers

Drill Date: December 15, 2010

Logged By: K.Williams

Log Prepared By: K.Williams

Checked By: A.Fantin

Note: Any decisions/actions made by a third party based on this log are the sole responsibilty of the third party. Franz Environmental Inc. accepts no liability for third party desisions/actions made based on this log.

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BOREHOLE LOGS

CSC Collins Bay Landfill 3 (CSC ID 441-L03)

Kingston, Ontario

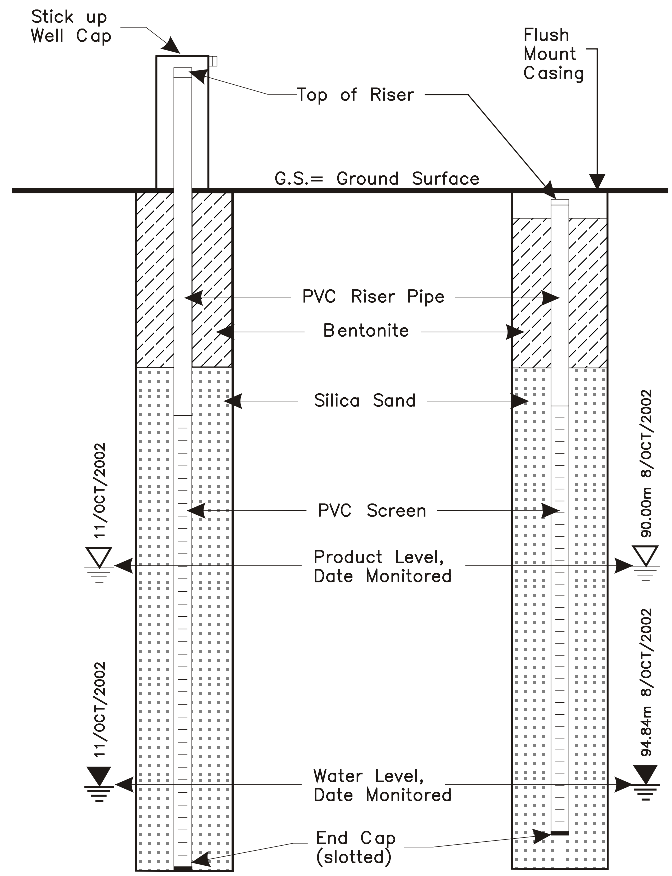
SNC·LAVALIN Environment

BOREHOLE LOG LEGEND

SAMPLING

- SPLIT SPOON SAMPLE
- AUGER SAMPLE
- DIRECT PUSH OR CONTINUOUS SOIL SAMPLE
- SAMPLE SUBMITTED FOR LABORATORY ANALYSIS
- BEDROCK CORE
- DAYLIGHTED HOLE SAMPLE
- GRAB SAMPLE
- AIR ROTARY/ TRI–CONE

WELL INSTALLATION



GRAPHIC LOG

WELL MATERIALS

SILICA SAND, FILL, GRAVEL, GROUT, SAND AND GRAVEL FILL, BENTONITE, CONCRETE, PEA GRAVEL

NATIVE SOILS

SANDY CLAY, SANDY SILT, CLAYEY SAND, TOPSOIL, CLAY, SILT, SAND, GRAVEL, PEAT, TILL, SILTY CLAY, CLAYEY SILT, SILTY SAND, SANDY GRAVEL

FILL

ASPHALT, CONCRETE, GRAVEL, SAND, SILTY SAND, SILT, CLAY, PAVEMENT, MIXED DEBRIS, SOD, SANDY TOPSOIL AND GRAVEL, PAVEMENT PIECES, BOULDERS, SAND & GRAVEL, CLAYEY SAND, SANDY CLAY

BEDROCK

UNDIFFER–ENTIATED ROCK, LIMESTONE, SANDSTONE, GRANITE, SHALE, WEATHERED SHALE, IGNEOUS, META–MORPHIC, SEDIMENTARY, VOLCANIC

FILE NAME: LEGEND_BH_SEP–2012.CDR

SNC • LAVALIN Environment

Borehole ID: BH-101

Project No.: 12317
Client: PWGSC
Date Completed: October 3, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 420M
OVM: GasTech 1238 ME

DEPTH (ft)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)
0–2	NA	BH-101-1		10	34
2–4	NA	BH-101-2		<5	59
4–6	NA	BH-101-3	◆	<5	59
6–8	NA	BH-101-4		<5	100
8–10	NA	BH-101-5		<5	100
10–12	NA	BH-101-6		<5	100
12–13.3	NA	BH-101-7	◆	<5	100

DESCRIPTION	ELEVATION (m)
Ground Surface	0.00
TOPSOIL	
clayey SAND FILL moist, soft, some gravel	
GRAVEL FILL moist, brown, soft, with wood chips	-1.00
SAND and GRAVEL FILL dry, light to dark brown, loose	
clayey SAND moist, brown, compact	-2.00
silty SAND moist, brown, compact, some clay	-3.00
wet	-4.00
Refusal at 4.1 m bgs.	

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

SNC • LAVALIN Environment

Borehole ID: BH-102

Project No.: 12317
Client: PWGSC
Date Completed: October 2, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 420M
OVM: GasTech 1238 ME

DEPTH (ft)	DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	DESCRIPTION	ELEVATION (m)
0	0						Ground Surface	0.00
0–1							TOPSOIL	
1		NA	BH-102-1	◆	25	100	clayey SAND FILL moist, dark brown, compact, trace organics	
2–3		NA	BH-102-2		<5	50	SAND and GRAVEL FILL dry, brown, medium, compact	
3–4	1	NA	BH-102-3		<5	50	clayey SAND FILL moist, light brown, compact, with wood chips	-1.00
4–5		NA	BH-102-4		<5	50	SAND and GRAVEL FILL dry, brown, loose, medium, with red stains	
5–6		NA	BH-102-5	◆	<5	50		
6–8	2	NA	BH-102-6		<5	50	SAND FILL moist, brown, medium, loose, with black staining and waste present	-2.00
8–10		NA	BH-102-7		<5	50	silty CLAY moist, grey/brown, compact mottled	
10–12	3	NA	BH-102-8	◆	<5	100	wet	-3.00
12–14	4	NA	BH-102-9	◆	<5	100		-4.00
14							End of borehole at 4.3 m bgs.	
15								
16								

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

BH-102-99 duplicate of BH-102-5.

SNC • LAVALIN Environment

Borehole ID: BH-103

Project No.: 12317
Client: PWGSC
Date Completed: October 2, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 420M
OVM: GasTech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
0 / 0							Ground Surface	0.00
0–1							TOPSOIL dry to moist, brown	
1	NA	BH-103-1		<5	21		SAND and GRAVEL FILL dry, brown, medium, compact	
3 / 1	NA	BH-103-2	◆	<5	47			-1.00
4.5	NA	BH-103-3		<5	47		clayey SAND moist, dark brown, soft with wood chips, cement waste	
5.5	NA	BH-103-4	◆	<5	47		loose	
7 / 2	NA	BH-103-5	◆	<5	50		wet, grey	-2.00
8							Refusal at 2.4 m bgs.	
10 / 3								-3.00
13 / 4								-4.00
16								

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

BH-103-99 duplicate of BH-103-4.

SNC • LAVALIN Environment

Borehole ID: BH-104

Project No.: 12317
Client: PWGSC
Date Completed: October 2, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 420M
OVM: GasTech 1238 ME

DEPTH (ft)	DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	DESCRIPTION	ELEVATION (m)
							Ground Surface	0.00
0	0						**TOPSOIL** dry to moist, brown	
0–2		NA	BH-104-1	◆	<5	60	**SAND and GRAVEL FILL** wet, dark brown, medium, compact	
2–4	1	NA	BH-104-2		<5	60		-1.00
4–6		NA	BH-104-3		<5	100		
6–8	2	NA	BH-104-4		<5	100	**CLAY** moist, grey, firm, mottled, with trace organics	-2.00
8–10		NA	BH-104-5	◆	<5	100	**silty CLAY** dry, light grey/brown, compact	
10	3						Refusal at 3.0 m bgs.	-3.00
13	4							-4.00
16								

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

BH-104-99 duplicate of BH-104-1.

SNC•LAVALIN Environment

Borehole ID: BH-105

Project No.: 12317
Client: PWGSC
Date Completed: October 2, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 420M
OVM: GasTech 1238 ME

DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	DESCRIPTION	ELEVATION (m)
						Ground Surface	0.00
0–0.21						TOPSOIL moist, brown	
	NA	BH-105-1		<5	17	SAND and GRAVEL FILL wet, orange/brown, compact	
	NA	BH-105-2	◆	<5	17		-1.00
	NA	BH-105-3		<5	17		
	NA	BH-105-4		<5	72	clayey SAND moist, black, soft, with organics	-2.00
	NA	BH-105-5	◆	<5	72	silty CLAY moist, grey/brown, soft	
	NA	BH-105-6		<5	72		
	NA	BH-105-7		<5	100	wet	-3.00
	NA	BH-105-8		<5	100		-4.00
						Refusal at 4.2 m bgs.	

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

SNC • LAVALIN Environment

Borehole ID: BH-106

Project No.: 12317
Client: PWGSC
Date Completed: October 3, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Split Spoon
Borehole Diameter: 5.2 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Bosch Electric Drill
OVM: GasTech 1238 ME

DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	0.00
0–0.53	NA	BH-106-1	◆	<5	67		TOPSOIL wet, brown, soft; CLAY wet, dark grey, soft to firm	
0.53–1.07	NA	BH-106-2		<5	57		silty SAND wet, grey/brown, compact, fine	-1.00
1.07–1.60	NA	BH-106-3		<5	67			-2.00
1.60–3.1	NA	BH-106-4		<5	67			-3.00
							Refusal at 3.1 m bgs.	-4.00

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

SNC • LAVALIN Environment

Borehole ID: BH-107

Project No.: 12317
Client: PWGSC
Date Completed: October 3, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Split Spoon
Borehole Diameter: 5.2 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Bosch Electric Drill
OVM: GasTech 1238 ME

DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)
0–0.76	NA	BH-107-1	◆	<5	63
0.76–1.52	NA	BH-107-2		5	50
1.52–2.29	NA	BH-107-3		<5	70
2.29–3.1	NA	BH-107-4		<5	53

DESCRIPTION	ELEVATION (m)
Ground Surface	0.00
TOPSOIL wet, brown, soft	
CLAY wet, dark grey, soft to firm	
silty SAND wet, grey/brown, compact, fine, trace clay	-1.00
	-2.00
Refusal at 3.1 m bgs.	-3.00
	-4.00

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

SNC • LAVALIN Environment

Borehole ID: BH-108

Project No.: 12317
Client: PWGSC
Date Completed: October 5, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 7822DT
OVM: GasTech 1238 ME

DEPTH	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)
0–0.76 m	NA	BH-108-1	◆	15	47
0.76–1.52 m	NA	BH-108-2		<5	47
1.52–2.29 m	NA	BH-108-3		<5	100
2.29–3.05 m	NA	BH-108-4		<5	100

DESCRIPTION	ELEVATION (m)
Ground Surface	0.00
TOPSOIL wet, organics present	
CLAY wet, dark grey to light grey, soft to firm, mottled	
silty SAND wet, grey/brown, firm	
End of borehole at 3.1 m bgs.	

Depth scale: ft 0–16; m 0–4. Elevation scale: 0.00, -1.00, -2.00, -3.00, -4.00

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

SNC • LAVALIN Environment

Borehole ID: BH-109

Project No.: 12317
Client: PWGSC
Date Completed: October 5, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 7822DT
OVM: GasTech 1238 ME

DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	0.00
0	NA	BH-109-1	◆	10	67		TOPSOIL wet, organics present; CLAY wet, grey, soft to firm, mottled	
	NA	BH-109-2	◆	<5	67			-1.00
	NA	BH-109-3		<5	100		silty SAND wet, grey/brown, soft	-2.00
	NA	BH-109-4		<5	100			
3							End of borehole at 3.1 m bgs.	-3.00

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

SNC • LAVALIN Environment

Borehole ID: BH-110

Project No.: 12317
Client: PWGSC
Date Completed: October 3, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 5.2 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Bosch Electric Drill
OVM: GasTech 1238 ME

DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
0							Ground Surface	0.00
0–0.1							TOPSOIL wet	
0.1–0.8	NA	BH-110-1	◆	<5	50		CLAY wet, grey, soft to firm	
0.8–1.1	NA	BH-110-2		<5	67		silty SAND wet to moist, grey/brown, firm, trace clay	-1.00
1.1–2.3	NA	NA		NA	NA		no recovery	-2.00
2.3							End of borehole at 2.3 m bgs.	

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

SNC • LAVALIN Environment

Borehole ID: BH-111

Project No.: 12317
Client: PWGSC
Date Completed: October 5, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 7822DT
OVM: GasTech 1238 ME

DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	DESCRIPTION	ELEVATION (m)
						Ground Surface	0.00
0 – 0.75	NA	BH-111-1	◆	10	60	TOPSOIL wet, black, organics present CLAY wet, grey, soft to firm, mottled	
0.75 – 1.5	NA	BH-111-2		<5	60	silty SAND wet, grey/brown, soft	-1.00
1.5 – 2.25	NA	BH-111-3		<5	70		-2.00
2.25 – 3.0	NA	BH-111-4		<5	70		
3.05						End of borehole at 3.1 m bgs.	-3.00

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

SNC•LAVALIN Environment

Borehole ID: BH-112

Project No.: 12317
Client: PWGSC
Date Completed: October 5, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 7822DT
OVM: GasTech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	0.00
0–0.5 m							TOPSOIL wet	
0.5–1.0 m	NA	BH-112-1	◆	<5	53		CLAY wet, grey, soft to firm, mottled	
1.0–1.5 m	NA	BH-112-2		<5	53			-1.00
1.5–2.0 m	NA	BH-112-3		<5	67		silty SAND wet, grey/brown, soft	-2.00
2.0–3.1 m	NA	BH-112-4		<5	67			-3.00
							End of borehole at 3.1 m bgs.	-4.00

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

BH-112-99 duplicate of BH-112-1.

SNC • LAVALIN Environment

Borehole ID: BH-113

Project No.: 12317
Client: PWGSC
Date Completed: October 5, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 7822DT
OVM: GasTech 1238 ME

DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	0.00
0 – 0.5	NA	BH-113-1	◆	<5	50		TOPSOIL wet, organics present; CLAY wet, grey, soft to firm, mottled	
0.5 – 1.0	NA	BH-113-2		<5	50			-1.00
1.0 – 1.5	NA	BH-113-3		<5	70		silty SAND wet, grey, soft	
1.5 – 3.1	NA	BH-113-4		<5	70			-2.00
							End of borehole at 3.1 m bgs.	-3.00

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

BH-113-99 duplicate of BH-113-1.

SNC • LAVALIN Environment

Borehole ID: BH-114

Project No.: 12317
Client: PWGSC
Date Completed: October 5, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 7822DT
OVM: GasTech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	0.00
0–0.3 m							TOPSOIL wet, organics present	
0–2 ft	NA	BH-114-1		5	60		CLAY wet, grey, soft to firm, mottled	
2.5–5 ft	NA	BH-114-2		<5	60			-1.00
5–7.5 ft	NA	BH-114-3		<5	73		silty SAND wet, brown/grey, soft	-2.00
7.5–10 ft	NA	BH-114-4		<5	73			-3.00
10 ft / 3.1 m							End of borehole at 3.1 m bgs.	

Depth scale: ft 0–16; m 0–4. Elevation scale: 0.00, -1.00, -2.00, -3.00, -4.00.

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

SNC • LAVALIN Environment

Borehole ID: BH-115

Project No.: 12317
Client: PWGSC
Date Completed: October 5, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 7822DT
OVM: GasTech 1238 ME

DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
0							Ground Surface	0.00
0–0.1							TOPSOIL wet	
0–0.5	NA	BH-115-1	◆	10	57		CLAY wet, grey, soft to firm, mottled	
0.5–1.0	NA	BH-115-2		<5	57			-1.00
1.0–1.5	NA	BH-115-3		<5	60		silty SAND wet, brown/grey, soft	-2.00
1.5–3.1	NA	BH-115-4		<5	60			-3.00
3.1							End of borehole at 3.1 m bgs.	-4.00

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

SNC◆LAVALIN Environment

Borehole ID: BH-201

Project No.: 12317
Client: PWGSC
Date Completed: October 2, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 420M
OVM: GasTech 1238 ME

DEPTH (ft)	DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
0	0							Ground Surface	0.00
0–2		NA	BH-201-1		<5	100		SAND and GRAVEL FILL dry, brown	
2–4	1	NA	BH-201-2		<5	100		silty SAND dry, brown, compact, with trace clay	-1.00
4–6		NA	BH-201-3		<5	100			
6–8	2	NA	BH-201-4		<5	100			-2.00
8–10		NA	BH-201-5		<5	100		silty CLAY moist, dark grey, firm	
10–12	3	NA	BH-201-6	◆	<5	100			-3.00
12–14	4	NA	BH-201-7		NA	100			-4.00
14–16								End of borehole at 4.3 m bgs.	

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

SNC◆LAVALIN Environment

Borehole ID: BH-202

Project No.: 12317
Client: PWGSC
Date Completed: October 2, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 420M
OVM: GasTech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
0 / 0							Ground Surface	0.00
0–2 ft	NA	BH-202-1		5	100		SAND and GRAVEL FILL dry, brown	
2–4 ft	NA	BH-202-2		<5	100		silty SAND dry, brown, loose, with trace clay	-1.00
4–6 ft	NA	BH-202-3		<5	100			
6–8 ft	NA	BH-202-4		5	55		clayey SAND moist, dark grey, firm/compact	-2.00
8–10 ft	NA	BH-202-5		<5	55		with trace organics	-3.00
10–12 ft	NA	BH-202-6		<5	100		silty CLAY moist to wet, grey, soft	
12–14 ft	NA	BH-202-7	◆	<5	100			-4.00
14–16 ft							End of borehole at 4.3 m bgs.	

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

SNC • LAVALIN Environment

Borehole ID: BH-301

Project No.: 12317
Client: PWGSC
Date Completed: October 3, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 420M
OVM: GasTech 1238 ME

DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	DESCRIPTION	ELEVATION (m)
0						Ground Surface	0.00
0–0.6	NA	BH-301-1		<5	21	SAND and GRAVEL FILL dry, brown, loose	
0.6–1.2	NA	BH-301-2		<5	100	clayey SAND FILL dry to moist, compact. fine, some gravel	-1.00
1.2–1.8	NA	BH-301-3		<5	100		
1.8–2.1	NA	BH-301-4		<5	42		-2.00
2.1–2.4	NA	BH-301-5		<5	42	silty CLAY wet, grey, soft	
2.4–3.0	NA	BH-301-6	◆	<5	42	silty SAND wet, grey, loose	-3.00
3.0–3.7	NA	BH-301-7		<5	100	moist to wet, grey/brown, firm, with trace clay	
3.7–4.3	NA	BH-301-8		<5	100		-4.00
4.3						End of borehole at 4.3 m bgs.	

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

BH-301-99 duplicate of BH-301-6.

SNC • LAVALIN Environment

Borehole ID: BH-302

Project No.: 12317
Client: PWGSC
Date Completed: October 5, 2012
Location: CSC Frontenac Landfill No. 3
Site Datum:

SLE Supervisor: E. Kelly
Drilling Method: Direct Push
Borehole Diameter: 8.3 cm

Drilling Company: Strata Soil Inc.
Drilling Equipment: Geoprobe 7822DT
OVM: GasTech 1238 ME

DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	SAMPLE LOCATION	OVM (2)	RECOVERY (%)	DESCRIPTION	ELEVATION (m)
						Ground Surface	0.00
0.0–0.2						TOPSOIL wet	
0.0–0.53	NA	BH-302-1	◆	5	47	CLAY wet, grey, soft to firm, mottled	
0.53–1.07	NA	BH-302-2		<5	47		-1.00
1.07–1.6	NA	BH-302-3		<5	70	silty SAND wet, brown/grey, soft	-2.00
1.6–3.1	NA	BH-302-4		<5	70		-3.00
3.1						End of borehole at 3.1 m bgs.	-4.00

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

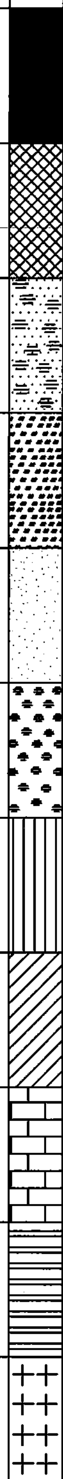
The data represented in this borehole log requires interpretation by SNC-Lavalin Environment personnel. Third parties using this log do so at their own risk.

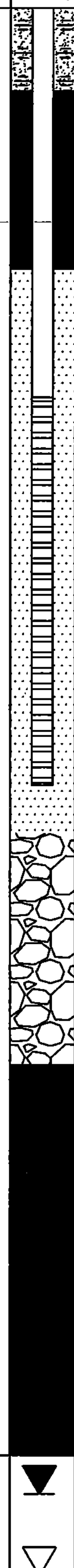
All elevations and locations are approximate.

◆ = Sample submitted for laboratory analysis.

NA = Not applicable

GRAPHICS, SYMBOLS AND ABBREVIATIONS ON BOREHOLE LOGS

STRATIGRAPHY DESCRIPTION	STRATA PLOT
ASPHALT	
FILL	
CONCRETE	
TOPSOIL	
SAND	
GRAVEL	
SILT	
CLAY	
LIMESTONE BEDROCK	
SHALE BEDROCK	
GRANITE BEDROCK	
DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS.	

WELL INSTALLATION	WELL INSTALLATION / GROUND WATER CONDITION DESCRIPTION
	FLUSH MOUNT CASING IN CONCRETE
	STANDPIPE RISER IN BENTONITE SEAL
	STANDPIPE RISER IN SILICA SAND
	SLOTTED STANDPIPE IN SILICA SAND
	SILICA SAND FILTER BOTTOM
	SLOUGH AUGER HOLE
	BENTONITE SEAL
	Free Petroleum Hydrocarbon Level
	Ground Water Level

STANDARD PENETRATION TEST (SPT)

Standard Penetration Test ("N Value") is the number of blows b a 66.3 kg (140 lb) hammer dropped 760 mm (30 in.) to drive a 50 mm (2 in.) diameter open sampler attached to "A" size drill rods for a distance of 300 mm (12 in.)

SAMPLE TYPE ABBREVIATIONS

SS	Split Spoon
AU	Auger Sample
DT	Dual Tube Sample
BS	Bulk Sample
RC	Rock Core
NT	No Recovery
TW	Thin wall Open
WS	Wash Sample
TP	Thin wall Piston
VT	Vane Test

ORGANIC VAPOUR MEASUREMENTS

%LEL	% of the lower explosive limit
ppm	parts per million
nd	not detected
nm	not measured due to insufficient sample volume

amec

RECORD OF BOREHOLE No BH1D

Project Client: PWGSC
Location: Frontenac Institution, Landfill 3, Collins Bay, Ontario (CSC ID: 441-L03)
Logged By: JD

Project Number: TC111025.3000
Borehole Type & Drilling Equipment: 200 mm Dia. Hollow Stem Augering, Track Mounted Drill
Compiled By: ZF

Project Datum: Local
Date: September 26, 2011
Checked By: SG

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	Combustible Organic Vapour, ppm (RKI EAGLE 2)	REMARKS
97.7 / 0.0	Grassed Surface, brown Clayey Silt **FILL**, trace sand and gravel, rootlets, damp	1	SS	25	5	nd	LF3 BH1D-1 - submitted for Metals and OCP
	paper, moist	2	SS	25	7	nd	
	concrete, cobbles	3	SS	16	6	nd	
95.4 / 2.3	grey **SILTY CLAY**, trace rootlets, about plastic limit	4	SS	67	6	5	LF3 BH1D-4 - submitted for PHC F1-F4, VOC, pH, PAH and PCB.
94.4 / 3.2	grey **CLAYEY SILT** with sand and gravel, trace rootlets, wet	5	SS	75	6	nd	
		6	SS	84	8	nd	
93.1 / 4.6	grey **SILT**, trace sand, wet	7	SS	33	9	nd	
92.3 / 5.3	**BEDROCK**						
89.7 / 7.9	**End of Borehole**						

Graph columns: DEPTH (m); G.W. CONDITION; ELEVATION (m); WELL INSTALLATION; DYNAMIC CONE PENETRATION TEST □; STANDARD PENETRATION TEST (SPT) ■ (10 20 30 40); Combustible Organic Vapour, % LEL ▲ (20 40 60 80); (RKI EAGLE 2) Combustible Organic Vapour, ppm ● (30 60 90 120); STRAT PLOT.

Measured ground water depth on October 27, 2011: 1.50 mbgs

Well Detail:
50 mm sched 40
(6.40 m - 7.92 m)
with sand pack (6.10 m - 7.92 m), bentonite plug above sand, capped with above-grade casing set in concrete with J-plug.

amec

RECORD OF BOREHOLE No BH1S

Project Client: **PWGSC**
Location: **Frontenac Institution, Landfill 3, Collins Bay, Ontario (CSC ID: 441-L03)**
Logged By: **JD**

Project Number: **TC111025.3000**
Borehole Type & Drilling Equipment: **200 mm Dia. Hollow Stem Augering, Track Mounted Drill**
Compiled By: **ZF**

Project Datum: **Local**
Date: **September 26, 2011**
Checked By: **SG**

ELEV DEPTH (m)	SOIL PROFILE – DESCRIPTION	STRAT PLOT	SAMPLES – NUMBER	TYPE	RECOVERY (%)	"N" VALUE	DEPTH (m)	G.W. CONDITION	ELEVATION (m)	WELL INSTALLATION	DYNAMIC CONE PENETRATION TEST □ / STANDARD PENETRATION TEST (SPT) ■ (10 20 30 40)	Combustible Organic Vapour, % LEL ▲ (20 40 60 80) / (RKI EAGLE 2) Combustible Organic Vapour, ppm ● (30 60 90 120)	REMARKS
97.7 0.0	Grassed Surface brown Clayey Silt **FILL** trace sand and gravel, rootlets damp ---- paper moist ---- concrete, cobbles						1 2	∇	97 96				Stratigraphy inferred form BH1D
95.4 2.3	grey **SILTY CLAY** trace rootlets about plastic limit						3		95				
94.5 3.2	grey **CLAYEY SILT** with sand and gravel trace rootlets wet						4		94				
93.2 4.6	**End of Borehole** Measured ground water depth on October 27, 2011: 2.24 mbgs Well Detail: 50 mm sched 40 (1.52 m - 4.57 m) with sand pack (1.22 m - 4.57 m), bentonite plug above sand, capped with above-grade casing set in concrete with J-plug.												

amec

RECORD OF BOREHOLE No BH2

Project Client: **PWGSC** | Location: **Frontenac Institution, Landfill 3, Collins Bay, Ontario (CSC ID: 441-L03)** | Logged By: **JD**

Project Number: **TC111025.3000** | Borehole Type & Drilling Equipment: **200 mm Dia. Hollow Stem Augering, Track Mounted Drill** | Compiled By: **ZF**

Project Datum: **Local** | Date: **September 26, 2011** | Checked By: **SG**

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	Combustible Organic Vapour, ppm (RKI EAGLE 2)	REMARKS
97.9 / 0.0	Grassed Surface brown Clayey Silt **FILL** with rootlets, gravel, sand and cobbles damp	1	SS	16	9	nd	LF3 BH2-1 - submitted for Metals and OCP
		2	SS	16	9	nd	
	trace wood, cinders, concrete moist to wet	3	SS	25	8	nd	LF3 BH2-3 - submitted for PHC F1-F4, VOC and PAH
95.7 / 2.3	No recovery	4	SS		4		
94.9 / 3.1	grey **CLAYEY SILT** wet	5	SS	59	8	nd	LF3 BH2-5 - submitted for PHC F1-F4 and VOC
94.0 / 4.0	**End of Borehole**						

Measured ground water depth on October 27, 2011: 2.40 mbgs

Well Detail:
50 mm sched 40
(1.22 m - 3.96 m)
with sand pack (0.91 m - 3.96 m),
bentonite plug above sand, capped
with above-grade casing set in
concrete with J-plug.

Column headings: SOIL PROFILE; SAMPLES; STRAT PLOT; DEPTH (m); G.W. CONDITION; ELEVATION (m); WELL INSTALLATION; DYNAMIC CONE PENETRATION TEST □; STANDARD PENETRATION TEST (SPT) ■ 10 20 30 40; Combustible Organic Vapour, % LEL ▲ 20 40 60 80; (RKI EAGLE 2) Combustible Organic Vapour, ppm ● 30 60 90 120; REMARKS

RECORD OF BOREHOLE No BH5

Project Client: **PWGSC** — Location: **Frontenac Institution, Landfill 3, Collins Bay, Ontario (CSC ID: 441-L03)** — Logged By: **JD**

Project Number: **TC111025.3000** — Borehole Type & Drilling Equipment: **200 mm Dia. Hollow Stem Augering, Track Mounted Drill** — Compiled By: **ZF**

Project Datum: **Local** — Date: **September 27, 2011** — Checked By: **SG**

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	SPT	Combustible Organic Vapour, ppm (RKI EAGLE 2)	REMARKS
97.8 / 0.0	Grassed Surface brown Clayey Silt **FILL** trace sand, gravel, cobbles and brick damp	1	SS	25	12		nd	LF3 BH5-1 - submitted for Metals and OCP
	------- mixed with cinders, trace brick	2	SS	33	4		nd	LF3 BH5-2 - submitted for PAH
96.2 / 1.6	grey-black **SILTY CLAY** with organics about plastic limit	3	SS	41	5		5	LF3 BH5-3 - submitted for PHC F1-F4, VOC and PCB. -Organic staining
95.4 / 2.3	grey **CLAYEY SILT** trace organics wet	4	SS	41	4		20	
		5	SS	59	13		20	
93.8 / 4.0	**End of Borehole**							

Measured ground water depth on October 27, 2011: 2.22 mbgs

Well Detail:
50 mm sched 40
(1.22 m - 3.96 m)
with sand pack (0.91 m - 3.96 m),
bentonite plug above sand, capped
with above-grade casing set in
concrete with J-plug.

amec

RECORD OF BOREHOLE No BH6

Project Client:	PWGSC	Location:	Frontenac Institution, Landfill 3, Collins Bay, Ontario (CSC ID: 441-L03)	Logged By:	JD
Project Number:	TC111025.3000	Borehole Type & Drilling Equipment:	200 mm Dia. Hollow Stem Augering, Track Mounted Drill	Compiled By:	ZF
Project Datum:	Local	Date:	September 27, 2011	Checked By:	SG

SOIL PROFILE

ELEV / DEPTH (m)	DESCRIPTION
97.6 / 0.0	Grassed Surface; dark brown Clayey Silt **FILL** with rootlets and organics, trace sand and gravel, red brick
96.9 / 0.8	**CONCRETE**
95.3 / 2.3	grey **CLAYEY SILT** with organics, moist to wet; sand, wet
93.8 / 3.8	grey **SILT** trace sand, wet
92.3 / 5.3	**BEDROCK**
89.7 / 7.9	**End of Borehole**

SAMPLES

NUMBER	TYPE	RECOVERY (%)	"N" VALUE	Combustible Organic Vapour (RKI EAGLE 2), ppm	REMARKS
1	SS	41	7	nd	LF3 BH6-1 - submitted for Metals and OCP
2	SS				
3	SS				
4	SS	41	4	50	LF3 BH6-4 - submitted for PHC F1-F4, VOC, PAH and PCB. -Organic staining
5	SS	41	3	nd	
6	SS	50	4	nd	
7	SS	16	12	nd	

Column headings: DEPTH (m); G.W. CONDITION; ELEVATION (m); WELL INSTALLATION; DYNAMIC CONE PENETRATION TEST □; STANDARD PENETRATION TEST (SPT) ■ (10, 20, 30, 40); Combustible Organic Vapour, % LEL ▲ (20, 40, 60, 80); (RKI EAGLE 2) Combustible Organic Vapour, ppm ● (30, 60, 90, 120).

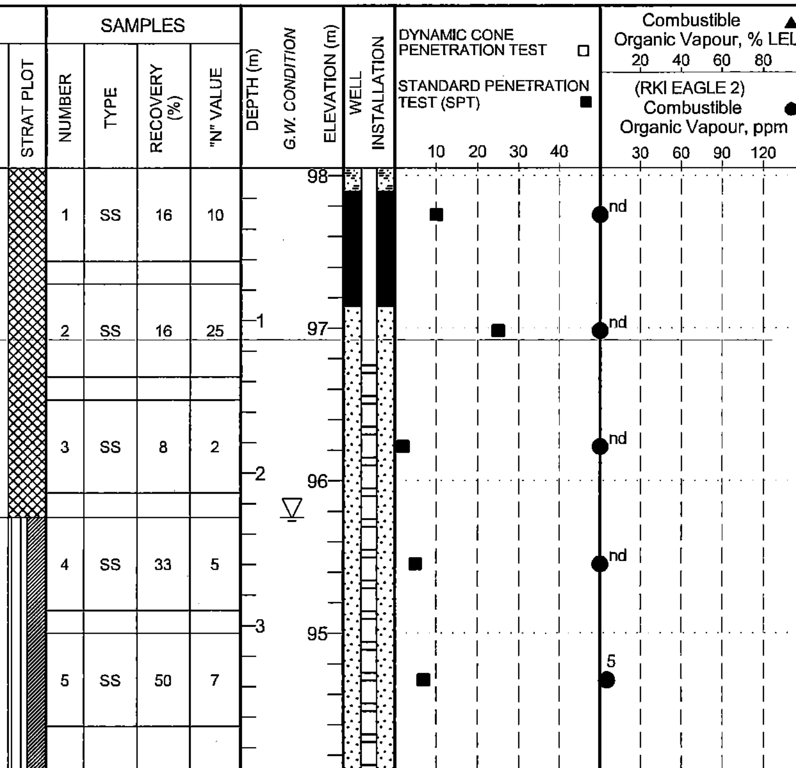
Measured ground water depth on October 27, 2011: 1.85 mbgs

Well Detail:
50 mm sched 40
(6.40 m - 7.92 m)
with sand pack (6.10 m - 7.92 m), bentonite plug above sand, capped with above-grade casing set in concrete with J-plug.

RECORD OF BOREHOLE No BH7

Project Client: PWGSC	Location: Frontenac Institution, Landfill 3, Collins Bay, Ontario (CSC ID: 441-L03)		Logged By: JD
Project Number: TC111025.3000	Borehole Type & Drilling Equipment: 200 mm Dia. Hollow Stem Augering, Track Mounted Drill		Compiled By: ZF
Project Datum: Local	Date: September 27, 2011		Checked By: SG

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	REMARKS
98.1 0.0	Grassed Surface brown Clayey Silt **FILL** concrete damp	1	SS	16	10	LF3 BH7-1 - submitted for Metals and OCP
	---- with sand, gravel and cobbles, cinders	2	SS	16	25	LF3 BH7-2 - submitted for PAH and PCB
	---- wet in tip	3	SS	8	2	
95.8 2.3	grey **CLAYEY SILT** with organics wet	4	SS	33	5	LF3 BH7-4 - submitted for PHC F1-F4, VOC and Metals. -Organic odour, black organic staining
	---- brown-grey	5	SS	50	7	
94.1 4.0	**End of Borehole** Measured ground water depth on October 27, 2011: 2.29 mbgs Well Detail: 50 mm sched 40 (1.22 m - 3.96 m) with sand pack (0.91 m - 3.96 m), bentonite plug above sand, capped with above-grade casing set in concrete with J-plug.					



amec

RECORD OF BOREHOLE No BH8

Project Client: **PWGSC**
Location: **Frontenac Institution, Landfill 3, Collins Bay, Ontario (CSC ID: 441-L03)**
Logged By: **JD**

Project Number: **TC111025.3000**
Borehole Type & Drilling Equipment: **200 mm Dia. Hollow Stem Augering, Track Mounted Drill**
Compiled By: **ZF**

Project Datum: **Local**
Date: **September 28, 2011**
Checked By: **SG**

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	SPT (blows)	Combustible Organic Vapour, ppm	REMARKS
98.4 / 0.0	Grassed Surface brown Clayey Silt **FILL** trace rootlets, damp; ------ with sand, gravel and cobbles, cinders	1	SS	50	8		nd	LF3 BH8-1 - submitted for PAH, Metals and OCP
		2	SS	41	7		nd	
96.6 / 1.8	brown **CLAYEY SILT** trace sand and gravel, moist; ------ grey, moist to wet	3	SS	33	7		nd	LF3 BH8-3 - submitted for PHC F1-F4, VOC, PAH and PCB
		4	SS	41	7		5	-Organic staining
		5	SS	41	15		nd	
94.6 / 3.8	grey-brown **SILT** trace clay, wet	6	SS	100	11		nd	
94.1 / 4.3	**End of Borehole**							

Chart headings: DEPTH (m); G.W. CONDITION; ELEVATION (m) 98, 97, 96, 95; WELL INSTALLATION; DYNAMIC CONE PENETRATION TEST □; STANDARD PENETRATION TEST (SPT) ■ 10 20 30 40; Combustible Organic Vapour, % LEL ▲ 20 40 60 80; (RKI EAGLE 2) Combustible Organic Vapour, ppm ● 30 60 90 120.

Measured ground water depth on October 27, 2011: 2.71 mbgs

Well Detail:
50 mm sched 40
(1.22 m - 4.27 m)
with sand pack (0.91 m - 4.27 m), bentonite plug above sand, capped with above-grade casing set in concrete with J-plug.

amec

RECORD OF BOREHOLE No BH9D

Project Client: PWGSC
Location: Frontenac Institution, Landfill 3, Collins Bay, Ontario (CSC ID: 441-L03)
Logged By: JD

Project Number: TC111025.3000
Borehole Type & Drilling Equipment: 200 mm Dia. Hollow Stem Augering, Track Mounted Drill
Compiled By: ZF

Project Datum: Local
Date: September 28, 2011
Checked By: SG

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	SPT	Combustible Organic Vapour, ppm (RKI EAGLE 2)	REMARKS
99.1 / 0.0	brown **CLAYEY SILT** trace rootlets, damp	1	SS	41	12	12	nd	LF3 BH9D-1 - submitted for Metals, PAH and OCP
		2	SS	59	15	15	nd	LF3 BH9D-2 - submitted for OCP
	damp to moist	3	SS	67	12	12	nd	
		4	SS	84	13	13	5	LF3 BH9D-4 - submitted for PHC F1-F4, VOC, Metals and PCB
96.1 / 3.1	grey **SILT** trace clay, moist to wet	5	SS	84	15	15	nd	
	wet	6	SS	84	19	19	5	
		7	SS	75	8	8	nd	
	trace clay and sand	8	SS	84	4	4	nd	
		9	SS	67	4	4	nd	
		10	SS	59	2	2	nd	
91.8 / 7.3	**BEDROCK**							

Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9. Elevation (m): 99, 98, 97, 96, 95, 94, 93, 92, 91, 90.

DYNAMIC CONE PENETRATION TEST; STANDARD PENETRATION TEST (SPT): 10 20 30 40

Combustible Organic Vapour, % LEL: 20 40 60 80; Combustible Organic Vapour, ppm: 30 60 90 120

amec

RECORD OF BOREHOLE No BH9D

Project Client: **PWGSC** | Location: **Frontenac Institution, Landfill 3, Collins Bay, Ontario (CSC ID: 441-L03)** | Logged By: **JD**

Project Number: **TC111025.3000** | Borehole Type & Drilling Equipment: **200 mm Dia. Hollow Stem Augering, Track Mounted Drill** | Compiled By: **ZF**

Project Datum: **Local** | Date: **September 28, 2011** | Checked By: **SG**

SOIL PROFILE			SAMPLES								DYNAMIC CONE PENETRATION TEST □ / STANDARD PENETRATION TEST (SPT) ■ (10 20 30 40)	Combustible Organic Vapour, % LEL ▲ (20 40 60 80) / (RKI EAGLE 2) Combustible Organic Vapour, ppm ● (30 60 90 120)	REMARKS
ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	DEPTH (m)	G.W. CONDITION	ELEVATION (m)	WELL INSTALLATION			
89.1 10.1	**End of Borehole** Measured ground water depth on October 27, 2011: 1.74 mbgs Well Detail: 50 mm sched 40 (8.53 m - 10.06 m) with sand pack (8.23 m - 10.06 m), bentonite plug above sand, capped with above-grade casing set in concrete with J-plug.												

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RECORD OF BOREHOLE No BH9S

Project Client: PWGSC
Location: Frontenac Institution, Landfill 3, Collins Bay, Ontario (CSC ID: 441-L03)
Logged By: JD

Project Number: TC111025.3000
Borehole Type & Drilling Equipment: 200 mm Dia. Hollow Stem Augering, Track Mounted Drill
Compiled By: ZF

Project Datum: Local
Date: September 28, 2011
Checked By: SG

ELEV DEPTH (m)	DESCRIPTION (SOIL PROFILE)	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUE	DEPTH (m)	G.W. CONDITION	ELEVATION (m)	WELL INSTALLATION	DYNAMIC CONE PENETRATION TEST / STANDARD PENETRATION TEST (SPT) 10 20 30 40	Combustible Organic Vapour, % LEL 20 40 60 80 / (RKI EAGLE 2) Combustible Organic Vapour, ppm 30 60 90 120	REMARKS
99.0 0.0	brown **CLAYEY SILT** trace rootlets, damp —— damp to moist						1 2 3	∇	98 97 96				Stratigraphy inferred form BH9S
96.0 3.1	grey **SILT** trace clay, moist to wet —— wet						4		95				
94.4 4.6	**End of Borehole**												

Measured ground water depth on October 27, 2011: 1.66 mbgs

Well Detail:
50 mm sched 40
(1.52 m - 4.57 m)
with sand pack (0.91 m - 4.57 m), bentonite plug above sand, capped with above-grade casing set in concrete with J-plug.

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RECORD OF BOREHOLE No BH10

Project Client: **PWGSC** | Location: **Frontenac Institution, Landfill 3, Collins Bay, Ontario (CSC ID: 441-L03)** | Logged By: **DN**

Project Number: **TC111025.3000** | Borehole Type & Drilling Equipment: **200 mm Dia. Hollow Stem Augering, Track Mounted Drill** | Compiled By: **ZF**

Project Datum: **Local** | Date: **September 29, 2011** | Checked By: **SG**

ELEV / DEPTH (m)	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	TYPE	RECOVERY (%)	"N" VALUE	Combustible Organic Vapour (RKI EAGLE 2), ppm	REMARKS
98.4 / 0.0	brown **CLAY** trace silt, organics, roots, damp	1	AU			nd	
97.6 / 0.8	buff-tan **SILT** with minor reddish mottling, trace clay, organics, damp	2	SS	84	20	nd	
	brown	3	SS	100	8	nd	
96.4 / 2.0	brown **CLAY** trace silt, organics, damp	4	SS	100	18	nd	
	fluvial layering, varved-like in appearance, damp, moist at tip; oxidation	5	SS	100	9	nd	
	moist	6	SS	100	9	nd	LF3 BH5 12.5-14.5 - submitted for PHC F1-F4, VOC, PAH, Metals and OCP
	moist to wet	7	SS	100	8	nd	
93.1 / 5.3	**End of Borehole**						

Legend: DYNAMIC CONE PENETRATION TEST □; STANDARD PENETRATION TEST (SPT) ■ (scale 10, 20, 30, 40); Combustible Organic Vapour, % LEL ▲ (scale 20, 40, 60, 80); (RKI EAGLE 2) Combustible Organic Vapour, ppm ● (scale 30, 60, 90, 120). Other columns: STRAT PLOT, DEPTH (m), G.W. CONDITION, ELEVATION (m), WELL INSTALLATION.

Measured ground water depth on October 27, 2011: 1.04 mbgs

Well Detail:
50 mm sched 40
(2.29 m - 5.33 m)
with sand pack (1.52 m - 5.33 m),
bentonite plug above sand, capped with above-grade casing set in concrete with J-plug.

amec

RECORD OF BOREHOLE No BH11

Project Client: **PWGSC**
Location: **Frontenac Institution, Landfill 3, Collins Bay, Ontario (CSC ID: 441-L03)**
Logged By: **DN**

Project Number: **TC111025.3000**
Borehole Type & Drilling Equipment: **200 mm Dia. Hollow Stem Augering, Track Mounted Drill**
Compiled By: **ZF**

Project Datum: **Local**
Date: **September 29, 2011**
Checked By: **SG**

ELEV DEPTH (m)	DESCRIPTION (SOIL PROFILE)	SAMPLE NUMBER	TYPE	RECOVERY (%)	"N" VALUE	REMARKS
98.1 / 0.0	Grassed Surface; dark brown Silt **FILL** trace clay, roots, organics; —— Clay/Silt trace gravel, sands, metal debris, glass, damp	1	AU			
97.1 / 1.0	brown **SILT** trace to some clay, some gravel, minor brick fragments, damp; —— brown-buff; —— brown-grey, trace oxidation zones, damp to moist	2	SS	100	22	LF3 BH11 2.5-4.5 - submitted for PAH, PCB, Metals and OCP
		3	SS	100	13	
		4	SS	100	17	LF3 BH11 7.5-9.5 - submitted for PHC F1-F4 and VOC -Reddish staining
95.0 / 3.1	brown-grey **CLAY** trace to some silt, moist to wet	5	SS	100	8	
94.2 / 3.8	brown-grey **SILT** trace clay, oxidized lenses throughout, wet	6	SS	100	12	
93.5 / 4.6	**End of Borehole**					

Combustible Organic Vapour (RKI EAGLE 2), ppm: nd for samples 1–6.

Measured ground water depth on October 27, 2011: 1.59 mbgs

Well Detail:
50 mm slot 10
(1.52 m - 4.57 m)
with sand pack (0.91 m - 4.57 m), bentonite plug above sand, capped with above-grade casing set in concrete with J-plug.

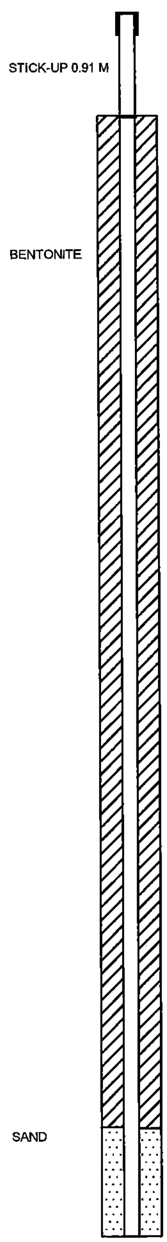
Chart headings: DEPTH (m); G.W. CONDITION; ELEVATION (m); WELL INSTALLATION; DYNAMIC CONE PENETRATION TEST □; STANDARD PENETRATION TEST (SPT) ■ (10 20 30 40); Combustible Organic Vapour, % LEL ▲ (20 40 60 80); (RKI EAGLE 2) Combustible Organic Vapour, ppm ● (30 60 90 120)

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Environmental Sciences Group
The Royal Military College of Canada
PO Box 17000 Stn Forces
Kingston, Ontario, K7K 7B4

PROJECT :	Frontenac Institution	**SAMPLED BY:**	S. Goure
AREA :	Kingston, Ontario	**LOGGED BY:**	S. Goure
BOREHOLE ID :	F2005-01-1	**DATE COMPLETED :**	February 2 & 3, 2005
		DRILLING METHOD :	Hand held auger

INSTALLATION



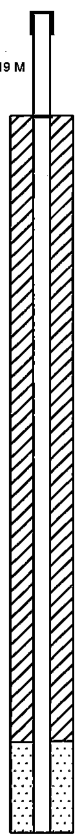
DEPTH BGS (ft)	DEPTH BGS (m)	ELEVATION (MASL) (m)
0	0	61.261
	1	60.261
	2	59.261
10	3	58.261
	4	57.261
	5	56.261
20	6	55.261
	7	54.261

SPLIT-SPOON NO.	RECOVERY (INCHES)	N-VALUE	SOIL UNIT	STRATIGRAPHIC DESCRIPTION
			FROZEN	
1	1.17	50<	SAND FILL	dense, red-brown, fine, medium and coarse grain sand, dry, noncohesive and some clasts
2	9	18		
3	0	16		
4	9	-	SILT	medium dense, mottled dark grey with orange staining, silt and trace clay, dry to moist, cohesive
5	20	50<		mottled red-brown to light brown orange staining
6	20	50<		
7	18	50<		
8	12	50<		
9	20	47		
10	24	18		light grey
11	24	20		
12	4	19	SILT TILL	very dense, light grey, silt with fine grain sand and some clay with angular to sub angular clasts up to 4 cm, moist, cohesive
13	16	50<		
				End of borehole

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Environmental Sciences Group
The Royal Military College of Canada
PO Box 17000 Stn Forces
Kingston, Ontario, K7K 7B4

PROJECT :	Frontenac Institution	**SAMPLED BY:**	S. Goure
AREA :	Kingston, Ontario	**LOGGED BY:**	S. Goure
BOREHOLE ID :	F2005-01-2	**DATE COMPLETED :**	February 2 & 3, 2005
		DRILLING METHOD :	Hand held auger



DEPTH BGS (ft)	DEPTH BGS (m)	ELEVATION (MASL) (m)
0	0	61.243
	1	60.243
	2	59.243
10	3	58.243
	4	57.243
	5	56.243
20	6	55.243
	7	54.243
24		

SPLIT-SPOON NO.	RECOVERY (INCHES)	N-VALUE
1	1 17	50<
2	9	18
3	0	16
4	9	-
5	20	50<
6	20	50<
7	18	50<
8	12	50<
9	20	47
10	24	18
11	24	20
12	4	19
13	16	50<

SOIL UNIT	STRATIGRAPHIC DESCRIPTION
FROZEN	
SAND FILL	dense, red-brown, fine, medium and coarse grain sand, dry, noncohesive and some clasts
SILT	medium dense, mottled dark grey with orange staining, silt and trace clay, dry to moist, cohesive mottled red-brown to light brown orange staining light grey
SILT TILL	very dense, light grey, silt with fine grain sand and some clay with angular to sub angular clasts up to 4 cm, moist, cohesive
End of borehole	

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Environmental Sciences Group
The Royal Military College of Canada
PO Box 17000 Stn Forces
Kingston, Ontario, K7K 7B4

PROJECT :	Frontenac Institution	**SAMPLED BY:**	S. Villeneuve
AREA :	Kingston, Ontario	**LOGGED BY:**	S. Goure
BOREHOLE ID :	F2005-03-1	**DATE COMPLETED :**	February 3, 2005
		DRILLING METHOD :	Hand held auger

INSTALLATION	DEPTH BGS (ft)	DEPTH BGS (m)	ELEVATION (MASL) (m)	SPLIT-SPOON NO.	RECOVERY (INCHES)	N-VALUE	SOIL UNIT	STRATIGRAPHIC DESCRIPTION
STICK-UP 1.265 M								
BENTONITE	0	0	57.921				TOPSOIL	loose, light brown, silt and fine grain sand with organics and trace clay, moist, cohesive
				1	18	40	CLAYEY SILT	dense, mottled grey with orange staining, silt (increasing with depth) with some clay, moist, cohesive
	2			2	7	50<		
		1	56.921					
	4			3	19	26	SILT	medium dense, light brown, silt, wet, noncohesive
								orange staining
	6	2	55.921	4	9	50<	SILT TILL	very dense, light brown, silt with fine grain sand and some clay with angular to sub angular clasts up to 4 cm, moist, cohesive
SAND	8			5	4	50<		
								End of borehole
	10	3	54.921					
	12							

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Environmental Sciences Group
The Royal Military College of Canada
PO Box 17000 Stn Forces
Kingston, Ontario, K7K 7B4

PROJECT :	Frontenac Institution	**SAMPLED BY:**	S. Villeneuve
AREA :	Kingston, Ontario	**LOGGED BY:**	S. Goure
BOREHOLE ID :	F2005-03-2	**DATE COMPLETED :**	February 3, 2005
		DRILLING METHOD :	Hand held auger

INSTALLATION: STICK-UP 1.235 M; BENTONITE; SAND

DEPTH BGS (ft)	DEPTH BGS (m)	ELEVATION (MASL) (m)
0	0	57.953
2		
	1	56.953
4		
6		
	2	55.953
8		
10	3	54.953
12		

SPLIT-SPOON NO.	RECOVERY (INCHES)	N-VALUE
1	18	40
2	7	50<
3	19	26
4	9	50<
5	4	50<

SOIL UNIT	STRATIGRAPHIC DESCRIPTION
TOPSOIL	loose, light brown, silt and fine grain sand with organics and trace clay, moist, cohesive
CLAYEY SILT	dense, mottled grey with orange staining, silt (increasing with depth) with some clay, moist, cohesive
SILT	medium dense, light brown, silt, wet, noncohesive orange staining
SILT TILL	very dense, light brown, silt with fine grain sand and some clay with angular to sub angular clasts up to 4 cm, moist, cohesive
End of borehole	

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Environmental Sciences Group
The Royal Military College of Canada
PO Box 17000 Stn Forces
Kingston, Ontario, K7K 7B4

PROJECT : Frontenac Institution

AREA : Kingston, Ontario

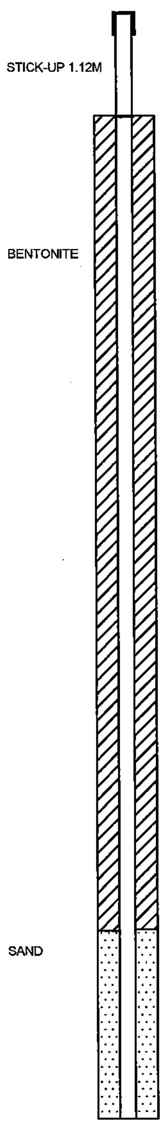
BOREHOLE ID : F2005-04-1

SAMPLED BY: S. Villeneuve

LOGGED BY: S. Goure

DATE COMPLETED : February 3, 2005

DRILLING METHOD : Hand held auger

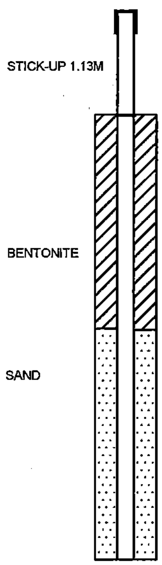


DEPTH BGS (ft)	DEPTH BGS (m)	ELEVATION (MASL) (m)	SPLIT-SPOON NO.	RECOVERY (INCHES)	N-VALUE	SOIL UNIT	STRATIGRAPHIC DESCRIPTION
0	0	58.034				FROZEN	
						CLAY	dense, mottled dark grey with orange staining clay with some silt, moist, cohesive
2			1	20	30	CLAYEY SILT	dense, mottled grey with orange staining, silt (increasing with depth) with some clay, moist, cohesive
	1	57.034					
4			2	19.25	35		
						SILT	medium dense, light brown, silt, dry to moist, noncohesive
6			3	16.5	35		
	2	56.034					
8			4	16	12	SILT TILL	very dense, light grey, silt with fine grain sand and some clay with angular to sub angular clasts up to 4 cm, moist, cohesive
10	3	55.034	5	7	50<		
						End of borehole	
12							

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Environmental Sciences Group
The Royal Military College of Canada
PO Box 17000 Stn Forces
Kingston, Ontario, K7K 7B4

PROJECT :	Frontenac Institution	**SAMPLED BY:**	S. Villeneuve
AREA :	Kingston, Ontario	**LOGGED BY:**	S. Goure
BOREHOLE ID :	F2005-04-2	**DATE COMPLETED :**	February 3, 2005
		DRILLING METHOD :	Hand held auger

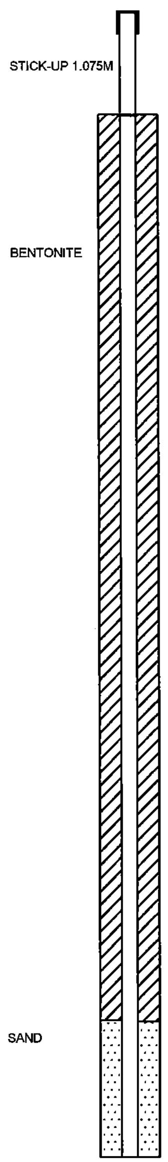


INSTALLATION	DEPTH BGS ft	DEPTH BGS m	ELEVATION (MASL) m	SPLIT-SPOON NO.	RECOVERY (INCHES)	N-VALUE	SOIL UNIT	STRATIGRAPHIC DESCRIPTION
STICK-UP 1.13M	0	0	57.878				FROZEN	
							CLAY	dense, mottled dark grey with orange staining clay with some silt, moist, cohesive
BENTONITE	2			1	20	30	CLAYEY SILT	dense, mottled grey with orange staining, silt (increasing with depth) with some clay, moist, cohesive
SAND		1	56.878					
	4			2	19.25	35		
							SILT	medium dense, light brown, silt, dry to moist, noncohesive
	6			3	16.5	35		
		2	55.878					
	8			4	16	12	SILT TILL	very dense, light grey, silt with fine grain sand and some clay with angular to sub angular clasts up to 4 cm, moist, cohesive
	10	3	54.878	5	7	50<		
								End of borehole
	12							

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Environmental Sciences Group
The Royal Military College of Canada
PO Box 17000 Stn Forces
Kingston, Ontario, K7K 7B4

PROJECT :	Frontenac Institution	**SAMPLED BY:**	S. Goure
AREA :	Kingston, Ontario	**LOGGED BY:**	S. Goure
BOREHOLE ID :	F2005-05-1	**DATE COMPLETED :**	February 3, 2005
		DRILLING METHOD :	Hand held auger



DEPTH BGS (ft)	DEPTH BGS (m)	ELEVATION (MASL) (m)
0	0	58.091
2		
	1	57.091
4		
6		
	2	56.091
8		
10	3	55.091
12		
	4	
14		

SPLIT-SPOON NO.	RECOVERY (INCHES)	N-VALUE	SOIL UNIT	STRATIGRAPHIC DESCRIPTION
			FROZEN	
1	10	10	CLAY	medium dense, black-brown, clay with some organics, moist, cohesive dense, mottled dark grey with orange staining, clay with some silt
			CLAYEY SILT	dense, mottled grey with orange staining, silt (increasing with depth) with some clay, moist, cohesive
2	20	25<		
3	17	24<	SILT	medium dense, mottled light brown with orange staining, silt, wet, noncohesive
4	18	47		
5	17	28	SILT TILL	very dense, light grey, silt with fine grain sand and some clay with angular to sub angular clasts up to 1 cm, moist, cohesive
			SILT	medium dense, light grey, silt, wet, noncohesive
6	9	50<	SILT TILL	very dense, light grey, silt with fine grain sand and some clay with angular to sub angular clasts up to 4 cm, moist, cohesive
			End of borehole	

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Environmental Sciences Group
The Royal Military College of Canada
PO Box 17000 Stn Forces
Kingston, Ontario, K7K 7B4

PROJECT :	Frontenac Institution	**SAMPLED BY:**	S. Goure
AREA :	Kingston, Ontario	**LOGGED BY:**	S. Goure
BOREHOLE ID :	F2005-05-2	**DATE COMPLETED :**	February 3, 2005
		DRILLING METHOD :	Hand held auger

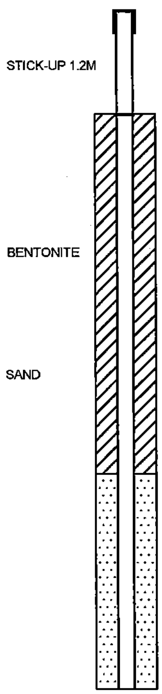
INSTALLATION	DEPTH BGS (ft / m)	ELEVATION (MASL) (m)	SPLIT-SPOON NO.	RECOVERY (INCHES)	N-VALUE	SOIL UNIT	STRATIGRAPHIC DESCRIPTION
STICK-UP 0.98 M							
BENTONITE	0 / 0	57.924				FROZEN	
	2		1	10	10	CLAY	medium dense, black-brown, clay with some organics, moist, cohesive dense, mottled dark grey with orange staining, clay with some silt
	1 m	56.924				CLAYEY SILT	dense, mottled grey with orange staining, silt (increasing with depth) with some clay, moist, cohesive
	4		2	20	25<		
SAND	6						
	2 m	55.924	3	17	24<	SILT	medium dense, mottled light brown with orange staining, silt, wet, noncohesive
	8		4	18	47		
	10 / 3	54.924	5	17	28	SILT TILL	very dense, light grey, silt with fine grain sand and some clay with angular to sub angular clasts up to 1 cm, moist, cohesive
						SILT SILT	medium dense, light grey, silt, wet, noncohesive
	12		6	9	50<	SILT TILL	very dense, light grey, silt with fine grain sand up to 4 cm, moist, cohesive
						End of borehole	End of borehole
	4 m	53.924					
	14						

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Environmental Sciences Group
The Royal Military College of Canada
PO Box 17000 Stn Forces
Kingston, Ontario, K7K 7B4

PROJECT :	Frontenac Institution	**SAMPLED BY:**	S. Villeneuve
AREA :	Kingston, Ontario	**LOGGED BY:**	S. Goure
BOREHOLE ID :	F2005-06	**DATE COMPLETED :**	February 4, 2005
		DRILLING METHOD :	Hand held auger

INSTALLATION



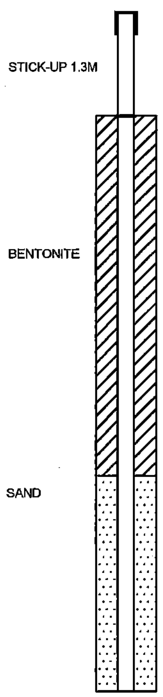
DEPTH BGS (ft)	DEPTH BGS (m)	ELEVATION (MASL) (m)
0	0	58.093
2		
	1	57.093
4		
6		
	2	56.093
8		
10	3	55.093
12		

SPLIT-SPOON NO.	RECOVERY (INCHES)	N-VALUE	SOIL UNIT	STRATIGRAPHIC DESCRIPTION
			FROZEN	
1	0	3	CLAY	medium dense, black-brown, clay with some organics, moist, cohesive dense, mottled dark grey with orange staining, clay with some silt
2	18	13		
3	17	36	SILT	medium dense, mottled light brown with orange staining, silt, wet, noncohesive
4	16	26		
5	16	26		light grey
6	9	50<	SILT TILL	very dense, light grey, silt with fine grain sand and some clay with angular to sub angular clasts up to 4 cm, moist, cohesive
			End of borehole	

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Environmental Sciences Group
The Royal Military College of Canada
PO Box 17000 Stn Forces
Kingston, Ontario, K7K 7B4

PROJECT :	Frontenac Institution	**SAMPLED BY:**	S. Villeneuve
AREA :	Kingston, Ontario	**LOGGED BY:**	S. Goure
BOREHOLE ID :	F2005-07	**DATE COMPLETED :**	February 4, 2005
		DRILLING METHOD :	Hand held auger



DEPTH BGS (ft)	DEPTH BGS (m)	ELEVATION (MASL) (m)	SPLIT-SPOON NO.	RECOVERY (INCHES)	N-VALUE	SOIL UNIT	STRATIGRAPHIC DESCRIPTION
0	0	58.142				FROZEN	
2			1	9	-	CLAY	dense, mottled dark grey with orange staining clay with some silt, moist, cohesive
4	1	57.142	2	18	38	CLAYEY SILT	dense, mottled grey with orange staining, silt (increasing with depth) with some clay, moist, cohesive
6	2	56.142	3	20	46	SILT	medium dense, dark grey with orange staining silt and trace clay, moist, cohesive
8			4	16	47		medium dense, mottled light brown with orange staining, silt, wet, noncohesive
10	3	55.142	5	18	50<		light grey
12			6	11	50<	SILT TILL	very dense, light grey, silt with fine grain sand and some clay with angular to sub angular clasts up to 4 cm, moist, cohesive
							End of borehole

DRILLING LOG

Logged By:	Reviewed By:	Sheet Number:	Borehole Number:
D. Dickson	H. Jackson	1 of 1	**MW-5**

Drilling Company:	Drilling Equipment:	Drilling Method:	Start Date:	End Date:
George Downing Estate Drilling	CME-55	HSA	21 Oct 00	21 Oct 00

Final Hole Depth (m):	Final Well Depth (m):	Hole Diameter (m):	Well Diameter (m):	Pipe Stick-up (m):
5.18	4.5	0.2	0.051	0.91

Ground Elevation (m):	TOC Elevation (m):	Depth to Water BTOC (m):	Depth to Water BGS (m):	Groundwater Elevation (m):
n.a.	Not Surveyed	2.89	1.98	n.a.

Sample Type Legend:

SS	Split Spoon Sample	AU	Auger Sample
PS	Pionjar Sample	VA	Vane Test Interval
GR	Grab Sample	SP	Standard Penetration Test
RX	Core Sample	SH	Shelby Tube Sample

Borehole Location Description/Notes:
in old landfill, south of main institution buildings

Sample Type, No., and Interval	Elevation (m) Depth (m)	Stratigraphic Description	Well Construction Details
		TOPSOIL - moist	- concrete seal
SS-1	0.18	**FILL AND WASTE MATERIALS** - asphalt waste, black shiny - concrete debris - fill: medium to coarse sand, brown, moist	- sand pack
SS-2		- well graded sand mixed with black cinders - trace red brick - dry to moist	- bentonite seal
SS-3		- light brown sand, some silt and clay - mixed with pulverized red brick - moist	- sand pack
SS-4	2.39	**CLAY** - some organics - black to light brown with depth - some silt to silty clay - medium plasticity - red oxidized pockets throughout	
SS-5	3.00	**SILT AND CLAY** - interbedded 5 cm silt and 2.5 cm clay layers - silt - rapid dilatency, oxidized layers throughout, light brown, wet - clay - silty to some silt, grey, medium plasticity, about plastic limit	- 10' screen
SS-6	3.81	**SILT TILL** - trace angular gravel and coarse sand - oxidized layers throughout - light brown - wet	
SS-7		- grades to grey - some angular cobbles - trace coarse sand and gravel	
	5.18	Depth to water at completion 1.98 m End of borehole at 5.18 m	

Depth Scale (m): 1, 2, 3, 4, 5

SNC•LAVALIN
Engineers & Constructors
2200 Lake Shore Blvd. West
Toronto Ontario M8V 1A4
Phone: (416) 252-5311
FAX: (416) 231-5356

Project Name: Frontenac Institution
Project Location: Kingston, ON
Project Number: 331142

SITE PHOTOGRAPHS

Photograph 1: Landfill #3 - looking east from site road

Photograph 2: Landfill #3 - south landfill slope, looking east

SITE PHOTOGRAPHS

Photograph 3: Landfill #3 - south landfill slope, culvert under site road

Photograph 4: Landfill #3 - south side between landfill slope and stream, looking east

SITE PHOTOGRAPHS

Photograph 5: Landfill #3 - East extent of landfill area, looking north

Photograph 6: Landfill #3 - Debris at south east corner of landfill area

SITE PHOTOGRAPHS

Photograph 7: Landfill #3 - East extent of landfill area, looking south

Photograph 8: Landfill #3 - North landfill slope, looking east

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SITE PHOTOGRAPHS

Photograph 9: Landfill #1 - Front Road ditch and fence line at temporary site access

Photograph 10: Landfill #1 - West portion of landfill area, looking south

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SITE PHOTOGRAPHS

Photograph 11: Landfill #1 - South limit of landfill, Looking east

Photograph 12: Landfill #1 - East limit of landfill, looking north

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SITE PHOTOGRAPHS

Photograph 13: Landfill #1 - Ditch at east limit of landfill, looking south

Photograph 14: Landfill #1 - Top of landfill and slope to ditch on east side of landfill area, looking south

SITE PHOTOGRAPHS

Photograph 15: Landfill #1 - Ditch and landfill slope at north east corner of landfill, looking north

Photograph 16: Landfill #1 - North east corner of landfill area, looking west

SITE PHOTOGRAPHS

Photograph 17: Landfill #1 - North slope of landfill, looking east

Photograph 18: Landfill #1 – North slope of landfill, looking west

COLLINS BAY AND FRONTENAC INSTITUTION

CONTRACTOR

HEALTH, SAFETY & SECURITY ORIENTATION

December 2012

Notice to Persons Granted Access

To prevent accidents and injuries, any person granted access to this institution must comply with the safety procedures relevant to their environment and work. Persons granted access must comply with any posted directives or those issued by Correctional Service Canada Staff. Non-compliance with any directive could automatically result in expulsion from this institution.

HEALTH, SAFETY & SECURITY ORIENTATION

FOR CONTRACTORS

INTRODUCTION

Collins Bay and Frontenac Institutions are federal penitentiaries, which creates a unique work environment as there are distinctive rules and regulations that may not apply to a traditional work site. This orientation package is to assist Contractors to better understand the requirements of working in a federal penitentiary. It is important that you understand the rules and regulations associated with this institution. With a clear understanding of the health, safety and security issues, you will contribute to the overall safety of yourself, the staff and the offenders.

It will be the responsibility of every contractor as well as any sub-contractors to follow the rules and regulations listed in this document as well as any applicable federal and provincial legislation.

ENTRY AND ACCESS TO THE INSTITUTION

All contractors are to report to the Main entrance prior to any work taking place. Security clearance (i.e. via a **CPIC**; Canadian Police Information Centre), must have been received and processed for each worker prior to the commencement of work. Please allow up to 2 weeks for a CPIC to be processed for this institution. Gate Passes may be issued upon admission into the institution. Each Contractor and/or Subcontractor must present photo identification (e.g. Drivers license) to staff, sign in and out on a daily basis and will wear the Institutional Visitor Identification badge when issued. It is the Contractor's duty to ensure this tag be picked up from the main entrance at the commencement of each working day and returned at the completion of each day to the Correctional Officer at the Main Entrance.

All tools and equipment that are being brought into the institution including personal items such as food, bags, identification, etc. may be passed through an x-ray machine. All persons entering the institution will be required to remove any metal objects from their person such as loose change, jewellery, etc. and to walk through a metal detector. The Correctional Officer on duty may also request that your personnel belongings be tested using an ion-scan device. Refusal to take the test will have your security clearance revoked and access denied. Additional security searches that may be utilized to persons entering the institution may include: Ion scan, hand wands and detector dog search.

The lead contractor will be responsible for notifying any and all deliveries that will be coming into the institution, especially with construction projects, prior to their arrivals. Special institutional knowledge and authorization (*Admittance to Institutional Property*) must be given to security at least 24 hours prior to the arrival of deliveries. This can be arranged through the Construction Liaison Officer or the Security Liaison Officer. Security at any point of entrance has the right to refuse entry of anyone who does not have prior written approval to enter.

TOOL CONTROL

Tool control is critical to the security of the institution and as such, all Contractors are responsible for the safekeeping of their tools. ***The best practise for tool control is to only bring in the tools you require to complete the job***. Additional items results longer inventory control periods both entering and exiting the Institution. The Contractor is responsible for adhering to the following rules:

a) The contractor must provide a list of all tools and equipment that will be brought into the institution. The list will be part of the gate-pass and only the items listed will be allowed in the institution. All tools and equipment will be checked against the inventory when entering and exiting the institution.

b) Power driven tools, "Ram-sets", etc, shall not be brought into the Institution until they are required. The number of cartridges brought in shall be counted and upon leaving the Institution, the number of live and expended cartridges shall be counted to ensure it coincides with the number of cartridges brought in.

c) All tools must be kept in a locked box stored in a secure location (contractor's gang box) when not in use. Particular attention being paid to ropes, ladders, cutting tools, extension cords, gauges, hoses, shovels, picks, wrecking bars, tips for acetylene torches, etc. Ladders are to be compacted and chained together to a stationary object and padlocked when not in use. At the end of each workday all tools must be accounted for, locked up or removed from the property.

d) All tools must be kept clear from any construction fence or security fence within the institution at all times. These areas are also not to be used as stationary places to secure items or tools when not in use. Some fences are equipped with motion sensors and disturbances to such areas may result in an emergency response from security. as this is not only a vehicle for deliveries but an emergency area for fire trucks etc. In the event of a major disturbance etc. (this can also be added to the institutional emergency part of the document)

e) In the event that a tool is unaccounted for the contractor must report this to the CSC Works Supervisor that they are in direct contact with for the on-site project.

f) Contractors are not to use institutional tools or equipment.

VEHICLES

All Contractor vehicles must be locked and secured at all times and be parked in the lower visitor parking area. Contractors that are required to bring a vehicle into the institution are required to make arrangements in advance. All vehicles entering the institution are subject to be thoroughly searched. The driver and passenger that enter through the Sally Port of Collins Bay must remain with the vehicle as it is searched and entered into the entrance log for the institution. It is recommended that any additional Contractors for the project should enter through the main entrance and be escorted to their work site. All tools and equipment in the vehicle must be secured at all times while in the institution. Tools found within the vehicle that are not required for the project may be held at this entrance point until the vehicle exits the institution.

COMMUNICATION DEVICES

Under most circumstances cellular phones, Blackberry's or other communication device are not permitted within the boundaries of a federal institution. Special permission may be approved for select persons to carry a communication device within the institution and Security will be notified in writing of who on a project is permitted to carry such a device. For all other personnel working on-site it is recommended that these devices be secured in their work vehicle prior to entering the institution.

CAMERAS, COMPUTERS AND OTHER ELECTRONICS

Cameras and Computers are not permitted in the institution without prior written approval from the Warden. If a camera or a computer (laptop, notebook, etc…) is needed for work within the facility, the contractor must notify their institutional contact who will seek approval. If a camera is needed for a project, the contractor must be certain that no inmates are included in any photograph.

Other electronics that are also not permitted within federal institutions include, but are not limited to such things as IPods, I Pads (or similar), MP3 players, memory sticks and other items that may have uploading or downloading capabilities for the transfer of information.

ALCOHOL, TOBACCO AND NARCOTICS

All CSC Institutions have a zero tolerance policy for alcohol and narcotics on institutional property. Discovery of such items onsite and identification of the person or persons responsible for them will be reported immediately to the Warden and may result in criminal charges. Contractors who appear to be under the influence of any drug or narcotic; or who behaves in an unusual manner, will be asked to leave the institutional property.

Tobacco and associated paraphernalia (e.g. Lighters, matches, etc.) are unauthorized items in all Correctional Service of Canada facilities. Contractors are asked to leave their tobacco products in their locked vehicles in the parking lot or in the lockers provided at the main entrance. There is a designated smoking area in the parking area.

If prescription medication must be taken during work hours it should be left in a locked vehicle or placed in a locker at Visitor Security.

CONTROL OF CONTRABAND

The contractor is responsible for ensuring that all persons employed by him/her directly or indirectly to work in the institution are familiar with Corrections and Conditional Release Act (CCRA) Section 45:

> *Every person commits a summary conviction offence whom:*

a. *Is in possession of contraband beyond the visitors control point in a Penitentiary;*

b. *Is in possession of contraband of anything referred to in sections (2b,d,f,g),(3), (4),(5) and (7c,d) of the definition of "contraband" in Section 2 before the visitors control point at a Penitentiary;*

c. *Delivers or attempt to deliver contraband to, or receives or attempt to receive contraband from an inmate;*

d. Without prior authorization, delivers jewellery to, or receives jewellery from an inmate; or

e. Trespasses at a penitentiary.

“contraband” means:

a. *an intoxicant,*

b. *a weapon or a component thereof, ammunition for a weapon, and anything that is designed to kill, injure or disable a person or that is altered so as to be capable of killing, injuring or disabling a person, when possessed without prior authorization,*

c. *an explosive or a bomb or a component thereof,*

d. *currency over any applicable prescribed limit, when possessed without prior authorization, and*

e. *any item not described in paragraphs (a) to (d) that could jeopardize the security of a penitentiary or the safety of persons, when that item is possessed without prior authorization.*

SEARCHING OF A PERSON

Persons entering a federal penitentiary may be subject to a non-intrusive search or frisk search if it is reasonably required for security purposes or if there is reasonable grounds to suspect the visitor is carrying contraband.

INTERACTION WITH OFFENDERS

Contractors working on-site may find that inmates might attempt to converse or interaction with them. However, Security encourages that NO INTERACTIONS take place with inmates while working on-site. If a contractor is approached by an inmate who is overly inquisitive, requests a favour or is in any way intimidating or threatening, the interaction must be report immediately to a Commissionaire, who will then contact Control and/or the Security Liaison Officer.

If an offender does attempt to approach you, visitors are expected to treat each other with dignity and respect. Please use the following guidelines:

a. Give nothing and take nothing from offenders;

b. Do not pass letters or messages for offenders (they have access to mail and inmate operated telephones;

If a Contractor should become aware of an offender that they know, please advise your contact at the institution as soon as possible.

POST EXPOSURE PROTOCOL AND FIRST-AID

Should the contractor or anyone reporting to the contractor receive a significant exposure to blood or any other body fluid (e.g. someone else's blood or body fluid on your broken skin), the following steps are recommended:

a. Remove the contaminated clothing;
b. Allow the wound to bleed;
c. Wash the injured area well with soap and water;
d. If the eyes, nose or mouth are involved, flush well with very large amounts of water; and
e. Immediately notify the CSC contact as all Hazardous Occurrences at the institution must be reported.

HARASSMENT IN THE WORK PLACE

As an employer of the Federal Public Service, the Treasury Board is committed to providing a work environment where all persons working for the Public Service are treated with respect and dignity. Harassment affects our workplace and an individual's well being; and will not be tolerated. The Canadian Human Rights Act provides every person in the workplace the right to freedom from harassment based on race, national or ethnic origin, colour, religion, age, sex, sexual orientation, marital status, disability and pardoned conviction. A copy of the Treasury Board Policy on the Prevention and Resolution of Harassment in the Workplace is available upon request

If a Contactor or their workers experience or witness any type of harassment while on site they are asked to report it immediately to their institutional contact and/or the Chief of Plant Maintenance.

FIRE

Contractors will be made aware of the fire exits, the location of fire pull stations and evacuation procedures by CSC personnel at the start up meeting for the project. If a contractor starts a fire or notices one, they should pull the nearest fire alarm and immediately exit the building. If a Contractor is doing any work that may accidently start a fire (i.e. Hot Work), they must have a fire extinguisher on hand prior to commencement of the work.

All CSC Institutions are equipped with a fire alarm system that is monitored by an onsite central control post twenty-four hours a day. If an intermittent alarm sounds, it indicates that there may be a fire or danger of fire in the area and workers should be prepared to evacuate. If the alarm rings continuously work must be stopped and everyone must immediately exit the building via the nearest exit. No person may re-enter a building unless the “all clear” is given by the Institutional Fire Chief or an Officer in Charge.

Access roads are located within the institution that allow for the free movement of security vehicles (i.e. fire, police, ambulance, etc.) in the event of an emergency or major disturbance. All contractors are encouraged to keep these roadways free of vehicles, tools, equipment, etc., while working in the institution, in the event of an emergency.

INSTITUTIONAL EMERGENCY

Working in a federal penitentiary can create some exceptional situations. In the case of an institutional emergency (e.g. escapes, assaults, etc) please follow the direction provided by the Commissionaire, your escort or other institutional staff.

CHEMICAL OR FUEL SPILLS

In the case of a chemical or fuel spill the contractor will follow the directions on the MSDS sheet for containment. If and when fuel is being delivered on-site to construction vehicles, the fuel supply vehicle must be equipped with spill response equipment capable of cleaning up any volume that may be spilled from the supply vehicle. The contractor will be responsible for any fuel or chemical spilled on the work site, including the clean-up and disposal of all materials. The contractor is required contact the Control or Security Liaison Officer and the Chief of Plant Maintenance at the institution in the event of any spill.

SAFETY – GENERAL

Safety is the responsibility of every person in the institution and cannot be overemphasized. Occupational Health & Safety matters at CSC Institution are governed by the Canada Labour Code and other applicable federal legislation. As a contractor working in a federal facility, you and/or those authorized by their company are expected to follow all legislated requirements, both federal and provincial. Assistance from the Correctional Service of Canada is limited to providing access to the Institution and to making Contractors aware of potential hazards associated with the work performed. Contractors should be aware of the occupational hazards within their area of expertise and report any concerns to their institutional contact.

Contractors hired to conduct work at Collins Bay and/or Frontenac Institution have the following responsibilities:

- Submit site-specific Health and Safety Plan prior to commencement of work or as soon as possible in the event of an emergency Works project. The Health and Safety Plan must include at minimum:
    - Results of site-specific safety hazard assessment;
    - Contingency and/or Emergency Response Plan specific to the project;

    - Contractor’s and Sub-contractor’s Safety Communication Plan;
    - Proof of Worker’s Compensation Insurance;
    - Proof of Worker’s training consistent with the work to be performed.

- Schedule and administer Health and Safety meetings with responsible staff at the institution if appropriate;
- Be responsible for the health and safety of all employees and sub-contractors as well as for the protection of all persons in the vicinity that may be affected by the work;
- Immediately address and report any health and safety issues to the responsible staff;
- Immediately address any health and safety issues identified by staff or other authority having jurisdiction and submit any related report or written direction;
- Submit Material Safety Data Sheets (MSDS) if applicable;
- File notice of Project with Provincial authorities, where applicable, prior to commencement of the job task;
- Submit copies of all incident and accident reports to the responsible staff at the institution;
- Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for the job task;
- Provide and utilize all necessary personal protective equipment; and
- Cooperate with the *Institutional Joint Occupational Safety and Health* Committee *(IJOSH)* in case of an inspection or hazardous occurrence investigation.

CONFINED SPACES

Collins Bay and Frontenac Institution both have comprehensive Confined Space Programs. There are several identified confined spaces within the facility. Contractors who will be required to work in a designated confined space will be required to follow these Confined Space Programs, as well as the requirements listed in the Canada Labour Code and other applicable legislation. Confined spaces at the institution have been identified according to the definition provided in the Canadian Occupational Safety and Health Regulations:

> *A confined space means an enclosed or partially enclosed space that:*
>
> *(a) is not designed or intended for human occupancy except for the purpose of performing work,*
>
> *(b) has restricted means of access and egress, and*
>
> *(c) may become hazardous to any person entering it owing to*
>
> *i. its design, construction, location, or atmosphere,*
>
> *ii. the materials or substances in it, or*
>
> *iii. any other conditions relating to it*

Contractors are required to provide proof of confined space entry training prior to entering a confined space. Contractors must complete a hazard assessment of the space, develop safe working procedures and complete an entry permit before any work in a confined space can take place. Contractors are responsible for supplying their own equipment and the personnel necessary to complete a safe entry and rescue.

If you have any questions concerning confined spaces at Collins Bay and Frontenac Institution or would like to view our Confined Space Program please contact the Environmental and Safety Officer at 613 536-6323.

FALL PROTECTION

Fall protection is required whenever a worker is exposed to the hazard of falling more than 2.4 meters or when they are working above any moving part of machinery or any other surface or thing that could cause injury to a person upon contact. The Canadian Occupational Health & Safety Regulations require the use of fall protection for:

(a) an unguarded structure that is;

   i. more than 2.4 m above the nearest permanent safe level; or

   ii. above any moving part of machinery or any other surface or thing that could cause injury to an employee upon contact.

(b) a temporary structure that is more than 6 m above a permanent safe level, or

(c) a ladder at a height or more than 2.4 m above the nearest permanent safe level where, because of the nature of the work, that person cannot use one hand to hold onto the ladder, the employer shall provide a fall-protection system.

Contractors working at heights are expected to follow all applicable federal legislation as well as the institution's Fall Protection Program. Proof of fall protection training must be provided prior to working at heights. Contractors are responsible for supplying their own CSA/MSA approved/certified personal protective equipment.

RESPIRATORY PROTECTION

Collins Bay and Frontenac Institution both have comprehensive Respiratory Protection Programs. Contractors who are required to wear a respirator while performing work at the Institution must meet the requirements of all federal legislation and regulations and provide proof that they are trained in respiratory protection. The contractor is responsible for supplying their own NIOSH certified respirators that have been fit-tested to each worker. Assistance from the Institution will be limited to providing access to the worksite and making the Contractors aware of the potential hazards associated with their work.

If you have any questions concerning respiratory protection, please contact the Environmental and Safety Officer at 613 536-6323.

WHMIS

Contractors that must bring any chemical or other controlled substance/s into the institution must follow all WHMIS requirements. All materials must be labelled appropriately and be stored in a suitable container. A Material Safety Data Sheet (MSDS) will be required for each substance and must be provided to the institutional contact as well as kept with the persons using the substance at all times.

ACCIDENTS AND HAZARDOUS OCCURRENCES

All accidents and hazardous occurrences that occur on institutional property must be reported immediately to the institutional contact and the Chief of Plant Maintenance at 536-6276.

If the accident has resulted in an injury, work will stop immediately in the area the accident occurred in and will not resume until the incident has been investigated and corrective actions have been taken when identified. CSC reserves the right to conduct its own investigation into any accident or hazardous occurrence. This does not, and should not preclude you from following any procedures normally carried out by your company.

HOT WORKS PERMIT

Hot Work Permits must be issued by the Chief of Plant Maintenance or their designate before any work involving a flame or other source of ignition (i.e. cutting, welding, soldering etc of metals) is undertaken.

LOCKOUT/TAGOUT

Correctional Services Canada deems that it is essential to establish and maintain an effective Lockout–Tagout Program while working on-site. It is recognized that improper Lockout-Tagout of equipment/machinery prior to the performance of *any work* can cause an unexpected release of energy from a *hazardous energy source*. This has the potential to result in a serious injury or fatality.

An effective Lockout–Tagout Program is essential to prevent injury to all staff, employees, and contractors; and to restrict damage to equipment through the unexpected release of energy from a *hazardous energy source*. It applies to all persons who perform work on Correctional Services equipment/machinery, their staff and outside contractors.

Legislative references for company's licensed in the Province of Ontario program are contained in the Ontario Occupational Health and Safety Act, Regulation 851 (Industrial Establishments), Sections 42, 74, 75, and 76. Federal reference is in the compliance with the *Canada Occupational Health and Safety Regulations, SOR/86-304, Canada Labour Code* and the *Treasury Board OSH Manual, Fifth Edition, Chapter 2-3.*

CONTRCTOR AGREEMENT

This is to certify that I understand the Institutions requirements for contractors on Health, Safety and Security and agree to abide by all the policies and procedures as outlined in the document. I also understand that I am not authorized to conduct any communication with any media representative regarding CSC Operations or information about staff or inmates.

Business Name: ______________________________

Site Supervisor or Company Representative: ______________________________
Name

Employee ______________________________

Employee ______________________________

Employee ______________________________

Employee

Employee ______________________________

Employee

____

CSC Briefing Official(s): ______________________________

SNC·LAVALIN

CSC Collins Bay Species at Risk

Species at Risk Legislation

Federal Species at Risk Act (SARA)

Provincial Endangered Species Act (ESA)

- Both work to protect species that are at risk **and** their habitats.
- Identify species at risk based on the best available scientific information and community knowledge.

Species at Risk Classification

Endangered – species that is facing imminent extirpation or extinction.

Threatened – species that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction.

Special Concern – species that may become a threatened or an endangered species due to a combination of biological characteristics and identified threats.

Species at Risk Mammals

Photo:
Nick Dunlop
http://www.nickdunlop.com

GREY FOX

SARA/ESA Threatened

- About the size of a small dog and is grey, with a reddish chest and sides of the belly, and white underparts. It is also distinguished by its black-tipped tail.
- Prefers deciduous forests, especially swampy areas.

Species at Risk
Birds

Photo:
Doug Backlund
http://www.allaboutbirds.org

COMMON NIGHTHAWK

SARA Threatened/ESA Special Concern

• Medium-sized bird, active at night or at twilight. It has cryptic plumage, long wings, short legs, a very short bill and a wide mouth.

• Can be found in a wide variety of habitats, in particular those with open or semi-open areas such as farmland, open woodlands, clearcuts, burns, rock outcrops, bogs ferns, prairies, gravel pits and urban rooftops.

Photo:
Mark Peck

www.rom.on.ca

LEAST BITTERN

SARA/ESA Threatened

•More likely heard than seen, as it "coo"s softly. Smallest of the North American herons and is distinguished by large chestnut patches on its' wings.

•In Ontario, it is mainly found in large, quiet cattail marshes near the Great Lakes.

Photo:
Mark Peck
www.rom.on.ca

BLACK TERN

ESA Special Concern

• Small, boldly marked waterbird with black head and underparts during the breeding season.

• In Ontario, Black Terns are found mainly in the marshes along the edges of the Great Lakes.

Photo:
John C. Avise
http://nathistoc.bio.uci.edu/

RED-SHOULDERED HAWK
SARA Special Concern

•Broad, rounded wings with crescent-shaped "windows" and reddish shoulder patches are characteristic of this species.

•Found in woodlots and forested areas throughout southern Ontario.

Photo:
Mark Peck

www.rom.on.ca

SHORT-EARED OWL

SARA/ESA Special Concern

•Has relatively long wings and is often seen hunting over fields with a bouncy, butterfly-like flight.

• Lives in open areas such as grasslands, marshes and tundra. Preferred habitat also includes areas of prairie and savannah.

Species at Risk Herptiles

Photo:
www.earthrangers.com

BLANDING'S TURTLE

SARA/ESA Threatened

•Medium-sized turtle easily identified by its characteristic bright yellow throat and jaw and smooth, domed shell.

•Inhabits a network of lakes, streams, and wetlands, preferring shallow wetland areas with abundant vegetation.

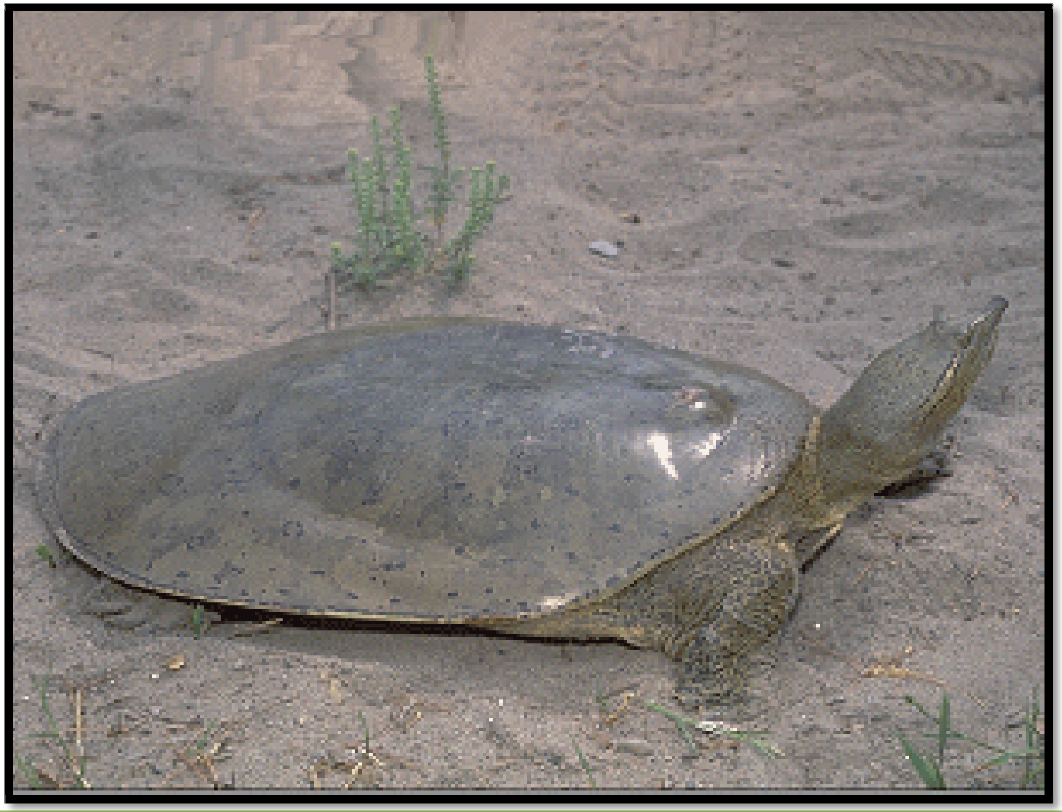

Photo:
John Mitchell
www.rom.on.ca

SPINY SOFTSHELL

SARA/ESA Threatened

- Also known as the "pancake turtle" because of its flat, round, leathery upper shell. Has a long neck and elongated, tubular snout.
- Highly aquatic turtle associated with lakes and large rivers. Rarely ventures far from the shoreline, and may be seen basking on beaches, sandbars, logs and rocks.

Photo:
KT McVeigh
www.townvibe.com

SNAPPING TURTLE

SARA/ESA Special Concern

•Large freshwater turtle with black, olive or brown shells typically covered in algae. Their tails have triangular crests along their length. Unlike other turtles, they are unable to withdraw into their shell.

•Preferred habitat is shallow, vegetated water. Often takes advantage of man-made structures for nest sites, including roads (especially gravel shoulders).

Photo:
Joe Crowley
http://www.ontarionature.org

NORTHERN MAP TURTLE

SARA/ESA Special Concern

- Has an olive green shell with fine yellow lines that look like the contour lines on a topographic map. The shell has a distinct ridge along the centre and serrations along its back edge. Both its head and legs have an intricate pattern of bright yellow lines and it has a yellow spot behind its eyes.
- Lives in large rivers and lakes with slow-moving water and soft bottoms.

Photo:
Joe Crowley

http://www.ontarionature.org

MILKSNAKE

SARA/ESA Special Concern

• Can grow to a length of >1m. Dorsal blotches are usually red with black borders, but colouration is quite variable and blotches may be brown or even green.

•Lives in a wide range of habitats and is more likely to be encountered at night when it is hunting, since during the day it is secretive and usually hides under objects. Often mistaken for the Eastern Massassauga.

Species at Risk
Fish

Photo:
Duane Raver/U.S. Fish & Wildlife Service

www.rom.on.ca

AMERICAN EEL

SARA Under Consideration/ESA Endangered

•Brownish, elongated fish normally growing up to 1 m in length and weighing up to 1.5 kg, with a single continuous dorsal fin and thick skin that can secrete large amounts slimy mucous.

•Widely distributed in freshwater systems. In Ontario, occurs mainly along the St. Lawrence River and Lake Ontario and their tributaries.

Species at Risk Invertebrates

Photo:
A. Lynch
www.rom.on.ca

MONARCH BUTTERFLY

SARA/ESA Special Concern

- Can be found in Ontario wherever there are milkweed plants for its caterpillars and wildflowers for a nectar source.
- Often seen on abandoned farmland and roadsides, but also in city gardens and parks.

What to do if you find a SAR?

- Prior to the start of the construction project, the area will be inspected by a qualified biologist to ensure that there are no SAR within the work limits.
- Do **NOT** touch a SAR if you are lucky enough to see one.
- Record date, time, and location (UTM or lat/long) of observation.
- If possible, take a photo.
- Contact Scott Clemow with these details **immediately** from the site.
- A permit under the *Species at Risk Act* is legally required to relocate any individuals of any SAR observed on site.

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