Groundwater Management Plan
Port Lands, Toronto

Prepared for

Waterfront Toronto

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Acronyms and Abbreviations

CBRA	community- based risk assessment
CSM	conceptual site model
DCS	Decommissioning Consulting Services
DNAPL	dense nonaqueous phase liquid
GHD	GHD Limited
LNAPL	light nonaqueous phase liquid
m/d	metre per day
m/m	metre per metre
m/sec	metre per second
m/y	metre per year
m	metre
m^3	cubic metre
m^3/d	cubic metre per day
masl	metre above sea level
mbgs	metre below ground surface
mm	millimetre
MOECC	Ontario Ministry for the Environment and Climate Change
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PHC	petroleum hydrocarbon
PTTW	Permit to Take Water
RSC	Record of Site Condition
SLR	SLR Consulting Canada Ltd.
SVOC	semivolatile organic compound
Table 3 SCS	*Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition* (MOECC, 2011b)
Table 9 SCS	*Table 9: Generic Site Condition Standards for Use within 30 m of a Water Body in a Non-Potable Groundwater Condition* (MOECC, 2011b)
VOC	volatile organic compound
WT	Waterfront Toronto

Tab G. Groundwater Management Plan

G.1 Baseline Conditions

G.1.1 Geology

The geologic conditions at the Site have been divided into five main stratigraphic units:

1. Heterogeneous fill from ground surface to up to 10.7 metres below ground surface (mbgs) that are composed of unconsolidated, gravel, sand, gravelly sand, sandy gravel, clay, silt, silty sand, and clayey silt. The fill may also contain debris, such as brick, glass, concrete, wood chips, charcoal, and cinders.
2. A thick, poorly-graded native sand unit continuous across the Site extending to bedrock. The native sand unit also contains silty sands, sand and gravel, and localized clay layers.
3. Discontinuous peat and organic layers up to 6.8 metres (m) thick. Peat and organic layers can be interbedded with sandy and silty layers at localized locations. The organics layers are discontinuous across the Site and can be found at different depths. The organics are usually located as layers within the native sand, or can be found above or below the native sand. Organic layer surface elevation and thickness are shown in Figure 5 and Figure 6.
4. Discontinuous native silt, clayey silt to clay till.
5. Georgian Bay Formation shale bedrock interbedded with limestone found at depths of approximately 10.8 to 41.31 mbgs. The bedrock consists of light grey, thinly-bedded fissile shale, with frequent horizontal fractures, and interbedded with limestone. The upper 5 m of bedrock is described as highly to slightly weathered with clay infills and typically highly fractured. The bedrock surface elevation is shown in Figure 7. The Rock Quality Designation has values ranging from 0 percent to 93 percent, indicating a very poor to excellent rock quality.

Nine geological cross sections were constructed and show the stratigraphic sections across the Site. Figure 8 shows the nine cross-section locations; Figures 9A through 9I are cross-sections A-A', B-B', C-C', D-D', E-E', F-F', G-G', H-H' and I-I', respectively. As shown on several of the geological cross sections, information gaps exist where the bottom of the native sand and the top of bedrock elevation has not been confirmed with boreholes (as shown by “To Be Confirmed” on geological cross sections). These gaps in the geology represent an uncertainty in the extent of the stratigraphic units which in turn represents an uncertainty in the extent of the hydrostratigraphic units described herein.

G.1.2 Hydrogeology

Two main hydrostratigraphic units were found at the Site: an unconfined fill/native sand aquifer and a weathered bedrock aquifer. Based on the hydraulic properties of the fill/native sand layers being similar based on their predominantly coarse granular materials, and the direct hydraulic connection between the two layers, groundwater will tend to flow horizontally and vertically within the fill/native sand layers, with the two layers acting as a single aquifer unit. The fill and native sand aquifer extends across the entire Site; however, the bottom of the native sand has not been confirmed in some areas of the Site. A weathered shale bedrock aquifer was identified underlying the fill/native sand aquifer. No aquitard separating the native sand and weathered shale bedrock units was identified, which means there may be a direct hydraulic connection between the two units.

Based on the recent investigations completed across the Site by GHD Limited (GHD; 2015): 97 monitoring wells were installed; 85 monitoring wells were screened in the fill/native sand aquifer; and 12 wells were screened in the bedrock aquifer. The hydraulic properties of the aquifers across the Site were evaluated using the results of single-well response tests (slug tests) conducted by GHD in August and December 2015. GHD conducted slug tests on 31 new monitoring wells screened in the fill. The calculated hydraulic conductivity values from the slug tests ranged from 2.2×10^{-6} to 8.8×10^{-4} metres per second (m/sec) for sandy fill (geometic mean 1.1×10^{-4} m/sec), and 1.5×10^{-7} to 7.5×10^{-6} m/sec for clay and silt fill (geometric mean 1.8×10^{-6} m/sec). The hydraulic conductivity results demonstrate that lower conductivity layers exist within the fill layer, and the higher conductivity of the fill falls within the hydraulic conductivity range of the native sand.

Slug tests were conducted in eight native sand aquifer monitoring wells across the Site by GHD. The calculated hydraulic conductivity values ranged from 3.1×10^{-5} to 8.7×10^{-4} m/sec. The geometric mean of the hydraulic conductivity within the native sand aquifer is 1.46×10^{-4} m/sec. This hydraulic conductivity is similar to the geometric mean hydraulic conductivity for the sandy fill, which provides support for combining the two stratigraphic units into one hydrostratigraphic unit.

Seven monitoring wells were screened within or across organic layers consisting of peat, organic silt, or organic clay. Hydraulic conductivity of the organic layers ranged from 3.6×10^{-7} to 1.7×10^{-4} m/sec (geometric mean of 1.5×10^{-5} m/sec). The hydraulic conductivity of the organics, at the higher end, fall within the same range of conductivities for the native sand.

GHD conducted slug tests in four wells (MW27A-15, MW31A-15, MW35A-15, and MW39A-15) screened in the shale bedrock. Hydraulic conductivity values ranged from 8.9×10^{-7} m/sec to 3.2×10^{-5} m/sec (geometric mean 8.2×10^{-6} m/sec).

The results of the slug tests to date indicate a fast to very fast hydraulic response for coarse textured deposits (fill, sand, and sand and gravel) and for some of the organic layers.

Table G1 summarizes the hydraulic conductivity testing completed at the Site.

Table G1. Summary of Hydraulic Conductivity

Hydrostratigraphic Unit	Hydraulic Conductivity (m/sec)		
	Minimum	**Maximum**	**Geometric Mean**
Fill (Sand)	2.21×10^{-6}	8.75×10^{-4}	1.14×10^{-4}
Fill (Silt and Clay)	1.49×10^{-7}	7.49×10^{-6}	1.76×10^{-6}
Organics Layers	3.64×10^{-7}	1.68×10^{-4}	1.49×10^{-5}
Native Sand Aquifer	3.05×10^{-5}	8.70×10^{-4}	1.46×10^{-4}
Upper Weathered Bedrock Aquifer	8.87×10^{-7}	3.21×10^{-5}	8.21×10^{-6}

On September 1, 2015, a groundwater elevation ‘snapshot’ across the new GHD monitoring well network measured the depth to groundwater in the fill/native sand aquifer, which ranged from 1.01 to 4.96 mbgs (74.80 to 76.06 metres above sea level [masl]) (Table G2; Figure 10A). The Lake Ontario mean daily surface elevation on September 1, 2015 at the Fisheries and Oceans Canada Tidal Observations Station Toronto #13320 was 75.02 masl. In July 2013, an investigation by Decommissioning Consulting Services (DCS) found that the depth to groundwater in the fill/native sand aquifer ranged from 0.2 to 2.34 mbgs (DCS, 2014) (Figure 10C). A review of historical investigation reports shows that between October 1991 and September 2014, groundwater elevations in the fill/native sand aquifer were reported to be 74.22 to 77.49 masl. These historical measurements provide the expected range of water levels and across the Site and indicate the seasonal variations that may be found in the water-level data. During the September 1, 2015 groundwater elevation ‘snapshot’, bedrock groundwater elevations were measured between 1.37 to 5.01 mbgs (74.42 to 75.16 masl).

On December 8, 2015, a groundwater elevation 'snapshot' across the new GHD monitoring well network measured the depth to groundwater in the fill/native sand aquifer, which ranged from 0.73 to 5.38 mbgs (74.43 to 75.75 masl) (Table G2; Figure 10B). The Lake Ontario mean daily surface elevation on December 8, 2015 at the Fisheries and Oceans Canada Tidal Observations Station Toronto #13320 was 74.50 masl. During the December 8, 2015 groundwater elevation 'snapshot', bedrock groundwater elevations were measured between 1.35 to 5.44 mbgs (74.49 to 75.41 masl).

Groundwater elevations in the fill/native sand aquifer on September 1, 2015, appear to be influenced by the level of Lake Ontario, including the Keating Channel and Shipping Channel to the north and south, respectively. The general groundwater flow direction within the fill/native sand aquifer is from east to west toward Lake Ontario, with localized northern and southern flow from the middle sections of the Site in the general direction of the Keating Channel and Shipping Channel (Figure 10A). Similar groundwater flow conditions were observed on March 9, 2009 by SLR Consulting Canada Ltd. (SLR; 2009) (Figure 10D). Based on the SLR piezometric contours in 2009, the horizontal hydraulic gradient of the fill/native sand aquifer across the Site was estimated to range between 0.003 and 0.007 metres per metre (m/m). Based on the September 1, 2015 piezometric contours, the horizontal hydraulic gradient of the fill/native sand aquifer is estimated to range between 0.004 and 0.0008 m/m. On September 1, 2015, groundwater elevations within the fill/native sand aquifer were on average approximately 0.2 m higher than the Lake Ontario mean daily surface elevation of 75.02 masl from the Fisheries and Oceans Canada Tidal Observations Station Toronto #13320.

Based on the December 8, 2015 piezometric contours in the fill/native sand aquifer, the average horizontal hydraulic gradient is calculated to be 0.005 m/m. The groundwater gradient continues to be generally flat, with groundwater elevations in the fill/native sand aquifer close to the level of Lake Ontario. Groundwater flow is radially outward towards the Toronto Harbour, Keating Channel, and Shipping Channel.

Lake Ontario exhibits a major hydraulic influence on groundwater elevations within the hydrostratigraphic units across the Site. A review of historical groundwater elevations at 150 Commissioners Street over three different groundwater monitoring events compared with historical Lake Ontario surface elevations (Figure 11) shows that in part, groundwater elevations are controlled by the surface elevation of Lake Ontario. Groundwater elevations correspond to the surface elevation of Lake Ontario, with a rise in Lake Ontario leading to a rise in groundwater elevations in the fill/native sand aquifer, and a decline in Lake Ontario leading to lower groundwater elevations in the fill/native sand aquifer.

In September 2015, 11 monitoring wells were screened in the shale bedrock. The groundwater potentiometric surface for the upper weathered bedrock aquifer (Figure 12A) was generated from measurements taken on September 1, 2015, with groundwater elevations ranging between 74.42 to 75.16 masl. Upper bedrock groundwater flow direction depicts groundwater flow in an eastern to western direction towards Lake Ontario, with a horizontal gradient of 0.0005 m/m. The groundwater potentiometric surface figure for the upper weathered bedrock aquifer (Figure 12B) was generated from measurements taken on December 8, 2015, with groundwater elevations ranging between 74.49 to 75.41 masl. Upper bedrock groundwater flow direction depicts groundwater flow in a southerly direction towards Lake Ontario, with a horizontal gradient of 0.001 m/m.

In September 2015, downward hydraulic gradients were generally observed from the fill to the native sand layers, with a geometric mean downward vertical gradient of 0.04 m/m. However, in several locations across the Site, upwards hydraulic gradients were calculated from the native sand to fill layers (nested monitoring wells MW1-15, MW2-15, MW3-15, MW8-15, MW26-15, MW31-15, MW34-15) (Table G3). Based on the hydraulic properties of the fill/native sand layers being similar and the direct hydraulic connection between the two layers, groundwater will tend to flow horizontally and vertically within the fill/native sand layers, with the two layers acting as a single aquifer unit. Generally, downward hydraulic gradients also exist between the native sand layer and the upper weathered bedrock, which defines the recharge area. The exception is at three nested monitoring well locations (MW30-15, MW35-15, and MW40-15), where upward hydraulic gradients are calculated to range between 0.001 to 0.004 m/m, indicate a groundwater discharge area. Vertical groundwater flow velocities calculated using the September 2015 data are estimated to range between 1 and 984 metres per year (m/y) (Table G3).

Based on the geometric mean of 12.61 metres per day (m/d) hydraulic conductivity calculated for the native sand (used as a conservative conductivity for the fill), the described hydraulic gradients and porosities of 30 percent for the fill/native sand and 2 percent for the bedrock, horizontal groundwater velocities are estimated to range from 12 to 77 m/y for the fill/native sand aquifer, and 6 m/y for the upper weathered bedrock aquifer based on a geometric mean hydraulic conductivity of 0.71 m/d.

In December 2015, downward hydraulic gradients were generally observed from the fill to the native sand layers, with a geometric mean downward vertical gradient of 0.06 m/m. However, in several locations across the Site, upwards hydraulic gradients were calculated from the native sand to fill layers (nested monitoring wells MW1-15, MW2-15, MW26-15, MW27-15, and MW36-15) (Table G3). As in September 2015, downward hydraulic gradients between the native sand layer and the upper weathered bedrock, continued to be measured in December 2015. The exception is at two nested monitoring well locations (MW27-15 and MW33-15), where upward hydraulic gradients are calculated to range between 0.003 to 0.013 m/m, indicating a groundwater discharge area. All groundwater is expected to eventually discharge to Lake Ontario under existing conditions, either through direct discharge or discharge to the Keating Channel or the Shipping Channel. Vertical groundwater flow velocities calculated using the December 2015 data are estimated to range between 1 and 1,185 m/y (Table G3).

Based on the geometric mean hydraulic conductivity of 12.61 m/d calculated for the native sand (used as a conservative conductivity for the fill), the described hydraulic gradients and porosities of 30 percent for the fill/native sand and 2 percent for the bedrock, horizontal groundwater velocities are estimated to range from 77 m/y for the fill/native sand aquifer, and 13 m/y for the upper weathered bedrock aquifer based on a geometric mean hydraulic conductivity of 0.71 m/d.

G.1.3 Groundwater Chemistry

Various subsurface environmental site investigations have been conducted within the Port Lands area between 1991 to present to assess soil and groundwater quality. Based on information obtained from historical and current subsurface investigations reviewed as part of this project, approximately 218 monitoring wells have been installed at varying depths ranging from 0.35 to 32.9 mbgs. Groundwater samples have typically been collected and submitted for chemical analyses for a variety of inorganic and organic parameters typically including volatile organic compounds (VOCs), petroleum hydrocarbons (PHCs), **polycyclic aromatic hydrocarbons** (PAHs), metals, and inorganics. In some instances, analyses were also completed for various other select parameters, including polychlorinated biphenyls (PCBs), chlorophenols, semivolatile organic compounds (SVOCs), and others.

Based on a review of the result of the historical groundwater quality data, exceedances of various parameters including PHCs, PAHs, VOCs, and to a lesser degree, metals and inorganic impacts have been identified at a number of locations. Free-phase product has also been detected historically floating on the groundwater table at several properties located north and south of the Keating Channel. The southern area, where free-phase product was found, was in the area of the lands commonly referred to as “former Imperial Oil lands,” which had been occupied by a number of oil companies since 1925.

The most recent groundwater quality sampling data available for the Port Lands Site were provided by GHD as part of the Environmental, Geotechnical, and Hydrogeological (GHD, 2015). Between July and November, 2015, GHD installed approximately 97 groundwater monitoring wells, consisting of 12 bedrock wells and 85 overburden wells (15, 40 and 30 wells to approximate depths of 10 mbgs, 7 mbgs, and 3 mbgs, respectively).. GHD collected one groundwater sample from each of the new monitoring wells installed during Stage 1 for analysis of the VOCs, PHCs, PAHs, and metals and inorganics. There was evidence of petroleum hydrocarbon sheen at 10 monitoring wells and measured light nonaqueous phase liquid (LNAPL) at six monitoring wells ranging from 5 to over 100 cm. One well (MW28C-15) additionally displayed evidence of dense nonaqueous phase liquid (DNAPL) (GHD, 2015).

For the purposes of this evaluation, the most recent groundwater quality from the GHD 2015 Port Lands Investigation (GHD, 2015) was used as an indicator of current conditions, with historical data noted for supporting either gaps in data or confirming extents of impacts.

As noted in Section 6 of the Conceptual Site Model (CSM) (Tab A), the Ontario Ministry for the Environment and Climate Change (MOECC) *Table 9: Generic Site Condition Standards for Use within 30 m of a Water Body in a Non-Potable Groundwater Condition* (Table 9 Site Condition Standards) (MOECC, 2011b) were used for comparison against the groundwater results as the Port Lands have a large portion of the Study Area that either currently or part of future plans is or will be within 30 m of a water body. The Table 9 Standards were derived with the objective of protecting surface water bodies from movement of groundwater directly into surface water and assuming there is no dilution in the groundwater for the aquatic protection pathway. The MOECC *Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition* (Table 3 Standards) (MOECC, 2011b) were also used for comparison to provide context, since the Table 9 Standards can be stringent, and they would apply to areas further than 30 m from the water bodies.

PHCs were found exceeding the Table 3 Standards and Table 9 Standards across the Port Lands (Figures 14A, 14E, 14I), with highest concentrations detected in the central areas of the Site within the former Imperial Oil Lands. High concentrations of VOCs exceeding the Table 3 Standards and Table 9 Standards were noted for benzene, toluene, ethylbenzene, and xylenes parameters and some chlorinated compounds. PAHs exceeded the Table 3 Standards and Table 9 Standards, but were generally found at low concentrations with the exception of a couple areas in the former Imperial Oil Lands. Metals and inorganics were generally below the Table 3 Standards and Table 9 Standards, with the exception of chloride, sodium and barium that were found mostly in the bedrock wells and in one well installed in the intermediate overburden. Based on experience at other sites within the area, it is anticipated that the higher barium, sodium, and chloride concentrations are likely naturally occurring. Overall groundwater impacts were most extensive in the monitoring wells screened between 3 and 7 mbgs, which would likely place the impacts in the fill/native sand. Deeper wells screened around 10 mbgs in the overburden had fewer impacts with lower concentrations, and the impacts from the overburden were not seen in the bedrock aquifer; impacts in the bedrock were limited to metals as stated above, thought to be naturally occurring as the concentrations were not found in the upper aquifer.

As a result of historical and current impacts identified in groundwater exceeding applicable MOECC Standards at the Site, any future redevelopment and construction activities will require careful consideration and management of groundwater. In particular, as outlined in the Groundwater Management Master Plan prepared for Waterfront Toronto (WT) by Environ (Environ, 2010), the groundwater management plan will include the analysis and interpretation of hydrogeological information to evaluate, on a preliminary basis, future groundwater management and dewatering requirements for excavation areas. In addition, the assessment, management, and remediation of groundwater may be required to support the filing of Records of Site Condition (RSC). An RSC may be required to permit a change in land use from current commercial and/or industrial land uses to proposed residential and parkland uses to limit the cross-site migration of contamination and to limit, if not eliminate, settlement damage to structures (Environ, 2010).

G.1.4 Summary of Excavation Conditions for Don River Channel, Sanitary Sewer, Storm Sewer, and Watermain Infrastructure

Based on the CSM and the hydrogeological data discussed previously, the following subsurface conditions were determined for use in the dewatering requirement calculations. These subsurface conditions are simplified and conservative. Below the water table, dewatering will be required to at least 1 m below the base of excavation.

Based on the geological conditions (fill/native sands) and the proposed installation depth of the sanitary and storm sewers, and water mains, a support of excavation system with internal bracing (two to three levels of strut) will be required for construction of the new sanitary and storm sewers. Dewatering requirements are based on excavation dimensions estimated from currently available preliminary design information and an assumption that the excavation will need to be fully dewatered where infrastructure or excavations will be below the water table.

To assess construction dewatering requirements, the following assumptions about excavation dimensions have been made:

- A total of 2,677 m of sanitary sewer pipe and 2,540 m of storm sewer pipe will be installed in three and four different alignments, respectively, with alignments between approximately 417 and 1,102 m long, and installed up to a depth of 13.60 mbgs (minimum bottom elevation of 66.10 masl).
- The dewatering assessment has assumed, as directed by WT design engineers, that the shallow watermain construction will be completed above the water table at all areas across the Site, with the exception of the microtunnelling section under the new Don River Channel, which is not predicted to require dewatering.
- Commencing at surface, excavations are expected to encounter up to approximately 10.7 m of heterogeneous fill, and silty sand, sand, and gravel within the native sand unit. In infrastructure alignments along the eastern part of the Site, in particular along Don Roadway, organic layers consisting of peat interbedded with sand and silt layers up to 6.8 m thick may be encountered.
- It should be considered that piezometric levels used in the dewatering assessments for the subsurface infrastructure construction were obtained from groundwater elevations measured by GHD on September 1, 2015 which were higher than the December, 2015 water level elevations, and that the groundwater regime may vary over time. Confirmation of existing groundwater conditions immediately before the construction of subsurface infrastructure is necessary to more accurately predict the magnitude of dewatering that will be required during construction.

G.2 Potential Effects Assessment Methodology

The preliminary effects of the Site’s redevelopment can be assessed based on the current Site conditions and based on general understandings of hydrogeological properties and groundwater flow. This assessment is likely to be simplified and based on a number of assumptions and therefore, relatively conservative in its reliability. To provide a more representative assessment of potential effects of development construction on groundwater across the Site, a groundwater model should be developed that models both groundwater and surface water flow characteristics at the Site, including contaminant fate and transport. The groundwater model should be constructed based on the existing hydrogeological conditions and calibrated to the observed field data so that it can be used for predictive analysis. A more detailed and final assessment of potential effects using a groundwater flow and contaminant transport model is recommended as part of the detailed design.

Before any development at the Site that may affect groundwater conditions, an understanding of the current hydrogeological conditions via the design and installation of an appropriately sized groundwater monitoring network immediately before the construction period should be developed and incorporated into any assessment of effects to account for potential variability over time. Such an example for the installation of subsurface structures that may influence groundwater flow conditions and the migration of contaminants, would entail collecting time series groundwater elevation data though the installation of a monitoring well network, river flow and stage height, groundwater chemistry, and Lake Ontario water elevation data. The data could be inputted into a groundwater flow and contaminant transport model and used to predict how the placement of subsurface infrastructure, and associated dewatering may influence groundwater flow, including how contaminants in the subsurface may migrate across the Site. The advantages of a groundwater flow model are that it can be used to evaluate the sensitivity of input parameters for uncertain hydraulic properties and to evaluate a number of development scenarios to determine the most sustainable and environmentally compatible development options.

G.3 Future Scenario Projections

G.3.1 Groundwater Dewatering Estimates during Construction

G.3.1.1 Methodology for Estimating Construction Dewatering

To estimate groundwater dewatering rates for the sanitary and storm sewers as shown on Figure 26, hydrogeological data from the Site was assessed using an analytical groundwater dewatering assessment. The assessment was based on equations of water table flow from a line source to a drainage trench provided in *Construction Dewatering and Groundwater Control: New Methods and Applications - Third Edition* (Powers et al., 2007), and as described herein. For the purposes of analysis, the analytical assessment also assumes steady-state flow.

G.3.1.1.1 Trench Dewatering

An assumption has been made that, apart from the microtunnelled sections for the Don River Channel crossings, and along Don Roadway, all other sanitary and storm sewers will be constructed using open-cut trenches, with indicative dimensions for base grade, and buffer either side of the pipe shown in Exhibit G1. The estimated dewatering rate per linear metre of excavation that is needed to achieve the required drawdown for dry working conditions during the construction of the sanitary and storm sewers and the corresponding drawdown radius of influence is calculated as follows:

$$Q_M = x\,K\,(H^2 - h^2) / L_o$$

Pumping rate per linear metre (Q_L) of the trench:

$$Q_L = Q_M / x$$

Where: Q_M = Total flow rate for the trench section at steady state (cubic metres per day [m^3/d])
x = Length of the trench (m)
K = Hydraulic conductivity (m/d)
H = Distance from static water level to bottom of aquifer (m)
h = Depth of water in the excavation below ground surface while pumping (m)
L_o = Distance from a point of greatest drawdown to a point where there is no drawdown (m)

The corresponding drawdown radius of influence because of dewatering is estimated as follows:

R – Radius of the cone of depression (m) using Empirical Sichardt Method (Sichardt, 1928):

$$R = R_e + 3000\,(H - h)\,\sqrt{K}$$

Where: R_e = Equivalent radius of excavation (m)
K = Hydraulic conductivity (m/sec)

Calculated dewatering rates are based on 18-m-long, open-cut trench excavations without shoring systems, with dewatering rates ranging from 444 to 588 m^3/d (Table G4), with radius of drawdown influence ranging between 41 to 415 m (radius of influence along the alignments shown on Figure 27). Assumptions used for the calculations include the following:

- Hydraulic conductivity of 12.61 m/d (geometric mean for the native sand hydrostratigraphic unit is used as a conservative estimate to account for the hydraulic conductivity of the fill)
- Groundwater elevation of 75.1 masl

- Over excavation below the pipe invert by 0.5 m and backfill with granular material
- Daily trench excavation length of 18 m
- A safety factor of 300 percent has been applied to the dewatering rates to account for variability in hydraulic conductivity across the Site, and variability in groundwater elevations over time.

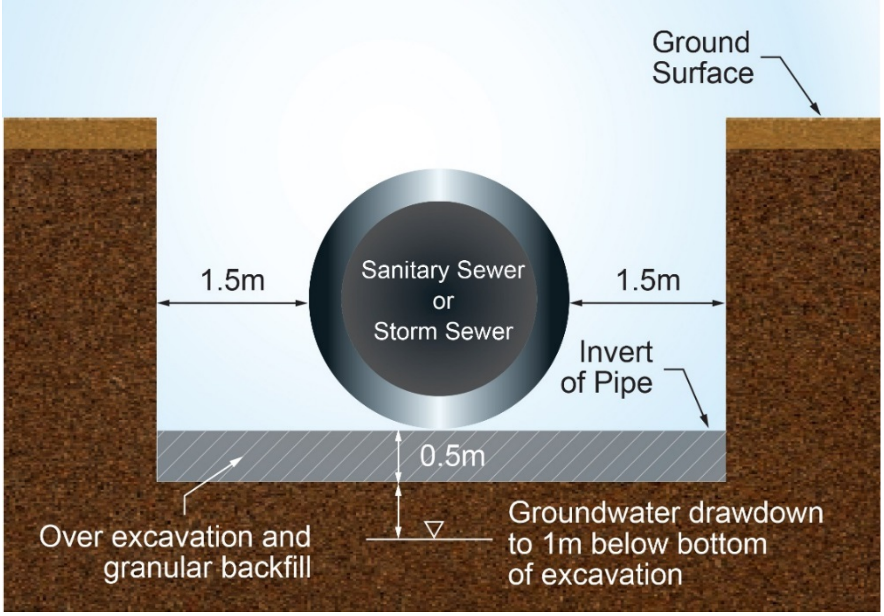

Exhibit G1. Schematic Diagram of Trench Excavation for Sanitary and Storm Sewer Construction
Waterfront Toronto – Port Lands

G.3.1.1.2 Microtunnel Launching, and Receiving Shaft Dewatering

Microtunnelling will be used for installing subsurface infrastructure below the proposed new Don River Channel or floodway, as well as for the section of sanitary sewer construction along the Don Roadway. The microtunnelling sections are assumed to not require active dewatering, with the exception of launching and receiving shafts, which will be constructed using secant caisson walls extending to bedrock. For dewatering requirements, an assumption has been made that the shafts will be constructed so that no groundwater seepage will occur. The shafts will only require a single dewatering event as presented in Table G5.

Table G5. Microtunnel Launching and Receiving Shaft Dewatering

Shaft Location	Ground Elevation (masl)	Bedrock Elevation (masl)	Depth to Bedrock (mbgs)	Groundwater Elevation (masl)	Shaft Diameter (m)	Dewatering Volume (m^3)
Storm Crossing Shaft 1 / Polson Street Shaft 1	78.7	63	15.7	75.1	10	950
Storm Crossing Shaft 2 / Commissioners Street Shaft 2	79	62	17	75.1	10	1029
Storm Crossing Shaft 3	79.15	59	20.15	75.7	10	1312
Commissioners Street Shaft 1 / Don Roadway Shaft 2	79.07	63	16.07	75.4	10	974
Street A Shaft 1 / Don Roadway Shaft 1	77.48	59	18.48	75.7	10	1312
Street A Shaft 2	79	58	21	75.7	10	1390

Note:
m^3 - cubic metre

G.3.2 Future Scenario Projections after Construction

Using professional judgment, knowledge of groundwater flow properties, and understanding of the existing predevelopment hydrogeological conditions at the Site, the following future scenario projections on groundwater flow conditions are presented:

- Redevelopment plans for the Site involves intercepting precipitation from buildings, roads, and paved surfaces. Intercepted storm water from building rooftops will be diverted directly to the Don River, while infiltration from paved surfaces will be diverted to a water treatment plant prior to being discharged to a wetland which will discharge directly to the Keating Channel. By minimizing groundwater recharge via infiltration, a lower water table elevation and changes to groundwater flow conditions can be expected.
- The installation of subsurface infrastructure including sanitary and storm sewers will provide discrete groundwater flow pathways through the Site because of the use of granular backfill around the pipes. Because the pipes will be installed within the fill/native sand, and the high hydraulic conductivity of these hydrostratigraphic units, it is predicted that groundwater flow conditions will stabilize after construction dewatering activities have ceased, and the subsurface infrastructure will have only minor impacts to groundwater flow, as groundwater will flow around the structures.
- The construction of the new Don River Channel will create a new hydraulic connection between surface water and groundwater though the middle of the Site within the fill/native sand hydrostratigraphic unit. Under current conditions, groundwater elevations are highly influenced by the surface elevation of Lake Ontario. By extending the Don River through the middle of the Site, and the assumption that the water elevation in the river from the new mouth to the current location where the Don River enters the Keating Channel will be close to the level of Lake Ontario, it is predicted that groundwater elevations across the site will more closely mimic that of Lake Ontario. The new river channel will create a groundwater low through the middle of the Site, which will change the groundwater flow regime across the Site. The Don River, at an elevation approximately the same as Lake Ontario will be a groundwater sink. Shallow groundwater will flow to and discharge into the new river channel from both sides of the river. The creation of the river channel as a groundwater low through the middle of the Site will likely lower the water table across the Site. The area of the Site most likely to exhibit the largest hydraulic influence will be in the northwestern Site area located to the north and west of the new Don River channel. Predicted groundwater flow conditions for post-construction are inferred on Figure 28.
- Based on the assumption that the new Don River Channel will be constructed with bed and bank material that is permeable during flood events when water levels within the river are high, the Don River may act as a recharge source to groundwater via bank storage, influencing water table elevations. During nonflood flow conditions, the Don River will act as a new groundwater sink through the middle of the Site, with groundwater flow towards and discharging to the river.

G.4 Groundwater Management

Excavation below the water table will require the management of groundwater. Where practical to minimize groundwater impacts, in situ groundwater control mechanisms should be incorporated.

G.4.1 During Construction

G.4.1.1 Sanitary Sewer and Storm Sewer Construction

During the construction of the sanitary and storm sewers, substantial groundwater dewatering will be required, as presented in Table G5 and described in Section G.3.1.1.2. A dewatering system such a well point cluster will need to be designed and installed before construction. Groundwater from dewatering will need to be monitored for quantity and quality before its discharge/disposal. In addition, the proposed construction depth of the infrastructure, coupled with the geotechnical characteristics of the loose fill/native sands, will create unstable working conditions, as well as high risk for ground settlement in Site locations where organic layers are present (discussed in more detail in Sections G.4.3.3. and G.5.1.2). During construction, shoring systems such as shoring boxes, or sheet piles should be installed to create stable excavations and minimize groundwater dewatering.

Along alignments where micro-tunnelling is proposed for construction, manhole connections into the tunnel pipes will be constructed. The excavation of vertical shafts for the manholes will require groundwater dewatering as described in Section G.3.1.1.2. To minimize the dewatering requirements at each manhole, sheet piles or similar shoring systems should be incorporated.

G.4.1.2 Don River Channel Naturalization

The Don River Channel naturalization excavation will be staged. The excavation will be conducted wet using a dredging system. During the excavation, groundwater will be encountered but will not be dewatered. Management of water from excavated soils is discussed in the Soil Management Plan (Tab F) and the Earthworks Methodology (Tab H). To manage groundwater within the excavation, and prevent discharge of contaminants to surface water (Lake Ontario or the existing Don River Channel connected to Keating Channel), earth dikes will be maintained at the future connection to Lake Ontario until the last phase of construction. Excavations below the water table will create suspended solids. As the excavation stages progress, silt control curtains and walls will be incorporated into the earthworks. In situ treatment of water within the channel excavation will be conducted progressively during excavation. Special permitting such as an Environmental Compliance Approval may be required for the discharge of the water within the excavation to surface water if contaminants are present.

G.4.2 Water Treatment and Disposal Options

To assess and evaluate potential groundwater management and treatment considerations that may need to be implemented during future site construction work including the potential for future discharge to municipal sanitary or storm sewers, historic and current groundwater data available in the database were compared against the City of Toronto’s Sewer Use By-Law (Sewer By-Law). Groundwater treatment and disposal options are based on the assumption that all dewatering discharge can be disposed to the sanitary sewer. Based on this comparison, it was determined that in general, of the 19,000 plus groundwater data points when compared relative to the Sewer By-Law, the majority of samples met the criteria for the City of Toronto’s Sanitary and Storm By-Law concentration limits for the parameters analyzed, with the exception of approximately 260 data points. These data points exceeded for one or more parameters, with the majority being selected VOCs, lead, or mercury. Specific areas that may require more management than other areas should be refined in Stage 2. For the purposes of this Groundwater Management Plan, it is assumed that final disposal of impacted water would be to the sanitary sewer, although pre-treatment may be required to meet the Sewer Use By-Law requirements.

For future dewatering activities, it is expected that suspended solids entrained within the groundwater will require sediment removal. Sediment removal is a common and recommended practice prior to discharging groundwater derived either from an excavation or a dewatering well. Sediment removal will be completed using filter bags.

Groundwater disposal will require discharging to the City of Toronto sanitary sewer system. Before groundwater is discharged to the sanitary sewer, construction contractors will be required to consult with the City of Toronto, to confirm that there is available capacity within the City of Toronto sanitary sewer system, and to obtain a discharge permit. This Groundwater Management Plan has assumed that final disposal of water to the sanitary sewer will be allowed by the City of Toronto.

An assessment of groundwater chemistry across the Site identified the following chemical parameters that exceeded the City of Toronto Sewer Use By-Law Discharge Criteria:

- Mercury
- Benzene
- Ethylbenzene
- 1,2-Dichlorobenzene
- 1,4-Dichlorobenzene
- Chloroform
- Toluene
- Xylenes, Total
- cis-1,2-Dichloroethene
- Trichloroethylene
- 3,3-Dichlorobenzidine
- Hexachlorobenzene
- Lead

Groundwater disposal options will rely on groundwater chemistry meeting the City of Toronto Sewer Use By-Law to enable groundwater pumped during construction dewatering to be discharged to the sanitary or storm sewer. Before groundwater is discharged to the sewer, ex situ groundwater treatment will need to be completed to lower the concentrations of the chemical parameters listed above. Groundwater treatment will entail pumping groundwater to a treatment plant where filter bags, carbon vessels, clay vessels and an oil/water separator will be used to treat groundwater prior to discharge directly to the sanitary sewer.

G.4.3 Monitoring and Mitigation Plan

G.4.3.1 Groundwater and Surface Water Monitoring

Because of the dewatering requirements for the different components of the project, a monitoring program will be required as part of a Permit to Take Water (PTTW), and is proposed to compare the effects of dewatering, and to monitor the long term effects of the new Don River Channel on groundwater. A summary of the monitoring program requirements are presented in Table G6.

Table G6. Summary of Groundwater and Surface Water Monitoring
Waterfront Toronto, Port Lands

Monitoring Period	Water Level Monitoring Location	Water Level Monitoring Frequency	Method	Triggers For Mitigation	Mitigation Measures
Preconstruction	Onsite monitoring wells	Daily	Manual/ Transducers	None	Completed to develop baseline conditions.
During Construction	Onsite monitoring wells	Daily during construction within vicinity of monitoring wells	Manual/ Transducers	Exceedance of trigger drawdown values calculated to be protective of ground settlement/ subsidence.	Should an adverse impact due to dewatering be observed, a change to the monitoring frequency should be considered. If unacceptable changes in groundwater levels occurs, mitigation measures will be considered, such as change to dewatering pumping rates through groundwater flow control measures such as installation of groundwater barriers or grouting.
Post-Construction	Onsite monitoring wells	Once per month after dewatering ceases.	Manual/ Transducers	Water level recovery less than 70% of pre-construction groundwater level conditions.	If post construction dewatering groundwater levels do not recover to approximately 70% of pre-construction condition, a review of causes is to be undertaken.

Triggers for mitigation will be reviewed as the project progress and will be re-evaluated each time a trigger is initiated to determine if the trigger is caused by construction activities or related to natural causes. As a result, triggers may be revised during the project if they are found to be too stringent or not protective.

G.4.3.2 Discharge Water Quality Monitoring and Mitigation

To maximize the likelihood that water discharged from dewatering operations during construction meets receptor objectives as well as discharge volume restrictions, water quality sampling and water quantity monitoring is to be completed by the construction contractor on a frequent basis. Water discharge volumes will be recorded continuously using a calibrated water flow meter, with discharge volumes recorded daily. Water samples are to be analyzed for parameters listed in the City of Toronto Sewer Use By-Law. If sample results indicate that the water chemistry does not meet the requirements of the receptor, the construction contractor will be required to undertake additional treatment to address the quality issue, or a violation of the discharge permit conditions may exist.

During construction of the new Don River Channel, water within the staged excavations will be collected and analyzed for contaminants of concern and Provincial Water Quality Objective parameters to confirm that water within the excavation meets the requirements to allow the discharge of the water to surface water in Lake Ontario. Before the opening of the new Don River Channel to Lake Ontario, the water chemistry within the excavation will be sampled and analyzed to confirm requirements for discharge to surface water.

G.4.3.3 Subsidence

Any work that may influence groundwater and groundwater-related settlement will have a plan for monitoring groundwater elevations, and subsurface ground movements related to selected structures or facilities. An increase in effective stress can cause consolidation in peat, soft clays, and silts, and to a lesser degree in loose sands. The consolidation will typically transfer to the ground surface in the form of settlement, which may be detrimental to structure foundations, utilities, and road surfaces. The construction contractor will be responsible for installing a subsidence monitoring network, and for subsidence monitoring and reporting. The greatest concern is the potential for ground movements that could lead to differential settlement and movement of structures or facilities. Depending on the structure or facility being monitored, a monitoring-review level will be set below the movement threshold (action level) at which damage might be anticipated. No action would be taken as long as ground or structure movements remain below the identified monitoring review level, unless it was clear that the rate of movement was increasing. In the latter case, or if the monitoring review level were to be attained, then the Site engineer would meet with the construction contractor to discuss how the contractor’s construction methods might be contributing to the observed ground movements and what modifications would be appropriate to either stop or limit further movements below the action level. The contractor would be required to take steps, as agreed and as necessary, to limit further ground or structure movements.

In this context, since the concern is with groundwater-related settlement, the necessary mitigating actions would involve measures to reduce or limit on-going groundwater infiltration to the various excavations. Such measures could include grouting of the soil at selected locations around the micro-tunnels or excavation trenches to lower permeability and, therefore, the rate of groundwater infiltration. For excavation trenches, this could include placing of temporary or permanent lining to limit infiltration. Actual measures that might be implemented will need to consider the progress of the work, the specific location(s) at which the monitoring review level was attained, the ground conditions and the specific facilities or structures of concern.

In the unlikely event that an action level was to be attained, the Site engineer would need to evaluate which additional mitigating measures could or should be implemented beyond those already in place.

Work suspension might be an option; however, this would be a last resort. If any damage did, in fact, occur as a result of project construction activities, including dewatering activities, then the construction contractor would be required to implement repairs.

G.4.3.4 Long-term Area-wide Groundwater Monitoring Plan

There will likely be two components of the long-term monitoring plan developed in the community-based risk assessment (CBRA): area wide and PHC monitoring. An area-wide groundwater monitoring program will be required to assess the potential for migration of contaminants post construction and reconfiguration of the land. A PHC groundwater monitoring program will also be required to assess the potential for development of free-phase product post construction and reconfiguration of the land. A PHC monitoring program is used to monitor for the development of free-phase product in areas where there is potential for free product based on soil and groundwater concentrations. The PHC monitoring network should focus on locations with potential free product. There may be additional long term monitoring required in the environmental assessment that needs to be incorporated into a master long-term monitoring program.

The total number of monitoring wells required to be installed to provide a sufficient monitoring network is approximately 15 nested wells and 20 shallow wells, specifically for PHC mobilization assessment. The number of monitoring wells will need to be refined after predictive hydrogeological modeling and development of the CBRA.

Following substantial completion of the development and before occupancy of the buildings or parkland use, the PHC groundwater monitoring program will be initiated to determine both depth to groundwater and the presence and absence of free-phase product in the monitored wells. The area-wide groundwater monitoring program will also be used to assess groundwater quality. The groundwater monitoring program should be conducted quarterly for the first year and semi-annually for additional years. A longer-term monitoring of up to 10 years has been assumed for an assessment of temporal changes.

Local hydrogeological conditions are anticipated to maintain the general flow direction from land towards the new channel and surface water. Actual groundwater monitoring well locations should be determined based on future development plans in the public realm, predicted hydrogeological conditions, and sensitive receptor locations.

G.5 Permitting

G.5.1 Permit to Take Water

A PTTW is required from the MOECC for groundwater extraction greater than 50 m^3/d. Based on the groundwater dewatering rates of between 384 to 595 m^3/d, a Category 3 PTTW will be required as the proposed groundwater dewatering rates will be greater than 400 m^3/d.

The PTTW process will involve refining the expected construction dewatering rates, and preparing an environmental effects assessment report which is required to address potential impacts on existing groundwater users, surface water bodies, subsidence, and contaminant migration as well as impacts from the discharge of the water. A groundwater monitoring program for water quantity and quality will also be required for the PTTW.

G.5.1.1 Impact to Existing Ground Water Uses

As part of the application for a Category 3 PTTW, a MOECC Well Records search will be required to identify potentially-affected groundwater users within the radius of influence of the proposed groundwater dewatering. If groundwater users are identified within the radius of influence of dewatering, a monitoring program will be developed to monitor drawdown effects at the point of groundwater extraction. If adverse effects on groundwater users are identified, such as decreased pumping yield or dry wells, the PTTW would require that the groundwater users be provided with an alternate water supply by the construction contractor.

G.5.1.2 Subsidence

As a result of the dewatering activities, groundwater heads in the fill/native sands will be lowered to below the deepest excavation level, around 1 m below the invert elevation of the sanitary sewer or storm sewer pipe. Dewatering lowers groundwater levels, which induces an increase in effective stresses acting upon subsurface strata. Such increase in effective stress can cause consolidation in soft clays and silts and to a lesser degree in loose sands. The consolidation will typically transfer to the ground surface in the form of settlement, which may be detrimental to structure foundations, utilities, and road surfaces.

Loose sands with localized organic layers consisting of peat, clay, and silt are present along the proposed infrastructure alignments and are located below the water table. The subsurface conditions include a substantial loose-sand saturated thickness. A preliminary assessment of the potential for subsidence across the Site has been completed. It is determined that approximately 18 mm of settlement may occur in compressible organic soils for every 1.0 m of dewatering. Because of dewatering up to depths of 7.38 m, the potential for settlement causing adverse effects is high. Groundwater control measures are to be installed by the construction contractor to minimize dewatering volumes and groundwater drawdown outside of excavation areas. A detailed subsidence assessment will be required as part of the Category 3 PTTW assessment, and the quantification and refinement of specific areas within the radius of influence of dewatering up to 272 m from dewatering locations should be undertaken in Stage 2.

G.5.1.3 Impact to Surface Water

The dewatering requirements and radius of influence calculations described in the previous sections for the sanitary sewer and storm sewer construction indicate that the impacts of dewatering may extend between 46 to 272 m from the trench dewatering points. Surface water features that fall within the dewatering radius of influence (Figure 28) includes Lake Ontario. Impacts on Lake Ontario due to temporary infrastructure construction dewatering are inferred to not be significant. Impacts to the Don River are unlikely as it is assumed that the new Don River channel will be excavated after the construction and dewatering of the storm and sanitary sewers.

G.5.1.4 Other Potential Impact Considerations

A number of potential contaminant sources are present within the radius of influence of the proposed new sanitary sewer and storm sewer alignments. Because of the calculated dewatering rates required during construction, contaminant migration across the Site may be an issue. Any contaminants present within groundwater extracted during construction dewatering will be treated as discussed in Section G4.2. If contaminated groundwater or free product is captured in a previously uncontaminated excavation, water treatment and soil management costs may increase.

G.5.2 Discharge Permit

Before excavation and construction dewatering occur, an industrial discharge permit will be required from the City of Toronto for disposal of treated water to the sanitary sewer system. The City of Toronto will require a plan detailing the proposed discharge of groundwater to the sanitary sewer system. The MOECC will also require details of the discharge permit to be included in the PTTW application before approval of a PTTW.

G.5.3 Direct Discharge to Surface Water

Because of the calculated volume of construction dewatering required to provide dry excavations, and the presence of chemical parameters above Toronto Storm Sewer By-Law Criteria, and the Provincial

Water Quality Objective Criteria listed under Section 23 of the Ontario Water Resources Act – Industrial Discharge, it would be cost prohibitive to treat groundwater pumped during construction dewatering to meet the receptor quality criteria that would be required under an Environmental Compliance Approval. Discharge to the sanitary sewer system is a critical component for dewatering; therefore, discussions need to be initiated with the City of Toronto to confirm availability of the sanitary sewer as a viable option for dewatering discharge.

G.6 References

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Tables

Table G2. Groundwater Elevation Measurements

Waterfront Toronto - Port Lands

Well No.	**Depth to bottom**	**Sandpack Interval**		**Lithology Screened**	**Ground Elevation**	**Reference Elevation[1]**	**Groundwater Elevations September 1, 2015**			**Groundwater Elevations December 8, 2015**		
	(mBGS)	**Top (mBGS)**	**Bottom (mBGS)**		**(mAMSL)**	**(mAMSL)**	**(mBTOR)**	**(mBGS)**	**(mAMSL)**	**(mBTOR)**	**(mBGS)**	**(mAMSL)**
MW1A-15	7.47	4.12	7.47	Sand (NATIVE)	77.32	77.25	2.03	2.11	75.22	2.34	2.42	74.91
MW1B-15	3.05	1.22	3.05	Sand (FILL)	77.29	77.21	2.03	2.11	75.18	2.34	2.42	74.87
MW2A-15	7.47	4.12	7.47	Sand (NATIVE)	77.41	77.33	2.16	2.24	75.17	2.47	2.55	74.86
MW2B-15	3.05	1.52	3.05	Silt/Sand (FILL)/Sand (NATIVE)	77.40	77.32	2.16	2.25	75.16	2.47	2.56	74.85
MW3A-15	7.62	3.96	7.62	Sand (NATIVE)	76.67	76.60	1.41	1.48	75.19	-	-	-
MW3B-15	3.05	1.22	3.05	Sand Native/Sand (FILL)	76.70	76.59	1.40	1.51	75.19	-	-	-
MW5A-15	6.86	3.20	6.86	Sand and Gravel (FILL)	76.92	76.82	1.72	1.83	75.10	2.20	2.31	74.62
MW5B-15	3.05	1.22	3.05	Sand and Gravel (FILL)	76.93	76.81	1.71	1.83	75.10	2.20	2.32	74.61
MW6A-15	7.32	3.05	7.32	Sand (NATIVE)	76.61	76.55	1.39	1.45	75.16	1.74	1.80	74.81
MW6B-15	3.05	1.52	3.05	Sand (NATIVE)	76.64	76.57	1.40	1.47	75.17	1.76	1.83	74.81
MW7A-15	7.62	3.96	7.62	Sand (NATIVE)	76.29	76.20	1.03	1.12	75.17	-	-	-
MW7B-15	3.05	1.52	3.05	Sand (FILL)/Sand (NATIVE)	76.28	76.21	1.03	1.10	75.18	-	-	-
MW8A-15	6.10	2.44	6.10	Silty Clay (FILL)/Silty Sand (NATIVE)	76.48	76.40	1.24	1.32	75.16	1.78	1.86	74.62
MW8B-15	3.05	1.22	3.05	Silty Clay (FILL)	76.47	76.37	1.21	1.32	75.16	1.75	1.86	74.62
MW9A-15	7.47	3.81	7.47	Clayey Silt/Sand/Gravelly Sand (FILL)	76.87	76.76	1.61	1.72	75.15	1.70	1.81	75.06
MW9B-15	3.05	1.22	3.05	Sand and Gravel/Sand (FILL)	76.87	76.75	1.45	1.57	75.30	2.05	2.17	74.70
MW10A-15	7.32	3.66	7.32	Sand and Gravel/Sand (FILL)	76.35	77.27	2.16	1.24	75.11	1.65	0.73	75.62
MW10B-15	3.05	1.22	3.05	Sand/Sand with Silt/Sand and Gravel (FILL)	76.34	77.29	2.16	1.21	75.13	1.68	0.73	75.61
MW11-15	7.50	2.90	6.50	Sand/Silty Sand/Peat (FILL)	76.84	76.76	-	-	-	1.99	2.07	74.77
MW12A-15	7.50	3.65	7.31	Clayey Silt/Sandy Silt/Peat/Sand/Sand & Gravel (NATIVE)	77.18	78.07	-	-	-	3.31	2.42	74.76
MW12B-15	3.04	1.21	3.04	Sandy Silt/Gravelly Sand (FILL)	77.20	78.00	-	-	-	2.61	1.81	75.39
MW13-15	7.31	3.65	7.31	Clayey Silt (FILL)/Peat and Sand (NATIVE)	77.24	78.13	-	-	-	2.96	2.06	75.17
MW14-15	7.46	3.50	7.16	Sand/Silty Clay/Silty Sand/Sand (FILL)	77.79	77.69	-	-	-	2.93	3.03	74.76
MW15-15	7.46	3.35	7.01	Silty Clay/Gravelly Sand (FILL)/Sand (NATIVE)	77.03	76.91	-	-	-	2.15	2.26	74.76
MW16A-15	7.46	3.65	7.31	Sand/Peat/Sand (NATIVE)	77.28	78.13	-	-	-	3.38	2.53	74.75
MW17-15	7.46	3.65	7.31	Sand/Silty Clay/Peat/Sand (NATIVE)	77.14	77.04	-	-	-	2.19	2.29	74.85
MW18A-15	7.47	3.81	7.47	Peat/Clayey Silt and Peat/Sand (NATIVE)	77.06	76.94	1.82	1.93	75.12	2.21	2.32	74.73
MW18B-15	3.05	1.22	3.05	Sand (FILL)	77.09	76.98	1.78	1.89	75.20	1.76	1.87	75.22
MW19-15	7.46	3.81	7.46	Sand/Peat/Sand (NATIVE)	77.65	78.54	-	-	-	3.69	2.80	74.85
MW20A-15	7.01	3.96	7.01	Silt/Organic Silt and Clay/Sand/Silt/Peat/Sand/Silt (NATIVE)	76.70	77.71	2.56	1.55	75.15	2.91	1.90	74.80
MW20B-15	3.05	1.52	3.05	Sand (FILL)	76.72	77.87	2.60	1.45	75.27	2.60	1.45	75.27
MW21A-15	9.15	5.49	9.15	Silty Clay/Sand and Silt/Silty Clay/Silt/Sand (NATIVE)	79.54	80.41	5.29	4.42	75.12	5.71	4.84	74.70
MW21B-15	6.10	4.27	6.10	Silty Sand (FILL)/Silty Clay (NATIVE)	79.56	80.43	4.56	3.69	75.87	4.80	3.93	75.63
MW22-15	9.14	7.31	9.14	Silty Clay (NATIVE)	78.26	79.20	-	-	-	3.93	2.99	75.27
MW23A-15	9.76	6.10	9.76	Peat/Sand (NATIVE)	79.98	80.89	5.79	4.87	75.10	6.22	5.30	74.67
MW23B-15	6.10	4.27	6.10	Sand and Silt/Silty Clay (FILL)	80.05	81.00	5.73	4.78	75.27	5.90	4.95	75.10
MW25A-15	10.06	6.34	10.06	Clayey Sand/Silty Clay/Clayey Sand (FILL)	79.08	80.02	4.96	4.03	75.06	5.39	4.46	74.63
MW25B-15	5.03	1.65	5.03	Gravel and Shale/Topsoil with Sand/Silty Clay/Silty Sand/Clayey Sand (FILL)	79.09	80.09	4.92	3.92	75.17	5.37	4.37	74.72
MW26A-15	19.82	16.46	19.82	Bedrock	76.75	77.59	2.71	1.88	74.88	2.18	1.35	75.41
MW26B-15	8.84	5.18	8.84	Sand (NATIVE)	76.73	77.64	2.52	1.61	75.12	1.98	1.07	75.66
MW26C-15	6.71	3.05	6.71	Sand Fill/Sand (NATIVE)	76.66	77.57	2.45	1.54	75.12	2.00	1.09	75.57
MW26D-15	3.05	1.22	3.05	Sand/Silty Sand (FILL)	76.65	77.59	2.48	1.54	75.11	2.00	1.06	75.59
MW27A-15	21.49	17.68	21.49	Bedrock	77.41	77.27	2.25	2.40	75.02	2.71	2.86	74.56
MW27B-15	10.67	7.01	10.67	Sand (NATIVE)	76.85	76.77	1.61	1.69	75.16	2.34	2.42	74.43
MW27C-15	6.10	2.44	6.10	Silt to Clayey Silt (FILL)/Silty Clay/Sand (NATIVE)	76.85	76.77	1.66	1.75	75.11	2.14	2.23	74.63
MW27D-15	3.05	1.22	3.05	Gravelly Sand/Silty Clay/Silt to Clayey Silt (FILL)	76.88	76.79	1.29	1.38	75.50	2.34	2.43	74.45
MW28A-15	45.72	28.95	33.52	Sand TILL/Silt/Sand (NATIVE)	76.87	76.76	-	-	-	2.07	2.18	74.69
MW28B-15	9.75	5.79	9.75	Sand (FILL)/Sand (NATIVE)	76.88	76.79	-	-	-	2.02	2.10	74.77
MW28C-15	6.70	3.04	6.70	Gravel/Clayey Silt/Sand (FILL)	76.87	76.83	-	-	-	2.05	2.09	74.78
MW28D-15	3.04	0.91	3.04	Sand/Gravel (FILL)	76.85	76.80	-	-	-	1.70	1.76	75.10
MW29A-15	10.66	8.53	10.66	Gravelly Sand/Sand (NATIVE)	76.95	78.02	-	-	-	3.28	2.21	74.74
MW29B-15	7.31	5.18	7.31	Peat/Sand (FILL)	77.05	78.08	-	-	-	2.61	1.58	75.47
MW29C-15	3.04	1.21	3.04	Sand/Sand & Gravel (FILL)	76.96	78.00	-	-	-	3.34	2.30	74.66
MW30A-15	24.80	21.14	24.80	Bedrock	77.07	78.05	2.89	1.90	75.16	3.42	2.43	74.63
MW30B-15	10.06	6.40	10.06	Sand Native	77.11	78.05	2.95	2.01	75.10	3.40	2.46	74.65
MW30C-15	6.10	2.44	6.10	Silty Clay/Peat/Silt (NATIVE)	77.15	78.16	2.95	1.95	75.21	3.25	2.25	74.91
MW30D-15	3.05	1.52	3.05	Sand/Silty Clay (FILL)	77.18	78.23	3.00	1.94	75.23	3.26	2.20	74.97
MW31A-15	24.17	20.43	24.17	Bedrock	80.03	81.06	6.04	5.01	75.02	6.47	5.44	74.59
MW31B-15	13.72	10.05	13.72	Sand and Gravel/Sand (NATIVE)	80.03	81.09	5.97	4.91	75.12	6.38	5.32	74.71
MW31C-15	10.37	6.71	10.37	Silty Clay/Sandy Silt/Silty Sand/Sand (FILL)	80.03	81.08	5.96	4.91	75.12	6.37	5.32	74.71
MW31D-15	6.10	4.27	6.10	Clayey Silt/Peat (NATIVE)	79.99	81.07	5.27	4.19	75.80	5.44	4.36	75.63
MW32A-15	20.12	16.46	20.12	Bedrock	76.93	76.87	1.74	1.80	75.13	2.18	2.24	74.69
MW32B-15	10.67	7.01	10.67	Sand (NATIVE)	77.00	76.96	1.83	1.87	75.13	2.27	2.31	74.69
MW32C-15	7.01	3.35	7.01	Peat/Silt (NATIVE)	77.03	76.90	1.79	1.92	75.11	2.15	2.28	74.75
MW32D-15	3.05	1.52	3.05	Silt/Sand/Silt (FILL)	77.07	77.02	0.96	1.01	76.06	2.18	2.23	74.84
MW33A-15	20.11	16.45	20.11	Bedrock	77.16	77.07	-	-	-	2.39	2.48	74.68
MW33B-15	10.36	7.92	10.36	Sand (NATIVE)	77.11	78.05	2.95	2.01	75.10	3.40	2.46	74.65
MW33C-15	7.01	4.57	6.85	Sandy Silt/Sand (FILL)	77.15	78.16	2.95	1.95	75.21	3.25	2.25	74.91
MW33D-15	3.04	1.21	3.04	Sand & Gravel/Silty Clay/Peat/Silty Clay (FILL)	77.18	78.23	3.00	1.94	75.23	3.26	2.20	74.97
MW34A-15	21.20	17.38	21.20	Bedrock	79.02	80.12	5.12	4.01	75.00	5.57	4.46	74.55
MW34B-15	13.72	10.06	13.72	Sand Fill/Silty Sand (NATIVE)	79.08	80.10	4.97	3.95	75.13	5.38	4.36	74.72
MW34C-15	10.67	7.01	10.67	Peat/Silty Clay (NATIVE)	79.11	80.14	5.02	3.99	75.12	5.43	4.40	74.71
MW34D-15	6.10	4.27	6.10	Gravelly Sand/Silt (FILL)	79.12	80.16	5.36	4.32	74.80	5.45	4.41	74.71
MW35A-15	23.02	19.36	23.02	Bedrock	77.17	77.10	1.96	2.03	75.14	2.41	2.48	74.69
MW35B-15	9.76	6.10	9.76	Peat/Silty Clay (NATIVE)	80.07	80.97	5.85	4.96	75.12	6.27	5.38	74.70
MW35C-15	6.10	4.27	6.10	Silty Clay (FILL)	80.07	80.98	5.10	4.19	75.88	5.23	4.32	75.75
MW35D-15*	12.80	9.15	12.80	Sand (FILL)	80.07	80.84	5.72	4.94	75.12	6.13	5.35	74.71
MW36A-15	21.54	17.68	21.54	Bedrock	76.43	76.32	1.26	1.37	75.06	1.83	1.94	74.49
MW36B-15	10.67	7.01	10.67	Sand (NATIVE)	76.49	76.41	1.23	1.31	75.18	1.55	1.63	74.86
MW36C-15	6.10	2.44	6.10	Sand (NATIVE)	76.45	76.36	1.19	1.28	75.17	1.50	1.59	74.86
MW36D-15	3.05	1.22	3.05	Sand (FILL)/Sand (NATIVE)	76.47	76.40	1.21	1.28	75.19	1.57	1.64	74.83
MW37A-15**	23.10	19.51	23.10	Bedrock	76.46	76.27	1.85	2.03	74.42	-	-	-
MW37B-15	10.67	7.01	10.67	Sand (FILL)	76.45	76.38	1.22	1.29	75.16	1.58	1.65	74.80
MW37C-15	7.62	3.96	7.62	Sand (FILL)	76.45	76.37	1.22	1.30	75.15	1.55	1.63	74.82
MW37D-15	3.05	1.52	3.05	Sand to Sandy Silt Fill/Sand (FILL)	76.45	76.38	1.22	1.28	75.16	1.57	1.63	74.81
MW38A-15	9.75	8.53	9.14	Sand (NATIVE)	76.97	77.85	-	-	-	3.13	2.24	74.72
MW38B-15	6.70	4.26	6.70	Peat/Sand (NATIVE)	76.97	77.82	-	-	-	3.09	2.24	74.73
MW38C-15	3.04	1.21	3.04	Silty Sand/Sand/Silty Sand (FILL)	76.97	77.83	-	-	-	2.56	1.70	75.27
MW39A-15	15.85	12.20	15.85	Bedrock	76.51	77.49	2.39	1.42	75.10	2.82	1.85	74.67
MW39B-15	10.67	7.01	10.67	Silty Clay/Silty Sand/Gravelly Sand/Shale (NATIVE)	76.50	77.48	2.36	1.38	75.12	2.80	1.82	74.68
MW39C-15	7.62	3.96	7.62	Peat/Silty Clay (NATIVE)	76.54	77.58	2.45	1.41	75.13	2.90	1.86	74.68
MW39D-15	3.05	1.22	3.05	Sand/Silty Clay/Peat (NATIVE)	76.55	77.52	2.41	1.44	75.11	2.77	1.80	74.75
MW40A-15	16.24	12.59	16.24	Bedrock	76.81	77.69	2.54	1.66	75.15	2.96	2.08	74.73
MW40B-15	10.57	7.01	10.57	Silty Sand/Sand (FILL)	76.89	77.72	2.57	1.74	75.15	2.99	2.16	74.73
MW40C-15	6.10	2.44	6.10	Silt/Sandy Silt/Silt/Sandy Silt (FILL)	76.90	77.66	2.43	1.67	75.23	2.78	2.02	74.88
MW40D-15	3.05	1.22	3.05	Gravel Fill/Clay (FILL)	76.93	77.81	2.39	1.51	75.42	2.57	1.69	75.24
MW41-15	7.46	3.65	6.09	Peat/Silt (FILL)/ Peat/Gravelly Sand (NATIVE)	77.00	77.74	-	-	-	3.00	2.27	74.74

Notes:

[1]	Reference elevation taken from top of riser pipe.
*	Elevations for MW35D-15 are approximate - to be confirmed in Stage 2.
**	Monitoring well casing damaged.
mAMSL	metres above mean sea level. Elevations referenced with respect to benchmark.
mBGS	metres below ground surface
mBTOR	metres Below Top of Riser

Table G3. Vertical Hydraulic Gradients and Groundwater Flow Velocities

Waterfront Toronto - Port Lands

Well No.	Easting	Northing	Depth to bottom	Sandpack Interval		Lithology Screened	Ground Elevation	Top of Riser Pipe Elevation	Bottom of Well	Groundwater Elevations *September 1, 2015*			Vertical Hydraulic Gradient	Vertical Hydraulic Gradient Direction	Horizontal Hydraulic Conductivity (K_x)	Vertical Hydraulic Conductivity (K_z)	Effective Porosity	Vertical Groundwater Flow Velocity	Groundwater Elevations *December 8, 2015*			Vertical Hydraulic Gradient	Vertical Hydraulic Gradient Direction	Horizontal Hydraulic Conductivity (K_x)	Vertical Hydraulic Conductivity (K_z)	Effective Porosity	Vertical Groundwater Flow Velocity
				Top	Bottom																						
			(mbgs)	(mbgs)	(mbgs)		(mamsl)	(mamsl)	(mamsl)	(mBTOR)	(mBGS)	(mAMSL)	(m/m)		(m/day)	(m/day)	(%)	(m/year)	(mBTOR)	(mBGS)	(mAMSL)	(m/m)		(m/day)	(m/day)	(%)	(m/year)
MW1B-15	316316.706	4833463.14	3.050	1.220	3.050	Sand (FILL)	77.293	77.211	74.243	2.030	2.112	75.181			57.37	5.74	0.35		2.34	2.42	74.87			57.37	5.74	0.35	
MW1A-15	316316.59	4833463.65	7.470	4.120	7.470	Sand (NATIVE)	77.321	77.245	69.851	2.030	2.106	75.215	-0.008	Upward Gradient	15.28	1.53	0.35	12	2.34	2.42	74.91	-0.009	Upward Gradient	15.28	1.53	0.35	15
MW2B-15	316383.78	4833402.5	3.050	1.520	3.050	Silt/Sand (FILL)/Sand (NATIVE)	77.402	77.316	74.350	2.160	2.246	75.156			9.33	0.93	0.35		2.47	2.56	74.85			9.33	0.93	0.35	
MW2A-15	316384.318	4833402.94	7.470	4.120	7.470	Sand (NATIVE)	77.405	77.326	69.935	2.160	2.239	75.166	-0.002	Upward Gradient	41.14	4.11	0.35	10	2.47	2.55	74.86	-0.002	Upward Gradient	41.14	4.11	0.35	10
MW3B-15	316424.903	4833587	3.050	1.220	3.050	Sand (FILL)/Sand (NATIVE)	76.699	76.590	73.649	1.400	1.509	75.190			9.33	0.93	0.35		-	-	-			9.33	0.93	0.35	
MW3A-15	316425.275	4833586.22	7.620	3.960	7.620	Sand (NATIVE)	76.668	76.603	69.048	1.410	1.475	75.193	-0.001	Upward Gradient	41.14	4.11	0.35	3	-	-	-			41.14	4.11	0.35	
MW5B-15	316587.538	4833403.56	3.050	1.220	3.050	Sand and Gravel (FILL)	76.925	76.807	73.875	1.710	1.828	75.097			118.71	11.87	0.30		2.2	2.32	74.61			118.71	11.87	0.30	
MW5A-15	316587.055	4833404.28	6.860	3.200	6.860	Sand and Gravel (FILL)	76.924	76.817	70.064	1.720	1.827	75.097	0.000	Downward Gradient	18.23	1.82	0.30	0	2.2	2.31	74.62	-0.003	Upward Gradient	18.23	1.82	0.30	6
MW6B-15	316603.13	4833627.67	3.050	1.520	3.050	Sand (NATIVE)	76.636	76.570	73.590	1.400	1.466	75.170			41.14	4.11	0.35		1.76	1.83	74.81			41.14	4.11	0.35	
MW6A-15	316602.702	4833628.43	7.320	3.050	7.320	Sand (NATIVE)	76.605	76.546	69.285	1.390	1.449	75.156	0.003	Downward Gradient	41.14	4.11	0.35	14	1.74	1.8	74.81	0.000	No Gradient	41.14	4.11	0.35	0
MW7B-15	316558.96	4833507.7	3.050	1.520	3.050	Sand (FILL)/Sand (NATIVE)	76.281	76.210	73.230	1.030	1.101	75.180			9.33	0.93	0.35		-	-	-			9.33	0.93	0.35	
MW7A-15	316558.651	4833508.6	7.620	3.960	7.620	Sand (NATIVE)	76.288	76.198	68.668	1.030	1.120	75.168	0.003	Downward Gradient	41.14	4.11	0.35	11	-	-	-			41.14	4.11	0.35	
MW8B-15	316422.349	4833284.86	3.050	1.220	3.050	Silty Clay (FILL)	76.474	76.367	73.424	1.210	1.317	75.157			0.54	0.05	0.20		1.75	1.86	74.62			0.54	0.05	0.20	
MW8A-15	316422.025	4833285.83	6.100	2.440	6.100	Silty Clay (FILL)/Silty Sand (NATIVE)	76.482	76.404	70.382	1.240	1.318	75.164	-0.002	Upward Gradient	18.85	1.89	0.30	5	1.78	1.86	74.62	0.000	No Gradient	18.85	1.89	0.30	0
MW9B-15	316688.78	4833597.61	3.050	1.220	3.050	Sand and Gravel/Sand (FILL)	76.866	76.745	73.816	1.450	1.571	75.295			3.44	0.34	0.30		2.05	2.17	74.7			3.44	0.34	0.30	
MW9A-15	316689.279	4833596.82	7.470	3.810	7.470	Clayey Silt/Sand/Gravelly Sand (FILL)	76.873	76.762	69.403	1.610	1.721	75.152	0.032	Downward Gradient	18.85	1.89	0.30	74	1.7	1.81	75.06	-0.082	Upward Gradient	18.85	1.89	0.30	187
MW10B-15	316422.616	4833781.78	3.050	1.220	3.050	Sand/Sand with Silt/Sand and Gravel (FILL)	76.335	77.285	73.285	2.160	1.210	75.125			18.85	1.89	0.30		1.68	0.73	75.61			18.85	1.89	0.30	
MW10A-15	316423.718	4833782.06	7.320	3.660	7.320	Sand and Gravel/Sand (FILL)	76.347	77.270	69.027	2.160	1.237	75.110	0.004	Downward Gradient	3.44	0.34	0.30	1	1.65	0.73	75.62	-0.002	Upward Gradient	3.44	0.34	0.30	1
MW12B-15	316995.02	4833670.02	3.040	1.210	3.040	Sandy Silt/Gravelly Sand (FILL)	77.200	78.000	74.160	-	-	-			5.39	0.54	0.30		2.61	1.81	75.39			5.39	0.54	0.30	
MW12A-15	316995.69	4833668.41	7.500	3.650	7.310	Clayey Silt/Sandy Silt/Peat/Sand/Sand & Gravel (NATIVE)	77.180	78.070	69.680	-	-	-			8.52	0.85	0.30		3.31	2.42	74.76	0.141	Downward Gradient	8.52	0.85	0.30	146
MW18B-15	317094.484	4833902.02	3.050	1.220	3.050	Sand (FILL)	77.093	76.980	74.043	1.780	1.893	75.200			57.37	5.74	0.35		1.76	1.87	75.22			57.37	5.74	0.35	
MW18A-15	317094.185	4833901.24	7.470	3.810	7.470	Peat/Clayey Silt and Peat/Sand (NATIVE)	77.056	76.941	69.586	1.820	1.935	75.121	0.018	Downward Gradient	45.20	4.52	0.35	84	2.21	2.32	74.73	0.110	Downward Gradient	45.20	4.52	0.35	518
MW20B-15	317129.43	4834167.4	3.050	1.520	3.050	Sand (FILL)	76.723	77.869	73.670	2.600	1.454	75.269			0.25	0.03	0.35		2.6	1.45	75.27			0.25	0.03	0.35	
MW20A-15	317128.801	4834166.08	7.010	3.960	7.010	Silt/Organic Silt and Clay/Sand/Silt/Peat/Sand/Silt (NATIVE)	76.699	77.713	69.689	2.560	1.546	75.153	0.029	Downward Gradient	0.54	0.05	0.30	2	2.91	1.9	74.8	0.118	Downward Gradient	0.54	0.05	0.30	8
MW21B-15	317254.528	4833832.32	6.100	4.270	6.100	Silty Sand (FILL)/Silty Clay (NATIVE)	79.557	80.425	73.457	4.560	3.692	75.865			18.85	1.89	0.30		4.8	3.93	75.63			18.85	1.89	0.30	
MW21A-15	317254.928	4833831.51	9.150	5.490	9.150	Silty Clay/Sand and Silt/Silty Clay/Silt/Sand (NATIVE)	79.544	80.411	70.394	5.290	4.423	75.121	0.243	Downward Gradient	0.54	0.05	0.30	16	5.71	4.84	74.7	0.304	Downward Gradient	0.54	0.05	0.30	20
MW23B-15	317249.74	4833950.5	6.100	4.270	6.100	Sand and Silt/Silty Clay (FILL)	80.045	80.996	73.945	5.730	4.779	75.266			0.54	0.05	0.30		5.9	4.95	75.1			0.54	0.05	0.30	
MW23A-15	317249.459	4833951.69	9.760	6.100	9.760	Peat/Sand (NATIVE)	79.977	80.893	70.217	5.790	4.874	75.103	0.044	Downward Gradient	45.20	4.52	0.35	206	6.22	5.3	74.67	0.115	Downward Gradient	45.20	4.52	0.35	544
MW25B-15	317621.77	4833906.85	5.030	1.650	5.030	Gravel and Shale/Topsoil with Sand/Silty Clay/Silty Sand/Clayey Sand (FILL)	79.086	80.085	74.056	4.920	3.921	75.165			18.85	1.89	0.30		5.37	4.37	74.72			18.85	1.89	0.30	
MW25A-15	317622.539	4833905.75	10.060	6.340	10.060	Clayey Sand/Silty Clay/Clayey Sand (FILL)	79.083	80.016	69.023	4.960	4.027	75.056	0.022	Downward Gradient	0.54	0.05	0.30	1	5.39	4.46	74.63	0.018	Downward Gradient	0.54	0.05	0.30	1
MW26D-15	316488.198	4833819.08	3.050	1.220	3.050	Sand/Silty Sand (FILL)	76.652	77.592	73.602	2.480	1.540	75.112			18.85	1.89	0.35		2	1.06	75.59			18.85	1.89	0.35	
MW26C-15	316489.528	4833819.82	6.710	3.050	6.710	Sand Fill/Sand (NATIVE)	76.659	77.569	69.949	2.450	1.540	75.119	-0.002	Upward Gradient	57.36	5.74	0.35	11	2	1.09	75.57	0.005	Downward Gradient	57.36	5.74	0.35	33
MW26B-15	316490.43	4833820.49	8.840	5.180	8.840	Sand (NATIVE)	76.726	77.635	67.886	2.520	1.611	75.115	0.002	Downward Gradient	41.14	4.11	0.35	8	1.98	1.07	75.66	-0.044	Upward Gradient	41.14	4.11	0.35	187
MW26A-15	316493.68	4833822.64	19.820	16.460	19.820	Bedrock	76.752	77.586	56.932	2.710	1.876	74.876	0.022	Downward Gradient	1.87	0.19	0.02	74	2.18	1.35	75.41	0.023	Downward Gradient	1.87	0.19	0.02	78
MW27D-15	316512.645	4833307.52	3.050	1.220	3.050	Gravelly Sand/Silty Clay/Silt to Clayey Silt (FILL)	76.875	76.787	73.825	1.290	1.378	75.497			18.85	1.89	0.20		2.34	2.43	74.45			18.85	1.89	0.20	
MW27C-15	316511.869	4833306.82	6.100	2.440	6.100	Silt to Clayey Silt (FILL)/Silty Clay/Sand (NATIVE)	76.854	76.766	70.754	1.660	1.748	75.106	0.127	Downward Gradient	0.54	0.05	0.30	8	2.14	2.23	74.63	-0.059	Upward Gradient	0.54	0.05	0.30	4
MW27B-15	316511.15	4833306.52	10.670	7.010	10.670	Sand (NATIVE)	76.846	76.770	66.176	1.610	1.686	75.160	-0.012	Upward Gradient	41.14	4.11	0.35	51	2.34	2.42	74.43	0.044	Downward Gradient	41.14	4.11	0.35	187
MW27A-15	316331.998	4833623.92	21.490	17.680	21.490	Bedrock	77.411	77.265	55.921	2.250	2.396	75.015	0.014	Downward Gradient	2.78	0.28	0.02	72	2.71	2.86	74.56	-0.013	Upward Gradient	2.78	0.28	0.02	64
MW28D-15	316878.99	4833757.44	3.040	0.910	3.040	Sand/Gravel (FILL)	76.850	76.800	73.810	-	-	-							1.7	1.76	75.1						
MW28C-15	316880.31	4833757.9	6.700	3.040	6.700	Gravel/Clayey Silt/Sand (FILL)	76.870	76.830	70.170	-	-	-							2.05	2.09	74.78	0.088	Downward Gradient				
MW28B-15	316875.96	4833755.72	9.750	5.790	9.750	Sand (FILL)/Sand (NATIVE)	76.880	76.790	67.130	-	-	-							2.02	2.1	74.77	0.003	Downward Gradient				
MW28A-15	316877.68	4833756.22	45.720	28.950	33.520	Sand TILL/Silt/Sand (NATIVE)	76.870	76.760	31.150	-	-	-							2.07	2.18	74.69	0.002	Downward Gradient				
MW29C-15	316966.55	4833710.86	3.040	1.210	3.040	Sand/Sand & Gravel (FILL)	76.960	78.000	73.920	-	-	-			3.32	0.33	0.30		3.34	2.3	74.66			3.32	0.33	0.30	
MW29B-15	316967.59	4833709.01	7.310	5.180	7.310	Peat/Sand (FILL)	77.050	78.080	69.740	-	-	-			8.57	0.86	0.35		2.61	1.58	75.47	-0.194	Upward Gradient	8.57	0.86	0.35	173
MW29A-15	316965	4833713.32	10.660	8.530	10.660	Gravelly Sand/Sand (NATIVE)	76.950	78.020	66.290	-	-	-			5.40	0.54	0.35		3.28	2.21	74.74	0.212	Downward Gradient	5.40	0.54	0.35	119
MW30D-15	317425.825	4833744.38	3.050	1.520	3.050	Sand/Silty Clay (FILL)	77.175	78.232	74.125	3.000	1.943	75.232			0.54	0.05	0.35		3.26	2.2	74.97			0.54	0.05	0.35	
MW30C-15	317424.528	4833743.6	6.100	2.440	6.100	Silty Clay/Peat/Silt (NATIVE)	77.154	78.156	71.054	2.950	1.948	75.206	0.008	Downward Gradient	45.20	4.52	0.40	35	3.25	2.25	74.91	0.020	Downward Gradient	45.20	4.52	0.40	81
MW30B-15	317423.35	4833742.9	10.060	6.400	10.060	Sand Native	77.106	78.050	67.046	2.950	2.006	75.100	0.026	Downward Gradient	41.14	4.11	0.35	113	3.4	2.46	74.65	0.065	Downward Gradient	41.14	4.11	0.35	278
MW30A-15	317422.446	4833742.35	24.800	21.140	24.800	Bedrock	77.065	78.053	52.265	2.890	1.902	75.163	-0.004	Upward Gradient	1.87	0.19	0.02	15	3.42	2.43	74.63	0.001	Downward Gradient	1.87	0.19	0.02	5
MW31D-15	317269.883	4833918.05	6.100	4.270	6.100	Sand (FILL)/Clayey Silt/Peat (NATIVE)	79.993	81.069	73.893	5.270	4.194	75.799			0.42	0.04	0.4		5.44	4.36	75.63			0.42	0.04	0.4	
MW31C-15	317269.34	4833918.85	10.370	6.710	10.370	Silty Clay/Sandy Silt/Silty Sand/Sand (NATIVE)	80.032	81.081	69.662	5.960	4.911	75.121	0.160	Downward Gradient	0.54	0.05	0.3	11	6.37	5.32	74.71	0.217	Downward Gradient	0.54	0.05	0.3	14
MW31B-15	317268.125	4833917.06	13.720	10.050	13.720	Sand and Gravel/Sand (NATIVE)	80.030	81.092	66.310	5.970	4.908	75.122	0.000	Upward Gradient	118.71	11.87	0.35	4	6.38	5.32	74.71	0.000	No Gradient	118.71	11.87	0.35	0
MW31A-15	317267.52	4833917.96	24.170	20.430	24.170	Bedrock	80.032	81.064	55.862	6.040	5.008	75.024	0.009	Downward Gradient	1.87	0.19	0.02	32	6.47	5.44	74.59	0.011	Downward Gradient	1.87	0.19	0.02	39
MW32D-15	317454.85	4834075.46	3.050	1.520	3.050	Silt/Sand/Silt (FILL)	77.074	77.021	74.024	0.960	1.013	76.061			0.54	0.05	0.3		2.18	2.23	74.84			0.54	0.05	0.3	
MW32C-15	317455.497	4834074.31	7.010	3.350	7.010	Peat/Silt (NATIVE)	77.030	76.896	70.020	1.790	1.924	75.106	0.239	Downward Gradient	45.20	4.52	0.4	984	2.15	2.28	74.75	0.022	Downward Gradient	45.20	4.52	0.4	93
MW32B-15	317456.236	4834073.08	10.670	7.010	10.670	Sand (NATIVE)	76.998	76.962	66.328	1.830	1.866	75.132	-0.007	Upward Gradient	41.14	4.11	0.35	30	2.27	2.31	74.69	0.016	Downward Gradient	41.14	4.11	0.35	70
MW32A-15	317456.517	4834071.84	20.120	16.460	20.120	Bedrock	76.929	76.865	56.809	1.740	1.804	75.125	0.001	Downward Gradient	1.87	0.19	0.02	3	2.18	2.24	74.69	0.000	No Gradient	1.87	0.19	0.02	0
MW33D-15	317136.19	4833963.39	3.040	1.210	3.040	Sand & Gravel/Silty Clay/Peat/Silty Clay (FILL)	77.180	78.230	74.140	3.000	1.940	75.230			0.54	0.05	0.35		3.26	2.2	74.97			0.54	0.05	0.35	
MW33C-15	317135.17	4833962.66	7.010	4.570	6.850	Sandy Silt/Sand (FILL)	77.150	78.160	70.140	2.950	1.950	75.210	0.005	Downward Gradient	0.54	0.05	0.3	0.3	3.25	2.25	74.91	0.015	Downward Gradient	0.54	0.05	0.3	1
MW33B-15	317133.99	4833961.99	10.360	7.920	10.360	Sand (NATIVE)	77.110	78.050	66.750	2.950	2.010	75.100	0.032	Downward Gradient	41.14	4.11	0.35	139	3.4	2.46	74.65	0.077	Downward Gradient	41.14	4.11	0.35	329
MW33A-15	317133.01	4833961.28	20.110	16.450	20.110	Bedrock	77.160	77.070	57.050	-	-	-			1.87	0.19	0.02		2.39	2.48	74.68	-0.003	Upward Gradient	1.87	0.19	0.02	11
MW34D-15	317222.144	4833996.19	6.100	4.270	6.100	Gravelly Sand/Silt (FILL)	79.119	80.158	73.019	5.360	4.321	74.798			3.44	0.34	0.3		5.45	4.41	74.71			3.44	0.34	0.3	
MW34C-15	317223.071	4833996.76	10.670	7.010	10.670	Peat/Silty Clay (NATIVE)	79.105	80.136	68.435	5.020	3.989	75.116	-0.069	Upward Gradient	45.20	4.52	0.4	286	5.43	4.4	74.71	0.000	No Gradient	45.20	4.52	0.4	0
MW34B-15	317224.159	4833997.58	13.720	10.060	13.720	Sand Fill/Silty Sand (NATIVE)	79.076	80.095	65.356	4.970	3.951	75.125	-0.003	Upward Gradient	41.14	4.11	0.35	13	5.38	4.36	74.72	-0.003	Upward Gradient	41.14	4.11	0.35	14
MW34A-15	317225.218	4833998.43	21.200	17.380	21.200	Bedrock	79.017	80.123	57.817	5.120	4.014	75.003	0.016	Downward Gradient	1.87	0.19	0.02	55	5.57	4.46	74.55	0.023	Downward Gradient	1.87	0.19	0.02	77
MW35D-15*	317221.088	4833892.04	12.800	9.150	12.800	Sand (FILL)	80.069	80.844	67.269	5.720	4.945	75.124			57.37	5.74	0.35		6.13	5.35	74.71			57.37	5.74	0.35	
MW35C-15	317221.376	4833891.91	6.100	4.270	6.100	Silty Clay (FILL)	80.066	80.976	73.966	5.100	4.190	75.876	0.112	Downward Gradient	0.41	0.04	0.3	6	5.23	4.32	75.75	0.155	Downward Gradient	0.41	0.04	0.3	8
MW35B-15	317220.8	4833892.17	9.760	6.100	9.760	Peat/Silty Clay (NATIVE)	80.071	80.966	70.311	5.850	4.955	75.116	0.208	Downward Gradient	45.20	4.52	0.4	858	6.27	5.38	74.7	0.287	Downward Gradient	45.20	4.52	0.4	1185
MW35A-15	316537.407	4833741.66	23.020	19.360	23.020	Bedrock	77.169	77.098	54.149	1.960	2.031	75.138	-0.001	Upward Gradient	0.98	0.10	0.02	2	2.41	2.48	74.69	0.001	Downward Gradient	0.98	0.10	0.02	1
MW36D-15	316492.448	4833472.65	3.050	1.220	3.050	Sand (FILL)/Sand (NATIVE)	76.469	76.397	73.419	1.210	1.282	75.187			57.36	5.74	0.35		1.57	1.64	74.83			57.36	5.74	0.35	
MW36C-15	316489.966	4833471.95	6.100	2.440	6.100	Sand (NATIVE)	76.451	76.362	70.351	1.190	1.279	75.172	0.005	Downward Gradient	41.14	4.11	0.35	21	1.5	1.59	74.86	-0.010	Upward Gradient	41.14	4.11	0.35	42
MW36B-15	316488.191	4833471.46	10.670	7.010	10.670	Sand (NATIVE)	76.488	76.406	65.818	1.230	1.312	75.176	-0.001	Upward Gradient	41.14	4.11	0.35	4	1.55	1.63	74.86	0.000	No Gradient	41.14	4.11	0.35	0
MW36A-15	316491.211	4833472.29	21.540	17.680	21.540	Bedrock	76.428	76.323	54.888	1.260	1.365	75.063	0.010	Downward Gradient	1.87	0.19	0.02	35	1.83	1.94	74.49	0.034	Downward Gradient	1.87	0.19	0.02	116
MW37D-15	316665.112	4833585.73	3.050	1.520	3.050	Sand to Sandy Silt Fill/Sand (FILL)	76.446	76.382	73.396	1.220	1.284	75.162			57.37	5.74	0.35		1.57	1.63	74.81			57.37	5.74	0.35	
MW37C-15	316664.119	4833585.28	7.620	3.960	7.620	Sand (FILL)	76.453	76.373	68.833	1.220	1.300	75.153	0.002	Downward Gradient	41.14	4.11	0.35	8	1.55	1.63	74.82	-0.002	Upward Gradient	41.14	4.11	0.35	9
MW37B-15	316663.224	4833584.84	10.670	7.010	10.670	Sand (FILL)	76.451	76.381	65.781	1.220	1.290	75.161	-0.003	Upward Gradient	41.14	4.11	0.35	11	1.58	1.65	74.8	0.007	Downward Gradient	41.14	4.11	0.35	28
MW37A-15**	316662.206	4833584.31	23.100	19.510	23.100	Bedrock	76.457	76.273	53.357	1.850	2.034	74.423	0.059	Downward Gradient	1.87	0.19	0.02	203	-	-	-			1.87	0.19	0.02	
MW38C-15	316937.49	4833535.74	3.040	1.210	3.040	Silty Sand/Sand/Silty Sand (FILL)	76.970	77.830	73.930	-	-	-			34.82	3.48	0.3		2.56	1.7	75.27			34.82	3.48	0.3	
MW38B-15	316938.21	4833534.24	6.700	4.260	6.700	Peat/Sand (NATIVE)	76.970	77.820	70.270	-	-	-			11.84	1.18	0.35		3.09	2.24	74.73	0.148	Downward Gradient	11.84	1.18	0.35	182
MW38A-15	316938.74	4833533.08	9.750	8.530	9.140	Sand (NATIVE)	76.970	77.850	67.220	-	-	-			41.14	4.11	0.3		3.13	2.24	74.72	0.003	Downward Gradient	41.14	4.11	0.3	16
MW39D-15	317100.827	4834259.29	3.050	1.220	3.050	Sand/Silty Clay/Peat (NATIVE)	76.547	77.517	73.497	2.410	1.440	75.107			57.36	5.74	0.4		2.77	1.8	74.75			57.36	5.74	0.4	
MW39C-15	317101.505	4834258.02	7.620	3.960	7.620	Peat/Silty Clay (NATIVE)	76.544	77.584	68.924	2.450	1.410	75.134	-0.006	Upward Gradient	45.20	4.52	0.4	24	2.9	1.86	74.68	0.015	Downward Gradient	45.20	4.52	0.4	63
MW39B-15	317102.203	4834256.99	10.670	7.010	10.670	Silty Clay/Silty Sand/Gravelly Sand/Shale (NATIVE)	76.498	77.480	65.828	2.360	1.378	75.120	0.005	Downward Gradient	45.20	4.52	0.3	25	2.8	1.82	74.68	0.000	No Gradient	45.20	4.52	0.3	0
MW39A-15	317102.825	4834256.14	15.850	12.200	15.850	Bedrock	76.514	77.487	60.664	2.390	1.417	75.097	0.004	Downward Gradient	1.87	0.19	0.02	15	2.82	1.85	74.67	0.002	Downward Gradient	1.87	0.19	0.02	7
MW40D-15	317305.962	4834284.53	3.050	1.220	3.050	Gravel Fill/Clay (FILL)	76.929	77.805	73.879	2.390	1.514	75.415			0.41	0.04	0.3		2.57	1.69	75.24			0.41	0.04	0.3	
MW40C-15	317305.072	4834285.52	6.100	2.440	6.100	Silt/Sandy Silt/Silt/Sandy Silt (FILL)	76.904	77.660	70.804	2.430	1.674	75.230	0.060	Downward Gradient	0.54	0.05	0.3	4	2.78	2.02	74.88	0.117	Downward Gradient	0.54	0.05	0.3	8
MW40B-15	317304.412	4834286.52	10.570	7.010	10.570	Silty Sand/Sand (FILL)	76.890	77.719	66.320	2.570	1.741	75.149	0.018	Downward Gradient	15.28	1.53	0.35	29	2.99	2.16	74.73	0.033	Downward Gradient	15.28	1.53	0.35	53
MW40A-15	317303.743	4834287.94	16.240	12.590	16.240	Bedrock	76.812	77.693	60.572	2.540	1.659	75.153	-0.001	Upward Gradient	1.87	0.19	0.02	2	2.96	2.08	74.73	0.000	No Gradient	1.87	0.19	0.02	0

Notes:

(1)	Reference elevation taken from top of riser pipe.
*	Elevations for MW35D-15 are approximate - to be confirmed in Stage 2.
**	Monitoring well casing damaged. Monitoring well to be repaired during Stage 2.
mamsl	metres above mean sea level. Elevations referenced with respect to benchmark.
mbgs	metres below ground surface
mBTOR	metres Below Top of Riser
	Lake Ontario Water Level Elevation 75.017 mASL on September 1, 2015 at Station Number 13320.
	Effective Porosity values referenced from Sara, Martin, N.2003. Site Assessment and Remediation Handbook (2nd ed.) CRC Press LLC, 501p.

Table G4. Port Lands Infrastructure Design for Storm Sewer, Sanitary Sewer and Dewatering Calculations

Waterfront Toronto - Port Lands

Infrastructure Dimensions																		
Street	**Invert**	**Station**	**Manhole Diameter (mm)**	**Pipe Diameter (mm)**	**Pipe Length (m)**	**Rim Elev.**	**SW Inv.**	**NE Inv.**	**NW Inv.**	**SE Inv.**	**N Inv.**	**E Inv.**	**W Inv.**	**S Inv.**	**Chainage (m)**	**Design Chainage Length (m)**	**Infrastructure Base Depth Below Ground Surface (m)**	**Construction Method**
Polson	SAN MH11A	0+400	1200	375		79.68		75.00							400	0	4.68	Open-Cut Trench
Polson	SAN MH12A	0+454	1200	375	54	79.29	74.73	74.70							454	54	4.59	Open-Cut Trench
Polson	SAN MH13A	0+533	1200	375	79	78.71	74.31		70.84						533	133	4.40	Open-Cut Trench
Don Roadway North	STM MH18	0+010	1200			78.44				76.65					10	0	1.79	Open-Cut Trench
Don Roadway North	STM MH19	0+118	1200	300	108	78.74			76.11	76.08					118	108	2.66	Open-Cut Trench
Don Roadway North	STM MH20	0+210	1200	375	92	78.89			75.62	75.59					210	200	3.30	Open-Cut Trench
Don Roadway North	STM MH22	0+317	1500	450	107	79.27	72.95	72.89	75.06						317	307	6.38	Open-Cut Trench
Commissioners Street East to Saulter Street	STM MH22	0+835	1500			79.27	72.95	72.89	75.06						835	0	6.38	Open-Cut Trench
Commissioners Street East to Saulter Street	STM MH33	0+915	1200	600	80	78.17	72.19	72.46							915	80	5.98	Open-Cut Trench
Commissioners Street East to Saulter Street	STM MH34	0+995	1200	600	80	77.37	72.06	72.03							995	160	5.34	Open-Cut Trench
Commissioners Street East to Saulter Street	STM MH35	1+077	1200	600	82	76.56	71.62			71.56					1077	242	5.00	Open-Cut Trench
Commissioners Street East to Saulter Street	SAN MH26A	0+819	1200			79.53	66.50	66.47							819	0	13.06	Micro-tunneling
Commissioners Street East to Saulter Street	SAN MH27A	0+930	1200	375	111	78.03	65.92	65.89							930	111	12.14	Micro-tunneling
Commissioners Street East to Saulter Street	SAN MH28A	1+042	1200	375	112	76.91	65.33		65.27						1042	223	11.64	Micro-tunneling
Cherry Street (North of Keating Channel)	STM MH30	0+055	1200			74.65			73.68					73.74	55	0	0.97	Open-Cut Trench
Cherry Street (North of Keating Channel)	STM MH29	0+159	1200	375	104	77.66				75.68	75.62				159	104	2.04	Open-Cut Trench
Cherry Street (North of Keating Channel)	STM MH28	0+259	1200	300	100	78.52			76.68						259	204	1.84	Open-Cut Trench
Cherry Street (Keating Channel to Commissioners Street	STM MH1	0+345	1200			78.13				75.86					345	290	2.27	Open-Cut Trench
Cherry Street (Keating Channel to Commissioners Street	STM MH2	0+420	1200	375	75	77.51			75.49	75.45					420	365	2.06	Open-Cut Trench
Cherry Street (Keating Channel to Commissioners Street	STM MH3	0+520	1200	600	100	78.02			74.95	74.92					520	465	3.10	Open-Cut Trench
Cherry Street (Commissioners Street to River)	STM MH4	0+594	2400	600	74	77.38	76.43	74.10	74.55	76.39					594	539	3.28	Open-Cut Trench
Cherry Street (Commissioners Street to River)	STM MH32	0+649	1200	375	55	78.86			76.66	76.72					649	594	2.20	Open-Cut Trench
Cherry Street (Commissioners Street to River)	STM MH31	0+684	1200	375	35	79.00			76.90						684	629	2.10	Open-Cut Trench
Cherry Street River to Shipping Channel	STM MH15	0+863				79.12				77.11					863	808	2.01	Open-Cut Trench
Cherry Street River to Shipping Channel	STM MH16	0+915		450	52	79.50			76.85	76.78					915	860	2.72	Open-Cut Trench
Cherry Street River to Shipping Channel	STM MH17	0+988		525	73	80.15			76.41	76.34					988	933	3.81	Open-Cut Trench
Cherry Street River to Shipping Channel	STM OGS1	1+079		600	91	79.32			75.88	74.05					1079	1024	5.27	Open-Cut Trench
Storm Crossing	SAN MH25A	0+445													445	202	-	Open-Cut Trench
Storm Crossing	SAN MH24A	0+336	1200	250	109	79.00			73.93	73.93					336	93	5.07	Open-Cut Trench
Storm Crossing	SAN MH23A	0+243	1200	250	93	67.64	67.64	67.58	73.00						243	0	0.06	Open-Cut Trench
Storm Crossing	STM MH14	0+424	3000			78.70		66.65		66.78					424	174	12.05	Open-Cut Trench
Storm Crossing	STM MH13	0+340	1800	1200	84	79.00			67.20	67.27					340	90	11.80	Open-Cut Trench
Storm Crossing	STM MH12	0+250	2400	1200	90	80.15			67.72	67.85					250	0	12.43	Open-Cut Trench
Commissioners Street	SAN MH14A																-	Open-Cut Trench
Commissioners Street	SAN MH15A																-	Open-Cut Trench
Commissioners Street	SAN MH16A	0+011	1200			78.36	75.46	75.43							11	0	2.93	Open-Cut Trench
Commissioners Street	SAN MH17A	0+111	1200	300	100	77.40	74.93	74.90							111	100	2.50	Open-Cut Trench
Commissioners Street	SAN MH18A	0+211	1200	300	100	77.71	74.40	74.37							211	200	3.34	Open-Cut Trench
Commissioners Street	SAN MH19A	0+270	1200	300	59	77.26	74.07	69.40		69.46					270	259	7.86	Open-Cut Trench
Commissioners Street	SAN MH20A	0+311	1200	375	41	77.52	69.19	69.16							311	300	8.36	Open-Cut Trench
Commissioners Street	SAN MH21A	0+411	1200	375	100	78.14	68.66	68.63							411	400	9.51	Open-Cut Trench
Commissioners Street	SAN MH22A	0+511	1200	375	100	78.77	68.13	68.10							511	500	10.67	Open-Cut Trench
Commissioners Street	SAN MH23A	0+603	1200	375	92	80.13	67.64	68.58	73.00						603	592	12.49	Open-Cut Trench
Commissioners Street	STM MH36																-	Open-Cut Trench
Commissioners Street	STM MH37																-	Open-Cut Trench
Commissioners Street	STM MH4	0+008	2400		74	77.38	76.43	74.10	74.55	76.39					8	0	3.28	Open-Cut Trench
Commissioners Street	STM MH5	0+108	1500	900	100	77.43	73.60	73.57							108	100	3.86	Open-Cut Trench
Commissioners Street	STM MH6	0+208	1500	900	100	77.74	73.07	73.04							208	200	4.70	Open-Cut Trench
Commissioners Street	STM MH7	0+308	1500	900	100	77.50	72.54	72.51							308	300	4.99	Open-Cut Trench
Commissioners Street	STM MH8	0+408	1800	900	100	78.12	72.01	71.86							408	400	6.26	Open-Cut Trench
Commissioners Street	STM MH9	0+508	1800	1050	100	78.75	71.36	71.33							508	500	7.42	Open-Cut Trench
Commissioners Street	STM OGS2	0+590	3000	1050	82	79.88	70.92				70.50				590	582	9.38	Open-Cut Trench

Note:

Dewatering equations referenced from Powers et al., 2007. *Construction Dewatering: New Methods and Applications - Third Edition. New York, New York: John Wiley & Sons*

Table G4. Port Lands Infrastructure Design for Storm Sewer, Sanitary Sewer and Dewatering Calculations

Waterfront Toronto - Port Lands

Hydrogeologic Characterization and Dewatering Equation Components											
Groundwater Elevation (mASL)	**Depth of Infrastructure Base Below Water Table (m)**	**Excavation Depth Below Water Table for Subgrade Backfill (m)**	**Depth Below Water Table (m) to lower groundwater 1 m below excavation to ensure dry construction**	**K - Hydraulic Conductivity of Fill / Native Sand**	**Top of Bedrock Elevation (mASL)**	**H - Distance from static water level to bottom of aquifer / top of bedrock (m)**	**h - Distance from pumping water level in the well to bottom of aquifer / top of bedrock (m)**	**L_o - Distance from a point of greatest drawdown to a point where there is no drawdown (m)**	**r_e – equivalent radius of excavation: $r_e=((w*x)/\pi)^{0.5}$**	**Radius of the cone of depression: $R = r_e + 3000 * (H – h) * K^{0.5}$; K is entered in m/s.**	**w – excavation width (m)**	**x – excavation length (m)**
75.1	0.1	0.6	1.6	12.61	57.5	17.6	16	-	-	-	3.375	18
75.1	0.4	0.9	1.9	12.61	57.5	17.6	15.7	73.26	4.40	73.26	3.375	18
75.1	0.79	1.29	2.29	12.61	57.5	17.6	15.31	87.39	4.40	87.39	3.375	18
75.1	Infrastructure Above Water Table	Infrastructure Above Water Table	Infrastructure Above Water Table	-	57.5	-	-	-	-	-	3	18
75.1	Infrastructure Above Water Table	Infrastructure Above Water Table	Infrastructure Above Water Table	-	57.5	-	-	-	-	-	3.3	18
75.1	Infrastructure Above Water Table	0.01	1.01	12.61	57.5	17.6	16.59	41.00	4.40	41.00	3.375	18
75.1	0.04	0.54	1.54	12.61	57.5	17.6	16.06	60.26	4.45	60.26	3.45	18
75.1	2.21	2.71	3.71	12.61	57.5	17.6	13.89	-	-	-	3	18
75.1	2.91	3.41	4.41	12.61	57.5	17.6	13.19	164.37	4.54	164.37	3.6	18
75.1	3.07	3.57	4.57	12.61	57.5	17.6	13.03	170.17	4.54	170.17	3.6	18
75.1	3.54	4.04	5.04	12.61	57.5	17.6	12.56	187.21	4.54	187.21	3.6	18
75.1	8.63	9.13	10.13	12.61	57.5	17.6	7.47	-	-	-	3	18
75.1	9.21	9.71	10.71	12.61	57.5	17.6	6.89	392.56	4.40	392.56	3.375	18
75.1	9.83	10.33	11.33	12.61	57.5	17.6	6.27	415.03	4.40	415.03	3.375	18
75.1	1.42	1.92	2.92	12.61	57.5	17.6	14.68	-	-	-	3	18
75.1	Infrastructure Above Water Table	Infrastructure Above Water Table	Infrastructure Above Water Table	-	57.5	-	-	-	-	-	3.375	18
75.1	Infrastructure Above Water Table	Infrastructure Above Water Table	Infrastructure Above Water Table	-	57.5	-	-	-	-	-	3.3	18
75.1	Infrastructure Above Water Table	Infrastructure Above Water Table	Infrastructure Above Water Table	-	57.5	-	-	-	-	-	3	18
75.1	Infrastructure Above Water Table	0.15	1.15	12.61	57.5	17.6	16.45	46.08	4.40	46.08	3.375	18
75.1	0.18	0.68	1.68	12.61	57.5	17.6	15.92	65.43	4.54	65.43	3.6	18
75.1	1	1.5	2.5	12.61	57.5	17.6	15.1	95.15	4.54	95.15	3.6	18
75.1	Infrastructure Above Water Table	Infrastructure Above Water Table	Infrastructure Above Water Table	-	57.5	-	-	-	-	-	3.375	18
75.1	Infrastructure Above Water Table	Infrastructure Above Water Table	Infrastructure Above Water Table	-	57.5	-	-	-	-	-	3.375	18
75.1	Infrastructure Above Water Table	Infrastructure Above Water Table	Infrastructure Above Water Table	-	57.5	-	-	-	-	-	3	18
75.1	Infrastructure Above Water Table	Infrastructure Above Water Table	Infrastructure Above Water Table	-	57.5	-	-	-	-	-	3.45	18
75.1	Infrastructure Above Water Table	Infrastructure Above Water Table	Infrastructure Above Water Table	-	57.5	-	-	-	-	-	3.525	18
75.1	1.05	1.55	2.55	12.61	57.5	17.6	15.05	96.96	4.54	96.96	3.6	18
75.1	-	-	-	-	-	-	-	-	-	-	-	-
75.1	1.17	1.67	2.67	12.61	57.5	17.6	14.93	101.08	4.32	101.08	3.25	18
75.1	7.52	8.02	9.02	12.61	57.5	17.6	8.58	331.23	4.32	331.23	3.25	18
75.1	8.45	8.95	9.95	12.61	57.5	17.6	7.65	364.76	4.15	364.76	3	18
75.1	7.9	8.4	9.4	12.61	57.5	17.6	8.2	345.59	4.91	345.59	4.2	18
75.1	7.38	7.88	8.88	12.61	57.5	17.6	8.72	326.74	4.91	326.74	4.2	18
75.1	-	-	-	-	-	-	-	-	-	-	-	-
75.1	-	-	-	-	-	-	-	-	-	-	-	-
75.1	Infrastructure Above Water Table	0.17	1.17	12.61	57.5	17.6	16.43	46.55	4.15	46.55	3	18
75.1	0.2	0.7	1.7	12.61	57.5	17.6	15.9	65.96	4.35	65.96	3.3	18
75.1	0.73	1.23	2.23	12.61	57.5	17.6	15.37	85.17	4.35	85.17	3.3	18
75.1	5.7	6.2	7.2	12.61	57.5	17.6	10.4	265.30	4.35	265.30	3.3	18
75.1	5.94	6.44	7.44	12.61	57.5	17.6	10.16	274.04	4.40	274.04	3.375	18
75.1	6.47	6.97	7.97	12.61	57.5	17.6	9.63	293.25	4.40	293.25	3.375	18
75.1	7	7.5	8.5	12.61	57.5	17.6	9.1	312.46	4.40	312.46	3.375	18
75.1	7.46	7.96	8.96	12.61	57.5	17.6	8.64	329.13	4.40	329.13	3.375	18
75.1	-	-	-	-	-	-	-	-	-	-	-	-
75.1	-	-	-	-	-	-	-	-	-	-	-	-
75.1	1	1.5	2.5	12.61	57.5	17.6	15.1	94.75	4.15	94.75	3	18
75.1	1.53	2.03	3.03	12.61	57.5	17.6	14.57	114.54	4.73	114.54	3.9	18
75.1	2.06	2.56	3.56	12.61	57.5	17.6	14.04	133.75	4.73	133.75	3.9	18
75.1	2.59	3.09	4.09	12.61	57.5	17.6	13.51	152.96	4.73	152.96	3.9	18
75.1	3.24	3.74	4.74	12.61	57.5	17.6	12.86	176.52	4.73	176.52	3.9	18
75.1	3.77	4.27	5.27	12.61	57.5	17.6	12.33	195.82	4.82	195.82	4.05	18
75.1	4.6	5.1	6.1	12.61	57.5	17.6	11.5	225.90	4.82	225.90	4.05	18

Note:

Dewatering equations referenced from Powers et al., 2007. *Construction Dewatering: New Methods and Applications - Third Edition. New York, New York: John Wiley & Sons*

Table G4. Port Lands Infrastructure Design for Storm Sewer, Sanitary Sewer and Dewatering Calculations
Waterfront Toronto - Port Lands

Dewatering Volumes without Safety Factor to account for variations in hydraulic conductivity or groundwater elevation variation				Dewatering Volumes with 3 x Safety Factor to account for variations in hydraulic conductivity or groundwater elevation variation			
Total flow rate (m^3/d) for the entire pipe section if remained open (both sides combined): $Q_M = x * K * (H^2 – h^2) / L_o$ or $Q_M = Q * 2 * x$	**Flow rate (m^3/d) per metre on one side of trench section if remained open: $Q = K * (H^2 – h^2) / 2 * L_o$**	**Flow rate (m^3/d) per metre combining both sides of trench section if remained open: $Q_L = Q * 2$**	**Dewatering Rate per 18 m open trench (m^3/day)**	**Total flow rate (m^3/d) for the entire trench section (x) if remained open (both sides combined): $Q_M = x * K * (H^2 – h^2) / L_o$ or $Q_M = Q * 2 * x$**	**Flow rate (m^3/d) per metre on one side of trench section if remained open: $Q = K * (H^2 – h^2) / 2 * L_o$**	**Flow rate (m^3/d) per metre combining both sides of trench section if remained open: $Q_L = Q_M / x$**	**Dewatering Rate per 18 m open trench (m^3/day)**
-	-	-	-	-	-	-	-
588	5	11	196	1764	16	33	588
859	5	11	196	2577	16	33	587
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
977	5	11	191	2931	16	32	573
1161	5	11	195	3482	16	33	586
-	-	-	-	-	-	-	-
833	5	10	188	2500	16	31	563
830	5	10	187	2489	16	31	560
840	5	10	184	2519	15	31	553
-	-	-	-	-	-	-	-
935	4	8	152	2806	13	25	455
920	4	8	148	2761	12	25	444
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
804	5	11	193	2411	16	32	579
1085	5	11	195	3256	16	33	586
802	5	11	195	2405	16	33	585
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
985	5	11	195	2956	16	32	585
-	-	-	-	-	-	-	-
1181	5	11	195	3543	16	33	585
836	4	9	162	2508	13	27	485
-	-	-	-	-	-	-	-
743	4	9	159	2230	13	27	478
812	5	9	162	2435	14	27	487
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
1089	5	11	196	3266	16	33	588
1089	5	11	196	3266	16	33	588
565	5	10	172	1696	14	29	517
390	5	10	171	1169	14	29	513
933	5	9	168	2800	14	28	504
916	5	9	165	2748	14	27	495
829	5	9	162	2486	14	27	486
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
805	5	11	196	2415	16	33	587
1073	5	11	193	3219	16	32	579
1062	5	11	191	3186	16	32	573
1049	5	10	189	3147	16	31	566
1031	5	10	186	3094	15	31	557
1016	5	10	183	3047	15	30	548
813	5	10	178	2438	15	30	535

Note:

Dewatering equations referenced from Powers et al., 2007. *Construction Dewatering: New Methods and Applications - Third Edition. New York, New York: John Wiley & Sons*