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February 24, 2023

GEL Project Number 1760-001-22

# Functional Servicing Report & Stormwater Management Report

**Regarding:**

Proposed Residential Condominium
582 Essa Road
Barrie, Ontario

**Prepared on behalf of:**

Inspiration Group of Companies

**By:**

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Barrie, ON L4N 9E7

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# 1. Introduction

Gerrits Engineering Ltd. (GEL) has been retained by Inspiration Group of Companies (CLIENT) to prepare a Functional Servicing Report for the proposed development of the 8 storey tower in the geographic City of Barrie (City), Ontario. The subject lands are approximately 0.39 ha in area and slopes gently from the east to the west in its existing conditions. It is proposed to construct a new building with a footprint of about 1,890 $m^2$ along with underground parking, as well as, surface parking located within the footprint. This report will address the detailed design and stormwater management controls required for the proposed building construction.

## 1.1. Supporting & Reference Documents

The following documents have been referenced in the preparation of this report:

- Ministry of the Environment, Stormwater Management Planning and Design Manual, March 2003
- Ministry of Transportation, Drainage Management Manual (MTO, 1997)
- City of Barrie, Storm Drainage & Stormwater Management Policies & Design Guidelines, November 2009
- Water Transmission and Distribution Policies and Design Standard, January 2021
- Sanitary Sewage Collection System Policies and Design Guideline, October 2017
- NVCA Stormwater Technical Guide, Nottawasaga Valley Conservation Authority, December 2013
- Ontario Building Code 2012 (O.B.C.)

## 1.2. Subject Property

The subject site as shown below in Figure 1 (in red) is approximately 0.39 ha in area and is designated for residential use. It is legally described as Part of Lot 16 on Registered Plan 1101 (In the Geographic Township of Innisfil) in the City of Barrie, Count of Simcoe, Ontario. The site is primarily vacant in its existing condition and consists mostly of undeveloped lands. The site, in its existing state, slopes predominantly to the southwest corner of the property before spilling onto the Essa Road Right-of-Way. There is also a small portion of the site that slopes towards the Warner Road Right-of-Way. The topographical information is based on a survey completed by Total Tech Surveying Inc., dated October 2, 2021, as well as an aerial map from Google Imagery.

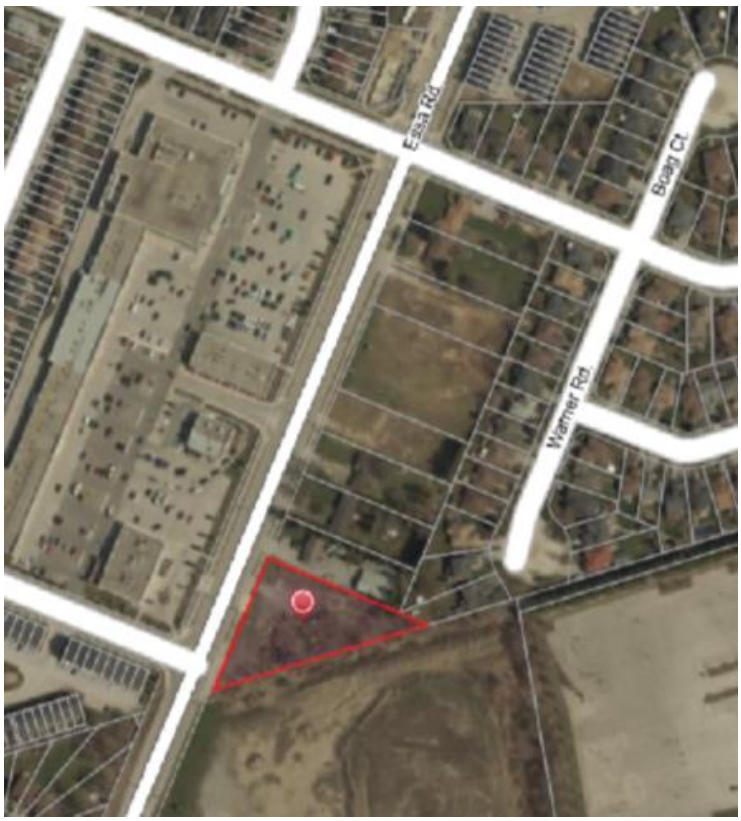



**Figure 1 - Subject Property (Red)**

### 1.3. Proposed Land Use

The proponent is seeking to undertake a new 8 Storey High Rise Residential Development. It is proposed that the building will be serviced with their own sanitary sewage, domestic water supply and fire water supply provided by the City of Barrie. There are 116 units being proposed within this building.

## 2. Servicing

### 2.1. Overview

Servicing of the Development will involve the connection to the City's existing water and sanitary distribution and collection system. The Development's internal collection and distribution system will be constructed as per the City and Ministry of Environment (MOE) design guidelines. The site's internal water distribution system will be designed to account for domestic and fire protection requirements.

### 2.2. Design Criteria

A summary of the water and wastewater design criteria is as follows:

**Serviced Population**

- High Density (Condominium) = 1.67 ppu
- Development residential population – 116 units x 1.67 ppu = 194 pers

**Wastewater Criteria**

- Average Day Flow (ADF) Residential (New Development) = 225 L/c/d
- Extraneous flows (peak per developable ha) = 0.1 L/s/ha
- Peak Factor (residential and commercial) Harmon

$$M = 1 + \frac{14}{4+P^{0.5}} = 4.35 = 4.0 \text{ (Maximum)}$$

**Water Criteria**

- Average Day Demand (ADD) Residential (New Development) = 225 L/c/d
- Max Day Factor (MDD) (Table 3.3 MOECC, 2008) = 4.52
- Peak Hour factor (PH) (Table 3.3 MOECC, 2008) = 6.80
- Minimum pressure in system at MDD = 275 kPa
- Maximum pressure in system at MDD = 700 kPa
- Minimum pressure in system at Peak Hour demand = 275 kPa
- Minimum pressure in system at Fire + MDD = 140 kPa

## 3. Sanitary Servicing

The projected daily average and peak sewage flows from the subject property are summarized in the table below.

**Table 1 – Design Wastewater Flows**

| | | |
|---|---|---|
| Average Daily Demand (Design) | 47.0 | $m^3/d$ |
| | 0.54 | L/s |
| Peak Hour Flow (Design) | 188.1 | $m^3/d$ |
| | 2.18 | L/s |

### 3.1. Proposed Sanitary Connection Point

Serviceability of the subject site can be provided on Essa Road. Flows from the development will be collected and then conveyed by gravity, which will flow west towards the existing sanitary maintenance hole structure on Essa Road (EX. SAN MH). This existing sanitary line currently services the surrounding existing residential and commercial properties. We have been provided with the external flows from the City of Barrie. After applying the above-mentioned design criteria parameters, a preliminary review of the proposed sewers indicate that sufficient capacity should be present for the proposed condominium development. Also, capacity within the existing sewer main is not anticipated to be an issue. Calculations are provided in Appendix A.

### 3.2. Internal Sanitary Collection System

It is proposed that the sanitary sewers be constructed in accordance with the City's Engineering Standards and MOE guidelines to service the Development. The proposed sewers will consist of PVC SDR 35 pipe with pipe diameters of 200mm and designed to meet minimum and maximum velocities under full flow conditions. The spacing interval of the manhole structures will be as per MOE and City guidelines. The minimum manhole diameter will be 1200mm, with larger structures being incorporated as required in accordance with Ontario Provincial Standard Specifications (OPSS). An adequately sized service connection will be provided to the proposed Residential Condominium as specified by City Standards. See attached Site Servicing Plan in Appendix C for reference.

## 4. Water Supply and Distribution

### 4.1. Existing Water System Analysis

A *Water Systems Analysis* has yet to be completed by Gerrits Engineering Ltd. for the proposed development. We suggest that the City review the watermain design requirements for this development with respect to the City's water treatment and supply capacities and confirm that capacity allocation is available for this development. Given the size and location of this development, this is not expected to be a concern.

The projected daily average, maximum day, and peak hourly flows from the subject property are summarized in the table below.

**Table 2 – Design Water Flows**

| | | |
|---|---|---|
| Average Daily Demand (Design) | 43.7 | $m^3/d$ |
| | 0.51 | L/s |
| Maximum Day Demand (Design) | 197.3 | $m^3/d$ |
| | 2.28 | L/s |
| Peak Hour Flow (Design) | 296.8 | $m^3/d$ |
| | 3.44 | L/s |

### 4.2. Internal Water Distribution System

The development will provide a water service connection to the Residential Condominium by a new internal 100mm diameter domestic water service and a new internal 150mm diameter fire water service, which are connected to the existing external 200mm diameter watermain on Essa Road. A new hydrant will be installed near the site entrance. Water services will be installed at the minimum 1.7m depth below finished grade. All systems will be constructed and tested in accordance with the City of Barrie Engineering Standards and MOE Guidelines. Refer to the Site Servicing Plan attached for the location of watermain connections and internal layout.

### 4.3. Fire Flow Requirement

Pressure flow tests have yet to be completed on the municipal system as part of this assessment. The hydrant that will be tested is located at the northwest corner of Essa Road and Coughlin Road. The minimum flow requirement is 88.4 L/s as per FUS Calculations. A new hydrant is being proposed within the site development. This hydrant will provide coverage to the entire

proposed development and will meet City and MOE standards. Details pertaining to the fire flow calculations can be found in Appendix A.

## 5. Storm Drainage and Stormwater Management

A key component of the Development is the need to address environmental and related Stormwater Management (SWM) issues. These are examined in a framework aimed at meeting the City of Barrie, Nottawasaga Valley Conservation Authority, and Ministry of the Environment, Conservation and Parks (MECP) requirements. SWM parameters have evolved from an understanding of the location and sensitivity of the site's natural systems.

It is understood that the objectives of the SWM plan are to:

- Protect life and property from flooding and erosion.
- Maintain water quality for ecological integrity, recreational opportunities etc.
- Protect and maintain groundwater flow regime(s).
- Protect aquatic and fishery communities and habitats.
- Maintain and protect significant natural features.
- Protect and provide diverse recreational opportunities that are in harmony with the environment.

### 5.1. Existing Drainage Conditions

In the pre-development condition, the subject site consists mostly of Undeveloped Lands with an existing asphaltic driveway. As per the City of Barrie Storm Drainage Area Plan (Dwg 2015-004) the subject site is accounted for within the storm system along Essa Road. Per this plan, the catchment area of the subject site is assigned a runoff coefficient of 0.40.

Given the size of the site, the Modified Rational Method will be used to determine the existing release rates:

| | |
|---|---|
| Catchment Area | = 0.39 |
| Runoff Coefficient | = 0.40 |
| Time of Concentration ($t_c$) | = 10 minutes |
| Rainfall Intensity | = City of Barrie IDF Curve Parameters |
| Peaking Factor ($C_i$) | = 1.00 (2-10 year design periods) |
| | = 1.10 (25 year design period) |
| | = 1.20 (50 year design period) |
| | = 1.25 (100 year design period) |
| Peak Runoff Rate ($Q_r$) | = C x I x A x $360^{-1}$ |

Applying the above results in the following release rates:

**Table 3: Subject Site Allowable Release Rate**

| | 2 year (L/s) | 5 year (L/s) | 10 year (L/s) | 25 year (L/s) | 50 year (L/s) | 100 year (L/s) |
|---|---|---|---|---|---|---|
| Allowable Release Rate | 36 | 48 | 55 | 71 | 86 | 98 |

## 5.2. Proposed Drainage Conditions

The proposed Development will increase the imperviousness of the site and it is important to quantify this change to determine quantity control requirements. The typical runoff coefficients as detailed in LSRCA Stormwater Management Guidelines and City of Barrie Engineering Design Standards were referenced to determine the post-development weighted runoff coefficient, which is as follows:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Undeveloped Lands | = | 1,118 $m^2$ | R | = | 0.10 | AR | = | 111.8 |
| Asphalt | = | 315 $m^2$ | R | = | 0.95 | AR | = | 299.3 |
| Building Roof | = | 1,890 $m^2$ | R | = | 0.95 | AR | = | 1,795.5 |
| Concrete | = | 257 $m^2$ | R | = | 0.95 | AR | = | 244.2 |
| Interlocking Paving | = | 350 $m^2$ | R | = | 0.95 | AR | = | 332.5 |
| | | | | | Total | AR | = | 2,783.3 |

Site Area = 3,930 $m^2$ AR = 2,783.3 Weighted R = 0.71

The anticipated post-development runoff coefficient of 0.70 is reasonable for a development of this type. The Modified Rational Method will be used to determine the proposed release rates.

| | |
|---|---|
| Catchment Area | = 0.39 ha |
| Runoff Coefficient | = 0.71 |
| Time of Concentration ($t_c$) | = 10 minutes |
| Rainfall Intensity | = City of Barrie IDF Curve Parameters |
| Peaking Factor ($C_i$) | = 1.00 (2-10 year design periods) |
| | = 1.10 (25 year design period) |
| | = 1.20 (50 year design period) |
| | = 1.25 (100 year design period) |
| Peak Runoff Rate ($Q_r$) | = C x I x A x $360^{-1}$ |

Applying the above results in the following release rates:

**Table 4: Post Development Release Rate**

| | 2 year (L/s) | 5 year (L/s) | 10 year (L/s) | 25 year (L/s) | 50 year (L/s) | 100 year (L/s) |
|---|---|---|---|---|---|---|
| Post-Development | 64 | 84 | 98 | 126 | 152 | 174 |

When reviewing the post development conditions, we find that the anticipated release rates are greater than the pre-development conditions and therefore additional quantity control measures will be required.

## 5.3. Quantity Control

The development of this Site increases the existing stormwater runoff rate above that of the allowable release rate. Therefore, site quantity controls have been designed to closely approximate the allowable release rates. Stormwater quantity control will be provided in underground storage located on the north side of the proposed Residential Condominium. Release from the subject site will be controlled by an outlet pipe sized using the following equation:

$Q = cA\sqrt{2gh}$

Q = allowable release rate
A = orifice area = 0.0177 $m^2$ (150mm dia)
c = orifice coefficient = 0.8
g = gravitational constant = 9.81$m/s^2$
h = high water level over center of orifice

Applying the above equation, we find that a 150mm orifice pipe will restrict the flows such that the controlled stormwater flow from the site is less than the allowable release rates for all storm events. The Pre/Post Development (Controlled) calculated release rates for the proposed development are detailed in Table 5 below. Calculations have been included within Appendix A.

**Table 5: Site Release Rates**

| | Design Storm Event Release Rate (L/s) | | | | | |
|---|---|---|---|---|---|---|
| | 2 yr | 5 yr | 10 yr | 25 yr | 50 yr | 100 yr |
| Allowable Release Rate | 36 | 48 | 55 | 71 | 86 | 98 |
| Post Development with Mitigation Release Rate | 36 | 42 | 46 | 55 | 62 | 68 |
| Storage Volume Required ($m^3$) | 16 | 22 | 27 | 37 | 46 | 55 |

Quantity storage requirements within the stormwater management facility are calculated to be approximately 55 $m^3$. The proposed SWMF has been sized with a total available quantity control volume of about 69 $m^3$, which exceeds storage requirements. Detailed calculations have been provided in Appendix A.

## 5.4. Quality Control

The MOE issued a "Stormwater Management Planning and Design Manual" in March 2003. This manual has been adopted by a variety of agencies including the City. The objective of our SWM quality control will be to ensure MOE's Enhanced Protection. To achieve Enhanced Protection, permanent and temporary control of erosion and sediment transport are proposed and are discussed in the following sections.

### 5.4.1. Stormwater Quality Control During Construction

To ensure stormwater quality control during construction, it is imperative that effective environmental and sedimentation controls be in place throughout the entire area subject to construction activities. With the requirement of earth grading, there will be a potential of soil erosion. It is therefore recommended that the following be implemented to assist in achieving acceptable stormwater runoff quality:

- Restoration of exposed surfaces with vegetation and non-vegetative material as soon as construction schedules permit;
- Installation of temporary sediment ponds, filter strips, silt fences and rock check dams or other similar facilities throughout the site, and specifically during all construction activities;
- Reduce stormwater drainage velocities where possible;
- Ensure that disturbed areas that are left inactive for more than 30 days shall be vegetated and stabilized as instructed by the Engineer;

- Minimize the amount of existing vegetation removed.

### 5.4.2. Permanent Quality Control

The objective of the permanent SWM quality controls will be to ensure MOE's Enhanced Protection. The proposed development will increase the imperviousness of the site. It is important to quantify this increase to evaluate the potential downstream impacts. As per the site's statistics, the post development's Total Imperviousness (TIMP) is:

| | | |
|---|---|---|
| Area of Building | = | 1,890 $m^2$ |
| Area of Asphalt | = | 315 $m^2$ |
| Area of Conc. | = | 257 $m^2$ |
| Area of Interlock | = | 350 $m^2$ |
| Total Area | = | 2,812 $m^2$ |

TIMP = $(A_{BLD} + A_{ASP} + A_{CONC}) / A_{TOTAL}$
= (2,812) / 3,930
= 0.715 (or 72%)

Given the nature of the site, and the favorable on-site soil conditions, it is proposed to utilize Low Impact Development (LID) methods in addition to end of pipe facilities to provide quality control in a treatment train process.

### 5.4.3. LID Facilities

$A_D$ = 3,930 $m^2$

TIMP = 72%

From Table 3.2 (interpolating for TIMP = 72%)

$V_{Req'd}$ = 35.0 $m^3$/ha

= 35.5 $m^3$/ha x 0.39 ha

= 14.0 $m^3$

Therefore, the combined volume of the LID facilities must provide about 14$m^3$ of volume for infiltration to meet MOE Enhanced removal requirements. On-site controls in the form of an Oil Grit Separator followed by an infiltration gallery is an appropriate alternative to addressing quality control for runoff.

### 5.4.4. Infiltration Gallery System

As indicated previously, it is proposed to utilize a GREENSTORM system/infiltration gallery within the landscaped area of the subject site to obtain the required quality control volume. The infiltration gallery will be sized at 3m x 0.5m in cross-sectional area. The total length of the infiltration gallery provided is about 21m. This will provide approximately 30$m^3$ of infiltration volume, which exceeds the MOE requirements of 14.0$m^3$. The infiltration gallery system will be installed at a minimum of 1.0m above the seasonal high groundwater table elevations listed in section 4.6 of the *Geotechnical Report by Cambium, December 22, 2022.* The galleries have been sized to meet the required footprint of 24-48 hour detention time, given the assumed percolation rates of 24mm/hr completed by Cambium. Details pertaining to the infiltration gallery sizing can be found in Appendix A.

### 5.4.5. Oil Grit Separator

A Stormfilter or equivalent treatment unit is proposed in order to treat the stormwater released from this site to the MOE's Enhanced or Level 1 Protection standard. This MOE standard stipulates a Total Suspended Solids (TSS) removal of at least 80%. The CDS2015-4 model will treat the post development flows to the required MOE quality standard, with a TSS removal rate of approximately 86%. The CDS unit will provide TSS removal for all storm flows entering the underground storage system. The design criteria and background information on how the CDS unit is sized is provided within Appendix B.

## 5.5. Water Balance and Volume Control

The proposed development will increase the impervious cover of the site, which decreases the infiltration of groundwater. This decrease in infiltration reduces groundwater recharge and soil moisture replenishment. Paragraph 6.3 of the LSRCA Watershed Development Policies state that "the Stormwater Management plan must make every feasible effort to maintain the pre-development infiltration and evapotranspiration rates and temperatures to the receiving waterbody and watershed". Further, Section 3.2.4 of the LSRCA Technical Guidelines indicate that 25mm of runoff from all impervious surfaces be infiltrated.

Cambium Inc. prepared a Hydrogeological Assessment Report for the subject site. Within this report a water balance assessment was completed. It was determined, through this analysis, that 35% of general roof water for infiltration was required to meet and maintain the existing pre-development infiltration characteristics of the site. It is proposed that a minimum of 10mm of each rainfall event be infiltrated from the rooftop surfaces using an infiltration gallery, which represents 70% of the average annual rainfall. This volume will be retained/treated on site. This volume has been computed as follows:

Volume = Runoff Surfaces X 10mm Event
= (1,890$m^2$) X 0.010m
= **18.9$m^3$**

To attain the 25mm infiltration volume of impervious surfaces we would require about 70 $m^3$ of volume for infiltration. The proposed design meets the pre-development water balance criteria and approximately 29 $m^3$ of infiltration volume has been provided. This is equivalent to about 10.5mm from all impervious surfaces.

## 5.6. Phosphorus Budget

In July 2009, the Lake Simcoe Protection Plan (LSPP) was finalized as a result of a collaboration and partnership among various agencies including, but not limited to, the MOE and the LSRCA. Through the study of Lake Simcoe's ecological health it was determined that there is an over abundance of phosphorus within Lake Simcoe.

As per Section 4.8-DP of the LSPP, new developments are to demonstrate "through an evaluation of anticipated changes in phosphorus loading between the pre & post-development, how the loadings shall be minimized".

We have completed such an analysis and have included our finding below and in Appendix A. The existing site generates approximately 0.07 kg of phosphorous annually (not considering any existing mitigation measures that may currently be in place) and the proposed lands will generate approximately 0.39 kg of phosphorous annually, with the addition of imperviousness. The following chart details the anticipated phosphorous loadings for the pre- and uncontrolled post-development conditions.

| | Total P (kg/yr) |
|---|---|
| Pre-Development | 0.07 |
| Uncontrolled Post Development | 0.39 |

As per the Phosphorous Budget Tool documentation provided by the MOE, the removal efficiency of 87% was selected for the areas draining towards the infiltration galleries. The following chart details the anticipated phosphorous loading for the post-development treated condition. Phosphorous budget calculations have been included in Appendix A.

| | Total P (kg/yr) |
|---|---|
| Controlled Post-Development | 0.17 |

Based on the post development phosphorus release without the presence of BMP's of 0.39 kg annually, and post development release of 0.17 kg annually with the presence of BMP's, the subject site is able to achieve about 56% in total phosphorus reduction. Based on the above calculations there is an anticipated phosphorus release from the site in the amount of 0.17 kg/yr. Phosphorus offset fees in accordance with the LSRCA's phosphorus offsetting policy is calculated as follows:

2.5 * 0.17 kg/yr * $35,000.00 = **$14,875.00.**

## 5.7. Erosion and Sediment Control

To ensure Stormwater runoff quality is controlled during construction, an erosion and sediment control strategy will be implemented to mitigate transportation of silt off-site to the existing roads and sewers. It is imperative that effective controls be put in place and maintained until all areas are stabilized with surface cover.

All erosion and sediment control Best Management Practices (BMP) shall be designed, constructed and maintained in accordance with the LSRCA's erosion control requirements.

Items that will be addressed for both temporary and permanent erosion and sediment controls are based on the following:

- Site location description and area;
- Existing and proposed land use;
- Vegetative cover;
- Existing drainage routes;
- Proposed site works;
- Proposed outlets;
- Permits required;
- Sediment filters and barriers - silt fences;
- Construction entrance location;
- Protection to catch basins and ditch inlets;

To prevent construction generated sediments from entering the storm sewers or leaving the site by overland flow, the following measures should be implemented during the construction phase:

- Temporary sediment control fencing should be erected around the perimeter of the grading activities.
- Temporary sediment fabric and stone filters should be installed on existing and proposed catch basins until surface cover has been stabilized.
- A temporary construction access mud mat should be implemented to reduce the amount of materials that may be transported off site.
- Construction during drier months should be monitored for wind-borne transport of sediments. At the direction of the engineer, the contractor may be directed to water down exposed earth areas with an aqueous solution of calcium chloride.
- All disturbed areas not under immediate construction for 30 days, or not intended for building activities within a 3-month time period, should be stabilized with seeding.

Built up sediment should be removed and disposed off-site at least once a month, or more frequently as directed by the engineer.

## 6. Conclusions

A summary of the servicing recommendations is as follows:

- **Water Servicing** – The development will provide a water service connection to the Residential Condominium by a new internal 50mm diameter potable water service and a 100mm Fire Service which is connected to the existing external 200mm diameter watermain on Essa Road. A *Water Systems Analysis* has yet to be completed by Gerrits Engineering Ltd. for the proposed development. We suggest that the City review the watermain design requirements for this development with respect to the City's water treatment and supply capacities and confirm that capacity allocation is available for this development. Given the size and location of this development, this is not expected to be a concern.
- **Sanitary Servicing** – Serviceability to the subject site can be provided Essa Road. Flows from the development will be collected and then conveyed by gravity, which will flow west towards the existing sanitary line via a proposed maintenance hole structure installed on the existing sanitary service provided to the subject property.
- **Stormwater Drainage and Management** – The SWM facility has been sized to provide for the storage of 1:100 year design storm events. A review of the stormwater management modeling indicates that the proposed development meets design standards and that sufficient volumes are present. An OGS is being proposed to provide the MECP's Enhanced or Level 1 Protection standard. The CDS 2015-4 model will treat the post development flows to the required MOE quality standard, with a TSS removal rate of approximately 86%. Water Balance has been achieved, as well as about 56% reduction in the anticipated offsite phosphorous loading. An offsetting phosphorous loading fee is anticipated since the proposed development will not meet the requirements of the LSRCA.

The preliminary analysis and conceptual design outlined in this report demonstrates that the servicing of this proposed development is feasible and, if based on sound engineering principles, the development will become a cohesive part of the Community of the City of Barrie.

All of which is respectfully submitted,
**Gerrits Engineering Ltd.**

Jeff McCuaig, P.Eng.
Director, Civil Engineer

# Appendix A
# Design Calculations

| | |
|---|---|
| Project: | Proposed Residential Condominium - 582 Essa Road, Barrie, Ontario |
| Project Number | 1760-001 |
| Location | City of Barrie |

## 1 FUS Formula

$$F = 220\ C\ \sqrt{A}$$

where: F = required fire flow in litres per minute
C= the Coefficient related to the type of construction; and
A = the total flow area in square metres (including all storeys but excluding basements at least 50% below grade)

Type of Construction: fire-resistive construction

| | | |
|---|---|---|
| C = | 0.6 | |
| A = | 2835 | Greatest Floor Area + 25% of the two immediately adjoining floors |
| F = | 7028 L/min | |
| | 117 L/s | |

## 2 Occupancy Adjustment

| | | |
|---|---|---|
| Type of Occupancy | Limited Combustible Contents | |
| Hazard Allowance | -15% | |
| Adjusted Fire Flow | | 5974 L/min |

## 3 Sprinkler Adjustment

| | | CREDIT | |
|---|---|---|---|
| NFPA 13 sprinkler standard | Yes | 30% | |
| Standard water supply | Yes | 10% | |
| Fully Supervised system | Yes | 10% | |
| Sprinkler Credit | | | 2987 L/min |

## 4 Exposure Adjustment

| | | Charge | |
|---|---|---|---|
| North Side | 3.1 to 10m | 11% | |
| East Side | >30m | 0% | |
| South Side | 3.1 to 10m | 11% | |
| West Side | 3.1 to 10m | 11% | |
| Exposures Surcharge | | 2319 | L/min |

| | |
|---|---|
| **Total Required Fire Flow** | 5306 L/min |
| | 88.4 L/sec |

**Table 3.2 Water Quality Storage Requirements based on Receiving Waters[1, 2]**

| Protection Level | SWMP Type | Storage Volume (m³/ha) for Impervious Level | | | |
|---|---|---|---|---|---|
| | | 35% | 55% | 70% | 85% |
| *Enhanced* 80% long-term S.S. removal | Infiltration | 25 | 30 | 35 | 40 |
| | Wetlands | 80 | 105 | 120 | 140 |
| | Hybrid Wet Pond/Wetland | 110 | 150 | 175 | 195 |
| | Wet Pond | 140 | 190 | 225 | 250 |
| *Normal* 70% long-term S.S. removal | Infiltration | 20 | 20 | 25 | 30 |
| | Wetlands | 60 | 70 | 80 | 90 |
| | Hybrid Wet Pond/Wetland | 75 | 90 | 105 | 120 |
| | Wet Pond | 90 | 110 | 130 | 150 |
| *Basic* 60% long-term S.S. removal | Infiltration | 20 | 20 | 20 | 20 |
| | Wetlands | 60 | 60 | 60 | 60 |
| | Hybrid Wet Pond/Wetland | 60 | 70 | 75 | 80 |
| | Wet Pond | 60 | 75 | 85 | 95 |
| | Dry Pond (Continuous Flow) | 90 | 150 | 200 | 240 |

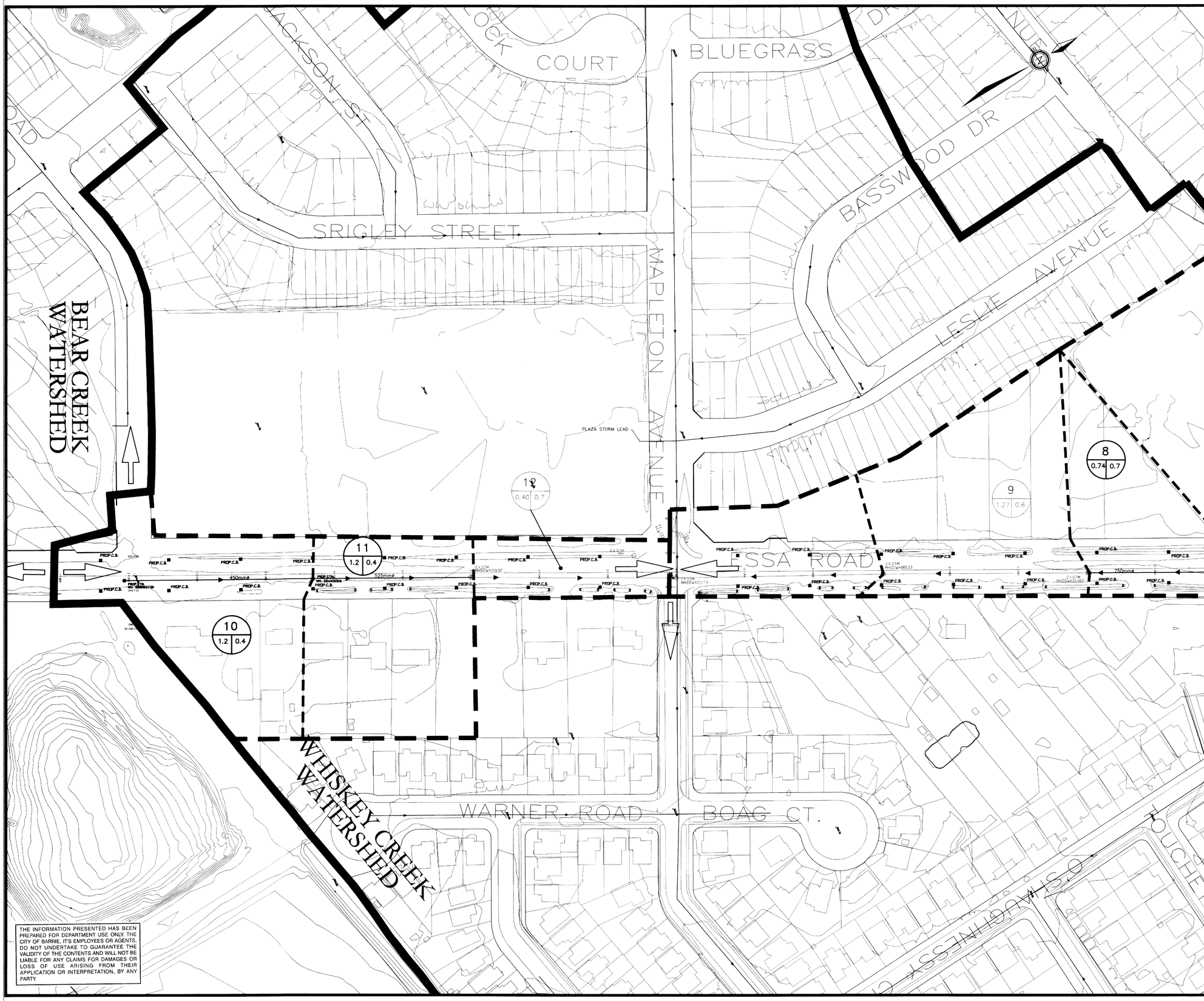
Site Area: 3930 $m^2$

Site Impervious Area: 2755 $m^2$

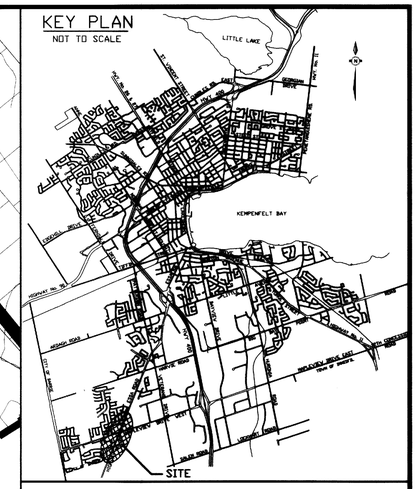
Impervious Level of Site: 70.1%

Volume Req'd for Quality Control: 35.0 $m^3$/ha

Volume Required: 13.8 $m^3$




KEY PLAN
NOT TO SCALE




## STORM LEGEND

- WATERCOURSE/FLOW DIRECTION
- DRAINAGE BOUNDARY
- CATCHMENT BOUNDARY
- CATCHMENT BOUNDARY OUTSIDE PRESENT CONTRACT
- SUB-CATCHMENT BOUNDARY
- MAJOR SYSTEM FLOW
- EXISTING STORM SEWER AND MAINTENANCE HOLE

EXISTING: 1 (2.45 | 0.70) — SUBCATCHMENT; AREA (ha) — RUNOFF COEFFICIENT

PROPOSED: 1 (2.45 | 0.70) — SUBCATCHMENT; AREA (ha) — RUNOFF COEFFICIENT

- XXXmmø — PROPOSED STORM SEWER
- CONSTRUCTED STORM SEWER
- PROP.STM. MH1DSWV171 — PROPOSED STORM MAINTENANCE HOLE
- CONSTRUCTED STORM MAINTENANCE HOLE
- PROP.C.B. — PROPOSED CATCH BASIN
- PROP.D.C.B. — PROPOSED DOUBLE CATCH BASIN
- PROP. D.I.C.B. — PROPOSED DITCH INLET CATCH BASIN

| NO. | REVISIONS | DATE | APPROVED |
|---|---|---|---|
| 0 | ISSUED FOR TENDER | 14/15 | DMJ |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

CITY OF BARRIE
APPROVED
DATE: Jan 26, 2015
DIRECTOR OF ENGINEERING

LICENCED PROFESSIONAL ENGINEER
D. M. JAMES
21723010
26/01/15
PROVINCE OF ONTARIO

# ESSA ROAD IMPROVEMENTS

## STORM DRAINAGE AREA PLAN

*The City of* BARRIE
ENGINEERING DEPARTMENT

| | | | |
|---|---|---|---|
| SCALE HOR. | 1:1000 | VERT. | --- |
| DESIGN | J.P.R. | DRAWN | J.P.R. |
| REVIEWED | D.M.J. | DATE | 2014.12.12 |

DRAWING NO. 2015-004
SHEET NO. STM2

2015-400-004

## Calculation of Weighted Runoff Coefficient

**Pre/Post Development Areas and Sub-Areas**

| Area ID | Total Area | 0.10 Undeveloped Lands | 0.08 Treed | 0.95 Asphalt | 0.95 Building Roof | 0.60 Gravel | 0.95 Concrete | 0.95 Interlocking Pavement | Weighted Rational Coefficient |
|---|---|---|---|---|---|---|---|---|---|
| **Post-Development** | 3930 | 1118 | 0 | 315 | 1890 | 0 | 257 | 350 | 0.71 |
| P-1 | 1890 | 0 | 0 | 0 | 1890 | 0 | 0 | 0 | 0.95 |
| P-2 | 230 | 148 | 0 | 0 | 0 | 0 | 82 | 0 | 0.40 |
| P-3 | 290 | 285 | 0 | 0 | 0 | 0 | 5 | 0 | 0.11 |
| P-4 | 765 | 110 | 0 | 250 | 0 | 0 | 55 | 350 | 0.83 |
| P-5 | 100 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0.10 |
| P-6 | 655 | 475 | 0 | 65 | 0 | 0 | 115 | 0 | 0.33 |
| **Uncontrolled (P-2, P-3 and P-6)** | 1175 | 908 | 0 | 65 | 0 | 0 | 202 | 0 | 0.29 |
| **Controlled SWM Tank (P-1, P-4 and P-5)** | 2755 | 210 | 0 | 250 | 1890 | 0 | 55 | 350 | 0.89 |

## Pre-Development Runoff Calculation

**X-1 - Essa Road**

| | | | |
|---|---|---|---|
| Area | 0.39 | ha | |
| Runoff Coefficient | 0.40 | | |
| Time of Concentration | 10 | min | |
| | Interpolated | | |
| Return Rate | 2 | year | |
| Coefficient | 1 | | |
| Rainfall Intesity | 83.1 | mm/hr | |
| Allowable Release Rate | 0.04 | $m^3/s$ | 36 L/s |
| Return Rate | 5 | year | |
| Coefficient | 1 | | |
| Rainfall Intesity | 109.1 | mm/hr | |
| Allowable Release Rate | 0.05 | $m^3/s$ | 48 L/s |
| Return Rate | 10 | year | |
| Coefficient | 1 | | |
| Rainfall Intesity | 126.4 | mm/hr | |
| Allowable Release Rate | 0.06 | $m^3/s$ | 55 L/s |
| Return Rate | 25 | year | |
| Coefficient | 1.1 | | |
| Rainfall Intesity | 148.3 | mm/hr | |
| Allowable Release Rate | 0.07 | $m^3/s$ | 71 L/s |
| Return Rate | 50 | year | |
| Coefficient | 1.2 | | |
| Rainfall Intesity | 164.1 | mm/hr | |
| Allowable Release Rate | 0.09 | $m^3/s$ | 86 L/s |
| Return Rate | 100 | year | |
| Coefficient | 1.25 | | |
| Rainfall Intesity | 180.4 | mm/hr | |
| Allowable Release Rate | 0.10 | $m^3/s$ | 98 L/s |

| Storm (yrs) | Coeff A | Coeff B | Coeff C |
|---|---|---|---|
| 2 | **675.6** | **4.681** | **0.78** |
| 5 | **843.0** | **4.582** | **0.763** |
| 10 | **976.9** | **4.745** | **0.76** |
| 25 | **1133.1** | **4.734** | **0.756** |
| 50 | **1251.5** | **4.847** | **0.753** |
| 100 | **1383.6** | **4.905** | **0.754** |

Modified Rational Method

$$Q = C_i C I A / 360$$

Where:

| | |
|---|---|
| Q - | Flow Rate (m3/s) |
| Ci - | Peaking Coefficient |
| C - | Rational Method Runoff Coefficient |
| I - | Storm Intensity (mm/hr) |
| A - | Area (ha.) |

# Gerrits
## Engineering Limited

### Post Development Runoff Calculation

**West Nipissing OPP**

| | | | |
|---|---|---|---|
| Area | 0.39 | ha | |
| Runoff Coefficient | 0.71 | | |
| Time of Concentration | 10 | min | |
| | Interpolated | | |
| Return Rate | 2 | year | |
| Coefficient | 1 | | |
| Rainfall Intesity | 83.1 | mm/hr | |
| Allowable Release Rate | 0.06 | $m^3/s$ | 64 L/s |
| Return Rate | 5 | year | |
| Coefficient | 1 | | |
| Rainfall Intesity | 109.1 | mm/hr | |
| Allowable Release Rate | 0.08 | $m^3/s$ | 84 L/s |
| Return Rate | 10 | year | |
| Coefficient | 1 | | |
| Rainfall Intesity | 126.4 | mm/hr | |
| Allowable Release Rate | 0.10 | $m^3/s$ | 98 L/s |
| Return Rate | 25 | year | |
| Coefficient | 1.1 | | |
| Rainfall Intesity | 148.3 | mm/hr | |
| Allowable Release Rate | 0.13 | $m^3/s$ | 126 L/s |
| Return Rate | 50 | year | |
| Coefficient | 1.2 | | |
| Rainfall Intesity | 164.1 | mm/hr | |
| Allowable Release Rate | 0.15 | $m^3/s$ | 152 L/s |
| Return Rate | 100 | year | |
| Coefficient | 1.25 | | |
| Rainfall Intesity | 180.4 | mm/hr | |
| Allowable Release Rate | 0.17 | $m^3/s$ | 174 L/s |

| Storm (yrs) | Coeff A | Coeff B | Coeff C |
|---|---|---|---|
| 2 | **675.6** | **4.681** | **0.78** |
| 5 | **843.0** | **4.582** | **0.763** |
| 10 | **976.9** | **4.745** | **0.76** |
| 25 | **1133.1** | **4.734** | **0.756** |
| 50 | **1251.5** | **4.847** | **0.753** |
| 100 | **1383.6** | **4.905** | **0.754** |

Modified Rational Method

$Q = C_i CIA / 360$

Where:

| | |
|---|---|
| Q - | Flow Rate (m3/s) |
| Ci - | Peaking Coefficient |
| C - | Rational Method Runoff Coefficient |
| I - | Storm Intensity (mm/hr) |
| A - | Area (ha.) |

**Gerrits**
**Engineering Limited**

## Post Development Runoff Calculation

**Controlled (P-1, P-4 and P-5)**

| | | | |
|---|---|---|---|
| Area | 0.28 | ha | |
| Runoff Coefficient | 0.89 | | |
| Time of Concentration | 10 | min | |
| | Interpolated | | |
| Return Rate | 2 | year | |
| Coefficient | 1 | | |
| Rainfall Intesity | 83.1 | mm/hr | |
| Allowable Release Rate | 0.06 | $m^3/s$ | 56.30 L/s |
| Return Rate | 5 | year | |
| Coefficient | 1 | | |
| Rainfall Intesity | 109.1 | mm/hr | |
| Allowable Release Rate | 0.07 | $m^3/s$ | 73.91 L/s |
| Return Rate | 10 | year | |
| Coefficient | 1 | | |
| Rainfall Intesity | 126.4 | mm/hr | |
| Allowable Release Rate | 0.09 | $m^3/s$ | 85.61 L/s |
| Return Rate | 25 | year | |
| Coefficient | 1.1 | | |
| Rainfall Intesity | 148.3 | mm/hr | |
| Allowable Release Rate | 0.11 | $m^3/s$ | 110.48 L/s |
| Return Rate | 50 | year | |
| Coefficient | 1.2 | | |
| Rainfall Intesity | 164.1 | mm/hr | |
| Allowable Release Rate | 0.13 | $m^3/s$ | 133.42 L/s |
| Return Rate | 100 | year | |
| Coefficient | 1.25 | | |
| Rainfall Intesity | 180.4 | mm/hr | |
| Allowable Release Rate | 0.15 | $m^3/s$ | 152.79 L/s |

**Uncontrolled (P-2, P-3 and P-6)**

| | | | |
|---|---|---|---|
| Area | 0.118 | ha | |
| Runoff Coefficient | 0.29 | | |
| Time of Concentration | 10 | min | |
| | Interpolated | | |
| Return Rate | 2 | year | |
| Coefficient | 1 | | |
| Rainfall Intesity | 83.1 | mm/hr | |
| Allowable Release Rate | 0.01 | $m^3/s$ | 7.95 L/s |
| Return Rate | 5 | year | |
| Coefficient | 1 | | |
| Rainfall Intesity | 109.1 | mm/hr | |
| Allowable Release Rate | 0.01 | $m^3/s$ | 10.44 L/s |
| Return Rate | 10 | year | |
| Coefficient | 1 | | |
| Rainfall Intesity | 126.4 | mm/hr | |
| Allowable Release Rate | 0.01 | $m^3/s$ | 12.09 L/s |
| Return Rate | 25 | year | |
| Coefficient | 1.1 | | |
| Rainfall Intesity | 148.3 | mm/hr | |
| Allowable Release Rate | 0.02 | $m^3/s$ | 15.60 L/s |
| Return Rate | 50 | year | |
| Coefficient | 1.2 | | |
| Rainfall Intesity | 164.1 | mm/hr | |
| Allowable Release Rate | 0.02 | $m^3/s$ | 18.84 L/s |
| Return Rate | 100 | year | |
| Coefficient | 1.25 | | |
| Rainfall Intesity | 180.4 | mm/hr | |
| Allowable Release Rate | 0.02 | $m^3/s$ | 21.58 L/s |

| Storm (yrs) | Coeff A | Coeff B | Coeff C |
|---|---|---|---|
| 2 | **675.6** | **4.681** | **0.78** |
| 5 | **843.0** | **4.582** | **0.763** |
| 10 | **976.9** | **4.745** | **0.76** |
| 25 | **1133.1** | **4.734** | **0.756** |
| 50 | **1251.5** | **4.847** | **0.753** |
| 100 | **1383.6** | **4.905** | **0.754** |

Modified Rational Method

$$Q = C_iCIA / 360$$

Where:

- Q - Flow Rate (m3/s)
- Ci - Peaking Coefficient
- C - Rational Method Runoff Coefficient
- I - Storm Intensity (mm/hr)
- A - Area (ha.)

STAGE - STORAGE - DISCHARGE - Subsurface/Surface Storage

| Elevation (m) | Area ($m^2$) | Vol. ($m^3$) | Cum. Volume ($m^3$) | Storage Vol. Above Orifice ($m^3$) | Depth 1 (m) | Flow ($m^3/s$) | Depth 2 (m) | Flow ($m^3/s$) | Total Flow ($m^3/s$) |
|---|---|---|---|---|---|---|---|---|---|
| 312.65 | 70 | 0 | 0 | 0 | 0.015 | 0.0077 | 0.000 | 0.0000 | 0.0077 |
| 312.85 | 70 | 13.7 | 14 | 14 | 0.215 | 0.0290 | 0.000 | 0.0000 | 0.0290 |
| 313.05 | 70 | 13.7 | 27 | 27 | 0.415 | 0.0403 | 0.000 | 0.0000 | 0.0403 |
| 313.25 | 70 | 13.7 | 41 | 41 | 0.615 | 0.0491 | 0.000 | 0.0000 | 0.0491 |
| 313.45 | 70 | 13.7 | 55 | 55 | 0.815 | 0.0565 | 0.000 | 0.0000 | 0.0565 |
| 313.65 | 70 | 13.7 | 69 | 69 | 1.015 | 0.0631 | 0.000 | 0.0000 | 0.0631 |

| Orifice 1 | |
|---|---|
| Diameter | 150 mm |
| Elevation | 312.56 m |
| Orifice Constant | 0.8 |
| Orifice Centroid | 312.64 m |

| | |
|---|---|
| | |

**Rectangular C Equation**

**y=(a+bx)/(1+cx+dx^2)**

| | |
|---|---|
| **a** | **-1.04E+04** |
| **b** | **3.42E+06** |
| **c** | **2.13E+06** |
| **d** | **-2.35E+05** |

Underground Storage

| Elevation (m) | Outflow (m3/sec) | Storage (m3) | Storage (ha - m) |
|---|---|---|---|
| 312.65 | 0 | 0 | 0 |
| 312.85 | 0.029 | 14 | 0.0014 |
| 313.05 | 0.040 | 27 | 0.0027 |
| 313.25 | 0.049 | 41 | 0.0041 |
| 313.45 | 0.057 | 55 | 0.0055 |
| 313.65 | 0.063 | 69 | 0.0069 |
| 0.00 | 0.000 | 0 | 0.0000 |

Pre/Post Flows and Storage

| Year | Pre | Post | Storage |
|---|---|---|---|
| 2 | 36 | 36 | 16 |
| 5 | 48 | 42 | 22 |
| 10 | 55 | 46 | 27 |
| 25 | 71 | 55 | 37 |
| 50 | 86 | 62 | 46 |
| 100 | 98 | 68 | 55 |

**CHECKING STORAGE RELEASE CHARACTERISTICS OF SUBSURFACE STORAGE GALLERIES**
**- MTO IDF EQUATIONS -**

**Controlled Release from Site**

| | | |
|---|---|---|
| 100 Year Post Development Flow | 152.792 | L/sec |
| Storm Duration | 20 | min |

**Pond Rating Curve**

| Elevation (m) | Outflow (L/sec) | Storage (ha - m) | Storage (L) |
|---|---|---|---|
| 312.65 | 0.01 | 0.0000 | 0.00 |
| 312.85 | 29.04 | 0.0014 | 13720.00 |
| 313.05 | 40.34 | 0.0027 | 27440.00 |
| 313.25 | 49.11 | 0.0041 | 41160.00 |
| 313.45 | 56.53 | 0.0055 | 54880.00 |
| 313.65 | 63.09 | 0.0069 | 68600.00 |
| 0.00 | 0.00 | 0.0000 | 0.00 |

**Hydrograph Data**

| Minute | In Flow | Out Flow | Del_Storage | Cumulative Storage |
|---|---|---|---|---|
| | (L/sec) | (L/sec) | (L) | (L) |
| (1) | (2) | (4) | (5) | (6) |
| 0 | 0.00 | 0.000 | 0 | 0 |
| 1 | 15.28 | 0.000 | 917 | 917 |
| 2 | 30.56 | 1.940 | 1717 | 2634 |
| 3 | 45.84 | 5.573 | 2416 | 5050 |
| 4 | 61.12 | 10.684 | 3026 | 8076 |
| 5 | 76.40 | 17.086 | 3559 | 11634 |
| 6 | 91.68 | 24.615 | 4024 | 15658 |
| 7 | 106.95 | 30.632 | 4579 | 20237 |
| 8 | 122.23 | 34.405 | 5270 | 25507 |
| 9 | 137.51 | 38.747 | 5926 | 31433 |
| 10 | 152.79 | 42.892 | 6594 | 38027 |
| 11 | 137.51 | 47.106 | 5424 | 43451 |
| 12 | 122.23 | 50.348 | 4313 | 47765 |
| 13 | 106.95 | 52.681 | 3256 | 51021 |
| 14 | 91.68 | 54.443 | 2234 | 53255 |
| 15 | 76.40 | 55.652 | 1245 | 54500 |
| 16 | 61.12 | 56.326 | 287 | 54787 |
| 17 | 45.84 | 56.481 | -639 | 54148 |
| 18 | 30.56 | 56.136 | -1535 | 52614 |
| 19 | 15.28 | 55.305 | -2402 | 50212 |
| 20 | 0.00 | 54.006 | -3240 | 46972 |
| 22 | 0.00 | 52.252 | -6270 | 40702 |
| 24 | 0.00 | 48.815 | -5858 | 34844 |
| 26 | 0.00 | 45.071 | -5409 | 29435 |
| 28 | 0.00 | 41.615 | -4994 | 24441 |
| 30 | 0.00 | 37.869 | -4544 | 19897 |
| 32 | 0.00 | 34.125 | -4095 | 15802 |
| 34 | 0.00 | 30.751 | -3690 | 12112 |
| 36 | 0.00 | 25.626 | -3075 | 9037 |
| 38 | 0.00 | 19.120 | -2294 | 6743 |
| 40 | 0.00 | 14.265 | -1712 | 5031 |
| 45 | 0.00 | 10.644 | -3193 | 1838 |
| 50 | 0.00 | 3.888 | -1166 | 671 |
| 55 | 0.00 | 1.420 | -426 | 245 |
| 60 | 0.00 | 0.519 | -156 | 90 |
| 65 | 0.00 | 0.189 | -57 | 33 |
| 70 | 0.00 | 0.069 | -21 | 12 |
| 75 | 0.00 | 0.025 | -8 | 4 |
| 80 | 0.00 | 0.009 | -3 | 2 |
| 85 | 0.00 | 0.003 | -1 | 1 |
| 90 | 0.00 | 0.001 | 0 | 0 |
| 95 | 0.00 | 0.000 | 0 | 0 |
| 100 | 0.00 | 0.000 | 0 | 0 |

**Uncontrolled Release from Site**

| | | |
|---|---|---|
| 100 Year Post Development Flow | 21.580 | L/sec |
| Storm Duration | 20 | min |

**Hydrograph Data**

| Minute | In Flow | Out Flow |
|---|---|---|
| | (L/sec) | (L/sec) |
| (1) | (2) | (4) |
| 0 | 0.00 | 0.000 |
| 1 | 2.16 | 2.158 |
| 2 | 4.32 | 4.316 |
| 3 | 6.47 | 6.474 |
| 4 | 8.63 | 8.632 |
| 5 | 10.79 | 10.790 |
| 6 | 12.95 | 12.948 |
| 7 | 15.11 | 15.106 |
| 8 | 17.26 | 17.264 |
| 9 | 19.42 | 19.422 |
| 10 | 21.58 | 21.580 |
| 11 | 19.42 | 19.422 |
| 12 | 17.26 | 17.264 |
| 13 | 15.11 | 15.106 |
| 14 | 12.95 | 12.948 |
| 15 | 10.79 | 10.790 |
| 16 | 8.63 | 8.632 |
| 17 | 6.47 | 6.474 |
| 18 | 4.32 | 4.316 |
| 19 | 2.16 | 2.158 |
| 20 | 0.00 | 0.000 |
| 22 | 0.00 | 0.000 |
| 24 | 0.00 | 0.000 |
| 26 | 0.00 | 0.000 |
| 28 | 0.00 | 0.000 |
| 30 | 0.00 | 0.000 |
| 32 | 0.00 | 0.000 |
| 34 | 0.00 | 0.000 |
| 36 | 0.00 | 0.000 |
| 38 | 0.00 | 0.000 |
| 40 | 0.00 | 0.000 |
| 45 | 0.00 | 0.000 |
| 50 | 0.00 | 0.000 |
| 55 | 0.00 | 0.000 |
| 60 | 0.00 | 0.000 |
| 65 | 0.00 | 0.000 |
| 70 | 0.00 | 0.000 |
| 75 | 0.00 | 0.000 |
| 80 | 0.00 | 0.000 |
| 85 | 0.00 | 0.000 |
| 90 | 0.00 | 0.000 |
| 95 | 0.00 | 0.000 |
| 100 | 0.00 | 0.000 |

**Total Release From Site**

| Minute | Outflow Flow | Cumulative Storage |
|---|---|---|
| | (L/sec) | (L) |
| (1) | (6) | (6) |
| 0 | 0 | 0 |
| 1 | 2 | 917 |
| 2 | 6 | 2634 |
| 3 | 12 | 5050 |
| 4 | 19 | 8076 |
| 5 | 28 | 11634 |
| 6 | 38 | 15658 |
| 7 | 46 | 20237 |
| 8 | 52 | 25507 |
| 9 | 58 | 31433 |
| 10 | 64 | 38027 |
| 11 | 67 | 43451 |
| 12 | 68 | 47765 |
| 13 | 68 | 51021 |
| 14 | 67 | 53255 |
| 15 | 66 | 54500 |
| 16 | 65 | 54787 |
| 17 | 63 | 54148 |
| 18 | 60 | 52614 |
| 19 | 57 | 50212 |
| 20 | 54 | 46972 |
| 22 | 52 | 40702 |
| 24 | 49 | 34844 |
| 26 | 45 | 29435 |
| 28 | 42 | 24441 |
| 30 | 38 | 19897 |
| 32 | 34 | 15802 |
| 34 | 31 | 12112 |
| 36 | 26 | 9037 |
| 38 | 19 | 6743 |
| 40 | 14 | 5031 |
| 45 | 11 | 1838 |
| 50 | 4 | 671 |
| 55 | 1 | 245 |
| 60 | 1 | 90 |
| 65 | 0 | 33 |
| 70 | 0 | 12 |
| 75 | 0 | 4 |
| 80 | 0 | 2 |
| 85 | 0 | 1 |
| 90 | 0 | 0 |
| 95 | 0 | 0 |
| 100 | 0 | 0 |

**CHECKING STORAGE RELEASE CHARACTERISTICS OF SUBSURFACE STORAGE GALLERIES**
**- MTO IDF EQUATIONS -**

**Controlled Release from Site**

| | | |
|---|---|---|
| 50 Year Post Development Flow | 133.421 | L/sec |
| Storm Duration | 20 | min |

**Uncontrolled Release from Site**

| | | |
|---|---|---|
| 50 Year Post Development Flow | 18.844 | L/sec |
| Storm Duration | 20 | min |

**Pond Rating Curve**

| Elevation (m) | Outflow (L/sec) | Storage (ha - m) | Storage (L) |
|---|---|---|---|
| 312.65 | 0.01 | 0.0000 | 0.00 |
| 312.85 | 29.04 | 0.0014 | 13720.00 |
| 313.05 | 40.34 | 0.0027 | 27440.00 |
| 313.25 | 49.11 | 0.0041 | 41160.00 |
| 313.45 | 56.53 | 0.0055 | 54880.00 |
| 313.65 | 63.09 | 0.0069 | 68600.00 |
| 0.00 | 0.00 | 0.0000 | 0.00 |

**Hydrograph Data**

| Minute | In Flow | Out Flow | Del_Storage | Cumulative Storage |
|---|---|---|---|---|
| | (L/sec) | (L/sec) | (L) | (L) |
| (1) | (2) | (4) | (5) | (6) |
| 0 | 0.00 | 0.000 | 0 | 0 |
| 1 | 13.34 | 0.000 | 801 | 801 |
| 2 | 26.68 | 1.694 | 1499 | 2300 |
| 3 | 40.03 | 4.866 | 2110 | 4410 |
| 4 | 53.37 | 9.329 | 2642 | 7052 |
| 5 | 66.71 | 14.920 | 3107 | 10159 |
| 6 | 80.05 | 21.494 | 3513 | 13673 |
| 7 | 93.39 | 28.928 | 3868 | 17541 |
| 8 | 106.74 | 32.184 | 4473 | 22014 |
| 9 | 120.08 | 35.869 | 5053 | 27067 |
| 10 | 133.42 | 40.032 | 5603 | 32670 |
| 11 | 120.08 | 43.682 | 4584 | 37254 |
| 12 | 106.74 | 46.611 | 3608 | 40861 |
| 13 | 93.39 | 48.917 | 2669 | 43530 |
| 14 | 80.05 | 50.390 | 1780 | 45310 |
| 15 | 66.71 | 51.353 | 921 | 46231 |
| 16 | 53.37 | 51.852 | 91 | 46322 |
| 17 | 40.03 | 51.901 | -712 | 45610 |
| 18 | 26.68 | 51.515 | -1490 | 44120 |
| 19 | 13.34 | 50.709 | -2242 | 41878 |
| 20 | 0.00 | 49.496 | -2970 | 38908 |
| 22 | 0.00 | 47.668 | -5720 | 33188 |
| 24 | 0.00 | 44.013 | -5282 | 27906 |
| 26 | 0.00 | 40.638 | -4877 | 23030 |
| 28 | 0.00 | 36.706 | -4405 | 18625 |
| 30 | 0.00 | 33.077 | -3969 | 14656 |
| 32 | 0.00 | 29.807 | -3577 | 11079 |
| 34 | 0.00 | 23.440 | -2813 | 8266 |
| 36 | 0.00 | 17.489 | -2099 | 6167 |
| 38 | 0.00 | 13.049 | -1566 | 4602 |
| 40 | 0.00 | 9.736 | -1168 | 3433 |
| 45 | 0.00 | 7.264 | -2179 | 1254 |
| 50 | 0.00 | 2.653 | -796 | 458 |
| 55 | 0.00 | 0.969 | -291 | 167 |
| 60 | 0.00 | 0.354 | -106 | 61 |
| 65 | 0.00 | 0.129 | -39 | 22 |
| 70 | 0.00 | 0.047 | -14 | 8 |
| 75 | 0.00 | 0.017 | -5 | 3 |
| 80 | 0.00 | 0.006 | -2 | 1 |
| 85 | 0.00 | 0.002 | -1 | 0 |
| 90 | 0.00 | 0.001 | 0 | 0 |
| 95 | 0.00 | 0.000 | 0 | 0 |
| 100 | 0.00 | 0.000 | 0 | 0 |

**Hydrograph Data**

| Minute | In Flow | Out Flow |
|---|---|---|
| | (L/sec) | (L/sec) |
| (1) | (2) | (4) |
| 0 | 0.00 | 0.000 |
| 1 | 1.88 | 1.884 |
| 2 | 3.77 | 3.769 |
| 3 | 5.65 | 5.653 |
| 4 | 7.54 | 7.538 |
| 5 | 9.42 | 9.422 |
| 6 | 11.31 | 11.307 |
| 7 | 13.19 | 13.191 |
| 8 | 15.08 | 15.076 |
| 9 | 16.96 | 16.960 |
| 10 | 18.84 | 18.844 |
| 11 | 16.96 | 16.960 |
| 12 | 15.08 | 15.076 |
| 13 | 13.19 | 13.191 |
| 14 | 11.31 | 11.307 |
| 15 | 9.42 | 9.422 |
| 16 | 7.54 | 7.538 |
| 17 | 5.65 | 5.653 |
| 18 | 3.77 | 3.769 |
| 19 | 1.88 | 1.884 |
| 20 | 0.00 | 0.000 |
| 22 | 0.00 | 0.000 |
| 24 | 0.00 | 0.000 |
| 26 | 0.00 | 0.000 |
| 28 | 0.00 | 0.000 |
| 30 | 0.00 | 0.000 |
| 32 | 0.00 | 0.000 |
| 34 | 0.00 | 0.000 |
| 36 | 0.00 | 0.000 |
| 38 | 0.00 | 0.000 |
| 40 | 0.00 | 0.000 |
| 45 | 0.00 | 0.000 |
| 50 | 0.00 | 0.000 |
| 55 | 0.00 | 0.000 |
| 60 | 0.00 | 0.000 |
| 65 | 0.00 | 0.000 |
| 70 | 0.00 | 0.000 |
| 75 | 0.00 | 0.000 |
| 80 | 0.00 | 0.000 |
| 85 | 0.00 | 0.000 |
| 90 | 0.00 | 0.000 |
| 95 | 0.00 | 0.000 |
| 100 | 0.00 | 0.000 |

**Total Release From Site**

| Minute | Outflow Flow | Cumulative Storage |
|---|---|---|
| | (L/sec) | (L) |
| (1) | (6) | (6) |
| 0 | 0 | 0 |
| 1 | 2 | 801 |
| 2 | 5 | 2300 |
| 3 | 11 | 4410 |
| 4 | 17 | 7052 |
| 5 | 24 | 10159 |
| 6 | 33 | 13673 |
| 7 | 42 | 17541 |
| 8 | 47 | 22014 |
| 9 | 53 | 27067 |
| 10 | 59 | 32670 |
| 11 | 61 | 37254 |
| 12 | 62 | 40861 |
| 13 | 62 | 43530 |
| 14 | 62 | 45310 |
| 15 | 61 | 46231 |
| 16 | 59 | 46322 |
| 17 | 58 | 45610 |
| 18 | 55 | 44120 |
| 19 | 53 | 41878 |
| 20 | 49 | 38908 |
| 22 | 48 | 33188 |
| 24 | 44 | 27906 |
| 26 | 41 | 23030 |
| 28 | 37 | 18625 |
| 30 | 33 | 14656 |
| 32 | 30 | 11079 |
| 34 | 23 | 8266 |
| 36 | 17 | 6167 |
| 38 | 13 | 4602 |
| 40 | 10 | 3433 |
| 45 | 7 | 1254 |
| 50 | 3 | 458 |
| 55 | 1 | 167 |
| 60 | 0 | 61 |
| 65 | 0 | 22 |
| 70 | 0 | 8 |
| 75 | 0 | 3 |
| 80 | 0 | 1 |
| 85 | 0 | 0 |
| 90 | 0 | 0 |
| 95 | 0 | 0 |
| 100 | 0 | 0 |

**CHECKING STORAGE RELEASE CHARACTERISTICS OF SUBSURFACE STORAGE GALLERIES**
**- MTO IDF EQUATIONS -**

**Controlled Release from Site**

| | | |
|---|---|---|
| 25 Year Post Development Flow | 110.480 | L/sec |
| Storm Duration | 20 | min |

**Pond Rating Curve**

| Elevation (m) | Outflow (L/sec) | Storage (ha - m) | Storage (L) |
|---|---|---|---|
| 312.65 | 0.01 | 0.0000 | 0.00 |
| 312.85 | 29.04 | 0.0014 | 13720.00 |
| 313.05 | 40.34 | 0.0027 | 27440.00 |
| 313.25 | 49.11 | 0.0041 | 41160.00 |
| 313.45 | 56.53 | 0.0055 | 54880.00 |
| 313.65 | 63.09 | 0.0069 | 68600.00 |
| 0.00 | 0.00 | 0.0000 | 0.00 |

**Hydrograph Data**

| Minute | In Flow | Out Flow | Del_Storage | Cumulative Storage |
|---|---|---|---|---|
| | (L/sec) | (L/sec) | (L) | (L) |
| (1) | (2) | (4) | (5) | (6) |
| 0 | 0.00 | 0.000 | 0 | 0 |
| 1 | 11.05 | 0.000 | 663 | 663 |
| 2 | 22.10 | 1.402 | 1242 | 1904 |
| 3 | 33.14 | 4.029 | 1747 | 3651 |
| 4 | 44.19 | 7.725 | 2188 | 5839 |
| 5 | 55.24 | 12.355 | 2573 | 8412 |
| 6 | 66.29 | 17.799 | 2909 | 11322 |
| 7 | 77.34 | 23.954 | 3203 | 14525 |
| 8 | 88.38 | 29.699 | 3521 | 18046 |
| 9 | 99.43 | 32.600 | 4010 | 22056 |
| 10 | 110.48 | 35.904 | 4475 | 26530 |
| 11 | 99.43 | 39.591 | 3590 | 30121 |
| 12 | 88.38 | 42.053 | 2780 | 32901 |
| 13 | 77.34 | 43.830 | 2010 | 34911 |
| 14 | 66.29 | 45.114 | 1270 | 36182 |
| 15 | 55.24 | 45.926 | 559 | 36740 |
| 16 | 44.19 | 46.283 | -125 | 36615 |
| 17 | 33.14 | 46.203 | -784 | 35831 |
| 18 | 22.10 | 45.702 | -1416 | 34415 |
| 19 | 11.05 | 44.797 | -2025 | 32390 |
| 20 | 0.00 | 43.503 | -2610 | 29780 |
| 22 | 0.00 | 41.835 | -5020 | 24760 |
| 24 | 0.00 | 38.132 | -4576 | 20184 |
| 26 | 0.00 | 34.361 | -4123 | 16060 |
| 28 | 0.00 | 30.964 | -3716 | 12345 |
| 30 | 0.00 | 26.118 | -3134 | 9211 |
| 32 | 0.00 | 19.487 | -2338 | 6872 |
| 34 | 0.00 | 14.540 | -1745 | 5127 |
| 36 | 0.00 | 10.848 | -1302 | 3826 |
| 38 | 0.00 | 8.094 | -971 | 2854 |
| 40 | 0.00 | 6.039 | -725 | 2130 |
| 45 | 0.00 | 4.506 | -1352 | 778 |
| 50 | 0.00 | 1.646 | -494 | 284 |
| 55 | 0.00 | 0.601 | -180 | 104 |
| 60 | 0.00 | 0.220 | -66 | 38 |
| 65 | 0.00 | 0.080 | -24 | 14 |
| 70 | 0.00 | 0.029 | -9 | 5 |
| 75 | 0.00 | 0.011 | -3 | 2 |
| 80 | 0.00 | 0.004 | -1 | 1 |
| 85 | 0.00 | 0.001 | 0 | 0 |
| 90 | 0.00 | 0.001 | 0 | 0 |
| 95 | 0.00 | 0.000 | 0 | 0 |
| 100 | 0.00 | 0.000 | 0 | 0 |

**Uncontrolled Release from Site**

| | | |
|---|---|---|
| 25 Year Post Development Flow | 15.604 | L/sec |
| Storm Duration | 20 | min |

**Hydrograph Data**

| Minute | In Flow | Out Flow |
|---|---|---|
| | (L/sec) | (L/sec) |
| (1) | (2) | (4) |
| 0 | 0.00 | 0.000 |
| 1 | 1.56 | 1.560 |
| 2 | 3.12 | 3.121 |
| 3 | 4.68 | 4.681 |
| 4 | 6.24 | 6.242 |
| 5 | 7.80 | 7.802 |
| 6 | 9.36 | 9.363 |
| 7 | 10.92 | 10.923 |
| 8 | 12.48 | 12.483 |
| 9 | 14.04 | 14.044 |
| 10 | 15.60 | 15.604 |
| 11 | 14.04 | 14.044 |
| 12 | 12.48 | 12.483 |
| 13 | 10.92 | 10.923 |
| 14 | 9.36 | 9.363 |
| 15 | 7.80 | 7.802 |
| 16 | 6.24 | 6.242 |
| 17 | 4.68 | 4.681 |
| 18 | 3.12 | 3.121 |
| 19 | 1.56 | 1.560 |
| 20 | 0.00 | 0.000 |
| 22 | 0.00 | 0.000 |
| 24 | 0.00 | 0.000 |
| 26 | 0.00 | 0.000 |
| 28 | 0.00 | 0.000 |
| 30 | 0.00 | 0.000 |
| 32 | 0.00 | 0.000 |
| 34 | 0.00 | 0.000 |
| 36 | 0.00 | 0.000 |
| 38 | 0.00 | 0.000 |
| 40 | 0.00 | 0.000 |
| 45 | 0.00 | 0.000 |
| 50 | 0.00 | 0.000 |
| 55 | 0.00 | 0.000 |
| 60 | 0.00 | 0.000 |
| 65 | 0.00 | 0.000 |
| 70 | 0.00 | 0.000 |
| 75 | 0.00 | 0.000 |
| 80 | 0.00 | 0.000 |
| 85 | 0.00 | 0.000 |
| 90 | 0.00 | 0.000 |
| 95 | 0.00 | 0.000 |
| 100 | 0.00 | 0.000 |

**Total Release From Site**

| Minute | Outflow Flow | Cumulative Storage |
|---|---|---|
| | (L/sec) | (L) |
| (1) | (6) | (6) |
| 0 | 0 | 0 |
| 1 | 2 | 663 |
| 2 | 5 | 1904 |
| 3 | 9 | 3651 |
| 4 | 14 | 5839 |
| 5 | 20 | 8412 |
| 6 | 27 | 11322 |
| 7 | 35 | 14525 |
| 8 | 42 | 18046 |
| 9 | 47 | 22056 |
| 10 | 52 | 26530 |
| 11 | 54 | 30121 |
| 12 | 55 | 32901 |
| 13 | 55 | 34911 |
| 14 | 54 | 36182 |
| 15 | 54 | 36740 |
| 16 | 53 | 36615 |
| 17 | 51 | 35831 |
| 18 | 49 | 34415 |
| 19 | 46 | 32390 |
| 20 | 44 | 29780 |
| 22 | 42 | 24760 |
| 24 | 38 | 20184 |
| 26 | 34 | 16060 |
| 28 | 31 | 12345 |
| 30 | 26 | 9211 |
| 32 | 19 | 6872 |
| 34 | 15 | 5127 |
| 36 | 11 | 3826 |
| 38 | 8 | 2854 |
| 40 | 6 | 2130 |
| 45 | 5 | 778 |
| 50 | 2 | 284 |
| 55 | 1 | 104 |
| 60 | 0 | 38 |
| 65 | 0 | 14 |
| 70 | 0 | 5 |
| 75 | 0 | 2 |
| 80 | 0 | 1 |
| 85 | 0 | 0 |
| 90 | 0 | 0 |
| 95 | 0 | 0 |
| 100 | 0 | 0 |

**CHECKING STORAGE RELEASE CHARACTERISTICS OF SUBSURFACE STORAGE GALLERIES**
**- MTO IDF EQUATIONS -**

**Controlled Release from Site**

| | | |
|---|---|---|
| 10 Year Post Development Flow | 85.614 | L/sec |
| Storm Duration | 20 | min |

**Uncontrolled Release from Site**

| | | |
|---|---|---|
| 10 Year Post Development Flow | 12.092 | L/sec |
| Storm Duration | 20 | min |

**Pond Rating Curve**

| Elevation (m) | Outflow (L/sec) | Storage (ha - m) | Storage (L) |
|---|---|---|---|
| 312.65 | 0.01 | 0.0000 | 0.00 |
| 312.85 | 29.04 | 0.0014 | 13720.00 |
| 313.05 | 40.34 | 0.0027 | 27440.00 |
| 313.25 | 49.11 | 0.0041 | 41160.00 |
| 313.45 | 56.53 | 0.0055 | 54880.00 |
| 313.65 | 63.09 | 0.0069 | 68600.00 |
| 0.00 | 0.00 | 0.0000 | 0.00 |

**Hydrograph Data**

| Minute | In Flow | Out Flow | Del_Storage | Cumulative Storage |
|---|---|---|---|---|
| | (L/sec) | (L/sec) | (L) | (L) |
| (1) | (2) | (4) | (5) | (6) |
| 0 | 0.00 | 0.000 | 0 | 0 |
| 1 | 8.56 | 0.000 | 514 | 514 |
| 2 | 17.12 | 1.087 | 962 | 1476 |
| 3 | 25.68 | 3.122 | 1354 | 2830 |
| 4 | 34.25 | 5.987 | 1696 | 4525 |
| 5 | 42.81 | 9.574 | 1994 | 6519 |
| 6 | 51.37 | 13.793 | 2255 | 8774 |
| 7 | 59.93 | 18.563 | 2482 | 11256 |
| 8 | 68.49 | 23.814 | 2681 | 13936 |
| 9 | 77.05 | 29.214 | 2870 | 16807 |
| 10 | 85.61 | 31.579 | 3242 | 20049 |
| 11 | 77.05 | 34.250 | 2568 | 22617 |
| 12 | 68.49 | 36.366 | 1928 | 24544 |
| 13 | 59.93 | 37.954 | 1319 | 25863 |
| 14 | 51.37 | 39.041 | 740 | 26603 |
| 15 | 42.81 | 39.650 | 189 | 26792 |
| 16 | 34.25 | 39.806 | -334 | 26458 |
| 17 | 25.68 | 39.531 | -831 | 25627 |
| 18 | 17.12 | 38.847 | -1303 | 24324 |
| 19 | 8.56 | 37.773 | -1753 | 22571 |
| 20 | 0.00 | 36.329 | -2180 | 20392 |
| 22 | 0.00 | 34.533 | -4144 | 16248 |
| 24 | 0.00 | 31.118 | -3734 | 12514 |
| 26 | 0.00 | 26.475 | -3177 | 9336 |
| 28 | 0.00 | 19.754 | -2370 | 6966 |
| 30 | 0.00 | 14.738 | -1769 | 5197 |
| 32 | 0.00 | 10.996 | -1320 | 3878 |
| 34 | 0.00 | 8.205 | -985 | 2893 |
| 36 | 0.00 | 6.122 | -735 | 2159 |
| 38 | 0.00 | 4.567 | -548 | 1611 |
| 40 | 0.00 | 3.408 | -409 | 1202 |
| 45 | 0.00 | 2.543 | -763 | 439 |
| 50 | 0.00 | 0.929 | -279 | 160 |
| 55 | 0.00 | 0.339 | -102 | 59 |
| 60 | 0.00 | 0.124 | -37 | 21 |
| 65 | 0.00 | 0.045 | -14 | 8 |
| 70 | 0.00 | 0.017 | -5 | 3 |
| 75 | 0.00 | 0.006 | -2 | 1 |
| 80 | 0.00 | 0.002 | -1 | 0 |
| 85 | 0.00 | 0.001 | 0 | 0 |
| 90 | 0.00 | 0.000 | 0 | 0 |
| 95 | 0.00 | 0.000 | 0 | 0 |
| 100 | 0.00 | 0.000 | 0 | 0 |

**Hydrograph Data**

| Minute | In Flow | Out Flow |
|---|---|---|
| | (L/sec) | (L/sec) |
| (1) | (2) | (4) |
| 0 | 0.00 | 0.000 |
| 1 | 1.21 | 1.209 |
| 2 | 2.42 | 2.418 |
| 3 | 3.63 | 3.628 |
| 4 | 4.84 | 4.837 |
| 5 | 6.05 | 6.046 |
| 6 | 7.26 | 7.255 |
| 7 | 8.46 | 8.464 |
| 8 | 9.67 | 9.674 |
| 9 | 10.88 | 10.883 |
| 10 | 12.09 | 12.092 |
| 11 | 10.88 | 10.883 |
| 12 | 9.67 | 9.674 |
| 13 | 8.46 | 8.464 |
| 14 | 7.26 | 7.255 |
| 15 | 6.05 | 6.046 |
| 16 | 4.84 | 4.837 |
| 17 | 3.63 | 3.628 |
| 18 | 2.42 | 2.418 |
| 19 | 1.21 | 1.209 |
| 20 | 0.00 | 0.000 |
| 22 | 0.00 | 0.000 |
| 24 | 0.00 | 0.000 |
| 26 | 0.00 | 0.000 |
| 28 | 0.00 | 0.000 |
| 30 | 0.00 | 0.000 |
| 32 | 0.00 | 0.000 |
| 34 | 0.00 | 0.000 |
| 36 | 0.00 | 0.000 |
| 38 | 0.00 | 0.000 |
| 40 | 0.00 | 0.000 |
| 45 | 0.00 | 0.000 |
| 50 | 0.00 | 0.000 |
| 55 | 0.00 | 0.000 |
| 60 | 0.00 | 0.000 |
| 65 | 0.00 | 0.000 |
| 70 | 0.00 | 0.000 |
| 75 | 0.00 | 0.000 |
| 80 | 0.00 | 0.000 |
| 85 | 0.00 | 0.000 |
| 90 | 0.00 | 0.000 |
| 95 | 0.00 | 0.000 |
| 100 | 0.00 | 0.000 |

**Total Release From Site**

| Minute | Outflow Flow | Cumulative Storage |
|---|---|---|
| | (L/sec) | (L) |
| (1) | (6) | (6) |
| 0 | 0 | 0 |
| 1 | 1 | 514 |
| 2 | 4 | 1476 |
| 3 | 7 | 2830 |
| 4 | 11 | 4525 |
| 5 | 16 | 6519 |
| 6 | 21 | 8774 |
| 7 | 27 | 11256 |
| 8 | 33 | 13936 |
| 9 | 40 | 16807 |
| 10 | 44 | 20049 |
| 11 | 45 | 22617 |
| 12 | 46 | 24544 |
| 13 | 46 | 25863 |
| 14 | 46 | 26603 |
| 15 | 46 | 26792 |
| 16 | 45 | 26458 |
| 17 | 43 | 25627 |
| 18 | 41 | 24324 |
| 19 | 39 | 22571 |
| 20 | 36 | 20392 |
| 22 | 35 | 16248 |
| 24 | 31 | 12514 |
| 26 | 26 | 9336 |
| 28 | 20 | 6966 |
| 30 | 15 | 5197 |
| 32 | 11 | 3878 |
| 34 | 8 | 2893 |
| 36 | 6 | 2159 |
| 38 | 5 | 1611 |
| 40 | 3 | 1202 |
| 45 | 3 | 439 |
| 50 | 1 | 160 |
| 55 | 0 | 59 |
| 60 | 0 | 21 |
| 65 | 0 | 8 |
| 70 | 0 | 3 |
| 75 | 0 | 1 |
| 80 | 0 | 0 |
| 85 | 0 | 0 |
| 90 | 0 | 0 |
| 95 | 0 | 0 |
| 100 | 0 | 0 |

**CHECKING STORAGE RELEASE CHARACTERISTICS OF SUBSURFACE STORAGE GALLERIES**
**- MTO IDF EQUATIONS -**

**Controlled Release from Site**

| | | |
|---|---|---|
| 5 Year Post Development Flow | 73.911 | L/sec |
| Storm Duration | 20 | min |

**Uncontrolled Release from Site**

| | | |
|---|---|---|
| 5 Year Post Development Flow | 10.439 | L/sec |
| Storm Duration | 20 | min |

**Pond Rating Curve**

| Elevation (m) | Outflow (L/sec) | Storage (ha - m) | Storage (L) |
|---|---|---|---|
| 312.65 | 0.01 | 0.0000 | 0.00 |
| 312.85 | 29.04 | 0.0014 | 13720.00 |
| 313.05 | 40.34 | 0.0027 | 27440.00 |
| 313.25 | 49.11 | 0.0041 | 41160.00 |
| 313.45 | 56.53 | 0.0055 | 54880.00 |
| 313.65 | 63.09 | 0.0069 | 68600.00 |
| 0.00 | 0.00 | 0.0000 | 0.00 |

**Hydrograph Data**

| Minute | In Flow | Out Flow | Del_Storage | Cumulative Storage |
|---|---|---|---|---|
| | (L/sec) | (L/sec) | (L) | (L) |
| (1) | (2) | (4) | (5) | (6) |
| 0 | 0.00 | 0.000 | 0 | 0 |
| 1 | 7.39 | 0.000 | 443 | 443 |
| 2 | 14.78 | 0.938 | 831 | 1274 |
| 3 | 22.17 | 2.696 | 1169 | 2443 |
| 4 | 29.56 | 5.168 | 1464 | 3907 |
| 5 | 36.96 | 8.265 | 1721 | 5628 |
| 6 | 44.35 | 11.907 | 1946 | 7574 |
| 7 | 51.74 | 16.025 | 2143 | 9717 |
| 8 | 59.13 | 20.559 | 2314 | 12031 |
| 9 | 66.52 | 25.455 | 2464 | 14495 |
| 10 | 73.91 | 29.674 | 2654 | 17149 |
| 11 | 66.52 | 31.861 | 2080 | 19229 |
| 12 | 59.13 | 33.575 | 1533 | 20762 |
| 13 | 51.74 | 34.838 | 1014 | 21776 |
| 14 | 44.35 | 35.673 | 520 | 22297 |
| 15 | 36.96 | 36.102 | 51 | 22348 |
| 16 | 29.56 | 36.144 | -395 | 21953 |
| 17 | 22.17 | 35.819 | -819 | 21134 |
| 18 | 14.78 | 35.144 | -1222 | 19912 |
| 19 | 7.39 | 34.138 | -1605 | 18308 |
| 20 | 0.00 | 32.816 | -1969 | 16339 |
| 22 | 0.00 | 31.193 | -3743 | 12596 |
| 24 | 0.00 | 26.649 | -3198 | 9398 |
| 26 | 0.00 | 19.883 | -2386 | 7012 |
| 28 | 0.00 | 14.835 | -1780 | 5232 |
| 30 | 0.00 | 11.069 | -1328 | 3903 |
| 32 | 0.00 | 8.258 | -991 | 2912 |
| 34 | 0.00 | 6.162 | -739 | 2173 |
| 36 | 0.00 | 4.597 | -552 | 1621 |
| 38 | 0.00 | 3.430 | -412 | 1210 |
| 40 | 0.00 | 2.559 | -307 | 903 |
| 45 | 0.00 | 1.909 | -573 | 330 |
| 50 | 0.00 | 0.697 | -209 | 120 |
| 55 | 0.00 | 0.255 | -76 | 44 |
| 60 | 0.00 | 0.093 | -28 | 16 |
| 65 | 0.00 | 0.034 | -10 | 6 |
| 70 | 0.00 | 0.012 | -4 | 2 |
| 75 | 0.00 | 0.005 | -1 | 1 |
| 80 | 0.00 | 0.002 | 0 | 0 |
| 85 | 0.00 | 0.001 | 0 | 0 |
| 90 | 0.00 | 0.000 | 0 | 0 |
| 95 | 0.00 | 0.000 | 0 | 0 |
| 100 | 0.00 | 0.000 | 0 | 0 |

**Hydrograph Data**

| Minute | In Flow | Out Flow |
|---|---|---|
| | (L/sec) | (L/sec) |
| (1) | (2) | (4) |
| 0 | 0.00 | 0.000 |
| 1 | 1.04 | 1.044 |
| 2 | 2.09 | 2.088 |
| 3 | 3.13 | 3.132 |
| 4 | 4.18 | 4.176 |
| 5 | 5.22 | 5.220 |
| 6 | 6.26 | 6.264 |
| 7 | 7.31 | 7.307 |
| 8 | 8.35 | 8.351 |
| 9 | 9.40 | 9.395 |
| 10 | 10.44 | 10.439 |
| 11 | 9.40 | 9.395 |
| 12 | 8.35 | 8.351 |
| 13 | 7.31 | 7.307 |
| 14 | 6.26 | 6.264 |
| 15 | 5.22 | 5.220 |
| 16 | 4.18 | 4.176 |
| 17 | 3.13 | 3.132 |
| 18 | 2.09 | 2.088 |
| 19 | 1.04 | 1.044 |
| 20 | 0.00 | 0.000 |
| 22 | 0.00 | 0.000 |
| 24 | 0.00 | 0.000 |
| 26 | 0.00 | 0.000 |
| 28 | 0.00 | 0.000 |
| 30 | 0.00 | 0.000 |
| 32 | 0.00 | 0.000 |
| 34 | 0.00 | 0.000 |
| 36 | 0.00 | 0.000 |
| 38 | 0.00 | 0.000 |
| 40 | 0.00 | 0.000 |
| 45 | 0.00 | 0.000 |
| 50 | 0.00 | 0.000 |
| 55 | 0.00 | 0.000 |
| 60 | 0.00 | 0.000 |
| 65 | 0.00 | 0.000 |
| 70 | 0.00 | 0.000 |
| 75 | 0.00 | 0.000 |
| 80 | 0.00 | 0.000 |
| 85 | 0.00 | 0.000 |
| 90 | 0.00 | 0.000 |
| 95 | 0.00 | 0.000 |
| 100 | 0.00 | 0.000 |

**Total Release From Site**

| Minute | Outflow Flow | Cumulative Storage |
|---|---|---|
| | (L/sec) | (L) |
| (1) | (6) | (6) |
| 0 | 0 | 0 |
| 1 | 1 | 443 |
| 2 | 3 | 1274 |
| 3 | 6 | 2443 |
| 4 | 9 | 3907 |
| 5 | 13 | 5628 |
| 6 | 18 | 7574 |
| 7 | 23 | 9717 |
| 8 | 29 | 12031 |
| 9 | 35 | 14495 |
| 10 | 40 | 17149 |
| 11 | 41 | 19229 |
| 12 | 42 | 20762 |
| 13 | 42 | 21776 |
| 14 | 42 | 22297 |
| 15 | 41 | 22348 |
| 16 | 40 | 21953 |
| 17 | 39 | 21134 |
| 18 | 37 | 19912 |
| 19 | 35 | 18308 |
| 20 | 33 | 16339 |
| 22 | 31 | 12596 |
| 24 | 27 | 9398 |
| 26 | 20 | 7012 |
| 28 | 15 | 5232 |
| 30 | 11 | 3903 |
| 32 | 8 | 2912 |
| 34 | 6 | 2173 |
| 36 | 5 | 1621 |
| 38 | 3 | 1210 |
| 40 | 3 | 903 |
| 45 | 2 | 330 |
| 50 | 1 | 120 |
| 55 | 0 | 44 |
| 60 | 0 | 16 |
| 65 | 0 | 6 |
| 70 | 0 | 2 |
| 75 | 0 | 1 |
| 80 | 0 | 0 |
| 85 | 0 | 0 |
| 90 | 0 | 0 |
| 95 | 0 | 0 |
| 100 | 0 | 0 |

**CHECKING STORAGE RELEASE CHARACTERISTICS OF SUBSURFACE STORAGE GALLERIES**
**- MTO IDF EQUATIONS -**

**Controlled Release from Site**

| | | |
|---|---|---|
| 2 Year Post Development Flow | 56.296 | L/sec |
| Storm Duration | 20 | min |

**Uncontrolled Release from Site**

| | | |
|---|---|---|
| 2 Year Post Development Flow | 7.951 | L/sec |
| Storm Duration | 20 | min |

**Pond Rating Curve**

| Elevation (m) | Outflow (L/sec) | Storage (ha - m) | Storage (L) |
|---|---|---|---|
| 312.65 | 0.01 | 0.0000 | 0.00 |
| 312.85 | 29.04 | 0.0014 | 13720.00 |
| 313.05 | 40.34 | 0.0027 | 27440.00 |
| 313.25 | 49.11 | 0.0041 | 41160.00 |
| 313.45 | 56.53 | 0.0055 | 54880.00 |
| 313.65 | 63.09 | 0.0069 | 68600.00 |
| 0.00 | 0.00 | 0.0000 | 0.00 |

**Hydrograph Data**

| Minute | In Flow | Out Flow | Del_Storage | Cumulative Storage |
|---|---|---|---|---|
| | (L/sec) | (L/sec) | (L) | (L) |
| (1) | (2) | (4) | (5) | (6) |
| 0 | 0.00 | 0.000 | 0 | 0 |
| 1 | 5.63 | 0.000 | 338 | 338 |
| 2 | 11.26 | 0.715 | 633 | 970 |
| 3 | 16.89 | 2.053 | 890 | 1861 |
| 4 | 22.52 | 3.936 | 1115 | 2975 |
| 5 | 28.15 | 6.295 | 1311 | 4287 |
| 6 | 33.78 | 9.069 | 1482 | 5769 |
| 7 | 39.41 | 12.206 | 1632 | 7401 |
| 8 | 45.04 | 15.659 | 1763 | 9164 |
| 9 | 50.67 | 19.388 | 1877 | 11041 |
| 10 | 56.30 | 23.359 | 1976 | 13017 |
| 11 | 50.67 | 27.540 | 1388 | 14404 |
| 12 | 45.04 | 29.599 | 926 | 15331 |
| 13 | 39.41 | 30.363 | 543 | 15873 |
| 14 | 33.78 | 30.810 | 178 | 16051 |
| 15 | 28.15 | 30.956 | -169 | 15883 |
| 16 | 22.52 | 30.818 | -498 | 15385 |
| 17 | 16.89 | 30.407 | -811 | 14574 |
| 18 | 11.26 | 29.739 | -1109 | 13465 |
| 19 | 5.63 | 28.488 | -1372 | 12093 |
| 20 | 0.00 | 25.586 | -1535 | 10558 |
| 22 | 0.00 | 22.338 | -2681 | 7878 |
| 24 | 0.00 | 16.667 | -2000 | 5878 |
| 26 | 0.00 | 12.435 | -1492 | 4385 |
| 28 | 0.00 | 9.278 | -1113 | 3272 |
| 30 | 0.00 | 6.923 | -831 | 2441 |
| 32 | 0.00 | 5.165 | -620 | 1821 |
| 34 | 0.00 | 3.854 | -462 | 1359 |
| 36 | 0.00 | 2.875 | -345 | 1014 |
| 38 | 0.00 | 2.145 | -257 | 757 |
| 40 | 0.00 | 1.601 | -192 | 564 |
| 45 | 0.00 | 1.194 | -358 | 206 |
| 50 | 0.00 | 0.436 | -131 | 75 |
| 55 | 0.00 | 0.159 | -48 | 28 |
| 60 | 0.00 | 0.058 | -17 | 10 |
| 65 | 0.00 | 0.021 | -6 | 4 |
| 70 | 0.00 | 0.008 | -2 | 1 |
| 75 | 0.00 | 0.003 | -1 | 0 |
| 80 | 0.00 | 0.001 | 0 | 0 |
| 85 | 0.00 | 0.000 | 0 | 0 |
| 90 | 0.00 | 0.000 | 0 | 0 |
| 95 | 0.00 | 0.000 | 0 | 0 |
| 100 | 0.00 | 0.000 | 0 | 0 |

**Hydrograph Data**

| Minute | In Flow | Out Flow |
|---|---|---|
| | (L/sec) | (L/sec) |
| (1) | (2) | (4) |
| 0 | 0.00 | 0.000 |
| 1 | 0.80 | 0.795 |
| 2 | 1.59 | 1.590 |
| 3 | 2.39 | 2.385 |
| 4 | 3.18 | 3.180 |
| 5 | 3.98 | 3.976 |
| 6 | 4.77 | 4.771 |
| 7 | 5.57 | 5.566 |
| 8 | 6.36 | 6.361 |
| 9 | 7.16 | 7.156 |
| 10 | 7.95 | 7.951 |
| 11 | 7.16 | 7.156 |
| 12 | 6.36 | 6.361 |
| 13 | 5.57 | 5.566 |
| 14 | 4.77 | 4.771 |
| 15 | 3.98 | 3.976 |
| 16 | 3.18 | 3.180 |
| 17 | 2.39 | 2.385 |
| 18 | 1.59 | 1.590 |
| 19 | 0.80 | 0.795 |
| 20 | 0.00 | 0.000 |
| 22 | 0.00 | 0.000 |
| 24 | 0.00 | 0.000 |
| 26 | 0.00 | 0.000 |
| 28 | 0.00 | 0.000 |
| 30 | 0.00 | 0.000 |
| 32 | 0.00 | 0.000 |
| 34 | 0.00 | 0.000 |
| 36 | 0.00 | 0.000 |
| 38 | 0.00 | 0.000 |
| 40 | 0.00 | 0.000 |
| 45 | 0.00 | 0.000 |
| 50 | 0.00 | 0.000 |
| 55 | 0.00 | 0.000 |
| 60 | 0.00 | 0.000 |
| 65 | 0.00 | 0.000 |
| 70 | 0.00 | 0.000 |
| 75 | 0.00 | 0.000 |
| 80 | 0.00 | 0.000 |
| 85 | 0.00 | 0.000 |
| 90 | 0.00 | 0.000 |
| 95 | 0.00 | 0.000 |
| 100 | 0.00 | 0.000 |

**Total Release From Site**

| Minute | Outflow Flow | Cumulative Storage |
|---|---|---|
| | (L/sec) | (L) |
| (1) | (6) | (6) |
| 0 | 0 | 0 |
| 1 | 1 | 338 |
| 2 | 2 | 970 |
| 3 | 4 | 1861 |
| 4 | 7 | 2975 |
| 5 | 10 | 4287 |
| 6 | 14 | 5769 |
| 7 | 18 | 7401 |
| 8 | 22 | 9164 |
| 9 | 27 | 11041 |
| 10 | 31 | 13017 |
| 11 | 35 | 14404 |
| 12 | 36 | 15331 |
| 13 | 36 | 15873 |
| 14 | 36 | 16051 |
| 15 | 35 | 15883 |
| 16 | 34 | 15385 |
| 17 | 33 | 14574 |
| 18 | 31 | 13465 |
| 19 | 29 | 12093 |
| 20 | 26 | 10558 |
| 22 | 22 | 7878 |
| 24 | 17 | 5878 |
| 26 | 12 | 4385 |
| 28 | 9 | 3272 |
| 30 | 7 | 2441 |
| 32 | 5 | 1821 |
| 34 | 4 | 1359 |
| 36 | 3 | 1014 |
| 38 | 2 | 757 |
| 40 | 2 | 564 |
| 45 | 1 | 206 |
| 50 | 0 | 75 |
| 55 | 0 | 28 |
| 60 | 0 | 10 |
| 65 | 0 | 4 |
| 70 | 0 | 1 |
| 75 | 0 | 0 |
| 80 | 0 | 0 |
| 85 | 0 | 0 |
| 90 | 0 | 0 |
| 95 | 0 | 0 |
| 100 | 0 | 0 |

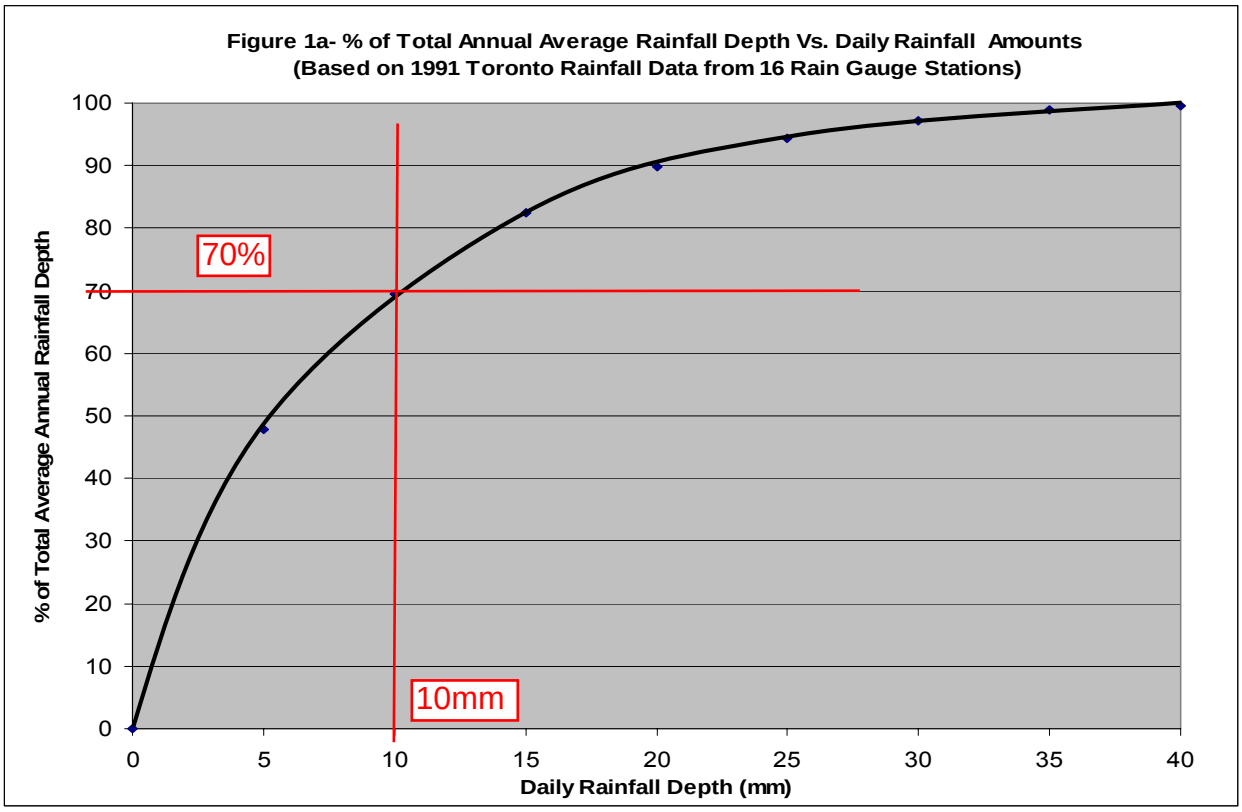


Figure 1a- % of Total Annual Average Rainfall Depth Vs. Daily Rainfall Amounts
(Based on 1991 Toronto Rainfall Data from 16 Rain Gauge Stations)
% of Total Average Annual Rainfall Depth
Daily Rainfall Depth (mm)
70%
10mm
0
10
20
30
40
50
60
70
80
90
100
0
5
10
15
20
25
30
35
40

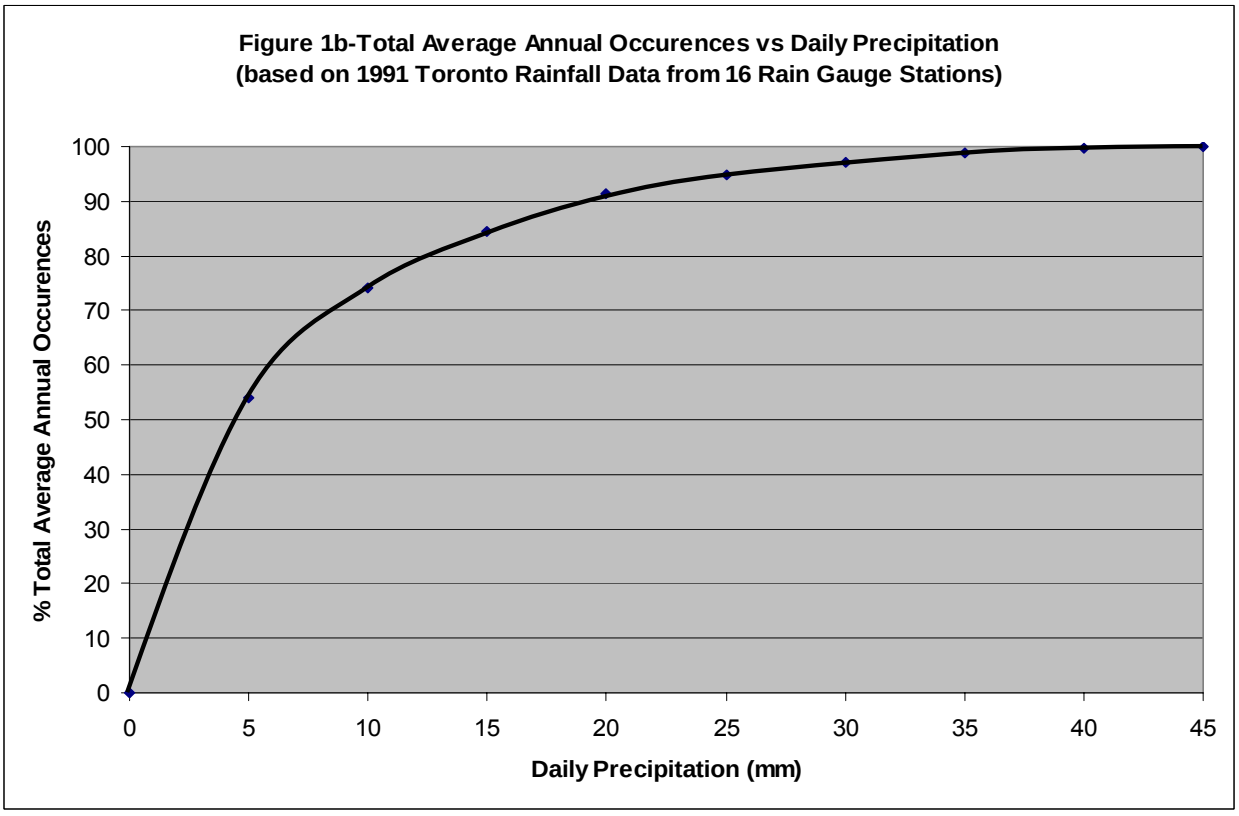


Figure 1b-Total Average Annual Occurences vs Daily Precipitation
(based on 1991 Toronto Rainfall Data from 16 Rain Gauge Stations)
% Total Average Annual Occurences
Daily Precipitation (mm)
0
10
20
30
40
50
60
70
80
90
100
0
5
10
15
20
25
30
35
40
45

# Grain Size Distribution Chart

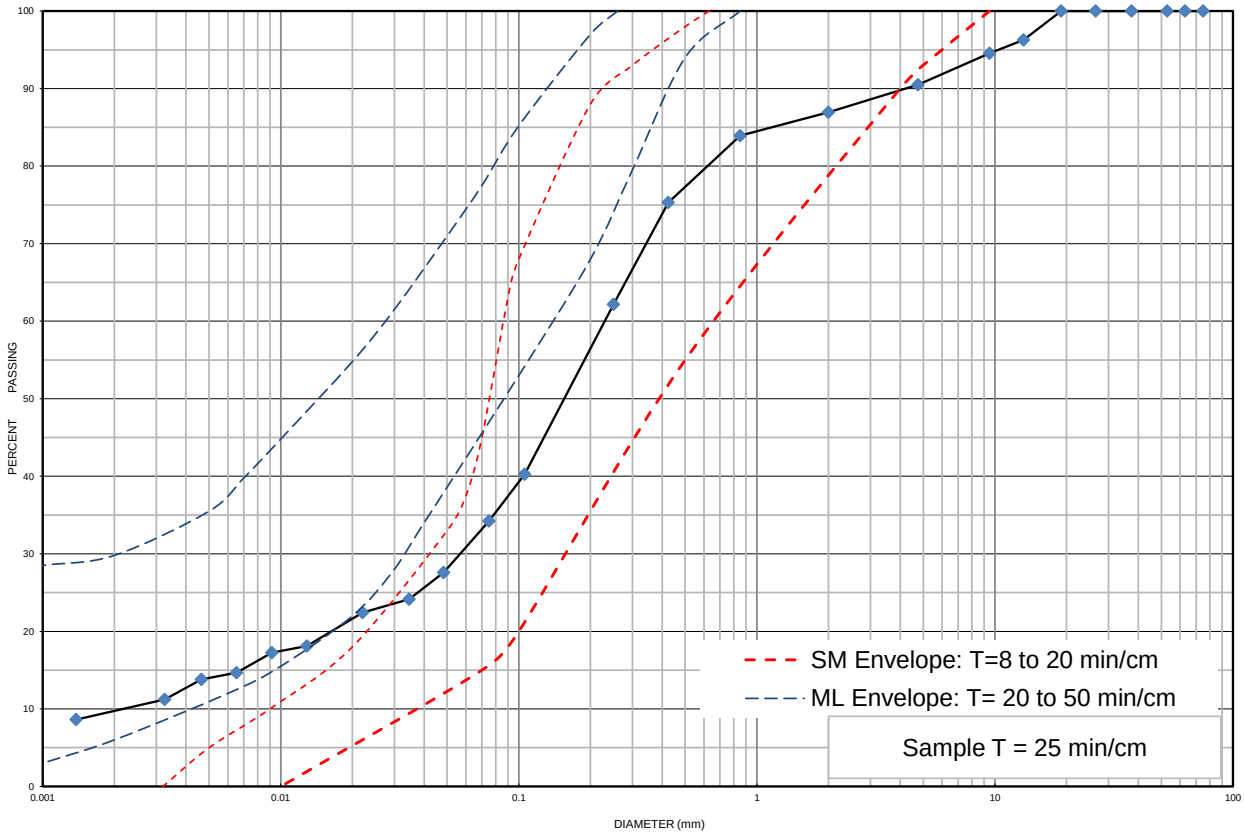
**Project Number:** *16304-001* **Client:** *Inspiration Group of Companies Ltd.*

**Project Name:** *Geotechnical Investigation - 582 Essa Road, Barrie*

**Sample Date:** *November 1, 2022* **Sampled By:** *Waleed El-Taweel - Cambium Inc.*

**Location:** *BH 101-22 SS 3* **Depth:** *1.5 m to 2.1 m* **Lab Sample No:** *S-22-1649*

| UNIFIED SOIL CLASSIFICATION SYSTEM | | | | | |
|---|---|---|---|---|---|
| CLAY & SILT (<0.075 mm) | SAND (<4.75 mm to 0.075 mm) | | | GRAVEL (>4.75 mm) | |
| | FINE | MEDIUM | COARSE | FINE | COARSE |




| MIT SOIL CLASSIFICATION SYSTEM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CLAY | SILT | FINE | MEDIUM | COARSE | FINE | MEDIUM | COARSE | BOULDERS |
| | | SAND | | | GRAVEL | | | |

| Borehole No. | Sample No. | Depth | Gravel | Sand | Silt | Clay | Moisture |
|---|---|---|---|---|---|---|---|
| BH 101-22 | SS 3 | 1.5 m to 2.1 m | 10 | 56 | 25 | 9 | 8.8 |

| Description | Classification | $D_{60}$ | $D_{30}$ | $D_{10}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|
| Silty Sand some Gravel trace Clay | SM | 0.2350 | 0.0560 | 0.0022 | 106.82 | 6.07 |

Additional information availabe upon request

*Issued By:* _____ *Date Issued:* *December 19, 2022*

(Senior Project Manager)

**Cambium Inc. (Laboratory)**
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# Grain Size Distribution Chart

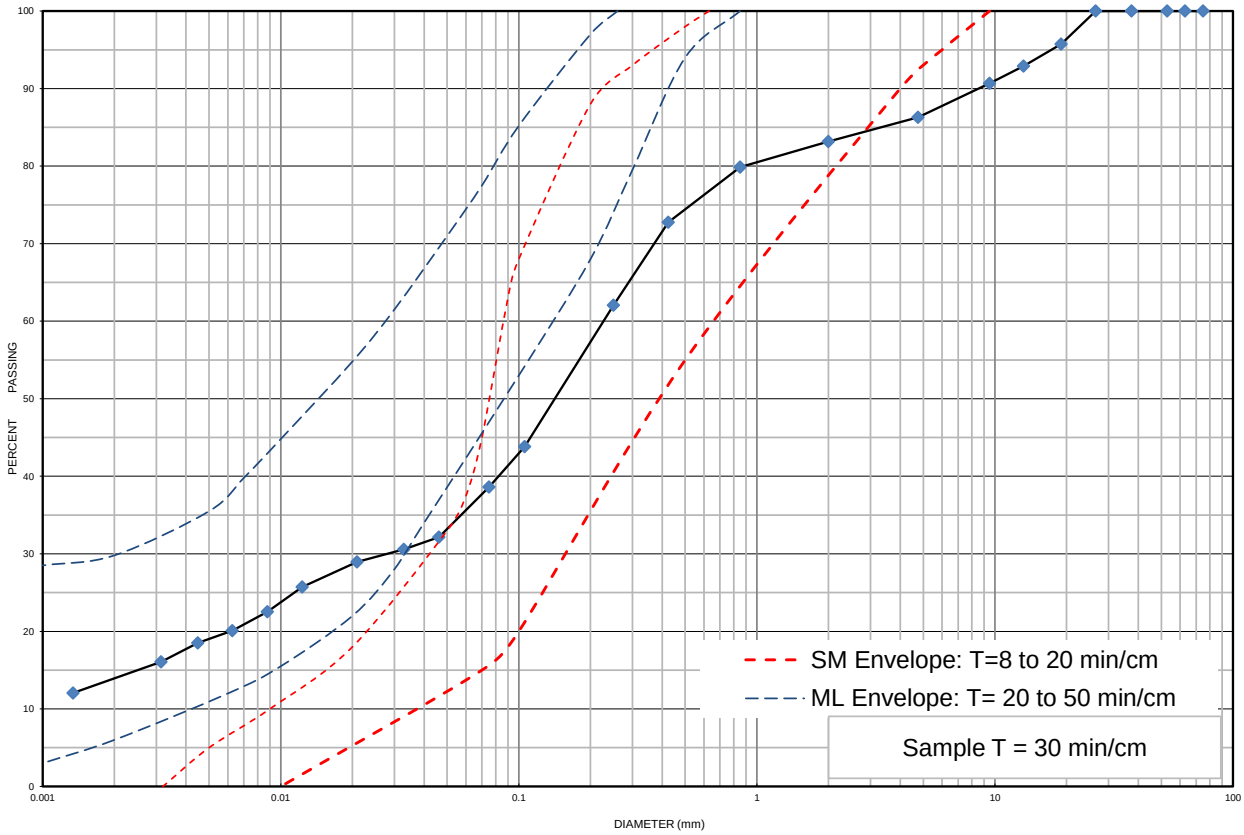
**Project Number:** *16304-001* **Client:** *Inspiration Group of Companies Ltd.*

**Project Name:** *Geotechnical Investigation - 582 Essa Road, Barrie*

**Sample Date:** *November 1, 2022* **Sampled By:** *Waleed El-Taweel - Cambium Inc.*

**Location:** *BH 101-22 SS 7* **Depth:** *6.1 m to 6.7 m* **Lab Sample No:** *S-22-1650*

| UNIFIED SOIL CLASSIFICATION SYSTEM | | | | | |
|---|---|---|---|---|---|
| CLAY & SILT (<0.075 mm) | SAND (<4.75 mm to 0.075 mm) | | | GRAVEL (>4.75 mm) | |
| | FINE | MEDIUM | COARSE | FINE | COARSE |




| MIT SOIL CLASSIFICATION SYSTEM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CLAY | SILT | FINE | MEDIUM | COARSE | FINE | MEDIUM | COARSE | BOULDERS |
| | | SAND | | | GRAVEL | | | |

| Borehole No. | Sample No. | Depth | Gravel | Sand | Silt | Clay | Moisture |
|---|---|---|---|---|---|---|---|
| BH 101-22 | SS 7 | 6.1 m to 6.7 m | 14 | 48 | 25 | 13 | 7.0 |

| Description | Classification | $D_{60}$ | $D_{30}$ | $D_{10}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|
| Silty Sand some Gravel some Clay | SM | 0.230 | 0.026 | - | - | - |

Additional information availabe upon request

*Issued By:* _____ *Date Issued:* *December 19, 2022*

(Senior Project Manager)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# Grain Size Distribution Chart

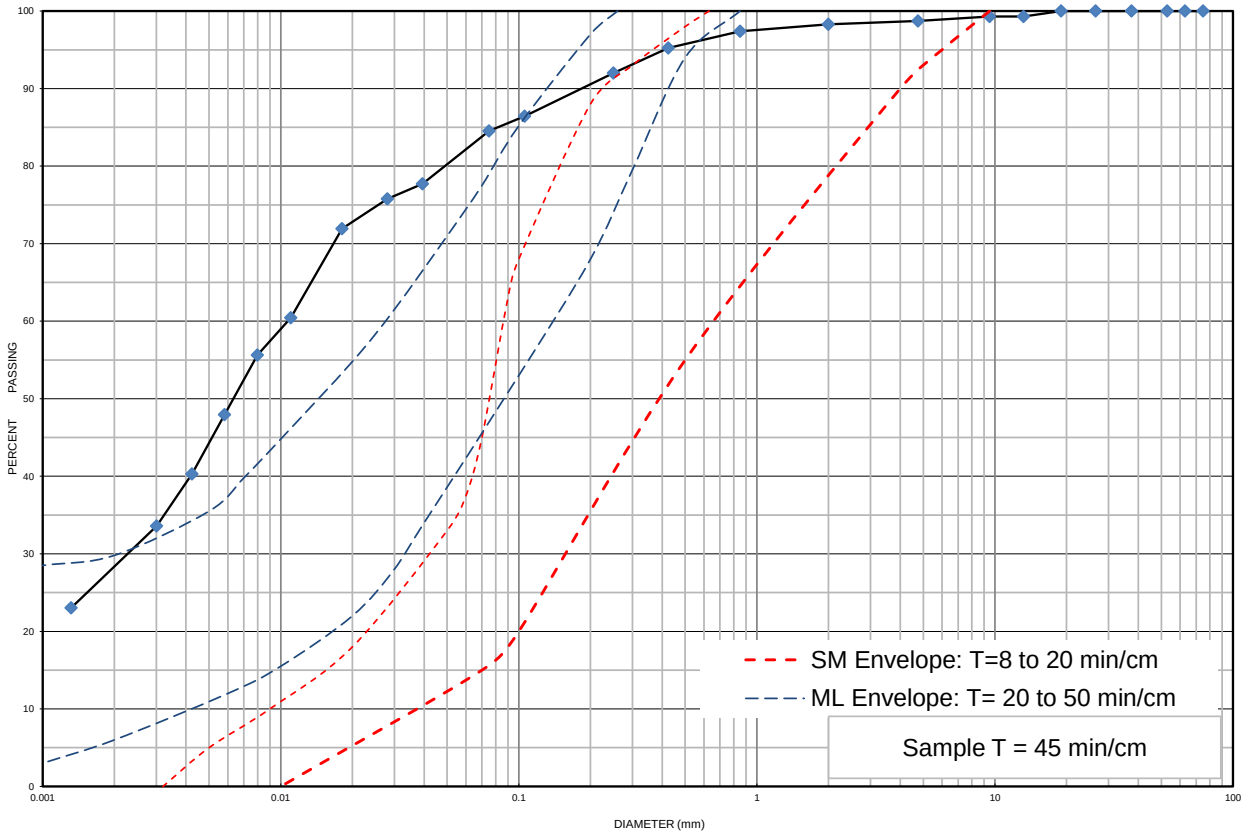
**Project Number:** *16304-001* **Client:** *Inspiration Group of Companies Ltd.*

**Project Name:** *Geotechnical Investigation - 582 Essa Road, Barrie*

**Sample Date:** *November 1, 2022* **Sampled By:** *Waleed El-Taweel - Cambium Inc.*

**Location:** *BH 102-22 SS 4* **Depth:** *2.3 m to 2.9 m* **Lab Sample No:** *S-22-1651*

| UNIFIED SOIL CLASSIFICATION SYSTEM | | | | | |
|---|---|---|---|---|---|
| CLAY & SILT (<0.075 mm) | SAND (<4.75 mm to 0.075 mm) | | | GRAVEL (>4.75 mm) | |
| | FINE | MEDIUM | COARSE | FINE | COARSE |




| MIT SOIL CLASSIFICATION SYSTEM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CLAY | SILT | FINE | MEDIUM | COARSE | FINE | MEDIUM | COARSE | BOULDERS |
| | | SAND | | | GRAVEL | | | |

| Borehole No. | Sample No. | Depth | Gravel | Sand | Silt | Clay | Moisture |
|---|---|---|---|---|---|---|---|
| BH 102-22 | SS 4 | 2.3 m to 2.9 m | 1 | 14 | 57 | 28 | 17.6 |

| Description | Classification | $D_{60}$ | $D_{30}$ | $D_{10}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|
| Clayey Silt some Sand trace Gravel | ML | 0.0110 | 0.0024 | - | - | - |

Additional information availabe upon request

*Issued By:* _____ *Date Issued:* *December 19, 2022*

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# Grain Size Distribution Chart

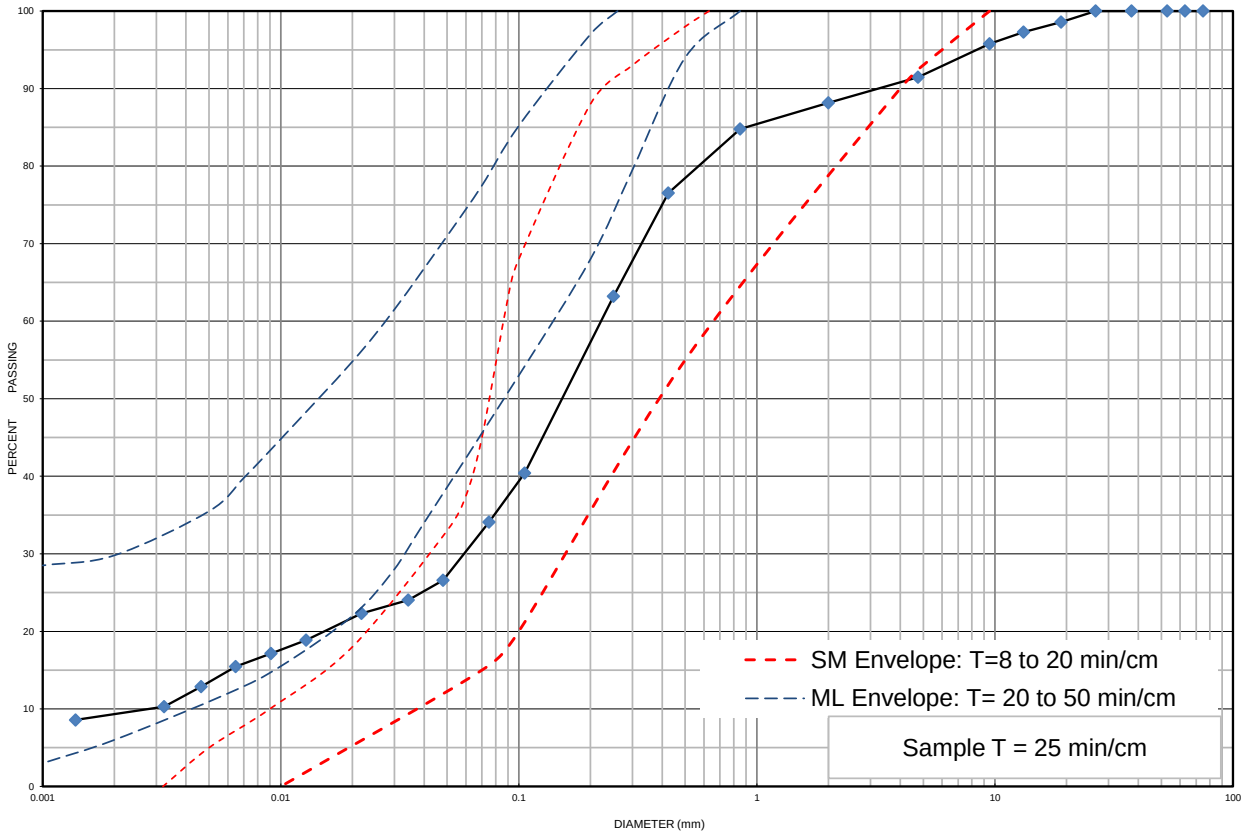
**Project Number:** *16304-001* **Client:** *Inspiration Group of Companies Ltd.*

**Project Name:** *Geotechnical Investigation - 582 Essa Road, Barrie*

**Sample Date:** *November 1, 2022* **Sampled By:** *Waleed El-Taweel - Cambium Inc.*

**Location:** *BH 103-22 SS 5* **Depth:** *3 m to 3.7 m* **Lab Sample No:** *S-22-1652*

| UNIFIED SOIL CLASSIFICATION SYSTEM | | | | | |
|---|---|---|---|---|---|
| CLAY & SILT (<0.075 mm) | SAND (<4.75 mm to 0.075 mm) | | | GRAVEL (>4.75 mm) | |
| | FINE | MEDIUM | COARSE | FINE | COARSE |




| MIT SOIL CLASSIFICATION SYSTEM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CLAY | SILT | FINE | MEDIUM | COARSE | FINE | MEDIUM | COARSE | BOULDERS |
| | | SAND | | | GRAVEL | | | |

| Borehole No. | Sample No. | Depth | Gravel | Sand | Silt | Clay | Moisture |
|---|---|---|---|---|---|---|---|
| BH 103-22 | SS 5 | 3 m to 3.7 m | 9 | 57 | 25 | 9 | 8.6 |

| Description | Classification | $D_{60}$ | $D_{30}$ | $D_{10}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|
| Silty Sand trace Gravel trace Clay | SM | 0.2250 | 0.0590 | 0.0025 | 90.00 | 6.19 |

Additional information availabe upon request

*Issued By:* _____ *Date Issued:* *December 19, 2022*

(Senior Project Manager)

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## Determine Minimum Sizing of Infiltration Gallery

**Table 4.4: Minimum Soil Percolation Rates**

| Soil Type | Percolation Rate (mm/h) |
|---|---|
| sand | 210 |
| loamy sand | 60 |
| sandy loam | 25 |
| loam | 15 |

$$A = \frac{1{,}000\,V}{Pn\triangle t}$$

**Equation 4.3: Infiltration Trench Bottom Area**

where $A$ = bottom area of the trench ($m^2$)
$V$ = runoff volume to be infiltrated (Table 3.2)
$P$ = percolation rate of surrounding native soil (mm/h)
$n$ = porosity of the storage media (0.4 for clear stone)
$\triangle t$ = retention time (24 to 48 hours)

$$d = \frac{PT}{1{,}000}$$

**Equation 4.2: Maximum Allowable Soakaway Pit Depth**

where $d$ = maximum allowable depth of the soakaway pit (m)
$P$ = percolation rate (Table 4.1) (mm/h)
$T$ = drawdown time (24 - 48 h) (h)

Soil Type
Silty Sand

| | | |
|---|---|---|
| Volume Required: | 28.100 | $m^3$ |
| Assumed Porosity: | 0.98 | |
| Percolation Rate: | 24 | mm/h |
| Percolation Rate (FS): | 9.6 | mm/h |
| Area Req'd (24hr): | 124.5 | $m^2$ |
| Area Req'd (48hr): | 62.2 | $m^2$ |
| Maximum Depth: | 0.5 | m |

Therefore: As the proposed trench footprint is equal to the area required for a 48hr drawdown, the anticipated drawdown time is estimated to be 48hrs.

***Phosphorous Concentrations by Land Use***

| | High Intensity | Transition | Low Intensity | Forest |
|---|---|---|---|---|
| Average Total P (kg/ha/year) Barrie Creeks | 1.32 | 0.06 | 0.13 | 0.05 |

**Pre-Development Condition**

Total Annual Rainfall Percipitation 940.0 mm

| | High Intensity | Transition | Low Intensity | Forest |
|---|---|---|---|---|
| Area (ha): | 0.0378 | 0.3552 | 0 | 0 |
| Total P (kg/yr) : | 0.05 | 0.02 | 0.00 | 0.00 |

**Total Pre-Development P (kg) : 0.07**

**Post Development Condition - Untreated**

| | High Intensity Pavement | High Intensity Dwelling | Low Intensity |
|---|---|---|---|
| Area (ha): | 0.0922 | 0.189 | 0.1118 |
| Total P (kg/yr) : | 0.12 | 0.25 | 0.01 |

**Total Post Development P (kg/yr) : 0.39**

**Post Development Condition - Treated**

| | High Intensity Pavement | High Intensity Dwelling | Low Intensity |
|---|---|---|---|
| Area (ha): | 0.0922 | 0.189 | 0.1118 |
| Total P (kg/yr) : | 0.12 | 0.25 | 0.01 |

**Without Treatment**

Total Post Development P (kg/yr) : 0.39

**With Treatment**

| | | | |
|---|---|---|---|
| Treatment Train Removal Efficiency : | 0 | 87 | 0 |
| P Removed (kg/yr) : | 0.00 | 0.22 | 0.00 |

**Total Post Development P (kg/yr) : 0.17**

# Appendix B
# OGS Unit Sizing

# CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
# BASED ON THE RATIONAL RAINFALL METHOD
# BASED ON A FINE PARTICLE SIZE DISTRIBUTION

**Project Name:** 582 Essa Rd.
**Location:** Barrie, ON
**OGS #:** OGS

**Engineer:** **Gerrits Engineering**
**Contact:** Jeff McCuaig, P.Eng.
**Report Date:** 23-Feb-23

| | | | | | |
|---|---|---|---|---|---|
| **Area** | 0.39 | ha | **Rainfall Station #** | 203 | |
| **Weighted C** | 0.71 | | **Particle Size Distribution** | FINE | |
| **CDS Model** | 2015-4 | | **CDS Treatment Capacity** | 20 | l/s |

| Rainfall Intensity[1] (mm/hr) | Percent Rainfall Volume[1] | Cumulative Rainfall Volume | Total Flowrate (l/s) | Treated Flowrate (l/s) | Operating Rate (%) | Removal Efficiency (%) | Incremental Removal (%) |
|---|---|---|---|---|---|---|---|
| 0.5 | 8.7% | 8.7% | 0.4 | 0.4 | 1.9 | 98.3 | 8.6 |
| 1.0 | 10.8% | 19.6% | 0.8 | 0.8 | 3.9 | 97.7 | 10.6 |
| 1.5 | 9.5% | 29.0% | 1.2 | 1.2 | 5.8 | 97.2 | 9.2 |
| 2.0 | 8.4% | 37.4% | 1.5 | 1.5 | 7.8 | 96.6 | 8.1 |
| 2.5 | 6.8% | 44.2% | 1.9 | 1.9 | 9.7 | 96.1 | 6.5 |
| 3.0 | 5.6% | 49.8% | 2.3 | 2.3 | 11.6 | 95.5 | 5.3 |
| 3.5 | 5.1% | 54.9% | 2.7 | 2.7 | 13.6 | 95.0 | 4.8 |
| 4.0 | 4.9% | 59.8% | 3.1 | 3.1 | 15.5 | 94.4 | 4.6 |
| 4.5 | 4.1% | 63.9% | 3.5 | 3.5 | 17.5 | 93.8 | 3.8 |
| 5.0 | 3.5% | 67.4% | 3.8 | 3.8 | 19.4 | 93.3 | 3.2 |
| 6.0 | 4.9% | 72.3% | 4.6 | 4.6 | 23.3 | 92.2 | 4.5 |
| 7.0 | 4.0% | 76.3% | 5.4 | 5.4 | 27.2 | 91.1 | 3.6 |
| 8.0 | 3.2% | 79.5% | 6.2 | 6.2 | 31.1 | 90.0 | 2.9 |
| 9.0 | 2.2% | 81.7% | 6.9 | 6.9 | 34.9 | 88.8 | 2.0 |
| 10.0 | 2.0% | 83.7% | 7.7 | 7.7 | 38.8 | 87.7 | 1.7 |
| 15.0 | 8.2% | 91.9% | 11.5 | 11.5 | 58.2 | 82.2 | 6.7 |
| 20.0 | 3.4% | 95.2% | 15.4 | 15.4 | 77.7 | 76.6 | 2.6 |
| 25.0 | 2.5% | 97.7% | 19.2 | 19.2 | 97.1 | 71.0 | 1.8 |
| 30.0 | 1.4% | 99.1% | 23.1 | 19.8 | 100.0 | 60.3 | 0.9 |
| 35.0 | 0.3% | 99.4% | 26.9 | 19.8 | 100.0 | 51.6 | 0.1 |
| 40.0 | 0.6% | 100.0% | 30.8 | 19.8 | 100.0 | 45.2 | 0.3 |
| 45.0 | 0.0% | 100.0% | 34.6 | 19.8 | 100.0 | 40.2 | 0.0 |
| 50.0 | 0.0% | 100.0% | 38.5 | 19.8 | 100.0 | 36.2 | 0.0 |
| | | | | | | | 92.0 |

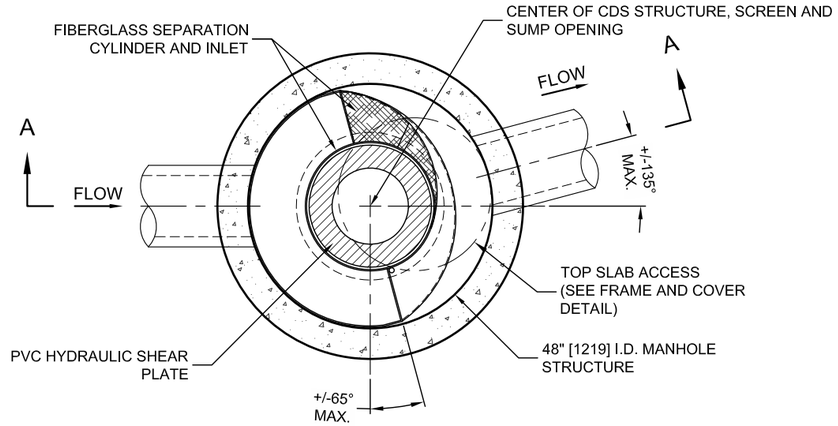
Removal Efficiency Adjustment[2] = 6.5%

**Predicted Net Annual Load Removal Efficiency = 85.5%**

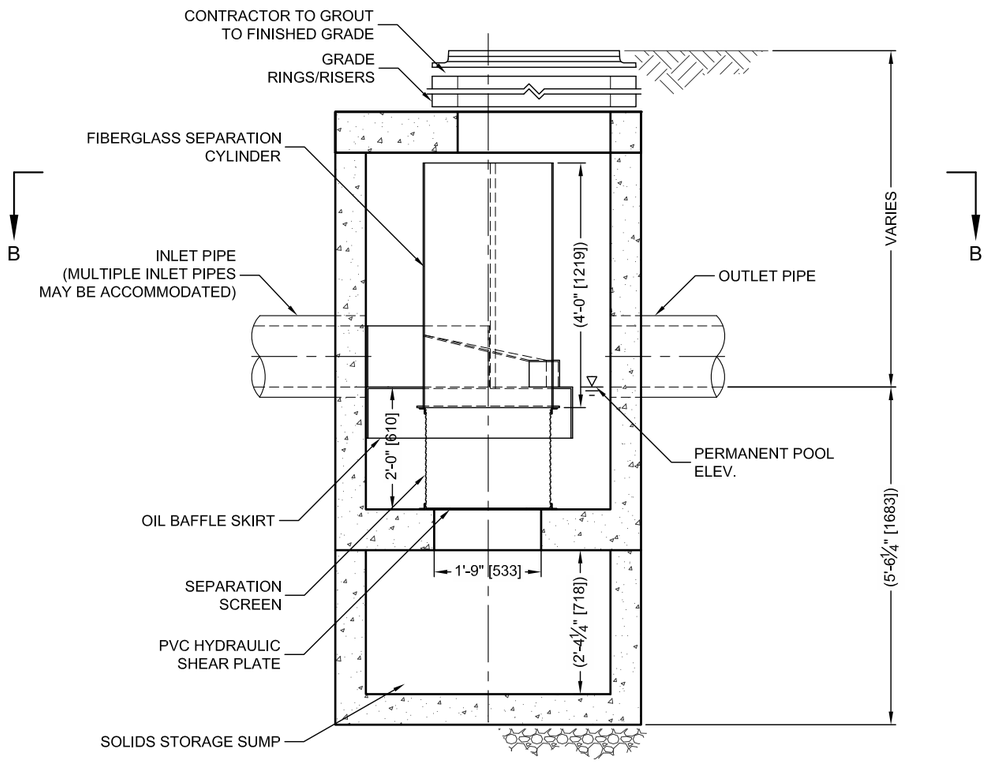
**Predicted Annual Rainfall Treated = 99.5%**

1 - Based on 27 years of hourly rainfall data from Canadian Station 6110557, Barrie ON

2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.




**PLAN VIEW B-B**
N.T.S.



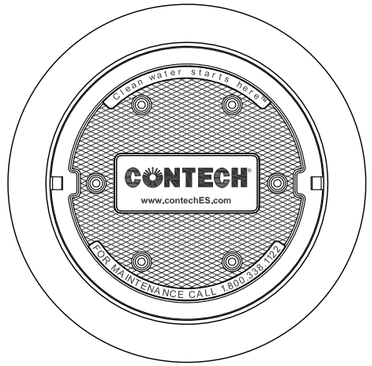

**ELEVATION A-A**
N.T.S.

THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 5,788,848; 6,641,720; 8,511,500; 6,581,783; RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING.

## CDS PMSU2015-4-C DESIGN NOTES

THE STANDARD CDS PMSU2015-4-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

| CONFIGURATION DESCRIPTION |
|---|
| GRATED INLET ONLY (NO INLET PIPE) |
| GRATED INLET WITH INLET PIPE OR PIPES |
| CURB INLET ONLY (NO INLET PIPE) |
| CURB INLET WITH INLET PIPE OR PIPES |
| CUSTOMIZABLE SUMP DEPTH AVAILABLE |
| ANTI-FLOTATION DESIGN AVAILABLE UPON REQUEST |




**FRAME AND COVER**
(DIAMETER VARIES)
N.T.S.

## SITE SPECIFIC DATA REQUIREMENTS

| | |
|---|---|
| STRUCTURE ID | |
| WATER QUALITY FLOW RATE (CFS OR L/s) | * |
| PEAK FLOW RATE (CFS OR L/s) | * |
| RETURN PERIOD OF PEAK FLOW (YRS) | * |
| SCREEN APERTURE (2400 OR 4700) | * |

| PIPE DATA: | I.E. | MATERIAL | DIAMETER |
|---|---|---|---|
| INLET PIPE 1 | * | * | * |
| INLET PIPE 2 | * | * | * |
| OUTLET PIPE | * | * | * |

| | |
|---|---|
| RIM ELEVATION | * |

| ANTI-FLOTATION BALLAST | WIDTH | HEIGHT |
|---|---|---|
| | * | * |

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.contechES.com
4. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET HS20 (AASHTO M 306) LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.

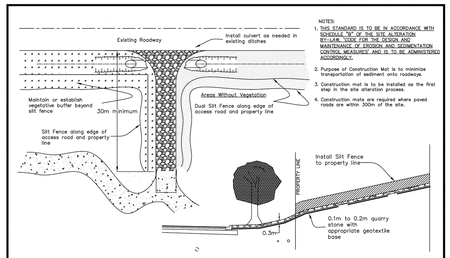
INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO ADD JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS, AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH® ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

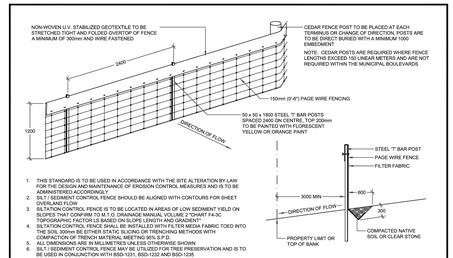
# CDS PMSU2015-4-C INLINE CDS STANDARD DETAIL

# Appendix C
# Hydrogeological Assessment

# Appendix D
# Design Drawings



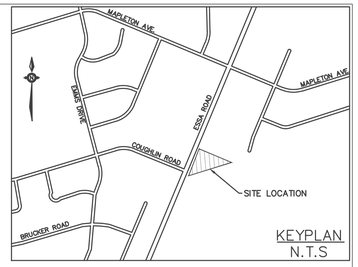

| CITY OF BARRIE STANDARD | | | | | |
|---|---|---|---|---|---|
| CONSTRUCTION ENTRANCE MAT | 1. | Standardized Dimension Text | J.S. | 05.10.28 | APP'D R.G.N. DATE 04.03.16 |
| | | | | | DRAWN A.S.C SCALE N.T.S |
| | NO. | REVISION | APP'D | DATE | BSD-23D |

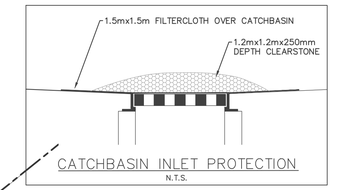


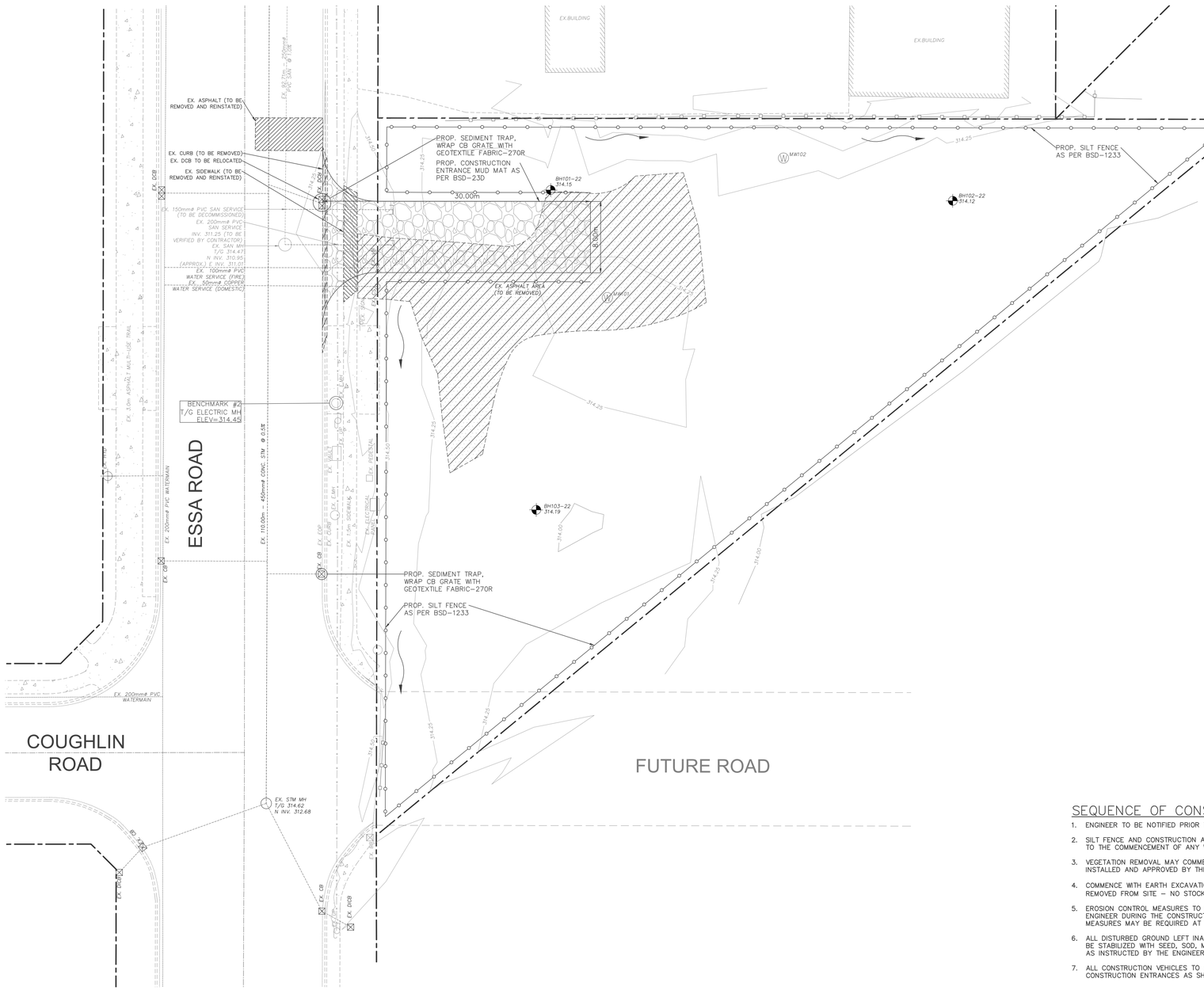

| Barrie STANDARD DETAIL | SILTATION CONTROL FENCING | REV NO. 2 | DATE: OCT 2017 SCALE: N.T.S | APPROVED Oct 10/17 DATE Original Signed By DIRECTOR OF ENGINEERING |
|---|---|---|---|---|
| | | BSD-1233 FORMERLY BSD-23A | | |

## LEGEND

- SILT FENCE
- ROCK CHECK DAM
- STRAW BALE
- TEMPORARY SWALE
- DIRECTION OF INTERIM OVERLAND FLOW
- NVCA / LSRCA REGULATION LIMIT
- ASPHALT REMOVAL AREA
- SIDEWALK REMOVAL AREA
- CONCRETE REMOVAL AREA
- DECIDUOUS TREE
- CONIFEROUS TREE




## NOTES FOR SEDIMENT & EROSION CONTROL

1. DISTURBED AREAS THAT HAVE FAILED TO HAVE STABLE GROUND COVER ESTABLISHED BY OCTOBER 30TH SHALL BE PROTECTED WITH A SILTATION CONTROL FENCE OR STRAW MULCH ETC. AND MAINTAINED BY THE CONTRACTOR UNTIL VEGETATION BECOMES ESTABLISHED IN THE SUBSEQUENT GROWING SEASON.
2. ANY DEWATERING WASTE SHALL BE DISCHARGED TO A VEGETATED AREA AT LEAST 30 M FROM ANY WATERCOURSE AND FILTERED. FILTERING METHODS MUST BE APPROVED BY THE SITE ADMINISTRATOR.
3. SILT FENCE SHALL BE PUT IN PLACE PRIOR TO AND MAINTAINED DURING ALL GRADING. SILT FENCE SHALL COMPLY WITH OPSD 219.110 FOR LIGHT DUTY AND / OR OPSD 219.130 FOR HEAVY DUTY; UNLESS NOTED OTHERWISE. SILT FENCE TO BE INSPECTED PRIOR TO COMMENCEMENT OF EARTH GRADING ACTIVITIES. SILT FENCE TO BE INSPECTED AND REPAIRED OR REPLACED IF DAMAGED AS DIRECTED BY THE SITE ADMINISTRATOR. SILT CONTROLS TO BE INSPECTED ON A REGULAR BASIS AND AFTER EVERY RAIN EVENT. INSTALLATION SHALL BE TO THE MANUFACTURER'S SUGGESTED SPECIFICATIONS.
4. THE CONTRACTOR SHALL BE PREPARED FOR UNEXPECTED CONDITIONS AND ACCORDINGLY HAVE STOCKPILED MATERIALS ON SITE FOR NECESSARY REPAIRS AS A RESULT OF FAILED OR INADEQUATE CONTROL MEASURES. ALL SEDIMENT AND EROSION CONTROL MEASURES SHALL BE INSPECTED AT LEAST ONCE A WEEK, AND AFTER EVERY RAINFALL EVENT.
5. MUD MATS WHERE CONSTRUCTION TRAFFIC ENTERS OR LEAVES THE SITE SHALL BE USED. MUD MATS TO BE 300mm IN DEPTH, 8.0m WIDE BY 30.0m LONG, MEETING MUNICIPAL STANDARDS AS IDENTIFIED.
6. CONTRACTOR SHALL OBTAIN A CURRENT COPY AND BECOME FAMILIAR WITH OPSS 805, CONSTRUCTION SPECIFICATION FOR TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES AS WELL AS ALL APPLICABLE MUNICIPAL STANDARDS.
7. THE CONTRACTOR MAY CONSIDER ALTERNATIVE SEDIMENT AND EROSION CONTROL MEASURES. SUCH MEASURES SHOULD BE PRESENTED IN WRITING FOR APPROVAL OF THE SITE ADMINISTRATOR AND MUST BE APPROVED IN WRITING BY THE CONSERVATION AUTHORITY.
8. THE TOPS OF ALL FILTER FABRIC MUST BE A MINIMUM OF 1.0 METRES ABOVE THE GROUND LEVEL AND ATTACHED TO THE FENCE WITH A CONTINUOUS STEEL WIRE. ALTERNATIVELY, THE FILTER FABRIC MUST BE FOLDED OVER THE TOP OF THE FENCE AND ATTACHED TO THE FENCE WITH WIRE LOOPED THROUGH THE FABRIC ON BOTH SIDES OF THE FENCE. FILTER FABRIC IS TO BE TERRAFIX 270R OR EQUIVALENT.
9. ALL DISTURBED GROUND LEFT INACTIVE SHALL BE STABILIZED BY SEEDING, SODDING, MULCHING, OR COVERING OR OTHER EQUIVALENT CONTROL MEASURES. THIS PERIOD OF INACTIVITY SHALL BE AT THE DISCRETION OF THE MUNICIPAL DIRECTOR OF ENGINEERING BUT SHALL NOT EXCEED (30) DAYS OR SUCH LONGER PERIOD DEEMED ADVISABLE BY THE MUNICIPAL DIRECTOR OF ENGINEERING.
10. CONTRACTOR SHALL INSTALL AND MAINTAIN CATCHBASIN SEDIMENT BARRIERS THROUGHOUT THE SITE DURING ALL CONSTRUCTION ACTIVITIES IN ORDER TO MITIGATE SEDIMENT ENTERING THE STORM STORM SEWERS.
11. NO FUEL TO BE STORED ON SITE. IN CASE OF A SPILL PLEASE CONTACT: MOECC SPILLS ACTION CENTER 1–800–268–6060.
12. SEDIMENT CONTROLS ARE TO REMAIN IN PLACE UNTIL WRITTEN DIRECTION IS RECEIVED FROM THE ENGINEER REGARDING THEIR REMOVAL.
13. EROSION AND SEDIMENT CONTROLS WILL BE INSPECTED ON AS PER MUNICIPAL REQUIREMENTS OR AFTER SIGNIFICANT RAINFALL EVENTS.

## SEQUENCE OF CONSTRUCTION

1. ENGINEER TO BE NOTIFIED PRIOR TO INITIATION OF ANY ON SITE WORKS.
2. SILT FENCE AND CONSTRUCTION ACCESS MATS TO BE INSTALLED PRIOR TO THE COMMENCEMENT OF ANY WORKS ONSITE.
3. VEGETATION REMOVAL MAY COMMENCE AFTER ALL SILT FENCE IS INSTALLED AND APPROVED BY THE ENGINEER.
4. COMMENCE WITH EARTH EXCAVATION AND SITE SERVICING (TO BE REMOVED FROM SITE – NO STOCKPILE).
5. EROSION CONTROL MEASURES TO BE MAINTAINED AS DIRECTED BY THE ENGINEER DURING THE CONSTRUCTION PERIOD. ADDITIONAL CONTROL MEASURES MAY BE REQUIRED AT THE DISCRETION OF THE ENGINEER.
6. ALL DISTURBED GROUND LEFT INACTIVE FOR MORE THAN 30 DAYS SHALL BE STABILIZED WITH SEED, SOD, MULCH OR OTHER ADEQUATE COVERING, AS INSTRUCTED BY THE ENGINEER.
7. ALL CONSTRUCTION VEHICLES TO ACCESS THE SITE VIA THE DESIGNATED CONSTRUCTION ENTRANCES AS SHOWN.

HORIZONTAL CONTROL:
ID# 03120040035
R.I.B. W/ BRASS CAP PROTECTED BY A WATER VALVE COVER, LOCATED JUST BEHIND THE SOUTH CURB LINE OF MAPLEVIEW DRIVE WEST, EAST OF VETERAN'S DRIVE, NORTHING–N4909639.121m, EASTING–E603897.740m

ID# 03120040027
R.I.B. W/ BRASS CAP PROTECTED BY A WATER VALVE COVER, LOCATED ON NW. CORNER OF MAPLEVIEW AND BARRIE VIEW DR AT BACK OF SIDEWALK
NORTHING–N4909901.795m, EASTING–E604588.426m

VERTICAL CONTROL:
ID# 03120060018
BRASS TABLET, LOCATED ON CULVERT HEADWALL NE. CORNER OF MAPLEVIEW AND VETERANS DR. SET FLUSH ON E. FACE OF HEADWALL, 110mm BELOW TOP OF WALL AND 110mm N. OF THE SOUTH INSIDE CORNER OF THE WALL. ELEVATION–306.589m

ID# 03120030031
BRASS TABLET, LOCATED ON CULVERT HEADWALL SW. CORNER OF MAPLEVIEW AND BARRIE VIEW DR. SET FLUSH ON W. FACE OF HEADWALL, 290mm BELOW TOP OF WALL AND 180mm NORTH OF THE S. END OF WALL. ELEVATION–301.195m

SITE BENCHMARK: TOP OF GRATE OF ELECTRIC MH ELEV=314.45

Gerrits ENGINEERING
222 Mapleview Drive West, Suite 300
Barrie, ON L4N 9E7 Canada
Tel.: 705.737.3303
Fax.: 705.737.1772
www.gerreng.com



| No. | Issuance Description | YY/MM/DD |
|---|---|---|
| 1. | CLIENT REVIEW | 23/02/13 |
| 2. | SITE PLAN SUBMISSION | 23/02/23 |

Issued For:

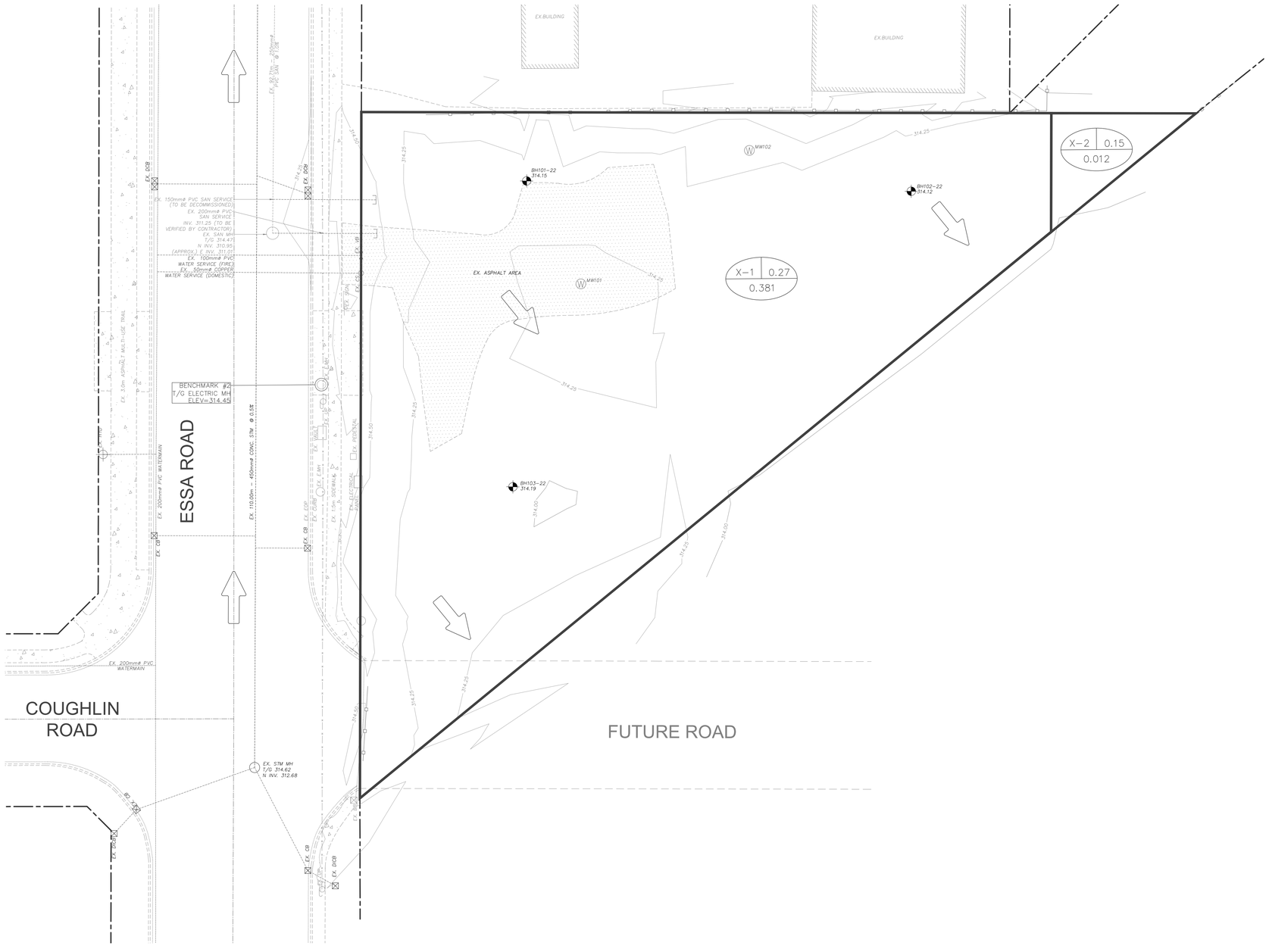
SITE PLAN SUBMISSION

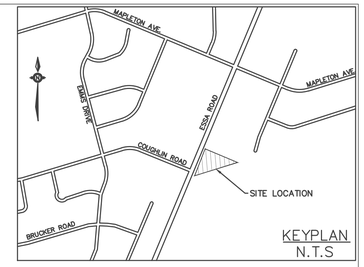
Client
INSPIRATION GROUP OF COMPANIES
218 Export Blvd, Suite 408,
Mississauga, ON L5S 7A7

Project
BARRIE APPARTMENTS
582 Essa Road, Barrie,
ON L4N 9E6

Drawing:
EROSION & SEDIMENT CONTROL PLAN

| Project No. 1760-001-22 | Designed by: RM | Checked by: KF |
|---|---|---|
| Scale: 1:250 | Drawn by: RM | Approved by: JDM |
| Orientation | Stamp | |
| | Drawing No. ESC-1 | |




## LEGEND

ID X/P-1 0.75 5.55 AREA (ha) — RUNOFF COEFFICIENT

CATCHMENT BOUNDARY

OVERLAND FLOW

100 YEAR PONDING AREA

**HORIZONTAL CONTROL:**

ID# 03120040035
R.I.B. W/ BRASS CAP PROTECTED BY A WATER VALVE COVER. LOCATED JUST BEHIND THE SOUTH CURB LINE OF MAPLEVIEW DRIVE WEST, EAST OF VETERAN'S DRIVE. NORTHING-N4909639.121m, EASTING-E603897.740m

ID# 03120040027
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ID# 03120030031
BRASS TABLET. LOCATED ON CULVERT HEADWALL SW. CORNER OF MAPLEVIEW AND BARRIE VIEW DR. SET FLUSH ON W. FACE OF HEADWALL, 290mm BELOW TOP OF WALL AND 180mm NORTH OF THE S. END OF WALL. ELEVATION-301.195m

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SITE PLAN SUBMISSION

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218 Export Blvd, Suite 408,
Mississauga, ON L5S 7A7

Project: BARRIE APPARTMENTS
582 Essa Road, Barrie,
ON L4N 9E6

Drawing:

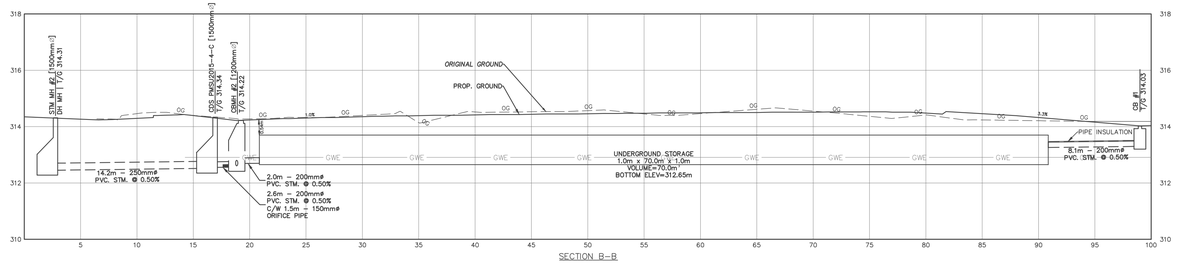
# PRE-DEVELOPMENT STORMWATER DRAINAGE PLAN

| | | | |
|---|---|---|---|
| Project No. | 1760-001-22 | Designed by: RM | Checked by: KF |
| Scale: | 1:250 | Drawn by: RM | Approved by: JDM |

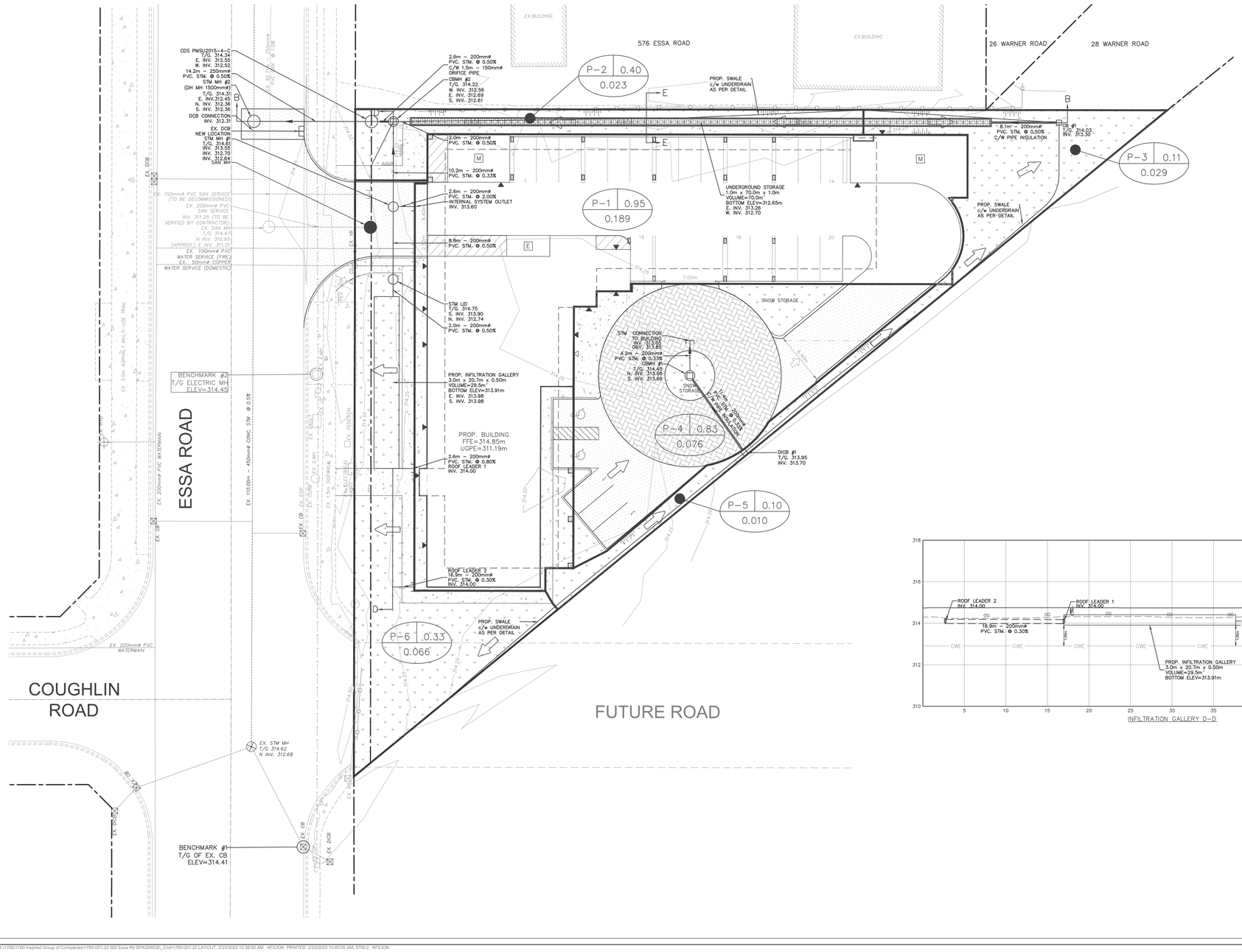
Orientation

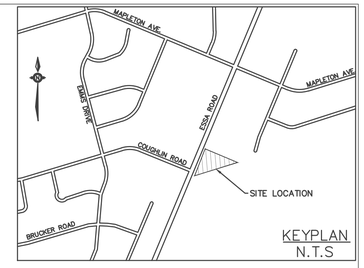
Stamp

Drawing No. STM-1




SECTION B–B




KEYPLAN
N.T.S

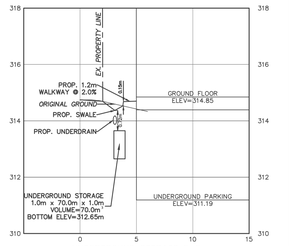
## LEGEND

ID X/P–1 0.75 RUNOFF COEFFICIENT
5.55
AREA (ha)

CATCHMENT BOUNDARY

OVERLAND FLOW

100 YEAR PONDING AREA




UNDERGROUND STORAGE E–E




INFILTRATION GALLERY D–D

**HORIZONTAL CONTROL:**
ID# 03120040035
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BRASS TABLET, LOCATED ON CULVERT HEADWALL SW. CORNER OF MAPLEVIEW AND BARRIE VIEW DR. SET FLUSH ON W. FACE OF HEADWALL, 290mm BELOW TOP OF WALL AND 180mm NORTH OF THE S. END OF WALL. ELEVATION–301.195m

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Orientation

Stamp

Drawing No. STM-2

SAVED: X:\1760\01760 Inspired Group of Companies\1760-001-22 582 Essa Rd SPA\DWGS_Civil\1760-001-22 LAYOUT, 2/23/2023 10:38:00 AM , KFILION PRINTED: 2/23/2023 10:40:05 AM, STM-2, KFILION