Functional Servicing and Stormwater Management Report Wendake Road Development Township of Tiny

File 10-116
June 18, 2021
Revised June 13, 2022

Prepared by

WMI & Associates Limited
119 Collier Street, Barrie Ontario L4M 1H5

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1.0 Background

1.1 General

WMI & Associates Limited has been retained by Margaret and Antonio Cerqueira to prepare a Functional Servicing and Stormwater Management Report in support of a proposed residential development located at the north end of Wendake Road in the Township of Tiny. Refer to the Site Location Plan, Figure 1, **Appendix A**.

The development includes the creation of two new residential lots (with one lot retained) and a hammerhead turning area that will be dedicated to the Township of Tiny as municipal right-of-way. The lots are proposed to be created by severance and will require re-zoning approvals from the municipality. This report is intended to support the application to create the lots and the re-zoning as noted in the Planning Justification Report prepared by Celeste Phillip Planning Inc.

This report presents an investigation of existing services and drainage patterns, and conceptual designs of proposed services and stormwater management controls to support the re-zoning of the subject lands. Fundamental servicing and drainage objectives, as detailed in this report, are based on pre-consultation meetings with Township of Tiny Planning and Public Works staff.

1.2 Site Description

The subject site comprises approximately 7.75ha and is located at the north end of Wendake Road in the Township of Tiny. The property is legally referred to as Part of Lot 21, Concession 5, Township of Tiny, in the County of Simcoe. Refer to the Site Location Plan included in **Appendix A.**

This report is based upon a topographic ground survey, prepared by Eplett Worobec Raikes Surveying Ltd., dated 2014, with supplemental topographical survey performed by WMI & Associates Ltd. in November 2021, and the Proposed Development Plan prepared by Azimuth Environmental Consulting Inc. The proposed lots are located at the northerly end of the property, and consequently the focus of this report is on that portion of the site only. The southern portion of the property (5.00ha) is not addressed in this report.

This report demonstrates how the proposed single family homes can be serviced in terms of on-site water supply, wastewater servicing, stormwater management and utilities. The level of detail presented is sufficient to support planning level approvals and shall serve as a basis for detailed design. The conceptual designs described herein are based on the Township of Tiny Standards, Ontario Ministry of the Environment and Climate Change (MOECC), Severn Sound Environmental Association and the Ontario Building Code (OBC) policies and design guidelines.

Refer to the Conceptual Servicing and Grading Plan and the Detail Sheet, contained in **Appendix C** for pertinent conceptual design details which are discussed throughout this report.

2.0 Existing Conditions

2.1 Topography and Drainage Patterns

There are no existing structures on the subject property, except for a small shed. The vegetative cover on the subject property is mixed deciduous and coniferous forest. It is noted that there are two large sand dunes on the property that are approximately 10-18 metres in height. The dunes are steeply sloped and generally vegetated and tree covered. There is generally very little to no topsoil on the subject property.

The existing site flow patterns are quite varied due to the topography, with the eastern portion of the property flowing from west to east (2-20% slope); drainage for the central portion of the property does not leave the site and infiltrates into the sandy soils; the northern drainage of the property is split to the northeast and west (1%-2:1 and 2:1 slopes, respectively); and, the southern portion of the north part of the site drains from east to west towards Wendake Road with all flow across the property in the form of sheet flow. The lands to the east of the subject property are heavily treed, with mixed deciduous and coniferous forest. There is some minor external flow entering the site from the residential properties to the west of the site.

2.2 Pre-Development Drainage

Based on the preceding information, the site comprises seven drainage areas within the area of interest (2.75ha) with the remaining 5.00ha for the southern portion of the site which is not part of this investigation. The northern portion of the site drains to the west and northeast and are referred to catchments PRE1 and PRE2, respectively. Centrally, the site does has two catchment areas PRE3 and PRE4 for which drainage stays within the site. The southern portion of the site along the residential properties on Wendake Road drains to the Wendake Road ROW. The eastern portion of the site comprises catchments PRE6 and PRE7 which drain to the east towards the existing residential properties and the Shades Valley Road ROW.

The Pre-Development Drainage Plan, **Figure 2,** is included in **Appendix A.**

2.3 Subsurface Conditions

Based on data from the Soils Map of Simcoe County, published by the Canada Department of Agriculture (1959), the predominant soil deposit in the area is identified as Tioga loamy sand (steep phase) as well as Eastport sand. These soils are considered to have good to excessive drainage characteristics, and are classified within hydrologic soils group 'A'.

The sub-surface conditions were further confirmed by GEI Consultants Ltd. in their field investigation and detailed in the Visual Slope Inspection report dated April 21, 2021. Seven (7) hand auger holes were advanced at various locations around the site to depths of 0.5 to 1.0m below grade and constantly encountered damp to moist sands.

2.4 Roads

Wendake Road is a surface treatment road that is approximately 5.5 metres in width. There is no roadside ditching or stormwater conveyance systems on Wendake Road. The existing northern portion of Wendake Road is a low point (sag) in the road system which prevents drainage from outletting. Stormwater flows from the northern portion of the subject site and adjacent area drain to a low point on Wendake Road and eventually spill approximately 70 metres south of the site.

Shades Valley Road is a surface treatment road that is approximately 6.7 metres in width. There is municipal ditching along Shades Valley Road; however, the existing surrounding topography is relatively flat with little option but for the stormwater to infiltrate into the sandy soils.

It is assumed that a large percentage of stormwater in the area infiltrates into the existing sandy soils. We anticipate that during larger rainfall events ponding will occur in the low depressed area on Wendake Road; however, it appears that eventually stormwater infiltrates into the sandy soils.

Asphalt for Shades Valley Road terminates approximately 25m from its southern right-of way limits. A 4.59m wide easement connects the southern end of Shades Valley Road to the subject site 68.1m to the west, crossing over Lot 29 as per Part 2, Plan 51R-11526 (Instrument Number RO785749).

3.0 Waste Water Servicing

There is no existing municipal wastewater collection system in the vicinity of the subject property. It is our understanding that the neighbouring properties in the area are predominantly serviced by on-site wastewater systems. These systems are generally septic tanks and conventional septic beds.

The proposed wastewater servicing for the development is an on-site wastewater treatment system for each individual lot. Each system will be installed in accordance with the Ontario Building Code and the Township of Tiny.

The on-site wastewater treatment system for all three residential lots is based on the Concept Plan and the following criteria:

- Floor space area of 200m².
- Four bedrooms.
- A total of 20 fixture units or less.
- A soil percolation rate of 10 min/cm (60mm/hr).

It is proposed that all of the residential lots be serviced with a conventional septic bed system (or approved equivalent, such as a Waterloo Biofilter System, where area limitations prevent conventional systems, to be determined at the detailed design stage). The full details of the system shall be provided during the detailed engineering design stage.

Based on the Concept Plan and the Conceptual Servicing and Grading Plan the available area for on-site wastewater systems are adequate but it is noted that Lot 1 is slightly restrictive. The grading on Lot 1 is generally steeper with smaller areas available for an onsite wastewater system which would benefit from the Waterloo Biofilter System (or equivalent), while Lot 2 and Lot 3 have shallower grades and more open areas so are potentially better suited for a conventional septic bed system.

It is noted that the Waterloo Biofilter Systems require regular maintenance and that the property owner is typically required to enter into a maintenance contract with the manufacturer. In addition, there are requirements for periodic inspections and removal of solids.

Refer to **Appendix C** for the Conceptual Servicing and Grading Plan.

4.0 Water Servicing

There is no existing municipal water distribution system in the vicinity of the subject property. It is our understanding that the neighbouring properties in the area are predominantly serviced by private wells.

It is proposed that each individual lot will be serviced by a private well. The wells will be installed in accordance with the Ontario Building Code and the Township of Tiny.

Refer to **Appendix C** for the Conceptual Servicing and Grading Plan.

5.0 Roads and Grading

The proposed road configuration is included on the Conceptual Servicing and Grading Plan. The proposed road will conform to the Township of Tiny "Typical Hammerhead Turnaround" with a width of 6.7 m and an edge of asphalt radius of 10m, which equates to a 13.35m centreline radius and is sufficient for emergency response vehicles per OBC 3.2.5.6. The proposed road grades are at 6.0%.

The proposed grading for the road and driveways are noted on the plan, as well as the grading and proposed elevations for the landscaped areas on the proposed lots. The maximum driveway grade is 6.0% and landscaped areas can be graded to a maximum of 3:1. Retaining walls are required along the western, northern and eastern perimeter of the proposed right of way for the Wendake Road turnaround area. The height of the retaining wall is 1.0m along the western boundary with a length of 17.4m, and up to 2.5m for the northern and eastern boundary, with lengths of 21.6m and 19.8m, respectively.

A slope study was performed for the site by GEI Consultants Ltd. GEI notes that the siting of the houses can to be a minimum 5.0m from the toe of the slope versus the 15.0m township standard. The proposed house for Lot 1 is approximately 7.0m from the toe of slope which is the only proposed structure to be less than the township standard but follows the recommendations of the slope study.

It is proposed to have Lot 3 be accessed from Shades Valley Road from the existing easement over Lot 29. This will require the asphalt for Shades Valley Road to be extended approximately 25m to the southern right-of-way boundary. The existing grade for Shades Valley Road is ~1.0% from the south to the north, with the south end of the road being the high point. Based on the existing topography, the driveway for Lot 3 will be graded at 0.5% from Shades Valley Road to the property line with a swale along its southern edge.

Refer to **Appendix C** for the Conceptual Servicing and Grading Plan.
Refer to **Appendix D** for the Slope Study Report.

6.0 Stormwater Management

The stormwater management design principles for the proposed development incorporate the policies and criteria of the Ministry of the Environment and Climate Change (MOECC), the Township of Tiny and the Severn Sound Environmental Association.

In view of the site conditions and the nature of the development the stormwater management design criteria are summarized below:

- Based on the existing sandy soils and the associated high infiltration rate, it is proposed to utilize various infiltration measures to reduce peak runoff as well as provide quality control and water balance benefit
- Quality control will be provided at an 'enhanced' level as defined by MOE's Stormwater Management Planning and Design Manual.
- Low Impact Development (LID) initiatives are to be employed in an effort to preserve some aspects of pre-development hydrology (water balance initiatives).
- Erosion and sediment control measures will be implemented prior to and during the construction of the development and maintained until the site is stabilized.

6.1 Post-Development Condition

Drainage patterns in the post-development condition will endeavor to match the pre-development conditions as closely as possible. However, in order to accommodate the entrances for Lot 1 and 2 at Wendake Road, some of the drainage that was previously contained and infiltrated within the site is now proposed to drain towards the Wendake Road right-of-way. A number of the catchments had similar peak flows in the post-development condition and were not required to be attenuated.

Long length swales with relatively flat slopes (in most instances) are proposed to provide major storm conveyance of driveway and roadway drainage for Catchment A4, which encompasses the majority of Lot 1 and Lot 2, to the existing portion of Wendake Road. Given the very high infiltration rate of the sandy soils, it is anticipated that significant peak flow reduction will occur within the long length swales themselves.

The functional design includes the installation of earthen check dams within the proposed roadside ditch for the hammerhead turning area of Wendake Road for quantity control, runoff volume control and quality control measures. Earthen check dams are also proposed to be installed within the long northern swale on the Lot 2, near the boundary with Lot 1, to provide additional storage for stormwater and decrease runoff velocities which further promotes infiltration.

In an effort to increase the total annual volume of infiltration in the post-development condition, rooftop retention is proposed by utilizing soak-away pits comprised of clear stone for each of the 3 residential lots, to draw down within 48 hours. Using design guidance from the MOE Stormwater Management Planning & Design Manual (March 2003), soak-away pits should be designed to store a maximum of 25mm rainfall depth over the area of each rooftop, since 96.5% of all daily rainfall depths are less than this amount.

Based on the assumed minimum percolation rate of the native soils, and through design guidance provided by the MOE, the total clear stone volume required is 6.4m^3 (with dimensions of 2.0m (L) x 2.0m (W) x 1.60m (D)) assuming a stone voids ratio of 0.4. This will be provided with 2-4 soak-away pits per house depending on final layout.

Typical soak-away pit and roof leader connection details are included on **Figure 4** in **Appendix A.** The soak-away pit sizing calculations are contained in **Appendix B** for reference.

Table 1a below summarizes the uncontrolled pre-development peak flows for various return period design storms.

Catchment I.D.	A (ha)	Tc (min.)	C	Q_{25mm} (m^3/s)	Q_2 (m^3/s)	Q_5 (m^3/s)	Q_{10} (m^3/s)	Q_{25} (m^3/s)	Q_{50} (m^3/s)	Q_{100} (m^3/s)
PRE1	0.11	10.0	0.18	0.001	0.004	0.006	0.006	0.008	0.010	0.012
PRE2	0.28	10.0	0.15	0.001	0.009	0.012	0.014	0.018	0.022	0.025
PRE3	0.56	10.0	0.21	0.005	0.025	0.033	0.038	0.050	0.060	0.069
PRE4	0.47	10.0	0.19	0.003	0.019	0.025	0.029	0.038	0.046	0.052
PRE5	0.25	10.0	0.21	0.002	0.011	0.015	0.017	0.022	0.027	0.031
PRE6	0.45	10.0	0.17	0.003	0.016	0.021	0.025	0.032	0.039	0.045
PRE7	0.63	10.0	0.13	0.003	0.017	0.023	0.027	0.035	0.042	0.048

Table 1b below summarizes the uncontrolled post-development peak flows for various return period design storms.

Catchment I.D.	A (ha)	Tc (min.)	C	Q_{25mm} (m^3/s)	Q_2 (m^3/s)	Q_5 (m^3/s)	Q_{10} (m^3/s)	Q_{25} (m^3/s)	Q_{50} (m^3/s)	Q_{100} (m^3/s)
A1	0.11	10.0	0.18	0.001	0.004	0.006	0.006	0.008	0.010	0.012
A2	0.28	10.0	0.17	0.002	0.010	0.013	0.016	0.020	0.024	0.028
A3	0.56	10.0	0.23	0.006	0.027	0.036	0.042	0.054	0.066	0.075
A4	0.55	10.0	0.28	0.008	0.032	0.043	0.050	0.065	0.079	0.090
A5	0.17	10.0	0.22	0.002	0.008	0.010	0.012	0.016	0.019	0.022
A6	0.43	10.0	0.17	0.003	0.015	0.020	0.024	0.031	0.037	0.043
A7	0.65	10.0	0.19	0.005	0.026	0.035	0.040	0.052	0.063	0.072

Since the catchment flows for A1 and A6 are similar for their respective pre-development catchments (PRE1, PRE6), quantity controls are not required for these catchments. Attenuation is required for the peak flows for the remaining catchments to the pre-development release rates. Allowable release rates are shown in **Table 2** below.

Table 2 below summarizes the allowable release rate for various return period design storms.

Description	Q_2 (m^3/s)	Q_5 (m^3/s)	Q_{10} (m^3/s)	Q_{25} (m^3/s)	Q_{50} (m^3/s)	Q_{100} (m^3/s)
Allowable Flow: 'A2' = PRE2	0.009	0.012	0.014	0.018	0.022	0.025
Allowable Flow: 'A3' = PRE3	0.025	0.033	0.038	0.050	0.060	0.069
Allowable Flow: 'A4+A5' = PRE5	0.011	0.015	0.017	0.022	0.027	0.031
Allowable Flow: 'A7' = PRE7	0.017	0.023	0.027	0.035	0.042	0.048

Attenuation of the peak flows will be achieved through a number of measures applicable for each catchment area. The peak flows for Catchment A2 were only marginally larger than the pre-development condition so the storage from the soakaway pits for half of Lot 2 will provide attenuation to the allowable flow rates. Drainage for Catchment A3, similarly to the pre-development condition PRE3, is contained within the site and can be attenuated with the storage of the soakaway pits and earthen check dams within the eastern portion of the Lot 2 swales. Attenuating the peak flows for Catchment A4 and A5, to the PRE5 peak flows requires 57.9m^3 of stormwater storage through the soakaway pits for Lot 1, and the earthen check dams within the proposed Wendake Road turnaround ditch as well as the earthen check dams within the western portion of the Lot 2 swales. To attenuate Catchment A7, the storage of 25.3m^3 of stormwater from the soakaway pits for Lot 3, earthen check dams within the Lot 3 swale and an infiltration trench with dimensions (7m(L) x 1.8m(W) x 1.6m(D)) adjacent to the driveway near the property line is required to get peak flows to pre-development levels.

Table 3 below summarizes the post-development peak flows and maximum storage volumes for various return period design storms.

Catchment I.D.	Area (ha)	Q_2 (m^3/s)	Q_5 (m^3/s)	Q_{10} (m^3/s)	Q_{25} (m^3/s)	Q_{50} (m^3/s)	Q_{100} (m^3/s)	Max Storage Required (m^3)
A2	0.28	0.009	0.012	0.014	0.018	0.022	0.025	1.7
A3	0.56	0.025	0.033	0.038	0.050	0.060	0.069	3.9
A4+A5	0.72	0.011	0.015	0.017	0.022	0.027	0.031	57.9
A7	0.65	0.017	0.023	0.027	0.035	0.042	0.048	25.3

In comparing pre-development peak flows from Table 1 and the controlled flows from Table 3, it can be seen that the total post-development release rates for all storm events can be achieved to allowable levels for catchments A2, A3, A4+A5, and A7.

The volume of storage provided by the LID features throughout the site (soakaway pits, earthen check dams within the swales and infiltration trench for Lot 3) are shown in **Table 4** below.

Table 4 below summarizes the provided storage volumes of the proposed LID Features.

Catchment ID	LID Feature	Required Storage Volume (m^3)	Provided Storage Volume (m^3)
A2 Lot 2 Rooftop	Soakaway Pits	1.7	2.6
Subtotal			2.6
A3 Lot 2 North Swale (east)	Earthen Check Dam	3.9	11.4
Subtotal			11.4
A4+A5 Lot 1 Rooftop	Soakaway Pits	57.9	2.6
A4+A5 Lot 2 North Swale (west)	Earthen Check Dam		26.5
A4+A5 Turnaround Ditch	Earthen Check Dam		30.5
Subtotal			59.6
A7 Lot 3 Rooftop	Soakaway Pits	25.3	2.6
A7 Lot 3 Swale	Earthen Check Dam		15.2
A7 Lot 3 Trench	Infiltration Trench		8.0
Subtotal			25.8
Total		**88.8**	**99.3**

The provided storage volumes of the proposed LID features is shown to be greater than the required storage volumes to attenuate the peak flows (both for each catchment and collectively). These provided storage volumes will be infiltrated into the existing site soils reducing runoff, improving water balance, promoting filtration, infiltration, evapotranspiration and phosphorus reduction.

The Post-Development Drainage Plan, **Figure 3,** is included in **Appendix A,** and all stormwater calculations are contained within **Appendix B**.

7.0 Utilities

A preliminary assessment of existing utilities in the area indicates that there is hydro and telephone services on both Wendake Road and Shades Valley Road. These services are both aerial services on poles and they currently service the existing residences along both roadways.

Enbridge have confirmed that there is an existing gas main on Wendake Road, which extends to the north limit of the right-of-way. The southern end of Shades Valley Road and Tsirargi Avenue have a number of newly developed properties so it is anticipated that gas is available to connect into.
In terms of servicing for the proposed development, we have not confirmed any requirements for upgrades to those services with the appropriate agencies. It is anticipated that the existing utilities can service the proposed three lots, however, this will be verified during the detailed design stage.

8.0 Erosion and Sedimentation Controls

Effective erosion and sediment control must be established prior to construction commencement and maintained until the site has been stabilized. Pro-active measures will be required to limit the amount of sediment travelling downstream. Where site grading is required, exposure of the soil during construction should be minimized to avoid erosion and sedimentation.

<u>Silt Fence:</u> Silt fence will be placed on the down slope of all excavated material to prevent sediment transport onto adjacent properties and the municipal roadways. Periodic inspections and repairs to the silt fence should be performed regularly, as well as after every rainfall event.

<u>Mud Mat:</u> Mud tracking from construction traffic must be controlled through the use of a mud-mat consisting of large diameter rip-rap located at the site entrance/exit.

<u>Vegetated Buffers:</u> Existing grassland vegetation/wooded and lawn areas along the development limits are to be maintained wherever possible. These areas will provide a natural barrier to filter potentially sediment-laden overland flow.

<u>Monitoring & Inspection:</u> Erosion monitoring and sediment removal should be undertaken every week, and after every rainfall event. All damaged or clogged control devices or fencing must be repaired immediately.

9.0 Summary

The Functional Servicing and Stormwater Management Report demonstrates how the proposed residential lots can be serviced in terms of servicing, road construction, grading, stormwater management and utilities. The summary specifics are:

- Wastewater treatment will be provide via the design and installation of on-site wastewater systems for each individual lot. The systems will employ specifications, materials and methodology approved by the Ontario Building Code and the Township of Tiny.
- Water supply to each individual lot will be achieved by the installation of a private drilled well system. The details and configuration of the private well systems will conform to the requirements of the Ontario Building Code and the Township of Tiny.
- Stormwater management controls will be provided by the design and installation of infiltration measures, including soak-away pits, earthen check dams and an infiltration trench. Based on the peak flows from the development being attenuated to the pre-development conditions, there will be no detrimental downstream impacts to downstream properties.
- There are existing natural gas, hydro and telephone services in the area that will be available to service the proposed residential lots. Confirmation of potential upgrades to the existing systems is required.
- The use of silt fence, a construction mud mat, and vegetated buffers will ensure downstream stormwater quality is maintained during construction.
- Requirements for fire access are met with the 10.0m radius hammerhead design.

This report supports the proposed residential lots to be created by consent and the proposed re-zoning.

Prepared by:
WMI & Associates Limited

Chris Jungkunz, EIT

Reviewed by:

REGISTERED PROFESSIONAL ENGINEER
S. R. MORASH
June 13, 2022
PROVINCE OF ONTARIO

Stephen Morash, P.Eng.

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APPENDIX A

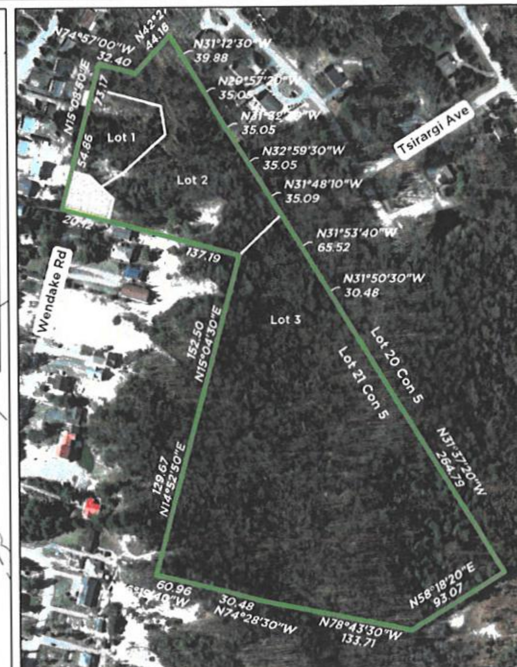
Report Figures

CONCEPT PLAN

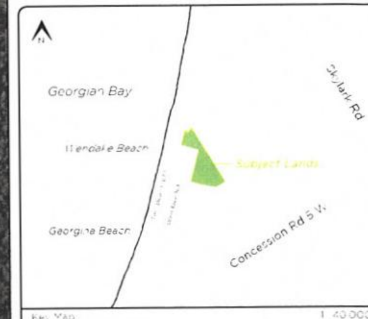
Part of Lot 21, Concession 5
Township of Tiny, County of Simcoe

Zoning Table - Shoreline Residential (SR) Zone

	Required	Proposed
Lot Area	4,000m²	±4,598.4m²
Lot Frontage	30m	±4.2m
Front Yard	8.0m	±14.4m
Interior Side Yard	3.0m & 1.8m	±15.6m
Rear Yard	7.5m	±7.5m
Coverage (max)	30%	<3%
Height (max)	11.0m	<11.0m
Ground Floor Area	75m²	±173.5m²
Setback to Toe of Slope	15.0m	±7.0m
Setback to Retaining Wall (>1m in Height) Front Yard Setback Side Yard Setback	 7.5m 1.0m	 0m 0m
Parking Spaces	1 per lot	1 per lot (minimum)



Property Boundary   Scale 1 : 4,000



Key Map   1:40,000

LEGEND

- Subject Lands — Lot Area: ±7.753ha (19.16ac)
- Proposed Lot Lines
- Proposed Dwellings
- Proposed Driveways
- Public Right-of-Way
- 0.5m Contours
- Wooded Area
- Existing Trail

Note: This drawing is for discussion purposes only.
Sources: Plan prepared by Eplett Worobec Raikes Surveying Ltd. dated July 2013. County of Simcoe interactive map. Concept Plan provided by others.

Scale 1:1250

Drawn By: A.M.   Date: May 10, 2022

celeste PHILLIPS PLANNING INC.
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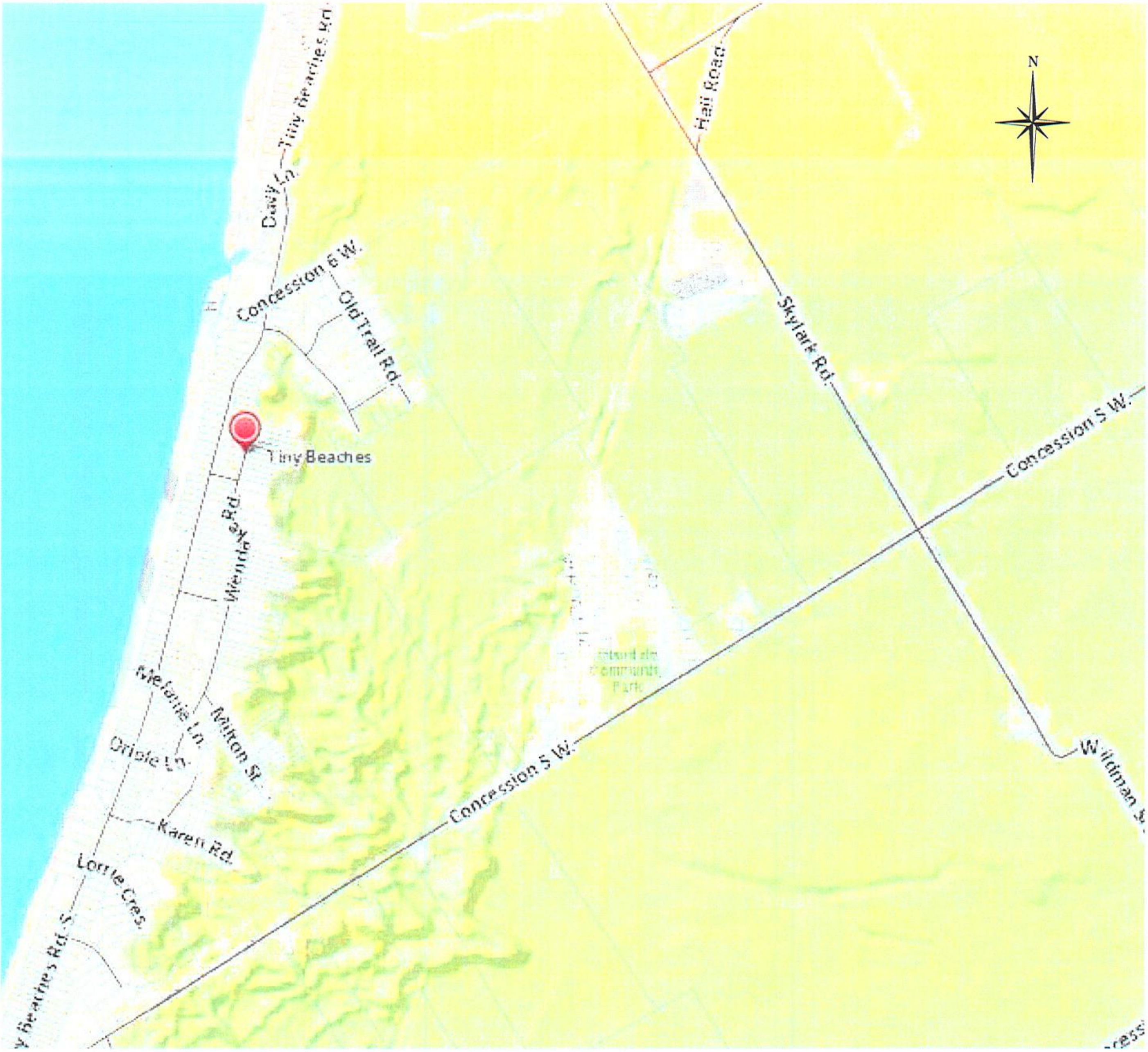


Drawing Title

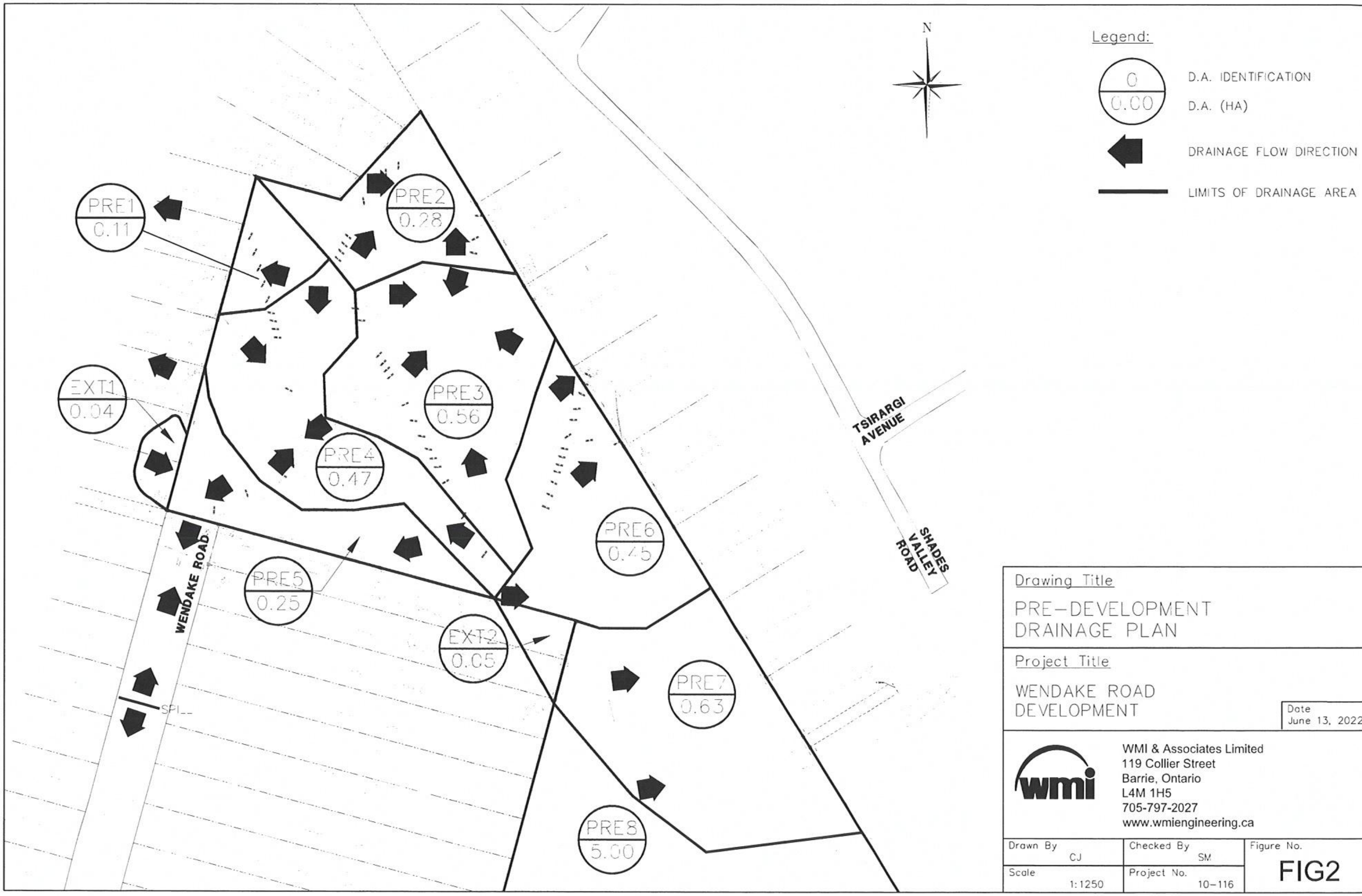
SITE LOCATION PLAN

Project Name:

WENDAKE ROAD DEVELOPMENT
TOWNSHIP OF TINY

WMI & Associates Limited
119 Collier Street
Barrie, Ontario
L4M 1H5
705-797-2027
www.wmiengineering.ca

Drawn By	Checked By	Figure No.
RDW	SM	FIG1
Scale N.T.S.	Project No. 10–116	



Drawing Title

PRE-DEVELOPMENT DRAINAGE PLAN

Project Title

WENDAKE ROAD DEVELOPMENT

Date June 13, 2022

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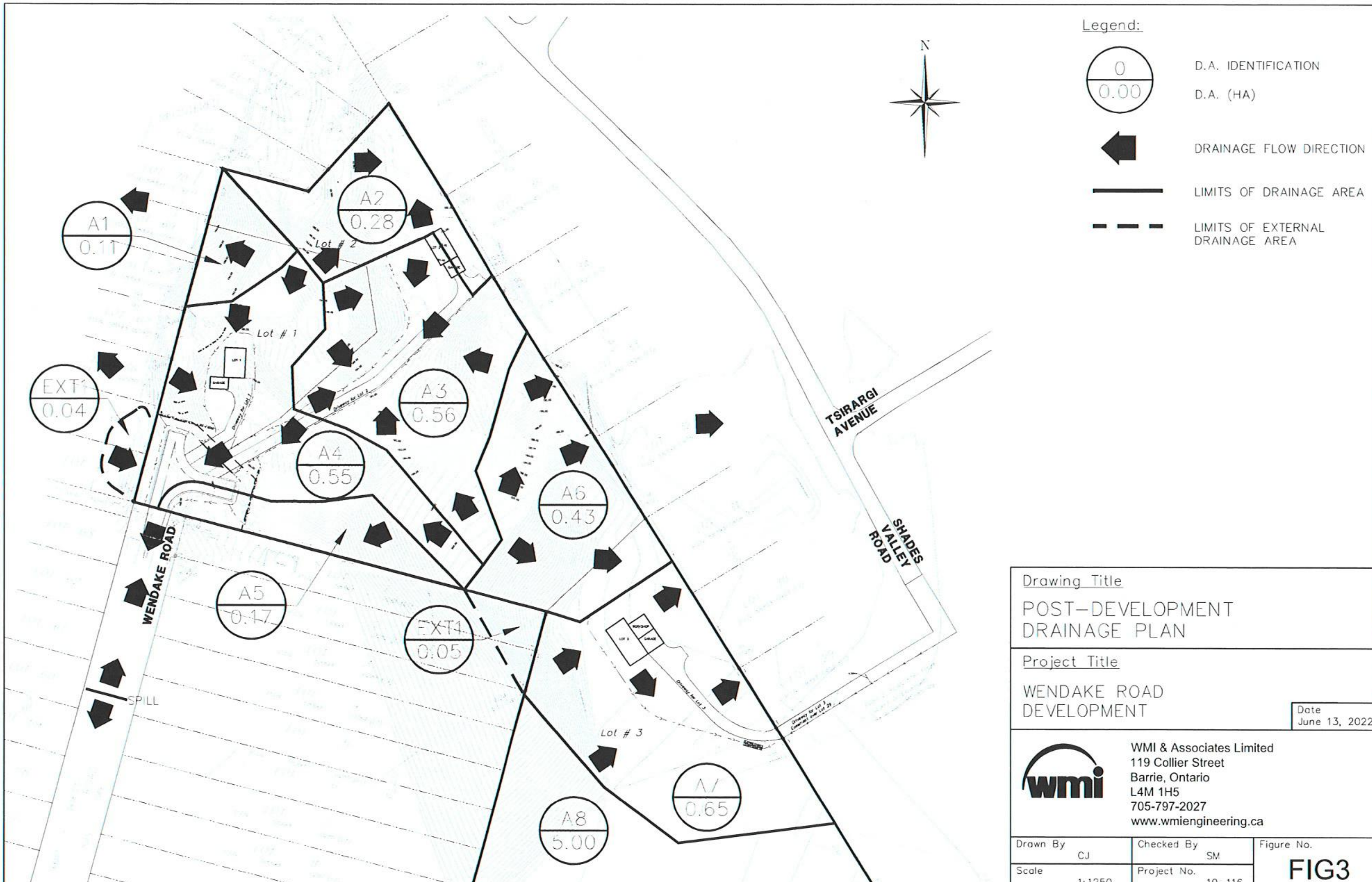
Drawn By	Checked By	Figure No.
CJ	SM	FIG2
Scale 1:1250	Project No. 10-116	



Drawing Title

POST-DEVELOPMENT DRAINAGE PLAN

Project Title

WENDAKE ROAD DEVELOPMENT

Date
June 13, 2022

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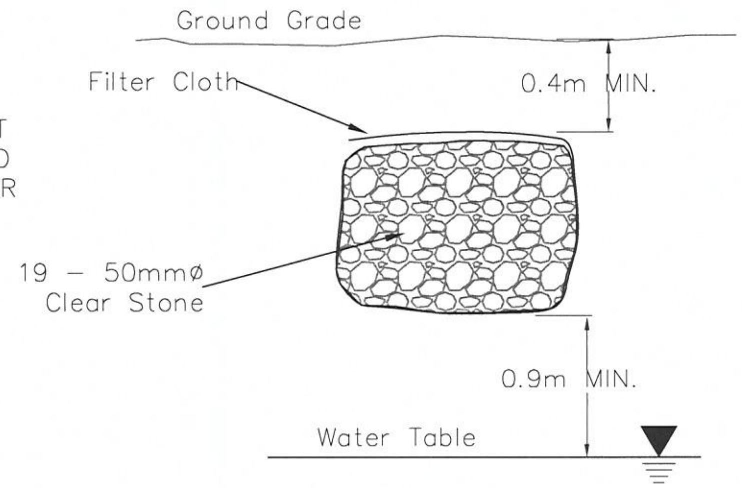
Drawn By	Checked By	Figure No.
CJ	SM	FIG3
Scale 1:1250	Project No. 10-116	

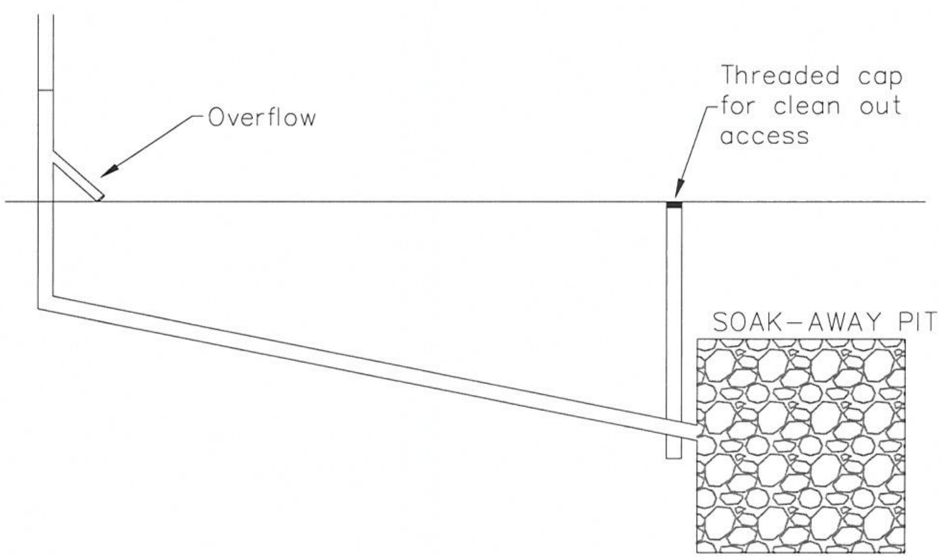
NOTES:
1. SOAK-AWAY PITS MUST HAVE SEDIMENT TRAP AND CLEANOUT ACCESS AS PER DETAIL 'B'.



DETAIL 'A'

SOAK-AWAY PIT

N.T.S.



DETAIL 'B'

ROOF LEADER CONNECTION

N.T.S.

Drawing Title

SOAK-AWAY PIT & ROOF LEADER DETAILS

Project Title

WENDAKE ROAD DEVELOPMENT

WMI & Associates Limited
119 Collier Street
Barrie, Ontario
L4M 1H5
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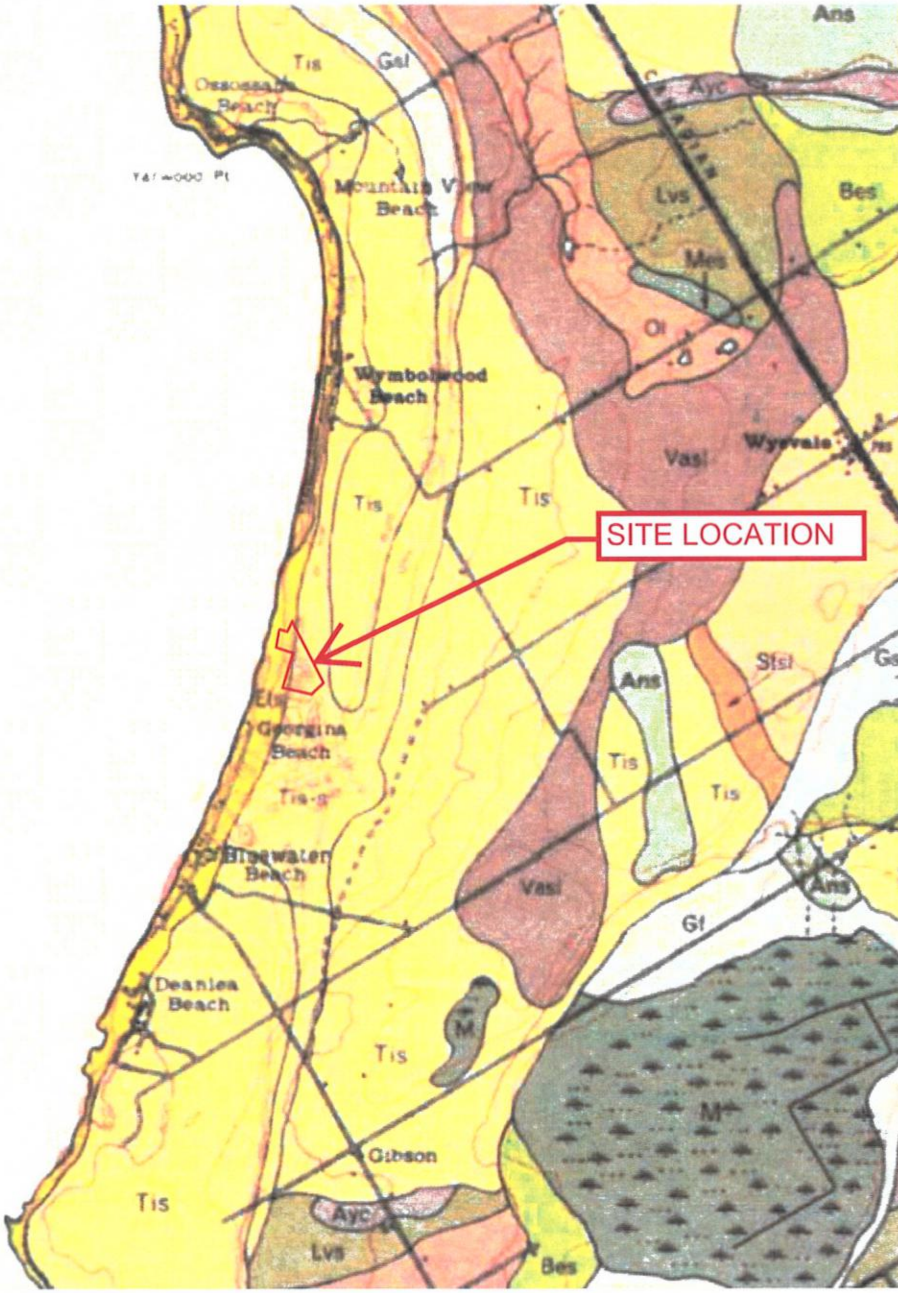
Drawn By	Checked By	Figure No.
RDW	SM	FIG4
Scale N.T.S.	Project No. 10–116	

APPENDIX B

Stormwater Management Calculations



TIOGA	EASTPORT
loamy sand Tis 75,500 sandy loam Tisl 44,500 fine sandy loam Tif 17,900 loamy sand — stony phase Tis-b 5,800 loamy sand — eroded phase Tis-e 1,300 loamy sand — steep phase Tis-s 8,500	sand Ets 2,000
Gr	Grey calcareous outwash sand.
Good.	Excessive.
Smooth, gently to irregular, steeply sloping.	Irregular, moderately sloping.
Stonefree to m	Stonefree.
Mediu	Alkaline.
Pod	Dry Sands.

CHART H2-6A (Cont'd)

CHART H2-6A - continued

Soils Series	Soil Texture	Hyd. Soil Grp.	Soils Series	Soil Texture	Hyd. Soil Grp.	Soils Series	Soil Texture	Hyd. Soil Grp.
Darlington	s	B	"	c l	C	Heidelburg	f s l	B
"	l	C	Ferndale	si l	BC	Hendrie	s /g	AB
Dawson	s l	A	"	c l	C	Henwood	s /g	A
"	l	B	Flamboro	s	B	Hespeler	s l	B
Deloro	l	B	"	s l	B	Hillier	c &c l	C
Devlin	si c /	C	Floradale	l	B	Hillsburgh	s l	A
	c l		Fonthill	g	A	Himsworth	si l	BC
Dinorwic	c	BC	"	l	B	Hinchinbr.	s l	B
Dobie	c /l	BC	Font	g s l	A	"	l	BC
Doe	s l	B	Forbes	c	D	"	si l	BC
"	si l	BC	Fox	s	A	Honeywood	s l	AB
Donald	l	B	"	s l	AB	"	si l	BC
Donnybrook	s g	A	"	gr l	AB	"	s	A
"	s l	AB	Foxboro	s	A	Howland	s l	B
"	l	B	Franktown	l	B	"	l	BC
Dorion	c /l	C	Freeport	s l	B	Huron	s l	B
Dorking	si c l	BC	Galesburg	s l	A	"	l	BC
Dumfries	s l	A	"	l	AB	"	si l	BC
"	l	AB	Gameland	s /g	AB	"	c l	CorD
Dummer	s l	A	Gananoque	c	C	"	c	D
"	l	B	Gerow	c l	C	Innisville	s l	B
Dundonald	s l	AB	Gilford	s l	B	Jeddo	l	BC
Dunedin	c	D	"	l	B	"	c l	C
Dymond	s l	AB	Gordon	si c	C	"	c	D
"	l	B	Granby	s	B	Kagawong	si l	BC
Eagle Lake	s /g	AB	"	s l	B	Kars	s /g	A
Eamer	l	BC	Grand	l	B	"	s l	B
Earlton	si l	B	Grenville	s l	A	Kemble	si l	BC
"	c l	C	"	l	BC	"	si c l	C
Eastport	s	A	Grimsby	s l	A	"	si c	C
Edenvale	s	AB	Guelph	s l	A	"	c l	D
"	s l	B	"	l	BC	Kenabeek	s	B
Eganville	l	B	"	si l	BC	"	s l	B
Elderslie	si l	BC	Guerin	s l	AB	Killean	l /s l	AB
"	si c l	C	"	l	B	King	si l	BC
"	c l	C	Gwillimb.	g	AB	"	c l	C
Eldorado	s l	A	Haileybury	si c l	C	Kirkland	s l	A
"	l	B	"	si c	C	Kossuth	s l	B
Elk Pit	s g	A	"	c	CD	L'Achigan	s	AB
Ellwood	c l	C	Haldimand	si l	BC	Lambton	l	BC
Elmbrook	si l	BC	"	si c l	C	"	si l	BC
"	c l	C	"	c	CorD	Lanark	c	C
"	c	C	"	c l	C	Lansdowne	c /si l	C
Elmira	l	B	Hanbury	si c l	C	Leech	si c l	C
Elmsley	s l	B	"	si c	C	"	c l	D
Embro	s l	BC	"	c	D	Leitrim	g	B
"	si l	C	Harkaway	l	B	Leith	si l	BC
Emily	l	B	"	si l	BC	Lily	l /s l	B
Emo	c & p	C	Harriston	l	BC	Lincoln	si c	C
Englehart	s l	B	"	si l	BC	"	c	C
Evanturel	si l	BC	Harrow	s	A	Lindsay	c l	C
"	si c l	C	"	s l	AB	"	c	C
Falardeau	si l	BC	"	l	B	Lisbon	s l	A
"	si c l	C	Havelock	s /g	A	Listowel	l	B/BC
Farmington	s l	A	Hawkesvi.	l	B	"	si l	BC
"	l	B	Haysville	s l	AB	Little Cur.	c	C

CHART H2-6A (Cont'd)

CHART H2-6A - continued

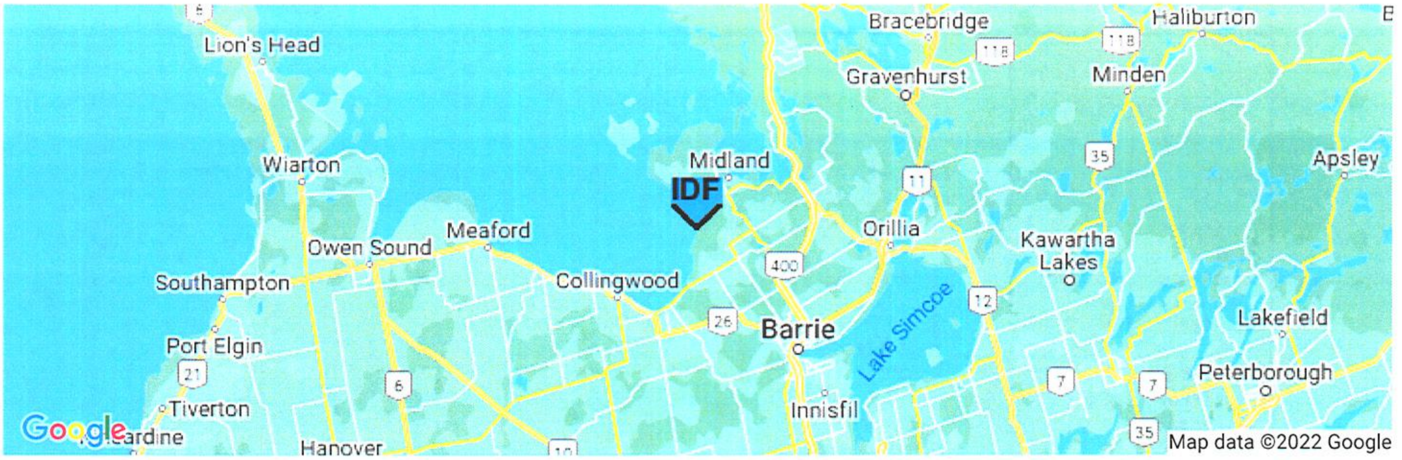
Soils Series	Soil Texture	Hyd. Soil Grp.	Soils Series	Soil Texture	Hyd. Soil Grp.	Soils Series	Soil Texture	Hyd. Soil Grp.
"	si l	BC	Uplands	s	A			
Snedden	si c l	C	"	s l	A			
Solmesville	c l	C	Upsala	f s	AB			
South Bay	c l	D	Vars	l	B			
"	c	D	Vasey	s l	AB			
Spohn	s /g /		"	l	B			
	c	BC	Vergennes	si l	BC			
Springvale	s l	A	"	l	BC			
Stafford	l	B	"	c	C			
Stockdale	si l/f		Vincent	si l	BC			
	s	B	"	si c l	C			
St. Clem.	s l	A	"	c l	D			
"	si c l	C	Vineland	s l	AB			
St. Jacobs	l	B	Wabi	s l	A			
St. Peter	s /g	A	"	l	B			
St. Rosalie	c	C	Wabigoon	c	C			
St. Samuel	s	B	Waterloo	s	A			
"	s l	B	"	s l	A			
St. Thomas	s	A	Watrin	s	B			
Sullivan	s	A	Waupoos	c l	D			
"	s l	A	"	c	D			
Sutton Bay	s	B	Wauseon	s l	B			
"	s l	B	Wayside	s	AB			
Tansley	c	D	Welland	c	C			
Tavistock	s l	AB	Wellesley	s l	AB			
"	si l	BC	"	si c l	C			
Tecumseth	s	AB	Wemyss	s l	AB			
			Wendigo	s	A			
Teeswater	si l	B	"	s l + r	AB			
Temisk'g	r &c	C	"	s l	AB			
Tennyson	s l	A	Wendover	c l	D			
Thames	c l	D	"	c	D			
Thorah	s	B	Westmeath	s	A			
Thornloe	c	C	Whitby	l	BC			
Thwaites	si l	BC	White Lake	s /g	A			
Tioga	s	A	Whitfield	si l	B			
"	s l	A	Wiarton	l	B			
Toledo	si l	BC	"	si l	BC			
"	si c l	C	Wilmot	s l	B			
"	c l	C	"	si c l	C			
"	c	C	Winona	s l	AB			
Trafalgar	c	D	Woburn	s l	A			
Trent	s	AB	"	l	B*			
Tuscola	s l	AB	Wolford	c l	D			
"	si l	BC	Wolsey	si c	C			
Tweed	s l	A	Wooler	si l/f				
"	s l + r	AB		s	AB			
"	r	AB	Woolwich	l	BC			
Undiffer'd	s l + r	AB or B(dep. on depth)	Worthing.	s /g /c	BC			
			Wyevale	s /g	A			

Ontario IDF CURVE LOOKUP

Active coordinate

44° 38' 15" N, 79° 58' 45" W (44.637500,-79.979167)

Retrieved: Mon, 30 May 2022 15:04:53 GMT



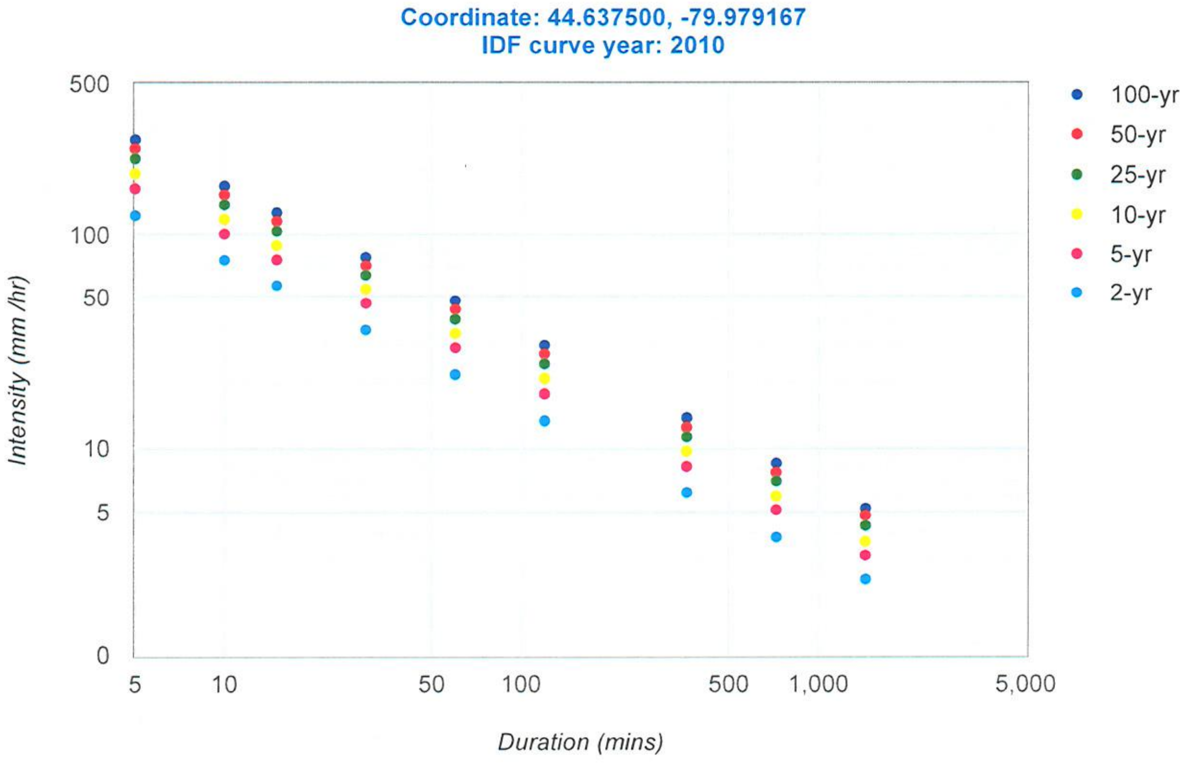
Location summary

These are the locations in the selection.

IDF Curve: 44° 38' 15" N, 79° 58' 45" W (44.637500,-79.979167)

Results

An IDF curve was found.



Coefficient summary

IDF Curve: 44° 38' 15" N, 79° 58' 45" W (44.637500,-79.979167)

Retrieved: Mon, 30 May 2022 15:04:53 GMT

Data year: 2010
IDF curve year: 2010

Return period	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
A	21.7	28.8	33.6	39.5	43.9	48.2
B	-0.699	-0.699	-0.699	-0.699	-0.699	-0.699

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	123.3	75.9	57.2	35.2	21.7	13.4	6.2	3.8	2.4
5-yr	163.6	100.8	75.9	46.8	28.8	17.7	8.2	5.1	3.1
10-yr	190.8	117.6	88.5	54.5	33.6	20.7	9.6	5.9	3.6
25-yr	224.4	138.2	104.1	64.1	39.5	24.3	11.3	7.0	4.3
50-yr	249.4	153.6	115.7	71.3	43.9	27.0	12.5	7.7	4.8
100-yr	273.8	168.6	127.0	78.2	48.2	29.7	13.8	8.5	5.2

Rainfall depth (mm)

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	10.3	12.7	14.3	17.6	21.7	26.7	37.2	45.8	56.5
5-yr	13.6	16.8	19.0	23.4	28.8	35.5	49.4	60.8	75.0
10-yr	15.9	19.6	22.1	27.3	33.6	41.4	57.6	71.0	87.5
25-yr	18.7	23.0	26.0	32.1	39.5	48.7	67.7	83.5	102.8
50-yr	20.8	25.6	28.9	35.6	43.9	54.1	75.3	92.7	114.3
100-yr	22.8	28.1	31.8	39.1	48.2	59.4	82.7	101.8	125.5

Terms of Use

Climate Normals 1981-2010 Station Data

Metadata including Station Name, Province, Latitude, Longitude, Elevation, Climate ID, WMO ID, TC ID

STATION_NAME	PROVINCE	LATITUDE	LONGITUDE	ELEVATION	CLIMATE_ID	WMO_ID	TC_ID
MIDLAND WATER POLLUTION CONTROL PLANT	ON	44°45'28.056" N	79°52'31.014" W	180.0 m	6115127		

Legend
A = WMO "3 and 5 rule" (i.e. no more than 3 consecutive and no more than 5 total missing for either temperature or precipitation)
B = At least 25 years
C = At least 20 years
D = At least 15 years

1981 to 2010 Canadian Climate Normals station data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
Days with Precipitation														
>= 0.2 mm	17	11.7	11.2	11.6	13.1	11.1	10.3	11.1	12.9	15.6	16.4	16.8	158.6	D
>= 5 mm	8.4	5.1	4.2	4.8	6.1	5	4.2	5	5.4	6.4	8	7.7	70	D
>= 10 mm	4.2	2.5	2.1	2	3.3	3.1	2.2	2.5	3.3	3.1	3.8	3.5	35.5	D
>= 25 mm	0.4	0.22	0.29	0.26	0.58	0.65	0.5	0.55	0.9	0.3	0.45	0.37	5.5	D

WMI Calculation

total >= 0.2 mm:	**158.6**
total >=25 mm:	**5.5**
%<25mm:	**96.5%**

WMI & Associates Limited
119 Collier Street, Barrie, Ontario L4M 1H5
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RUNOFF COEFFICIENT CALCULATIONS
"C" SPREADSHEET

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

RUNOFF COEFFICIENT NUMBERS

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade	0.22	0.35	0.55
	5 - 10% grade	0.3	0.45	0.6
	10 - 30% grade	0.4	0.65	0.7
Pasture Land	0 - 5% grade	0.1	0.28	0.4
	5 - 10% grade	0.15	0.35	0.45
	10 - 30% grade	0.22	0.4	0.55
Woodlot or Cutover	0 - 5% grade	0.08	0.25	0.35
	5 - 10% grade	0.12	0.3	0.42
	10 - 30% grade	0.18	0.35	0.52
Lakes and Wetlands		0.05	0.05	0.05
Impervious Area	(i.e. buildings, roads, parking lot, etc.)	0.95	0.95	0.95
Gravel	(not used for proposed parking or storage areas)	0.4	0.5	0.6
Residential	Single Family	0.3	0.4	0.5
	Multiple (i.e. semi, townhouse, apartment, etc.)	0.5	0.6	0.7
Industrial	Light	0.55	0.65	0.75
	Heavy	0.65	0.75	0.85
Commercial		0.6	0.7	0.8
Unimproved Areas		0.1	0.2	0.3
Lawn	< 2% grade	0.05	0.11	0.17
	2 - 7% grade	0.1	0.16	0.22
	> 7% grade	0.15	0.25	0.35

Ref: Runoff Coefficient Numbers - Adapted from Design Chart 1.07, Ontario Ministry of Transportation, "MTO Drainage Management Manual", MTO. (1997)

<<< **Elements Requiring Input Information**

PRE-DEVELOPMENT CONDITION PRE1

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade	0.11		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)			
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade			
	> 7% grade			

Total Area (ha) = 0.11 **Runoff Coefficient, C =** **0.18**

PRE-DEVELOPMENT CONDITION PRE2

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade	0.13		
	10 - 30% grade	0.15		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)			
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade			
	> 7% grade			

Total Area (ha) = 0.28 **Runoff Coefficient, C =** **0.15**

PRE-DEVELOPMENT CONDITION PRE3

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade	0.06		
	10 - 30% grade	0.47		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)	0.03		
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade			
	> 7% grade			

Total Area (ha) = 0.56 **Runoff Coefficient, C =** **0.21**

PRE-DEVELOPMENT CONDITION PRE4

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade	0.05		
	10 - 30% grade	0.41		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)	0.01		
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade			
	> 7% grade			

Total Area (ha) = 0.47 **Runoff Coefficient, C =** **0.19**

PRE-DEVELOPMENT CONDITION PRE5

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade	0.24		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)	0.01		
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade			
	> 7% grade			

Total Area (ha) = 0.25 **Runoff Coefficient, C =** **0.21**

PRE-DEVELOPMENT CONDITION PRE6

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade	0.09		
	10 - 30% grade	0.36		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)			
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade			
	> 7% grade			

Total Area (ha) = 0.45 **Runoff Coefficient, C =** **0.17**

PRE-DEVELOPMENT CONDITION PRE7

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade	0.53		
	10 - 30% grade	0.1		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)			
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade			
	> 7% grade			

Total Area (ha) = 0.63 **Runoff Coefficient, C =** **0.13**

EXTERNAL EXT1

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)			
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade			
	> 7% grade	0.04		

Total Area (ha) = 0.04 **Runoff Coefficient, C =** **0.15**

EXTERNAL EXT2

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade	0.05		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)			
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade			
	> 7% grade			

Total Area (ha) = 0.05 **Runoff Coefficient, C =** **0.18**

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RUNOFF COEFFICIENT CALCULATIONS
"C" SPREADSHEET

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

RUNOFF COEFFICIENT NUMBERS

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade	0.22	0.35	0.55
	5 - 10% grade	0.3	0.45	0.6
	10 - 30% grade	0.4	0.65	0.7
Pasture Land	0 - 5% grade	0.1	0.28	0.4
	5 - 10% grade	0.15	0.35	0.45
	10 - 30% grade	0.22	0.4	0.55
Woodlot or Cutover	0 - 5% grade	0.08	0.25	0.35
	5 - 10% grade	0.12	0.3	0.42
	10 - 30% grade	0.18	0.35	0.52
Lakes and Wetlands		0.05	0.05	0.05
Impervious Area	(i.e. buildings, roads, parking lot, etc.)	0.95	0.95	0.95
Gravel	(not used for proposed parking or storage areas)	0.4	0.5	0.6
Residential	Single Family	0.3	0.4	0.5
	Multiple (i.e. semi, townhouse, apartment, etc.)	0.5	0.6	0.7
Industrial	Light	0.55	0.65	0.75
	Heavy	0.65	0.75	0.85
Commercial		0.6	0.7	0.8
Unimproved Areas		0.1	0.2	0.3
Lawn	< 2% grade	0.05	0.11	0.17
	2 - 7% grade	0.1	0.16	0.22
	> 7% grade	0.15	0.25	0.35

Ref: Runoff Coefficient Numbers - Adapted from Design Chart 1.07, Ontario Ministry of Transportation, "MTO Drainage Management Manual", MTO, (1997)

<<< **Elements Requiring Input Information**

POST-DEVELOPMENT CONDITION A1

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade	0.11		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)			
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade			
	> 7% grade			

Total Area (ha) = 0.11 **Runoff Coefficient, C =** **0.18**

POST-DEVELOPMENT CONDITION A2

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade	0.13		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)	0.01		
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade	0.14		
	> 7% grade			

Total Area (ha) = 0.28 **Runoff Coefficient, C =** 0.17

POS–DEVELOPMENT CONDITION A3

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade	0.47		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)	0.04		
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade	0.05		
	> 7% grade			

Total Area (ha) = 0.56 **Runoff Coefficient, C =** 0.23

POST-DEVELOPMENT CONDITION A4

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade	0.26		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)	0.08		
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade	0.05		
	> 7% grade	0.16		

Total Area (ha) = 0.55 **Runoff Coefficient, C =** 0.28

POST-DEVELOPMENT CONDITION A5

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade	0.13		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)	0.01		
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade			
	> 7% grade	0.03		

Total Area (ha) = 0.17 **Runoff Coefficient, C =** **0.22**

POST-DEVELOPMENT CONDITION A6

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade	0.08		
	10 - 30% grade	0.35		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)			
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade			
	> 7% grade			

Total Area (ha) = 0.43 **Runoff Coefficient, C =** **0.17**

POST-DEVELOPMENT CONDITION A7

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade			
	5 - 10% grade	0.3		
	10 - 30% grade	0.1		
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)	0.05		
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade	0.2		
	> 7% grade			

Total Area (ha) = 0.65 **Runoff Coefficient, C =** **0.19**

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RATIONAL METHOD CALCULATIONS

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

<<< **Elements Requiring Input Information**

Rainfall Intensity-Duration-Frequency Coefficients from: MTO IDF Curve

2-year		5-year		10-year		25-year		50-year		100-year	
A =	21.7	A =	28.8	A =	33.6	A =	39.5	A =	43.9	A =	48.2
B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699

Rational Method Formula

$$Q = \frac{C \times I \times A}{360} \quad (m^3/s)$$

where, C = Runoff Coefficient
I = Rainfall Intensity, (mm/hr)
A = Drainage Area, (ha)

Rainfall Intensity Equation (2-100 year storm events)

$$I_{2\text{-}100} = A \times (T_C / 60)^B \quad (mm/hr)$$

where, A = Rainfall IDF Coefficient
B = Rainfall IDF Coefficient
T_C = Time of Concentration, (min)

Runoff Coefficient Equations
Based on MTO Drainage Manual (1984), page BD-4

2-year	C_2 =	C
5-year	C_5 =	C
10-year	C_{10} =	C
25-year	C_{25} =	1.10 x C
50-year	C_{50} =	1.20 x C
100-year	C_{100} =	1.25 x C

For storms having a return period of more than 10 years, the Runoff Coefficient, C, will be increased as indicated above, up to a maximum value of 1.

Rainfall Intensity Equation (25mm storm event)
Based on the MOE SWMP Manual (2003), Eq'n 4.9

$$I_{25mm} = (43 \times C) + 5.9 \quad (mm/hr)$$

where, C = Runoff Coefficient

Catchment I.D.	A (ha)	T_C (min.)	C	Q_{25mm} (m^3/s)	Q_2 (m^3/s)	Q_5 (m^3/s)	Q_{10} (m^3/s)	Q_{25} (m^3/s)	Q_{50} (m^3/s)	Q_{100} (m^3/s)
PRE1	0.11	10.0	0.18	0.001	0.004	0.006	0.006	0.008	0.010	0.012
PRE2	0.28	10.0	0.15	0.001	0.009	0.012	0.014	0.018	0.022	0.025
PRE3	0.56	10.0	0.21	0.005	0.025	0.033	0.038	0.050	0.060	0.069
PRE4	0.47	10.0	0.19	0.003	0.019	0.025	0.029	0.038	0.046	0.052
PRE5	0.25	10.0	0.21	0.002	0.011	0.015	0.017	0.022	0.027	0.031
PRE6	0.45	10.0	0.17	0.003	0.016	0.021	0.025	0.032	0.039	0.045
PRE7	0.63	10.0	0.13	0.003	0.017	0.023	0.027	0.035	0.042	0.048
EXT1	0.04	10.0	0.15	0.000	0.001	0.002	0.002	0.003	0.003	0.004
EXT2	0.05	10.0	0.18	0.000	0.002	0.003	0.003	0.004	0.005	0.005
A1	0.11	10.0	0.18	0.001	0.004	0.006	0.006	0.008	0.010	0.012
A2	0.28	10.0	0.17	0.002	0.010	0.013	0.016	0.020	0.024	0.028
A3	0.56	10.0	0.23	0.006	0.027	0.036	0.042	0.054	0.066	0.075
A4	0.55	10.0	0.28	0.008	0.032	0.043	0.050	0.065	0.079	0.090
A5	0.17	10.0	0.22	0.002	0.008	0.010	0.012	0.016	0.019	0.022
A6	0.43	10.0	0.17	0.003	0.015	0.020	0.024	0.031	0.037	0.043
A7	0.65	10.0	0.19	0.005	0.026	0.035	0.040	0.052	0.063	0.072
A4+A5	0.72	10.0	0.27	0.009	0.040	0.054	0.063	0.081	0.098	0.112

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MODIFIED RATIONAL METHOD CALCULATIONS
5-year Design Storm Event

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

[ ] <<< **Elements Requiring Input Information**

Rainfall Intensity-Duration-Frequency Coefficients from: http://www.mto.gov.on.ca/IDF_Curves/terms.shtml

2-year		5-year		10-year		25-year		50-year		100-year	
A =	21.7	A =	28.8	A =	33.6	A =	39.5	A =	43.9	A =	48.2
B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699

Rational Method Formula

$$Q = \frac{C \times I \times A}{360} \quad (m^3/s)$$

where, C = Runoff Coefficient
I = Rainfall Intensity, (mm/hr)
A = Drainage Area, (ha)

Runoff Coefficient Equations
Based on MTO Drainage Manual (1984), page BD-4

2-year	C_2 =	C
5-year	C_5 =	C
10-year	C_{10} =	C
25-year	C_{25} =	1.10 x C
50-year	C_{50} =	1.20 x C
100-year	C_{100} =	1.25 x C

For storms having a return period of more than 10 years, the Runoff Coefficient, C, will be increased as indicated above, up to a maximum value of 1.

Rainfall Intensity Equation (2-100 year storm events)

$$I_{2\text{-}100} = A \times (t_d/60)^B \quad (mm/hr)$$

where, A = Rainfall IDF Coefficient
B = Rainfall IDF Coefficient
t_d = Storm Duration, (min)

Runoff Volume

$$V_{Runoff} = Q_{Runoff} \times t_d \quad (m^3)$$

where, Q_{Runoff} = Runoff Peak Flow Rate, (m^3/sec)
t_d = Storm Duration, (sec)

Released Volume

$$V_{Released} = Q_{Released} \times (t_d + T_C)/2 \quad (m^3)$$

where, $Q_{Released}$ = Max. Release Rate, (m^3/sec)
t_d = Storm Duration, (sec)
T_C = Time of Concentration, (sec)

Max. Storage Required

$$V_{Storage} = V_{Runoff} - V_{Released} \quad (m^3)$$

V_{Runoff} = Runoff Volume, (m^3)
$V_{Released}$ = Released Volume, (m^3)

Z:\Projects\2010\10-116\Spreadsheets\[Modified_Rational_Method_Calcs(A,B).xlsx]A2 Mod. Rational Method (5YR)

Catchment I.D.	Storm Event	Area A (ha)	Runoff Coeff. C	Runoff Coeff. C_{MOD}	Time of Conc. T_C (min.)	Storm Time Step (min.)	Release Rate (m^3/s)
A2	5-year	0.28	0.17	0.17	10	10	0.012

NOTES: 5-year pre-development target is **0.012** m^3/s

Storm Duration t_d (min.)	Rainfall Intensity (mm/hr)	Runoff Peak Flow Rate (m^3/s)	Runoff Volume (m^3)	Released Volume (m^3)	Storage Volume (m^3)	Max. Storage Required (m^3)
10	100.8	0.013	7.99	7.20	0.79	0.79
20	62.1	0.008	9.85	10.80	0.00	
30	46.8	0.006	11.13	14.40	0.00	
40	38.2	0.005	12.13	18.00	0.00	
50	32.7	0.004	12.98	21.60	0.00	
60	28.8	0.004	13.71	25.20	0.00	
70	25.9	0.003	14.36	28.80	0.00	
80	23.6	0.003	14.95	32.40	0.00	
90	21.7	0.003	15.49	36.00	0.00	
100	20.2	0.003	15.99	39.60	0.00	
110	18.9	0.002	16.45	43.20	0.00	
120	17.7	0.002	16.89	46.80	0.00	
130	16.8	0.002	17.30	50.40	0.00	
140	15.9	0.002	17.69	54.00	0.00	
150	15.2	0.002	18.06	57.60	0.00	
160	14.5	0.002	18.42	61.20	0.00	
170	13.9	0.002	18.76	64.80	0.00	
180	13.4	0.002	19.08	68.40	0.00	
190	12.9	0.002	19.39	72.00	0.00	
200	12.4	0.002	19.70	75.60	0.00	
210	12.0	0.002	19.99	79.20	0.00	
220	11.6	0.002	20.27	82.80	0.00	
230	11.3	0.001	20.54	86.40	0.00	
240	10.9	0.001	20.81	90.00	0.00	
250	10.6	0.001	21.06	93.60	0.00	
260	10.3	0.001	21.31	97.20	0.00	
270	10.1	0.001	21.56	100.80	0.00	
280	9.8	0.001	21.80	104.40	0.00	
290	9.6	0.001	22.03	108.00	0.00	
300	9.4	0.001	22.25	111.60	0.00	
310	9.1	0.001	22.47	115.20	0.00	

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MODIFIED RATIONAL METHOD CALCULATIONS
100-year Design Storm Event

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

<<< **Elements Requiring Input Information**

Rainfall Intensity-Duration-Frequency Coefficients from: http://www.mto.gov.on.ca/IDF_Curves/terms.shtml

2-year		5-year		10-year		25-year		50-year		100-year	
A =	21.7	A =	28.8	A =	33.6	A =	39.5	A =	43.9	A =	48.2
B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699

Rational Method Formula

$$Q = \frac{C \times I \times A}{360} \quad (m^3/s)$$

where, C = Runoff Coefficient
I = Rainfall Intensity, (mm/hr)
A = Drainage Area, (ha)

Runoff Coefficient Equations
Based on MTO Drainage Manual (1984), page BD-4

2-year	C_2 =	C
5-year	C_5 =	C
10-year	C_{10} =	C
25-year	C_{25} =	1.10 x C
50-year	C_{50} =	1.20 x C
100-year	C_{100} =	1.25 x C

For storms having a return period of more than 10 years, the Runoff Coefficient, C, will be increased as indicated above, up to a maximum value of 1.

Rainfall Intensity Equation (2-100 year storm events)

$$I_{2\text{-}100} = A \times (t_d/60)^B \quad (mm/hr)$$

where, A = Rainfall IDF Coefficient
B = Rainfall IDF Coefficient
t_d = Storm Duration, (min)

Runoff Volume

$$V_{Runoff} = Q_{Runoff} \times t_d \quad (m^3)$$

where, Q_{Runoff} = Runoff Peak Flow Rate, (m^3/sec)
t_d = Storm Duration, (sec)

Released Volume

$$V_{Released} = Q_{Released} \times (t_d + T_C)/2 \quad (m^3)$$

where, $Q_{Released}$ = Max. Release Rate, (m^3/sec)
t_d = Storm Duration, (sec)
T_C = Time of Concentration, (sec)

Max. Storage Required

$$V_{Storage} = V_{Runoff} - V_{Released} \quad (m^3)$$

V_{Runoff} = Runoff Volume, (m^3)
$V_{Released}$ = Released Volume, (m^3)

Z:\Projects\2010\10-116\Spreadsheets\[Modified_Rational_Method_Calcs(A,B).xlsx]A2 Mod. Rational Method (5YR)

Catchment I.D.	Storm Event	Area A (ha)	Runoff Coeff. C	Runoff Coeff. C_{MOD}	Time of Conc. T_C (min.)	Storm Time Step (min.)	Release Rate (m^3/s)
A2	100-year	0.28	0.17	0.21	10	10	0.025

NOTES: 100-year pre-development target is 0.025 m^3/s

Storm Duration t_d (min.)	Rainfall Intensity (mm/hr)	Runoff Peak Flow Rate (m^3/s)	Runoff Volume (m^3)	Released Volume (m^3)	Storage Volume (m^3)	Max. Storage Required (m^3)
10	168.6	0.028	16.72	15.00	1.72	1.72
20	103.9	0.017	20.60	22.50	0.00	
30	78.2	0.013	23.28	30.00	0.00	
40	64.0	0.011	25.38	37.50	0.00	
50	54.8	0.009	27.15	45.00	0.00	
60	48.2	0.008	28.68	52.50	0.00	
70	43.3	0.007	30.04	60.00	0.00	
80	39.4	0.007	31.27	67.50	0.00	
90	36.3	0.006	32.40	75.00	0.00	
100	33.7	0.006	33.45	82.50	0.00	
110	31.6	0.005	34.42	90.00	0.00	
120	29.7	0.005	35.33	97.50	0.00	
130	28.1	0.005	36.19	105.00	0.00	
140	26.7	0.004	37.01	112.50	0.00	
150	25.4	0.004	37.79	120.00	0.00	
160	24.3	0.004	38.53	127.50	0.00	
170	23.3	0.004	39.24	135.00	0.00	
180	22.4	0.004	39.92	142.50	0.00	
190	21.5	0.004	40.57	150.00	0.00	
200	20.8	0.003	41.21	157.50	0.00	
210	20.1	0.003	41.81	165.00	0.00	
220	19.4	0.003	42.40	172.50	0.00	
230	18.8	0.003	42.98	180.00	0.00	
240	18.3	0.003	43.53	187.50	0.00	
250	17.8	0.003	44.07	195.00	0.00	
260	17.3	0.003	44.59	202.50	0.00	
270	16.8	0.003	45.10	210.00	0.00	
280	16.4	0.003	45.60	217.50	0.00	
290	16.0	0.003	46.08	225.00	0.00	
300	15.6	0.003	46.55	232.50	0.00	
310	15.3	0.003	47.02	240.00	0.00	

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MODIFIED RATIONAL METHOD CALCULATIONS
5-year Design Storm Event

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

<<< Elements Requiring Input Information

Rainfall Intensity-Duration-Frequency Coefficients from: http://www.mto.gov.on.ca/IDF_Curves/terms.shtml

2-year		5-year		10-year		25-year		50-year		100-year	
A =	21.7	A =	28.8	A =	33.6	A =	39.5	A =	43.9	A =	48.2
B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699

Rational Method Formula

$$Q = \frac{C \times I \times A}{360} \quad (m^3/s)$$

where, C = Runoff Coefficient
I = Rainfall Intensity, (mm/hr)
A = Drainage Area, (ha)

Runoff Coefficient Equations
Based on MTO Drainage Manual (1984), page BD-4

2-year	C_2 =	C
5-year	C_5 =	C
10-year	C_{10} =	C
25-year	C_{25} =	1.10 x C
50-year	C_{50} =	1.20 x C
100-year	C_{100} =	1.25 x C

For storms having a return period of more than 10 years, the Runoff Coefficient, C, will be increased as indicated above, up to a maximum value of 1.

Rainfall Intensity Equation (2-100 year storm events)

$$I_{2\text{-}100} = A \times (t_d/60)^B \quad (mm/hr)$$

where, A = Rainfall IDF Coefficient
B = Rainfall IDF Coefficient
t_d = Storm Duration, (min)

Runoff Volume

$$V_{Runoff} = Q_{Runoff} \times t_d \quad (m^3)$$

where, Q_{Runoff} = Runoff Peak Flow Rate, (m^3/sec)
t_d = Storm Duration, (sec)

Released Volume

$$V_{Released} = Q_{Released} \times (t_d + T_C)/2 \quad (m^3)$$

where, $Q_{Released}$ = Max. Release Rate, (m^3/sec)
t_d = Storm Duration, (sec)
T_C = Time of Concentration, (sec)

Max. Storage Required

$$V_{Storage} = V_{Runoff} - V_{Released} \quad (m^3)$$

V_{Runoff} = Runoff Volume, (m^3)
$V_{Released}$ = Released Volume, (m^3)

Z:\Projects\2010\10-116\Spreadsheets\[Modified_Rational_Method_Calcs(A,B).xlsx]A2 Mod. Rational Method (5YR)

Catchment I.D.	Storm Event	Area A (ha)	Runoff Coeff. C	Runoff Coeff. C_{MOD}	Time of Conc. T_C (min.)	Storm Time Step (min.)	Release Rate (m^3/s)
A3	5-year	0.56	0.23	0.23	10	10	0.033

NOTES: 5-year pre-development target is **0.033** m^3/s

Storm Duration t_d (min.)	Rainfall Intensity (mm/hr)	Runoff Peak Flow Rate (m^3/s)	Runoff Volume (m^3)	Released Volume (m^3)	Storage Volume (m^3)	Max. Storage Required (m^3)
10	100.8	0.036	21.63	19.80	1.83	1.83
20	62.1	0.022	26.65	29.70	0.00	
30	46.8	0.017	30.11	39.60	0.00	
40	38.2	0.014	32.83	49.50	0.00	
50	32.7	0.012	35.11	59.40	0.00	
60	28.8	0.010	37.09	69.30	0.00	
70	25.9	0.009	38.86	79.20	0.00	
80	23.6	0.008	40.45	89.10	0.00	
90	21.7	0.008	41.91	99.00	0.00	
100	20.2	0.007	43.26	108.90	0.00	
110	18.9	0.007	44.52	118.80	0.00	
120	17.7	0.006	45.70	128.70	0.00	
130	16.8	0.006	46.81	138.60	0.00	
140	15.9	0.006	47.87	148.50	0.00	
150	15.2	0.005	48.88	158.40	0.00	
160	14.5	0.005	49.83	168.30	0.00	
170	13.9	0.005	50.75	178.20	0.00	
180	13.4	0.005	51.63	188.10	0.00	
190	12.9	0.005	52.48	198.00	0.00	
200	12.4	0.004	53.30	207.90	0.00	
210	12.0	0.004	54.08	217.80	0.00	
220	11.6	0.004	54.85	227.70	0.00	
230	11.3	0.004	55.59	237.60	0.00	
240	10.9	0.004	56.30	247.50	0.00	
250	10.6	0.004	57.00	257.40	0.00	
260	10.3	0.004	57.68	267.30	0.00	
270	10.1	0.004	58.33	277.20	0.00	
280	9.8	0.004	58.98	287.10	0.00	
290	9.6	0.003	59.60	297.00	0.00	
300	9.4	0.003	60.21	306.90	0.00	
310	9.1	0.003	60.81	316.80	0.00	

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MODIFIED RATIONAL METHOD CALCULATIONS
100-year Design Storm Event

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

<<< Elements Requiring Input Information

Rainfall Intensity-Duration-Frequency Coefficients from: http://www.mto.gov.on.ca/IDF_Curves/terms.shtml

2-year		5-year		10-year		25-year		50-year		100-year	
A =	21.7	A =	28.8	A =	33.6	A =	39.5	A =	43.9	A =	48.2
B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699

Rational Method Formula

$$Q = \frac{C \times I \times A}{360} \quad (m^3/s)$$

where, C = Runoff Coefficient
I = Rainfall Intensity, (mm/hr)
A = Drainage Area, (ha)

Runoff Coefficient Equations
Based on MTO Drainage Manual (1984), page BD-4

2-year	C_2 =	C
5-year	C_5 =	C
10-year	C_{10} =	C
25-year	C_{25} =	1.10 x C
50-year	C_{50} =	1.20 x C
100-year	C_{100} =	1.25 x C

For storms having a return period of more than 10 years, the Runoff Coefficient, C, will be increased as indicated above, up to a maximum value of 1.

Rainfall Intensity Equation (2-100 year storm events)

$$I_{2\text{-}100} = A \times (t_d/60)^B \quad (mm/hr)$$

where, A = Rainfall IDF Coefficient
B = Rainfall IDF Coefficient
t_d = Storm Duration, (min)

Runoff Volume

$$V_{Runoff} = Q_{Runoff} \times t_d \quad (m^3)$$

where, Q_{Runoff} = Runoff Peak Flow Rate, (m^3/sec)
t_d = Storm Duration, (sec)

Released Volume

$$V_{Released} = Q_{Released} \times (t_d + T_C)/2 \quad (m^3)$$

where, $Q_{Released}$ = Max. Release Rate, (m^3/sec)
t_d = Storm Duration, (sec)
T_C = Time of Concentration, (sec)

Max. Storage Required

$$V_{Storage} = V_{Runoff} - V_{Released} \quad (m^3)$$

V_{Runoff} = Runoff Volume, (m^3)
$V_{Released}$ = Released Volume, (m^3)

Z:\Projects\2010\10-116\Spreadsheets\[Modified_Rational_Method_Calcs(A,B).xlsx]A2 Mod. Rational Method (5YR)

Catchment I.D.	Storm Event	Area A (ha)	Runoff Coeff. C	Runoff Coeff. C_{MOD}	Time of Conc. T_C (min.)	Storm Time Step (min.)	Release Rate (m^3/s)
A3	100-year	0.56	0.23	0.29	10	10	0.069

NOTES: 100-year pre-development target is 0.069 m^3/s

Storm Duration t_d (min.)	Rainfall Intensity (mm/hr)	Runoff Peak Flow Rate (m^3/s)	Runoff Volume (m^3)	Released Volume (m^3)	Storage Volume (m^3)	Max. Storage Required (m^3)
10	168.6	0.075	45.25	41.40	3.85	3.85
20	103.9	0.046	55.75	62.10	0.00	
30	78.2	0.035	62.99	82.80	0.00	
40	64.0	0.029	68.69	103.50	0.00	
50	54.8	0.024	73.46	124.20	0.00	
60	48.2	0.022	77.60	144.90	0.00	
70	43.3	0.019	81.29	165.60	0.00	
80	39.4	0.018	84.62	186.30	0.00	
90	36.3	0.016	87.68	207.00	0.00	
100	33.7	0.015	90.50	227.70	0.00	
110	31.6	0.014	93.13	248.40	0.00	
120	29.7	0.013	95.61	269.10	0.00	
130	28.1	0.013	97.94	289.80	0.00	
140	26.7	0.012	100.15	310.50	0.00	
150	25.4	0.011	102.25	331.20	0.00	
160	24.3	0.011	104.25	351.90	0.00	
170	23.3	0.010	106.17	372.60	0.00	
180	22.4	0.010	108.02	393.30	0.00	
190	21.5	0.010	109.79	414.00	0.00	
200	20.8	0.009	111.50	434.70	0.00	
210	20.1	0.009	113.15	455.40	0.00	
220	19.4	0.009	114.74	476.10	0.00	
230	18.8	0.008	116.29	496.80	0.00	
240	18.3	0.008	117.79	517.50	0.00	
250	17.8	0.008	119.24	538.20	0.00	
260	17.3	0.008	120.66	558.90	0.00	
270	16.8	0.008	122.04	579.60	0.00	
280	16.4	0.007	123.38	600.30	0.00	
290	16.0	0.007	124.69	621.00	0.00	
300	15.6	0.007	125.97	641.70	0.00	
310	15.3	0.007	127.22	662.40	0.00	

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MODIFIED RATIONAL METHOD CALCULATIONS
5-year Design Storm Event

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

<<< **Elements Requiring Input Information**

Rainfall Intensity-Duration-Frequency Coefficients from: http://www.mto.gov.on.ca/IDF_Curves/terms.shtml

2-year		5-year		10-year		25-year		50-year		100-year	
A =	21.7	A =	28.8	A =	33.6	A =	39.5	A =	43.9	A =	48.2
B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699

Rational Method Formula

$$Q = \frac{C \times I \times A}{360} \quad (m^3/s)$$

where, C = Runoff Coefficient
I = Rainfall Intensity, (mm/hr)
A = Drainage Area, (ha)

Runoff Coefficient Equations
Based on MTO Drainage Manual (1984), page BD-4

2-year C_2 = C
5-year C_5 = C
10-year C_{10} = C
25-year C_{25} = 1.10 x C
50-year C_{50} = 1.20 x C
100-year C_{100} = 1.25 x C

For storms having a return period of more than 10 years, the Runoff Coefficient, C, will be increased as indicated above, up to a maximum value of 1.

Rainfall Intensity Equation (2-100 year storm events)

$$I_{2\text{-}100} = A \times (t_d/60)^B \quad (mm/hr)$$

where, A = Rainfall IDF Coefficient
B = Rainfall IDF Coefficient
t_d = Storm Duration, (min)

Runoff Volume

$$V_{Runoff} = Q_{Runoff} \times t_d \quad (m^3)$$

where, Q_{Runoff} = Runoff Peak Flow Rate, (m^3/sec)
t_d = Storm Duration, (sec)

Released Volume

$$V_{Released} = Q_{Released} \times (t_d + T_C)/2 \quad (m^3)$$

where, $Q_{Released}$ = Max. Release Rate, (m^3/sec)
t_d = Storm Duration, (sec)
T_C = Time of Concentration, (sec)

Max. Storage Required

$$V_{Storage} = V_{Runoff} - V_{Released} \quad (m^3)$$

V_{Runoff} = Runoff Volume, (m^3)
$V_{Released}$ = Released Volume, (m^3)

Z:\Projects\2010\10-116\Spreadsheets\[Modified_Rational_Method_Calcs(A,B).xlsx]A2 Mod. Rational Method (5YR)

Catchment I.D.	Storm Event	Area A (ha)	Runoff Coeff. C	Runoff Coeff. C_{MOD}	Time of Conc. T_C (min.)	Storm Time Step (min.)	Release Rate (m^3/s)
A4+A5	5-year	0.72	0.27	0.27	10	10	0.015

NOTES: 5-year pre-development target is **0.015** m^3/s

Storm Duration t_d (min.)	Rainfall Intensity (mm/hr)	Runoff Peak Flow Rate (m^3/s)	Runoff Volume (m^3)	Released Volume (m^3)	Storage Volume (m^3)	Max. Storage Required (m^3)
10	100.8	0.054	32.65	9.00	23.65	
20	62.1	0.034	40.22	13.50	26.72	
30	46.8	0.025	45.44	18.00	27.44	27.44
40	38.2	0.021	49.55	22.50	27.05	
50	32.7	0.018	53.00	27.00	26.00	
60	28.8	0.016	55.99	31.50	24.49	
70	25.9	0.014	58.65	36.00	22.65	
80	23.6	0.013	61.05	40.50	20.55	
90	21.7	0.012	63.25	45.00	18.25	
100	20.2	0.011	65.29	49.50	15.79	
110	18.9	0.010	67.19	54.00	13.19	
120	17.7	0.010	68.98	58.50	10.48	
130	16.8	0.009	70.66	63.00	7.66	
140	15.9	0.009	72.25	67.50	4.75	
150	15.2	0.008	73.77	72.00	1.77	
160	14.5	0.008	75.22	76.50	0.00	
170	13.9	0.008	76.60	81.00	0.00	
180	13.4	0.007	77.93	85.50	0.00	
190	12.9	0.007	79.21	90.00	0.00	
200	12.4	0.007	80.44	94.50	0.00	
210	12.0	0.006	81.63	99.00	0.00	
220	11.6	0.006	82.78	103.50	0.00	
230	11.3	0.006	83.90	108.00	0.00	
240	10.9	0.006	84.98	112.50	0.00	
250	10.6	0.006	86.03	117.00	0.00	
260	10.3	0.006	87.05	121.50	0.00	
270	10.1	0.005	88.05	126.00	0.00	
280	9.8	0.005	89.01	130.50	0.00	
290	9.6	0.005	89.96	135.00	0.00	
300	9.4	0.005	90.88	139.50	0.00	
310	9.1	0.005	91.78	144.00	0.00	

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MODIFIED RATIONAL METHOD CALCULATIONS
100-year Design Storm Event

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

<<< **Elements Requiring Input Information**

Rainfall Intensity-Duration-Frequency Coefficients from: http://www.mto.gov.on.ca/IDF_Curves/terms.shtml

2-year		5-year		10-year		25-year		50-year		100-year	
A =	21.7	A =	28.8	A =	33.6	A =	39.5	A =	43.9	A =	48.2
B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699

Rational Method Formula

$$Q = \frac{C \times I \times A}{360} \quad (m^3/s)$$

where, C = Runoff Coefficient
I = Rainfall Intensity, (mm/hr)
A = Drainage Area, (ha)

Rainfall Intensity Equation (2-100 year storm events)

$$I_{2-100} = A \times (t_d/60)^B \quad (mm/hr)$$

where, A = Rainfall IDF Coefficient
B = Rainfall IDF Coefficient
t_d = Storm Duration, (min)

Runoff Coefficient Equations
Based on MTO Drainage Manual (1984), page BD-4

2-year	C_2 =	C
5-year	C_5 =	C
10-year	C_{10} =	C
25-year	C_{25} =	1.10 x C
50-year	C_{50} =	1.20 x C
100-year	C_{100} =	1.25 x C

For storms having a return period of more than 10 years, the Runoff Coefficient, C, will be increased as indicated above, up to a maximum value of 1.

Runoff Volume

$$V_{Runoff} = Q_{Runoff} \times t_d \quad (m^3)$$

where, Q_{Runoff} = Runoff Peak Flow Rate, (m^3/sec)
t_d = Storm Duration, (sec)

Released Volume

$$V_{Released} = Q_{Released} \times (t_d + T_C)/2 \quad (m^3)$$

where, $Q_{Released}$ = Max. Release Rate, (m^3/sec)
t_d = Storm Duration, (sec)
T_C = Time of Concentration, (sec)

Max. Storage Required

$$V_{Storage} = V_{Runoff} - V_{Released} \quad (m^3)$$

V_{Runoff} = Runoff Volume, (m^3)
$V_{Released}$ = Released Volume, (m^3)

Z:\Projects\2010\10-116\Spreadsheets\[Modified_Rational_Method_Calcs(A,B).xlsx]A2 Mod. Rational Method (5YR)

Catchment I.D.	Storm Event	Area A (ha)	Runoff Coeff. C	Runoff Coeff. C_{MOD}	Time of Conc. T_C (min.)	Storm Time Step (min.)	Release Rate (m^3/s)
A4+A5	100-year	0.72	0.27	0.34	10	10	0.031

NOTES: 100-year pre-development target is 0.031 m^3/s

Storm Duration t_d (min.)	Rainfall Intensity (mm/hr)	Runoff Peak Flow Rate (m^3/s)	Runoff Volume (m^3)	Released Volume (m^3)	Storage Volume (m^3)	Max. Storage Required (m^3)
10	168.6	0.114	68.30	18.60	49.70	
20	103.9	0.070	84.15	27.90	56.25	
30	78.2	0.053	95.07	37.20	57.87	57.87
40	64.0	0.043	103.67	46.50	57.17	
50	54.8	0.037	110.87	55.80	55.07	
60	48.2	0.033	117.13	65.10	52.03	
70	43.3	0.029	122.69	74.40	48.29	
80	39.4	0.027	127.72	83.70	44.02	
90	36.3	0.025	132.33	93.00	39.33	
100	33.7	0.023	136.59	102.30	34.29	
110	31.6	0.021	140.57	111.60	28.97	
120	29.7	0.020	144.30	120.90	23.40	
130	28.1	0.019	147.82	130.20	17.62	
140	26.7	0.018	151.15	139.50	11.65	
150	25.4	0.017	154.32	148.80	5.52	
160	24.3	0.016	157.35	158.10	0.00	
170	23.3	0.016	160.25	167.40	0.00	
180	22.4	0.015	163.03	176.70	0.00	
190	21.5	0.015	165.70	186.00	0.00	
200	20.8	0.014	168.28	195.30	0.00	
210	20.1	0.014	170.77	204.60	0.00	
220	19.4	0.013	173.18	213.90	0.00	
230	18.8	0.013	175.51	223.20	0.00	
240	18.3	0.012	177.78	232.50	0.00	
250	17.8	0.012	179.97	241.80	0.00	
260	17.3	0.012	182.11	251.10	0.00	
270	16.8	0.011	184.19	260.40	0.00	
280	16.4	0.011	186.22	269.70	0.00	
290	16.0	0.011	188.20	279.00	0.00	
300	15.6	0.011	190.13	288.30	0.00	
310	15.3	0.010	192.01	297.60	0.00	

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MODIFIED RATIONAL METHOD CALCULATIONS
5-year Design Storm Event

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

<<< **Elements Requiring Input Information**

Rainfall Intensity-Duration-Frequency Coefficients from: http://www.mto.gov.on.ca/IDF_Curves/terms.shtml

2-year		5-year		10-year		25-year		50-year		100-year	
A =	21.7	A =	28.8	A =	33.6	A =	39.5	A =	43.9	A =	48.2
B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699

Rational Method Formula

$$Q = \frac{C \times I \times A}{360} \quad (m^3/s)$$

where, C = Runoff Coefficient
I = Rainfall Intensity, (mm/hr)
A = Drainage Area, (ha)

Runoff Coefficient Equations
Based on MTO Drainage Manual (1984), page BD-4

2-year	C_2 =	C
5-year	C_5 =	C
10-year	C_{10} =	C
25-year	C_{25} =	1.10 x C
50-year	C_{50} =	1.20 x C
100-year	C_{100} =	1.25 x C

For storms having a return period of more than 10 years, the Runoff Coefficient, C, will be increased as indicated above, up to a maximum value of 1.

Rainfall Intensity Equation (2-100 year storm events)

$$I_{2\text{-}100} = A \times (t_d/60)^B \quad (mm/hr)$$

where, A = Rainfall IDF Coefficient
B = Rainfall IDF Coefficient
t_d = Storm Duration, (min)

Runoff Volume

$$V_{Runoff} = Q_{Runoff} \times t_d \quad (m^3)$$

where, Q_{Runoff} = Runoff Peak Flow Rate, (m^3/sec)
t_d = Storm Duration, (sec)

Released Volume

$$V_{Released} = Q_{Released} \times (t_d + T_C)/2 \quad (m^3)$$

where, $Q_{Released}$ = Max. Release Rate, (m^3/sec)
t_d = Storm Duration, (sec)
T_C = Time of Concentration, (sec)

Max. Storage Required

$$V_{Storage} = V_{Runoff} - V_{Released} \quad (m^3)$$

V_{Runoff} = Runoff Volume, (m^3)
$V_{Released}$ = Released Volume, (m^3)

Z:\Projects\2010\10-116\Spreadsheets\[Modified_Rational_Method_Calcs(A,B).xlsx]A2 Mod. Rational Method (5YR)

Catchment I.D.	Storm Event	Area A (ha)	Runoff Coeff. C	Runoff Coeff. C_{MOD}	Time of Conc. T_C (min.)	Storm Time Step (min.)	Release Rate (m^3/s)
A7	5-year	0.55	0.28	0.28	10	10	0.023

NOTES: 5-year pre-development target is **0.023** m^3/s

Storm Duration t_d (min.)	Rainfall Intensity (mm/hr)	Runoff Peak Flow Rate (m^3/s)	Runoff Volume (m^3)	Released Volume (m^3)	Storage Volume (m^3)	Max. Storage Required (m^3)
10	100.8	0.043	25.86	13.80	12.06	12.06
20	62.1	0.027	31.86	20.70	11.16	
30	46.8	0.020	36.00	27.60	8.40	
40	38.2	0.016	39.26	34.50	4.76	
50	32.7	0.014	41.98	41.40	0.58	
60	28.8	0.012	44.35	48.30	0.00	
70	25.9	0.011	46.46	55.20	0.00	
80	23.6	0.010	48.36	62.10	0.00	
90	21.7	0.009	50.11	69.00	0.00	
100	20.2	0.009	51.72	75.90	0.00	
110	18.9	0.008	53.23	82.80	0.00	
120	17.7	0.008	54.64	89.70	0.00	
130	16.8	0.007	55.97	96.60	0.00	
140	15.9	0.007	57.24	103.50	0.00	
150	15.2	0.006	58.44	110.40	0.00	
160	14.5	0.006	59.58	117.30	0.00	
170	13.9	0.006	60.68	124.20	0.00	
180	13.4	0.006	61.73	131.10	0.00	
190	12.9	0.006	62.75	138.00	0.00	
200	12.4	0.005	63.72	144.90	0.00	
210	12.0	0.005	64.67	151.80	0.00	
220	11.6	0.005	65.58	158.70	0.00	
230	11.3	0.005	66.46	165.60	0.00	
240	10.9	0.005	67.32	172.50	0.00	
250	10.6	0.005	68.15	179.40	0.00	
260	10.3	0.004	68.96	186.30	0.00	
270	10.1	0.004	69.75	193.20	0.00	
280	9.8	0.004	70.52	200.10	0.00	
290	9.6	0.004	71.26	207.00	0.00	
300	9.4	0.004	72.00	213.90	0.00	
310	9.1	0.004	72.71	220.80	0.00	

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MODIFIED RATIONAL METHOD CALCULATIONS
100-year Design Storm Event

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

<<< **Elements Requiring Input Information**

Rainfall Intensity-Duration-Frequency Coefficients from: http://www.mto.gov.on.ca/IDF_Curves/terms.shtml

2-year		5-year		10-year		25-year		50-year		100-year	
A =	21.7	A =	28.8	A =	33.6	A =	39.5	A =	43.9	A =	48.2
B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699

Rational Method Formula

$$Q = \frac{C \times I \times A}{360} \quad (m^3/s)$$

where, C = Runoff Coefficient
I = Rainfall Intensity, (mm/hr)
A = Drainage Area, (ha)

Runoff Coefficient Equations
Based on MTO Drainage Manual (1984), page BD-4

2-year	C_2 =	C
5-year	C_5 =	C
10-year	C_{10} =	C
25-year	C_{25} =	1.10 x C
50-year	C_{50} =	1.20 x C
100-year	C_{100} =	1.25 x C

For storms having a return period of more than 10 years, the Runoff Coefficient, C, will be increased as indicated above, up to a maximum value of 1.

Rainfall Intensity Equation (2-100 year storm events)

$$I_{2\text{-}100} = A \times (t_d/60)^B \quad (mm/hr)$$

where, A = Rainfall IDF Coefficient
B = Rainfall IDF Coefficient
t_d = Storm Duration, (min)

Runoff Volume

$$V_{Runoff} = Q_{Runoff} \times t_d \quad (m^3)$$

where, Q_{Runoff} = Runoff Peak Flow Rate, (m^3/sec)
t_d = Storm Duration, (sec)

Released Volume

$$V_{Released} = Q_{Released} \times (t_d + T_C)/2 \quad (m^3)$$

where, $Q_{Released}$ = Max. Release Rate, (m^3/sec)
t_d = Storm Duration, (sec)
T_C = Time of Concentration, (sec)

Max. Storage Required

$$V_{Storage} = V_{Runoff} - V_{Released} \quad (m^3)$$

V_{Runoff} = Runoff Volume, (m^3)
$V_{Released}$ = Released Volume, (m^3)

Z:\Projects\2010\10-116\Spreadsheets\[Modified_Rational_Method_Calcs(A,B).xlsx]A2 Mod. Rational Method (5YR)

Catchment I.D.	Storm Event	Area A (ha)	Runoff Coeff. C	Runoff Coeff. C_{MOD}	Time of Conc. T_C (min.)	Storm Time Step (min.)	Release Rate (m^3/s)
A7	100-year	0.55	0.28	0.35	10	10	0.048

NOTES: 100-year pre-development target is **0.048** m^3/s

Storm Duration t_d (min.)	Rainfall Intensity (mm/hr)	Runoff Peak Flow Rate (m^3/s)	Runoff Volume (m^3)	Released Volume (m^3)	Storage Volume (m^3)	Max. Storage Required (m^3)
10	168.6	0.090	54.11	28.80	25.31	25.31
20	103.9	0.056	66.66	43.20	23.46	
30	78.2	0.042	75.31	57.60	17.71	
40	64.0	0.034	82.12	72.00	10.12	
50	54.8	0.029	87.83	86.40	1.43	
60	48.2	0.026	92.79	100.80	0.00	
70	43.3	0.023	97.19	115.20	0.00	
80	39.4	0.021	101.18	129.60	0.00	
90	36.3	0.019	104.83	144.00	0.00	
100	33.7	0.018	108.21	158.40	0.00	
110	31.6	0.017	111.36	172.80	0.00	
120	29.7	0.016	114.31	187.20	0.00	
130	28.1	0.015	117.10	201.60	0.00	
140	26.7	0.014	119.74	216.00	0.00	
150	25.4	0.014	122.25	230.40	0.00	
160	24.3	0.013	124.65	244.80	0.00	
170	23.3	0.012	126.95	259.20	0.00	
180	22.4	0.012	129.15	273.60	0.00	
190	21.5	0.012	131.27	288.00	0.00	
200	20.8	0.011	133.31	302.40	0.00	
210	20.1	0.011	135.28	316.80	0.00	
220	19.4	0.010	137.19	331.20	0.00	
230	18.8	0.010	139.04	345.60	0.00	
240	18.3	0.010	140.83	360.00	0.00	
250	17.8	0.010	142.57	374.40	0.00	
260	17.3	0.009	144.27	388.80	0.00	
270	16.8	0.009	145.91	403.20	0.00	
280	16.4	0.009	147.52	417.60	0.00	
290	16.0	0.009	149.09	432.00	0.00	
300	15.6	0.008	150.61	446.40	0.00	
310	15.3	0.008	152.11	460.80	0.00	

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STORMWATER MANAGEMENT CALCULATIONS
SOAKAWAY PITS - ROOF TOPS

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

Purpose: Soakaway pits are proposed on-site to provide quality control, water balance, volume control and phosphorus reduction benefits The soakway pits will be sized to store the entire runoff volume generated from the roof tops of each of the proposed lots during a 25mm storm event while maintaining a maximum draw down time of 48 hours.

☐ <<< **Elements Requiring Input Information**

Infiltration Volume:

Total Area = **0.01** ha / 100 m^2
Runoff Volume = **25** mm

Infiltration Volume = A (ha) x RV (mm) x 10 m^3
= 0.01 ha x 25 mm x 10 m^3
= **2.5** m^3

Max. Allowable Depth:
Based on the Ministry of the Environment's (MOE) Stormwater Management Design Manual dated March 2003, Page 4-20, Equation 4.2: Maximum Allowable Depth is:

$$d = \frac{PT}{1000} = \frac{60 \quad 48}{1000} = 2.88 \text{ m}$$

where,
d = maximum allowable depth (m)
P = percolation rate (Table 4.4 of MOE Manual OR Geotechnical/Hydrogeological Assessments) (mm/hr)
T = draw down time (24-48hr) (hr)

Provided Depth = **1.60** m

Min. Bottom Area:
Based on the Ministry of the Environment's (MOE) Stormwater Management Design Manual dated March 2003, Page 4-26, Equation 4.3: Infiltration Bottom Area is:

Min. Required Bottom Area:

$$A = \frac{1000\,V}{P\,n\,t} = \frac{1000 \quad 2.5}{60 \quad 0.4 \quad 48} = 2.2 \ m^2$$

where,
A = bottom area (m^2)
V = runoff volume to be infiltrated (m^3)
P = percolation rate of surrounding native soil (mm/hr)
n = porosity of the storage media (0.4 for clear stone/1.0 for infiltration basins)
t = retention time (hr)

Provided Bottom Area = **4.0** m^2

Excavation Volume:

Min. Required Excavation Volume = Infiltration Volume/porosity of the storage media
$= \frac{2.5}{0.4}$ < (0.4 for clear stone/1.0 for infiltration basins)
= **6.3** m^3

Provided Excavation Volume = L x W x D m^3
= **2** m x **2** m x **1.6** m
= **6.4** m^3

Soil Cover:
Based on the Ministry of the Environment's (MOE) Stormwater Management Design Manual dated March 2003, Page 4-21, Figure 4.4: Soil Cover for Trenches (based on frost heave potential).

Min. Soil Cover = **1.1** m

Notes: - The native soil deposit for the site is a Tioga Loamy Sand and Eastport Sand, as identified in the Simcoe County Soils Maps, published by the Canada Department of Agriculture (1959). This soil is classified within hydrologic soils group 'A', and is considered to have good to excessive drainage. Field visits to the subject site has verified the presence of free-draining sand (there are numerous sand dunes within the site). For the purposes of the soak away it design, the percolation rate is estimated to be 60mm/hr for a loamy sand, as identified in table 4.4 in the MOE's Stormwater Management Design Manual.

The groundwater elevation was detemined to be greater than 4m below ground elevation based on geotechnical site review and Georgian Bay water surface elevation (~177m).

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STORMWATER MANAGEMENT CALCULATIONS
LOT 3 INFILTRATION TRENCH

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

Purpose: An infiltration trench is required near the eastern property line of Lot 3 (adjacent to the driveway entrance) to provide the remaining stormwater storage volume requirements for peak flow attenuation (~8m^3) which is in addition to the volume storage requirement provided by the soakaway pits from the rooftop (2.5m^3) and the storage provided by the earthen check dams within the swale (15.2m^3).

[ ] <<< **Elements Requiring Input Information**

Infiltration Volume:

= **8** m^3

Max. Allowable Depth:

Based on the Ministry of the Environment's (MOE) Stormwater Management Design Manual dated March 2003, Page 4-20, Equation 4.2: Maximum Allowable Depth is:

$$d = \frac{PT}{1000} = \frac{60 \quad 48}{1000} = 2.88 \text{ m}$$

where,
d = maximum allowable depth (m)
P = percolation rate (Table 4.4 of MOE Manual OR Geotechnical/Hydrogeological Assessments) (mm/hr)
T = draw down time (24-48hr) (hr)

Provided Depth = **1.60** m

Min. Bottom Area:

Based on the Ministry of the Environment's (MOE) Stormwater Management Design Manual dated March 2003, Page 4-26, Equation 4.3: Infiltration Bottom Area is:

Min. Required Bottom Area:

$$A = \frac{1000\,V}{P\,n\,t} = \frac{1000 \quad 8}{60 \quad 0.4 \quad 48} = 6.9 \text{ m}^2$$

where,
A = bottom area (m^2)
V = runoff volume to be infiltrated (m^3)
P = percolation rate of surrounding native soil (mm/hr)
n = porosity of the storage media (0.4 for clear stone/1.0 for infiltration basins)
t = retention time (hr)

Provided Bottom Area = **12.6** m^2

Excavation Volume:

Min. Required Excavation Volume = Infiltration Volume/porosity of the storage media

$$= \frac{8}{0.4} = 20.0 \text{ m}^3$$

< (0.4 for clear stone/1.0 for infiltration basins)

Provided Excavation Volume = L x W x D m^3
= **7** m x **1.8** m x **1.6** m
= **20.2** m^3

Soil Cover:

Based on the Ministry of the Environment's (MOE) Stormwater Management Design Manual dated March 2003, Page 4-21, Figure 4.4: Soil Cover for Trenches (based on frost heave potential).

Min. Soil Cover = **1.1** m

Notes: - The native soil deposit for the site is a Tioga Loamy Sand and Eastport Sand, as identified in the Simcoe County Soils Maps, published by the Canada Department of Agriculture (1959). This soil is classified within hydrologic soils group 'A', and is considered to have good to excessive drainage. Field visits to the subject site has verified the presence of free-draining sand (there are numerous sand dunes within the site). For the purposes of the soak away it design, the percolation rate is estimated to be 60mm/hr for a loamy sand, as identified in table 4.4 in the MOE's Stormwater Management Design Manual.

The groundwater elevations were detemined to be greater than 4m below ground elevation based on geotechnical site review and Georgian Bay water surface elevation.

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STORMWATER MANAGEMENT CALCULATIONS
Catchment A3 Runoff Retention - Swale & Ditch Storage and Ponding Calculations

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

It is proposed to incorporate earthen check dams within various swales and ditches to retain runoff and allow for enhanced infiltration into the native soils. The following calculates the total volume of runoff retention provided by the proposed check dams.

Example Ditch Volume Calculation: **Triangular ditch @ 4.3% slope, 3:1 side slopes, 0.4 m height check dam**

Dam x-section area:

$$A_d = \frac{(\text{Dam depth} \times 3 \times 2) \times \text{dam height}}{2} = \frac{(0.40 \times 3 \times 2) \times 0.40}{2} = 0.48\ m^2$$

Minimum check dam spacing:

$$L = \text{ditch height} / \text{ditch slope} = 0.40 / 0.043 = 9.3\ m$$

Ditch volume behind dam :

$$V = (A_d \times L) = (0.27 \times 9.3) = \mathbf{4.47\ m^3}$$

Retention Volume Summary: Triangular Ditch

dam depth: 0.60 m
bottom width: 0.00 m

Ditch slope	Min. Check Dam Spacing (m)	Ditch Volume per Check Dam (m^3)	# of Occurrences	Total Volume (m^3)
5.7%	10.5	11.37	1	11.4
			Total:	**11.4**

Note:

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STORMWATER MANAGEMENT CALCULATIONS
Catchment A4 & A5 Runoff Retention - Swale & Ditch Storage and Ponding Calculations

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

It is proposed to incorporate earthen check dams within various swales and ditches to retain runoff and allow for enhanced infiltration into the native soils. The following calculates the total volume of runoff retention provided by the proposed check dams.

Example Ditch Volume Calculation: **Triangular ditch @ 4.3% slope, 3:1 side slopes, 0.4 m height check dam**

Dam x-section area:

$$A_d = \frac{(\text{Dam depth} \times 3 \times 2) \times \text{dam height}}{2} = \frac{(0.40 \times 3 \times 2) \times 0.40}{2} = 0.48\ m^2$$

Minimum check dam spacing:

$$L = \text{ditch height / ditch slope} = 0.40 / 0.043 = 9.3\ m$$

Ditch volume behind dam :

$$V = (A_d \times L) = (0.27 \times 9.3) = \mathbf{4.47\ m^3}$$

Retention Volume Summary: Triangular Ditch

dam depth: 0.40 m
bottom width: 0.00 m

Ditch slope	Min. Check Dam Spacing (m)	Ditch Volume per Check Dam (m^3)	# of Occurrences	Total Volume (m^3)
* 0.5%	80.0	38.40	0.3	11.5
4.3%	9.3	4.47	3	13.4
5.6%	7.1	3.43	1	3.4
6.0%	6.7	3.20	1	3.2
8.2%	4.9	2.34	1	2.3
			Total:	**33.9**

Note: *The 0.5% slope ditch has a length of ~24m (as well as including two driveway culverts) which is ~30% of the check dam spacing and is shown adjusted above to account for this lesser volume

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STORMWATER MANAGEMENT CALCULATIONS
Catchment A4 & A5 Runoff Retention - Swale & Ditch Storage and Ponding Calculations

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

It is proposed to incorporate earthen check dams within various swales and ditches to retain runoff and allow for enhanced infiltration into the native soils. The following calculates the total volume of runoff retention provided by the proposed check dams.

Example Ditch Volume Calculation: **Triangular ditch @ 4.3% slope, 3:1 side slopes, 0.4 m height check dam**

Dam x-section area:

$A_d = \frac{(\text{Dam depth} \times 3 \times 2) \times \text{dam height}}{2} = \frac{(0.40 \times 3 \times 2) \times 0.40}{2} = 0.48\ m^2$

Minimum check dam spacing:

L = ditch height / ditch slope = 0.40 / 0.043 = 9.3 m

Ditch volume behind dam :

$V = (A_d \times L) = (0.27 \times 9.3) = \mathbf{4.47\ m^3}$

Retention Volume Summary: Triangular Ditch

dam depth: 0.60 m
bottom width: 0.00 m

Ditch slope	Min. Check Dam Spacing (m)	Ditch Volume per Check Dam (m^3)	# of Occurrences	Total Volume (m^3)
5.6%	10.7	11.57	2	23.1
			Total:	**23.1**

Note:

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STORMWATER MANAGEMENT CALCULATIONS

Catchment A7 Runoff Retention - Swale & Ditch Storage and Ponding Calculations

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

It is proposed to incorporate earthen check dams within various swales and ditches to retain runoff and allow for enhanced infiltration into the native soils. The following calculates the total volume of runoff retention provided by the proposed check dams.

Example Ditch Volume Calculation: **Triangular ditch @ 0.6% slope, 3:1 side slopes, 0.3 m height check dam**

Dam x-section area:

$$A_d = \frac{(\text{Dam depth} \times 3 \times 2) \times \text{dam height}}{2} = \frac{(0.30 \times 3 \times 2) \times 0.30}{2} = 0.27 \text{ m}^2$$

Minimum check dam spacing:

$$L = \text{ditch height / ditch slope} = 0.30 / 0.006 = 50.0 \text{ m}$$

Ditch volume behind dam :

$$V = (A_d \times L) = 1.08 \times 14) = \mathbf{13.50 \text{ m}^3}$$

Retention Volume Summary: Triangular Ditch

dam depth: 0.30 m
bottom width: 0.00 m

Ditch slope	Min. Check Dam Spacing (m)	Ditch Volume per Check Dam (m^3)	# of Occurrences	Total Volume (m^3)
0.6%	50.0	13.50	1	13.5
1.6%	18.8	1.69	1	1.7
			Total:	**15.2**

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MANNING'S PIPE EQUATION
LOT 1 AND LOT 2 DRIVEWAY CULVERT PIPE DESIGN

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

Mannings' Equation		
Pipe Diameter (mm) =	**300**	
Area =	0.071	m^2
Slope (%) =	**0.50**	
Manning 'n' =	**0.013**	
Nom'l Pipe Capacity, Q =	0.068	m^3/sec
Actual Pipe Capacity, Q =	**0.071**	m^3/sec

Box Culvert		
Height =	0.00	
Width =	0	
Q =	0.00	
Velocity		
	0.97	m/s
	1.01	m/s
R=	**0.075**	
Sf=	**0.0050**	

NOTE: Capacity of culverts exceed 100yr flows for Catchment A4+A5 attenuated to pre-development conditions (PRE5=0.031m^3/s).

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MANNING'S OPEN CHANNEL EQUATION
LOT 2 NORTH SWALE (Catchment A3)

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

Mannings' Equation			TRAPEZOIDAL CHANNEL		
Flow Depth (m) =	0.600				
Side Slope Ratio (H:V) =	3.0	/1	Top width	3.6	
Bed Width (m)=	0.00		Hyd. Rad. 'R'		
Area (m^2)=	1.080		**0.284605**	m	
Wetted Perimeter (m)=	3.795	m	Friction Slope Sf		
Slope (%) =	1.00		**0.0100**	m/m	
Manning 'n' =	0.035		Velocity		
Channel Capacity, Q =	**1.335**	m^3/sec	**1.236**	m/s	

NOTE: The 100yr peak flow for A3 is 0.075m^3/s, so the swale has excess capacity.

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MANNING'S OPEN CHANNEL EQUATION

LOT 2 SOUTH SWALE (Catchment A3)

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

Mannings' Equation			TRAPEZOIDAL CHANNEL		
Flow Depth (m) =	0.150				
Side Slope Ratio (H:V) =	3.0	/1	Top width	0.9	
Bed Width (m)=	0.00		Hyd. Rad, 'R'		
Area (m^2)=	0.068		0.071151	m	
Wetted Perimeter (m)=	0.949	m	Friction Slope Sf		
Slope (%) =	2.00		0.0200	m/m	
Manning 'n' =	0.035		Velocity		
Channel Capacity, Q =	**0.047**	m^3/sec	0.694	m/s	

NOTE: The portion of Catchment A3 going to swale is ~55% of the total area. 55% of the 100yr flow rate for A5 is (0.55 x 0.075m3/s) 0.041m^3/s which is less than the capacity of the swale.

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MANNING'S OPEN CHANNEL EQUATION

LOT 3 SWALE (Catchment A7)

Date: 13-Jun-22 **Project No.:** 10-116

Project: Wendake Road **Prepared By:** CJ

Mannings' Equation			TRAPEZOIDAL CHANNEL		
Flow Depth (m) =	0.300				
Side Slope Ratio (H:V) =	3.0	/1	Top width	1.8	
Bed Width (m)=	0.00		Hyd. Rad. 'R'		
Area (m^2)=	0.270		0.142302	m	
Wetted Perimeter (m)=	1.897	m	Friction Slope Sf		
Slope (%) =	0.60		0.0060	m/m	
Manning 'n' =	0.035		Velocity		
Channel Capacity, Q =	**0.163**	m^3/sec	0.603	m/s	

NOTE: The 100yr peak flow for A7 is 0.072m^3/s, so the swale has excess capacity.

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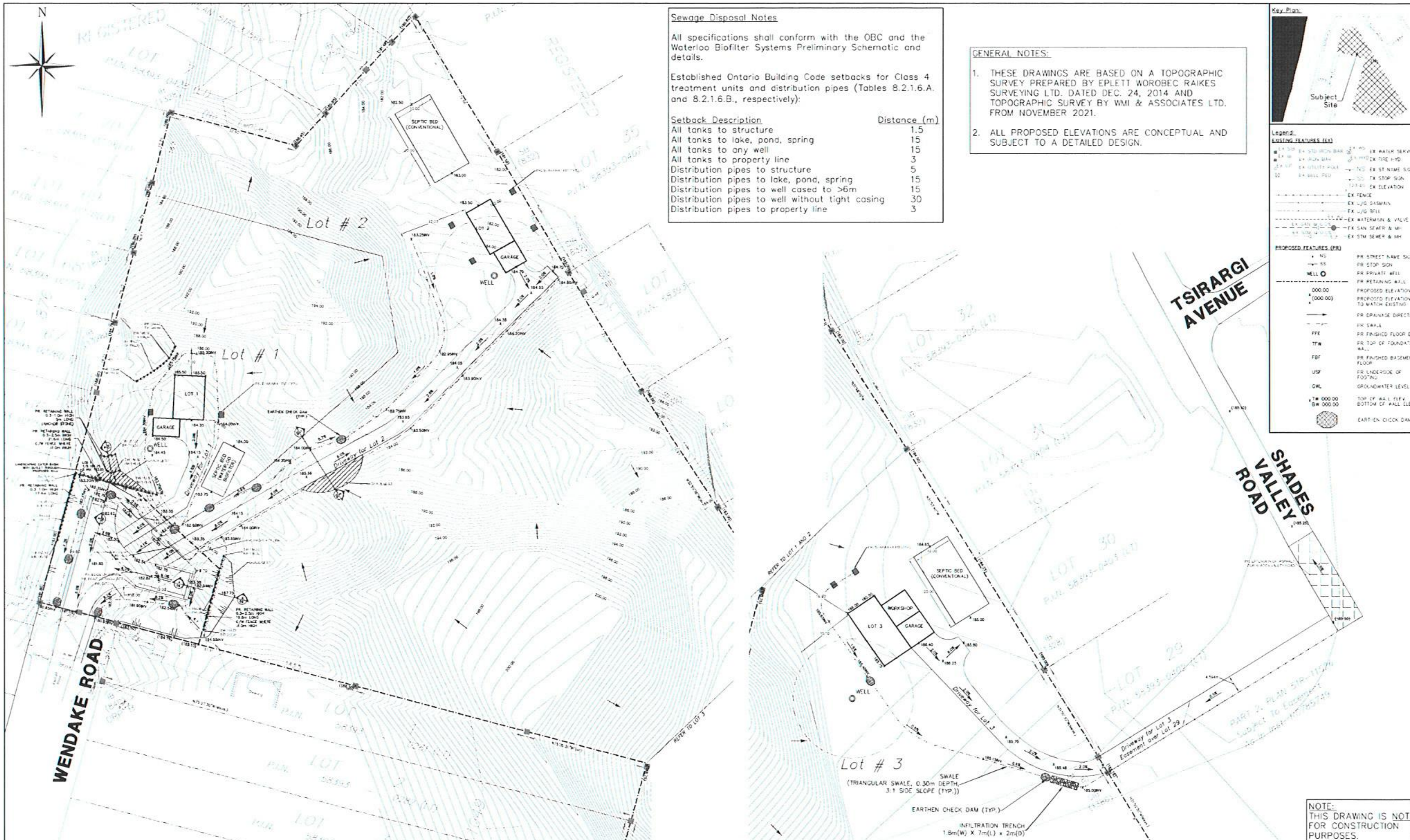
APPENDIX C

Preliminary Drawings



Sewage Disposal Notes

All specifications shall conform with the OBC and the Waterloo Biofilter Systems Preliminary Schematic and details.

Established Ontario Building Code setbacks for Class 4 treatment units and distribution pipes (Tables 8.2.1.6.A. and 8.2.1.6.B., respectively):

Setback Description	Distance (m)
All tanks to structure	1.5
All tanks to lake, pond, spring	15
All tanks to any well	15
All tanks to property line	3
Distribution pipes to structure	5
Distribution pipes to lake, pond, spring	15
Distribution pipes to well cased to >6m	15
Distribution pipes to well without tight casing	30
Distribution pipes to property line	3

GENERAL NOTES:

1. THESE DRAWINGS ARE BASED ON A TOPOGRAPHIC SURVEY PREPARED BY EPLETT WOROBEC RAIKES SURVEYING LTD. DATED DEC. 24, 2014 AND TOPOGRAPHIC SURVEY BY WMI & ASSOCIATES LTD. FROM NOVEMBER 2021.
2. ALL PROPOSED ELEVATIONS ARE CONCEPTUAL AND SUBJECT TO A DETAILED DESIGN.

NOTE:
THIS DRAWING IS NOT FOR CONSTRUCTION PURPOSES.

Notes:

1. Unless noted otherwise, the measurements and distances shown on this drawing are shown in meters.
2. Do not scale drawings.
3. This drawing is not for construction purposes.
4. This drawing is to be read and understood in conjunction with all other relevant documents applicable to this project.
5. This drawing is the exclusive property of WMI & Associates Ltd. and the reproduction of any part of this document without prior written consent is strictly prohibited.

REGISTERED PROFESSIONAL ENGINEER
S. R. MORASH
June 13, 2022
PROVINCE OF ONTARIO

No.	Issue / Revision	Date
1	FUNCTIONAL SERVICING REPORT	JUNE 18, 2021
2	REV. FUNCTIONAL SERVICING REPORT	JUNE 13, 2022

Wendake Road Development

CONCEPTUAL SERVICING AND GRADING PLAN

THIS DRAWING IS NOT FOR CONSTRUCTION

Client:
P. AND T. CERQUIERA
16 BANCROFT CRESCENT
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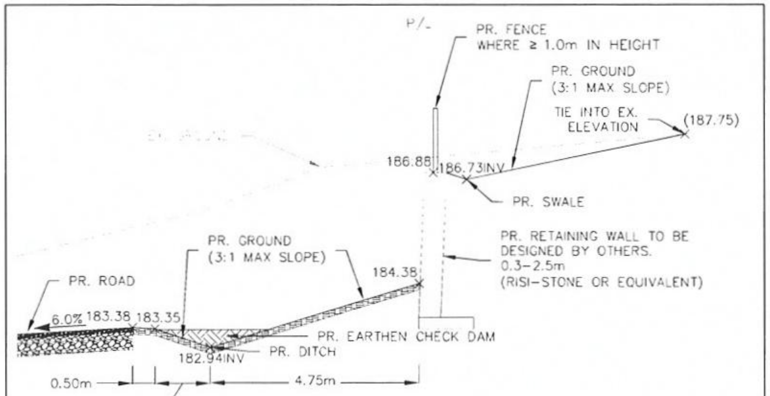
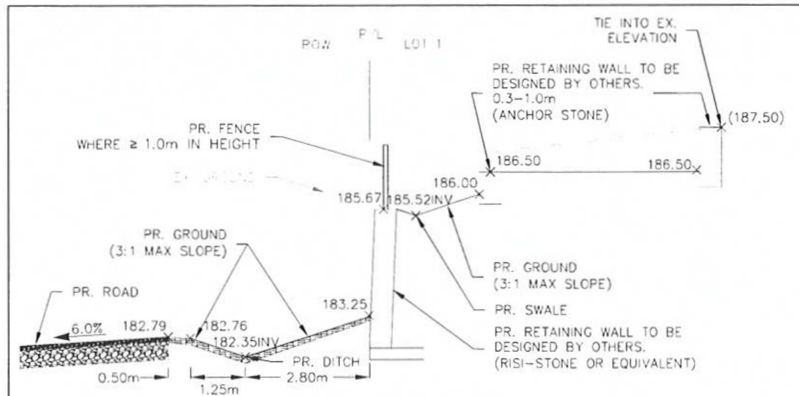
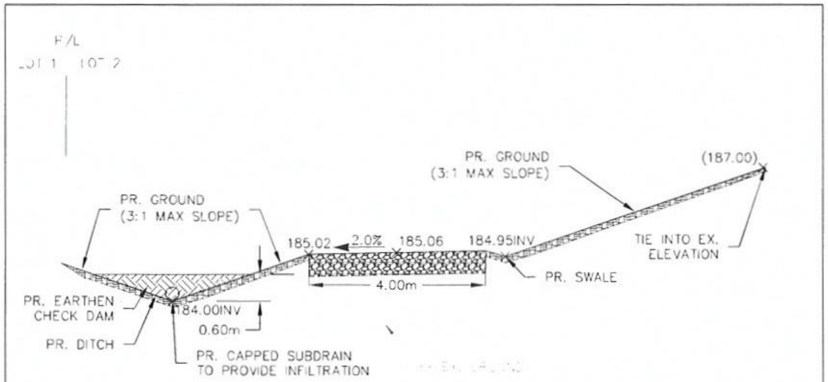
Drawn By: CJ | Checked By: SM | Drawing No.: CSGP
Scale: 1:400 | Project No.: 10-116



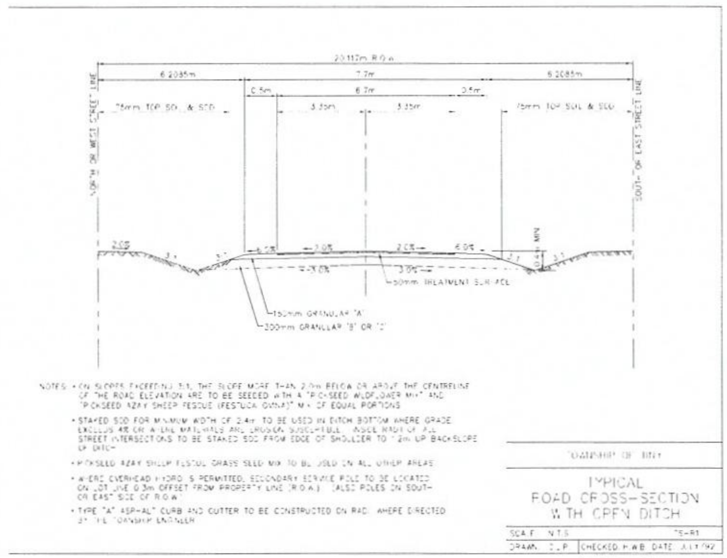
RETAINING WALL DETAIL
SECTION A–A
N.T.S



RETAINING WALL DETAIL
SECTION B–B
N.T.S

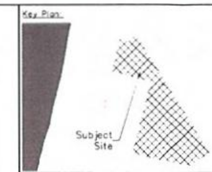


LOT 2 DRIVEWAY DETAIL
SECTION C–C
N.T.S



"MODIFIED"

Key Plan:



Legend:

EXISTING FEATURES (EX)

- EX WATER SERVICE
- EX FIRE HYD
- EX ST NAME SIGN
- EX STOP SIGN
- EX ELEVATION
- EX FENCE
- EX U/G GASMAIN
- EX U/G BELL
- EX WATERMAIN & VALVE
- EX SAN SEWER & MH
- EX STM SEWER & MH

PROPOSED FEATURES (PR)

NS	PR STREET NAME SIGN
SS	PR STOP SIGN
WELL	PR PRIVATE WELL
	PR RETAINING WALL
000.00	PROPOSED ELEVATION
(000.00)	PROPOSED ELEVATION TO MATCH EXISTING
	PR DRAINAGE DIRECTION
	PR SWALE
FFE	PR FINISHED FLOOR ELEV
TFW	PR TOP OF FOUNDATION WALL
FBF	PR FINISHED BASEMENT FLOOR
USF	PR UNDERSIDE OF FOOTING
GWL	GROUNDWATER LEVEL
TW 000.00 BW 000.00	TOP OF WALL ELEV BOTTOM OF WALL ELEV
	EARTHEN CHECK DAMS

NOTE:
THIS DRAWING IS NOT FOR CONSTRUCTION PURPOSES.

Notes:

1. Unless noted otherwise, the measurements and distances shown on this drawing are shown in meters
2. Do not scale drawings.
3. This drawing is not for construction purposes.
4. This drawing is to be read and understood in conjunction with all other relevant documents applicable to this project.
5. This drawing is the exclusive property of WMI & Associates Ltd. and the reproduction of any part of this document without prior written consent is strictly prohibited.

REGISTERED PROFESSIONAL ENGINEER
S. R. MORASH
June 13, 2022
PROVINCE OF ONTARIO

No	Issue / Revision	Date
1	REV. FUNCTIONAL SERVICING REPORT	JUNE 13, 2022

Wendoke Road Development

DETAIL SHEET

THIS DRAWING IS NOT FOR CONSTRUCTION

Client:

P. AND T. CERQUIERA
16 BANCROFT CRESCENT
WHITBY, ON
L1R 2E6

WMI & Associates Limited
119 Collier Street
Barrie, Ontario
L4M 1H5
Ph 705-797-2027
www.wmiengineering.ca

Drawn By	Checked By	Drawing No
CJ	SM	DS
Scale NTS	Project No 10-116	

APPENDIX D

Slope Study and Letter
(GEI Consultants Ltd.)

GEI Consultants

April 7, 2021

Attn: Dawn Critchley

RE: Visual Slope Inspection for Proposed Residential Development
Wendake Road, Township of Tiny
Project No. 2101018

GEI Consultants (GEI) was retained to complete a visual slope inspection and prepare a slope stability letter to address comments from the Township of Tiny regarding the proposed residential development at the north end of Wendake Road, in Tiny, Ontario.

1. INTRODUCTION & SCOPE OF WORK

GEI was provided with the following information to review in preparation of this letter report:

- "*Concept Plan, Part of Lot 21, Concession 5, Township of Tiny, County of Simcoe*", dated February 26, 2021, by Celeste Phillips Planning Inc.
- "*Topographic Survey of Part of Lot 21, Concession 5, Township of Tiny, County of Simcoe*", Project No. 132389, dated December 23, 2014, by Eplett Worobec Raikes Surveying Ltd.
- Site photographs taken November 12, 2020 from the client.

The site is primarily forested with mature trees and some moderate undergrowth. The site has significant topographic undulations from historical sand dunes, with some portions of the site being as high as Elev. 204 metres and some portions of the site being as low as Elev. 182 metres. In general, there are two main dune features at the site. One dune feature is located on proposed Lots 1 and 2 and a second dune feature is located on proposed Lot 3. Based on the topographic survey, conceptual site plan and site photographs, the dune slopes have inclinations as steep as approximately 1.2 horizontal to 1 vertical in some locations.

It is proposed to construct 3 residential single-family dwellings on site in areas at the base of the dunes, setback slightly from the existing base of the dunes. Wendake Road would be extended slightly into a cul-de-sac, with a driveway extending to the three lots. Section 4.23.5 of the Township of Tiny Zoning By-Law 06-001 states the following:

> *"Notwithstanding any other provision in this By-law, no building or structure shall be located within 15.0 metres of the toe and top of a slope or embankment that exceeds 1 to 3. This provision shall also not prevent the expansion or replacement of buildings or structures that existed on the effective date of this By-law within this setback area, provided the expansion or replacement does not have the effect of reducing the setback*

647 Welham Road, Unit 14, Barrie, Ontario, L4N 0B7 (705) 719-7994

from the slope or increasing the volume or floor area of a building or structure in the setback area."

It is understood that the Township is requesting that a geotechnical engineer complete a slope stability letter in support of the proposed dwelling locations due to the proximity to the base of the slopes (in some cases less than 15 metres). The purpose of the study was to complete a visual slope inspection, investigate the subsurface conditions using shallow hand auger holes, carry out a background review of the site, and to provide confirmation that the locations of the dwellings will not be adversely impacted by possible future slope instability of the dune slopes in the long-term planning horizon.

2. SITE DESCRIPTION AND SLOPE CONDITIONS

2.1 Visual Slope Inspection

A visual inspection of the slope and site area was conducted on March 24, 2021, by Bo Hwang, a Senior Field Technician of GEI. General information pertaining to the existing slope features, such as slope profile, drainage, vegetation cover, structures, erosion features and slope slide features were obtained. A summary of the results of the visual inspection is presented below. Photographs taken during the site visit are included as Enclosure 4 and the MNR Slope Inspection Record and Slope Rating Form are included as Enclosure 2. A photograph and site features plan is provided in Enclosure 6.

The site is located in the Township of Tiny at the northern end of Wendake Road. The properties are generally bounded by residential properties and Shades Valley Road to the north and east, greenspace and an unevaluated wetland to the southeast, residential properties and Wendake Road to the south, and residential properties and Tiny Beaches Road South to the west. The nearest watercourse is Georgian Bay which is located about 160 metres west of the site. The site contains a dirt driveway / trail and a small shed measuring about 3 x 1.5 metres near proposed Lot 2 but is otherwise vacant and undeveloped.

The site contains two main historic dune features. One dune is located in the northwestern area of the site on proposed Lots 1 and 2. The dune is approximately 10 metres in height with slope inclinations ranging from approximately 1.7 to 1.2 horizontal to 1 vertical near the proposed dwelling locations. The second dune is located in the eastern part of the site on proposed Lot 3. The dune is approximately 20 metres in height with slope inclinations of up to 1.2 horizontal to 1 vertical near the proposed dwelling location.

The top, bottom, and face of the dune slopes are generally well vegetated with large trees, some shrubs and other undergrowth, but the driveway / trail at the bottom of the slope is bare. Some of the trees on the slope face are tilting. No signs of concentrated overland flow or seepage from the slope were observed but general sheet drainage will occur down the slope. The slope consists of moist to damp sand based on visual observations in localized bare areas and the results of the shallow hand auger holes.

No signs of erosion were observed at the top of the dune slopes. There are some localized bare areas on the slope face but these are attributed to lack of a topsoil layer on the sand dunes and limited underbrush beneath the large trees with an extensive canopy. There are some erosion scarps up to 1.5 metres in height mainly along the driveway at the bottom of the slopes. The scarps show soil loss, exposed roots, and are over-steepened. It is expected that the scarps formed as a result of grading activities to create the driveway access (e.g. minor cutting to flatten the area). No signs of deep-seated or shallow slope instability was observed. Many trees on the slope faces are tilting but this is likely from long-term creep of the slope.

The MNR Slope Rating Form obtained a rating value of 32, which indicates a slight potential for slope instability and the recommendation for a site inspection, surveying, preliminary study, and detailed report (as completed in this slope stability letter).

2.2 Subsurface Conditions

Based on surficial geology mapping from the Ontario Geological Survey, this area of Tiny Township consists of a mixture of eolian deposits (fine sand and silt) and coarse-textured lacustrine deposits (littoral sands and gravels). A map of the site and surrounding area showing surficial geological mapping is included as Enclosure 3, and eolian deposits are shown to exist at the specific site location. The surficial mapping also shows there are numerous historic dunes in the surrounding area.

This soil description is corroborated by MECP well records in near vicinity to the site, visual observations of sandy soil on exposed slope areas during the visual inspection, and results of the shallow hand auger holes. Seven (7) shallow hand auger holes were advanced at the top, bottom and face of the slope across the site to determine the near-surface stratigraphy. The hand augers extended to depths of about 0.5 to 1 metre below grade and consistently encountered damp to moist sands. No groundwater was encountered in any of the hand auger holes. Sample photographs of the hand auger soil cuttings are shown in Enclosure 5 and the hand auger locations are shown in Enclosure 6.

2.3 Historic Aerial Images

Historic aerial images of the site were taken from County of Simcoe online mapping from 1978 to 2018, to compare the site conditions over time and look for possible signs of past slope instability. The aerial images are included as Enclosure 1 and observations are as follows:

- The site is well vegetated with mature trees from 1978 to 2018.
- Some bare areas that appear to consist of sand (former sand dunes) are present on nearby properties throughout the images.

- Most of the nearby residential dwellings were constructed prior to 1978.
- A few trees appear to have fallen in isolated areas but there are no visible signs of slope instability. The isolated trees may have fallen from natural causes.
- A small area of trees disappears in the 2016 image near the proposed location of the dwelling on Lot 1, just north of Wendake Road. The area becomes bare and exposed sand is visible in the 2018 image along with what appears to be a bulldozer in the area. This corresponds with site grading activities and construction of a new dwelling on the property immediately west of the area, and the activities may be related.

3. DISCUSSION

The following discussion is based on the visual slope inspection, background review, and hand auger holes advanced at the site to address the Township of Tiny comment and By-law.

The Town By-law and comments pertaining to a 15 metre setback from the slope toe for dwellings (or municipal roadways) are interpreted to be for maintaining access during an emergency in the event that a slope failure occurs from up-slope (e.g. talus accumulation near the bottom of the slope), and to ensure that talus material from a potential slope failure does not damage the roadway or dwelling and endanger public life.

No signs of slope instability were observed during the visual slope inspection, and no obvious signs of slope instability were observed in the historic aerial images. Trees on the slope are tilting but this is attributed to long-term creep of the slope and not deep-seated slope instability. Some erosion is occurring at the bottom of the slopes, generally along the driveway / trail through the site (the erosion scarps possibly were formed by grading to create the trail). In their existing condition, the dune slopes are considered stable (i.e. have factors of safety greater than 1.0 for slope stability).

To cause a slope failure in the future, a trigger will need to occur that reduces the factor of safety below 1.0. Possible triggers include elevated groundwater levels or temporary perched water tables, loss of vegetation and root mat reinforcement, surficial erosion that over-steepens the slope, loading on the top or face of the slope, cutting the bottom or toe of the slope, or seismic events.

The contours and grades surrounding the site show that the dune slopes are isolated elevated features, and the surrounding grades are generally at a lower elevation (e.g. near Elev. 182 to 184 metres). This means that the prevailing groundwater table is likely below the bottom of the dune slopes, and there is a low risk of elevated groundwater levels triggering instability. The main source of groundwater within the dune slopes is from infiltration at the top of the isolated slopes during precipitation or snow melt events, but the slopes consist of sand which is permeable and it is expected that perched water levels will typically not form within the slope.

It is critical that the bottom and toe of the slopes are not excavated during construction of the dwellings as this will increase the risk of slope instability. This includes lowering site grades at the bottom of the slope or cutting into the slopes (e.g. for driveway construction). If site grading must occur, the bottom of the slope could be filled as this helps to create a buttress against the existing slopes which may provide a nominal increase in overall slope stability. Any areas of existing erosion or soil loss along the driveway could be buttressed using rip rap, boulders, or small engineered retaining walls to protect the slope toe and provide nominal additional support to the slope. Retaining walls are not required for stabilization purposes at the base of the dune slopes in the areas where the proposed dwellings will be situated.

After the dwellings are constructed at the bottom of the slopes, loading at the top or face of the slopes should not occur (e.g. no new foundation loads, stockpiles of soil or other materials, etc.) to reduce driving forces and reduce the risk of long-term instability. Construction and restoration activities should be conducted in a manner which does not result in surface erosion of the slope.

A healthy vegetative cover should be maintained on the slope, where possible. Any slope areas disturbed by construction or by other activities in the future should be restored with suitable native vegetation to reduce erosion in the long-term. To help vegetation re-establish and to reduce risk of erosion immediately following construction, turf reinforcement mats or erosion control blankets can be installed on areas of the slope face that are disturbed during construction, reducing short-term erosion until vegetation can re-establish through hydro-seeding, planting, live-staking or similar methods. Similar slope treatments and re-vegetating should be used if surficial erosion is observed in the future.

The Natural Resources Canada online seismic hazard mapping was reviewed and Tiny (as well as most of southern Ontario) has a “low” hazard for seismic activity. The risk of seismic activity triggering a slope failure at the site is therefore also considered to be low.

The entire dune slopes consist of sands which experience shallow, translation slope failures that typically will displace a smaller volume of soil, and do not experience deep-seated slope failures like in clays that can displace a significant volume of soil. Translation failures also typically daylight on the slope face and the failure surfaces typically do not daylight beyond the bottom of the slope. If a slope failure were to occur in the future at the dune slope, the exact volume and distance of talus runout beyond the toe is unknown but is expected to be relatively minor based on experience at other sandy slopes. It is expected that any talus will have a minimal impact onto the dwellings or roadways even if the structures are closer than 15 metres to the slope toe. The setback from the toe should be as far as possible to reduce risk, but a minimum setback of 5 metres is recommended to allow for emergency and maintenance vehicle access between the dwelling and slope.

In summary, it is GEI’s opinion that the proposed residential dwellings can be constructed less than 15 metres from the bottom of the dune slopes at the site with a negligible risk of being significantly impacted by slope instability (e.g. talus movement) in the long-term. The dune slopes are stable in their existing condition, and the risk of potential triggers causing instability over the long-term is considered low. It is recommended that at least a 5-metre setback between the proposed dwellings and slope toe be maintained for emergency access and future slope maintenance works.

4. CLOSURE

We trust this information is sufficient for your present purposes. Should you have any questions concerning the above, or can be of any further assistance, please do not hesitate to contact the undersigned.

Yours truly,
GEI Consultants

Alexander Winkelmann, P.Eng.
Geotechnical & Earth Sciences Manager

LICENSED PROFESSIONAL ENGINEER
A.WINKELMANN
100150146
Apr. 7, 2021
PROVINCE OF ONTARIO

Russell Wiginton, P.Eng.
Senior Geotechnical Engineer

LICENSED PROFESSIONAL ENGINEER
R. M. WIGINTON
100193069
Apr. 7, 2021
PROVINCE OF ONTARIO

Enclosures:

Enclosure 1 – Historic Aerial Images
Enclosure 2 – Slope Inspection Record and Slope Rating Chart
Enclosure 3 – Surficial Geology Mapping
Enclosure 4 – Site and Slope Photographs
Enclosure 5 – Sample Photographs of Hand Auger Soil Cuttings
Enclosure 6 – Photograph and Site Features Plan

ENCLOSURE 1

Historic Aerial Images

Aerial Image of Site - 1978

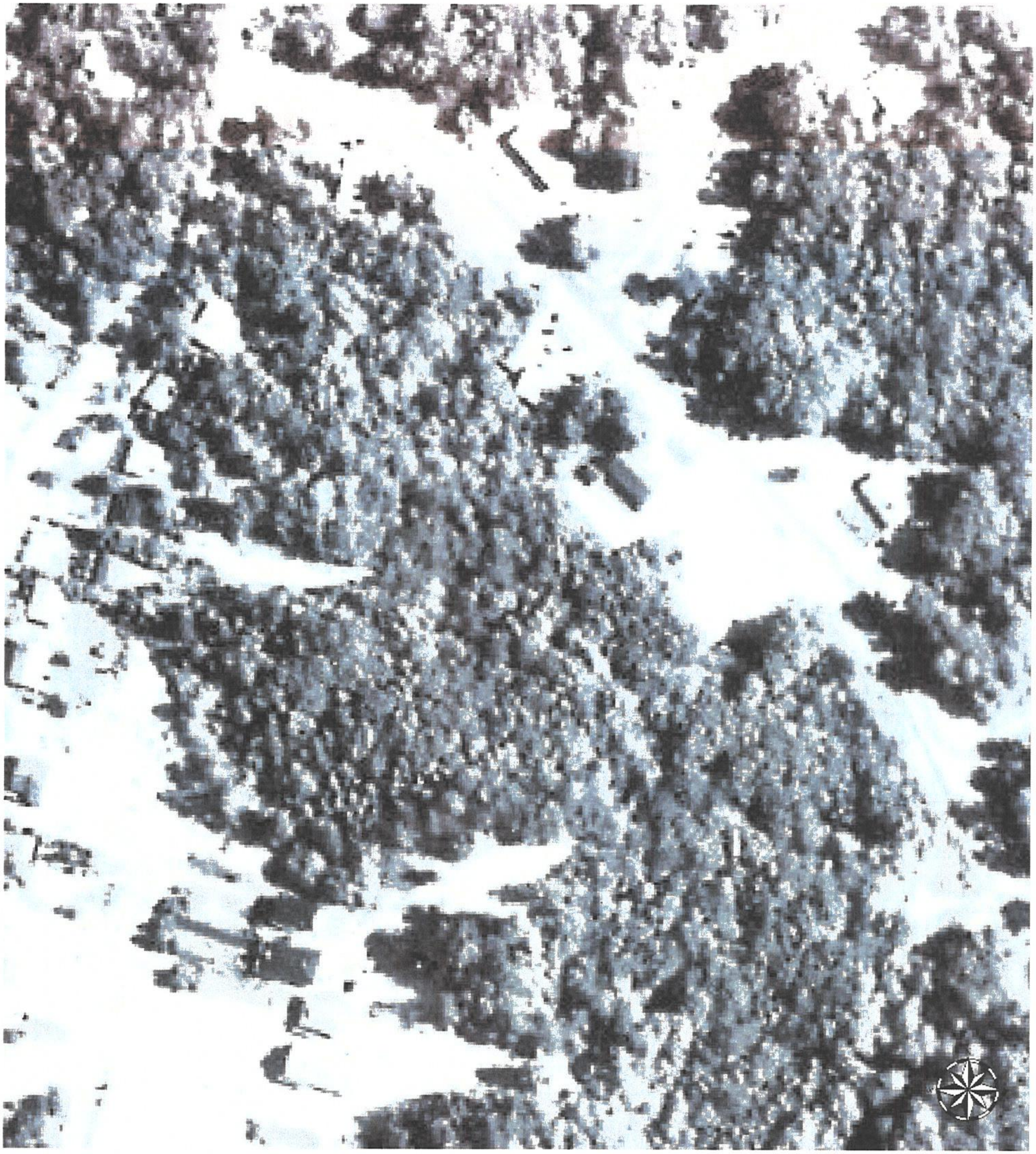
0 20 40 60m

1 : 2,257

COUNTY OF SIMCOE

Apr 5, 2021

Aerial Image of Site - 1989



0 20 40 60m

1 : 2,257

COUNTY OF SIMCOE

Apr 5, 2021

Aerial Image of Site - 1997

0 20 40 60m

1 : 2,257

COUNTY OF SIMCOE

Apr 5, 2021

Aerial Image of Site - 2002

0 20 40 60m

1 : 2,257

COUNTY OF SIMCOE

Apr 5, 2021

Aerial Image of Site - 2008

0 20 40 60m

1 : 2,257

COUNTY OF SIMCOE

Apr 5, 2021

Aerial Image of Site - 2012

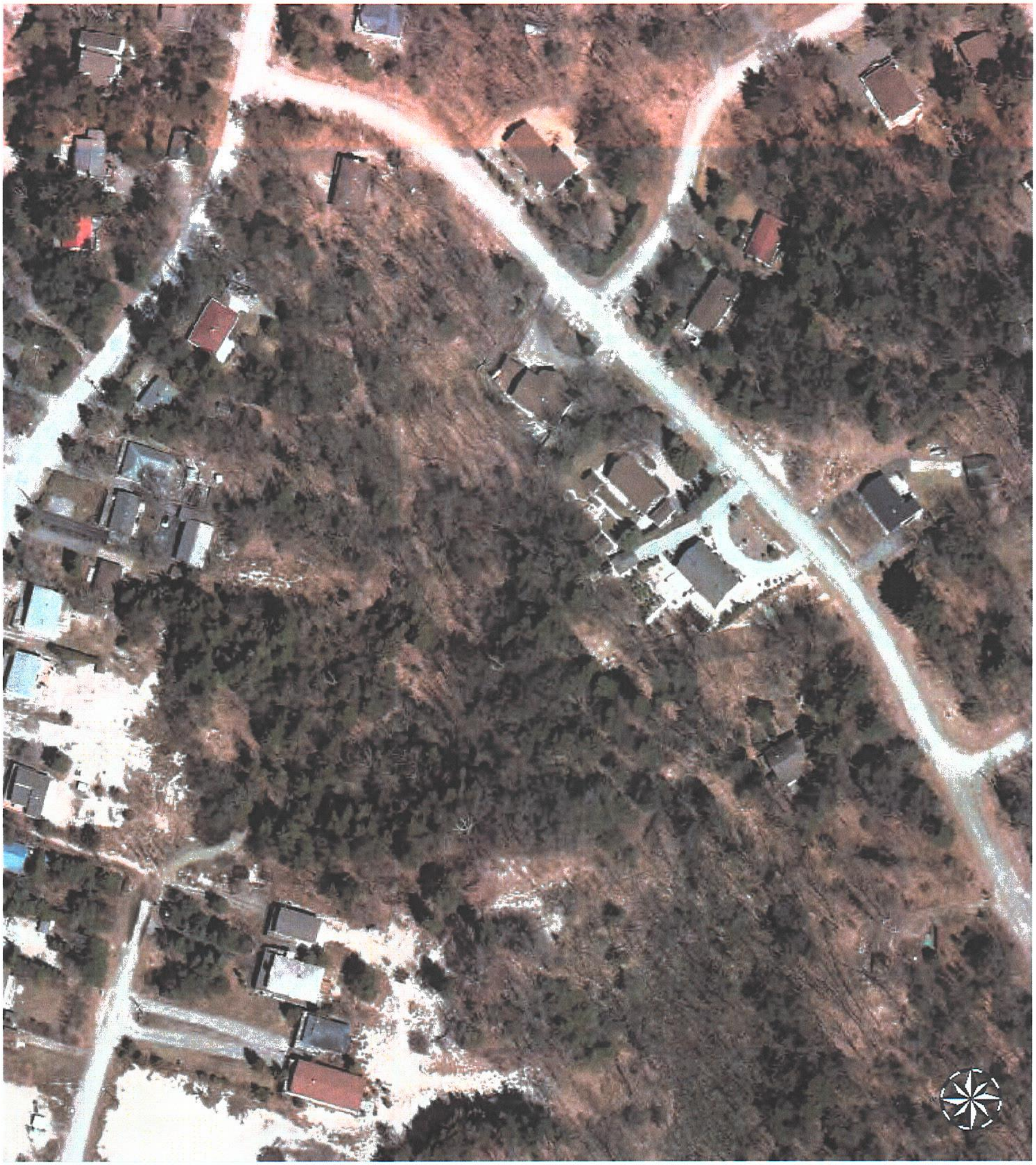
0 20 40 60m

1 : 2,257

COUNTY OF SIMCOE

Apr 5, 2021

Aerial Image of Site - 2016



0 20 40 60m

1 : 2,257

COUNTY OF SIMCOE

Apr 5, 2021

Aerial Image of Site - 2018

0 20 40 60m

1 : 2,257

COUNTY OF SIMCOE

Apr 5, 2021

ENCLOSURE 2

Slope Inspection Record and Slope Rating Chart

SLOPE INSPECTION FORM

GEI Consultants

File No: 2101018

File Name: Wendake Road Slope Inspection

Inspection Date: March 24, 2021

Inspected By (name): Bo Hwang

Weather (circle): ☒ sunny ☐ partly cloudy ☐ overcast ☐ calm ☒ breezy ☐ windy

☒ clear ☐ fog ☐ rain ☐ snow ☐ cold ☒ cool ☐ warm ☐ hot

Est. Air Temp. (°C): 16 C

Site Location / Directions (describe main roads, features):

Properties between Wendake Road, Tiny Beaches Road South, and Shades Valley Road.

Site Location Sketch:

Property Ownership (name, address, phone):

Legal Description:

Lot 21

Concession 5

Township Tiny

County Simcoe

Watershed: Georgian Bay

Governing Regional Body: Township of Tiny

Governing Conservation Authority: N/A

Current Land Use (circle and describe):

☒ Vacant – Field, bush, woods, forest, wilderness, tundra

☐ Passive – Recreational parks, golf courses, non-habitable structures, buried utilities, swimming pools

☐ Active – Habitable structures, residential, commercial, industrial, warehousing, storage

☐ Infrastructure/Public Use – Stadiums, hospitals, schools, bridges, high voltage power lines, waste management sites

SLOPE DATA

Height

☐ 3 - 6 m ☐ 6 - 10 m ☐ 10 - 15 m ☒ 15 - 20 m

☐ 20 - 25 m ☐ 25 - 30 m ☐ >30 m

Estimated height (m): Up to 20m

Inclination / Shape

☐ 4:1 or flatter (25% / 14°) ☐ Up to 3:1 (33% / 18.5°) ☐ Up to 2:1 (50% / 26.5°)

☒ Up to 1:1 (100% / 45°) ☐ Up to 0.5:1 (200% / 63.5°) ☐ Steeper than 0.5:1 (>63.5°)

SLOPE DRAINAGE (describe):

TOP

Sheet drainage. No signs of concentrated runoff or seepage noted on site. Due to cohesionless nature of underlying soils, it is expected that water would infiltrate quickly at this property.

FACE

As above.

BOTTOM

As above.

SLOPE SOIL STRATIGRAPHY (describe, positions, thicknesses, types):

TOP

Sand (historic sand dune) observed in bare areas of slope and encountered in the hand auger boreholes.

FACE

As above.

BOTTOM

As above.

WATER COURSE FEATURES (circle and describe):

SWALES, GULLIES, DITCHES, CHANNELS

None observed.

STREAMS, CREEKS, RIVERS

None observed.

PONDS, BAYS, LAKES

Nearest watercourse is Georgian Bay, about 160 metres west of site.

SPRINGS, SEEPS, MARHSY GROUND

None observed.

VEGETATION COVER (grasses, weeds, shrubs, saplings, trees):

TOP

Well vegetated with mature trees and some shrubs / grass.

FACE

Well vegetated with mature trees and some shrubs / grass. Some trees are tilting down the slope.

BOTTOM

Some trees and shrubs but bare along the trail.

STRUCTURES (buildings, walls, fences, sewers, roads, stairs, decks, towers):

TOP

None observed.

FACE

None observed.

BOTTOM

Small shed (about 3 x 1.5 metres) near proposed Lot #2 area.

EROSION FEATURES (scour, undercutting, bare areas, piping, rills, gully):

TOP

None observed.

FACE

Some localized bare areas on the slope face, primarily due to relatively steep slope, cohesionless native soil subgrade at limited low-lying vegetation present.

BOTTOM

Some erosion scarps up to 1.5 metres in height located at the slope toe along the driveway / trail (soil loss, exposed roots and over-steepened). Possibly formed due to grading activities when the driveway was constructed.

SLOPE SLIDE FEATURES (tension cracks, scarps, slumps, bulges, grabens, ridges, bent trees):

TOP

None observed.

FACE

Some leaning trees observed on the slope face, but expected to be from long-term creep of the slope.

BOTTOM

None observed.

GEI Consultants

SLOPE RATING FORM

Site Location:	Wendake Road, Tiny	File No:	2101018
Property Owner:	-	Inspection Date:	March 24, 2021
Inspected By:	Bo Hwang	Weather:	Sunny, 16C

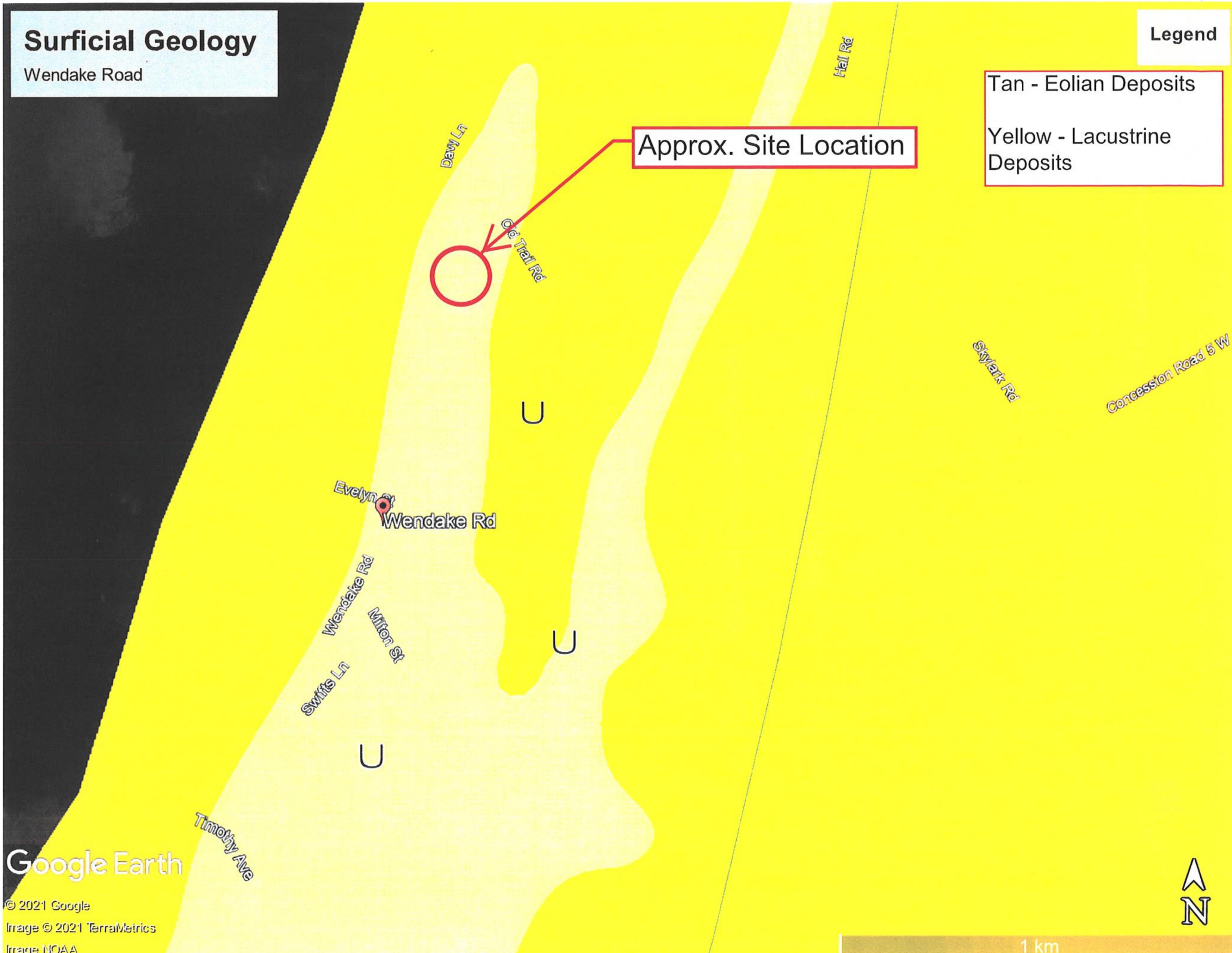
				Rating Value	
1.	**SLOPE INSPECTION**				
		Degrees	***Horiz. : Vert.***		
	a)	18 or less	3 : 1 or flatter	0	☐
	b)	18 to 26	2 : 1 to 3 : 1	6	☐
	c)	more than 26	steeper than 2 : 1	16	☒
2.	**SOIL STRATIGRAPHY**				
	a)	Shale, Limestone, Granite (Bedrock)		0	☐
	b)	Sand, Gravel		6	☒
	c)	Glacial Till		9	☐
	d)	Clay, Silt		12	☐
	e)	Fill		16	☐
	f)	Leda Clay		24	☐
3.	**SEEPAGE FROM SLOPE FACE**				
	a)	None or Near bottom only		0	☒
	b)	Near mid-slope only		6	☐
	c)	Near crest only or from several levels		12	☐
4.	**SLOPE HEIGHT**				
	a)	2 metres or less		0	☐
	b)	2.1 to 5 metres		2	☐
	c)	5.1 to 10 metres		4	☐
	d)	Greater than 10 metres		8	☒
5.	**VEGETATION COVER ON SLOPE FACE**				
	a)	Well vegetated; heavy shrubs or forested with mature trees		0	☒
	b)	Light vegetation; Mostly grass, weeds, occasional trees, shrubs		4	☐
	c)	No vegetation; bare		8	☐
6.	**TABLELAND DRAINAGE**				
	a)	Tableland flat, no apparent drainage over slope		0	☐
	b)	Minor drainage over slope, no active erosion		2	☒
	c)	Drainage over slope, active erosion, gullies		4	☐
7.	**PROXIMITY OF WATERCOURSE TO SLOPE TOE**				
	a)	15 metres or more from slope toe		0	☒
	b)	Less than 15 metres from slope toe		6	☐
8.	**PREVIOUS LANDSLIDE ACTIVITY**				
	a)	No		0	☒
	b)	Yes		6	☐
				TOTAL	32

	SLOPE INSTABILITY RATING	RATING VALUE TOTAL	INVESTIGATION REQUIREMENTS
1.	Low potential	<24	Site inspection only, confirmation, report letter.
2.	Slight potential	25-35	Site inspection and surveying, preliminary study, detailed report.
3.	Moderate potential	>35	Boreholes, piezometers, lab tests, surveying, detailed report.

NOTES:
a) Choose only one from each category; compare total rating value with above requirements.
b) If there is a water body (stream, creek, river, pond, bay, lake) at the slope toe; the potential for toe erosion and undercutting should be evaluated in detail and, protection provided if required.

ENCLOSURE 3

Surficial Geology Mapping


Surficial Geology
Wendake Road
Legend
Tan - Eolian Deposits
Yellow - Lacustrine Deposits
Approx. Site Location
Hall Rd
Davy Ln
Old Trail Rd
Skylark Rd
Concession Road 5 W
Evelyn St
Wendake Rd
Wendake Rd
Milton St
Swifts Ln
Timothy Ave
U
U
U
Google Earth
© 2021 Google
Image © 2021 TerraMetrics
Image NOAA
N
1 km

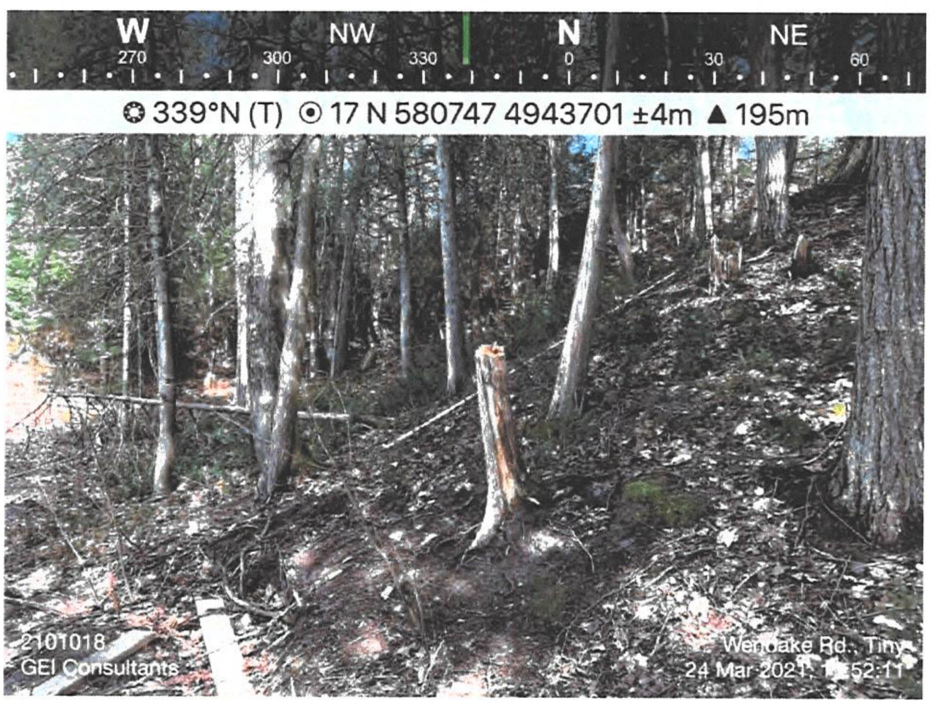
ENCLOSURE 4

Site and Slope Photographs

PHOTOGRAPH 1

Description:
A view of the trail / driveway entering the site.

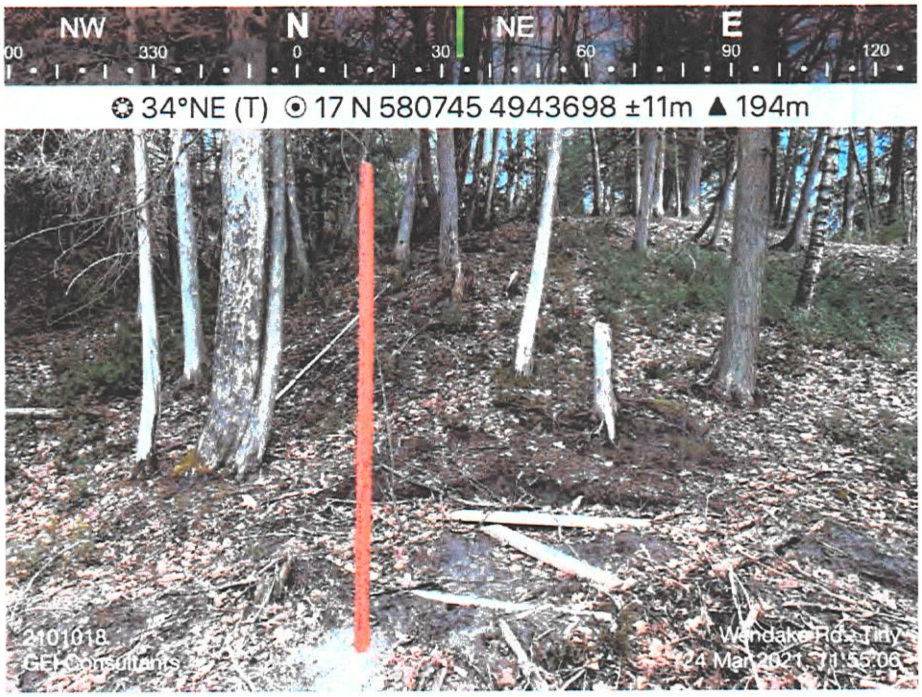
(GEI 2021)



PHOTOGRAPH 2

Description:
A view of the well vegetated dune slope toe near the proposed dwelling on Lot 1.

(GEI 2021)



PHOTOGRAPH 3

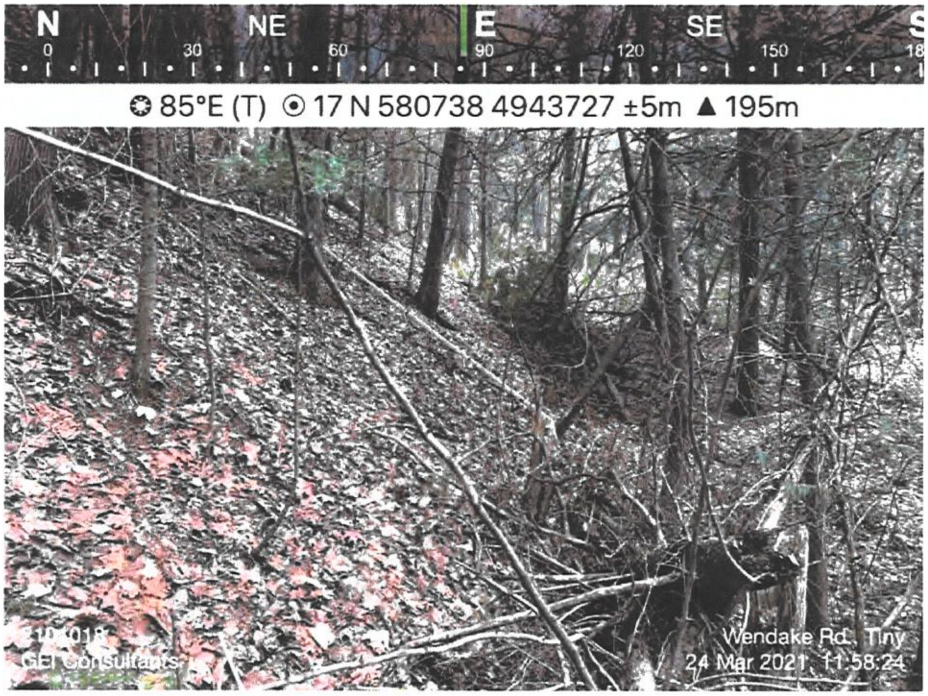
Description:
A view of the dune slope face near the proposed dwelling on Lot 1.

(GEI 2021)

PHOTOGRAPH 4

Description:
Another view of the dune slope face near the proposed dwelling on Lot 1.

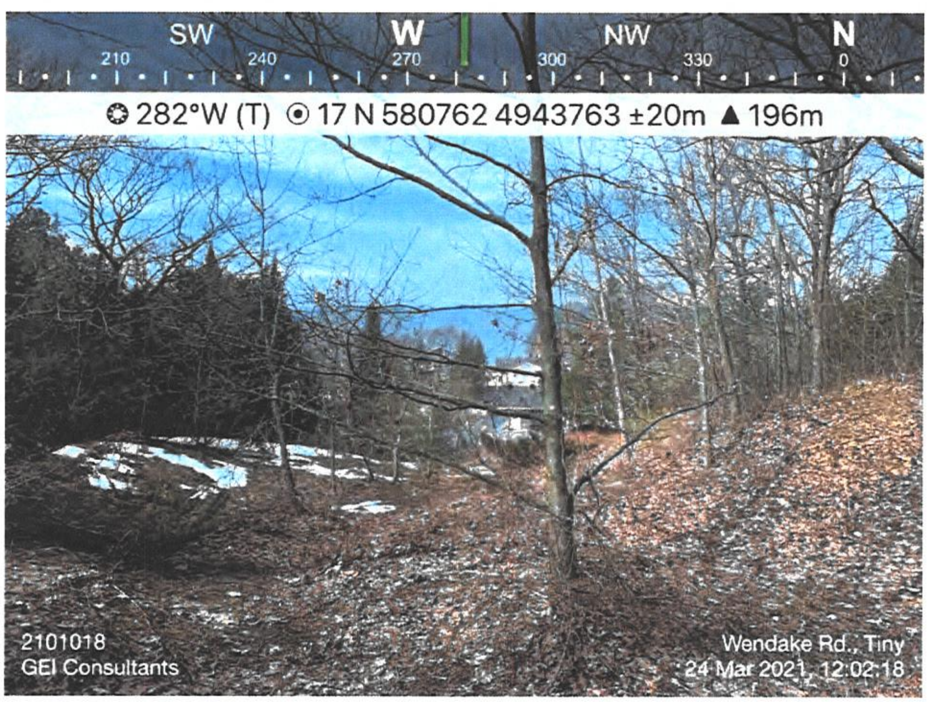
(GEI 2021)



PHOTOGRAPH 5

Description:
A view of the dune slope profile near the proposed dwelling on Lot 1.

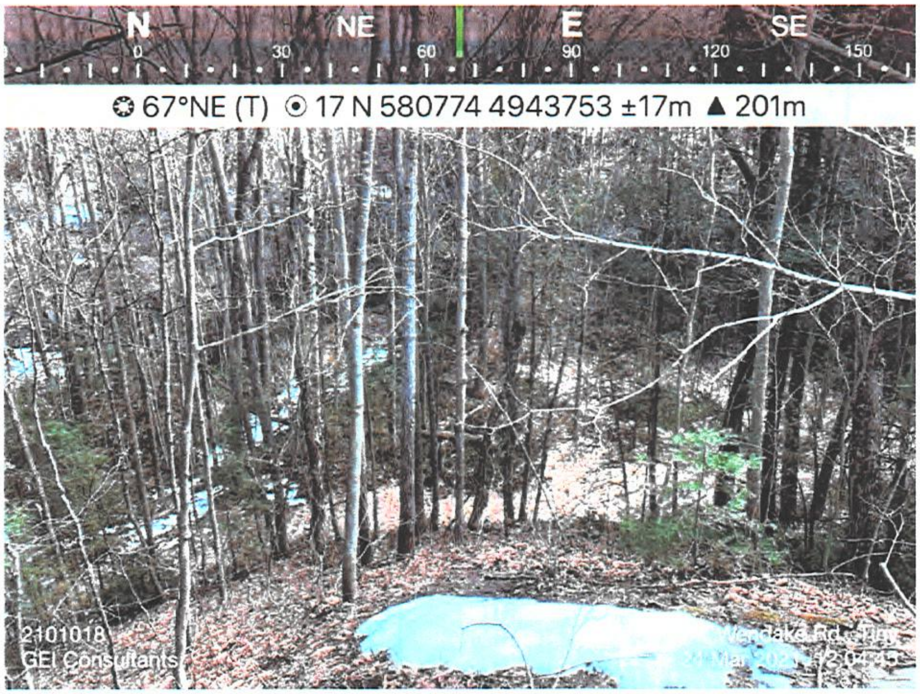
(GEI 2021)



PHOTOGRAPH 6

Description:
A view near the top of the dune on Lot 1, looking west.

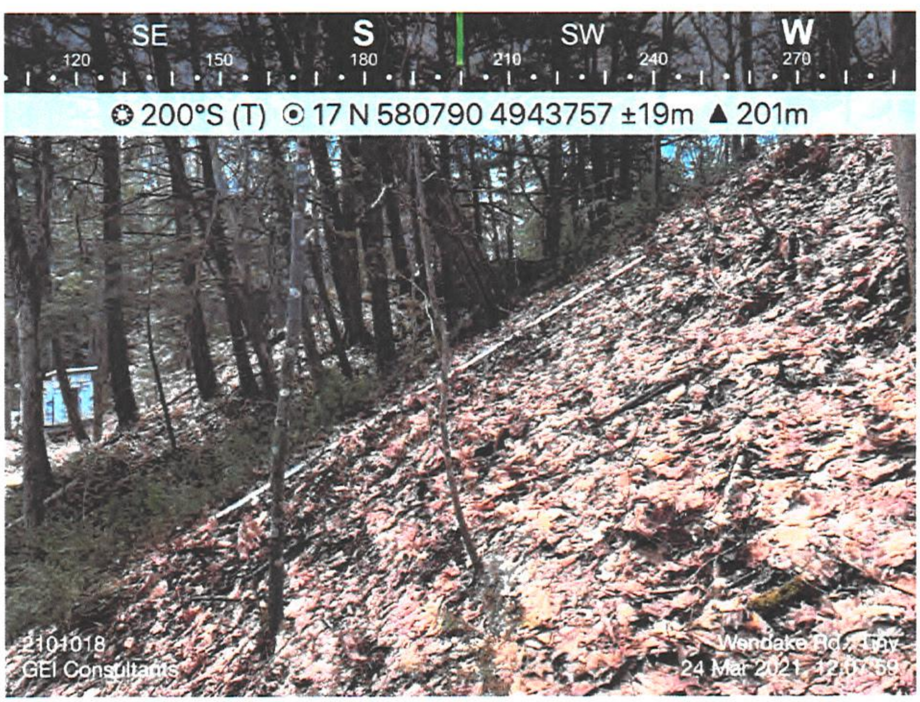
(GEI 2021)



PHOTOGRAPH 7

Description:
A view looking northeast down the dune slope on Lots 1 and 2, facing the general direction of the propose dwelling on Lot 2.

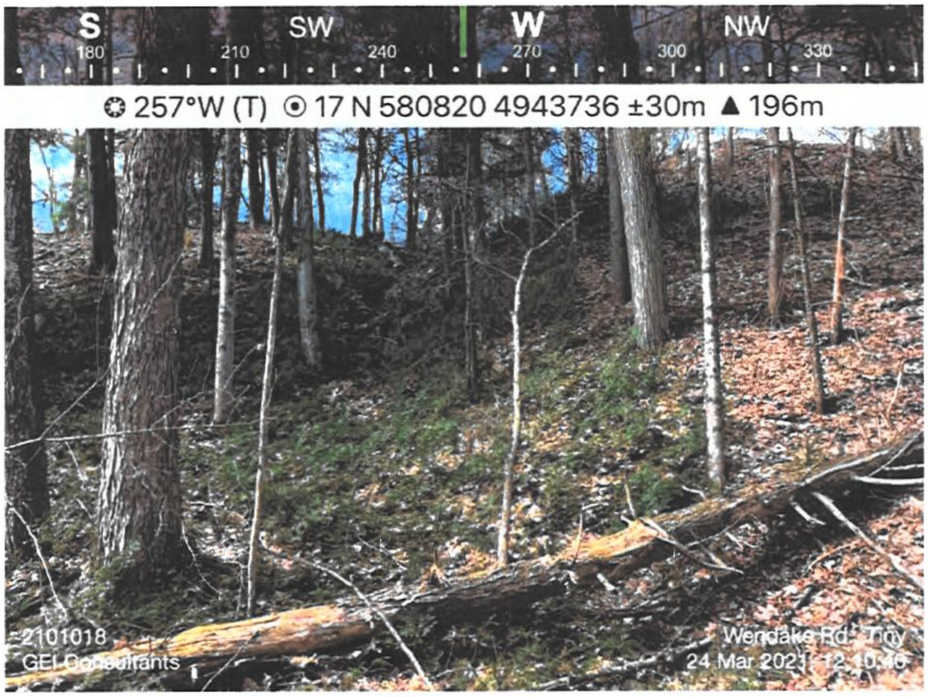
(GEI 2021)



PHOTOGRAPH 8

Description:
A view of the slope profile near the proposed dwelling on Lot 2.

(GEI 2021)



PHOTOGRAPH 9

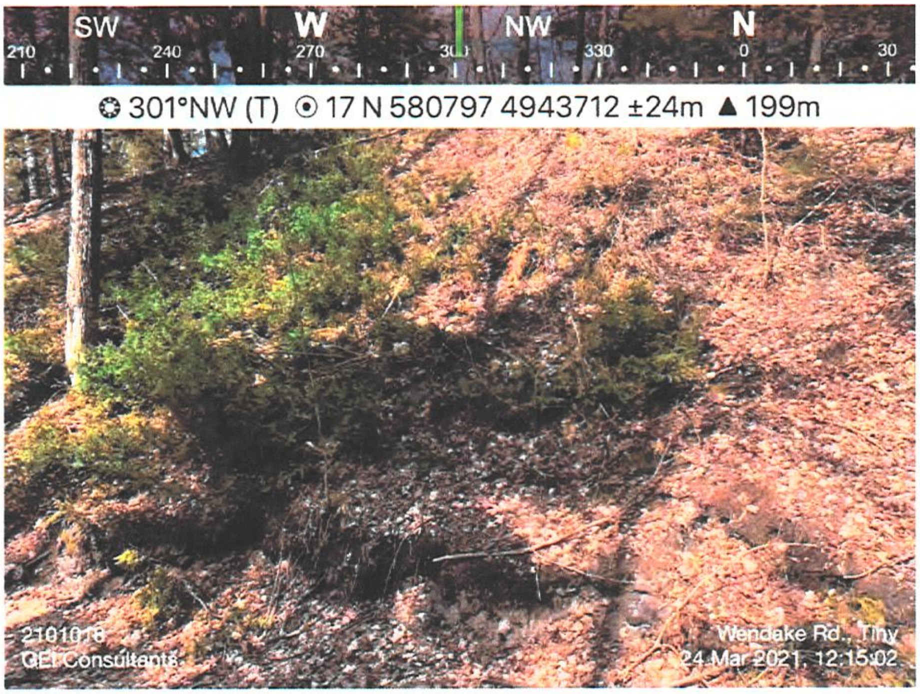
Description:
A view of the slope near the proposed dwelling on Lot 2.

(GEI 2021)

PHOTOGRAPH 10

Description:
A view of the bottom of the slopes from Lot 2 facing Lot 3.

(GEI 2021)



PHOTOGRAPH 11

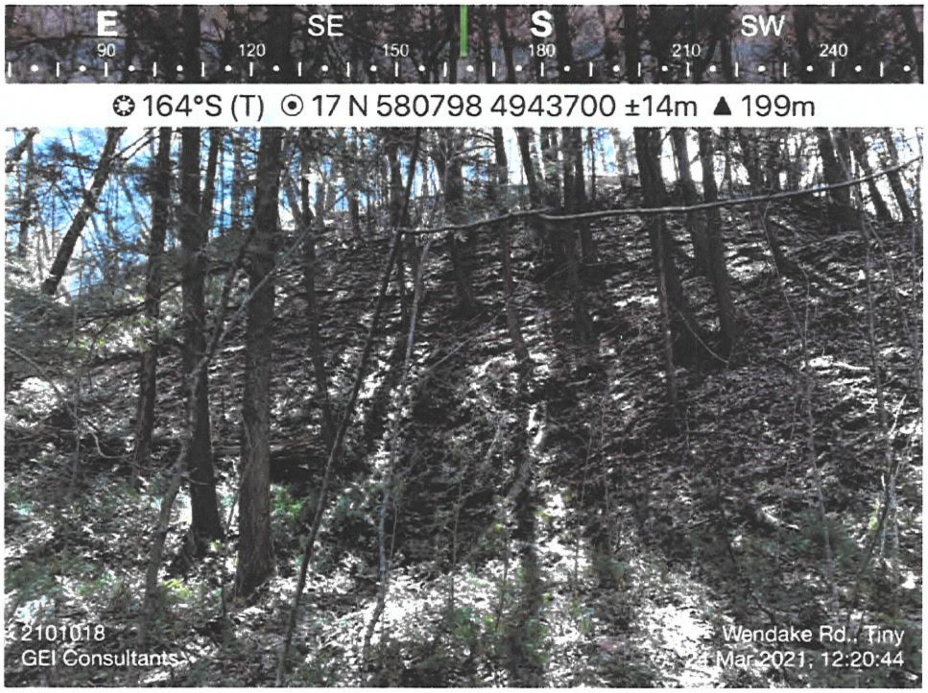
Description:
A view of some minor erosion at the slope toe along the driveway (no proposed dwellings near this area).

(GEI 2021)

PHOTOGRAPH 12

Description:
A view of the slope profile and bottom of slope along the driveway.

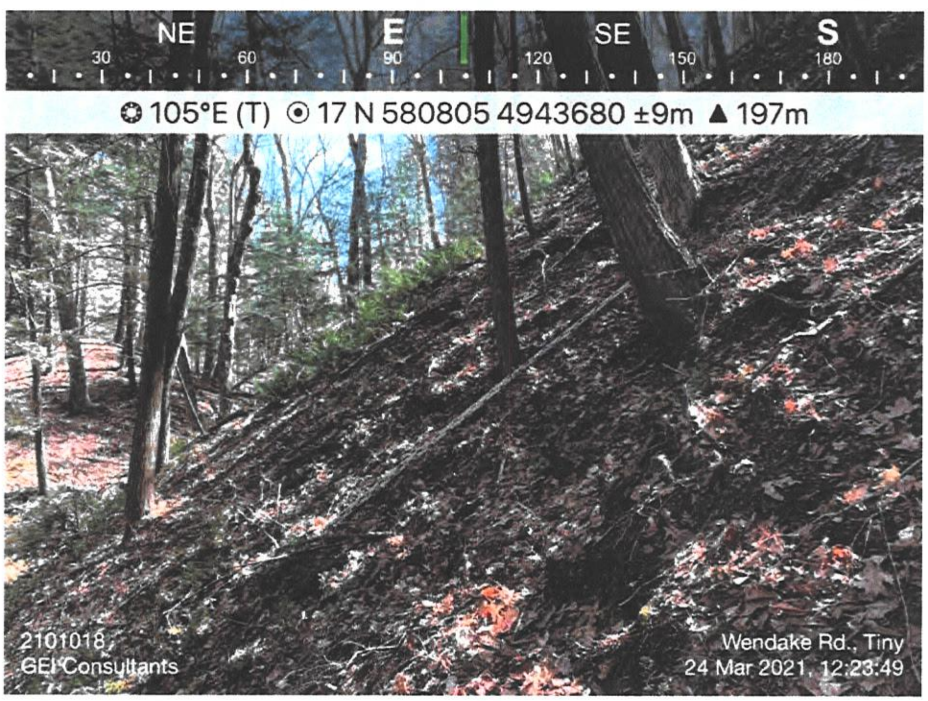
(GEI 2021)



PHOTOGRAPH 13

Description:
A view of the overall dune slope to the south of the proposed dwelling on Lot 3.

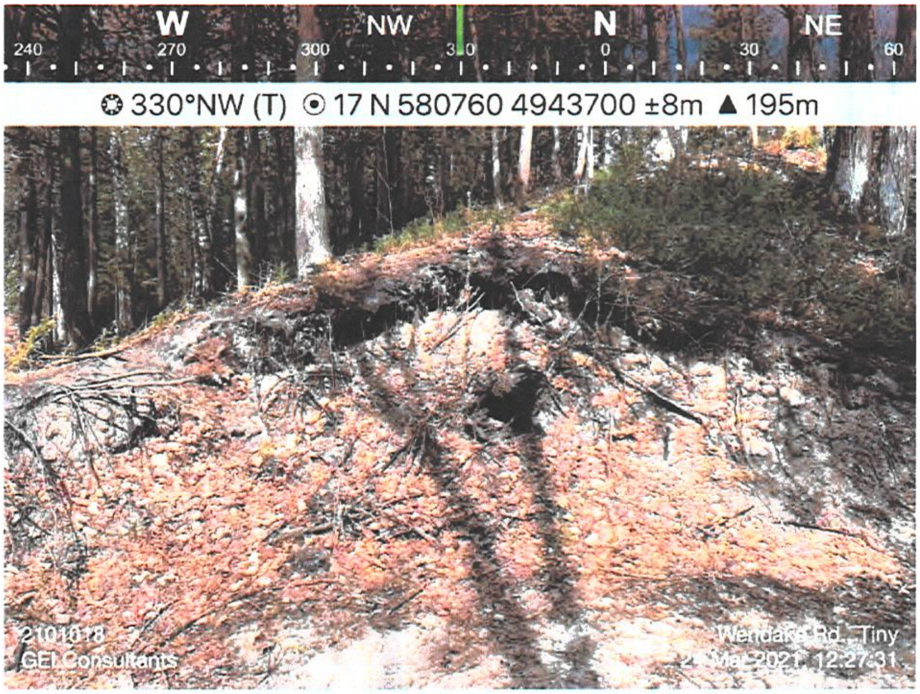
(GEI 2021)



PHOTOGRAPH 14

Description:
A view of the slope profile near the proposed dwelling on Lot 3.

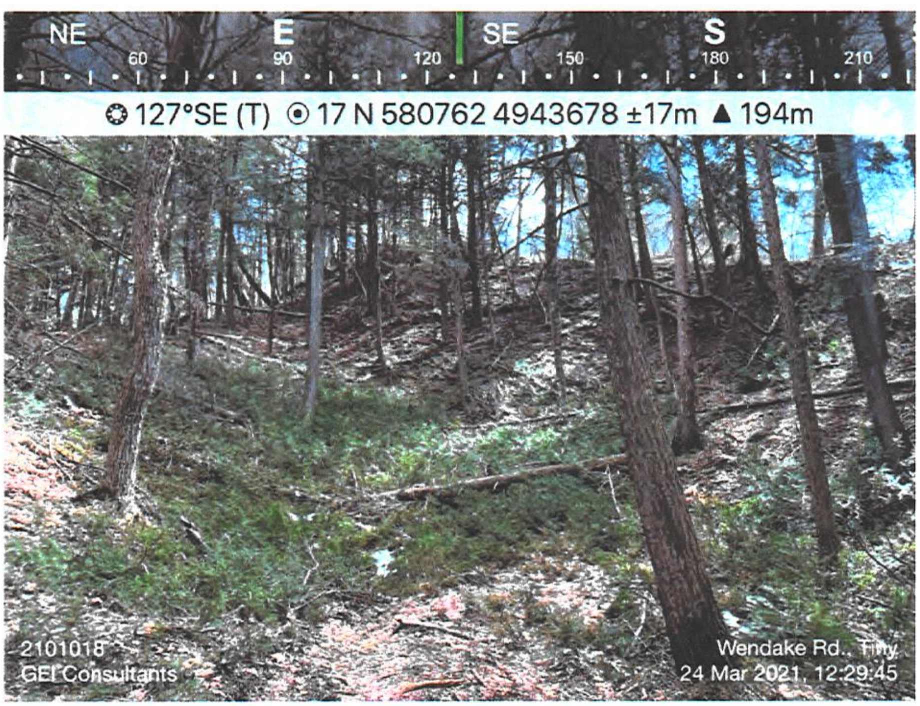
(GEI 2021)



PHOTOGRAPH 15

Description:
A view of the erosion scarp along the driveway / trail through the site. There are no proposed dwellings near the area.

(GEI 2021)



PHOTOGRAPH 16

Description:
A view of the dune slopes in the southern part of the site.

(GEI 2021)

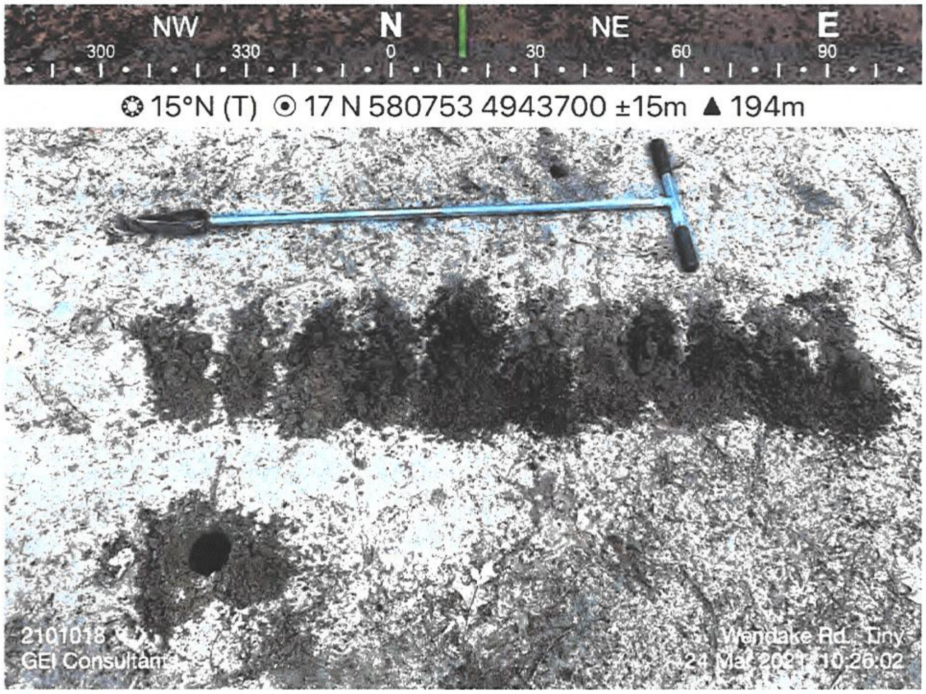
PHOTOGRAPH 17

Description:
A view of the profile for the dune slopes in the southern area of the site.

(GEI 2021)

ENCLOSURE 5

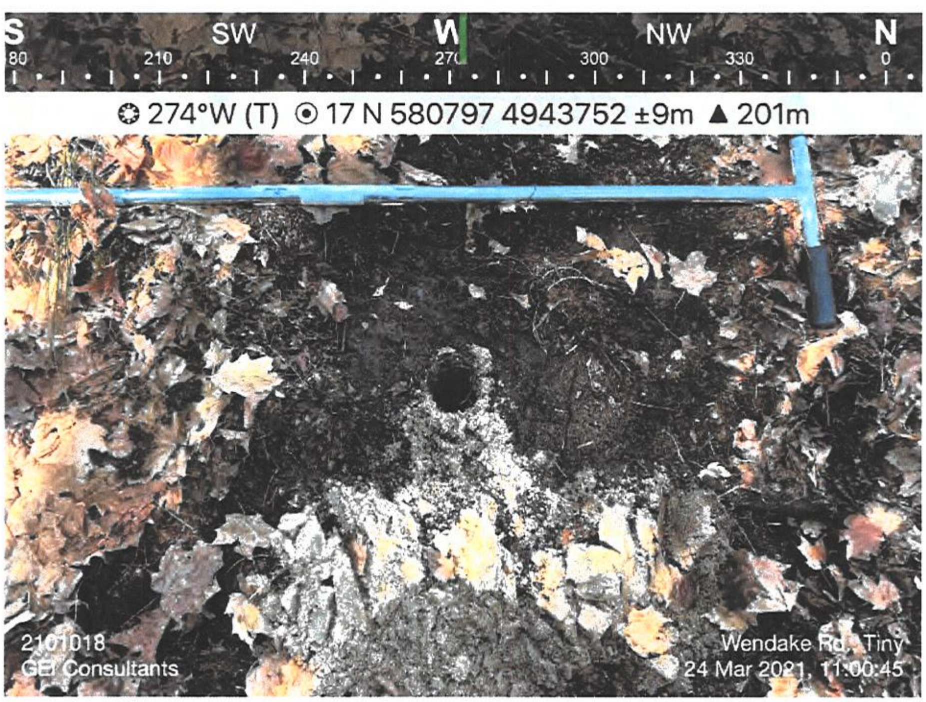
Sample Photographs of Hand Auger Soil Cuttings



Hand Auger Hole

Description:
The hand auger holes consistently encountered sands beneath the top, bottom and face of the dune slopes.

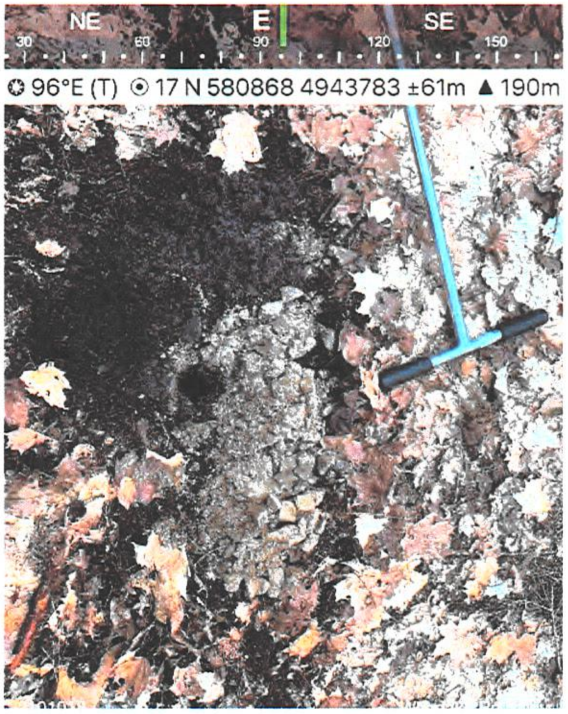
(GEI 2021)



Hand Auger Hole

Description:
The hand auger holes consistently encountered sands beneath the top, bottom and face of the dune slopes.

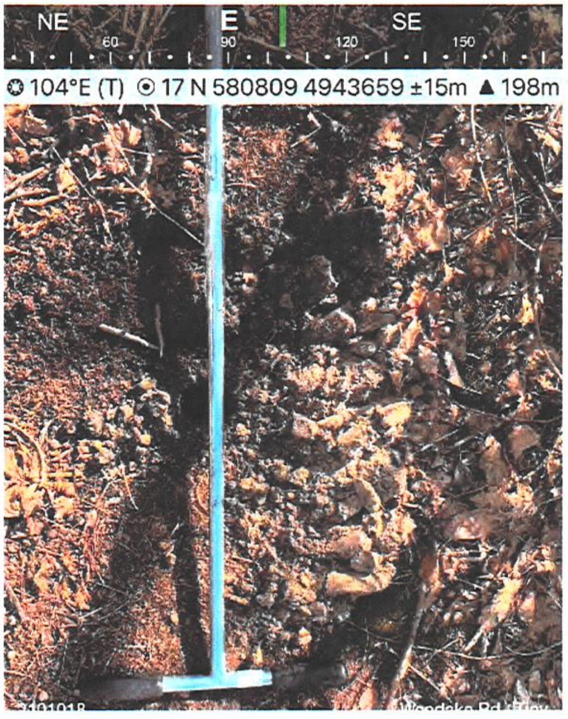
(GEI 2021)



Hand Auger Hole

Description:
The hand auger holes consistently encountered sands beneath the top, bottom and face of the dune slopes.

(GEI 2021)



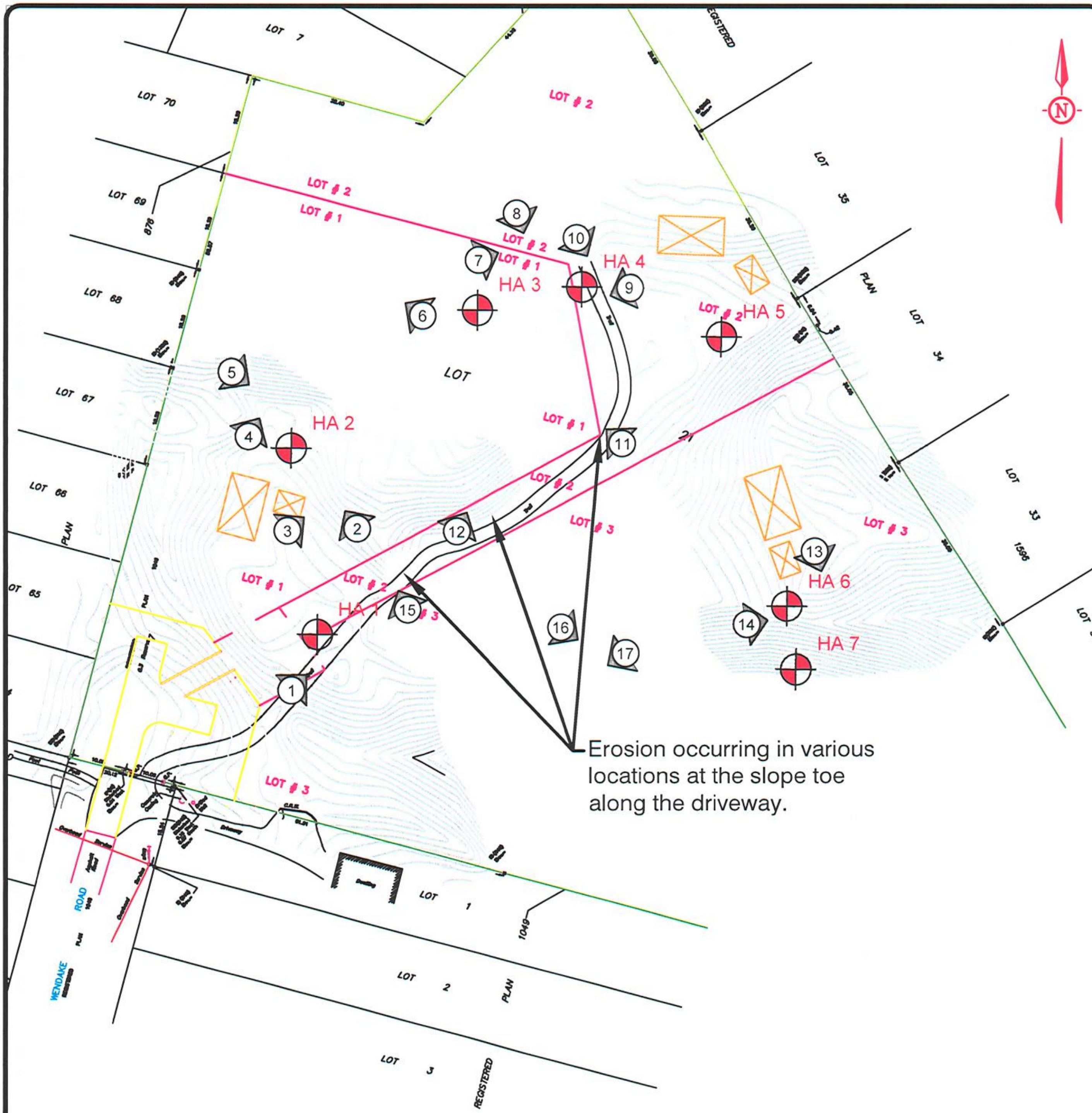
Hand Auger Hole

Description:
The hand auger holes consistently encountered sands beneath the top, bottom and face of the dune slopes.

(GEI 2021)

ENCLOSURE 6

Photograph and Site Features Location Plan



Legend:

Approx. Photo Location and Direction

Approx. Hand Auger Hole Location

Reference:

"Topographic Survey of Part of Lot 21, Concession 5, Township of Tiny, County of Simcoe," Project No. 132389, dated December 23, 2014, by Eplett Worobec Raikes Surveying Ltd.

GEI Consultants

647 Welham Rd, Unit 14, Barrie, ON L4N 0B7
P: (705) 719-7994

Project: Wendake Road, Tiny		
Title: Photograph and Site Features Location Plan		
Approved by: A.W.	Date: April 2021	Project No.: 2101018
Drawn by: R.W.	Scale: 1:1000	Figure No.: 1

GEI Consultants

June 6, 2022

Attn: Dawn Critchley

RE: Geotechnical Review of Updated Concept Plan
Wendake Road, Township of Tiny
Project No. 2101018

GEI Consultants (GEI) was retained to review an updated concept plan for the proposed residential development at the north end of Wendake Road as it relates to the recommendations provided in GEI's previous visual slope inspection letter report. GEI reviewed the following documentation as part of the current review:

- "*Concept Plan, Part of Lot 21, Concession 5, Township of Tiny, County of Simcoe*", dated May 10, 2022, by Celeste Phillips Planning Inc.
- "*Visual Slope Inspection for Proposed Residential Development, Wendake Road, Township of Tiny*", dated April 7, 2021, Project No. 2101018, by GEI Consultants.

The differences between the concept plan reviewed as part of the original slope inspection letter prepared by GEI and the most current concept plan are summarized as follows:

- Lot 1: Dwelling has been shifted north by approximately 8 metres. The dwelling was originally 15 metres away from the base of the slope and is now 7 metres away.
- Lot 2: Dwelling has been rotated slightly. The dwelling was originally 13 metres away from the base of the slope and is now 17 metres away.
- Lot 3: Dwelling has been moved to a completely new location on the property. The dwelling is now 15 metres away from the base of the slope.

Section 4.23.5 of the Township of Tiny Zoning By-Law 06-001 states the following:

> *"Notwithstanding any other provision in this By-law, no building or structure shall be located within 15.0 metres of the toe and top of a slope or embankment that exceeds 1 to 3. This provision shall also not prevent the expansion or replacement of buildings or structures that existed on the effective date of this By-law within this setback area, provided the expansion or replacement does not have the effect of reducing the setback from the slope or increasing the volume or floor area of a building or structure in the setback area."*

Based on the above Lots 2 and 3 are in conformance with the Township of Tiny Zoning By-Law by being a minimum of 15 metres away from the toe of a slope and are therefore acceptable in their currently proposed configuration.

Lot 1 is closer than the specified 15 metres away from the toe of a slope (currently 7 metres away from the toe of a slope). As per the visual slope inspection letter report dated April 7, 2021, GEI maintains the opinion that Lot 1 can be constructed less than 15 metres from the bottom of the dune slopes at the site with a negligible risk of being significantly impacted by slope instability (e.g. talus movement) in the long-term. The dune slopes are stable in their existing condition, and the risk of potential triggers causing instability over the long-term is considered low. It is recommended that at least a 5-metre setback between the proposed dwellings and slope toe be maintained for emergency access and future slope maintenance works, which is the case as Lot 1 is currently configured.

We trust this information is sufficient for your present purposes. Should you have any questions concerning the above, or can be of any further assistance, please do not hesitate to contact the undersigned.

Yours truly,
GEI Consultants

Alexander Winkelmann, P.Eng.
Geotechnical & Earth Sciences Manager

LICENSED PROFESSIONAL ENGINEER
A.WINKELMANN
100150146
June 6/22
PROVINCE OF ONTARIO

Russell Wiginton, P.Eng.
Senior Geotechnical Engineer

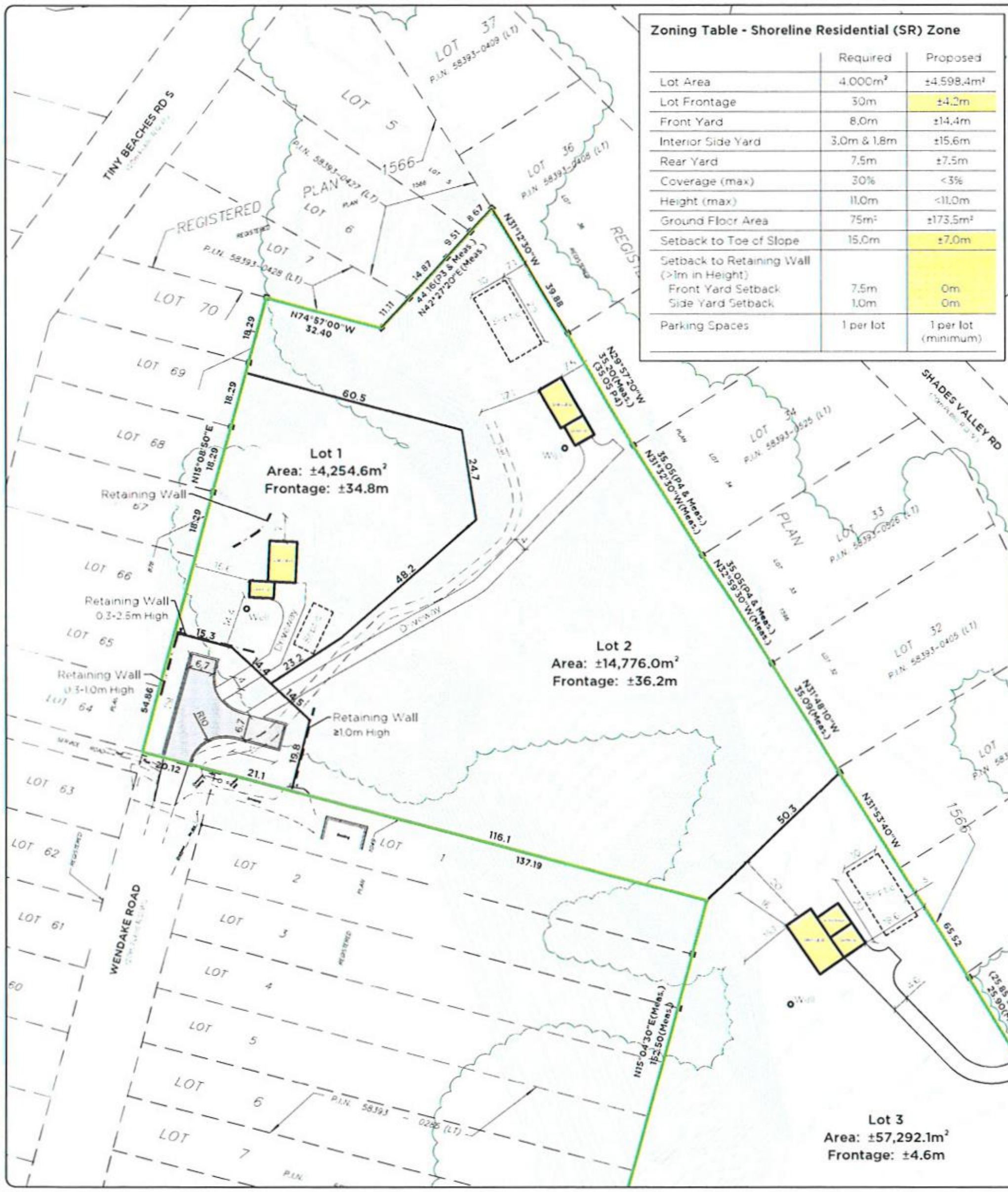
LICENSED PROFESSIONAL ENGINEER
R. M. WIGINTON
100193069
June 6/22
PROVINCE OF ONTARIO

Enclosures:

Enclosure 1 – Concept Plan (May 10, 2022)

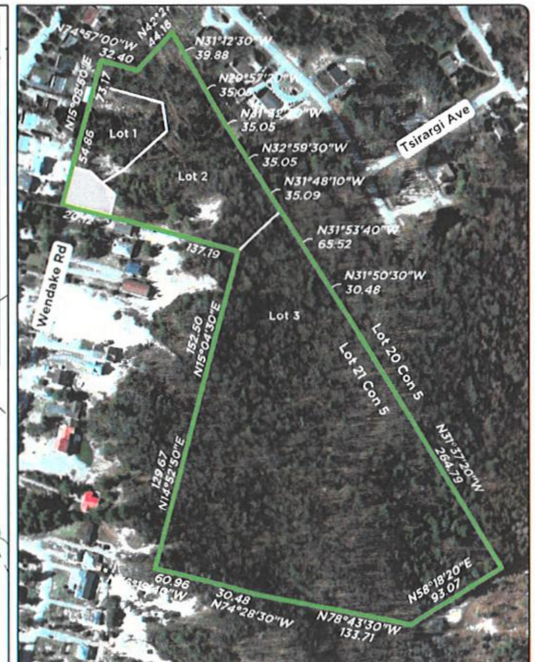
ENCLOSURE 1

Concept Plan (May 10, 2022)



Zoning Table - Shoreline Residential (SR) Zone

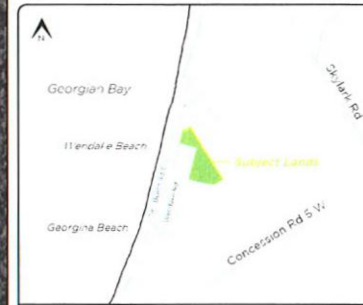
	Required	Proposed
Lot Area	4,000m²	±4,598.4m²
Lot Frontage	30m	±4.2m
Front Yard	8.0m	±14.4m
Interior Side Yard	3.0m & 1.8m	±15.6m
Rear Yard	7.5m	±7.5m
Coverage (max)	30%	<3%
Height (max)	11.0m	<11.0m
Ground Floor Area	75m²	±173.5m²
Setback to Toe of Slope	15.0m	±7.0m
Setback to Retaining Wall (>1m in Height)		
Front Yard Setback	7.5m	0m
Side Yard Setback	1.0m	0m
Parking Spaces	1 per lot	1 per lot (minimum)



Property Boundary
Scale 1: 4,000

CONCEPT PLAN

Part of Lot 21, Concession 5
Township of Tiny, County of Simcoe



Key Map 1: 40,000

LEGEND

- Subject Lands Lot Area: ±7.753ha (19.16ac)
- Proposed Lot Lines
- Proposed Dwellings
- Proposed Driveways
- Public Right-of-Way
- 0.5m Contours
- Wooded Area
- Existing Trail

Note: This drawing is for discussion purposes only.
Sources: Plan prepared by Eplett Worobec Raikes Surveying Ltd. dated July 2013. County of Simcoe interactive map. Concept Plan provided by others.

Scale 1:1,250

Drawn By: A.M.
Date: May 10, 2022

celeste PHILLIPS PLANNING INC.
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C: 705 730 8850
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